

RTM NAGPUR UNIVERSITY, NAGPUR

Semester Pattern Syllabus with Skill Development

For B. Sc. Botany



B. Sc. SEMESTER-I 2020-21 onwards

- PAPER-I : Viruses, Prokaryotes, Algae and Biofertilizers
- PAPER-II : Fungi, Plant-Pathology, Lichen, Bryophyta and Mushroom Cultivation

B. Sc. SEMESTER-II 2020-21 onwards

- PAPER-I : Palaeobotany, Pteridophytes, Gymnosperms and Soil Analysis
- PAPER-II : Morphology of Angiosperms and Floriculture

B. Sc. SEMESTER-III 2021-22 onwards

- PAPER-I : Angiosperm Systematics, Embryology and Indoor Gardening
- PAPER-II : Angiosperm Anatomy and Horticulture

B. Sc. SEMESTER-IV 2021-22 onwards

- PAPER-I : Cell Biology, Plant Breeding, Evolution and Seed Technology
- PAPER-II : Genetics, Molecular Biology and Plant Nursery

B. Sc. SEMESTER-V 2022-23 onwards

- PAPER-I : Plant Physiology, Mineral Nutrition and Hydroponics
- PAPER-II : Plant Ecology and Organic Farming

B. Sc. SEMESTER-VI - 2022-23 onwards

- PAPER-I : Biochemistry, Biotechnology and Herbal Technology
- PAPER-II : Phytogeography, Utilization of plants, Techniques and Pharmacognosy

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B. Sc. Botany
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B. Sc. SEMESTER- I
PAPER- I
(Viruses, Prokaryotes, Algae and Biofertilizers)

Unit-I: Virus and Prokaryotes:

1. **Viruses:** Nature of viruses (Non-living and living characteristics), Ultra-structure of TMV, Structure and multiplication of T-4 bacteriophage, Economic Importance of viruses.
2. **Mycoplasma:** Properties, Structure and Reproduction.
3. **Bacteria:** General characteristics, Ultrastructure of bacterial cell, Reproduction (Binary Fission and Conjugation), Economic importance of bacteria (with reference to their role In Agriculture and industry).

Unit-II: Cyanobacteria and Algae:

1. **Cyanobacteria:** Cell ultrastructure, Structure of heterocyst, Structure and Reproduction in *Nostoc*, Economic importance of Cyanobacteria.
2. **Algae:** General characteristics, Classification (Fritsch, 1954), Economic Importance of Algae.

Unit-III: Algae:

Life cycles in Algae: *Chara*, *Vaucheria*, *Ectocarpus* and *Batrachospermum*.

Unit-IV: Skill Development: Biofertilizers:

1. **Biofertilizers:** Definition, scope and importance
2. Various microbes used as Biofertilizers
3. Commercial production of Biofertilizers: *Rhizobium*, *Azotobacter*, PSB (Phosphate Solubilizing Bacteria, e.g. *Bacillus polymyxa*) and *Azolla*.

List of Practical: Paper-I

1. Study of viruses from models/photographs (TMV and T4 bacteriophage).
2. Gram staining of Bacteria, ultra-structure of bacteriophage from TEM photographs.
3. Study of Cyanobacteria: *Nostoc*
4. Study of vegetative and reproductive structures in *Nostoc*
5. Study of Algal genera: *Chara*, *Vaucheria*, *Ectocarpus* and *Batrachospermum*.
6. Identification and characterization of *Rhizobium*, *Azotobacter*, PSB and *Azolla*.

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B. Sc. SEMESTER- I
PAPER-II
(Fungi, Plant-Pathology, Lichens, Bryophyta and Mushroom Cultivation)

Unit-I: Fungi:

1. **Fungi:** General characteristics, Classification (Alexopoulos, 1996), Economic importance.
2. Life history of *Albugo*, *Mucor*, *Puccinia* and *Cercospora*.

Unit-II: Plant Pathology and Lichens:

1. **Plant-Pathology:** Host, Pathogen, Symptoms, Causes and control of diseases: Leaf curl of Papaya, Citrus canker and red rot of Sugarcane
2. **Lichens:** Introduction, Types, Reproduction and Economic importance.

Unit-III: Bryophyta:

1. **Bryophyta:** General Characteristics, Classification (Proskauer, 1957), Economic importance.
2. Life history of *Marchantia*, *Anthoceros* and *Funaria*.

Unit-IV: Skill Development: Mushroom Cultivation:

1. **Introduction:** Nutritional and medicinal value of edible mushroom; Poisonous mushroom. Edible mushroom: *Volvariella volvacea*, *Plerotuscitrino pileatus*, *Agaricus bisporus*.
2. **Technology of Mushroom cultivation: Infrastructure:** Mushroom unit (Thatched house); **Tools:** Polythene bags, vessels, inoculation hook, inoculation loop, low cost stove, sieves, culture rack, water sprayer, tray, medium.
3. **Techniques:** Substrate, preparation of medium and spawn, sterilization, multiplication, bed preparation (Paddy-straw, sugarcane trash, banana leaves)

Note: 1. Developmental stages are not expected
 2. Short excursion tour/visit to biofertilizer laboratory or Mushroom cultivation center is expected

List of practical: Paper-II:

1. Study of Fungal genera: *Albugo*, *Mucor*, *Puccinia*, *Cercospora*
2. Study of Lichen: Thallus structure, Types of lichens.
3. Plant pathology: Leaf curl of Papaya, Red rot of Sugarcane, Citrus canker
4. Study of Bryophytes: *Marchantia*, *Anthoceros*, *Funaria*.
5. To study different instruments/tools used in mushroom cultivation.
6. To study method of preparation of spawn.
7. To study preparation of mushroom beds

