Scheme of Examination and Syllabus

For B.Sc. (CBZ)

Subject: BOTANY

Semester I to VI (2022-2025)

RAFFLES UNIVERSITY

SCHOOL OF BASIC AND APPLIED SCIENCES (SOBAS)

RAFFLES UNIVERSITY

Japanese Zone, National Highway-48, Neemrana-301705,

District: Alwar, RAJASTHAN, INDIA

www.rafflesuniversity.edu.in

Course Specific Outcomes for Department of Botany (B.Sc. Medical)

On completion of the course the students will:

1. acquire the basic knowledge of plant sciences through theory and practical.
2. get immense knowledge of different specializations and biological processes of Botany such as plant taxonomy, developmental biology, biochemistry, physiology, morphology, anatomy, reproduction, genetics, plant breeding, biotechnology, evolution, ecology and molecular biology of different forms of life.
3. able to understand, identify, classify and compare the different groups of plants (from algae to angiosperms).
4. help students to understand the degree of genetic diversity and phylogeny of plants.
5. understand the economic importance of Algae, Fungi and other microbes in the field of Industry, Medicine and Agriculture that will help them to do advanced studies and serve the institutions, industry, and society efficiently.
6. be able to understand the contribution of plant sciences in the production of medicines and other natural plant-based products.
7. be able to understand the advanced techniques of applied sciences that will help students in finding career opportunities in higher education in the field of plant sciences.
8. be able to describe and perform certain fundamental and applied experiments in various fields of plant sciences.
9. possess minimum standards of communication skills expected from a Botany graduate in the country.

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Department of Botany
(Syllabus and Scheme of Studies w. e. f. 2022-23)
B. Sc. I Year (I Semester)

Examination Time: 3 Hrs **Maximum Marks: 50 (20+30)**
Paper Title: Diversity of microbes and plant pathology
Paper Code: BOT-101 **Schedule per week Lectures: 3**

Note: Examiner will set nine questions and the students will be required to attempt five questions in all, Question number one is compulsory containing six short answer types' questions covering the entire syllabus and will be of 1 mark. Further examiner will be set two questions from each unit and the students will be required to attempt one question from each unit which will be of 6 marks each.

UNIT-I

Bacteria: Structure, nutrition, reproduction and economic importance; General account of cyanobacteria (with reference to *Nostoc*).

UNIT-II

Algae: General characters, classification upto classes (Lee 1980) and economic importance; Important features and life-history (excluding development) of *Volvox*, (Chlorophyceae), *Chara* (Charophyceae) *Vaucheria* (Xanthophyceae), *Ectocarpus* (Phaeophyceae) and *Polysiphonia* (Rhodophyceae).

UNIT-III

Viruses: General account of Viruses including structure of TMV and Bacteriophages.

General account of Lichens.

UNIT-IV

Fungi: General characters, classification upto classes (Ainsworth 1971) and economic importance; important features and life-history of *Phytophthora* (Mastigomycotina), *Mucor* (Zygomycotina), *Penicillium* (Ascomycotina), *Puccinia* (Basidiomycotina), *Colletotrichum* (Deuteromycotina).

SUGGESTED READINGS

1. Ahluwalia, A.S. (Ed.). Phycology: Principles, Processes and Applications. Daya Publishing House, New Delhi. 2003.
2. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley and Sons (Asia), Singapore. 4th edition.

3. Campbell, N.A., Reece J.B., Urry L.A., Cain M.L., Wasserman S.A. Minorsky P.V., Jackson R.B. (2008). Biology, Pearson Benjamin Cummings, USA.8th edition.

4. Dube, H.C. 1990. An Introduction to Fungi, Vikas Publishing House Pvt. Ltd., Delhi.

5. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 2nd edition.

6. Lee, R.E. (2008). Phycology, Cambridge University Press, Cambridge.4th edition.

7. Mehrotra, R.S.& Aneja, K.R. 1990: An introduction of Mycology, New Age International Press, N. Delhi

8. Mehrotra, R.S. and Aggarwal, Ashok (2013) Fundamentals of Plant Pathology, Tata McGraw-Hill Publishing company Ltd, New Delhi

9. Pelczar, M.J. (2001) Microbiology, 5th edition, Tata McGraw-Hill Co, New Delhi.

10. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005). Biology. Tata McGraw Hill, Delhi.

11. Sahoo, D. (2000). Farming the ocean: seaweeds cultivation and utilization. Aravali International, New Delhi.

12. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi & Their Allies, MacMillan Publishers Pvt. Ltd., Delhi.

13. Sharma, O.P. 1992. Text Book of Thallophytes, McGraw Hill Publishing Co.

14. Sharma, P.D. 1991. The Fungi. Rastogi & Co., Meerut.

15. Smith, G.M. 1971. Cryptogamic Botany. Vol. I. Algae & Fungi. Tata McGraw Hill Publishing Co., New Delhi.

16. Thakur, A.K. and Bassi, S.K. (2008). Diversity of Microbes and Cryptogams. S. Chand & Co., Delhi.

17. Wiley J. M., Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International.

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B. Sc. I Year (I Semester)

Examination Time: 3 Hrs **Maximum Marks: 50 (20+30)**
Paper Title: Plant Ecology
Paper Code: BOT-103 **Schedule per week Lectures: 3**

Note: Examiner will set nine questions and the students will be required to attempt five questions in all, Question number one is compulsory containing six short answer types' questions covering the entire syllabus and will be of 1 mark. Further examiner will be set two questions from each unit and the students will be required to attempt one question from each unit which will be of 6 marks each.

