# BOTANY (CBCS)
# [Semester-I]
# For examinations to be held in December 2021, 2022 & 2023

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## PRINCIPLES OF MICROBIOLOGY

**Course No.: PSBOTC101**
**Credits: 4**
**Duration: 2½ hrs**

**Maximum Marks: 100**
**Minor Test I: 20 Marks**
**Minor Test II: 20 Marks**
**Major Test: 60 Marks**

***Objectives:***

***Microbes comprising the largest group of living organisms, contribute to human welfare in many ways. The course is conceived to familiarize the students with the diversity exhibited by microbes, their structural and reproductive details and economic aspects.***

**UNIT I: Development of Microbiology**

1.1 Discovery of microorganisms; major groups and classification (Haeckel's three kingdom concept, three domain concept of Carl Woese, Bergey's manual).

1.2 Bright field microscopy (magnification, contrast, resolution).

1.3 Microbiological stains (basic, acidic), types of staining (simple staining, negative staining, Gram staining, flagella staining, acid-fast staining, endospore staining).

1.4 Cultivation of microbial cells on solid media (Nutrient agar and potato dextrose agar) and liquid media (batch culture and continuous culture system), maintenance of microbial cultures (agar slants, storage under mineral oil, water storage, soil storage, lyophilization, liquid nitrogen storage).

**UNIT II: Eubacteria and Archaebacteria**

2.1 General account of Eubacteria (size, shape and arrangement, types of reproduction).

2.2 Eubacterial cell wall, structures external to the cell wall (glycocalyx, flagella, pili), plasma membrane, cytoplasm and cytoplasmic inclusions, bacterial endospores-their formation, structure and types.

2.3 Phytoplasma-general characteristics and diseases (aster yellows, lethal yellowing of coconut palms, peach X disease).

2.4 General account of Archaebacteria (methanogenic, halophilic and thermo-acidophilic), production of methane (bio-methanation).

**UNIT III: Plant Viruses and Viroids**

3.1 Structural characteristics of plant viruses (TMV and TYMV), symptoms of virus infection in plants.

3.2 Isolation and purification of stable plant virus TMV, chemical nature and replication of TMV.

3.3 Transmission and prevention of plant viruses, common viral diseases of plants.

3.4 Structure, replication and transmission of viroids, important diseases caused by viroids (potato spindle tuber, cadang cadang of coconut, citrus exocortis).

**UNIT IV: Animal Viruses, Bacteriophages and Prions**

4.1 Structural characteristics of animal viruses (Influenza virus and Poxvirus), types of infections caused by animal viruses.

4.2 Replication of HIV and SARS-CoV2, transmission and prevention of viral infections in humans (vaccines and drugs), emerging and resurgent viral diseases.

4.3 Discovery and significance of bacteriophages, structure and replication of virulent DNA (T4), temperate DNA (λ lambda) and filamentous DNA (M13) bacteriophages.

4.4 Discovery and characteristics of prions, diseases caused by prions.

**Course No.: PSBOTC101** **PRINCIPLES OF MICROBIOLOGY**

**UNIT V: Microbial applications and interactions**

5.1 Microbial fermentation, bioreactors, fermented foods and probiotics.
5.2 Microbes in bioremediation (recovery of metals and oil spills) and space research (general concept).
5.3 Microbes in nanotechnology.
5.4 Plant microbial interactions: PGPR.

**Note for Paper Setting**

| Theory Examination | Syllabus to be covered in the Examination | Time allotted for the Exam | % weightage (marks) |
|---|---|---|---|
| Minor Test I | Up to 20% | 1 Hr. | 20 |
| Minor Test II | 20% to 40% | 1 Hr. | 20 |
| Major Test | 41% to 100% | 2½Hr. | 60 |

**Pattern to be followed for Major Test:**

a. Major test will have seven questions each of 15 marks.
b. One question will be compulsory and will consist of very short answer type of multiple parts spread over entire syllabus.
c. Rest of the six questions will be from the remaining 41%-100% portion of the syllabus and the candidate will have to attempt any three of them.

**Literature recommended**:

1. Black, J. G. (2013). Microbiology. 8th Edn. John Wiley & Sons. New York.
2. Sumbali G. and Mehrotra R.S. (2009). Principles of Microbiology. 1st Edn. Tata McGraw Hill Publishing Co. Ltd. New Delhi.
3. Madigane, M. T. et al (2009). Brock's Biology of microorganisms. 12th ed. Pearson, Benjamin.
4. Satayanarayana, T. and Johri, B. N. (eds.) (2013). Microbial diversity: current perspective and potential application. I K International, Delhi.
5. Cowan, M. Kelly. (2015). Microbiology: a systems approach. 3rd ed. Mc Graw Hill, New Delhi.
6. Wiley, J., Sandman K. and Wood, D. (2020). Prescott's Microbiology. 11th ed. Mc Graw Hill, New Delhi.

# BOTANY (CBCS)
# [Semester-I]
# For examinations to be held in December 2021, 2022 & 2023

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## DIVERSITY AND EVOLUTION OF ALGAE AND BRYOPHYTES

**Course No.: PSBOTC102**
**Credits: 4**
**Duration: 2½ hrs**

**Maximum Marks: 100**
**Minor Test I: 20 Marks**
**Minor Test II: 20 Marks**
**Major Test: 60 Marks**

***Objectives:***

***Representing botanical novelties, Algae and Bryophytes are of great human use particularly in agriculture and biotechnology based industries. The course is designed to familiarize the students with the diversity, biology and economic value of these interesting non-flowering groups.***

**UNIT I: Classification, thallus organization and fossils of algae**

1.1 Modern trends in classification of algae (F.E. Fritsch, 1935 vs Robert Edward Lee, 2008).

1.2 Evolutionary trends, parallelism in evolution and range of thallus structure in algae, Modes of reproduction: vegetative, asexual and sexual: origin of sex utility in algae.

1.3 Major patterns of life cycles in algae: mono-, di- and tri-genetic types.

1.4 Fossil algae with special reference to India. A short account of *Rafatazmia chitrakootensis*. Centers of algal research in India. Contribution of Indian phycologists: MOP Iyenger, G.S Venkataraman and TV Desikachary.

**UNIT II: Distinguishing features of Cyanophyta, Chlorophyta, Bacillariophyta, Chrysophyta, Dinophyta, Euglenophyta, Cryptophyta, Xanthophyta, Phaeophyta and Rhodophyta with emphasis on**

2.1 Structural and compositional diversity of cell wall and flagellar apparatus.

2.2 Structure and diversity of chloroplasts.

2.3 Structure and diversity of pyrenoids and eyespots.

2.4 Diversity of reserve storage products.

**UNIT III: Classification of Bryophyes; Diversity and reproduction in Marchantiophyta and Anthocerophyta**

3.1 Introduction and recent trends in classification of Bryophytes (Sandra Holmes, 1986 vs Troitsky et al., 2007).

3.2 Comparative morphology, anatomy and diversity of thalloid liverworts (Sphaerocarpales, Metzgeriales and Marchantiales).

3.3 Comparative morphology, anatomy and diversity of leafy liverworts (Calobryales and Jungermanniales).

3.4 Comparative morphology and anatomy of Anthocerophyta.

**UNIT IV: Bryophyta-diversity, morphogenesis and phylogeny**

4.1 Bryophyta: Introduction; Morphology, anatomy and reproduction in Funariales and Sphagnales.

4.2 Growth and differentiation in bryophytes- role of growth regulators in morphogenesis; differentiation of protonema, bud formation, mechanism of bud initiation.

4.3 Bryophytes as model systems, molecular attributes of mosses. Bryophyte phylogeny: Phylogenetic relationships among major lineages of mosses.

4.4 Alternation of generations in archegoniatae-Antihetic and homologous theory, phenomena of apogamy and apospory, origin and evolution of bryophytes.

**UNIT V: Economic importance of algae and bryophytes**

5.1 Algae in biotechnology: Products, processes and applications; seaweed polysaccharides (Agar, Carrageenan and Alginates); Algal biofuels; Algae in Climate change: $CO_2$ sequestration and pollution control.

5.2 Algal blooms and Toxins.

5.3 Bryophytes as indicators of environmental pollution; biologically active compounds from Bryophytes.

5.4 Ecology of Bryophytes-Autecology, Synecology; their role in carbon and nitrogen cycling.

# BOTANY (CBCS)
# [Semester-I]
# For examinations to be held in December 2021, 2022 & 2023

**Course No.: PSBOTC102** **DIVERSITY AND EVOLUTION OF ALGAE AND BRYOPHYTES**

**Note for Paper Setting**

| Theory Examination | Syllabus to be covered in the Examination | Time allotted for the Exam | % weightage (marks) |
|---|---|---|---|
| Minor Test I | Up to 20% | 1 Hr. | 20 |
| Minor Test II | 20% to 40% | 1 Hr. | 20 |
| Major Test | 41% to 100% | 2½ Hr. | 60 |

**Pattern to be followed for Major Test:**

a. Major test will have seven questions each of 15 marks.
b. One question will be compulsory and will consist of very short answer type of multiple parts spread over entire syllabus.
c. Rest of the six questions will be from the remaining 41%-100% portion of the syllabus and the candidate will have to attempt any three of them.

## Literature recommended:

### I. Algae


1. Fritsch, F.E. (1945). The Structure and Reproduction of Algae. Vol. I & II. Cambridge University Press.
2. Smith, G.M. (1955). Cryptogamic Botany. Vol. I. McGraw Hill Co. Ltd.
3. Bold. H.C. and Wynne, M. J. (1978). Introduction to the Algae: Structure and Function. Prentice Hall of India.
4. Trainor, F.R. (1978). Introductory Phycology. John Wiley and Sons Inc.
5. Kumar, H.D. and Singh, H.N. (1982). A Text Book of Algae. East West Press.
6. Lee, R. E. (2012). Phycology. 4th ed. Cambridge University Press, New Delhi.


### II. Bryophytes


1. Puri, P. (1985). Bryophytes: A Broad Perspective. Atma Ram & Sons, Delhi.
2. Rashid, A. (1998). An Introduction to Bryophyta, Vikas Publ. House, Pvt. Ltd.
3. Schuster R. M. (1983). New manual of Bryology Vol. I & II. The Hattori Botanical Laboratory, Japan.
4. Smith, G.M. (1955). Cryptogamic Botany Vol II, Tata McGraw Publishing Company, Inc., N.Y.
5. Vander Poorten, A. and Goffinet, B. (2009). Introduction to Bryophytes. Cambridge University Press, New York.