BOTANY PRACTICAL EXAMINATION

B. Sc.

SEMESTER-I

TIME: FIVE HOURS

MAX. MARKS:30

- Q. 1: Gram stain the given bacterial strain/stain the Cyanobacterial material (A) and identify giving reasons. 04 M
- Q. 2: Identify the given Algal material (B). Prepare temporary mount and write identifying characters. 04 M
- Q. 3: Identify the given Fungal material (C). Prepare temporary mount and write identifying characters. 04 M
- Q. 4: Identify the given Bryophytic material (D). Prepare temporary mount and write identifying characters. 04 M
- Q. 5: Spotting: 06 M
(E) Virus/Bacteria (F) Algae/Fungi/Bryophyte (G) Plant pathology
(H) Lichen (I) Biofertilizers (J) Mushroom cultivation
- Q. 6: Viva-voce. 03 M
- Q. 7: Practical Record and Excursion report. 05 M

Suggested readings: B. Sc. Semester I

- Alexopoulos, C. J. and G. W. Min & M. Blackwell, Introductory Mycology, CBS distributors & publishers, Delhi.
- Alexopoulos, C.J. (1962): Introductory Mycology, John Wiley Eastern Pvt. Ltd.
- Alexopoulos, C.J. and Mims C.W. (1979): Introductory Mycology 3rd Edition, John Wiley and Sons, Inc. Wiley, New York.
- Aneja, K.R. (1993): Experimental in Microbiology, Plant Pathology & Tissue Culture, Wiswa Prakashan, New Delhi.
- Barnett, J.H. (1968): Fundamentals of Mycology. The English Language Book Society and Edward Arnold Publication, Limited.
- Bold, H. C. and M. J. Wynne [1978]: Introduction of Algae: Structure and Reproduction (Prentice Hall Of India, Pvt. Ltd)
- Bold, H.C. C. J Alexopoulos and T Delevoryas [1980]: Morphology of Plants and Fungi (Harper and Row Publishers, N.Y.)
- Cavers, F. (1910): The interrelationship of Bryophyta I-IV. New Phytologist.
- Cavers, F. (1911): The interrelationship of Bryophyta VII-IX. New Phytologist.
- Chopra, G. Land D I Yadav [1980]: A text Book of Bryophyta (Arihant Press)
- Chauhan, N. M., Gajre, N. K. and Prajapati, V. P. (2013), Scientific Cultivation of Mushroom, Boitech Books.
- Dube, H. C. [1990] Introduction to Fungi (Vikas Publishing House Pvt. Ltd, Delhi)
- Dube, R.C. and D. K. Maheshwari (1999): A Text Book of microbiology, S.Chand & Co. Ltd.
- Dube, R.C. and D. K. Maheshwari (2000): Practical Microbiology -S.Chand & Co. Ltd.
- Dubey, R. C. and D. K. Maheshwari [1999]: Text Book of Microbiology (S. Chand & Co)
- Eggins, H.O.W. and Allsop (1975): The Filamentous Fungi Vol. 1 Industrial Mycology (Biodeterioration and Biodegradation by Fungi) Eds. J.E. Smith and D.R. Berry Edward Arnold, London.

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- Emmons, C. W., C. H. Binford, J.P. Utz and Know Chung (1977): Medical Mycology, Lea and Febigo, Philadelphia.
- Ganguly and Kar: College Botany, Vol II (New Central Book Agency, Calcutta)
- Kumar H.D. (1988): Introductory Phycology. Affiliated East-West Press Ltd. New Delhi
- Kumar, H. D. and H. N. Singh (1982): A text Book of Algae (Affiliate East - West Press, Pvt. Ltd, New Delhi)
- Mehrotra, R. S. and Aneja, K. R. (1990): An Introduction to Mycology (Wiley Eastern Ltd.)
- Mehrotra, R.S. and K. R. Aneja (1998): An Introduction to Mycology, New Age Intermediate Press.
- Morris I (1986): Introduction to the Algae. Cambridge University Press, UK
- Parihar N. S. (1976): An introduction to Embryophyta, Bryophyta (Central Book House, Allahabad)
- Parihar, N. S. [1997]: The Biology and Morphology of Bryophytes (Central Book Depot, Allahabad)
- Pelzer, M.J. Jr.Cahn, E.C.S. and N.R.Krieg (1993): Microbiology, Tata McGraw Hill.
- Prempuri [1980]: Bryophyta (Atma Ram & Sons Delhi)
- Prescott et al [1999]: Microbiology 3rd (Wm C Brown Pub)
- Ram Udar [1970]: An Introduction to Bryophyta (Shashidhar Malviya Prakashan, Lucknow)
- Rai, M. K. (2006), Handbook of Microbial Biofertilizers, Food Product Press, An Imprints of the Haworth Press, Inc. New York.
- Reynolds CS (1984): The ecology of phytoplankton, Cambridge Univ Press
- Reddy Shankara, R. (2012), Biofertilizer Technology, Akhand Publishing House
- Round FE (1986): The Biology of Algae. Cambridge University Press, UK
- Schlegel, H.G. (1996): General Microbiology, 7th Edition, Cambridge University Press.
- Sharma A. K. (2007) Biofertilizers for sustainable Agriculture Agrobios (India) Jodhpur
- Sharma, O.P.(1992): Text Book Of Thallophtyes (McGraw Hill Publishing Co.)
- Sharma, P. D. [1991]: The Fungi (Rastogi & Co. Meerut)
- Sharma, P.D. [1993]: Microbiology and plant pathology (Rastogi & Co)
- Sharma, S. G. (2005), Mushroom: Cultivation and Uses, Agrobios (India)
- Smith G. M. (1955): Cryptogamic Botany-vol. 2 Bryophyta and Pteridophyta (McGraw Hill Book Company, New York)
- Smith, G. M. [1971]: Cryptogamic Botany, Vol. I Algae and Fungi(TMH)
- Smith,G.M.[1971]: Cryptogamic Botany, vol. II Bryophytes and Pteridophytes (THM)
- Smith, K. M. [1992]: Plant Viruses 6th Ed (university Book Stall, New Delhi)
- Sporne, K. R. I]: The Morphology of Bryophytes (Hutchinson University, London)
- Sullia, S. B. [1998]: General Microbiology (Oxford & IBI)
- Sunder Rajan, S. (2001): Tools and Techniques of Microbiology, Anmol Publ. New Delhi.
- Tortora, G. E. B. R. Funke, C. I. Case U (1997): Microbiology, An Introduction, 6th Ed (Addison Nesley Logman, Inc.)
- Vashishtha, B. R. [1992]: Bryophyta (S. Chand & Co. New Delhi)
- Vasishtha, B. R. [1990]: Algae (S. Chand & Co. New Delhi)
- Vasishtha, B. R. [1990] : Fungi (S. Chand and Co. New Delhi)

B. Sc. SEMESTER-II
PAPER-I
(Palaeobotany, Pteridophytes, Gymnosperms and Soil analysis)

Unit-I: Palaeobotany:

1. Palaeobotany: Definition; fossil and Pseudo-fossil, Importance of fossils.
2. Types of fossils: Compression, Impression, Cast-Mold, Petrification and Amber.
3. Geological time scale: Definition, Outline and brief account of Eras.
4. Fossil leaf: *Glossopteris*, Fructification: *Scutum*.

