

**B.Sc. Part – I  
BOTANY 2021**

Theory

Course	Nomenclature	Number of Papers	Number of Periods per week	Maximum marks	Minimum marks
Paper I	Algae, Lichens and Bryophytes	1	2	50	54
Paper II	Mycology, Microbiology and Phytopathology	1	2	50	
Paper III	Palaeobotany, Pteridophytes and Gymnosperms	1	2	50	
PRACTICAL COURSE			6	75	27

Duration of examination of each theory papers

3 hours

Duration of examination of practicals

5 hours

**PAPER I: ALGAE, LICHENS AND BRYOPHYTES**

**Unit I:** General characters and classification of algae. Important features of Chlorophyceae-structure and life history of *Volvox*, *Oedogonium* and *Coleochaete*.

**Unit II:** Important features of Charophyceae- structure and life history of *Chara*; Xanthophyceae-structure and life history of *Vaucheria*; Phaeophyceae-structure and life cycle of *Ectocarpus* and *Sargassum*.

**Unit III:** Important features of Rhodophyceae- Structure and life history of *Polysiphonia*. Economic importance of Algae. Morphology, anatomy and reproduction of Lichens. Brief account on *Parmelia* and *Usnea*. Economic importance of Lichens.

**Unit IV:** General characters, alternation of generations and classification of Bryophyta. Characters and Classification of Hepaticopsida- structure and life history of *Riccia* and *Marchantia*.

**Unit V:** Characters and classification of Anthocerotopsida- structure and life history of *Anthoceros*; Bryopsida- structure and life history of *Sphagnum*. Economic importance of Bryophyta.

**Suggested Laboratory Exercises**

Algae: Microscopic preparation and study of following algal materials: *Volvox*, *Oedogonium*, *Coleochaete*, *Vaucheria*, *Chara*, *Ectocarpus*, *Sargassum* and *Polysiphonia*.

Lichens: Study of *Parmelia* and *Usnea*

Bryophytes: Study of external morphology and microscopic preparations of following Bryophytes: *Riccia*, *Marchantia*, *Anthoceros* and *Sphagnum*.

### **Suggested Readings**

- Bold, H.C., Alexopoulos, C.J. and Delevoryas, T. Morphology of Plant and Fungi (4th Ed.) Harper & Foul Co., New York, 1980.
- Ghemawat, M.S., Kapoor, J.N. and Narayan, H.S. A text book of Algae, Ramesh Book Depot, Jaipur, 1976.
- Gilbert, M.S. Cryptogamic Botany, Vol. I & II (2nd Ed.), Tata McGraw Hill, Publishing Co. Ltd., New Delhi, 1985.
- Kumar, H.D. Introductory Phycology, Affiliated East–West Press, Ltd., New York, 1988.
- Pandey, S.N. and Trivedi, P.S.A Text Book of Botany 2000 Volume I, Vikas Pub. House Pvt. Ltd., New Delhi.
- Puri, P. Bryophytes, Atmaram & Sons, Delhi, Lucknow, 1985.
- Singh, V., Pande, P.C. and Jain, D.K. A Text Book of Botany, Rastogi & Co., Meerut, 2001.
- Vashista, B.R. Botany for Degree Students (Algae, Fungi Bryophyta), S. Chand & Co. Ltd., New Delhi, 2002.

## **PAPER II: MYCOLOGY, MICROBIOLOGY AND PHYTOPATHOLOGY**

**Unit I:** General characters and Classification of Fungi. Important features and life history of Mastigomycotina–*Pythium* and *Albugo*; *Zygomycotina*–*Rhizopus*; *Ascomycotina*–*Saccharomyces* and *Penicillium*.

**Unit II:** Important features and life history of Basidiomycotina– *Ustilago*, *Puccinia* and *Agaricus*; Deuteromycotina– *Alternaria* and *Colletotrichum*. Brief account on local wild edible macrofungi–*Phellorinia* (Maru Kumbhi). Economic importance of fungi.

**Unit III:** General characters, structure and multiplication of viruses. Structure of Tobacco mosaic virus (TMV) and Covid-19. Transmission of plant viruses. Structure and replication of Bacteriophages. General account of Viroids and Prions.

**Unit IV:** Bacteria: General characters, structure, nutrition, reproduction and economic importance of Bacteria. Cyanobacteria–Important features and Life history of *Nostoc* and *Oscillatoria*. Nitrogen fixation–by Cyanobacteria (Blue green algae). General account of Mycoplasma and Phytoplasma.

**Unit V:** Symptoms, causal organism and disease cycle of plant diseases with special reference to green ear disease of Bajra, loose smut of wheat, citrus canker, little leaf of brinjal and root knot nematode disease of vegetables. General account of plant disease management.

### **Suggested Laboratory Exercises**

Microscopic preparation and study of following fungal materials: *Albugo*, *Rhizopus*, *Saccharomyces*, *Penicillium*, *Ustilago*, *Puccinia*, *Agaricus*, *Alternaria* and *Colletotrichum*. Specimen of local mushroom (*Phellorinia*).

Viruses: Tobacco mosaic virus (TMV).

Bacteria: Gram staining of bacteria, Root nodules–*Rhizobia* (specimen)

Cyanobacteria: Microscopic preparation and study of *Nostoc* and *Oscillatoria*.