UNIT-I

Introduction to Ecology: Definition; scope and importance; levels of organization. **Environment:** Introduction; environmental factors- climatic (water, humidity, wind, light, temperature), edaphic factors (soil profile, physico-chemical properties), topographic and biotic factors (species interaction). Adaptations of plants to water stress and salinity (morphological and anatomical features of hydrophytes, xerophytes and halophytes).

UNIT-II

Population Ecology: Basic concept; characteristics; biotic potential, growth curves; ecotypes and ecads. **Community Ecology:** Concepts; characteristics (qualitative and quantitative-analytical and synthetic); methods of analysis; ecological succession.

UNIT-III

Ecosystem: Structure (components) and functions (trophic levels, food chains, food webs, ecological pyramids and energy flow)

Biogeochemical Cycles: Carbon and Nitrogen; Hydrological (water) cycle.

UNIT-IV

Phyto-geography: Phyto-geographical regions of India; vegetation types of India (forests).

Environmental Pollution: Sources, types and control of air and water pollution.

Global Change: Greenhouse effect and greenhouse gases; impacts of global warming; carbon trading.

Suggested Readings

1. Botkin, D.B. and E.A. Keller, 2004. Environment Science: Earth as a Living Planet, John Wiley & Sons Inc., New York.
2. Kormondy, E.J. 1996: Concepts of Ecology, Prantice-Hall of India Pvt. Ltd., New Delhi.
3. Mackenzie, A. et al. 1999: Instant Notes in Ecology, Viva Books Pvt. Ltd., New Delhi.
4. Odum, E.P. 1983. Basic Ecology, Saunders, Philadelphia.
5. Sharma, P.D., 2010 Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.
6. Singh, J.S., Singh, S.P. and Gupta, S.R. 2006. Ecology, Environment and Resource Conservation, Anamaya Publishers, New Delhi.
7. Smith, R.L. 1996, Ecology and Field Biology, Harper Collins, New York.

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B. Sc. I Year (I Semester)

Examination Time: 4 Hrs **Maximum Marks: 50 (20+30)**
Paper Title: Botany Lab-I
Paper Code: BOT-105 **Schedule per week Lectures: 3**

1. Ecological experiment A & B (as per the list) 08

2. Write Ecological notes on the specimens C and D 05

3. Identify, classify and write short morphological notes giving well labelled relevant diagrams on the given specimens/slide A & B (one each from Algae & Fungi). 06

4. Write short note on given chart/Photograph/Specimen 6 & 7 (one from Viruses/Bacteria & one from Cyanobacteria/ Lichen). 03

5. Note-book 04

6. Viva-voce. 04

List of practical

1. **Viruses**: EMs/Models of viruses: T-Phage and TMV, Line drawing/Photograph of Lytic and Lysogenic Cycles.

2. **Bacteria**: Types of Bacteria from temporary/permanent slides/photographs; EM bacterium; Binary Fission; Conjugation; Structure of root nodule.

3. **Cyanobacteria &Algae**: Study of vegetative and reproductive structures of *Nostoc*, *Volvox*, *Chara*, *Vaucheria*, *Ectocarpus* and *Polysiphonia* through temporary preparations and permanent slides.

4. **Fungi**: Study of vegetative & reproductive structures of *Phytophthora*, *Mucor*, *Puccinia*, *Penicillium* & *Colletotrichum*: Asexual and sexual stages through temporary preparations and permanent slides.

5. **Lichens**: Study of growth forms of lichens (crustose, foliose and fruticose).

6. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter.

7. Determination of pH, and analysis of two soil samples for carbonates, chlorides and sulphates by rapid field test.

8. Comparison of bulk density, porosity and rate of infiltration of water in soil of three habitats.

9. (a) Study of morphological adaptations of hydrophytes and xerophytes (four each).

10. (b) Study of biotic interactions of the following: Stem parasite (*Cuscuta*), Root parasite (*Orobanche*), Epiphytes (Orchid) and Predation (Insectivorous plants) using museum specimens/ live plants.

11. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus or nearby fields by species area curve method (species to be listed).

12. Quantitative analysis of herbaceous vegetation in the college campus or nearby fields for frequency and comparison with Raunkiaer's frequency distribution law.

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Examination Time: 3 Hrs **Maximum Marks: 50 (20+30)**
Paper Title: Biodiversity (Archegoniate)
Paper Code: BOT-102 **Schedule per week Lectures: 3**

Note: Examiner will set nine questions and the students will be required to attempt five questions in all, Question number one is compulsory containing six short answer types' questions covering the entire syllabus and will be of 1 mark. Further examiner will be set two questions from each unit and the students will be required to attempt one question from each unit which will be of 6 marks each.

UNIT-I

Bryophyta: General characters, classification upto classes (Smith, 1935), alternation of generations, structure and reproduction (excluding development) of *Marchantia* (Hepaticopsida), *Anthoceros* (Anthocerotopsida), *Funaria* (Bryopsida).

UNIT-II

Pteridophyta: General characters, classification upto classes (Proskauer1957), Alternation of generations.

Gymnosperms-General characteristics, classification up to family (Smith 1955).

UNIT-III

Pteridophyta: Structure and Reproduction (excluding development) of *Rhynia* (Psilopsida), *Selaginella* (Lycopsida), *Equisetum* (Sphenopsida) and *Pteris* (Pteropsida).

UNIT-IV

Gymnosperms- Morphology, anatomy and reproduction of *Cycas*, *Pinus and Ephedra* (developmental details not to be included); Ecological and economic importance.