Unit-II: Pteridophytes:

1. Pteridophyta: General characteristics, Classification (Smith, 1952).
2. Fossil Pteridophyte: *Rhynia*
3. Life history of: *Selaginella* and *Equisetum*.
4. Heterospory and seed habit.
5. Brief account of types of steles

Unit-III: Gymnosperms:

1. Gymnosperms: General characteristics, Classification (Steward, 1982), Economic Importance
2. Fossil Gymnosperms: *Cycadeoidea* flower
3. Life cycle of: *Cycas* and *Pinus*.

Unit-IV: Skill Development: Soil analysis:

1. Soil: Types of soil, method of collection of soil samples.
2. Physical properties of soil: Soil texture, soil colour, Water Holding Capacity (WHC), Water Rising Capacity (WRC), Bulk Density (BD) and Porosity (P).
4. Chemical properties of soil: pH, Carbonates as CaCO_3 , Available Nitrogen, Available Phosphorous, Available Potassium.

List of Practical: Paper-I:

1. Fossils: Types (Compression, Impression, Cast-Mold, Petrification); *Glossopteris*, *Rhynia*, *Cycadeoidea*.
2. Study of Pteridophytes: *Selaginella* and *Equisetum*.
3. Study of Gymnosperms: *Cycas* and *Pinus*
4. Types of soil
5. To study Physical properties of soil samples
6. To study Chemical properties of soil samples

B. Sc. SEMESTER-II
PAPER-II
(Morphology of Angiosperms and Floriculture)

Unit-I: Vegetative Morphology:

1. **Root:** Tap root and adventitious root, modification of root for storage and respiration
2. **Stem:** Shape, surface, and nature. Branching (Monopodial and Sympodial), Modification of stem (Runner, Rhizome, Tuber, Bulb)
3. **Leaf:** Typical leaf, Types (Simple and Compound), Types of phyllotaxy, Venation, Modification of leaf (Tendrils, Phyllode)

Unit-II: Reproductive Morphology:

1. **Inflorescence:** Definition, Racemose, Cymose and Special types
2. **Flower:** Definition, Structure of Typical flower, Variation in thalamus (Androphore, Gynophore and Gynandrophore)
3. **Calyx and Corolla:** Cohesion, Forms of corolla and Aestivation.
4. **Androecium:** Parts, Cohesion, Adhesion and Fixation.

Unit-III: Carpel and Fruit:

1. **Gynoecium:** Parts, Cohesion, Adhesion and Placentation.
2. **Fruit:** Definition, Pericarp, Types of fruits: Simple (Dehiscent, Schizocarpic, Dry Indehiscent, Fleshy Indehiscent); Aggregate (Etaerio) fruits, Composite Fruits (Sorosis and Syconus).

Unit-IV: Skill Development: Floriculture:

1. **Floriculture:** Definition, commercial aspects.
2. **Methods of cultivation of:** Important cut flowers such as Carnation, Asters, Gerbera, Dahlia, Marigold with reference to soil type, sowing pattern, weather condition, irrigation regime, fertilizers and harvesting.
3. Diseases and control measures.

List of practical: Paper-II:

1. Study of different root modifications
2. Study of nature of branching and modification of stem
3. Study of leaf: Types (Simple & Compound), Phyllotaxy, Venation and Modifications.
4. Inflorescence: Types mentioned in theory.
5. Flower: Parts, calyx, corolla, androecium, gynoecium, variation in thalamus.
6. Fruits: Study of different types of fruits
7. Identification and commercial aspect of cut flowers mentioned in theory.

Note: 1. Developmental stages are not expected

2. Short excursion tour/visit to soil testing laboratory or Polyhouse is expected

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J.P.

BOTANY PRACTICAL EXAMINATION
B. Sc.
SEMESTER-II

TIME: FIVE HOURS

MAX. MARKS: 30

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| Q. 1: Identify the given Pteridophytic material (A). Prepare temporary mount and write identifying characters. | 04 M |
| Q. 2: Identify the given Gymnospermic material (B). Prepare temporary mount and write identifying characters. | 04 M |
| Q. 3: To study the physical or chemical properties (any two) of given soil sample (C) | 03M |
| Q. 4: Describe the given leaf material (D). | 03 M |
| Q. 5: Describe the given flower (E). | 03 M |
| Q. 6: Spotting: | 05 M |
| (F) Palaeobotany (G) Pteridophyta (H) Gymnosperm | |
| (I) Fruit (J) Floriculture | |
| Q. 7: Viva-voce. | 03 M |
| Q. 8: Practical Record and Excursion report. | 05 M |

Suggested Readings: B. Sc. Semester-II

Agashe, S. N. (1995): Palaeobotany, Plants of the past, their evolution, palaeo-environment and application in exploration of fossil fuels. Oxford & IBH publishing company-New Delhi.

Arnold, C.A. (1947): Introduction to Palaeobotany, Mc-Graw Hill Book Co. Inc., New York and London.

Beck, C.B.(1976): Current status of the Progymnospermosida, Review of Palaeobotany and Palynology

Bhatnagar, S. P. and Moitra A. (1996): Gymnosperms. New Age International Limited, New Delhi

Bierhorst, D. W. [1971]: Morphology of Vascular Plants. Macmillon & Co. N. R.