Study of symptoms of following diseases (specimen or photographs):

Green ear disease of bajra

Loose smut of wheat

Black rust of wheat

Citrus canker

Little leaf of brinjal  
Root knot nematode disease

### **Suggested Readings**

- Alexopoulos, C.J. and Mims. Introductory Mycology, John Wiley and Sons, New York, 2000.  
Bilgrami, K.S. and Dube, H.C. A Text Book of Modern Plant Pathology, Vikas Publ. House, New Delhi, 1976.  
Biswas, S.B. and Biswas, A. An Introduction to Viruses, Vikas Publ. House, New Delhi, 2000.  
Clifton, A. Introduction to Bacteria, McGraw Hill Co., New York, 1985.  
Dube, H.C. Fungi, Rastogi Publication, Meerut, 1989.  
Kaushik, P. Microbiology, Emkay Publication, 2001.  
Madahar, C.L. Introduction to plant viruses, S. Chand & Co. Ltd., New Delhi, 1978.  
Palezer, Chan and King. Microbiology, McGraw Hill Book Co., London, 1995.  
Pathak, V.N. Fundamentals of Plant Pathology, Agro Botanica. 2000.  
Purohit, S.S. Microbiology, Agro. Bot. Publication, Jodhpur, 2002.  
Sharma, O.P. Fungi, Today and tomorrow Publication, 2000.  
Sharma, P.D. Microbiology and Plant Pathology, Rastogi Publ. Meerut, 2003.  
Singh, V. and Srivastava, V. Introduction to Bacteria, Vikas Publication, 1998.  
Vashista, B.R. Botany for Degree Student Fungi, S. Chand & Co., New Delhi, 2001.

## **PAPER III: PALAEOBOTANY, PTERIDOPHYTES AND GYMNOSPERMS**

**Unit I:** Geological time scale and Fossilization. General characters and classification of Pteridophytes. Stellar systems in Pteridophyta. Brief account on fossil *Rhynia*. Important characters of Psilophyta-structure and life cycle of *Psilotum*.

**Unit II:** Important characters of Lycopphyta-structure and life cycle of *Lycopodium* and *Selaginella*; Sphenophyta-structure and life cycle of *Equisetum*.

**Unit III:** Important characters of Pterophyta-structure and life history of *Adiantum* and *Marsilea*. Heterospory and seed habit in Pteridophyta. Economic importance of Pteridophyta.

**Unit IV:** General characteristics, classification and evolution of gymnosperms. Important characters of Cycadophyta- Morphology, anatomy, reproduction and life cycle of *Cycas*.

**Unit V:** Important characters of Coniferophyta-Morphology, Anatomy, reproduction and life cycle of *Pinus*; Gnetophyta- Morphology, Anatomy, reproduction and life cycle of *Ephedra*. Economic importance of Gymnosperms.

### **Suggested Laboratory Exercises**

#### **Palaeobotany:**

Image specimen of *Rhynia*.

#### **Pteridophytes:**

Study of external morphology of *Lycopodium*, *Selaginella*, *Equisetm*, *Adiantum* and *Marsilea*.

Microscopic study of temporary double stained preparations of stem/rhizome of *Lycopodium*, *Selaginella*,

*Equisetum* and *Marsilea*.

**Study of temporary single stained microscopic preparations of L.S. of cone of Lycopodium, Selaginella and Equisetum. L.S. of Sporophyll of Adiantum and H.L.S. of sporocarp of Marsilea.**

Gymnosperms: Study of external morphology of plant parts of *Cycas*: young and old foliage leaf, scale leaf, male cone, microsporophyll, megasporophyll and mature seed (if available).

Microscopic temporary double stained preparations of rachis and leaflet of *Cycas*.

Study of T.S. of normal and Corolloid root by permanent slides.

Study of external morphology of plant parts of *Pinus* habit, long and dwarf shoot, male cone; and female cone.

Microscopic temporary preparation of pollen grains (W.M.) of *Pinus*.

Study through permanent slides T.S. stem: young and old; male/female cone of *Pinus*.

Study of habit and structure of whole male and female cone of *Ephedra*.

Microscopic preparation of male and female flowers of *Ephedra*.

**Suggested Readings**

Bold, H.C., Alexopolous, C.J. and Delevoryas, T. Morphology of plant and fungi (4th ed.), Harper and Foul, Co., New York, 1980.

Gifford, E.M. and Foster, A.S. Morphology and Evolution of Vascular Plants, W.H. Freeman and Company, New York, 1988.

Pandey, S.N., Mishra, S.P., Trivedi, P.S. A Text Book of Botany Vol. II, VikasPub.House Pvt. Ltd., New Delhi 2000.

Raven, P.H. Evert, R.F. and Eichhom, S.C. Biology of plants, (5th ed.), W.H. Reema and Co., Worth Publication, New York, U.S.A., 1999.

Sharma, O.P. Pteridophytes, Today and tomorrow Publication, 2000.

Sporne, K.R. The Morphology of Gymnosperms, B.I. Publ. Pvt., Bombay, Calcutta, Delhi, 1991.

Vashista, P.C. Gymnosperm, S. Chand & Co. Ltd., New Delhi, 2002.

Vashista, P.C. Pteridophyta, S. Chand & Co. Ltd., New Delhi, 2002.

Wilson, N.S. and Rothewall, G.W. Palaeobotany and evolution of Plants, (2nd ed.), Cambridge University Press, U.K., 1993.

**Suggested Laboratory Exercises**

**Part -I: Algae, Fungi, Lichens, Microbiology and Plant Pathology**

**Part-II: Bryophytes, Pteridophytes, Gymnosperms and Palaeobotany**

**Part-I**

**Algae:** *Volvox*, *Oedogonium*, *Coleochaete*, *Chara*, *Ectocarpus*, *Sargassum* and *Polysiphonia*

**Fungi:** *Albugo*, *Rhizopus*, *Saccharomyces*, *Penicillium*, *Ustilago*, *Puccinia* (Wheat), *Agaricus*, *Alternari* and *Colletotrichum*.

**Lichen:** External morphology of different types. Crustose (*Rhizocarpon*), Foliose (*Parmelia*) and Fruticose (*Usnea*)

**Microbiology:**

- a) Gram's staining of bacteria
- b) *Nostoc*
- c) *Oscillatoria*
- d) Root nodules- *Rhizobia* (specimen)
- e) Phytoplasma (Image specimen)
- f) Tobacco mosaic virus (Image specimen)

**Plant Pathology:**

Symptoms of the following diseases:

- (a) Green ear disease of bajra
- (b) Loose smut of wheat
- (c) Citrus canker
- (d) Little leaf of brinjal
- (e) Root knot nematodes of vegetables

## **Part-II**

### **Bryophytes:**

External morphology and microscopic preparation of following genera:  
*Riccia*, *Marchantia*, *Anthoceros* and *Sphagnum*

### **Pteridophytes:**

*Lycopodium*: External morphology, stem and cone (slide only)

*Selaginella*: External morphology, stem and cone.