# BOTANY (CBCS)
# [Semester-I]
# For examinations to be held in December 2021, 2022 & 2023

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## CYTOLOGY, GENETICS AND CYTOGENETICS

**Course No.: PSBOTC103**
**Credits: 4**
**Duration: 2½ hrs**

**Maximum Marks: 100**
**Minor Test I: 20 Marks**
**Minor Test II: 20 Marks**
**Major Test: 60 Marks**

***Objectives*:**

***Genetics and cytogenetics provide scientific basis to the art of plant and animal breeding. Genetic improvement of crop plants cannot be sound, unless their genetic architecture has been fully understood. This course aims at equipping the student with up-to-date knowledge of the nature and structure of genetic material and principles of heredity in diploid, polyploid and aneuploid organisms.***

**UNIT I: Chromatin organization**

1.1 Chromosome morphology; molecular organization of nucleosome, centromere and telomere.
1.2 Cytological techniques: Classical methods, chromosome banding, FISH, GISH.
1.3 Specialized chromosomes; structure, occurrence and behavior of B- and sex chromosomes, Polytene and lampbrush chromosomes.
1.4 Organization of chloroplast and mitochondrial genomes and role in inheritance; cross talk between nuclear and organelle genomes.

**UNIT II: Numerical alterations in the genome**

2.1 Origin, occurrence, production and meiosis of monoploids and haploids.
2.2 Origin and production of autopolyploids: concept of chromosome and chromatid segregation and double reduction.
2.3 Allopolyploids - types, genome constitution and analysis of wheat and cotton.
2.4 Aneuploid types-Origin, occurrence, production, meiosis and detection of monosomics and trisomics and their use in chromosome mapping.

**UNIT III: Genetic recombination and gene mapping**

3.1 Recombination: Holliday's model of recombination at molecular level, role of Rec A and Rec B, C, D enzymes; site-specific recombination.
3.2 Chromosome mapping, genetic markers, linkage maps, tetrad analysis, mapping with molecular markers, development of mapping populations in plants.
3.3 Correlation of genetic and physical maps; somatic cell genetics-an alternative approach to gene mapping
3.4 Genetic transformation, conjugation and mapping of genes by interrupted mating, transduction and sexduction in bacteria.

**UNIT IV: Gene structure, expression and sudden changes**

4.1 Gene fine structure; cis-trans test; r II locus.
4.2 Regulation of gene expression in prokaryotes (lac operon and trp operon) and eukaryotes (hormonal control and methylation); concept and applications of epigenetics.
4.3 Mutations: Causes and detection of mutant types – lethal, conditional, biochemical, loss-of-function, gain-of-function, germinal vs. somatic mutants; insertional mutagenesis and site directed mutagenesis; DNA damage and repair mechanisms.
4.4 Transposable elements in prokaryotes and eukaryotes; IS, Tn3, Tn5, Tn9, Tn10 in prokaryotes; Ac-Ds and Spm-dSpm in maize, Copia and P elements in *Drosophila* and Ty elements of yeast; LINE and SINE in humans; concept of transposon tagging.

**Course No.: PSBOTC103** **CYTOLOGY, GENETICS AND CYTOGENETICS**

**UNIT V: Cytogenetics of higher plants**

5.1 Breeding behaviour and genetics of complex translocation heterozygotes, translocation tester sets; Robertsonian translocations.

5.2 Breeding behaviour and genetics of inversion heterozygotes.

5.3 Production, characterization and utility of alien addition and substitution lines: classical and modern approaches.

5.4 Polygenic inheritance, heritability and its measurements; QTL mapping.

**Note for Paper Setting**

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| Minor Test II | 20% to 40% | 1 Hr. | 20 |
| Major Test | 41% to 100% | 2½Hr. | 60 |

**Pattern to be followed for Major Test:**

a. Major test will have seven questions each of 15 marks.
b. One question will be compulsory and will consist of very short answer type of multiple parts spread over entire syllabus.
c. Rest of the six questions will be from the remaining 41%-100% portion of the syllabus and the candidate will have to attempt any three of them.

**Literature recommended:**

1. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D. (1989). Molecular Biology of the Cell. Garland Publishing Inc. NY & London.
2. Alberts et al. (2015). Molecular biology of the cell. 6th ed. Garland Science, New York.
3. Avers, C. (1984). Genetics. PWS Publishers.
4. Brown, T. A. (1989). Genetics: A Molecular Approach. VNR international.
5. Brown, T. A. (1990). Gene Cloning-An introduction. Chapman and Hall, London.
6. Brown, T. A. (2016). Gene cloning and DNA analysis. 7th ed. Wiley Blackwell, UK.
7. Cooper, G. M. and Hausman, R. E. (2018). The Cell: A molecular approach. 7th ed. Sinauer Association, USA.
8. Gupta, P.K. (1997). Genetics. Rastogi Publications, Meerut.
9. Gupta, P.K. (2002). Cell and Molecular Biology. Rastogi Publications, Meerut.
10. Hartl, D.L. and Jones, E.W. (2000). Genetics – An Analysis of Genes and Genomes. Jones & Bartlett Publishers.
11. Iwasa, J. and Marshall, W. (2016). Karp's Cell and Molecular Biology-Concepts and Experiments. 8th ed. Wiley Plus, Singapore.
12. Jones, Russell et al (2017). Molecular life of plants. Wiley Blackwell, New Delhi.
13. Karp, G. (1999). Cell and Molecular Biology – Concepts and Experiments. John Wiley and Sons Inc.
14. Klug, W. S. (2012). Concept of Genetics. 10th Edn. Pearson publications.
15. Krebs, J. E. (2018). Lewin's Genes XII. Jones & Bartlett, Burlington.
16. Lewin, B. (2000). Genes VII. Oxford University Press, NY.

17. Lodish et al. (2016). Molecular Cell Biology. 8th ed. Macmillan, New York.
18. Old, R.W. and Primrose, S.B. (1994). Principles of Gene Manipulation. Blackwell Scientific Publication, London.
19. Pierce, B. A. (2018). Genetics essentials: Concepts and connections. 4th ed. Macmillan, USA.
20. Pollard, T. D. et al (2017). Cell Biology. 3rd ed. Elsevier, USA.
21. Primose, S. B. and Twyman, R. M. (2014). Principles of gene manipulation and genomics. 7th ed. Wiley Blackwell, New Delhi.
22. Russel, P.J. (1998). Genetics. Benjamin/Cummings Publishing Co. Inc.
23. Singh, R. J. (2017). Plant Cytogenetics. 3rd ed. CRC Press, Boston.
24. Sinnott, E.W., Dunn L.C. and Dobzhansky T. (1958). Principles of Genetics. Kugakusha Co. Ltd.
25. Snustad, D.P. and Simmons, M.J. (2000). Principles of Genetics. John Wiley & Sons, NY.
26. Snustad, D. P. and Simmons, M. J. (2019). Principles of Genetics. 7th ed. John Wiley & Sons, NY.
27. Stansfield, W.D. (1991). Genetics (Schaums outlines), McGraw Hill.
28. Strickberger, M.W. (1976). General Genetics. McMillan Publishing Co. Inc. NY.
29. Swanson C.P., Merz, T. and Young, W.J. (1967). Cytogenetics. Prentice Hall of India, Pvt. Ltd.
30. Watson, J.D., Hopkins, N.H., Roberts, J.W., Steitz, J.A. and Weiner A.M.L. (1987). Molecular Biology of the Gene. The Benjamin/Cummings Publishing Company Inc.

# BOTANY (CBCS)
# [Semester-I]
# For examinations to be held in December 2021, 2022 & 2023

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## PLANT ANATOMY

**Course No.: PSBOTC104**
**Credits: 4**
**Duration: 2½ hrs**

**Maximum Marks: 100**
**Minor Test I: 20 Marks**
**Minor Test II: 20 Marks**
**Major Test: 60 Marks**

***Objectives:***

***This course will acquaint the students with internal basic architecture and cellular composition of plant body. This will help them to correlate important functions performed by different plant parts.***

**UNIT I: Plant growth, development and cellular organization**

1.1 Unique features of plant growth and development-polarity and cell division
1.2 Shoot and Root System: primary structure and basic vasculature.
1.3 Primary pit fields: pits and their types.
1.4 Diversity of cell types in plants - modifications in parenchyma; types and distribution of collenchyma and sclerenchyma in plant organs.

**UNIT II: Fundamental tissues, types and constituent cells**

2.1 Epidermis-structure in root and aerial parts, origin and composition of cuticle.
2.2 Stomata and trichomes- structural diversity, origin and functions.
2.3 Xylem- origin and elements, structure and functions of tracheary elements.
2.4 Phloem- origin and elements, structure and functions of sieve tube elements and companion cells.

**UNIT III: Meristems and vascular tissues-components and composition**

3.1 Meristems - types, composition, structure, cyto-histological zonation and function of root and shoot apical meristems
3.2 Vascular cambium- organization, formation of secondary xylem and phloem.
3.3 Secondary xylem- basic structure; storied and non-storied wood; growth rings.
3.4 Secondary phloem- structure of sieve tube elements and companion cells

**UNIT IV: Physiological and genetic control of leaf and root formation**

4.1 Leaf formation and expansion –physiological and metabolic pathways
4.2 Molecular pathways and role of transcription factors in regulating leaf formation, expansion and senescence
4.3 Molecular pathways and role of transcription factors in regulating root formation, root branching under varied habitats
4.4 Genetic factors regulating leaf and root adaptations to abiotic stresses.

**UNIT V: Histology of the stem and roots**

5.1 Anatomy of nodes in dicots and monocots, the node-internode transition, formation of leaf and branch traces.
5.2 Wood anatomy, growth rings, types and ultra-structure of tracheids, physical factors affecting wood formation, methods of wood quality parameters in India.
5.3 Functional anatomy of specialized structures: laticifers, lenticels, nectaries, osmophores, salt glands and hydathodes.
5.4 Transfer cells: structure, distribution, ontogeny and functions.