Biswas, T. D. and Mukherjee, S. K. (2017), Text Book of Soil Science, Tata McGraw Hill Education, New Delhi (India)

Bold, H.C. C. J Alexopoulos and T Delevoryas [1980]: Morphology of Plants and Fungi (Harper and Row Publishers, N.Y.)

Chandra,S. and Surange, K.R.(1979): Revision of the Indian species of Glossopteris, Monograph, Birbal Sahni Institute of Palaeobotany.

Davis, P. H. and Heywood V. H. (1963): Principals of Angiosperm Taxonomy. Oliver and Boyd London.

Das, D. K. (2015), Introductory Soil Science, Kalyani Publishers, Lakhnow (India)

Des R. (2013): Floriculture at glance. Kalyani Publ., New Delhi.

Ganguly and Kar : College Botany. Vol II (New Central Book Agency, Calcutta)

Hartmann HT, Kester DE, Davies FT and Geneve RL. (2002): Plant Propagation: Principles and Practices. Prentice Hall India Ltd.

Kubitzki K. (1990): The families and genera of vascular plants Pteridophytes and Gymnosperms, Springer Verlag, New York

Majumdar, S. P. and Singh, R. A. (2000), Analysis of soil: Physical and Chemical properties, Agrobios (India), Jodhapur

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Parihar, N.S.(1995): Essentials of Palaeobotany, Central Book -Allahabad.

Parihar N.S. (1977): The biology and morphology of the Pteridophytes (Central Book Depot, Allahabad).

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Randhawa GS and Mukhopadhyay A. (2004): Floriculture in India. Allied Publishers Pvt. Limited.

Randhwa G. S. and Mukhopadhyay A (1986): Floriculture in India. Allied Publ., New Delhi.

Rashid A. (1982): (4th edn) An introduction to pteridophyta (Vikas Publ House Pvt Ltd.)

Rashid, A. [1989]: An Introduction to Pteridophyta Vikas Publishing House, Pvt. Ltd. New Delhi

Rowley, J.R. (1967): Fibrils, microtubules and lamellae in Pollen grains. Rev. Palaeobotany. Palynol 3:213-226,

Sai Prasad, S. V., Ramesh, A., Jat, J. R. and Patidar, C. P. (2016), Soil Science, New Vishal Publication,

Sharma O.P (1996): Textbook of Pteridophyta (Mac Millan India Ltd, New Delhi)

Sharma, O. P. [1990]: Text Book of Pteridophyta (Mcmillan India Ltd.)

Siddiqui, K.A. (2002): Elements of Palaeobotany, Kitab Mahal, Allahabad.

Singh, H. (1978): Embryology of Gymnosperms, Encyclopedia of Plant Anatomy X, Gebryder, Bortragear, Berlin.

Smith G. M. (1955): Cryptogamic Botany-vol. 2 Bryophyta and Pteridophyta (McGraw Hill Book Company, New York)

Smith, G. M. [1971]: Cryptogamic Botany, vol. II, Bryophytes and Pteridophytes (THM)

Spicer, R.A. & Thomas, B.A. (1986): Systematic and taxonomic approaches in Palaeobotany. Systematic Association Special Volume.

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Stewart, W. N. and G. W. Rothwell (1993): Paleobotany and the Evolution of Plants, 2nd Edn. Cambridge University Press.

Swarup Vishnu. (2003): Garden Flowers. National Book Trust

Vashishtha, B. R. [1992]: Gymnosperm (S. Chand & Co. New Delhi)

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B. Sc. SEMESTER-III

PAPER-I

(Angiosperm Systematics, Embryology and Indoor Gardening)

Unit-I: Systemic botany:

1. **Origin of Angiosperms:** (Benettitalean theory)
2. **Fossil angiosperms:** Flower (*Sahianthus*); Fruit (*Enigmocarpon*)
3. **Angiosperm Taxonomy:** Floras, Herbarium, Keys (Intended and Bracketed)
4. **Botanical Nomenclature:** Principles (Rank and taxon, Principle of priority)
5. **Modern trends in taxonomy:** Cytotaxonomy (Karyotype), Phytochemistry (Proteins and Flavenoids)

Unit-II: Angiosperm: Classification and Families:

1. **Systems of Classification:** Benthem and Hooker; Engler and Prantl (along with merits - demerits)
2. **Study of families:** Dicot: *Malvaceae, Brassicaceae, Papillonaceae, Asteraceae, - Asclepiadaceae;* Monocot: *Poaceae.*

Unit-III: Embryology:

1. **Pollination:** Types and Significance.
2. **Anther:** T. S. Anther, Microsporogenesis; Structure of pollen grain, Development of male gametophyte.
3. **Ovule:** Types of ovule, Structure of anatropous ovule, Megasporogenesis, Development of female gametophyte (*Polygonum* type)
4. **Fertilization:** Double fertilization and triple fusion, Endosperm and its types, Structure of Dicot embryo (*Onagrad*) and Monocot embryo.

Unit-IV: Skill Development: Landscaping and Indoor gardening

1. **Landscaping:** Definition, scope of landscaping (Landscaping at offices, industrial premises, educational institutes and parks)
2. **Indoor gardening:** Brief account of places of house plants, pots and containers; Factors required for growing house plants (Temperature, light, humidity, ventilation, watering, soil, feeding, potting)
3. **Popular house plants:** **Foliage Plants:** *Coleus blumei, Begonia sp., Ferns:* *Adiantum sp., Nephrolepis sp., Palms:* *Chrysalidocarpus lutescens- Areca palm, Howea forsteriana- Kentia palm, Flowering plant:* *Anthurium sp., Begonia sp., Orchids:* *Vanda sp., Dendrobium sp.*

List of practical: Paper-I

1. Study of fossil Angiosperms from specimens/slides.
2. Study of dicot and monocot families mentioned in theory syllabus.
3. To calculate percent germination of pollen grains in the given material.
4. Study of structure of anther and pollen grain.
5. Study of different types of ovule.
6. Study of dicot and monocot embryos from permanent micro-preparation.
7. Study of different popular house plants.