*Equisetum*: External morphology, stem (internodes) and cone (slide only)

*Marsilea*: External morphology, rhizome, petiole and sporocarp (H.L.S.)

*Adiantum*: External morphology and sporophyll (L.S.)

### **Gymnosperms:**

*Cycas*: External morphology, (normal root, coralloid root and rachis- slides only),  
Leaflet (T.S.), male cone and female Megasporophyll (specimen)

*Pinus*: External morphology, needle (T.S.), stem (slide only) pollen grains, male and female cones

*Ephedra*: External morphology, stem (T.S.), male and female reproductive parts.

### **Palaeobotany:**

*Rhynia* (Image specimen)

(B.Sc. Part-I Practical Examination)

Time : 5 Hours

Max. Marks : 75  
Mim. Pass. Marks : 27

	<u>Regular</u>	<u>Ex-Student</u>
Q.1 Cut a T.S/L. "A" (Pteridophyta/Gymnosperm) and make Single/ double stained temporary mount of the same. Draw labeled diagram. Identify the material and giving reasons. Leave your preparation for inspection दिये गये पदार्थ "ए" का अनुप्रस्थ /अनुदैर्घ्य/ क्षैतिज अनुदैर्घ्य का काट काटिए एवं इसका एकल /दोहवा अभिरंजित अस्थाई आरोपण कीजिए। नामांकित चित्र बनाईए। कारण देते हुए पदार्थ को पहचानिए। अपनी कृति को निरीक्षण के लिये छोड़िए।	11	13
Q.2 Make suitable preparation of the given material "B" (Algae/Bryophyta ). Draw labeled diagram. <b>Identify and comments upon the features of interest. Leave your preparation for inspection.</b> दिये गये पदार्थ "बी" का उचित आरोपण कर नामांकित चित्र बनाईए। इसकी पहचान कीजिए व प्रमुख लक्षणों का उल्लेख कीजिए। अपनी कृति को निरीक्षण के लिये छोड़िए।	11	13
Q.3 Make suitable preparation of the given materials "C" and "D" Identify and comments upon your Preparation. Leave your preparation for inspection A. Fungal material (material C) B. Bacterial staining (Material D) दिये गये पदार्थ "सी" व "डी" का उचित आरोपण कर पहचानिए। अपनी कृति पर टिप्पणी / व्याख्या कीजिए एवं निरीक्षण के लिए छोड़िये। { ए } कवक पदार्थ { पदार्थ सी } { बी } जीवाणु पदार्थ { पदार्थ डी }	11 (7+4)	13(8+5)
Q.4 Identify and comments upon the given spots 1 to 9 दिये गये प्रादर्श 1 से 9 को पहचानिए एवं व्याख्या कीजिए । (प्रत्येक पेपर में से तीन) 1 6 2 7 3 8 4 9 5	27	27
Q.5 Viva Voce/ मौखिक परीक्षा	06	09
Q.6 Practical records / प्रायोगिक अभिलेख	09	00
<b>Total</b>	<b>75</b>	<b>75</b>

**B.Sc. Part – II  
BOTANY 2022**

**Theory**

Course	Nomenclature	Number of Papers	Number of Periods per week	Maximum marks	Minimum marks
Paper I	Taxonomy and Embryology of Angiosperms	1	2	50	54
Paper II	Anatomy of Angiosperms, Economic Botany and Ethnobotany	1	2	50	
Paper III	Cell Biology, Genetics, Plant Breeding and Evolution	1	2	50	
PRACTICAL COURSE			6	75	27

Duration of examination of each theory papers 3 hours

Duration of examination of practicals 5 hours

**PAPER I: TAXONOMY AND EMBRYOLOGY OF ANGIOSPERMS**

**Unit I:** Diversity in plant form in annuals, biennials and perennials, Canopy architecture in angiosperms: tree-origin, development, arrangement and diversity in size and shape, Flower-modified shoot, structure and development of flower, Inflorescence-types of Inflorescence.

**Unit II:** Angiosperms: Origin and evolution. Some examples of primitive angiosperms. Angiosperm taxonomy; (Alpha-taxonomy, Omega-taxonomy, holotaxonomy) Taxonomic literature. Botanical nomenclature; principles and rules; taxonomic ranks, type concept, principle of priority. Classification of angiosperms; salient features of the systems proposed by Bentham and Hooker and Engler and Prantl.

**Unit III:** Major contributions of cytology and molecular biology, phytochemistry and taxometrics to taxonomy. Diversity of flowering plants as illustrated by members of the families Ranunculaceae, Papaveraceae, Caryophyllaceae, Capparidaceae, Cucurbitaceae, Rutaceae and Apiaceae.

**Unit IV:** Diversity of flowering plants as illustrated by members of the families Asteraceae, Acanthaceae, Apocynaceae, Asclepiadaceae, Scrophulariaceae, Lamiaceae, Euphorbiaceae, Musaceae and Poaceae.

**Unit V:** Embryology: Structure of anther and pistil. Development of the male and female gametophytes; pollen-pistil interactions, self incompatibility; Double fertilization; Development of endosperm and embryo; Brief account of experimental embryology. Basics of gene imprinting.

### Suggested Laboratory Exercises

Field study of diversities found in leaf shapes, size, thickness and surface properties.

