

Annexure - I

Semester I

Subject: Botany

Paper I: History and Development of Botany

Credits: 04 = Theory 02 (30 Hours) + Practical 02 (60 Hours)

Evaluation Scheme:

Total Marks: 100 = Theory: 50 Marks (40 UA + 10 CA) + Practical; 50 Marks (30 UA + 20 CA)

Unit I: (07 Hours)

1. Botany as a Science –

1.1. Introduction;

1.2. Definition and Etymology;

1.3. Importance of Botany;

1.4. Branches of Botany (Definitions only)

1.4.1. Basic Botany (Morphology, Anatomy, Phycology, Mycology, Lichenology Bryology, Pteridology, Palynology, Paleobotany, Anthology, Plant Physiology, Plant Taxonomy, Embryology, Phytochemistry, Biophysics)

1.4.2. Applied Botany (Ethnobotany, Plant Pathology, Plant Ecology, Phytogeography, Plant Genetics and Breeding, Agronomy, Economic Botany, Biotechnology, Molecular Biology, Horticulture, Forestry, Biostatistics, Nursery-Gardening-Landscaping, Food Science and Technology, Natural Resource Management).

1.5. Scientific Method to study Botany (Observations – Identifying Problem – Hypothesis Prediction - Experiment – Result Analysis – Report Publication);

1.6. Scope of Botany study (Research Scientists, Plant Pathologists, Plant Taxonomists, Plant Ecologists, Plant Geneticists and Breeder, Conservation Biologists, Environmental Educators, Pharmaceutical Botanists, Botanical Illustrators).

1.7. Plants and People (Co-evolution, Domestication, Exploration for plants, Green Revolution, Genetic Engineering, Sustainable Agriculture).

Unit II (8 Hours)

2. History and Development of Botany –

2.1. Prehistoric Era (Contribution of Charak, Sushrut, Atreya and Jivak);

2.2. 4th Century BC (Contribution of Aristotle and Theophrastus),

2.3. 1st Century BC (Contribution of Parashar),

2.4. 60 AD (Contribution of Pedanius Dioscorides),

2.5. 16th Century (Contribution of Otto Brunfels, Matthias de l'Obel, Leonhart Fuchs, Andrea Caesalpino and Gaspard Bauhin).

2.6. 17th Century (Contribution of Antonie Van Leeuwenhoek, Johannes Van Helmont, Robert Hooke, Nehemiah Grew, Marcello Malpighi, John Ray, and Rudolph Jacob Camerarius),

2.7. 18th Century (Contribution of Johann Hedwig, Carolus Van Linnaeus, Erik Acharius, Stephen Hales, Joseph Priestley),

2.8. 19th Century –

2.8.1. Contribution of Gregor Johann Mendel in understanding Inheritance,

2.8.2. Contribution of Robert Brown, Schwann-Schleiden-Virchow-Sachs,

2.8.3. Contribution of Heinrich Anton de Bary, F O Bower and C J Chamberlain,

2.8.4. Contribution of Ernst Haeckel in the field of Ecology,

2.8.5. Contribution of Mayer in discovering process of Photosynthesis,

2.8.6. Contribution of Adolphe Theodore Brongniart in the field of Paleobotany,

2.8.7. Contribution of Charles Darwin and Russel Wallace in the field of understanding Evolution,

2.8.8. Contribution of A P de Condolle, Stephen Endlicher, Bentham-Hooker in the field of Taxonomy.

Unit III: (7 Hours) –

3. History and Development of Botany in 20th Century

3.1. Contribution of Bessy, Rendle, Hutchinson, Takhtajan, Goldberg and Thorne in the field of Taxonomy.

3.2. Contribution of Van Neil, Robert Hill, Ruben-Kamen, Melvin Kelvin-Benson-Bassham, Arnon, Emerson, Hatch-Slack-Kortschak, C V Rama Das in discovering the process of Photosynthesis.

3.3. Contribution of Embden, Meyerhof, Parnas and Hans Krebs in discovering the process of Cellular Respiration.

3.4. Contribution of Sir J C Bose in the field of Botany.

Unit IV: (8 Hours) –

4. History and Development of Botany in 20th Century

4.1. Contribution of F E Fritsch in Phycology

4.2. Contribution of Sutton-Boveri, Hugo de Vries, Hugo de Vries-Carl Correns Erich Von Tschermak, Watson-Crick-Wilkins-Franklin, HarGovind Khorana in the field of Genetics and Molecular Biology.

4.3. Contribution of Gottlieb Haberlandt, Gautheret, F W Went, Skoog-Miller, Murashige –Skoog and P Maheshwari in the field of Plant Tissue culture.

4.4. Contribution of N Srampelli, N E Hansen, G H Shull, Nikolai Vavilov, V Symyrenko, N E Borlaug, P S Khankhoje, M S Swaminathan, D R Khobragade in the field of Plant Breeding.

Laboratory Exercises:

1. To study plan of typical Botany Laboratory.
2. To study basic instrumentation facilities in the Botany Laboratory.
3. To learn Laboratory Etiquette.
4. To prepare Fixing Agents and Preservatives used in the Botany Laboratory.
5. To prepare different stains used to stain plant materials.
6. To prepare mounting media for permanent slide preparation.
7. To learn technique for section cuttings.
8. To learn laboratory techniques like Maceration, Peeling, Smearing and Squash.
9. To learn techniques for specimen staining.
10. To learn techniques for stained specimen mounting.
11. To learn Micrometry.
12. To learn tools and techniques involved in the preparation and preservation of herbarium (Wet and Dry mount).

Suggested Readings:

1. Mauseth, J. D. (2014). *Botany: An Introduction to Plant Biology* (5th ed.). Jones & Bartlett Publishers.
2. Bold, H. C., Alexopoulos, C. J. and Delevoryas, T. (1980). *Morphology of Plants and Fungi* (Harper and Row Publishers, N.Y.).
3. Kumar, H. D. and Singh, H. N. (1982). *A text book of Algae* (Affiliate East-West Press, Pvt. Ltd., New Delhi).
4. Lee, R. E. (2018). *Phycology, Fifth Edition* (Cambridge University Press, Cambridge).
5. Raven, P. H., Johnson, G. B., Losos, J. B. and Singer, S. R. (2005). *Biology*. (Tata McGraw Hill, Delhi, India).
6. Krishnamurthy, K. V. (2015). *Growth and Development in Plants*. ISBN:9788172339340 (Scientific Publisher)
7. Sachs, J. V., Garnsey, H. E. F. and Balfour, I. B. (2010). *History of Botany, 1530-1860*. ISBN-10: 1164458809. ISBN-13: 978-1164458807 (Kessinger Publishing, USA).
8. Morton, A. G. (1997). *History of Botanical Science: An account of the Development of Botany from Ancient Times to the Present Day*. ISBN-10: 0125083823. ISBN-13: 978-0125083829 (Academic Press Inc.).
9. Greene, Edward Lee (2015). *Landmarks of Botanical History* (Palala Press).
10. Giesecke, A. and Mabberley, D. (2022). *A Cultural History of Plants* (Bloomsbury Academic, Volumes 1-6).
11. Pelczar, R. M., Pelczar, M. J. and Steere, W. C. (2023, November 28). *botany*. Encyclopedia Britannica. <https://www.britannica.com/science/botany>
12. Schader, Meg. (2021, September 30). *What Are Five Different Fields of Botany?*. sciencing.com. Retrieved from <https://sciencing.com/five-different-fields-botany-16728.html>

13. <https://biology.anu.edu.au/news-events/news/evolutionary-origin-higher-plants>

14. Bendre, A. and Kumar, A. (2018). A Textbook of Practical Botany, Volume II (Rastogi Publications, Meerut, India).

Gondwana University, Gadchiroli

Practical Examination Pattern

FY B. Sc. SEMESTER – I

Subject - Botany

Paper I: History and Development of Botany

Course Code: _____

Time: 06 Hours

Total Marks: 30

Question No. 01: 05 Marks = 03 Skill + 02 Expression

To take fine section (Transverse/Cross/ Radial or Tangential Longitudinal) of the given plant material.