# BOTANY (CBCS)
# [Semester-I]
# For examinations to be held in December 2021, 2022 & 2023

**Course No.: PSBOTC104** **PLANT ANATOMY**

**Note for Paper Setting**

| Theory Examination | Syllabus to be covered in theExamination | Time allotted for the Exam | % weightage (marks) |
|---|---|---|---|
| Minor Test I | Up to 20% | 1 Hr. | 20 |
| Minor Test II | 20% to 40% | 1 Hr. | 20 |
| Major Test | 41% to 100% | 2½ Hr. | 60 |

**Pattern to be followed for Major Test:**

a. Major test will have seven questions each of 15 marks.
b. One question will be compulsory and will consist of very short answer type of multiple parts spread over entire syllabus.
c. Rest of the six questions will be from the remaining 41%-100% portion of the syllabus and the candidate will have to attempt any three of them.

**Literature recommended:**


1. Atwell, B.J., Kriedermann, P.E. and Jumbull, C.G.N. (1999). Plants in Action: Adaptation in Nature, Performance in Cultivation. Mc Millan Education, Sydney, Australia.
2. Bewley, J.D. and Black, M. (1994). Seeds: Physiology of Development and Germination. Plenum Press, New York.
3. Burgess, J. (1985). An Introduction to Plant Cell Development. Cambridge University Press, Cambridge.
4. Cutler D.F., Bother, C.E.G. and Stevenson, D.W. (2011). Plant Anatomy: An Applied Approach. Blackwell Publishing, USA.
5. Crang, Richard. (2018). Plant Anatomy. Springer, Switzerland.
6. Dickison, W. C. (2014). Integrative Plant Anatomy. Academic Press, Amsterdam.
7. Evert, et al. (2017). Esau's Plant Anatomy. 3rd ed. Wiley, USA.
8. Fahn, A. (1982). Plant Anatomy. 3rd Edn. Pergamon Press, Oxford.
9. Fosket, D.E. (1994). Plant Growth and Development: A Molecular Approach. Academic Press, San Diego.
10. Howell, S.H. (1998). Molecular Genetics of Plant Development. Cambridge University Press, Cambridge.
11. Murphy, T.H. and Thompson, W.F. (1988). Molecular Plant Development. Prentice Hall, New Jersey.
12. Steeves, T.A. and Sussex, I.M. (1989). Patterns in Plant Development. 2nd Edn. Cambridge University Press, Cambridge.
13. Steeves, T. A. and Sawhney, V. K. (2017). Essentials of Developmental Plant Anatomy. Oxford University Press, USA.

# BOTANY (CBCS)
# [Semester-I]
# For examinations to be held in December 2021, 2022 & 2023

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**Course No. PSBOPC105 (Based on PSBOTC101 and PSBOTC102)**

**Credits: 4** **Maximum Marks: 100**
**Daily evaluation of practical records /Assignment test / Viva voce etc. : 50**
**Final Practical performance +viva voce:50**

**Laboratory Exercises based on PSBOTC101**

1. Demonstration of various staining techniques for bacteria (Gram staining, negative/indirect staining, cell wall staining and endospore staining).
2. Symptomatology of plant diseases caused by bacteria (leaf spot of peach, angular leaf spot of cotton, Kresek of rice and citrus canker).
3. Symptomatology of plant diseases caused by viruses (tobacco mosaic virus, tomato aspermy virus, carnation ring spot virus, cauliflower mosaic virus, tobacco necrosis virus, tobacco leaf curl virus, bean common mosaic virus and yellow vein mosaic virus).

## Laboratory Exercises based on PSBOTC102

1. Morphological study of representative members of Algae: *Microcystis, Aulosira, Oocystis, Pediastrum, Hydrodictyon. Ulva, Pithophora, Stigeoclonium, Draparnaldiopsis, Closterium, Cosmarium, Ch*ara.
2. Study of morphology, anatomy and reproductive structures of bryophytes: *Marchantia, Anthoceros, Polytrichum,Plagiochasma, Asterella.*

# BOTANY (CBCS)
# [Semester-I]
# For examinations to be held in December 2021, 2022 & 2023

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**Course No. PSBOPC106 (Based on PSBOTC103 and PSBOPC104)**

**Credits: 4**

**Maximum Marks: 100**
**Daily evaluation of practical records /Assignment test / Viva voce etc. : 50**
**Final Practical performance +viva voce: 50**

**Laboratory Exercises based on PSBOTC103**

1. Karyotype analysis and preparation of ideogram.
2. Study of somatic chromosomes from root tip squashes.
3. Comparative effect of various pretreating agents on somatic chromosomes.
4. Study the effect of various known mutagens and adulterants on somatic chromosomes.
5. Study of chromosomes during meiosis (*Aloe vera, Delphinium ajacis. Allium cepa. Tradescantia canaliculata*, *Phlox drummondii, Papaver sominiferum*).
6. Attempt silver banding for staining nucleolus – organizing region.
7. Study the polytene chromosomes in Chironomus.
8. Study the characteristics and behavior of B chromosomes in an appropriate material.
9. Study the sex chromosomes of *Spinacea, Rumex/Cannabis, Mirabilis*.
10. Study the effect of induced polyploidy on plant phenotype, meiosis, pollen and seed fertility and fruit set.
11. Work out the effect of mono and trisomy on fertility and meiotic behaviour.
12. Study the effect of translocation heterozygosity on chromosome pairing, chromosome disjunction and pollen and seed fertility.
13. Study the meiosis of complex translocation heterozygotes.
14. Construction of genetic maps from the given data.
15. Calculation of recombination frequencies.
16. Determination of linkage relationships.
17. Study of Mendelian and non-Mendelian inheritance patterns.

**Laboratory Exercises based on PSBOTC104**

1. Study of living shoot apices by dissections using aquatic plants such as *Ceratophyllum* and *Hydrilla*.
2. Study of cytohistological zonation in the shoot apical meristem in sectioned and double stained permanent slides of suitable plant such as *Coleus, Kalanchoe, Tobacco*.
3. Examination of shoot apices in a monocotyledon in both T.S. and L.S. to show the origin and arrangement of leaf primordia.
4. Study of alternate and distichous, alternate and superposed, opposite and decussate leaf arrangement. Examination of rosette plants (*Raphanus, Hyoscyamus* etc.) and induction of bolting under natural conditions as well as by GA treatment.
5. Microscopic examination of vertical sections of leaves such as *Cannabis, Tobacco, Nerium*, maize and wheat to understand the internal structure of leaf tissues and trichomes, glands etc. Also study the leaf anatomy of C3 and C4 plants.
6. Study of epidermal peels of leaves such as *Coccinia, Tradescantia*, etc.
7. To study the development and final structure of stomata and determine stomata index. Demonstration of the effect of ABA on stomata closure.
8. Study of whole roots in monocots and dicots. Examination of L.S. of root from a permanent preparation to understand the organization of apical meristem and its derivatives (use maize, aerial roots of banyan, *Pistia*). Origin of lateral roots with different types of nodules.

# BOTANY (CBCS)
# [Semester-II]
# For examinations to be held in May 2022, 2023 & 2024

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## CELL AND MOLECULAR BIOLOGY OF PLANTS

**Course No.: PSBOTC201**
**Credits: 4**
**Duration: 2½ hrs**

**Maximum Marks: 100**
**Minor Test I: 20 Marks**
**Minor Test II: 20 Marks**
**Major Test: 60 Marks**

***Objectives*:**
***The present course envisages the structural and functional aspects of cell and its related organelles at micro- and macro-molecular levels. Basic aim is to impart student this knowledge and updated information pertaining to the fine structure of gene and gene expression in pro- and eukaryotes.***

**UNIT I: Plant cell; its envelope and unique features**

1.1 Evolution and diversity of cell – various theories.
1.2 Extracellular matrix; a general account of different types, structure, function and biogenesis of primary and secondary cell wall in plants.
1.3 Plasma membrane- chemical composition, organization of various components, fluid- mosaic model; concept of asymmetrical membranes and lipid rafts; artificial membranes.
1.4 Plasma membrane and cellular details of transport; carriers, pumps and channels.

**UNIT II: Cytoskeleton and Cell organelles**

2.1 Cytoskeleton – a general concept, details of structure and role of microfilaments and microtubules.
2.2 Unique structures of a plant cell- structure and functions of vacuole and plasmodesmata.
2.3 Structure, biogenesis and an overview of functions of mitochondria and chloroplasts.
2.4 Structure and functioning of endoplasmic reticulum, Golgi apparatus and Microbodies (lysosomes, peroxisomes and melanosomes).

**UNIT III: Nucleus and its contents including structure and function of DNA**

3.1 Nucleus; structure, nuclear pore complex and transport; ultrastructure of nucleolus.
3.2 DNA structure; A, B and Z forms; single stranded DNA; supercoiling of DNA.
3.3 DNA replication; mechanism in pro- and eukaryotes; rolling circle replication.
3.4 Transcription- mechanism and regulation; plant promoters and transcription factors.

**UNIT IV: RNA and Proteins-structure, synthesis and function**

4.1 Types of RNA- mRNA, tRNA and rRNA; their structure and biosynthesis; concept of micro-RNAs.
4.2 Introns- types and their significance; RNA splicing; mRNA transport.
4.3 Translation-ribosomes; mechanism in pro- and eukaryotes; factors involved thereof.
4.4 Organelle genomes: transcription and translation, Genetic codes and RNA editing; inheritance patterns.

**UNIT V: Cell cycle and cell death**

5.1 Protein trafficking- concept of chaperones, co-translation and post-translation transport.
5.2 Cell cycle: control mechanism; role of cyclins and cyclin dependent kinases; retinoblastoma and E2F proteins; concept of hereditary and non-hereditary cancers.
5.3 Cell cycle: checkpoints in cell cycle regulation; cytokinesis and cell plate formation.
5.4 Types of cell death, programmed cell death in the life cycle of plants.