The following families are for detailed taxonomic studies:

(i)	Ranunculaceae:	<i>Ranunculus, Delphinium</i>
(ii)	Papaveraceae:	<i>Papaver, Argemone</i>
(iii)	Caryophyllaceae:	<i>Dianthus, Saponaria</i>
(iv)	Capparidaceae:	<i>Capparis, Cleome</i>
(v)	Cucurbitaceae:	Any cucurbit
(vi)	Rutaceae:	<i>Citrus</i>
(vii)	Apiaceae:	<i>Coriandrum</i>
(viii)	Asteraceae:	<i>Helianthus, Sonchus</i>
(ix)	Acanthaceae:	<i>Adhathoda, Barleria</i>
(x)	Apocynaceae:	<i>Catharanthus, Thevetia, Nerium</i>
(xi)	Asclepiadaceae:	<i>Calotropis</i>
(xii)	Scrophulariaceae:	<i>Antirrhinum, Linaria</i>
(xiii)	Lamiaceae:	<i>Ocimum, Salvia</i>
(xiv)	Euphorbiaceae:	<i>Euphorbia pulchirrima, Ricinus</i>
(xv)	Musaceae:	<i>Musa</i>
(xvi)	Poaceae:	<i>Triticum</i>

### Spots:

- (i) **Leaf:** Simple and compound
- (ii) **Inflorescence:** Cyathium, Verticillaster and Umbel
- (iii) **Fruits:** Pepo, Caryopsis, Cremocarp and Hesperidium
- (iv) **Translator structure:** *Calotropis*
- (v) Study of **placentation:** Axile, Free-central, Parietal, Marginal and Basal [slides as well as T.S. of ovary]
- (vi) Structure of **ovule:** Orthotropus (slide), Anatropus (slide & in *Calotropis*, pea & Dog flower), Campylotropus (slide & in *Capparis*, & *Dianthus*) and Amphitropus (slide & in *Ranunculus* & *Papaver*)
- (vii) **Endosperm & embryo:** Coconut and Ruminant in walnut & Sitafoal. Embryo developments (slides only)

### Suggested Readings

Bhandari, M.M. Flora of Indian Desert.

Bhojwani, S.S. and Bhatnagar, S.P. The Embryology of Angiosperms, 4th Revised and enlarged edition, Vikas Publ., New Delhi, 2002.

Davis, P.H. and Heywood, V.H. Principles of Angiosperm Taxonomy, Oliver and Boyd, London, 1963.

Fegerig K. and Vender Pifi The Principles of Pollination Ecology, Pergamon Press, 1979.

Gifford, E.M. and Foster, A.S. Morphology and Evolution of Vascular Plants, W.H. Freeman and Company, New York, 1979.

Heywood, V.H. and Moore, D.M. (eds.) Morphology and Evolution of Vascular Plants, W.H. Freeman and Company, New York, 1984.



- Jeffrey, C. An Introduction to Plant Taxonomy, Cambridge University Press, Cambridge, London, 1982.
- Jones, S.D. Jr. and Suchsinger, A.E. Plant Systematic (2nd ed.) McGraw-Hill Book Co., New York, 1986.
- Maheshwari, J.K. Flora of Delhi, CSIR, New Delhi, 1963.
- Redford, A.E.: Fundamentals of Plant Systematics, Harper and Row, New York, 1986.
- Sharma, O.P. Taxonomy: Tata McGraw Hill Pub. Company Ltd., New Delhi 2000.
- Singh, G. Plant Systematics – Theory and Practices, Oxford and IBH Pvt. Ltd., New Delhi, 1999.
- Singh, V., Pandey, P.C. and Jain, D.K. Angiosperms, 2005, Rastogi Pub., Meerut.

## **PAPER II: ANATOMY OF ANGIOSPERMS, ECONOMIC BOTANY AND ETHNOBOTANY**

- Unit I:** Anatomy of Angiosperms: Concept of stem cell in plants. Root system; Root apical meristem; differentiation of primary and secondary tissues and their roles; structural modification for storage, respiration, reproduction and for interaction with microbes.
- Unit II:** Shoot system: The shoot apical meristem and its histological organization; vascularization of primary shoot in monocotyledons and dicotyledons; cambium and its functions; formation of secondary xylem, a general account of wood structure in relation to conduction of water and minerals; characteristics of growth rings, sapwood and heart wood; secondary phloem-structure, function relationship; Periderm.
- Unit III:** Abnormal secondary growth and Leaf: Abnormal secondary growth in stems due to abnormal origin and activity of cambium. Leaf: Internal structure in relation to photosynthesis and water loss; adaptations to water stress; senescence and abscission.
- Unit IV:** Economic Botany, Food plants: Rice, wheat, maize, potato, sugarcane. Fibers: Cotton and Jute. Vegetable oils: Groundnut, mustard and coconut, General account of sources of firewood, timber and bamboos. Beverages: Tea and coffee; Rubber.
- Unit V:** Spices and Condiments: General account. Medicinal plants with special reference to Rajasthan: *Aloe*, *Asparagus*, *Commiphora*, *Boswellia*, *Pedaliium*, *Zyziphus*, *Haloxylon*, *Tribulus*, *Vitex*, and *Withania*. Ethnobotany: Introduction, Methods of Ethnobotanical studies, knowledge of aboriginals in Rajasthan.

### **Suggested Laboratory Exercises**

#### **Anatomy:**

- (i) Types of simple and complex tissues: (Sunflower/ Sonchus, Cucurbit stem)
- (ii) **Dicot stem:** *Sunflower*, *Cucurbit*, *Nyctanthes*, *Bignonia*, *Leptadenia*, *Salvadora*, *Boerhavia* and *Achyranthes*, *Capparis*.
- (iii) **Monocot stem:** Maize/ *Triticum* and *Dracaena*
- (iv) **Dicot root:** *Tinospora*
- (v) **Monocot root:** Maize

- (vi) **Dicot leaf:** *Nerium* and *Ficus*  
(vii) **Monocot leaf:** Maize / any other grass

**Spots:**

- (i) Slide of above any plant material for anatomical study  
(ii) Different types of stomata and thickening in xylem vessels (slides/photographs)  
(iii) Medicinal plants/Ethnobotany specimens:  
Medicinal plants: *Aloe*, *Asparagus*, *Commiphora*, *Tribulus* and *Withania*  
Ethnobotany: *Abrus*, *Leptadenia*, *Calotropis* and *Crotalaria*