Question No. 02: 05 Marks = 03 Skill + 02 Expression

To stain (counter/double) and mount section obtained in Q. No. 01 to prepare temporary/permanent slide.

Question No. 03: 05 Marks = 03 Skill + 02 Expression

To perform micrometry of the given specimen.

Question No. 05: To identify and comment on the given spots. 06 Marks

Spot A: Instruments and Equipments in the Laboratory

Spot B: Hand tools used in the laboratory

Spot C: Different stains used in the laboratory

Spot D: Different fixatives and preservatives used in the laboratory

Spot E: Different mounting media

Spot F: Herbarium preparation tool

Question No. 06: Practical Assignment/Field or Excursion Report Submission 02 Marks

Question No. 07: Duly certified Practical Record Submission 02 Marks

Question No. 08: Viva-Voce 05 Marks

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Theory Question Paper Pattern

FY B. Sc. SEMESTER – I

Subject - Botany

Paper I: History and Development of Botany

Course Code: _____

Time: 03 Hours

Total Marks: 40

Note: 1) All questions are compulsory and carry equal marks.

2) Draw well labeled diagram where ever necessary.

Question No. 1. (Based on Unit – I)

A) Long Answer

04 x 02 = 08 Marks

B) Long Answer

OR

A) Short Answer

02 x 04 = 08 Marks

B) Short Answer

C) Short Answer

D) Short Answer

Question No. 2. (Based on Unit – II)

A) Long Answer

04 x 02 = 08 Marks

B) Long Answer

OR

A) Short Answer

02 x 04 = 08 Marks

B) Short Answer

C) Short Answer

D) Short Answer

Question No. 3. (Based on Unit – III)

A) Long Answer

04 x 02 = 08 Marks

B) Long Answer

OR

A) Short Answer

02 x 04 = 08 Marks

B) Short Answer

C) Short Answer

D) Short Answer

Question No. 4. (Based on Unit – IV)

A) Long Answer

04 x 02 = 08 Marks

B) Long Answer

OR

A) Short Answer

02 x 04 = 08 Marks

B) Short Answer

C) Short Answer

D) Short Answer

Question 5. Write answers in one or two lines only (Any Eight)

1 x 8 = 08 Marks

(Diagram NOT expected)

- a) Unit – I
- b) Unit – I
- c) Unit – II
- d) Unit – II
- e) Unit – III
- f) Unit – III
- g) Unit – IV
- h) Unit – IV

Annexure – II

OPEN ELECTIVE

GROUP A

Semester I (Credits=2)

(For students having other than Botany as major)

Course Code: USBOTVSC01

Bamboo Cultivation

Laboratory Exercises:

60 Hours

1. To study taxonomic description (morphological characterization) of Bamboo sp.
2. To study anatomy of Bamboo culm and leaf.
3. To demonstrate the process of propagating bamboo saplings in the nursery.
4. To study the process of selecting bamboo varieties for cultivation.
5. To demonstrate field preparation for Bamboo cultivation.
6. To demonstrate the process of transplanting and maintaining the bamboo saplings in the field.
7. To study process of pruning and weeding in the bamboo crop.
8. To demonstrate the process of carrying out irrigation, nutrient management and intercropping in Bamboo crop.
9. To demonstrate the process of carrying out integrated pest and disease management for the Bamboo crop.
10. To demonstrate the process of carrying out harvesting, post-harvest processing and marketing activities.
11. To study Laboratory technique for in vitro propagation of Bamboo.
12. To explain the basic entrepreneurial activities for small enterprise.
13. To describe the process of undertaking employability and entrepreneurial practices.
14. To enlist Institutes related to Bamboo cultivation and processing training at Regional, National and International levels.

Suggested Readings:

- Gnanaharan, R. (1997) Technologies for Bamboo and Rattan. New Delhi, India.
- Trier, H. V. (2006). Bamboo for Survival. France: ActesSud; ActesSudEdition,France.
- Industrialization of the Bamboo Sector in India, a Report by India Development Foundation, November 2007.
- Gupta, A. et al. (2008). Potential of Bamboo in Sustainable Development, Asia-Pacific Business Review. Vol. IV, No.3, pp. 100-107. ISSN: 0973-2470.
- M. Shah, et al. (2016). A review on the tensile properties of bamboo fiber reinforced polymer composites. Bio Res. 11(4): 10654-10676.

- Raj, D.A. et al. (2014). Bamboo as a building material, journal of civil engineering and environmental technology print ISSN: 2349-8404; Online ISSN: 2349-879X; 1(3); August, 2014 pp. 56-61.
- Tripathi, Y.C. (2008). Bamboo Entrepreneurship-Opportunities for rural employment. Indian Forester. DOI: 10.36808/if/ 2008/v134i9/967.
- Pandey, C.N., Bamboo Based Composites: Material for Future, March 2019.
- Pramudi, G. et al. (2020). Utilization of Bamboo Fiber in the Development of Environmentally Friendly Composite - A Review, ICIMECE 2020.
- Raj, D.A. et al. (2014). Bamboo as a building material, journal of civil engineering and environmental technology print ISSN: 2349-8404; Online ISSN: 2349-879X; 1(3); August, 2014 pp. 56-61.
- Ray, A. K. et al. (2005). Bamboo - A functionally graded composite- correlation between microstructure and mechanical strength. Journal of Material Science. 40: 5249-5253.
- Rahman, et al. (2011), Performance Evaluation of Bamboo Reinforced Concrete Beam.
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OPEN ELECTIVE

GROUP B (Semester I)

Minor forest product processing

Theory- 50 & Practical 50

Total credits- 02

Unit-I

1. Introduction- Definition & Classification of MFP
2. Scope- Importance of MFP in rural & Tribal economy.
3. Cultivation & Harvesting- Challenges during harvesting of MFP, Sustainable harvesting methods

Unit- II

1. Edible plant products- Leafy vegetables, Roots, Fruits & Seed
2. Leaves- Plates & cup making, Thatching, Basket making.
3. Medicinal plants – Cultivation & sustainable harvesting practices of some potent medicinal plants

Unit-III

1. Bamboo - Cultivation & harvesting, Bamboo based products
2. Mushrooms- Cultivation practices of Oyster & Button mushroom, Mushroom based product & their packaging.
3. Mahua – Mahua based products & marketing

Unit-IV

1. Employability & Entrepreneurial practices
2. Value addition of MFP- Processing of Jam, Jelly, Fruit toffee, Pickle, Chutney etc.
3. Marketing of Minor Forest Produce- Mechanism & role of various bodies in promotion of MFPs.