SUGGESTED READINGS

1. Bhatnagar, S.P. & Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.

2. Campbell, N.A., Reece J.B., Urry L.A., Cain M.L., Wasserman S.A. Minorsky P.V., Jackson R.B. (2008). Biology, Pearson Benjamin Cummings, USA.8th edition.

3. Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad.

4. Puri, P., 1980, Bryophyta, Atma Ram & Sons, Delhi.

5. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. 2005.Biology. Tata McGraw Hill, Delhi.

6. Sharma, O.P. 1990. Text Book of Pteridophyta, McMillan India Ltd.

7. Sharma, O.P. 1992. Text Book of Thallophytes, McGraw Hill Publishing Co.

8. Smith, G.M. 1971. Cryptogamic Botany, Vol. II, Bryophytes & Pteridophytes. Tata McGraw Hill Publishing Co., New Delhi.

9. Thakur, A.K. and Bassi, S.K. (2008). Diversity of Microbes and Cryptogams. S. Chand & Co., Delhi.

10. Vanderpoorten, A. & Goffinet, B. (2009) Introduction to Bryophytes. Cambridge University Press.

11. Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Pteridophyta, S. Chand. Delhi, India.

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B. Sc. I Year (II Semester)

Examination Time: 3 Hrs **Maximum Marks: 50 (20+30)**
Paper Title: Plant Taxonomy
Paper Code: BOT-104 **Schedule per week Lectures: 3**

Note: Examiner will set nine questions and the students will be required to attempt five questions in all, Question number one is compulsory containing six short answer types' questions covering the entire syllabus and will be of 1 mark. Further examiner will be set two questions from each unit and the students will be required to attempt one question from each unit which will be of 6 marks each.

UNIT-I

Taxonomy and systematics, fundamental components of taxonomy (identification, classification, description, nomenclature and phylogeny). Role of chemotaxonomy and cytotaxonomy in relation to taxonomy.

Botanical nomenclature, principles and rules, principle of priority. Type concept, author citation, taxonomic ranks. Keys to identification of plants.

UNIT-II

Herbarium: General introduction and importance of herbaria. Botanical gardens and their importance.

Documentation of Floristic Diversity: Brief idea about floras, monograph and journals. Flower and types of inflorescences.

UNIT-III

Types of classification: Artificial, natural and phylogenetic.

Bentham and Hooker system of classification (upto series), Angiosperm Phylogeny Group (APG)- general introduction.

UNIT-IV

Diversity of Flowering Plants: Diagnostic features and economic importance of the following families: Ranunculaceae, Brassicaceae, Malvaceae, Euphorbiaceae, Rutaceae, Leguminosae, Apocynaceae, Solanaceae, Asteraceae, Liliaceae and Poaceae.

Suggested Readings

1. B.P. Pandey. 2001. A Textbook of Botany: Angiosperms - Taxonomy, Anatomy, Embryology and Economic Botany. S Chand and Co Delhi.

2. Chopra, GL. 1984. Angiosperms: Systematic & Life-Cycle. Pradeep Publications.

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

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

5. Heywood, V.H. and Moore, D.M. (Eds.) 1984.Current Concepts in Plant Taxonomy. Academic Press, London.

6. Jeifrey, C. 1982. An introduction to Plant Taxonomy. Cambridge University Press, Cambridge, London.

7. Jones, S.B., Jr. Luchsinger, A.E. 1986. Plant Systematics (2nd edition). McGraw Hill Book Co.

8. Radford, A.E. 1986. Fundamentals of Plant Systematics. Harper and Row, New York.

9. Simpson, M.G. (2006). *Plant Systematics.* Elsevier Academic Press, San Diego, CA, U.S.A.

10. Singh and Jain, 2015. Taxonomy of Angiosperms 10 Edition. Rastogi Publication Meerut.

11. Singh, G. 2017. Plant Systematics Theory And Practice 3rd Edition, Oxford & IBH Publishing

12. Stace, C.A. 1989. Plant Taxonomy and Biosystematics (2nd edition). Edward Arnold, London.

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B. Sc. I Year (II Semester)

Examination Time: 4 Hrs **Maximum Marks: 50 (20+30)**
Paper Title: Botany Lab-II
Paper Code: BOT-106 **Schedule per week Lectures: 3**

1. Identify, classify and write short morphological notes giving well labelled relevant diagrams on the given specimens A, B & C (one each from Bryophytes, Pteridophytes & Gymnosperms). 06

2. Identify, giving two important characters of identification, the spots 1, 2 & 3 (one slide or material each from Bryophytes, Pteridophytes & Gymnosperms). 06

3. Describe/compare the given flowers A and B in semi-technical language giving V.S. of flowers, T.S. of ovaries, Floral Diagrams and Floral Formulae. Identify and assign them to their respective families giving reasons. 06

5. Note-book 04

6. Collection and Collection Report. 04

7. Viva-voce. 04

List of Practicals

1. ***Marchantia***- Morphology of thallus, W.M. rhizoids and scales, V.S. thallus with gemma cup, W.M. gemmae, V.S. antheridiophore, archegoniophore, L.S. sporophyte (temporary/permanent slides).
2. ***Anthoceros***- Morphology of thallus, W.M. rhizoids, V.S. thallus, VS Antheridia and Archegonia, L.S. sporophyte (temporary/permanent slides).
3. ***Funaria***- Morphology, W.M. leaf, rhizoids, operculum, peristome, annulus, spores, slides showing antheridial and archegonial heads, L.S. capsule (temporary /permanent slides).
4. ***Selaginella***- Morphology, W.M. leaf with ligule, T.S. stem, W.M. strobilus, W.M. microsporophyll and megasporophyll, L.S. strobilus (temporary/ permanent slide).