**Suggested Readings**

- Cutter, E.G. Plant Anatomy: Experiment and Interpretation, Part II. Organs, Edward Arnold, London, 1971.  
Esau, K. Anatomy of Seed Plants, 2nd John Wiley & Sons, New York, 1977.  
Fahn, A. Plant Anatomy. 2nd ed. Pergamon Press, Oxford, 1974.  
Kocchar, S.L. Economic Botany in Tropics. 2nd ed. Mac-millan India Ltd., New Delhi, 1998.  
Mauseth, J.D. Plant Anatomy, The Benjamin/Cummings Publ. Company Inc., Menlo Park, California, USA, 1988.  
Sambamurthy, A.V.S.S. and Subramanyam, N.S. A Text book of Economic Botany, Wiley Eastern Ltd., New York, 1989.  
Sharma, O.P. Hill's Economic Botany (Late Dr. A.F. Hill, Adapted by O.P. Sharma), Tata McGraw Hill Co., Ltd., New Delhi, 1996.  
Simpson, B.B. and Conner-Ororzaly, M. Economic Botany Plants in Our World, McGraw Hill, New York, 1986.

**PAPER III: CELL BIOLOGY, GENETICS, PLANT BREEDING AND EVOLUTION**

**Unit I:** History of cell biology: Concept of cell and cell theory. Cell cycle and its regulation. Mitosis and meiosis. Structural and Molecular organization of cell. Structure and function of cell wall; plasmodesmata, plasma membrane; Golgi complex, plastid, mitochondria, endoplasmic reticulum, peroxisomes, vacuoles and nucleus.

**Unit II:** Chromatin organization: Organization and structure of chromosomes. Concept of nucleosomes, chromatin remodeling. Types of chromosomes and determination of sex in plants. Chromosome alteration: Structural alteration; deletion, duplication, translocation, inversion; Numerical variation: aneuploidy and polyploidy. Molecular basis of mutation: Spontaneous and induced, brief account of DNA damage and repair. Introduction to epigenetics.

**Unit III:** Nature of inheritance; Laws of Mendelian inheritance and its exceptions. Crossing-over and linkage analysis. DNA the genetic material: Structure and replication, brief account of DNA-protein interaction. Definition of a gene-modern Concept of gene (Promoter, coding sequences, terminator). RNA polymerases and general transcription. Regulation of gene expression in prokaryotes and basics of gene regulation in eukaryotes.

**Unit IV:** Origin of Agriculture, Centers of origin of crop plants and centers of Diversity. Concepts of Centers and Non-center (Harlan Hypothesis) Principles of plant breeding- Domestication, Introduction, Selection, Clonal propagation, Hybridization, Mutation breeding; Breeding work done on wheat; Green revolution; Assessment and Consequences; Biodiversity and Conservation of germplasm.

**Unit V:** Theories of Evolution: Catastrophism, The Lamark's theory, Darwin's theory, Evidences of organic evolution, mechanism of evolution. Origin of basic biomolecules evolution of prokaryotic and eukaryotic cell. and Origin of species. Population genetics: Allele and genotype frequency, Hardy- Weinberg principles.

### **Suggested Laboratory Exercises**

#### **Cytogenetics/Genetics/Plant breeding/ Evolution:**

1. Slide preparation of *Allium* root tips (mitosis) / *Allium* flower bud (meiosis)

#### **Spots:**

- (i) Slides/Models/Photographs/Drawings: Cell structure and cell organelles: Molecular organization of Plasmodesmata&plasmalemma, Chloroplast, Mitochondria, Nucleus Nuclear pore complex, Peroxisome, Chromosomes (Types and Solenoid Model), DNA- Physical & Chemical properties
- (ii) Chart showing pure line and mass selection
- (iii) With the help of seed samples explain the principles involved in the following ratio: 3:1, 1:2:1, 1:1, 9:3:3:1, 9:7 and 12:3:1
- (iv) Hardy-Weinberg's Principle
- (v) Photographs with names, "Scientific Contribution of Darwin, Lamarck, de-Vries Vavilov, J.R. Harlan
- (vi) Chromosomal Abbreviation (Numerical & Structural)

#### **Suggested Readings**

Alberts, B., Bray, D. Lewis, J., Raff, M., Roberts, K. and Watson, I.D. *Molecular Biology of cell*. Garland publishing Co., New York, USA

Chaudhary, H.K. *Elementary principles of plant Breeding*, Oxford & IBH Publishing New Delhi.

Gupta, P.K. *A Textbook of cell and Molecular Biology*, Rastogi Publications, Meerut, 1999

Gupta, P.K. *Cytology, Genetics, Evolution and plant Breeding*, Rastogi, Publication, Meerut, 2000.

Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell, J. *Molecular Cell Biology*, W.H. Freeman & Co. New York, USA

Miglani, G.S. *Advanced Genetics*, Narosa publishing Co., Inc., USA

Russel, P.J. *Genetics*. The Benjamin/ Cummings Publishing Co., Inc., USA

Shukla, R.S. and Chandel, P.S. *Cytogenetics, Evolution and Plant Breeding*, S.Chand&Co.Ltd., New Delhi

Singh B.D. *Textbook of plant Breeding*. Kalyani publishers, Ludhiana, 1999

Sinha, U. and Sinha, S. *Cytogenetics, Plant Breeding and Evolution*, Vikas Publishing House, New Delhi, 1997

Sunstand, D.P. and Simmons, M.J. *Principles of Genetics*, John Wiley & Sons Inc., USA 2000