FIELD EXERCISE

1. To visit nearby herbal drug production unit.
2. To visit nearby mushroom cultivation unit.
3. To visit nearby MFP market places.
4. To visit nearby forest area to identify important MFP yielding plants.
5. To interview local medicine man (Vaidu) for collection of information about medicinal plants.
6. To visit nearby leaves plates making unit.

Open Elective Course (OE)

(For Students having other than Botany as major)

Organic Farming

Unit 1

Organic Farming: Introduction and Theory, History of organic farming, Development of organic farm, need of organic farming, Advantages and disadvantages of organic farming, Converting soil to organic soil, create good growing conditions, Soil Compaction, Types of soil cultivation.

Unit 2

Basic concepts of cropping pattern, Crop Planning and Management, Crop Rotation, Intercropping.

Green manuring: Types, advantages, disadvantages, Biofertilizers: Type, application, benefits, Azolla and BGA culture and its application.

Mulching: Definition, Usage, application of mulch.

Unit 3

Nutrient and water management in organic production, weed management in organic production and Pest management in organic production.

Plant Propagation, Criteria for Seed Evaluation, Characterization and multiplication of seed, importance of traditional varieties of seeds & its conservation and seed bank for organic farming.

Unit 4

Standards for organic food and marketing, organic certification requirement & procedure and advantages of organic certification.

Practical

- 1) Soil sampling and determination of soil Ph.
- 2) Determination of water holding capacity of soil, soil moisture content.
- 3) Nursery and seed bed preparation.
- 4) Bio-fertilizer Preparation.

- 5) Study the preparation of green manure.
- 6) Farm Yard Manure (FYM) and compost preparation.
- 7) Types of Mulching.
- 8) Identification of different types of insecticides, fungicides and herbicides.
- 9) Seed treatment with fungicide and bio-fertilizer.
- 10) Cost benefit analysis of organic farming.
- 11) Seed certification procedure.
- 12) Visit the field of any crop and compare healthy plants with diseased and pest affected plants.

Suggested Reading Books

- 1) Principles of Organic Farming by S. R. Reddy (2017), Publisher – Kalyani Publishers, New Delhi.
- 2) Basics of Organic Farming by Mamta Bansal (2017), Publisher – CBS Publishers & Distributors.
- 3) Principles of Organic Farming: Textbook by P. L. Maliwal (2019), Publisher – Scientific Publishers.
- 4) Organic Farming (Theory and Practices) by S. P. Palaniappan and Annadurai, Publisher – Scientific Publishers.
- 5) Principles of Agronomy by S. R. Reddy (2005), Publisher – Kalyani Publishers, New Delhi.
- 6) Textbook of Organic Farming by Amit Kumar Singh and Vinod Singh (2023), Publisher – Astral International Pvt. Ltd.
- 7) Principles of Crop Production by S. R. Reddy (2014), Publisher – Kalyani Publishers, New Delhi.
- 8) Soil and Orchard Management by A. Sharma & N. P. Singh (2011), Publishers – Daya Publishing House, New Delhi.
- 9) Seed Technology by R. L. Agarwal (2018), Publisher – Oxford and IBH Publishing.
- 10) Fertilizers: A Textbook by Basak Ranjan Kumar (2016), Publisher – Kalyani Publishers, New Delhi.
- 11) Training Manual for Organic Agriculture, chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.fao.org/fileadmin/templates/nr/sustainability_pathways/docs/Compilation_techniques_organic_agriculture_rev.pdf
- 12) Handbook of Microbial Biofertilizers by M. K. Rai (2006), Publisher – Food Products Press, chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.k-state.edu/fungi/Greeting/Publications_files/2006%20Handbook.pdf
- 13) Practical Manual on Fundamentals to Soil Science chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://coabhatapara.ac.in/downloads/PRACTICAL_MANUAL_ON_FUNDAMENTALS_TO_SOIL_SCIENCE.pdf
- 14) chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.apeda.gov.in/apedawebsite/organic/organic_contents/english_organic_sept05.pdf

15) Modern Nursery Techniques A Manual, chrome-extension://efaidnbnmnnibpcajpcglclefindmkaj/https://hindi.icfre.gov.in/UserFiles/File/Books/Nursery%20Technology.pdf

Tendu Cultivation

Unit I: **06 Hours**

Introduction – Botanical description, Nutritive value, Uses, Origin and distribution, Area or region of cultivation or availability, Genus and different species, Cytogenetics.

Unit II: **07 Hours**

Domestication, Climate and soil, Propagation and Root stock, Varieties and crop improvement, Inheritance pattern, Problem in Breeding, Floral Biology.

Unit III: **10 Hours**

Cultivation – Raising of Seedlings through seeds, Soft wood grafting, Wedge grafting, Veneer grafting, Air layering, Planting, Training and Pruning, Orchard Management; Irrigation, Mulching, Intercropping, Nutrient application, Water Management, Disease and Pest management, Yield.

Unit IV: **07 Hours**

Harvesting and Post Harvest management, Value addition-Food, Fodder, Fuel, Timber, Medicine, Marketing, Future Research thrust. **(02 Credits = 30 Hours)**

Suggested Readings:

- Kumar, S., Lal, N. and Nath, V. (2017) Tendu (*Diospyros melanoxylon* Roxb.) In: Underutilized Fruit Crops: Importance and Cultivation Part II. Edⁿ. II Ghosh, S. N., Singh. A., Thakur, A. pp. 12.
- Anonymous, 2004. Annual Progress Report -2004, NAIP on Plant Biodiversity HARP, Ranchi.
- Arora, R.K. and Pandey, a. 1996. Wild edible plant of India : diversity, conservation and use, NBPGR, New Delhi. pp. 1-294.
- Arora, R.K. and Pandey, A. 1996. Wild edible plants of India: Diversity, conservation and use, NBPGR, New Delhi. 1-294.
- Daood, H.C.; Bicas, P.; Czinkotai, B. and Hoschke, A. 1992. Food Chemistry, 45: 151-155.
- Gill, B.S., Singhal, V.K., Bedi, Y.S. and Bir, S.S. 1990. Cytological evolution in the woody taxa of Pachmarhi hills. Journal of Cytology and Genetics, 25: 308-320.
- Gupta, T. and Guleria, A. 1982. Non wood forest products in India, New Delhi, India: Oxford and IBH Co.
- Ito, S. 1980. In: tropical and sub-tropical fruits-Composition, properties and used. (Eds S. Nagy and PE. Saw). AVI Publishing, Inconnecticut, USA pp. 442-468.
- Jadhav J. K.Masirkar V. J., Deshmukh V. N. 2009. Antihyperglycemic effect of *Diospyros melanoxylon* (Roxb.) bark against Alloxan-induced diabetic rats. International urnal of PharmTech Research CODEN(USA);,Vol.1, No.2, pp 196-200 ,
- Kitagawa, H. and Glucina, P.G. 1984. Persimmon cultivation in New Zealand. Science Information Publishing Centre, Wellington pp. 1-74.
- Kotobuki, K. 1978. Seed storage of Japanese persimmon, *Diospyros kaki*. In Long term preservation of favourable germplasm in arboreal crops, pp. 36-42, Ibaraki-ken, Japan.
- Lal, Pranay. 2009. "Bidi – A short history". Current Science, 96 (10): 1335–1337. Retrieved 5 May June 2013.
- Lalitha, K.G., Senthuram, M.G. and Raj Kapoor, B. 2002 Indian drugs, Analgesic activity of *Sarcostemma brevistigma*. Bombay: Indian Drug Manufacture's Association, 39(10): 541-542.
- Maridass, M. 2010. Survey of phytochemical diversity of secondary metabolism in selected wild medicinal plants. Ethn. Bot. Leaflets. 14:615-625.
- Nath, V., Pandey, V., Pandey, D. Pandey and Kumar, D. 2009. Fruits for the future Vol. 2: 196
- Troup, R. 1921. Silviculture of Indian Trees. Clarendon Press, Oxford, UK.
- Umesh C. Sahu, Sandeep K. Panda, Uma B. Mohapatra and Ramesh C. Ray. 2012. Preparation and evaluation of wine from tendu (*Diospyros melanoxylon* L.) fruits with antioxidants, Intl. J. of Food. Ferment. Technol., 2(2): 167-178.