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B. Sc. SEMESTER-III
PAPER-II
(Angiosperm Anatomy and Horticulture)

Unit-I: Anatomy:

1. **Tissue:** Definition, Characteristics of Meristematic tissue; Classification of meristems (based on origin and position).
2. **Simple Permanent Tissue and their functions:** Parenchyma, Collenchyma, and Sclerenchyma
3. **Complex Permanent Tissue and their functions:** Xylem and Phloem
4. **Apical meristem of root and shoot:** Apical cell theory, Histogen theory, Tunica-Corpus theory, Newman's theory
5. **Cambium:** Structure, Types and functions.

Unit-II: Primary and Secondary Growth in stem and root:

1. **Types of vascular bundles:** Radial, Conjoint, Concentric.
2. **Normal Primary structure of root:** Dicot (*Sunflower*) and Monocot (*Maize*)
3. **Normal Primary structure of stem:** Dicot (*Sunflower*) and Monocot (*Maize*)
4. **Normal secondary growth in dicot stem:** *Sunflower*
5. **Anomalous Secondary growth in:** Dicot stem (*Bignonia*) and Monocot stem (*Dracaena*)

Unit-III: Periderm, growth rings, Sap-heartwood, leaf anatomy:

1. **Growth rings:** Spring wood and winter wood
2. Sap wood, Heart wood, Tyloses
3. **Periderm:** Composition, functions and Structures associated with periderm (Lenticel, Bark, Commercial cork)
4. **Anatomy of leaf:** Dicot (*Nerium*) and Monocot (*Maize*)
5. Senescence and Abscission.

Unit-IV: Skill Development: Horticulture

1. **Horticulture:** Definition and scope; importance of horticulture, water requirement and irrigation, nutrient management.
2. Methods of propagation of following horticultural crops (propagation by seeds, vegetative propagation, propagation through specialized organs): *Rose, Chrysanthemum, Crotons, Mango, Citrus, Guava, Lilium.*
3. Technique of Bonsai preparation.

List of Practical: Paper-II:

1. Study of simple and complex tissue from permanent micro-preparation.
2. Study of different types of vascular bundles.
3. Study of internal structure of dicot and monocot roots with the help of temporary micro-preparation.
4. Anatomy of dicot and monocot stem with the help of temporary or double stained permanent micro-preparation.
5. Anatomy of normal and anomalous secondary growth in stem with the help of double stained permanent micro-preparation.
6. Study of internal structure of dicot (*Nerium*) and monocot leaf (*Maize*) with the help of temporary micro-preparation.
7. Study of various horticultural crops mentioned in syllabus.

Note: 1. Developmental stages are not expected

2. Short excursion tour is expected

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BOTANY PRACTICAL EXAMINATION

B. Sc.

SEMESTER-III

TIME: FIVE HOURS

MAX. MARKS: 30

- Q. 1: Describe in technical language the given **Angiospermic** material (A). Classify and identify the family giving reasons. 05 M
- Q. 2: Calculate percent germination of **pollen grains** in given material (B). 03 M
- Q. 3: Prepare temporary mount of the given **root/leaf** material (C) and identify giving diagnostic characters. 04M
- Q. 4: Prepare double stained permanent mount of the **given stem** material (D). Identify giving diagnostic characters. 05 M
- Q. 5: **Spotting:** 05 M
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|-------------------------|-------------------------|------------|
| (E) Fossil angiosperms | (F) Embryology | (G) Tissue |
| (H) Popular house plant | (I) Horticultural plant | |
- Q. 6: Viva-voce. 03 M
- Q. 7: Practical Record and Excursion report. 05 M

Suggested Readings: Semester-III

- Agarwal, V. Kr., and Bhargava P. (2017), Home Gardening, Pustak Mahal, Allahabad (India)
- Baker, H.G. (1954): Aperture membranes in Studies of Pollen Morphology and Taxonomy. New Phytologist, 54(3), 8.
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B. Sc. SEMESTER-IV
PAPER-I

(Cell Biology, Plant Breeding, Evolution and Seed Technology)

Unit-I: Cell organization:

1. **Cell:** Brief account of Cell theory, Comparison between Prokaryotic and Eukaryotic cell organization, Structure of typical plant cell.
2. **Structure and functions of:** Cell wall, Plasma membrane (Fluid Mosaic model), Endoplasmic reticulum, Golgi complex, Ribosomes and Vacuole.

Unit-II: Cell biology:

1. **Structure and functions of:** Chloroplast, Mitochondria and Nucleus
2. **Chromosome morphology:** Chromatid, chromomeres, centromere, telomere, secondary constriction, satellite.
3. **Molecular organization of chromosome:** Nucleosome model.
4. **Sex Chromosomes:** Definition, Structure of sex chromosomes (X and Y) in *Melandrium* plant.
5. **Cell division:** Mitosis and Meiosis (Mechanism and significance).

Unit-III: Plant breeding and Evolution.

1. **Plant Breeding:** Definition and objectives
2. **Methods of Plant breeding:** Definition; Procedure or technique of Pure line selection, Clonal selection, Hybridization, Heterosis (Definition and Scope)
3. **Biostatistics:** Mean; Median, Mode, Standard deviation and Standard error
4. **Evolution:** Neo-Darwinism and Miller's theory.

Unit-IV: Skill Development: Seed Technology

1. **Seed:** Structure and types
2. **Seed dormancy:** Causes of seed dormancy, methods to break seed dormancy
3. **Seed technology:** Seed storage, seed banks, factors affecting seed viability, genetic erosion, methods of seed production, seed testing and certification.
4. **Commercial types of seeds:** Farmers seed, foundation seeds, breeders seed and certified seed.

List of Practical: Paper-I:

1. Study of cell organelles with the help of photographs or slides.
2. Study of mitosis in suitable plant material.
3. Study of meiosis in suitable plant material.
4. To calculate mean, median, mode and standard error of the given data.
5. To study the methods of breaking seed dormancy.
6. To study the seed viability and percentage seed germination by paper slot method or tetrazolium salt.

**B. Sc. SEMESTER-IV
PAPER-II
(Genetics, Molecular Biology and Plant Nursery)**

Unit-I: Genetics: (Mendelism, Linkage and crossing over).