**Practical Examination Scheme  
B.Sc. Botany Part II**

**Time: 5 hours**

**Max. Marks 75**

**Min. Pass Marks 27**

		<u>Regular</u>	<u>Ex-Student</u>
Q.1	(a) Describe the given flower in botanical terminology language with floral diagram and floral formula, mentioning special features of identification. Cut a T.S. of anther/ovary/ovule of the same flower and describe the arrangement of anther and ovule from taxonomical point of view. <i>दिये गए पुष्प का पुष्प चित्र व पुष्प सूत्र के साथ वानस्पतिक भाषा में वर्णन कीजिए तथा पहचान के विशिष्ट लक्षण लिखिए । उसी पुष्प के परागकोश / अण्डाशय / अण्डाणु का अनुप्रस्थ काट काटिये तथा परागकोश एवं अण्डाणु की व्यवस्था का वर्गिकी के आधार पर वर्णन कीजिए।</i>	08	09
Q.	(b) Prepare a temporary slid of given gynoecium / androecium / embryo material. Draw a labeled diagram and comment on embryological point of view. <i>दिये गए पादप पदार्थ के जायांग / पुमंग / भ्रुण की अस्थाई स्लाइड बनाईयें। तथा इसका नामांकित चित्र बनाइये एवं इसके भ्रौणिकी लक्षण लिखिए।</i>	03	04
Q.2	Cut a T.S./V.S. of given stem/root/leaf and make a double stained preparation of the same. Draw a labeled diagram (outline & cellular) and identify with special features. <i>दिये गए तने / जड़ / पत्ती का अनुप्रस्थ / ऊर्ध्वधर काट काटिए तथा इसका द्विअभिरंजित काट तैयार कीजिए । रेखीय तथा कोशिकीय चित्र बनाइए व विशिष्ट लक्षणों की सहायता से पहचानिए ।</i>	11	13
Q.3	Prepare a suitable smear preparation of the given plant material to observe mitosis/meiosis. Draw labeled diagrams of any two visible stages. Submit the slide for evaluation. <i>दिये गए पादप पदार्थ की स्लाइड तैयार कीजिए तथा समसूत्री। अर्द्धसूत्रीविभाजन की अवस्था विभाजन की दिग्ग्राई दे रही किन्हीं दो अवस्थाओं का नामांकित चित्र बनाइए । स्लाइड को निरीक्षण हेतु जमा करवाइए ।</i>	11	13
Q.4	Spots- (Three from each paper) <i>स्पॉट ( प्रत्येक पेपर में से तीन )</i>	27	27
	1	6	
	2	7	
	3	8	
	4	9	
	5		
Q.5	Viva Voce/ <i>मौखिक परीक्षा</i>	06	09
Q.6	Practical records / <i>प्रायोगिक अभिलेख</i>	09	00
<b>Total</b>		<b>75</b>	<b>75</b>

**B.Sc. Part – III  
BOTANY 2023**

**Theory**

Course	Nomenclature	Number of Papers	Number of Periods per week	Maximum marks	Minimum marks
Paper I	Ecology and Environmental Biology	1	2	50	54
Paper II	Plant Physiology and Biochemistry	1	2	50	
Paper III	Plant Biotechnology and Molecular Biology	1	2	50	
<b>PRACTICAL COURSE</b>			6	75	27

Duration of examination of each theory papers

3 hours

Duration of examination of practicals

5 hours

**PAPER I: ECOLOGY AND ENVIRONMENTAL BIOLOGY**

**Unit I:** Plants and Environment: Atmosphere (gaseous composition), water (properties of water cycle), light (global radiation, photosynthetically active radiation), temperature, soil (development, soil profiles, physico-chemical properties) and biota.

Morphological, anatomical and physiological responses of plants to water (hydrophytes and xerophytes), Halophytes and their vegetation characteristics, Temperature (thermoperiodicity and vernalization), light (photoperiodism, heliophytes and sciophytes)

**Unit II:** Population ecology: Concept and characters, growth curves, biotic potential, ecotypes and ecads. Seed: The significance, suspended animation; ecological adaptation and dispersal strategies

Community ecology and Succession: Community characteristics, frequency, density, cover, life forms and biological spectrum. Succession: concept, classification and examples (hydrosere&xerosere)

**Unit III:** Ecosystems and Productivity: Ecosystem — Structure, abiotic & biotic components, food chain, food web, ecological pyramids, energy flow, biogeochemical cycles of carbon, nitrogen, phosphorus and Sulphur.

Productivity: Primary productivity, its measurements and factors affecting primary productivity

**Unit IV:** Environmental Biology of Indian Desert: Climate, vegetation types, adaptive strategies of desert plants. Desertification: meanings, causes, critical issues & driving forces. Agroforestry and its impact on desert agriculture. Desert biodiversity,

Geomorphology, Threatened plants and their classification; Rare and threatened plants of Indian Thar desert and their conservation strategies, Wildlife Sanctuaries and National Parks of Rajasthan, Invasive plants: Meaning and adaptations, Natural resources exploitation and their impact on desert environment

**Unit V:** Pollution Ecology: Definitions, classification, air, water and land pollution. Concepts of Industrial Ecology in pollution management. Global warming: Concepts and Current status.

Phytogeography: Vegetation types of India — Forest and Grasslands. Biogeographical regions of India, Remote sensing: The basics and applications in ecological studies

### **Suggested Laboratory Exercises**

1. To determine minimum number of quadrats required for reliable estimation of biomass in herbaceous vegetation
2. To study the frequency of herbaceous species and to compare the frequency distribution with Raunkaier's Standard frequency diagram
3. To estimate Importance Value Index for herbaceous vegetation on the basis of relative frequency, relative density and relative biomass in protected and Gochar land
4. To measure the vegetation cover of grassland through point frame
5. To measure the above ground plant biomass in a natural field
6. To determine diversity indices (richness Simpson, Shannon-Weaver) in natural fields
7. To estimate bulk density and porosity of soil samples
8. To determine moisture contents, water holding capacity and texture of soil samples
9. To estimate qualitatively nitrate, phosphate and potassium in soil samples
10. To study the vegetation structure through profile diagram
11. To estimate transparency and pH of different water bodies
12. To measure dissolved oxygen content in polluted and unpolluted water samples
13. To estimate salinity, hardness, carbonates and bicarbonate in different water samples
14. To determine the percent leaf area injury of different leaf samples collected around polluted site
15. To estimate dust holding capacity of the leaves of different plant species
16. Invasive plants of the Campus:
  - a. Seed out put
  - b. Modes of regeneration
  - c. Adaptive ecology of *Lantana camara*, *Partheniumhysterophorus*, *Prosopisjuliflora*,
17. Plant adaptive modifications: Specimens/Slides:
  - i) Succulents: *Opuntia*, *Euphorbia*
  - ii) Salt secretion: *Atriplex*, *Chloris*
  - iii) Salt accumulation: *Suaeda*, *Salsola*, *Zygophyllum*
  - iv) Xerophytes: *Capparis*, *Leptadenia*, *Parkinsonia*
  - v) Hydrophytes: *Eichhornia*, *Nymphaea*, *Hydrilla*
  - vi) Rare/Threatened plants: *Calligonumpolygonoides*, *Dipcadierythraeum*, *Commiphorawightii*, *Tribulusrajasthanensis*, *Withaniacoagulans*