# BOTANY (CBCS)
# [Semester-II]
# For examinations to be held in May 2022, 2023 & 2024

**Course No.: PSBOTC201** **CELL AND MOLECULAR BIOLOGY OF PLANTS**

**Note for Paper Setting**

| Theory Examination | Syllabus to be covered in the Examination | Time allotted for the Exam | % weightage (marks) |
|---|---|---|---|
| Minor Test I | Up to 20% | 1 Hr. | 20 |
| Minor Test II | 20% to 40% | 1 Hr. | 20 |
| Major Test | 41% to 100% | 2½ Hr. | 60 |

**Pattern to be followed for Major Test:**

a. Major test will have seven questions each of 15 marks.
b. One question will be compulsory and will consist of very short answer type of multiple parts spread over entire syllabus.
c. Rest of the six questions will be from the remaining 41%-100% portion of the syllabus and the candidate will have to attempt any three of them.

**Literature recommended:**


1. Alberts et al. (2015). Molecular biology of the cell. 6th ed. Garland Science, New York.
2. Brown, T.A. (1989). Genetics: A molecular Approach. VNR International
3. Brown, T.A. (2010). Gene cloning and DNA Analysis- An introduction. 6th Edn. Wiley Blackwell.
4. Brown, T.A. (2010). Genomes. John Wiley and Sons (Asia) Pvt. Ltd.
5. Cooper, G. M. and Hausman, R. E. (2018). The Cell: A molecular approach. 7th ed. Sinauer Association, USA.
6. De, D.N. (2000). Plant Cell Vacuoles: An introduction. CSIRO Publication, Colling wood, Australia.
7. Freifelder, D. and Malacinski (1993). Essentials of Molecular Biology. Jones and Bartlett Publishers.
8. Gardner, E.J., Simmons, M.J. and Snustad, D. (1991). Principles of Genetics. 8th Edn. John Wiley.
9. Gupta, P.K. (1997). Elements of Biotechnology. Rastogi Publications, Meerut.
10. Gupta, P.K. (2002). Cell and Molecular Biology. Rastogi Publications, Meerut.
11. Hardin, Jeff. (2012). Becker's world of the cell. 8th ed. Pearson, Harlow.
12. Hartl, D.L. and Jones, E.W. (2000). Genetics – An Analysis of Genes and Genomes. Jones and Bartlett Publishers.
13. Helms, Volkhard. (2019). Principles of computational cell biology. 2nd ed. Wiley, Germany.
14. Iwasa, J. and Marshall, W. (2016). Karp's Cell and Molecular Biology-Concepts and Experiments. 8th ed. Wiley Plus, Singapore
15. Jones, Russell et al (2017). Molecular life of plants. Wiley Blackwell, New Delhi.
16. Karp, G. (1999). Cell and Molecular Biology – Concepts and Experiments. John Wiley and Sons Inc.
17. Kleinsmith, L.J and Kish, V.M. (1995). Principles of Cell and Molecular Biology. Harper Collins College Publishers, NY.
18. Krishna Murphy, K.V. (2000). Methods in Cell Wall Cytochemistry. CRC Press, Boca Raton, Florida.
19. Lewin, B. (2000). Genes VII. Oxford University Press. N.Y.
20. Lodish et al. (2016). Molecular Cell Biology. 8th ed. Macmillan, New York.
21. Old, R.W. and Primrose, S.B. (1994). Principles of Gene Manipulation. Blackwell Scientific Publication, London.
22. Pollard, T. D. et al (2017). Cell Biology. 3rd ed. Elsevier, USA.
23. Russel, P.J. (1998). Genetics. Benjamin/Cummings Publishing Co. Inc.
24. Sadava, D. E. (1992). Cell Biology – Organelle Structure and Function. Jones & Bartlett Publishers.
25. Snustad, D.P. and Simmons, M.J. (2000). Principles of Genetics. John Wiley and Sons, NY.
26. Stansfield, W.D. (1991). Genetics (Schaums outlines). McGraw Hill.
27. Watson, J.D., Hopkins, N.H., Roberts, J.W., Steitz, J.A. and Weiner, A.M.L. (1987). Molecular Biology of the Gene. The Benjamin/Cummings Publishing Company Inc.
28. Wolfe, S.L. (1993) Molecular and Cellular Biology. Wadsworth Publishing Co. Calfornia, USA.

# BOTANY (CBCS)
# [Semester-II]
# For examinations to be held in May 2022, 2023 & 2024

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## DIVERSITY AND EVOLUTION OF PTERIDOPHYTES AND GYMNOSPERMS

**Course No.: PSBOTC202**
**Credits: 4**
**Duration: 2½hrs**

**Maximum Marks: 100**
**Minor Test I: 20 Marks**
**Minor Test II: 20 Marks**
**Major Test: 60 Marks**

***Objectives:***

***Pteridophytes and gymnosperms represent important non-flowering plants. While the former are important for maintaining the ecosystems, gymnosperms are in great demand in Himalayas for timber. The present course will unfold the diversity as well as structural and biological details of these plant groups to the students. The information generated will help in conservation of these plants.***

**UNIT I: Pteridophytes: Distinguishing features, classification and diversity among early land plants and microphyllous taxa**

1.1 Distinguishing characters, origin of pteridophytes (algal and bryophyte origins), Apospory, Apogamy, Parthenogenesis, evolution of stelar types, heterospory and seed habit [eu- and lepto sporangiate].

1.2 Classification of pteridophytes (Sporne1975; Parihar1996) up to ordinal level. Comparative morphology, anatomy and reproduction of fossil pteridophytes: *Rhynia, Trimerophyton, Zosterophyllum, Lepidodendron, Sphenophyllum* and *Calamites*.

1.3 Comparative morphology, anatomy and reproduction of *Psilotum, Lycopodium, Selaginella* and *Isoetes*.

1.4 Morphology, anatomy and reproduction of *Equisetum*.

**UNIT II: Diversity among megaphyllous pteridophytes**

2.1 Comparative morphology, anatomy and reproduction of eusporangiate ferns: *Ophioglossum* and *Marattia*.

2.2 Morphology, anatomy and reproduction of proto-leptosporangiate ferns: *Osmunda*.

2.3 Comparative morphology, anatomy and reproduction of homosporous leptosporangiate ferns: *Schizaea, Pteris, Dryopteris, Ceratopteris, Platyzoma, Asplenium* and *Acrostichum*.

2.4 Comparative morphology, anatomy and reproduction of heterosporous leptosporangiate ferns: *Marsilea* and *Salvinia*.

**UNIT III : Evolutionary trends in pteridophytes and introduction to gymnosperms**

3.1 Soral (Eu- and Lepto-sporangiate) and prothallial evolution with emphasis on the role of cytology, polyploidy and hybridization in speciation of ferns.

3.2 Economic and ecological importance of pteridophytes: As ornamental plants, food supplements and medicine; Phytoremediation by ferns; Azolla –Anabaena model of biofertilizers; Role in stabilization of disturbed habitats, prevention of nutrient leaching, micro habitat for seed/spore germination.

3.3 General characters of gymnosperms.

3.4 Past and present trends in the classification of gymnosperms with reference to Sporne (1965) and Sandra Holmes (1986).

**UNIT IV: Morphology and anatomy of vegetative and reproductive organs of major orders of gymnosperms.**

4.1 Morphology and anatomy of the vegetative organs of Cycadales, Ginkgoales and Coniferales.

4.2 Reproductive organs of Cycadales, Ginkgoales and Coniferales with emphasis on male gametophyte development.

4.3 Morphology and anatomy of vegetative organs of Ephedrales, Welwitschiales and Gnetales.

4.4 Reproductive organs of Ephedrales, Welwitschiales and Gnetales with emphasis on male gametophyte development.

**Course No.: PSBOTC202 DIVERSITY AND EVOLUTION OF PTERIDOPHYTES AND GYMNOSPERMS**

**UNIT V: General account of fossil gymnosperms and distribution of living gymnosperms in India.**

5.1 Distribution of living gymnosperms in India.
5.2 Concept of Progymnosperms.
5.3 General account of Cycadeoidales.
5.4 General account of Cordaitales.

**Note for Paper Setting**

| Theory Examination | Syllabus to be covered in the Examination | Time allotted for the Exam | % weightage (marks) |
|---|---|---|---|
| Minor Test I | Upto 20% | 1 Hr. | 20 |
| Minor Test II | 20% to 40% | 1 Hr. | 20 |
| Major Test | 41% to 100% | 2½Hr. | 60 |

**Pattern to be followed for Major Test:**

a. Major test will have seven questions each of 15 marks.
b. One question will be compulsory and will consist of very short answer type of multiple parts spread over entire syllabus.
c. Rest of the six questions will be from the remaining 41%-100% portion of the syllabus and the candidate will have to attempt any three of them.

**Literature recommended**

1. Bierhorst, D.W. (1971). Morphology of Vascular Plants. Mac Millan Co.
2. Bower, F.O. (1923, 1926 and 1928). The Ferns. Vol. I-III, Cambridge University Press.
3. Bower, F.O. (1935). Primitive Land Plants. Mac Millan Co.
4. Eames, A.J. (1936). Morphology of Vascular Plants. McGraw Hill, NY.
5. Foster, A.S. and Gifford, E.M. (1979). Comparative Morphology of Vascular Plants. W.H. Freeman & Co.
6. Jenkins et al. (2017). Annotated checklist of Indian Pteridophytes; pt. 1 (Lycopodiaceae to
7. Thelypteridaceae). Bishen Singh Mahindra Pal Singh, Dehradun.
8. Parihar, N.S. (1989). The Biology and Morphology of Pteridophytes (Diversity and Differentiation). Vikas Publishing House.
9. Rashid, A. (1976). An Introduction to Pteridophytes (Diversity and Differentiation). Vikas Publishing House.
10. Vashishta, P. C., Sinha, A. K. and Kumar, A. (2010). Pteridophyta. S. Chand & Co., New Delhi.
11. Sporne K.R. (1970). The Morphology of Pteridophytes. Hutchinson University Library, London.
12. Bhatnagar, S. P. and Moitra, A. (2018). Gymnosperms. New Age International, New Delhi.