5. ***Equisetum***- Morphology, T.S. internode, L.S. strobilus, T.S. strobilus, W.M. sporangiophore.
6. ***Pteris***- Morphology, T.S. rachis, V.S. sporophyll, W.M. sporangium, W.M. spores, T.S. rhizome.
7. ***Cycas***- Morphology (coralloid roots, bulbil, leaf, megasporophyll), T.S. normal & coralloid root, T.S. rachis, T.S. leaflet and microsporophyll.
8. ***Pinus***- Morphology (long and dwarf shoots, W.M. dwarf shoot, male cones and female cones), T.S. Pinus needle, T.S. Stem and male cone.
9. ***Ephedra***- Morphology, T.S. internode, L.S./T.S. male and female strobili, W.M. spores (wet and dry), T.S. rhizome (temporary/permanent slide), T.S. stem (young & mature).
10. **Excursion Report**: Report on excursion tours with photographs, collection, preservation and preparation of herbarium sheets and specimens related to Archegoniates and Angiosperms. Mounting of a collected, properly dried and pressed specimen of minimum 20 wild plants with herbarium label.
11. Study of vegetative and floral characters of the one or two member of each family/sub-family mentioned in theory syllabus (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification).

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B. Sc. II Year (III Semester)

Examination Time: 3 Hrs **Maximum Marks: 50 (20+30)**
Paper Title: Plant Anatomy
Paper Code: BOT-201 **Schedule per week Lectures: 3**

Note: Examiner will set nine questions and the students will be required to attempt five questions in all, Question number one is compulsory containing six short answer types' questions covering the entire syllabus and will be of 1 mark. Further examiner will be set two questions from each unit and the students will be required to attempt one question from each unit which will be of 6 marks each.

UNIT-I

Diversity in plant forms: Annuals, biennials and perennials.

Tissues: Meristematic and permanent (simple and complex).

Epidermis: Uniseriate and multiseriate, epidermal appendages and their morphological types.

UNIT-II

Leaf: Types of leaves (simple and compound); phyllotaxy. Anatomy of typical monocot and dicot leaf and cell inclusions in leaves; Leaf abscission.

Stomatal apparatus and their morphological types.

UNIT-III

Shoot system: Shoot apical meristem and its histological organizations (monocot and dicot stem); **Cambium:** Structure and functions; secondary growth in dicot stem; characteristics of growth rings; sap wood and heart wood, periderm.

Anomalous secondary growth (*Achyranthes* & *Boerhaavia*)

UNIT-IV

Root system: Root apical meristem; histological organization of monocot and dicot roots. Secondary growth in dicot root.

Structural modifications in roots: Storage (*Beta*), respiratory (*Rhizophora*), epiphytic (*Vanda*). Anatomical aspects of adaptations in xerophytes, hydrophytes, halophytes.

Suggested Readings

1. Bryan G. Bowes 1999. A Colour Atlas of Plant Structure. Manson Publishing

2. Cutter, E.G. 1969. Plant Anatomy Part-I, Cells and Tissues, Edward Arnold, London.

3. Cutter, E.G. 1971. Plant Anatomy: Experiment and Interpretation. Part-II Organs, Edward Arnold London.

4. Esau, K. 1977. Anatomy of Seed Plants, 2nd Edition. John Wiley & Sons, New York.

5. Fahn, A. 1974. Plant Anatomy, 2nd Edition. Pergamon Press, Oxford.

6. Hartmann, H.T. and Kestler, D.E. 1976. Plant Propagation; Principles and Practices. 3rdEdition.Prentice Hall of India Pvt. Ltd. New Delhi.

7. King. J. 1997. Reaching for the Sun: How Plants Work. Cambridge University Press, Cambridge, U.K.

8. Mauseth, J.D. 1988. Plant Anatomy. The Benjamin/Cummings Publishing Company Inc., Menlo Park, California, USA.

9. Pandey, B.P 2012. Plant Anatomy. S. Chand & Co. Publisher

10. Raven, P.H. Evert, R.F. and Eichhorn, S.E. 1999. Biology of Plants.5th edition. W.R. Freeman and Co., Worth Publishers, New York.

11. Sharma MK. Plant Structure (An Introduction To Plant Anatomy) JBC Press

12. William C. Dickison 2015. Integrative Plant Anatomy. Academic Press

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B. Sc. II Year (III Semester)

Examination Time: 3 Hrs **Maximum Marks: 50 (20+30)**
Paper Title: Plant Embryology
Paper Code: BOT-203 **Schedule per week Lectures: 3**

Note: Examiner will set nine questions and the students will be required to attempt five questions in all, Question number one is compulsory containing six short answer types' questions covering the entire syllabus and will be of 1 mark. Further examiner will be set two questions from each unit and the students will be required to attempt one question from each unit which will be of 6 marks each.

UNIT-I

Flower-a modified shoot; functions of various floral parts.

Pollination (types and agencies); pollen germination (micro gametogenesis). Pollen-pistil interaction; self-incompatibility.

UNIT-II

Male gametophyte. Microsporangium, its wall and dehiscence mechanism. Microsporogenesis, pollen grains and its structure (pollen wall).

Structure of megasporangium (ovule) & its curvatures. Megasporogenesis and mega gametogenesis.