1. **Mendelism:** Basic terminology, Law of segregation and law of independent assortment.
2. **Interaction of genes:** Allelic: Incomplete dominance (1:2:1); Non-allelic: Complementary factors (9:7) and Dominant epistasis (12:3:1).
3. **Linkage:** Definition, Theory of linkage: Coupling and Repulsion, Types: Complete and Incomplete linkage
4. **Crossing over:** Definition, Breakage and reunion theory, significance of crossing over.

Unit-II: Genetics: (Mutation)

1. **Mutation:** Definition, Types: Spontaneous and induced mutation, Physical and Chemical mutagens, applications of induced mutations.
2. **Chromosomal aberrations:** Deficiency, Duplications, Inversion and Translocation
3. **Variation in chromosome number:** Aneuploidy (Nullisomics, Monosomics, Trisomics and Tetrasomics), Euploidy (Autopolyploidy, Allopolyploidy); Significance.
4. **DNA Damage and Repair:** Photoreactivation and Excision Repair

Unit-III: Molecular biology

1. **DNA:** Structure of DNA (Watson and Crick's model), Replication of DNA: Semiconservative method of DNA replication,
2. **RNA:** Types, Clover leaf model of t-RNA
3. **Concept of gene:** Classical: Cistron, Muton and Recon
4. **Genetic code:** Definition and characteristics
5. **Protein synthesis:** Transcription and Translation
6. **Regulation of gene action:** Lac-Operon model

Unit-IV: Skill Development: Plant nursery

1. **Nursery:** Definition and Role or objective; nursery infrastructure
2. **Planning and seasonal activities:** Preparation of nursery beds, Planting: direct seeding and transplant, Air layering, Budding, Grafting, cutting, rooting medium, hardening of plant
3. **Nursery management:** Routine garden operations, soil sterilization, seed sowing, pricking, planting and transplanting, shading, stopping or pinching, defoliation, wintering, mulching and topiary.

List of Practical: Paper-II:

1. To prove Mendel's law of segregation with the help of colored beads.
2. To prove Mendel's law of independent assortment with the help of colored beads.
3. To work out the type of gene interaction mentioned in theory from given data.
4. To study different methods of vegetative propagation (Air layering, cutting, budding and grafting)
5. To study the method of soil sterilization for plant nursery.

Note: 1. Developmental stages are not expected,
2. Short excursion tour/visit to Nursery is expected

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BOTANY PRACTICAL EXAMINATION
B. Sc.
SEMESTER-IV

TIME: FIVE HOURS

MAX. MARKS: 30

- Q. 1: To prepare semi-permanent squash/smear of the given plant material (A), identify stage/s of cell division. 04 M
- Q. 2: To solve given problem of Biostatistics from the given data (B). 03 M
- Q. 3: To determine seed viability of the given seeds (C) and report the finding. 03M
- Q. 4: To prove Mendel's law of inheritance by using colored beads (D) and apply Chi-Square test. 04 M
- Q. 5: To work out the type of gene interaction from the given data (E). 04 M
- Q. 6: Spotting: 04 M
- (F) Cell organelle (G) Cell division
- (H) Tools used in nursery (I) Method of vegetative propagation.
- Q. 7: Viva-voce. 03 M
- Q. 8: Practical Record and Excursion report. 05 M
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Suggested Readings: Semester: IV

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B. Sc. SEMESTER-V
PAPER-I
(Plant Physiology, Mineral Nutrition and Hydroponics)

Unit-I: Plant-Water relation:

1. **Water relation:** Concept and significance of Imbibition, Diffusion, Osmosis, Osmotic pressure, Cell as osmotic system, DPD, Plasmolysis.
2. **Ascent of sap:** Definition, Root pressure theory, Cohesion-adhesion theory.
3. **Transpiration:** Definition, Types, Mechanism of Stomatal movements (K^+ Malate Hypothesis)
4. **Phloem transport:** Munch Hypothesis
5. **Mineral uptake:** Passive (Donnan's Equilibrium), Active (Carrier Concept).

Unit-II: Photosynthesis and Respiration:

1. **Photosynthesis:** Definition, Significance; Photosynthetic pigments (Type and role), Photosystems.
2. **Mechanism of photosynthesis:** Light reaction: Cyclic and non-cyclic photophosphorylation, Dark Reaction: Calvin Cycle (C_3), HSK pathway (C_4), CAM pathway.
3. **Respiration:** Definition, Types, significance and Respiratory Quotient (RQ)
4. **Mechanism of respiration:** Glycolysis, Krebs's Cycle, Oxidative phosphorylation (ETS).
5. **Fermentation:** Definition, Types, Mechanism of fermentation: Lactic acid and Alcoholic.

Unit-III: N- Fixation, Plant Movements, Photoperiodism:

1. **Nitrogen Metabolism:** Definition, Mechanism of Biological N-Fixation (Symbiotic and Non-symbiotic)
2. **Plant Movements:** Definition, Outline, Tropic (Geotropic, Phototropic, Thigmotropic) and Nastic (Seismonastic).
3. **Photoperiodism:** Definition, Classification (Short Day Plant, Long Day Plant and Day Neutral Plant), photoperiodic induction, Florigen hormone.
4. Circadian rhythms and Biological clock.

Unit-IV: Skill Development: Mineral nutrition and Hydroponics:

1. **Mineral nutrition:** Definition, source, types (Macro and micronutrients)
2. **Role and deficiency symptoms of Macronutrients:** Nitrogen, Phosphorous, Potassium and Calcium
3. **Role and deficiency symptoms of Micronutrients:** Iron, Manganese, Boron and Zinc.
4. **Hydroponics:** Definition, advantages and disadvantages, Types of hydroponic systems (Deep water culture and Nutrient Film Technique); Nutrient composition.
5. **Methods:** Hydroponic farming of Tomato, Cucumber, Spinach and Cabbage.

List of Practical: Sem.-V, Paper-I:

A. Major Physiology Experiments:

1. To study the effect of temperature on the permeability of cell membrane.
2. To study the effect of various organic solvents on the permeability of cell membrane.
3. To determine the osmotic pressure/potential of vacuolar sap by plasmolytic method.
4. To study ascent of sap in suitable plant material.