# BOTANY (CBCS)
# [Semester-II]
# For examinations to be held in May 2022, 2023 & 2024

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## TAXONOMY AND SYSTEMATICS OF ANGIOSPERMS

**Course No.: PSBOTC203**
**Credits: 4**
**Duration: 2½ hrs**

**Maximum Marks: 100**
**Minor Test I: 20 Marks**
**Minor Test II: 20 Marks**
**Major Test: 60 Marks**

***Objectives:***

***The course is designed to understand the taxonomy, various systems of classification and recent advancements in taxonomy and systematics. Recent treatment of classification, adoptions of Shenzhen code and application of multidisciplinary approach in classification process are some important components of the course. Together these will make students understand the progress being made in the subject of Angiosperm taxonomy and Systematics.***

**UNIT I: Taxonomy, systematics and classifications**

1.1 Taxonomy – role, scope, impediments and global taxonomic initiatives.
1.2 Systematics - importance, evolution and phylogeny.
1.3 Systems of classification; artificial (Carl Linnaeus), natural (Bentham and Hooker) and phylogenetic systems (Takhtajan-Cronquist), phenetics (principles, selection of characters, character-taxon matrix, similarity matrix, phenogram construction).
1.4 Cladistics (Concept, terminology, taxon and character selection, cladogram construction and analysis).

**UNIT II: Taxonomic tools and identification**

2.1 Taxonomic categories and characters: structure of taxonomic hierarchy; concept of taxonomic categories (supra-specific, species, and infra-specific); taxonomic characters (kinds and criteria).
2.2 Taxonomic tools: keys, field and herbarium techniques; DNA hybridization, amino acid sequencing, serology, GIS, electrophoresis, computer application in systematics.
2.3 Plant identification: field work, virtual herbarium, electronic sources, identification methods (literature, efloras, manuals, icons, journals, supporting literature).
2.4 Alpha taxonomy versus modern taxonomy: chemotaxonomy, cytotaxonomy, numerical taxonomy, anatomy, palynology and embryology in relation to taxonomy.

**UNIT III: Nomenclature and phylogeny**

3.1 ICN, Shenzhen Code, principles of plant nomenclature, names of taxa, type method, author citation, principles of priority, effective publication.
3.2 Rejection of names, basionyms, synonyms, homonyms, autonyms and tautonyms.
3.3 Origin of angiosperms; inter-relationships of dicots and monocots.
3.4 Phylogeny of Ranales, Amentiferae, Tubiflorae and Helobiales and their treatment in the modern systems of classification.

**UNIT IV: Advances in plant taxonomy**

4.1 Classification of flowering plants: Introduction of Angiosperms Phylogeny Group (IV) Classification, Taxonomic evidence: structural and biochemical characters.
4.2 Plant Molecular Systematics: DNA sequence data, types of sequence data, sequence alignment.
4.3 Phylogenetic analysis (Parsimony, Maximum Likelihood, Bayesian approaches, Neighbor-Joining).
4.4 Barcoding concept; standard barcode markers: nrDNA, cpDNA and mtDNA. Phylogenomic approach towards understanding plant systematics.

**Course No.: PSBOTC203** **TAXONOMY AND SYSTEMATICS OF ANGIOSPERMS**

**UNIT V: New Approaches in plant taxonomy**

5.1 Basal angiosperms; taxonomic description of Magnoliaceae and Piperaceae (Magnoliids).

5.2 Basal, petaloid and commelinid monocots; taxonomic description of Araceae (basal), Liliaceae and Orchidaceae (petaloid), Poaceae and Zingiberaceae (commelinid) monocots.

5.3 Eudiots; taxonomic description of Ranunculaceae and Caryophyllaceae (superasterids).

5.4 Eudicots; taxonomic description of Fabaceae (fabids), Malvaceae (malvids), Asteraceae (campanulids), Lamiaceae and Solanaceae (lamiids).

**Note for Paper Setting**

| Theory Examination | Syllabus to be covered in the Examination | Time allotted for the Exam | % weightage (marks) |
|---|---|---|---|
| Minor Test I | Up to 20% | 1 Hr. | 20 |
| Minor Test II | 20% to 40% | 1 Hr. | 20 |
| Major Test | 41% to 100% | 2½ Hr. | 60 |

**Pattern to be followed for Major Test:**

a. Major test will have seven questions each of 15 marks.

b. One question will be compulsory and will consist of very short answer type of multiple parts spread over entire syllabus.

c. Rest of the six questions will be from the remaining 41%-100% portion of the syllabus and the candidate will have to attempt any three of them.

**Literature recommended:**

1. Angiosperm Phylogeny Group (2016). An update of the Angiosperm Phylogeny Group Classification for the orders and families of flowering plants: APG IV. Botanical Journal of the Linnaean Society 181: 1-20.
2. Besse, Pascale. (2014). Molecular Plant Taxonomy. Human Press, London.
3. Crawford, D.J. (2003). Plant Molecular Systematics. Cambridge University Press, Cambridge, UK.
4. Cronquist, A. (1981). An Integrated System of Classification of Flowering Plants. Columbia University Press, New York.
5. Davis P.H. and Heywood V.S. (2011) Principles of Taxonomy. Scientific Publishers.
6. Davis P.H. and Heywood V. H. (2011). Principles of Angiosperm taxonomy Scientific Publications.
7. Singh, Gurcharan 2021. Plant Systematics: Theory and Practice 4th ed. CBS Publishers and Distributors Pvt. Ltd. India.
8. Hillis D.M., Moritz C. and, Mable B K., (1996) Molecular Systematics, Sinauer Associates, Massachusetts.
9. Hollingsworth, P.M., Bateman, R.M. and Gornall, R.J. (1999). Molecular Systematics and Plant Evolution. Taylor and Francis, London.
10. Judd, W.S., Campbell, C.S, Kellogg, E.A., Stevens, P.A. and Donoghue, M.J. (2016). Plant Systematics: A Phylogenetic Approach. Sinauer Associaes, Inc., Massachusetts.
11. Patané, J.S.L., Martins, J. and Setubal, J.C. (2018). Phylogenomics. In: Setubal J., Stoye J., Stadler P. (eds) Comparative Genomics. Methods in Molecular Biology, vol 1704. Humana Press, New York, NY.
12. Pullaiah, T. and Karuppusamy, S. (2018). Taxonomy of Angiosperms. 4th rev. ed. Astral International Pvt. Ltd., New Delhi.
13. Stuessy, T. F. (2002). Plant Taxonomy. Bishen Singh Mehandra Pal Singh, Dehradun.
14. Stuessy, T.F. (2008). Plant Taxonomy: The systematic Evaluation of Comparative Data. Columbia University Press, New York.

15. Stuessy, T.F., Crawford, D.J., Soltis, D.E. and Soltis, P.S. (2014). Plant Systematics: The origin, interpretation, and ordering, of plant biodiversity. Koeltz Scientific Books, Konigstein, Germany.
16. Simpson, M.G. (2010). Plant Systematics. Elsevier, Amsterdam.
17. Woodland, D. W. (2009). Contemporary Plant Systematics. Andrews University Press, Michigan.

# BOTANY (CBCS)
# [Semester-II]
# For examinations to be held in May 2022, 2023 & 2024

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## EMBRYOLOGY AND REPRODUCTION IN FLOWERING PLANTS

**Course No.: PSBOTC204**
**Credits: 4**
**Duration: 2½ hrs**

**Maximum Marks: 100**
**Minor Test I: 20 Marks**
**Minor Test II: 20 Marks**
**Major Test: 60 Marks**

***Objectives:***

***Knowledge regarding plant reproduction and development plays a pivotal role in making students understand population structure and natural diversity in a better way. The course so framed on these aspects includes classical as well as experimental approaches to the phenomena of sporogenesis, gametogenesis, fertilization, and embryogenesis and seed development.***

**UNIT I: Reproductive modes in flowering plants; Genetics of sexuality**

1.1 Types of reproduction-General account of asexual and sexual modes; Variability in sex expression- its chromosomal, genetic and hormonal controls.

1.2 Transition to flowering- Autonomous, photoperiodic and vernalisation pathways; variability of gene expression in various pathways.

1.3 Development and structure of flower- Genetics of floral organ determination. Role of homeotic mutants.

1.4 Apomixis-General concept, types and control. Endosperm development in apomictic seeds. Role in crop improvement.

**UNIT II: Male and female gametophytes; Pollen biology**

2.1 Structure of anthers- microsporogenesis, role of tapetum-origin and deposition of pollen surface components.

2.2 Pistil- Structure of stigma and style; Extra cellular components on the surface of stigma and in the style.

2.3 Ovule development- megasporogenesis, mega-gametogenesis-types. organization of embryo sac- structure of individual cells.

2.4 Pollen biology- Pollen fertility and sterility, viability, importance in forensic science, allergy and as health components.

**UNIT III: Pollination and Breeding systems**

3.1 Types of pollinations- concept of auto-, geitono- and xenogamy; Biotic and abiotic Pollinations; Syndromes of abiotic pollinations.

3.2 Major Biotic pollinators-floral rewards and advertisements; Generalised and specialized pollination systems; Diurnal and nocturnal pollinations; pollen and nectar robbers.

3.3 Nursery pollination – Global Pollinators, crisis due to human induced environmental changes and their impact on crop productivity and sustenance of flowering plant diversity; melisso-palynology and commercial honey production.

3.4 Breeding systems- Concept and types, various in- and outbreeding devices; an overview of evolution of breeding systems.

**UNIT IV: Pollen pistil interaction and fertilization**

4.1 Screening of pollen for compatibility and quality by the pistil; Role of pollen wall components and stigma surface components in pollen germination and pollen tube entry into stigma, pollen tube growth in style and in ovary; Self-incompatibility- types and genetics of control.

4.2 Double fertilization, entry of pollen tube into one of the synergids; discharge of male gametes, fertilization events and products. Ovule pollination, in- vitro fertilization using isolated male and female gametes.

4.3 Brief accounts of the types of embryo development, monocot and dicot embryos, polarity of the embryo, Embryo storage products.

4.4 Endosperm- types and development, detailed structure of cereal endosperm, storage products of endosperm; Interaction between the embryo and endosperm during seed development.

**UNIT V: Fruit and seed**

5.1 Dynamics of fruit growth and development, Biochemistry of fruit ripening.

5.2 Sexual seed- types and structure; Seed germination; metabolism of nucleic acids, proteins and mobilization of food reserves.

5.3 Seed dispersal and recruitment of new individuals- Dispersal agents, importance of seed dispersal, effects of human activities, hunting, habitat destruction and fragmentation, climate change on dispersal agents and their impact on recruitment and sustenance of populations.