UNIT-III

Female gametophyte (monosporic, bisporic and tetrasporic)- organization and ultrastructure of mature embryo sac.

Double fertilization.

Endosperm types and their biological importance.

UNIT-IV

Embryogenesis in dicot and monocot; Polyembryony and apomixis.

Structure of dicot and monocot seed.

Fruit types; dispersal mechanisms in fruits and seeds.

Suggested Readings

1. B.M. Johri Editor (1984) Embryology of Angiosperms Springer Verlag

2. Bhojwani, S.S. & Bhatnagar, S.P. (2011). Embryology of Angiosperms. Vikas Publication House Pvt. Ltd. New Delhi. 5th edition.

3. Fageri, K. and Van der Pijl1979.The Principles of Pollination Ecology. Pergamon Press, Oxford.

4. Hartmann, H.T. and Kestler, D.E. 1976. Plant Propagation; Principles and Practices. 3rdEdition.Prentice Hall of India Pvt. Ltd. New Delhi.

5. King. J. 1997. Reaching for the Sun: How Plants Work. Cambridge University Press, Cambridge, U.K.

6. P. Maheshwari (1950) An Introduction to the Embryology of Angiosperms McGraw Hill

7. Proctor, M. and Yeo, P. 1973. The Pollination of Flowers. William Collins Sons, London.

8. Raven, P.H. Evert, R.F. and Eichhorn, S.E. 1999. Biology of Plants.5th edition. W. R. Freeman and Co., Worth Publishers, New York.

9. Thomas, P. 2000. Trees: Their Natural History. Cambridge University Press, Cambridge.

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B. Sc. II Year (III Semester)

Examination Time: 4 Hrs **Maximum Marks: 50 (20+30)**
Paper Title: Botany Lab-III
Paper Code: BOT-205 **Schedule per week Lectures: 3**

1. Cut Transverse Section and prepare a double-stained permanent mount of the given material A and B (from angiosperms). Identify giving reasons and show it to the examiner. 10

2. Identify, giving the important characters of identification, the spots 1, 2, 3 and 4 (one material/photograph/ slide from embryology of angiosperms). 08

3. Dissect out the globular/heart-shaped embryo from the given material. 04

7. Note-book 04

8. Viva-voce 04

List of Practicals

1. Study of meristems through permanent slides and photographs.
2. Tissues (parenchyma, collenchyma and sclerenchyma); Macerated xylary elements, Phloem (Permanent slides, photographs)
3. Stem: Monocot: *Zea mays*; Dicot: *Helianthus*; Secondary: *Helianthus* (Permanent slides preparation).
4. Root: Monocot: *Zea mays*; Dicot: *Helianthus*; Secondary: *Helianthus* (Permanent slides preparation).
5. Leaf: Dicot and Monocot leaf (Permanent slides).
6. Adaptive anatomy: Xerophyte (*Nerium* leaf); Hydrophyte (*Hydrilla* stem).
7. Structure of anther (young and mature), tapetum (amoeboid and secretory) (Permanent slides).
8. Types of ovules: anatropous, orthotropous, circinotropous, amphitropous/campylotropous (Permanent Slides).

9. Female gametophyte: *Polygonum* (monosporic) type of Embryo sac Development (Permanent slides/photographs).

10. Ultrastructure of mature egg apparatus cells through electron micrographs.

11. Pollination types and seed dispersal mechanisms (including appendages, aril, caruncle) (Photographs and specimens).

12. Dissection of embryo/endosperm from developing seeds.

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B. Sc. II Year (IV Semester)

Examination Time: 3 Hrs **Maximum Marks: 50 (20+30)**
Paper Title: Plant Physiology
Paper Code: BOT-202 **Schedule per week Lectures: 3**

Note: Examiner will set nine questions and the students will be required to attempt five questions in all, Question number one is compulsory containing six short answer types' questions covering the entire syllabus and will be of 1 mark. Further examiner will be set two questions from each unit and the students will be required to attempt one question from each unit which will be of 6 marks each.

UNIT-I

Plant-water Relations: Importance of water to plant life; physical properties of water; Imbibition, Diffusion, Osmosis and Plasmolysis; absorption and transport of water; transpiration-types, physiology of stomata, factors affecting transpiration, importance of transpiration.

UNIT-II

Mineral Nutrition: Essential macro and micro elements; criteria of essentiality of elements; Role of essential elements; mineral uptake; deficiency symptoms.

Transport of Organic Substances: Mechanism of phloem transport; source-sink relationship; factors affecting translocation

UNIT-III

Seed dormancy; Plant movements; Concept of photoperiodism; Physiology of flowering; Florigen concept; Physiology of senescence; Fruit ripening.

Growth and Development: Definitions; phases of growth and development.

UNIT-IV

Plant Hormones: Auxins, Gibberellins, Cytokinins, Abscisic acid and Ethylene, history of their discovery, mechanism of action.

Photo-morphogenesis: phytochromes and their discovery, physiological role and mechanism of action.

Suggested Readings

1. Dennis, D.T., Turpin, D.H., Lefebvre, D.D. and Layzell (eds.). 1997: Plant Metabolism (2nd Edition), Longman, Essex, England.

2. Galston, A.W. 1989: Life Processes in Plants, Scientific American Library, Springer-Verlag, New York, USA.

3. Harborne, J.B. (1973). Phytochemical Methods. John Wiley & Sons. New York.

4. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology.John Wiley and Sons.U.S.A.4th edition.