- Wallnofer, B. 2001. The biology and systematics of Ebenaceae: a review. Ann. Naturhist. Mus. Wien, 103: 485–512.
- Zeven, A.C. and Zhukosky, P.M. 1975. Dictionary of cultivated plants and their centres of diversity. CAPD, Wageningen. 1-219.

VSC-ADVANCED PRACTICAL BASED ON CORE GROUP SUBJECT-I

Annexure IX

Gardening and Landscaping

Unit I:

Introduction to Landscape and Elements in Landscaping:

Landscape Designing, Elements of Landscape: Hardscaping Lighting Design Streetscaping, Aqua scaping Irrigation, Vertical walls.

Unit 2:

Designing of a Garden:

Garden Designs, Indoor Gardening, Specialized Gardens.

Unit 3:

Gardening:

Definition, objectives and scope - different types of gardening - landscape and home gardening - parks and its components - plant materials and design - computer applications in landscaping - Gardening operations: soil laying, manuring, watering, management of pests and diseases and harvesting.

Unit 4:

Landscape softwares, Case studies and Budgeting:

CAD Software,

Case studies,

Budget and estimation (Hardscaping and soft scaping).

Suggested Laboratory:

1. Identification of Physical Elements in Landscape (Hardscape).
2. Identification of plants- ground cover plants and bulbous plants, hedge and edge, pergolas, arches, Palms , foliage and flowering Shrubs , foliage and flowering, climbers and ramblers, Lawn grasses and Plantation of lawn.
3. Identification of Garden tools and Implements.
4. Landscape designing of Residential area and Public Garden.
5. Designing of Water garden (Lotus and Water Lilies), Rock Garden.
6. Estimate of given garden design- BOQ preparation.
7. Designing of Tray Landscape.
8. Designing of Terrarium.
9. Reading of CAD Drawings.

10. Case study based on landscape design.
11. Field notebook comprising reports of all field visits.

Suggested Readings:

1. Bose T.K. & Mukherjee, D., 1972, Gardening in India, Oxford & IBH Publishing Co., New Delhi.
2. Sandhu, M.K., 1989, Plant Propagation, Wile Eastern Ltd., Bangalore, Madras.
3. Kumar, N., 1997, Introduction to Horticulture, Rajalakshmi Publications, Nagercoil.
4. Edmond Musser & Andres, Fundamentals of Horticulture, McGraw Hill Book Co., New Delhi.
5. Agrawal, P.K. 1993, Hand Book of Seed Technology, Dept. of Agriculture and Cooperation, National –Seed Corporation Ltd., New Delhi.
6. Janick Jules. 1979. Horticultural Science. (3rd Ed.), W.H. Freeman and Co., San Francisco, USA.

iii) Mushroom Cultivation Credit: 2 (30 hours)

1. Introduction, Nutritional and medicinal value of edible mushrooms; Poisonous mushrooms. Types of edible mushrooms available in India - Volvariellavolvacea, Pleurotuscitrinopileatus, Agaricusbisporus.

2. Cultivation methods: Infrastructure:- substrates (locally available) Polythene bag, vessels, Inoculation hook, inoculation loop, low cost stove, sieves, culture rack, mushroom unit (Thatched house) water sprayer, tray, small polythene bag. Pure culture: Medium, sterilization, preparation of spawn, multiplication.

Mushroom bed preparation - paddy straw, sugarcane trash, maize straw, banana leaves. Factors affecting the mushroom bed preparation.

3. Storage and nutrition: Short-term storage (Refrigeration - upto 24 hours), Long term Storage (canning, pickles, papads), drying, storage in salt solutions. Nutrition condition of mushrooms:- Carbohydrates, Crude fibre content, amino acids, Proteins, mineral elements and Vitamins.

4. Food preparation: Delicacies of mushroom and its value addition, Research Centres - National level and Regional level. Cost benefit ratio - Marketing in India and abroad, Export Value.

Suggested readings

Bahl, N. (2000). Hand book of Mushrooms. Oxford &Ibh Publishing Co. Pvt Ltd.

Marimuthu, T. Krishnamoorthy, A.S. Sivaprakasam, K. and Jayarajan. R. (1991): Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.

Swaminathan, M. (1990).Food and Nutrition.Bappco, The Bangalore Printing and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore - 560018.

Tewari, P. and Kapoor, S.C. (1988). Mushroom cultivation, Mittal Publications, Delhi.

Semester II

Subject: Botany

Paper II – Botany in 21st Century

Credits: 04 = Theory 02 (30 Hours + Practical 02 (60 Hours)

Evaluation Scheme:

Total Marks: 100 = Theory: 50 Marks (40 UA + 10 CA) + Practical; 50 Marks (30 UA + 20 CA)

Unit I: (07 Hours)

1. Botany in 21st Century

1.1. Plant Breeding (Conventional and Modern)

1.1.1. Definition and Concept;

1.1.2. Methods in brief (Selection, Hybridization, Mutation, Genomic Selection, Marker Assisted Selection, High Throughput Phenotyping);

1.1.3. Examples of Improved crop varieties (Rice, Wheat, Sorghum, Maize)

1.2. Plant Tissue Culture

1.2.1. Definition and Concept;

1.2.2. Scope and applications of Micropropagation, Disease free plant production, Somatic Hybrids, Secondary metabolite production and Germplasm Conservation.

1.3. Epigenomics

1.3.1. Definition and Concept;

1.3.2. Principle and Applications in Plant Sciences (Gene regulation and Parental Imprinting).

1.4. Biofertilizers

1.4.1. Definition and Concept;

1.4.2. Use of Botanicals (Algae, Moss and Ferns) as Biofertilizers.

1.5. Bioindicators

1.5.1. Definition and Concept;

1.5.2. Examples of Plant species/Groups/Communities being used as Ecological indicators for monitoring ores/minerals resources, Pollution and Climate change.

Unit II: (08 Hours)

2. Botany in 21st Century

2.1. Molecular Biology, Recombinant DNA Technology and Genetic Engineering

2.1.1. Definition and Concept;

2.1.2. Examples of Genetically modified crops (Flavr-Savr Tomato, Bt Cotton, Golden Rice, RoundUp Soybean, Moondust Carnation, Edible Vaccines, Biodegradable Plastic)

2.2. Bioinformatics

2.2.1. Definition and Concept;

2.2.2. Approaches and applications in Plant Science (Plant Genomics, Proteomics, Transcriptomics, Metabolomics, DNA Barcoding).