5. To compare rate of transpiration from two surfaces of leaf by cobalt chloride method and Bell jar method.
6. To separate chlorophyll pigments by paper chromatography and calculate Rf value of different pigments.
7. To measure the rate of photosynthesis by Willmott's bubbler under variable conditions of light (quantity and quality).
8. To measure the rate of photosynthesis by Willmott's bubbler under variable conditions of temperature and CO₂ concentration.
9. To determine the respiratory quotient (RQ) of the given plant material.

II. Minor Physiology Experiments:

1. To demonstrate the phenomenon of imbibition.
2. To demonstrate root pressure in suitable plant material.
3. To demonstrate that light is necessary for photosynthesis (Ganong's light screen).
4. To demonstrate that light, chlorophyll and CO₂ is necessary for photosynthesis (Moll's half leaf experiment).
5. To demonstrate fermentation by Kuhne's tube.
6. To demonstrate the evolution of CO₂ during respiration.

C. Plant movement, Photoperiodism, mineral nutrition and hydroponics:

1. To demonstrate the phenomenon of nastic movement in *Mimosa pudica* plant
2. To demonstrate the phenomenon of soil less growth in plants mentioned in syllabus.

B.Sc. SEMESTER-V
PAPER-II
(Plant Ecology and Organic Farming)

Unit-I: Plant and environment:

1. **Ecology:** Definition, branches and significance.
2. **Climatic factors:** Atmospheric (Gaseous composition); Effect of Light and Temperature on vegetation
3. **Edaphic factors:** Pedogenesis, Soil profile, Soil micro-organisms.
4. **Physiographic factors:** Biotic factors: Interaction between plants and animals and humans and interaction between plants growing in a community.

Unit-II: Ecosystem:

1. **Ecosystem:** Definition, types; Components: Biotic and abiotic components, Food chain, Food web, Ecological pyramids.
2. **Autecology:** Definition, Importance, Ecads, Ecotypes: Characteristics and importance, Growth curve.
3. **Synecology:** Definition, Study of community: Quantitative characteristics: Frequency, Density, Abundance; Qualitative characteristics: Life forms, Raunkier's Biological Spectrum and Synthetic characteristics: Presence, fidelity and dominance.

Unit-III: Plant Succession and adaptations:

1. **Plant Succession:** Definition, Causes of succession, Hydrosere, Xerosere
2. **Plant Adaptations:** Morphological and anatomical adaptations of Hydrophyte (*Hydrila*, *Nymphaea*), Xerophyte (*Casuarina*, *Nerium*), Halophyte and Epiphyte (*Vanda*).
3. **Biogeochemical cycles:** Nitrogen and Phosphorous

Unit-IV: Skill development: Organic farming:

1. **Organic farming:** Definition, concept, advantages and disadvantages, green manure and organic fertilizers.
2. **Methods:** Recycling of biodegradable kitchen, agricultural and industrial waste.
3. **Methods of:** Preparation of Bio-compost, preparation of vermicompost and its type, isolation and inoculum production of VAM.
4. **Organic manure:** Effect of organic manures on growth and yield productivity of various crop plants.

List of Practical: Paper-II:

1. To determine frequency, density and abundance of community by quadrat method.
2. To determine homogeneity of vegetation by Raunkier's frequency diagram.
3. To determine the minimum number of quadrates required for reliable estimate of biomass in grasslands.
4. To study the frequency of herbaceous species in grassland and to compare the frequency distribution with Raunkier's standard frequency diagram.
5. To measure the above ground plant biomass in a grassland.
6. To study soil profile at different locations of nearby area.
7. To estimate transparency, pH and temperature of different water bodies.
8. To estimate salinity of different water samples.

- 9 To study the morphological and anatomical characteristics of hydrophyte, xerophyte, halophytes and epiphyte with reference to ecological adaptations.
 10 Collection and identification of various organic manures.
 11 To study the methodology of preparation of vermi-compost.

Note: 1. Developmental stages are not expected,
 2. Short excursion tour/ visit to Organic farm is expected

**BOTANY PRACTICAL EXAMINATION
 SEMESTER-V**

ME: FIVE HOURS

MAX. MARKS: 30

- Q 1: To perform the given major physiology experiment (A) and report the findings. 05 M
 Q 2: To perform the given minor physiology experiment (B) and report the findings. 03 M
 Q 3: To perform the given ecological experiment (C) and report the finding. 05 M
 Q 4: To study morphological and anatomical characteristics of the given plant material (D), with reference to ecological adaptations. 05 M
 Q 5: Spotting: 04 M
- (E) Plant physiology (F) Ecology
 (G) Hydroponics (H) Manures.
- Q 6: Viva-voce. 03 M
 Q 7: Practical Record and Excursion report. 05 M

Suggested Reading: Semester-V

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- Taiz, L. and Zeiger, E. (1998): Plant Physiology. Sinaucr Associates, Inc., Publishers, Massachus, USA.

B. Sc. SEMESTER-VI
PAPER-I
(Biochemistry, Biotechnology and Herbal Technology)



Unit-I: Biochemistry: Lipids and Enzymology:

1. **Lipids:** Definition, Properties and role of fatty acids, oils and waxes; Degradation of fats (β -Oxidation and Glyoxylic acid cycle)
2. **Enzymology:** Enzymes: Definition, Nomenclature and classification of enzymes; Characteristics (Properties) of enzymes
3. **Basic concepts of enzymology:** Holoenzyme, Apoenzyme, Prosthetic group, Co-enzyme, Co-factor, Active site, Isoenzyme
4. **Mechanism of enzyme action:** Enzyme-substrate complex theory, Lock and key model, Induced fit model
5. **Enzyme inhibitors:** Definition, Competitive and noncompetitive.