### **Suggested Readings**

Dash, M.C. Fundamental of Ecology, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1996  
Kormondy, E.J. Concepts of Ecology, Prentice – Hall of India Pvt., New Delhi, 1996  
Kumar, H.D. General Ecology, Vikash Publishing House Pvt. New Delhi, 1995  
Mukherjee, B. Environmental Biology, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1997  
Odum, E.P. Basic Ecology, Saunders, Philadelphia, 1983  
Sen, D.N. Environment and Plant Life in Indian Desert, Geobios International, Jodhpur, 1982  
Sharma, P.D. Ecology and Environment, Rastogi Publications, Meerut 2018

## **PAPER – II PLANT PHYSIOLOGY AND BIOCHEMISTRY**

**Unit 1:** Plant-water relations: Importance of water to plant life; physical properties of water; diffusion and osmosis; absorption, transport of water and transpiration; physiology of stomata. Mineral nutrition: Essential macro- and micro-elements and their role, mineral uptake; deficiency and toxicity symptoms, Introduction to phloem transport; source-sink relationship; factors affecting translocation

**Unit 2:** Photosynthesis: Significance; historical aspects; photosynthetic pigments; action spectra and enhancement effects; concept of two photosystems; Z-scheme; photophosphorylation; Calvin cycle; C<sub>4</sub> pathway; CAM plants; photorespiration. Rubisco enzyme.

**Unit 3:** Respiration: Aerobic and anaerobic respiration; Krebs' cycle; electron transport mechanism (chemi – osmotic theory); redox potential; oxidative phosphorylation pentose phosphate pathway. Basics of enzymology: Discovery and nomenclature; characteristics of enzymes; concept of holoenzyme, apoenzyme, coenzyme and cofactors; regulation of enzyme activity; mechanism of action, Protein structures

**Unit 4:** Nitrogen and lipid metabolism: Biological Nitrogen fixation. Importance of nitrate reductase and its regulation; ammonium assimilation. Structure and function of lipids; fatty acid biosynthesis;  $\beta$ -oxidation; storage and mobilization of fatty acids

**Unit 5:** Growth and development: Definitions; phases of growth and development. Brief account on seed dormancy, seed germination and senescence. Photoperiodism, physiology of flowering; florigen concept, biological clock, vernalization. Plant Hormones-Auxins, gibberellins, cytokinins, abscisic acid and ethylene, history of their discovery, Physiological role and general mode of actions. Photomorphogenesis; Brief account on phytochromes and cryptochromes.

### **Suggested Laboratory Exercises**

Major Exercises:

1. Determine osmotic potential by diffusion pressure deficit
2. Separate chlorophyll pigments by paper chromatography
3. Demonstrate opening and closing of stomata using distilled water, sucrose and KCl and compute SI

4. Demonstrate plasmolysis using 0, 0.1, 0.2, 0.3, 0.4, 0.5 & 0.6M sucrose solution and identify incipient plasmolytic concentration

Minor exercises:

1. Determine R<sub>f</sub> value of an unknown amino acid using paper chromatography
2. Demonstrate effect on membrane permeability by different temperature (room, hot water treatments)
3. Demonstrate effect on membrane permeability by different organic solvents (three at least)

Spots

1. Contribution of Scientist to Physiology and Biochemistry: M. Calvin, H.P. Hatch and C.R. Slack, E. Fischer, P. Mitchel, J.C. Bose
2. Ripening of fruits
3. IBA effect on rooting
4. Photomorphogenesis
5. Senescence
6. RQ
7. Root nodules (Types, internal structure, organogenesis, symbiotic home)

**Suggested Readings**

- Dennis, D.T., Turpin, D.H., Lefebvre, D.D. and Layzell (eds.). Plant Metabolism (2nd ed.), Longman, Essex, England, 1997
- Galston, A.W. Life processes in Plants, Scientific American Library, Springer-Verlag, New York, USA, 1989
- Hopkins, W.G. Introduction to plant physiology, John Wiley & Sons, Inc., New York, USA, 1995
- Lea, P.J. and Leegood, R.C. Plant Biochemistry and Molecular Biology, John Wiley & Sons, Chichester, England, 1999
- Mohr, H. and Schopfer, P. Plant Physiology, Springer-Verlag, Berlin, Germany, 1995
- Salisbury, F.B. and Ross, C.W. Plant Physiology (4th ed.), Wadsworth Publishing Co., California, USA, 1992
- Srivastava, H.S. Plant Physiology, Rastogi Publication, Meerut, 2001
- Taiz, L. and Zeiger, E. Plant Physiology (2nd ed.), SinauerAssociats, Inc. Publishers, Massachusetts, USA, 1998

**Suggested Readings**

(for Laboratory Exercises)

- Amar Singh. Practical Plant Physiology, Kalyani Publishers, New Delhi, 1977
- Moore, T.C. Research Experiences in Plant Physiology: A Laboratory Manual, Springer-Verlag, Berlin, 1974
- Nifa, A.J. and Ballou, D.P. Fundamental Laboratory Approaches for Biochemistry and Biotechnology, Fitzrerald Science Press, Inc., Maryland, USA, 1998
- Robalts and Tucker, G.A. (Eds.) Plant Hormone Protocols, Humana Press, New Jersey, USA, 2000
- Scot, R.P.W. Techniques and Practice of Chromatography Marcel Dekker, Inc., New York, 1995
- Wilson, K. and Goulding, K.H. A Biologists Guide to principles and techniques of Practical Biochemistry, Ed-ward Arnold, London, 1986



**PAPER-III**  
**PLANT BIOTECHNOLOGY AND MOLECULAR BIOLOGY**

**Unit 1:** Cell theory and concept of totipotency and pluripotency. History of plant tissue culture and biotechnology. Basic tools and techniques of Plant tissue culture and molecular biology. General introduction and applications of biotechnology, bioinformatics, DNA finger printing and NanoBiotechnology.