2.3. Biosensors

2.3.1. Definition and Concept;

2.3.2. Examples of Enzyme based Biosensors (Polyphenol Oxidase, Peroxidase, Acid Phosphatase, Urease, Oxalate Oxidase, Ascorbic Oxidase, Pyruvate Decarboxylase, Diamine Oxidase, Pectinesterase, Sulfite Oxidase, Asparaginase) and Mushroom Tissues as biocatalyst.

2.4. Biomimicry

2.4.1. Definition and Concept;

2.4.2. Examples of plants/plant systems used for Biomimicry (Diatoms and Aquaporins-Water Desalination and Filtration, Lotus leaf-Hydrophobicity, Pax Lily-Spiral flows, Bur seeds-Velcro, Pitcher Plant-Substance Repellent Container Coating, Xylem Tissue-Cost Effective Filtration System, Underwater Plants-Renewable Energy Solution, Sycamore Seed Pod-Elegant and Efficient Ceiling Fan, Evapotranspiration-Safe, waterless Toilets, Photosynthesis-Chemical Reactions using Light, Algae-Biodegradable shoes, Slime Mold-City Planning, Fungi-Land Restoration and Toxic waste cleaning, Fungi-Green Building Material, Coral organisms-Innovative Carbon Sequestering, Forest-Chemical free Water Filtration System, Mangroves-Living Seawall, Nature-Circular Economy

Unit III: (08 Hours)

3. Botany in 21st Century –

3.1. Remote (Satellite or Airplane) Sensing in Botany

3.1.1. Definition and Concept;

3.1.2. Applications (Wetland Mapping, Biodiversity Mapping, Forest Monitoring, Phenology Study, Vegetation and Crop Health Assessment, Invasive Species Detection,

Climate Change Research, Conservation Efforts);

3.2. Four Dimensional Imaging in Plant Science

3.2.1. Definition and Concept;

3.2.2. Applications (Analysis of Cell/Tissue/Organ dynamics, Plant Architecture-Phenotyping, Quantification of Morphogenesis, Bioprinting).

3.3. Virtual/Digital Herbarium

3.3.1. Definition and Concept;

3.3.2. Tools, Techniques and Importance.

Unit III: (07 Hours)

4. Botany in 21st Century –

4.1. Advanced Phyto chemistry and Herbal Technology

4.1.1. Definition and Concept;

4.1.2. Scope and Applications (Authentication, Extraction, Separation, Purification, Identification of Phytochemicals).

4.2. Environmental DNA (eDNA)

4.2.1. Definition and Concept

4.2.2. Scope and Applications in Botanical Research.

4.3 Angiosperm Phylogeny Groups

4.3.1. Definition and Concept;

4.3.2. Principles and Applications

Laboratory Exercises:

1. To get acquainted with Plant Breeder's Kit.
2. To list out varieties of major crops cultivated in the region and trace their parental cultivars.
3. To study flower structure of self pollinated and cross pollinated crops.
4. To demonstrate Emasculation and Hybridization techniques in self-pollinated plant.
5. To study basic instrumentation facilities in the Plant Tissue Culture Laboratory.
6. To list out commercially growing tissue culture plants in India and abroad.
7. To learn Epigenomics through DNA modification and Histone Code charts/PPT/Video lectures.
8. To learn BGA biofertilizer production.
9. To learn production of Azollabiofertilizer.
10. To study Instruments and Equipments in Genetic Engineering Laboratory.
11. To visit Bioinformatics websites (NCBI, EMBL and DDBJ) and learn their use.
12. To visit Angiosperm Phylogeny Website (<http://www.mobot.org/MOBOT/Research/APweb>, Tree of Life <http://tolweb.org/tree> Tree Base <http://www.treebase/index.html>) and learn their applications.
13. To prepare Phylogenetic Tree using morphological characters of plant species/groups.
14. To demonstrate Peroxidase activity using plant tissues.
15. To demonstrate Catalase activity using plant tissues.
16. To demonstrate application of Remote Sensing Technology for Vegetation mapping using chart/PPT/Video.
17. To demonstrate application of 4-D imaging Technology in Plant Science using chart/PPT/Video.
18. To conduct virtual tour to Herbarium of Botanical Survey of India (<https://bsi.gov.in/page/en/virtual-herbarium>) and explore Digital Herbarium.
19. To prepare Digital Collection of the locally available plant species.
20. To list out phytochemicals (active principles) from the routinely used plants/plant products and draw their structures.
21. To demonstrate extraction of Curcumin from Turmeric Rhizome using Soxhlet apparatus.

Suggested Readings:

1. Knauft, D. A. Laboratory suggestions for introductory plant breeding courses. University of Florida. Dept. of Agronomy Journal Series No. 3112.
2. Fehr, W. R. and Hadley, H. H. (1981) Hybridization of crop plants. American Society of Agronomy, Madison, Wis.
3. Hawk, J. H. and Crowder, L. V. (1978) *Brassica campestris* L., a higher plant with potential for teaching genetics. *J. Hered.* 69:121-124.
4. Marx, G. A. (1974) A scheme for demonstrating some classical genetic principles in the classroom. *J. Hered.* 65:252-254.
5. Yadav, A. N. (2021) Production Technology for Bioagents and Biofertilizers – A Laboratory Manual. Eternal University, Sirmour, HP.
6. Karthikeyan B. and Sivasakthivelan P. Biofertilizer Technology. Dept of Agricultural Microbiology, Annamalai University.
7. Singh, A. K. and Verma N. (2019) Plant and plant-derived materials used for Biosensor Development. *Industrial Biotechnology*.
8. Rincón, M.G.; Mendez, D.; Colorado, J.D. Four-Dimensional Plant Phenotyping Model Integrating Low-Density LiDAR Data and Multispectral Images. *Remote Sens.* 2022, 14, 356. <https://doi.org/10.3390/rs14020356>.
9. Bassel, G. W. and Smith, R. S. (2016) Quantifying morphogenesis in plants in 4D. *Current Opinion in Plant Biology*, 29:87-94.
10. Domozych, D. S. (2012) The quest for Four-Dimensional imaging in plant cell biology: it's Just a matter of time. *Annals of Botany*, 110:461-474.
11. Roth-Nebelsick A. and Krause M. (2023) The Plant Leaf: A Biomimetic Resource for Multifunctional and Economic Design. *Biomimetics*, 8(2):145 <https://doi.org/10.3390/biomimetics8020145>
12. Barthlott, W., Mail, M., Bhushan B. and Koch, K. (2017) Plant Surfaces: Structures and Functions for Biomimetic Innovations.
13. Cozea, A., Manea, G. C., Bucur, E. and Catrina, G. A. (2020) Sensitive bioindicator plants studies, under the environmental conditions of Climate Change impact. *Sciendo* ISSN2558-9652.
14. Holt, E. A. and Miller, S. W. (2010) Bioindicators: using Organisms to Measure Environmental Impacts. *Nature Education Knowledge* 3(10):8.
15. Manning, W. J. (1998) The use of plants as bioindicators of ozone, In: Proceeding of the International Symposium on air pollution and climate change effects on forest ecosystems. *Gen. Tech. Rep.:* 19-26.
16. Ducerf, G. (2003) Encyclopedia of Bio-indicating Plants, Volume-3.
17. Smith, P. L. (2013) Indicator Plants (Colour): using Plants to Evaluate the Environment, ISBN: 9781904098355 (WildtrackPublishing).
18. Johnson, M. D., Freeland, J. R., Parducci, L., Evans, D. M., Meyer, R. S., Molano-Flores, B. and Davis, M. A. (2023) Environmental DNA as an emerging tool in botanical research. *American Journal of Botany* 110(2): e16120. <https://doi.org/10.1002/ajb2.16120>
19. Swarup S, Cargill EJ, Crosby K, Flagel L, Kniskern J, Glenn KC. Genetic diversity is indispensable for plant breeding to improve crops. *Crop Science.* 2021;61:839–852. <https://doi.org/10.1002/csc2.20377>
20. <https://modis.ornl.gov/exercises.html>