5. Hopkins, W.G., 1995: Introduction to Plant Physiology, John Wiley & Sons, Inc., New York, USA.

6. Mohr, H. and Schopfer, P. 1995: Plant Physiology. Springer-Verlag, Berlin Germany.

7. Pandey, S.N &Sinha BK. 2018. Plant Physiology 4/Ed .Vikas Publishing House Pvt Ltd

8. Salisbury, F.B. and Ross, C.W. 1986: Plant Physiology. CBS Publishers and Distributors, New Delhi.

9. Taiz, L. and Zeiger, E. 2003: Plant Physiology. Panima Publishing Corporation, New Delhi.

10. Taiz, L., Zeiger, E., Moller, I.M. and Murphy, A. (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.

11. Verma, V. 2015. Plant Physiology 2nd Ed. Athena Academic

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B. Sc. II Year (IV Semester)

Examination Time: 3 Hrs **Maximum Marks: 50 (20+30)**
Paper Title: Plant Metabolism
Paper Code: BOT-204 **Schedule per week Lectures: 3**

Note: Examiner will set nine questions and the students will be required to attempt five questions in all, Question number one is compulsory containing six short answer types' questions covering the entire syllabus and will be of 1 mark. Further examiner will be set two questions from each unit and the students will be required to attempt one question from each unit which will be of 6 marks each.

UNIT-I

Photosynthesis: Significance; historical aspects; photosynthetic pigments; action spectra and enhancement effects; concept of two photosystems; Z-scheme; photo-phosphorylation; Calvin cycle; C4 pathway; CAM plants; photorespiration.

UNIT-II

Respiration: ATP–the biological energy currency; aerobic and anaerobic respiration; Krebs cycle; electron transport mechanism (chemi-osmotic theory); redox -potential; oxidative phosphorylation; pentose phosphate pathway.

UNIT-III

Nitrogen metabolism: Biology of nitrogen fixation; importance of nitrate reductase and its regulation; ammonium assimilation.

Lipid metabolism: Structure and functions of lipids; fatty acid biosynthesis; B-oxidation; saturated and unsaturated fatty acids; storage and mobilization of fatty acids.

UNIT-IV

Basics of Enzymology: Discovery, nomenclature & characteristics of enzymes; concept of holoenzyme, apoenzyme, coenzyme & co-factors; regulation of enzyme activity.

Suggested Readings:

1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons.U.S.A.4th edition.

2. Taiz, L., Zeiger, E., Moller, I.M. and Murphy, A. (2015). Plant Physiology and Development. Sinauer Associates Inc. USA.6th edition.

3. Harborne, J.B. (1973). Phytochemical Methods. John Wiley & Sons. New York.

4. Dennis, D.T., Turpin, D.H., Lefebvre, D.D. and Layzell (eds.). 1997: Plant Metabolism (2nd Edition), Longman, Essex, England.

5. Galston, A.W. 1989: Life Processes in Plants, Scientific American Library, Springer-Verlag, New York, USA.

6. Hopkins, W.G., 1995: Introduction to Plant Physiology, John Wiley & Sons, Inc., New York, USA.

7. Mohr, H. and Schopfer, P. 1995: Plant Physiology. Springer-Verlag, Berlin Germany.

8. Salisbury, F.B. and Ross, C.W. 1986: Plant Physiology. CBS Publishers and Distributors, New Delhi.

9. Taiz, L. and Zeiger, E. 2003: Plant Physiology. Panima Publishing Corporation, New Delhi.

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B. Sc. II Year (IV Semester)

Examination Time: 4 Hrs **Maximum Marks: 50 (20+30)**
Paper Title: Botany Lab-IV
Paper Code: BOT-206 **Schedule per week Lectures: 3**

1. Devise experiments A and B to demonstrate the physiological process (as per the list). Perform it and show it to the examiners. 08

2. Comment on the physiological experiment C and D (Specimen/ set-up / Model / Chart). 04

3. Test for carbohydrates / Proteins / Fats. 06

4. Note Book and Report 08

5. Viva-voce. 04

List of Practicals

1. Demonstration of imbibition by plaster of Paris method.

2. Demonstration of Osmosis by potato osmoscope method.

3. To study the Osmotic pressure of onion scale/ Rhoeo leaf peel by plasmolytic method.

4. Calculation of stomatal index and stomatal frequency of a mesophyte and a xerophyte.

5. Demonstration of transpiration by Ganong's/ Farmer's potometer.

6. To separate of photosynthetic pigments by thin layer/paper chromatography.

7. Demonstration of Ascent of sap/Transpiration pull

8. To study the rate of photosynthesis under varying CO2 concentration using Wilmott's bubbler.

9. To study the effect of light intensity on oxygen evolution during photosynthesis Using Wilmott's bubbler.

10. Demonstration of aerobic & anaerobic respiration.

11. To study the evolution of heat during respiration

12. Demonstration of manometric determination of R. Q.

13. Demonstration of phototropism, geotropism and hydrotropism.

14. Simple tests for the detection of carbohydrates (monosaccharides, disaccharides and starch); Proteins and Fats.

15. Preparation of report on use of plant hormones in vegetative reproduction, seed germination etc.

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B. Sc. III Year (V Semester)

Examination Time: 3 Hrs **Maximum Marks: 50 (20+30)**
Paper Title: Economic Botany
Paper Code: BOT-301 **Schedule per week Lectures: 3**

Note: Examiner will set nine questions and the students will be required to attempt five questions in all, Question number one is compulsory containing six short answer types' questions covering the entire syllabus and will be of 1 mark. Further examiner will be set two questions from each unit and the students will be required to attempt one question from each unit which will be of 6 marks each.