5.4 Seedling growth; Hormonal control, gene expression during growth- role of mutants in understanding the process.

**Note for Paper Setting**

| Theory Examination | Syllabus to be covered in the Examination | Time allotted for the Exam | % weightage (marks) |
|---|---|---|---|
| Minor Test I | Up to 20% | 1 Hr. | 20 |
| Minor Test II | 20% to 40% | 1 Hr. | 20 |
| Major Test | 41% to 100% | 2½ Hr. | 60 |

**Pattern to be followed for Major Test:**

a. Major test will have seven questions each of 15 marks.

b. One question will be compulsory and will consist of very short answer type of multiple parts spread over entire syllabus.

c. Rest of the six questions will be from the remaining 41%-100% portion of the syllabus and the candidate will have to attempt any three of them.

**Literature recommended:**

1. Bradford, K. J. and Nonogaki, W eds. (2007). Seed development, dormancy and germination. Blackwell Publications, Oxford.
2. Bewley, J.D. and Black, M. (1994). Seeds-Physiology of Development and Germination. Plenum Press, New York.
3. Bhojwani, S. S., Bhatnagar, S. P. and Dantu, P. K. (2018). The embryology of angiosperms. 6th ed. Vikas Publishing House, Noida.
4. Burgess, J. (1985). An Introduction to Plant Cell development. Cambridge University Press, Cambridge.
5. Faegri, K. and Vander Pijl, L. (1979). The Principles of Pollination Ecology. Pergamon Press, Oxford.
6. Fahn, A. (1982). Plant Anatomy. 3rd Edn. Pergamon Press, Oxford.
7. Fosket, D.E. (1994). Plant Growth and Development: A Molecular Approach. Academic Press, San Diego.
8. Geber, M.A., Dawson, T.E. and Delph, L.F. (1999). Gender and Sexual Dimorphism in Flowering Plants. Springer Berlin-Heidelberg.
9. Howell, S.H. (1998). Molecular Genetics of Plant Development. Cambridge University press, Cambridge.
10. Johri, B. M. ed. (1984). Embryology of Angiosperms. Springer, Berlin.
11. Johri, B. M. et al (2015). Comparative embryology of Angiosperms. Vol. 1-2. Springer, New Delhi.

12. Levis, P., Tucker, S.C. and Endress, P.K. (1988). Aspects of Floral Development. J. Cramer, Germany.
13. Lyndon, R. (1990). Plant Development: The Cellular Basis. Springer, London.
14. Murphy, T.H. and Thompson, W.F. (1988). Molecular Plant Development. Hall, New Jersey.

15. Proctor, M. and Yeo, P. (1973). The Pollination of Flowers. William Collins Sons, London.
16. Raghavan, V. (1997). Molecular Embryology of Flowering Plants. Cambridge University Press, Cambridg.
17. Raghavan, V. (1999). Developmental Biology of Flowering Plants. Springer- Verlag, New York.
18. Ramawat, K. G. et al. (2014). Reproductive biology of plants. CRC Press, Boca Raton.
19. Raghvan, V. (2006). Double fertilization. Springer Verlag, Berlin-Heidelberg.
20. Real, Leslie ed. (2013). Pollination biology. Academic Press.
21. Richards, A. J. (1986). Plant Breeding Systems. Chapman and Hall, London
22. Salisbury, F.B. and Ross, C.W. (1992). Plant Physiology. 4th Edn. Wadsworth Publishing, Belmont, California.
23. Shivanna, K.R. (2003). Pollen Biology and Biotechnology. Science Publishers Inc., CRC Press, USA
24. Shivanna, K.R. and Sawhney, V.K. (1997). Pollen Biotechnology for Crop Production and Improvement. Cambridge University Press, Cambridge.
25. Shivanna, K.R. and Rangaswamy, N.S. (1992). Pollen Biology-A Laboratory Manual. Springar-Verlag, Berlin.
26. Shivanna, K.R. and Johri, B.M. (1986). The Angiosperm Pollen: Structure and Function. Wiley Eastern Ltd., New York.
27. Shivanna, K. R. and Tandon, R. (2014). Reproductive ecology of flowering plants: a manual. Springer, New Delhi.
28. Sinu, P. A. and Shivanna, K. R. eds. (2016) Mutualistic interactions between flowering plants and animals. Manipal University Press, Manipal.
29. Steeves, T.A. and Sussex, I.M. (1989). Patterns in Plant development. 2nd Edn. Cambridge University Press, Cambridge.
30. Taiz, L. et al. (2018). Plant Physiology and Development. 6th ed. Oxford, New York.
31. The Plant Cell. Special issue on Reproductive Biology of Plants, Vol. 5(10) (1993). The American society of Plant Physiologists. Rockville, Maryland, USA.
32. Willmer, P. (2011). Pollination and floral ecology. Princeton University Press.

# BOTANY (CBCS)
# [Semester-II]
# For examinations to be held in May 2022, 2023 & 2024

**Course No.** **PSBOPC205 (BASED ON PSBOTC201 AND PSBOTC204)**

**Credits: 4** **Maximum Marks: 100**
**Daily evaluation of practical records /Assignment test /Viva voce etc.: 50**
**Final Practical performance +viva voce:50**

**Laboratory Exercises based on PSBOTC201**

1. Demonstration of SEM using an appropriate plant material and detailed study of electron micrograph of the plant cell thus taken to see the distribution of cell organelles.
2. Isolation of mitochondria and the activity of its marker enzyme, succinate dehydrogenase (SDH).
3. Isolation of chloroplasts and SDS-PAGE profiles of proteins to demarcate the two subunits of Rubisco.
4. Fluorescence staining with FDA for cell viability and cell wall staining with calcoflour..
5. Work out various problems associated with DNA replication process from the given data.
6. Calculation of replication rates from the provided data.
7. Preparation of agarose gel.
8. Isolation of plasmid DNA from an appropriate host by alkali lysis method.
9. Study the effect of some restriction enzymes on DNA.
10. Estimate the molecular weight of different DNA fragments generated above (S.No.5).
11. Work out the biochemical pathways operative in Neurospora on the basis of experimental data.
12 Study the genic and extragenic inheritance patterns.
13 Detection of structural changes in the chromosomes using FISH technique.
14. Bring out the phylogenetic relation between different taxa (varieties, species, genera) on the basis of enzyme profiles.
15. Work out interspecific variation using zymograms and mt DNA-RFLP.
16. Isolation of nuclei and identification of histones by SDS-PAGE.
17. Isolation of DNA and its quantification by spectrophotometric method.
18. Isolation of DNA and preparation of 'Cot' curve.
19. Restriction digestion of plant DNA: its separation by agarose gel electrophoresis and visualization by ethidium bromide staining.
20. Northern and southern blot analysis using a gene specific probe.
21. Western blotting.

**Laboratory Exercises based on PSBOTC204**

1. Study of structure of dicot and monocot seed; albuminous and exalbuminous seeds.
2. Seed storage structures- maize and pulses.
3. Study of seed dormancy and methods to break dormancy.
4. Study of diversity of vegetative propagation in plants, its comparison to sexual reproduction.
5. Study flower as organ of sexual reproduction: accessory vs. essential organs, reproductive apparatus.
6. Study of microsporogenesis and microgametogenesis by making acetocarmine squashes of anthers of different developmental stages.
7. Examination of modes of anther dehisence and collection of pollen grains for microscopic examination (Maize, Grasses, *Solanum*, *Petunia*, *Acacia*, *Canna*, *Calotropis*, etc.).
8. Test for pollen viability using stains and *in-vitro* germination. Pollen germination using hanging drop and sitting drop cultures: Suspension culture and surface culture.
9. Estimating percentage and average pollen tube length in vivo using fluorescence microscope.

**Course No.** **PSBOPC205 (BASED ON PSBOTC201 AND PSBOTC204)**

10. Field study of several types of flowers with different pollination mechanisms i.e., pollination effected by wind, thrips, bees, butterflies and birds.
11. Emasculation, bagging and hand pollination to study pollen germination, seed set and fruit development using self-compatible and obligate out crossing system.
12. Study of cleistogamous flowers and their adaptations.
13. Study of nuclear and cellular endosperm through dissections and staining.
14. Isolation of zygotic, globular, heart-shaped, torpedo shaped and mature embryo from suitable material.
15. Study of polyembryony in *Citrus* by dissections.

**Course No. PSBOPC206 (Based on PSBOTC202 and PSBOTC203)**

**Credits: 4**

**Maximum Marks: 100**
**Daily evaluation of practical records /Assignment test / Viva voce etc. : 50**
**Final Practical performance +viva voce:50**

**Laboratory Exercises based on PSBOTC202**

1. Anatomy of fossil pteridophytes (*Aglaophyton, Rhynia, Asteroxylon, Lepidophloios, Lepidocarpon, Sphenophyllum, Calamites*) from permanent slides.
2. Morphology and anatomy of fern-allies (*Psilotum, Lycopodium, Selaginella, Isoetes, Equisetum*).
3. Anatomy of spore-bearing organs of taxa listed at S.No. 2.
4 Diversity in spore bearing organs of some ferns (*Ophioglossum, Cyathea, Dryopteris, Gleichenia, Pteris, Asplenium, Salvinia*).
4. Anatomy of vegetative and reproductive organs of some ferns listed at S.No. 4.
5 Comparative study of the anatomy of vegetative and reproductive parts of *Cycas, Ginkgo, Pinus, Cedrus, Abies, Picea, Cupressus, Araucaria, Podocarpus, Agathis, Taxus* and *Ephedra*.
1. Study of important fossil gymnosperms from prepared slides and specimens.

**Laboratory Exercises based on PSBOTC203**

1. Description of a specimen from representative, locally available families.
2. Description of various species of a genus; location of key characters and preparation of keys at genetic level.
3. Compilation of field notes and preparation of herbarium sheets.
4. Study of types of corolla borne by angiosperms growing in the botanical garden.
5. To study the types and arrangement of androecium in angiosperms growing in the botanical garden.
6. Study of inflorescence types in flowering plants.
7. To study the types of placentation in flowers of angiosperms.