21. Cushman, K.C., Albert, L.P., Norby, R.J. and Saatchi, S. (2023), Innovations in plant science from integrative remote sensing research: an introduction to a Virtual Issue. *New Phytol*, 240: 1707-1711. <https://doi.org/10.1111/nph.19237>
22. Beniwal J., Dhundwal A., Goyal A., Kumari A., Behl RK., Munjal R., 2023. Accelerating Crop Breeding in the 21st Century: A Comprehensive Review of Next Generation Phenotyping Techniques and Strategies. *Ekin J.* 9(2):160-171.
23. Ricroch A, Chopra S, Fleischer SJ. 2014. *Plant biotechnology: Experience and future prospects.* Springer, Switzerland.
24. <https://ebooks.inflibnet.ac.in/esp06/chapter/application-of-remote-sensing-for-vegetation-mapping/#:~:text=Vegetation%20mapping%20based%20on%20Indices%3A&text=Like%20other%20earth's%20surface%20features,vegetation%20among%20the%20other%20features.>

Practical Examination Pattern

FY B. Sc. SEMESTER – II

Subject - Botany

Paper I: Botany in 21st Century

Course Code: _____

Time: 06 Hours

Total Marks: 30

Question No. 01: Based on Unit I

05 Marks = 03 Skill + 02 Expression

To demonstrate Emasculation and Hybridization techniques in given Plant species.

OR

To identify Gene expression Regulation from DNA modification and Histone Code chart.

Question No. 02: Based on Unit II

05 Marks = 03 Skill + 02 Expression

To identify Gene source, Vector and Method of gene Transfer in given Transgenic Plant.

OR

To demonstrate the use of Bioinformatics website for retrieving given information.

OR

To prepare Phylogenetic Tree using morphological characters of given plant species/groups.

OR

To demonstrate Peroxidase/Catalase activity using plant tissues.

Question No. 03: Based on Unit III

05 Marks = 03 Skill + 02 Expression

To demonstrate extraction of Curcumin from Turmeric Rhizome using Soxhlet apparatus.

OR

To retrieve digital herbarium of the given species using Virtual Herbarium Website.

Question No. 05: To identify and comment on the given spots.	06 Marks
Spot A: Based on Unit I	
Spot B: Based on Unit I	
Spot C: Based on Unit II	
Spot D: Based on Unit II	
Spot E: Based on Unit III	
Spot F: Based on Unit III	
Question No. 06: Practical Assignment/Field or Excursion Report Submission	02 Marks
Question No. 07: Duly certified Practical Record Submission	02 Marks
Question No. 08: Viva-Voce	05 Marks

Theory Question Paper Pattern

FY B. Sc. SEMESTER – I

Subject - Botany

Paper II: Botany in 21st Century

Course Code: _____

Time: 03 Hours

Total Marks: 40

Note: 1) All questions are compulsory and carry equal marks.

2) Draw well labeled diagram where ever necessary.

Question No. 1. (Based on Unit – I)

A) Long Answer 04 x 02 = 08 Marks

B) Long Answer

OR

a) Short Answer 02 x 04 = 08 Marks

b) Short Answer

c) Short Answer

d) Short Answer

Question No. 2. (Based on Unit – II)

A) Long Answer 04 x 02 = 08 Marks

B) Long Answer

OR

a) Short Answer 02 x 04 = 08 Marks

b) Short Answer

c) Short Answer

d) Short Answer

Question No. 3. (Based on Unit – III)

A) Long Answer

04 x 02 = 08 Marks

B) Long Answer

OR

a) Short Answer

02 x 04 = 08 Marks

b) Short Answer

c) Short Answer

d) Short Answer

Question No. 4. (Based on Unit – IV)

A) Long Answer

04 x 02 = 08 Marks

B) Long Answer

OR

a) Short Answer

02 x 04 = 08 Marks

b) Short Answer

c) Short Answer

d) Short Answer

Question 5. Write answers in one or two lines only (Any Eight)

1 x 8 = 08 Marks

(Diagram NOT expected)

a) Unit – I

b) Unit – I

c) Unit – II

d) Unit – II

e) Unit – III

f) Unit – III

g) Unit – IV

h) Unit – IV

Open Elective Course (OE)

Group - A

(For students having other than Botany as major)

Greenhouse Technology

Unit I: 06 Hours

Overview on Controlled Environment Agriculture - Definition, concept, and history. Characteristics of controlled environment plant production. Current status and trends in Greenhouse industry.

Unit II: 07 Hours

Environmental Modifications - Greenhouse structure and construction, Greenhouse cover materials, Bench construction and space utilization, Greenhouse heating, cooling, and ventilation, Lights and lighting, Carbon dioxide enrichment.

Unit III: 10 Hours

Greenhouse Production Technology – Growing media, Greenhouse irrigation methods, Plant nutrients and fertilization, Chemical growth regulation, Insect and disease control, Hydroponics and substrate.

Unit IV: 07 Hours

Business and Marketing - Labor and production management, Production costs, price determination, Accounting and record keeping, Market channels for Greenhouse grown crops.(02 Credits = 30 Hours)

Suggested Readings:

- Arora, J.S. (1990). Introductory Ornamental Horticulture. Kalyani Publishers.
- Pant V, Nelson. 1991. Green House Operation and Management .Bali Publ.
- Pradeepkumar T, Suma B, Jyothibhaskar & Satheesan KN. 2007. Management of Horticultural Crops. Parts I, II by New India Publications.
- George Acquah. Horticulture, Principles and Practices .Eastern Economy Edition.
- Iyengar Gopalswamy. Complete Gardening in India.
- Alex Lauric and Victor h Ries. Floriculture, Fundamentals and Practices, Agrobios, India.
- Ramachandrappa and Nanjappa. Fertigation Technology, Agrobios, India.
- Prasad, S. and Kumar, U. Green House Management for Horticultural Crops. Agrobios India.
- Biswas, T. D. and Mukherjee, S. K. Text Book of Soil Science by, Tata McGrawHill Publishing Company Limited.
- Prasad, S. and Kumar, U. Principles of Horticulture, Agrobios India.
- Boodley, J. W. (1998). The commercial greenhouse. Albany, N.Y.: Delmar.
- Preparing A Business Plan: Greenhouse Vegetable Example. 1992. Published by the Extension Systems Branch, British Columbia, Ministry of Agriculture, Canada.
- Natarajan K., Gordon, E Entrepreneurship and Small Business, Himalayan Publishing House ,Pvt. Ltd.