UNIT-I

Origin, distribution, botanical description, brief idea of cultivation and uses of the following:

Food plants: Cereals (Rice, Wheat and Maize).

Pulses: Gram, Arhar and Pea. **Vegetables:** Potato, Tomato and Onion.

UNIT-II

Morphology of plant part used, brief idea of cultivation and uses of the following:

Spices: Coriander, Ginger, Turmeric and Cloves.

Fibers: Cotton, Jute and Flax.

Oils: Groundnut, Mustard and Coconut.

UNIT-III

Morphology of plant part used, brief idea of cultivation and uses of the following:

Medicinal Plants: *Cinchona*, *Rauwolfia*, *Atropa*, Opium, *Cannabis*, Neem, *Withania* and other industrially important medicinal plants.

Energy plantations and bio-fuels.

UNIT-IV

Botanical description and processing of:

Beverages: Tea and Coffee; **Rubber:** *Hevea*; **Sugar:** Sugarcane.

General account and sources of timber.

Suggested Readings:

1. Kocchar, S.L. 1998: Economic Botany in Tropics, 2nd edition, MacMillan India Ltd., New Delhi.
2. Kocchar, S.L. 2016. Economic Botany: A Comprehensive Study, 5 Ed, Cambridge India.
3. Sambammurthy, A.V.S.S. And Subramanyam, N.S. 1989: A Textbook of Economic Botany, Wiley Eastern Ltd., New Delhi.
4. Sharma, O.P. 1996: Hills Economic Botany (Late Dr. A.F. Hill adapted by O.P. Sharma), Tata McGraw Hill Co. Ltd., New Delhi.
5. Simpson, B.B. and Conner-Ogorzaly, M. 1986: Economic Botany- Plants in our World, McGraw Hill, New York.

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B. Sc. III Year (V Semester)

Examination Time: 3 Hrs **Maximum Marks: 50 (20+30)**
Paper Title: Plant Biotechnology
Paper Code: BOT-303 **Schedule per week Lectures: 3**

Note: Examiner will set nine questions and the students will be required to attempt five questions in all, Question number one is compulsory containing six short answer types' questions covering the entire syllabus and will be of 1 mark. Further examiner will be set two questions from each unit and the students will be required to attempt one question from each unit which will be of 6 marks each.

UNIT I

Historical perspective of plant tissue culture; Composition of media; Nutrient and hormone requirements; Totipotency; Organogenesis; Embryogenesis; Protoplast culture; Plant tissue culture applications (micropropagation, androgenesis, virus elimination, secondary metabolite production; Cryopreservation. Restriction Endonucleases- types and role.

UNIT II

Brief idea about cloning vectors- Ti plasmid, BAC, Lambda phage, M13phagemid, cosmid, shuttle vector; eukaryotic vectors (YAC).

Recombinant DNA, bacterial transformation and selection of recombinant clones, PCR mediated gene cloning; Genomic and cDNA libraries.

UNIT III

Methods of gene transfer- Agrobacterium mediated, electroporation, microinjection, microprojectile bombardment; Selection of transgenics– selectable marker and reporter genes (Luciferase, GUS, GFP).

Industrial enzymes (aspergillase, protease, lipase); Biosafety concerns.

UNIT IV

Applications of biotechnology-pest resistant (Bt-cotton); herbicide resistant plants (Round-Upready soybean); Transgenic crops with improved quality traits (FlavrSavr tomato, golden rice); Improved horticultural varieties (Moondust carnations).

Suggested Readings

1. BD Singh. Biotechnology. Kalyani Publications

2. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.

3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.

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B. Sc. III Year (V Semester)

Examination Time: 4 Hrs **Maximum Marks: 50 (20+30)**
Paper Title: Botany Lab-V
Paper Code: BOT-305 **Schedule per week Lectures: 3**

1. Identify and Classify spots 1, 2, 3, and 4 from the point of view of economic importance and morphology of the plant part used. 08

2. Perform the Applied Botany experiment (as per the list). 04

3. Comment on the specimen A and B (Chart/ Model /Photograph from Biotechnology) 06

4. Note Book, Collection and field report. 08

5. Viva-voce. 04

List of Practicals

1. Study of economically important plants: Wheat, Rice, Gram, Pea, Arhar, Soybean, Black pepper, Ginger, Clove, Turmeric, Tea, Coffee, Cocoa, Cotton, Jute, Coir, Groundnut, Coconut and Mustard

2. Collection and preparation of report on various crops and economically important plants being cultivated/wildly available in your area.

3. Brief introduction to the components and working of the instruments- oven, autoclave, incubator, centrifuge and laminar air flow). Familiarization with basic equipment in tissue culture and Preparation of MS medium.

4. To prepare the slants and petri plates for plant tissue culture.

5. Demonstration of in vitro sterilization and inoculation methods using leaf and nodal explants of tobacco, Datura, Brassica etc.

6. Study of anther, embryo and endosperm culture, micropropagation, somatic embryogenesis & artificial seeds through photographs.

7. Study of methods of gene transfer through photographs: Agrobacterium-mediated,

direct gene transfer by electroporation, microinjection, microprojectile bombardment.

8. Study of steps of genetic engineering for production of Bt cotton, Golden rice, FlavrSavr tomato through photographs.

9. Isolation and quantification of genomic DNA from bacteria (*E. coli*) or Plants

10. Study of Blotting techniques: Southern, Northern and Western, DNA fingerprinting, DNA sequencing, PCR through photographs.