# BOTANY (CBCS)
# [Semester-III]
# For examinations to be held in December 2022, 2023 & 2024

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## PLANT PHYSIOLOGY AND METABOLISM

**Course No.: PSBOTC301** | **Maximum Marks: 100**
**Credits: 4** | **Minor Test I: 20 Marks**
**Duration: 2½ hrs** | **Minor Test II: 20 Marks**
**Major Test: 60 Marks**

***Objectives:***

***The course is designed to make students understand how different enzymes, molecular signals and hormones regulate important reactions and activities in plants. Another aim is to impart students' knowledge regarding the mechanisms underlying absorption of water and minerals, solute transport, photosynthesis, respiration, nitrogen and sulphur metabolism***

**UNIT I: Enzymology and its role in life processes**

1.1 Enzymes: International Union of Biochemists classification system, special reference to latest developments.
1.2 Enzyme structure: holoenzyme, apoenzyme, structural and functional sites of enzymes, mechanism of enzyme regulation with suitable examples.
1.3 Enzyme kinetics: Michaelis-Menton equation, line Weaver Burk plots, double reciprocal plots, ping pong mechanism with suitable examples.
1.4 Protein data banks: 2D and 3D structural and functional relation in enzymes, molecular factors regulating enzymes of CO2 fixation and nitrogen metabolism.

**UNIT II: Photobiology and signal transduction**

2.1 Signal transduction- concept, receptors, G-proteins, phospholipid signaling, second messengers-a general account.
2.2 Diversity in protein kinases and phosphatases, calcium-calmodulin cascade, specific signaling mechanisms; two component sensor-regulator system in bacteria.
2.3 Phytochromes and cryptochromes-discovery, photochemical and biochemical properties, photo-physiology of light induced responses; signal perception and execution.
2.4 Scotobiology-over view, impact of darkness on plant growth and development, ecological responses of night pollution on plant habits

**UNIT III: Plant hormone signaling and perception**

3.1 Auxins, cytokinins, gibberellins and brassinosteroids – biosynthesis (overview) and signal transduction in plants.
3.2 Abscisic acid, ethylene, jasmonic acid, salicylic acid and strigolactones- biosynthesis (overview) and signal transduction in plants.
3.3 Novel class of plant hormones- terpenoids, Karrikins, Plant natriuretic peptides (PNPs) role in plant growth and development.
3.4 Hydrogen peroxide, hydrogen sulfide, reactive oxygen species and reactive nitrogen species interaction with plant hormones and role in stress management.

**UNIT IV: Photochemistry and photosynthesis.**

4.1 Evolution of photosynthetic apparatus, light harvesting complexes, photo-oxidation of water.
4.2 Mechanism of electron and proton transport, energy flow pathways, cyclic, non-cyclic and pseudo cyclic pathways.
4.3 Carbon assimilation-Calvin cycle, C4 cycle, difference between C3 and C4 pathways, CAM pathways, photorespiration and its significance.
4.4 Biosynthesis of starch and sucrose and their regulation.

**Course No.: PSBOTC301** **PLANT PHYSIOLOGY AND METABOLISM**

**UNIT V: Respiration, nitrogen and Sulphur metabolism.**

5.1 Overview of plant respiration, glycolysis, TCA cycle.
5.2 Electron transport system and recent advances in mechanism of ATP synthesis.
5.3 Nitrogen fixation-overview, biological nitrogen fixation, nodule formation and nod factors, mechanism of nitrate uptake and reduction; ammonium assimilation.
5.4 Sulphur metabolism- overview, sources and mechanism of Sulphur uptake, transport, assimilation and its significance.

**Note for Paper Setting**

| Theory Examination | Syllabus to be covered in the Examination | Time allotted for the Exam | % weightage (marks) |
|---|---|---|---|
| Minor Test I | Up to 20% | 1 Hr. | 20 |
| Minor Test II | 20% to 40% | 1 Hr. | 20 |
| Major Test | 41% to 100% | 2½ Hr. | 60 |

**Pattern to be followed for Major Test:**

a. Major test will have seven questions each of 15 marks.
b. One question will be compulsory and will consist of very short answer type of multiple parts spread over entire syllabus.
c. Rest of the six questions will be from the remaining 41%-100% portion of the syllabus and the candidate will have to attempt any three of them.

**Literature Recommended:**

1. Bhatla, S. C. and Lal, Manju. (2018). Plant Physiology, development and metabolism Springer.
2. Brown T.A. (2017) Biochemistry. Viva Publishers.
3. Buchanan, B.B., Gruissem, W. and Jones, R.L. (2015). Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologist, Maryland, USA.
4. Gardner, et al. (2013). Physiology of crop plants. Scientific Publishers, Jodhpur.
5. Garrett, R. M. and Grisham. (2013). Biochemistry. 5th ed. Brooks/ Cole, Australia.
6. Heldt, H-W. (2016). Plant Biochemistry. 4th ed. Academic Press, USA.
7. Hopkins, G.W. and Hiinner, N.P.A. (2008). Introduction to Plant Physiology. 4th Edn. Wiley and Sons. Inc. New York, U.S.A.
8. Nelson, D.L. and Cox, M.M. (2013). Lehninger-Principles of Biochemistry. Worth Publishers Inc. New York, USA.
9. Nobel, P.S. (1999). Physio-chemical and Environmental Plant Physiology. 2nd Edn. Academic Press, San Diego, U.S.A.
10. Prasad, M. N. V. (2014). Plant Ecophysiology. John Wiley, New York.
11. Salisbury, F.B. and Ross, C.W. (1992). Plant Physiology. 4th Edn. Wadsworth Publishing Co., California, U.S.A.
12. Srivastava, L.M. (2002). Plant Growth and Development. Academic Press, USA.
13. Taiz, L. and Zeiger, E. (2010). Introduction to Plant Physiology. 5th Edn. Sinauer Associates, Inc.
14. Taiz, L. et al. (2018). Plant Physiology and Development. 6th ed. Oxford, New York.
15. Voet, D., Voet, J. G. and Pratt. C. W. (2016). Voet's Principles of Biochemistry. 5th ed. John Wiley & Sons, Singapore.
16. Willey, Neil. (2016). Environmental Plant Physiology. Garland Science, New York.

# BOTANY (CBCS)
# [Semester-III]
# For examinations to be held in December 2022, 2023 & 2024

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## PLANT BREEDING AND BIOSTATISTICS

**Course No.:PSBOTC302**
**Credits: 4**
**Duration: 2½ hrs**

**Maximum Marks: 100**
**Minor Test I: 20 Marks**
**Minor Test II: 20 Marks**
**Major Test: 60 Marks**

***Objectives:***

***Knowledge of various plant breeding techniques is a must for designing strategies to meet the ever-increasing demand of food in a progressing country like India. Understanding developed by the student on these aspects will be of great practical application. Clubbing with Biostatistics will prove helpful in designing biological experiments and analyzing and interpreting the data generated.***

**UNIT I: Plant Breeding: Introduction, genetic background and selection methods**

1.1 Introduction- aims and scope. Methods of crop improvement; their correlation with reproductive modes operative in a species- Concept of Homozygous and Heterozygous balance, Hardy- Weinberg equation.
1.2 Concept of purelines, inbreeding depression and heterosis; significance of these phenomena in plant breeding.
1.3 Selection and crop improvement- relative importance in self- and cross-pollinated taxa- Pure line, and mass selection methods, advantages and disadvantages.
1.4 Selection after hybridization- Pedigree and bulk population selection; Back cross breeding – method and importance.

**UNIT II: Breeding methods and crop improvement**

2.1 Hybridization: Methods, for producing hybrid and synthetic varieties; Use of recurrent selection.
2.2 Clonal selection and hybridization- method and implications.
2.3 Use of tissue culture in plant breeding: Pollen embryogenesis; Technique and Utility; pollen in gene transfer.
2.4 Indication, development and maintenance of somatic embryos; synthetic seeds – concept, development and uses.

**UNIT III: Data collection, presentation and descriptive statistics**

3.1 Biostatistics; conceptual understanding of statistic; variations-discrete and continuous; populations, finite and infinite populations; Sample, parameter, variable and its types.
3.2 Descriptive statistics of the distribution of any variable: mean, mode, median, variance, standard deviation, coefficient of variation, Merits and demerits of each.
3.3 Descriptive statistics of averages, dispersion, skewness and kurtosis.
3.4 Sampling of data: random and non-random sampling methods.

**UNIT IV: Probability distributions and various tests of significance**

4.1 Applications of probability distribution; binomial and normal distribution; Poisson distribution and its applications.
4.2 Tests of hypothesis and two types of errors.
4.3 Parametric and Non-parametric tests- concept and major differences.
4.4 Tests of means and proportions; t-, z-, F- and Chi-square tests and their applications.

**UNIT V: Experimental designs, analysis of data and their significance.**

5.1 Principles and designs of experiments, examples of CRD and RBD.
5.2 Simple regression and correlation; Regression lines; Coefficients of correlation, regression and determination.
5.3 One way and two way analysis of variance– their importance in the study of variation.
5.4 Logistic regression-concept, computation and Maximum likelihood procedures. Analysis of co-variance: concept and applications; a brief idea of GLM and HLM.

# BOTANY (CBCS)
# [Semester-III]
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**Course No.:PSBOTC302** **PLANT BREEDING AND BIOSTATISTICS**

**Note for Paper Setting**

| Theory Examination | Syllabus to be covered in the Examination | Time allotted for the Exam | % weightage (marks) |
|---|---|---|---|
| Minor Test I | Up to 20% | 1 Hr. | 20 |
| Minor Test II | 20% to 40% | 1 Hr. | 20 |
| Major Test | 41% to 100% | 2½Hr. | 60 |

**Pattern to be followed for Major Test:**

a. Major test will have seven questions each of 15 marks.
b. One question will be compulsory and will consist of very short answer type of multiple parts spread over entire syllabus.
c. Rest of the six questions will be from the remaining 41%-100% portion of the syllabus and the candidate will have to attempt any three of them.