- Sherlekar S.A, Krishnamoorthy R Marketing and Advertising Management, Himalayan Publishing House ,Pvt. Ltd.
- Awasthi Dinesh, Jaggi Raman, Padmanand V, 2006. Manual for Enterpreneurs by Entrepreneurship Development Institute of India, Ahmedabad.

Vocational Skill Courses (VSC) (Credits 2)

Practical based on OE

Semester I

Bamboo Technology

USBOVSC03

Laboratory Exercises:

1. To study taxonomic description (morphological characterization) of Bamboo sp.
2. To study anatomy of Bamboo culm and leaf.
3. To study different types of joints and applications of Bamboo in construction.
4. To study biochemical constituents of Bamboo shoot (soluble sugar, soluble protein, Phenols, Flavonoids etc.).
5. To study Post harvest protection of Bamboo culms using chemical methods.
6. To study design, working principle and operation of different tools and machines used in Bamboo Processing.
7. To study Bamboo minor crafts and design.
8. To study Laboratory technique for in vitro propagation of Bamboo.
9. To workout Government and Non-Government schemes related to Bamboo Technology.
10. Field demonstrations on different types of nursery beds, conventional vegetative propagation techniques (Branch cutting, Culm cutting, Rhizome technique etc.).

Suggested Readings:

- Gnanaharan,R.(1997)Technologies for Bamboo and Rattan.New Delhi, India.
- Trier,H.V. (2006). Bamboo for Survival.France:ActesSud; ActesSudEdition,France.
- Industrialization of the Bamboo Sector in India, a Report by India Development Foundation, November 2007.
- Gupta, A. et al. (2008). Potential of Bamboo in Sustainable Development, Asia-Pacific Business Review. Vol. IV, No.3, pp. 100-107. ISSN: 0973-2470.
- M. Shah, et al. (2016). A review on the tensile properties of bamboo fiber reinforced polymer composites. Bio Res. 11(4): 10654-10676.
- Raj, D.A. et al. (2014). Bamboo as a building material, journal of civil engineering and environmental technology print ISSN: 2349-8404; Online ISSN: 2349-879X; 1(3); August, 2014 pp. 56-61.
- Tripathi, Y.C. (2008). Bamboo Entrepreneurship-Opportunities for rural employment.Indian Forester. DOI: 10.36808/if/ 2008/v134i9/967.

- Pandey, C.N., Bamboo Based Composites: Material for Future, March 2019.
- Pramudi, G. et al. (2020). Utilization of Bamboo Fiber in the Development of Environmentally Friendly Composite - A Review, ICIMECE 2020.
- Raj, D.A. et al. (2014). Bamboo as a building material, journal of civil engineering and environmental technology print ISSN: 2349-8404; Online ISSN: 2349-879X; 1(3); August, 2014 pp. 56-61.
- Ray, A.K. et al. (2005). Bamboo-A functionally graded composite- correlation between microstructure and mechanical strength. Journal of Material Science. 40: 5249-5253.
- Rahman, et al. (2011), Performance Evaluation of Bamboo Reinforced Concrete Beam.

Open Elective Course (OE)

Group - B

Paper: Plant Nursery Development

UNIT I. Nursery: Definition, objectives and scope and general practices and building up of infrastructure for nursery, planning and seasonal activities.

2. Planting - direct seeding and transplants, synthetic growth mediums for pots and nursery.

UNIT II 1. Vegetative propagation: Air-layering, cutting, selection of cutting, collecting season, treatment of cutting, rooting medium and planting of cuttings.

2. Hardening of plants : Green house, mist chamber, shed root, shade house and glass house.

UNIT III 1. Gardening : Definition, objectives and scope. Different types of gardening - landscape and home/terrace gardening, parks and its components.

2. Gardening operations: soil laying, manuring, watering, management of pests and diseases and harvesting

UNIT IV 1. Storage and marketing procedures. Developing and maintenance of different types of lawns. Bonsai technique

2. Plant materials and design. Computer applications in landscaping,

Laboratory Exercises:

1. Study of site selection for Nursery
2. Study of Nursery Layout
3. Study of Garden Tools and equipment
4. Study of soil texture and pH.
5. Study of fertilizers, organic manures & substrates.
6. Preparation of soil mixture for potting.
7. Preparation of pot for potting.
8. Preparation of beds for raising seedlings.
9. Demonstration of nursery Pot filling / polybag filling
10. Study of Propagation by stem cutting.

11. Study of Propagation by layering.
12. Study of propagation by grafting.
13. Study of propagation by budding.
14. Plant protection measures for nursery plants.
15. Transplantation of nursery seedlings / sapling
16. Visit to nursery to observe practices in propagation

REFERENCE BOOKS

1. Agrawal, P.K. (1993). Hand Book of Seed Technology. New Delhi, Delhi: Dept. of Agriculture and Cooperation, National Seed Corporation Ltd.
2. Bose T.K., Mukherjee, D. (1972). Gardening in India. New Delhi, Delhi: Oxford & IBH PublishingCo.
3. Jules, J. (1979). Horticultural Science, 3rd edition. San Francisco, California: W.H. Freeman and Co.
4. Kumar, N. (1997). Introduction to Horticulture. Nagercoil, Tamil Nadu: Rajalakshmi Publications.
5. Musser E., Andres. (2005). Fundamentals of Horticulture. New Delhi, Delhi: McGraw Hill Book Co.
6. Sandhu, M.K. (1989). Plant Propagation. Madras, Bangalore: Wile Eastern Ltd.

Open Elective Course (OE)

(For students having other than Botany as major)

Moha Cultivation

Unit I:	06 Hours
Introduction – Botanical description, Nutritive value, Uses, Origin and distribution, Area or region of cultivation or availability, Genus and different species, Cytogenetics.	
Unit II:	07 Hours
Domestication, Climate and soil, Propagation and Root stock, Varieties and crop improvement, Inheritance pattern, Problem in Breeding, Floral Biology.	
Unit III:	10 Hours
Cultivation – Raising of Seedlings through seeds, Soft wood grafting, Wedge grafting, Veneer grafting, Air layering, Planting, Training and Pruning, Orchard Management; Irrigation, Mulching, Intercropping, Nutrient application, Water Management, Disease and Pest management, Yield.	
Unit IV:	07 Hours
Harvesting and Post Harvest management, Value addition-Food, Fodder, Fuel, Timber, Medicine, Marketing, Future Research thrust.	