Unit II: Plant tissue culture:

1. **Brief account of:** Tissue culture, Totipotency, Explant, Aseptic cultures, Micropropagation, Differentiation and Morphogenesis.
2. **Methods of sterilization:** Autoclaving, Dry heat and Chemical sterilization
3. **Culture Media:** MS media (Preparation and nutrient contents)
4. **Tissue Cultures:** Callus and organ culture (Shoot tip and Anther culture) and its applications
5. Protoplast culture and its applications.
6. Applications of tissue culture

Unit-III: Genetic engineering:

1. **Genetic engineering:** Definition, Tools in genetic engineering: Enzymes (Restriction enzymes, Ligases, DNA-polymerases), Host.
2. **Cloning vectors:** General Characteristics, method of Isolation of vector, Plasmid as a vector (pBR³²²).
3. **DNA Library:** Definition, Construction of Genomic library and C-DNA library and their significance
4. **Agrobacterium mediated gene transfer:** Structure of Ti-plasmid, mechanism of transfer.
5. Role of biotechnology in crop improvement

Unit-IV: Skill Development: Herbal technology:

1. **Herbal technology:** History and importance of herbal technology
2. **Basic concepts:** Drugs, cosmetics, Natural dyes, Difference between organized and unorganized drugs
3. **Methods:** Cultivation, harvesting, processing, storage and utilization of *Withania somnifera*, *Aloe vera*, *Ocimum sanctum*
4. **Dye yielding herbal plants:** *Lawsonia alba* (Henna), *Rivinia humilis*, *Indigofera tinctoria*
5. **Herbs used in cosmetics:** *Cocos nucifera* (Coconut oil), *Curcuma longa* (Turmeric), *Cucumis sativa* (Cucumber), *Lavendula* sps. (Lavender oil), *Rosa* sps. (Rose), *Hibiscus rosa-sinensis* (China rose) (With reference to parts used, chemical constituents, uses and Marketed products)

List of Practical: Paper-I:

1. To study the effect of temperature on the activity of enzyme Amylase in the suitable plant material.
2. To study the effect of temperature on the activity of enzyme Catalase/Peroxidase in the suitable plant material.
3. To perform micro-chemical test for oils/lipids.
4. To study principle and working of autoclave, oven, pH meter, laminar air flow.
5. To study the structure of plasmid vector and Ti-plasmid from the photograph/diagrams.
6. Extraction and preparation of *Aloe vera* juice from mature leaves of plant.
7. To study the method of preparation of Rose-water.
8. To study the method of preparation of oil from *Hibiscus* flower.
9. To study the method of extraction of natural dye from suitable dye yielding plant.

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**B. Sc. SEMESTER-VI
PAPER-II**

(Phytogeography, Utilization of Plants, Techniques and Pharmacognosy)

Unit-I: Phytogeography, Pollution, Natural resources:

1. **Phytogeography:** Principles of phytogeography, Distribution (Wides, Endemics, Discontinuous species); Climatic regions of India, Phytogeographic regions of India (Chatterjee, 1962) (Name, Distribution area, Typical Vegetation)
2. **Environmental pollution:** Causes and Control measures of Agriculture pollution and Noise pollution
3. **Natural Resources:** Renewable and Non-renewable resources, factors for their depletion
4. **Conservation strategies:** Conservation of forest and water resources.

Unit-II: Utilization of plants and Ethnobotany:

1. **Utilization of plants:** Morphology, Utilization and important chemical constituents of the plants: Food (Wheat), Oil (Groundnut), Fiber (Cotton), Spices (Clove), Beverages (Coffee), Medicinal (*Adhatoda vassica*), and Rubber.
2. **Ethnobotany:** Definition, Brief history, branches and importance of Ethnobotany.
3. **Plants of ethnobotanical importance:** Vegetable, Fruits, Seeds, Medicinal and Narcotics (Two plants each with reference to family, parts used and tribal areas)

Unit-III: Microscopy and Techniques:

1. **Microscopy:** Principle, types and application of microscope (Light, Fluorescent, SEM and TEM).
2. **Techniques:** Principle, types and application of Centrifugation, Electrophoresis (SDS-PAGE and Agarose), Spectroscopy (UV-Vis), Chromatography (Paper and Thin Layer Chromatography (TLC))

Unit-IV: Skill development: Pharmacognosy:

1. **Pharmacognosy:** Definition and scope, Drug adulteration: Types; methods of drug evaluation: Biological testing of herbal drugs, phytochemical screening tests for secondary metabolites (Alkaloids and Flavonoids)
2. **Pharmacological plants:** Biological source, staining, diagnosis, micro-chemical tests, chemical constituents, preparation and uses of drug extracted from the plants: *Datura* leaf, *Vinca rosea*, *Plantago ovata* (Isapgol) seeds, *Linum usitatissimum* (Linseed) seeds, *Elettaria cardamomum* fruit, *Coriandrum sativum* fruit, *Eugenia caryophyllus* (Clove) flower-bud, *Rauwolfia serpentina* root, *Zingiber officinale* (Ginger) rhizome.

- Note:** 1. Developmental stages are not expected,
2. Short excursion tour is expected

List of Practical: Paper-II:

1. To find out the level of noise pollution of different nearby areas with the help of decimeter and compare it with tolerance limit.
2. To study the morphology, utilization and important chemical constituents of plants mentioned in theory (Utilization of plants).
3. To study ethnobotanical importance of plants under the different categories mentioned in theory.
4. To study the principle and working of microscope, spectrophotometer, centrifuge and gel-electrophoresis apparatus.
5. To study different adulterants used with reference to drug adulteration.
6. To study biological source, chemical constituents, preparation and uses of drugs obtained from plants mentioned in theory.

BOTANY PRACTICAL EXAMINATION SEMESTER-VI

TIME: FIVE HOURS

MAX. MARKS: 30

- Q. 1: To perform the given **biochemical experiment (A)** and report the findings. 03 M
- Q. 2: To perform the given **micro-chemical test (B)** and report the findings. 03 M
- Q. 3: To extract and prepare the **herbal product (C)** from the given plant material. 04M
- Q. 4: Write about the **morphology and utilization** of the given plant material **(D)**. 03 M
- Q. 5: To prepare **crude drug extract** from the given plant material **(E)** and mention its use. 04 M
- Q. 6: Spotting: 05 M
- (F) Biotechnology (Instrument) (G) Genetic engineering (Tool) - (H) Herbal plant
- (I) Ethnobotany (J) Plant used in Pharmacognosy
- Q. 7: Viva-voce. 03 M
- Q. 8: Practical Record and Excursion report. 05 M

Suggested Readings: Semester-VI

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