**Unit 2:** Introduction to Bacterial Genome organization. Genetic recombination in bacteria. Introduction to vectors for gene cloning: ColE1, pSC101 (natural cloning vectors), p-BR322, pUC8, PAC, YAC and BAC. Detection and screening of recombinant DNA.

**Unit 3:** Protoplast isolation, fusion and somatic hybridization. Cryopreservation of germplasm. Introduction to bioreactors and production of secondary metabolites with special reference to alkaloids obtained from *Ephedra*, shikonin, diosgenin and Strategies used to optimize secondary metabolite production.

**Unit-4:** Genetic engineering of plants: *Agrobacterium* mediated gene transfer, t-DNA transfer mechanism integration and expression in plants. Direct method of gene transfer in plants: Chemical methods electroporation, particle gun delivery, lipofection, microinjection, macroinjection, pollen transformation, laser induced and silicon fiber mediated. Molecular biology and genetic engineering of biological nitrogen fixation.

**Unit-5:** Biotechnology and society: Development of transgenic crop plants against biotic and abiotic stresses. Genetically modified crops: Golden rice, Bt cotton (as a model system). Intellectual Property Right (IPR) and Plant Breeder's Rights (PBR) in current regime of WTO. Impact of GM crops on society and environment.

**SUGGESTED LABORATORY EXERCISES**

**Major:**

1. Extract DNA from given plant sample (Cauliflower/Onion) by Rapid Method.
2. Prepare MS Medium using suitable PGRs for activation of axillary shoot bud. Surface sterilized suitable explant and inoculate under aseptic condition.
3. Prepare MS Medium using suitable PGRs for induction of callus from haploid cells (anther). Surface sterilized suitable explant and inoculate under aseptic condition.
4. Prepare MS Medium using suitable PGRs for induction of callus from somatic cells. Surface sterilized suitable explant (young leaf, apical shoots, nodal shoot segment) and inoculate under aseptic condition.

**Spots**

1. Contribution of Scientist to Biotechnology: Gottlieb Haberlandt, Guha and Maheshwari
2. Synthetic seeds
3. Organogenesis
4. Tools for aseptic culture: Laminar air flow bench, Autoclave
5. Tools for molecular biology: PCR, Electrophoreses

6. In vitro production: Shikkonin, Bioreactor
7. Cloning vectors: Ti plasmid, pUC8
8. GM Crops (Golden rice, Bt cotton)

### **Suggested Readings**

- Bhojwani, S.S. Plant Tissue Culture: Application and Limitation, Elsevier Science Publishers, New York, USA, 1990
- Old, R.W. and Primrose, S.B. Principles of Gene Manipulation, Black well Scientific Publications, Oxford, U.K., 1986
- Raghavan, O. Embryogenesis in Angiosperms: A Developmental and Experimental Study, Cambridge University, Press, New York, USA, 1986
- Vasil, I.K. and Thorpe, T.A. Plant Cell and Tissue Culture, Kluwer Academic Publishers, The Netherlands, 1994

### **Suggested Readings**

(for Laboratory Exercises)

- Ball, R.D. (ed.) Plant Cell Culture Protocols, Humana Press, Inc. New Jersey, USA, 1999
- Dixon, R.A. (ed.) Plant Cell culture: a Practical Approach, IRL, Press Oxford, 1987
- Glick, B.R. and Thompson, J.E. Methods in Plant Molecular Biology and Biotechnology, CRC Press, Boca Raton, Florida, 1993
- Roberts, J. and Tucker, G.A. (eds.) Plant Hormone Protocols Humana Press, New Jersey, USA 2000.

**B.Sc. Botany Part III**

**Time: 5 hours**  
**75**

**Max. Marks**

**Min. Pass Marks**

27

	<u>Regular</u>	<u>Ex-Student</u>
Q.1 Perform the Ecological experiment allotted to you by lots and report the results in suitable form. <i>दिये गये पारिस्थितिकी प्रयोग को प्रदर्शित कीजिए एवं निष्कर्ष को उचित रूप में प्रतिवेदन कीजिए।</i>	11	13
Q.2 Perform the Physiological experiment allotted to you by lots and report the results in suitable form. <i>दिये गये शारीर क्रिया विज्ञान प्रयोग को प्रदर्शित कीजिए एवं निष्कर्ष का उचित रूप में प्रतिवेदन कीजिए।</i>	11	13
Q.3 Perform the Biotechnology/ Molecular Biology experiment allotted to you by lots and report the results in suitable form. <i>दिये गये जैवप्रौद्योगिकी / आणविक जैविकी प्रयोग को प्रदर्शित कीजिए एवं निष्कर्ष को उचित रूप में प्रतिवेदन कीजिए।</i>	11	13
Q.4 Identify and comments upon spots 1 to 9 (Three from each paper) <i>दिये गये पदार्थ 1 - 9 को पहचानिए एवं व्याख्या कीजिए ( प्रत्येक पेपर में से तीन )</i>	27	27
1	6	
2	7	
3	8	
4	9	
5		
Q.5 Viva- Voce/ <i>मौखिक परीक्षा</i>	06	09
Q.6 Practical records / <i>प्रायोगिक अभिलेख</i>	09	00
<b>Total</b>	<b>75</b>	<b>75</b>