(02 Credits = 30 Hours)

Suggested Readings:

- Singh, S, Singh A. K., Bagle, B. G. and More, T. A. (2008) Mahua – A multipurpose tree for tribals. Technical Bulletin No. 32, Central Horticultural Experiment Station, Indian Council of Agricultural Researches (India).
- Dhakar, M. K., Sarolia, D. K., Kaushik, R. A., Kumawat, K. L., Singh, S. and Singh, A. K. (2015) Mahua – *Madhuca longifolia* (Koenig) J. F. Macbride: Breeding of Underutilized Fruit Crops Part II; Ed. S. N. Ghosh, Narendra Publishing House, pp 305-3025.
- Abraham, Z., Yadav, S., Latha, M., Mani, S. and Mishra, S. K. 2010. Seed variability in *Madhuca longifolia* (Koenig) J. F. Macbride, a source of oil for use as bio-energy. *Genetic Resources for crop Evolution*, 57: 619-623.
- Behera, S., Mohanty, R. C. and Ray, R. C. 2011. Biochemistry of post-harvest spoilage of mahula (*Madhuca latifolia* L.) flowers: changes in total sugar, ascorbic acid, phenol and phenylalanine ammonia-lyase activity. *Arc. Phytopathol. Plant Protection.*, 45(7): 846–855.
- Bulbul, I.J. and Begum, Y. 2014. Antibacterial, cytotoxic and antioxidant activities of *Madhuca indica*. *Scientific Res. J.*, 2(4): 15–20.
- Behl, P. N. and Sriwasrawa, G. S. 2002. Herbs useful in dermatological therapy, CBS Publishers and Distributors, New Delhi, Edition 2: 94–95.
- Bhattacharya, A. and Mandal, S. 2012. Pollination biology of ten medicinally important angiosperms of West Bengal (India). *Appl. Biol. Res.*, 14(1): 86–94.
- Jebaseelan, S. and Ramasubramanian, P. 2014. Screening of *Madhuca indica* for Antidiabetic Activity in Alloxan Induced Diabetic Rats. *Res. J. Pharmacy Technol.*, 7(2): 188–190.
- Singh, A.K., Anju Bajpai, Ravishankar, H., Singh, V.K. and Singh, J.P. 2012. Evaluation of genetic variability of mahua under Lucknow conditions of Uttar Pradesh. Abstract in: 5 th Indian Horticulture Congress-2012, (Non-6,9): 334–335.
- Singh, I.S. 1998. Mahua-Anoil-bearing tree. Technical Bulletin, pp 3–11, ND University of Agriculture and Technology, Kumarganj, Faizabad, Uttar Pradesh, India.
- Singh, I.S., Srivastava, A.K. and Singh, B. 1999. Improvement of some underutilized fruits through selection. *J. App. Hort.*, 1(1): 34–37.
- Yadav, S., Suneja, P., Hussain, Z., Abraham, Z. and Mishra, S.K. 2011a. Prospects and potential of *Madhuca longifolia* (Koenig) J.F. Macbride for nutritional and industrial purpose. *Biomass and Bioenergy*. 35(4): 1539–1544.
- Yadav, S., Suneja, P., Hussain, Z., Abraham, Z. and Mishra, S.K. 2011b. Genetic variability and divergence studies in seed and oil parameters of mahua (*Madhuca longifolia* Koenig) J.F. Macbride accessions. *Biomass and Bioenergy*. 35(5): 1773–1778.

ANNEXURE IX (VSC)

Herbal Technology

Unit I:

Herbal medicines: history and scope - definition of medical terms, cultivation - harvesting - processing - storage - marketing and utilization of medicinal plants.

Unit II:

Pharmacognosy: Taxonomic description, systematic position medicinal uses of the locally available herbs in curing various ailments; Tulsi, Ginger, Fenugreek, Indian Goose berry, Turmeric etc. Analytical pharmacognosy: Biological testing of herbal drugs - Phytochemical screening tests for secondary metabolites (alkaloids, flavonoids, steroids, triterpenoids, phenolic compounds).

Unit III:

Phytochemistry: Active principles and methods of their testing - identification and utilization of the medicinal herbs; *Catharanthus roseus* (cardiotonic), *Withaniasomnifera* (drugs acting on nervous system), *Clerodendron phlomoides* (anti-rheumatic) and *Centella asiatica* (memory booster).

Unit IV:

Drug adulteration : types, methods of drug evaluation. Medicinal plant banks: micro-propagation of important species (*Withaniasomnifera*, *Andrographis paniculata*) Herbal foods: future of pharmacognosy.

Suggested Laboratory Exercises:

1. Preparation of land, fertigation and irrigation for medicinal plant cultivation (Ginger, Turmeric, Periwinkle, Aloe vera, Ahwagandha, Asparagus etc.).
2. Cultivation of locally available medicinal herbs using seeding, cutting or grafting (Ginger, Turmeric, Periwinkle, Aloe vera, Ahwagandha, Asparagus etc.).
3. Use and handling of flora and pharmacopia for identification and study of medicinal plants.
4. Taxonomic description, classification and identification of locally available medicinal plants.
5. Preparation of herbarium (manual and digital) and preservation of collected herbal specimens.
6. Rapid Microchemical tests for identification of active principle from crude sample.
7. Extraction of secondary metabolites from the medicinally important herbs.
8. Qualitative estimation of secondary metabolites using TLC/HPTLC.
9. Quantitative estimation of extracted secondary metabolites from crude drug.
10. Harvesting, drying and processing of locally available medicinal herbs (Ginger, Turmeric etc.).

Suggested Readings:

1. Trivedi P C, 2006. Medicinal Plants: Ethnobotanical Approach, Agrobios, India.
2. Purohit and Vyas, 2008. Medicinal Plant Cultivation: A Scientific Approach, 2nd edn. - Agrobios, India.
3. Glossary of Indian medicinal plants, R.N.Chopra, S.L.Nayar and I.C.Chopra, 1956. C.S.I.R, New Delhi.
4. The indigenous drugs of India, Kanny, Lall, Dey and Raj Bahadur, 1984. International Book Distributors.
5. Herbal plants and Drugs Agnes Arber, 1999. Mangal Deep Publications.

6. Ayurvedic drugs and their plant source. V.V. Sivarajan and Balachandran Indra 1994. Oxford IBH publishing Co.
7. Ayurveda and Aromatherapy. Miller, Light and Miller, Bryan, 1998. Banarsidass, Delhi.
8. Pharmacognosy, Dr.C.K.Kokate et al. 1999. NiraliPrakashan

ANNEXURE X (SEC)

Floriculture

Credit: 2 (30 hours)

- a) Introduction: Importance and scope of floriculture. Nursery Management and Routine Garden Operations; Sexual and vegetative methods of propagation; Soil sterilization; Seed sowing; Pricking; Planting and transplanting; Role of plant growth regulators.
- b) Ornamental Plants: Flowering annuals; Herbaceous perennials; Shade and ornamental trees; Cacti and succulents; Palms and Cycads; Ferns; Cultivation of plants in pots; Indoor gardening; Bonsai.
- c) Features of a garden: Garden wall, Fencing, Steps, Hedge, Edging, Lawn, Flower beds, Shrubbery, Borders, Water garden. Some Famous gardens of India.
- d) Commercial Floriculture: Factors affecting flower production; Production and packaging of cut flowers; Cultivation of Important cut flowers (Carnation, Aster, Chrysanthemum, Dahlia, Gerbera, Gladiolous, Marigold, Rose, Liliun, Orchids).

Suggested readings

Randhawa, G.S. and Mukhopadhyay, A. (1986). Floriculture in India. Allied Publishers.

Laboratory Exercises:

1. To study green house setup for floriculture.
2. To study soil sterilization methods.
3. To study cultivation methods of plants in pots.
4. To study the preparation of beds in garden.
5. To study cultivation techniques of important / local varieties of cut flowers.
6. To study different ornamental plants for commercial production of flowers.