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B. Sc. III Year (VI Semester)

Examination Time: 3 Hrs **Maximum Marks: 50 (20+30)**
Paper Title: Cell Biology & Genetics
Paper Code: BOT-302 **Schedule per week Lectures: 3**

Note: Examiner will set nine questions and the students will be required to attempt five questions in all, Question number one is compulsory containing six short answer types' questions covering the entire syllabus and will be of 1 mark. Further examiner will be set two questions from each unit and the students will be required to attempt one question from each unit which will be of 6 marks each.

Unit I

Heredity: Brief life history of Mendel; Terminologies; Laws of Inheritance.

Modified Mandelian Ratios: Lethal Genes; Co-dominance, incomplete dominance; Gene interaction (9:7; 9:4:3; 13:3; 12:3:1, 15:1).

Linkage: Concept & history, complete & incomplete linkage.

Unit II

Cell organelles: Golgi Apparatus, Endoplasmic Reticulum, Lysosomes, Peroxisomes and Vacuoles. **Ultra-structure and function:** Chloroplast, Mitochondria, Nucleus and Nucleolus. **Cell Cycle:** General account and its Phases, Molecular basis of cell cycle control and checkpoints. **Cell Division:** Mitosis and Meiosis - Stages and Significance.

Unit III

Cytoplasmic Inheritance: leaf variegation in *Mirabilis jalapa,*

Chromosome theory of Inheritance. Sex-determination and Sex-linked Inheritance.

Crossing over: concept and significance, cytological proof of crossing over.

Mutations & Chromosomal Aberrations; Types of mutations, effects of different mutagens.

Numerical chromosomal changes: Euploidy, Polyploidy and Aneuploidy.

Structural chromosomal changes: Deletions, Duplications, Inversions & Translocations

Unit IV

Genetic Material: DNA - the genetic material, DNA structure and replication, DNA-Protein interaction, The Nucleosome Model, Genetic Code, Satellite and Repetitive DNA.

Gene Expression: Modern concept of gene; RNA; Ribosomes; Transfer of genetic information - transcription and translation.

Suggested Readings

1. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley India.
2. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.
3. Klug WS, Cummings MR, Spencer, C, Palladino, M (2011). Concepts of Genetics, 10th Ed., Benjamin Cummings
4. Pierce BA (2011) Genetics: A Conceptual Approach, 4th Ed., Macmillan Higher Education Learning
5. Singh, BD. Genetics. Kalyani Publishers Delhi

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B. Sc. III Year (VI Semester)

Examination Time: 3 Hrs **Maximum Marks: 50 (20+30)**
Paper Title: Plant Breeding
Paper Code: BOT-304 **Schedule per week Lectures: 3**

Note: Examiner will set nine questions and the students will be required to attempt five questions in all, Question number one is compulsory containing six short answer types' questions covering the entire syllabus and will be of 1 mark. Further examiner will be set two questions from each unit and the students will be required to attempt one question from each unit which will be of 6 marks each.

Unit- I

Introduction and objectives of Plant Breeding: Breeding systems; modes of reproduction in crop plants; Important achievements and undesirable consequences of plant breeding.

Methods of crop improvement: Introduction; Centres of origin and domestication of crop plants; plant genetic resources; Acclimatization.

Unit II

Selection methods: For self-pollinated, cross pollinated and vegetatively propagated plants.

Hybridization: For self, cross and vegetatively propagated plants–Procedure, advantages and limitations.

Unit III

Quantitative inheritance: Concept, mechanism, examples. Monogenic vs. polygenic Inheritance. **Inbreeding depression and heterosis**: History, genetic basis of inbreeding depression and heterosis.

Unit IV

Crop improvement and breeding Applications.

Role of mutations, polyploidy, distant hybridization and role of biotechnology in crop improvement.

Suggested Readings

1. Acquaah, G. (2007). Principles of Plant Genetics & Breeding. Blackwell Publishing.
2. Chaudhari, H.K. (1984). Elementary Principles of Plant Breeding. Oxford – IBH. 2nd edition.
3. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.
4. Poehlman JM and Sleper DA (1995) Breeding Field Crops, AVI. Publ., U.S.A.
5. Singh, B.D. (2005). Plant Breeding: Principles and Methods. Kalyani Publishers. 7th edition.

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B. Sc. III Year (VI Semester)

Examination Time: 4 Hrs **Maximum Marks: 50 (20+30)**
Paper Title: Botany Lab-VI
Paper Code: BOT-306 **Schedule per week Lectures: 3**

1. Numerical regarding Genetics (Mendelian Inheritance or Gene Interaction) as per syllabus. 04
2. Identify and comment on the specimen A, B, C and D (Chart/ Model /Photograph) 08
3. Identify giving two important characters of identification of the given spots 1 and 2 (One each from mitosis and meiosis) 06
4. Note Book and Chart/Model/Report on any Genetics/Plant Breeding Phenomenon. 08
5. Viva-voce. 04

List of Practicals

1. Mendel's laws through seed ratios. Laboratory exercises in probability and chi-square.

2. Chromosome mapping using point test cross data.

3. Pedigree analysis for dominant and recessive autosomal and sex-linked traits.

4. Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3,15:1, 12:3:1, 9:3:4).

5. Cell Divisions: Mitosis Stages, Meiosis – Stages.

6. Photographs/Permanent Slides showing Translocation Ring, Laggards and Inversion Bridge.

7. Hybridization techniques - Emasculation, Bagging & Cross Pollination (For demonstration only).

8. Induction of polyploidy conditions in plants (For demonstration only).