**Literature Recommended:**


1. Acquaah, G. (2020). Principles of Plant Genetics and Breeding, Wiley-Blackwell, USA
2. Allard, R. W. (2018). Principles of plant breeding. 2nd ed. Wiley, New Delhi.
3. Atwell, B. J., Kriedemann, P. E. and Turnbull, C. G. N. (1999). Plants in action: adaptation in nature, performance in cultivation. McMillan Education, Australia.
4. Balaam, L. N. (1972) Fundamentals of Biometry. Unwin Publishers Inc. London (Halsted Press; JohnWiley & Sons).
5. Brown, Jack Caligeri, Peter and Compos, Hugo. (2014). Plant Breeding. 2nd ed. Wiley Blackwell, U. K.
6. Datta, A. K. (2006) Basic Biostatistics and its Applications. New Central Book Agency (P) Ltd., Kolkata, India.
7. Dhar, M. K. and Kaul, S. (1997) Statistics in Biology. Malhotra Publishers, Jammu.
8. Gupta, S. P. (2019). Statistical Methods. Sultan Chand, New Delhi.
9. Khan and Khanum. (2018). Fundamentals of Biostatistics. 5th rev ed. Ukaaz Publications, Hyderabad.
10. Norman, G. R. and Streiner, D. L. (2008) Biostatistics-the Bare Essentials. B C Decker Inc., Hamilton, Canada.
11. Richards, A. J. (1986). Plant Breeding Systems. Chapman and Hall, London.
12. Roy, Darbeshwar. (2012). Plant breeding: a biometrical approach. Narosa, New Delhi.
13. Senedecor, G. and Cochran, W. (1980) Statistical Methods. 7th Edn. Iowa State University Press.
14. Sharma, J. R. (1994) Principles and practice of Plant Breeding. Tat-McGraw Hill Publishers.
15. Sharma, J. R. (1998) Statistical and Biometrical Techniques in Plant Breeding. New Age International Publishers.
16. Singh, B. D. (2013) Plant Breeding. Kalyani Publishers, New Delhi.
17. Singh, R. K. and Chaudhary, B. D. (1999). Biometrical methods in Quantitative Genetic Analysis. Kalyani Publishers, New Delhi.
18. Sokal, R. R. and Rohlf, F. J. (1973). An Introduction to Biostatistics. W. H. Freeman and Company, New York.
19. Sokal, R. R. and Rohlf, F. J. (2001) Biometry-The Principles and Practice of Statistics in Biological Research. W. H. Freeman and Company, New York.
20. Sukhatme, P.V. and Amble, V. N. (1976) Statistical Methods for Agricultural Workers. ICAR, New Delhi.
21. Wang et al. (2011) Genetics, Genomics and Breeding of Cucurbits. Science Publications, USA.

# BOTANY (CBCS)
# [Semester-III]
# For examinations to be held in December 2022, 2023 & 2024

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## PLANT RESOURCE UTILIZATION AND CONSERVATION

**Course No.: PSBOTC303**
**Credits: 2**
**Duration: 2 hrs**

**Maximum Marks: 50**
**Minor Test I: 10 Marks**
**Minor Test II: 10 Marks**
**Major Test: 30 Marks**

***Objectives:***
***This course has been framed for enhancing the knowledge of students about the important plant resources and their sustainable utilization. Knowledge about the origin and domestication will help the students appreciate the need to conserve.***

**UNIT I: Plant Resource Utilization**

1.1 World's centres (primary and secondary) of origin of crop plants; Cereals and millets-distribution, cultivation in India; nutritional values.
1.2 Pulse crops – distribution and cultivation in India, nutritional value of pulses.
1.3 Spices, condiments, resins, tannins, gums and natural dyes in India; sources and utilization.
1.4 Distribution and utility of bamboos and rattans; Raw materials for paper industry and processes involved in paper making.

**UNIT II: Plant Resource Utilization, Extinction and Conservation**

2.1 Alkaloids, steroids and glycosides- sources, classification and distribution; Psychoactive drugs- sources, types, distribution and mode of action.
2.2 Extinction, types and causes, and methods to prevent biodiversity extinction; IUCN categories of plants; methods to assess the threat status of plants; land races and RET plants as the target groups of extinction.
2.3 Concepts, objectives and aims of conservation, Principles of conservation and resource management, problems of resource depletion, preservation, conservation and restoration, CBD, CITES, TRAFFIC, NGT.
2.4 Habitat protection and improvement, sacred groves; Farm and urban forestry.

**UNIT III: In-site/ off site conservation practices and conservation enactments**

3.1 In-site conservation: protected areas-concept, categories, design of protected areas; sanctuaries, national parks and biosphere reserves and wetlands.
3.2 Off-site conservation: role of botanic gardens, field gene banks and seed banks in conservation; cryopreservation of pollen and seed- a tool for plant conservation.
3.3 Legislation and enactments on resource conservation and environmental protection in India.
3.4 Intellectual property rights: basic concept of patenting in R&D, patenting system in India; a brief account of bioprospecting and bio piracy.

**Note for Paper Setting**

| Theory Examination | Syllabus to be covered in the Examination | Time allotted for the Exam | % weightage (marks) |
|---|---|---|---|
| Minor Test I | Up to 20% | 30 min. | 10 |
| Minor Test II | 20% to 40% | 30 min. | 10 |
| Major Test | 41% to 100% | 2 Hr. | 30 |

**Course No.: PSBOTC303** **PLANT RESOURCE UTILIZATION AND CONSERVATION**

**Pattern to be followed for Major Test:**

a. Major test will have five questions each of 10 marks.
b. One question will be compulsory and will consist of very short answer type of multiple parts spread over entire syllabus.
c. Rest of the four questions will be from the remaining 41%-100% portion of the syllabus and the candidate will have to attempt any two of them.

**Literature Recommended:**

1. Akeroyd, J. and Jackson, P.W. (1995). A Handbook of Botanic Garden and Reintroduction of Plants to the Wild. Botanic garden conservation Union, UK.
2. Arora, R.K. and Nayar, E.R. (1984). Wild Relatives of Crop Plants in India. NBPGR Science Monograph No.7.
3. Chandel, K.P.S., Shukla, G. and Sharma, N. (1996). Biodiversity in Medicinal and Aromatic Plants in India-Conservation and Utilization. National Bureau of Plant Genetic Resources, New Delhi.
4. Chowdhery, H.J. and Murty, S.K. (2000). Plant Diversity and Conservation in India – an overview. Bishen Singh Mahendra Pal Singh, Dehradun.
5. Falk, D.A., Olwell, M. and Millan C. (1996). Restoring Diversity. Island press, Columbia, USA.
6. FAO/IBPGR (1989). Technical Guidelines for the Safe Movement of Germplasm. FAO/IBPGR, Rome.
7. Frankel, O.H., Brown, A.H.D. and Burdon, J.J. (1995). The Conservation of Plant Diversity. Cambridge University Press, Cambridge, U.K.
8. Gardner, et al. (2013). Physiology of crop plants. Scientific Publishers, Jodhpur.
9. Haunter, M.L. and Gibbs, J. (2007). Fundamentals of Conservation Biology. 3rd Edn. Blackwell Publishing, U.K.
10. Heywood, V. (1995). Global Biodiversity Assessment. United National Environment Programme. Cambridge University Press, Cambridge, U.K.
11. Kothari, A. (1997). Understanding Biodiversity: Life Sustainability and Equity. Orient Longman.
12. Krishnamurthy, K. V. (2017). Advanced Textbook on biodiversity: principles and practices. Oxford & IBH, New Delhi.
13. Meffe, G.K. and Ronald, C.R. (1994). Principles of Conservation Biology. Sinauer Associates. INC Publishers, USA.
14. Paroda, R.S. and Arora, R.K. (1991). Plant Genetic Resources Conservation and Management. IPGRI Publication. South Asia Office, C/O NBPGR. Pusa Campus, New Delhi.
15. Plucknett, D.L., Smith, N.J.H. William, J.T. and Murti Annishetty, N. (1987). Gene Banks and Worlds Food. Princeton University Press, Princeton, New Jersey, USA.
16. Primack, R.E. (2006). Essentials of Conservation Biology. 4th Edn. Sinauer Associates, U.S.A.
17. Rodgers, N.A. and Panwar, H.S. (1988). Planning a Wildlife Protected Area Network in India. Vol. I. The Report Wildlife Institute of India, Dehradun.
18. Swaminathan, M.S. and Kocchar, S.L. (1989). Plants and Society. MacMillan Publication Ltd., London.
19. Trivedi, P. C. and Sharma, Niranjan. (2010). Plant Resource Utilization. Pointer Publications.
20. Wagner, H. and Bladt, S. (1996). Plant Drug Analysis. 2nd ed. Springer, New Delhi.
21. Walter, K.S. and Gillett, H.J. (1998). 1997 IUCN Red List of Threatened Plants. IUCN, the World Conservation Union, IUCN, Gland. Switzerland and Cambridge, U.K.

# BOTANY (CBCS)
# [Semester-III]
# For examinations to be held in December 2022, 2023 & 2024

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## ENTREPRENEURSHIP IN BOTANY

**Course No.: PSBOTE304**
**Credits: 4**
**Duration: 2½ hrs**

**Maximum Marks: 100**
**Minor Test I: 20 Marks**
**Minor Test II: 20 Marks**
**Major Test: 60 Marks**

***Objectives:***

***This course will prepare students to establish their plant resource based business units. Therefore, the course content involves practices used for growing and maintaining economically important plant species.***

**UNIT I: Food and fodder.**

1.1 Essential components of human nutrition; concept of human disorders due to nutritional deficiencies, concept of rabi (wheat) and kharif (rice) crops.
1.2 Cereals- rice and wheat, nutritional value, agro-technology and varieties.
1.3 Legumes- pea and soybean, nutritional value, agro-technology and varieties.
1.4 Fodder crops- types (conserved forage, compound feed, crop residues, freshly cut forage) and their storage.

**UNIT II: Horticulture and floriculture.**

2.1 Fruits- types, nutritional value, economic importance, preservation and storage.
2.2 Ber and amla - agro-technology, varieties and market trends.
2.3 Flowers - economic importance (decorative, medicinal, aromatic, food).
2.4 Gladiolus and marigold – agro-technology and market trends.

**UNIT III: Medicinal and aromatic plants (MAPs).**

3.1 Introduction, history of use of MAPs and quality control in medicinal plants.
3.2 Ashwgandha and safed musli - agro-technology, market trends and economics.
3.3 Lemon grass and rose- cultivation, agro-technology and economics.
3.4 Extraction of essential oils (distillation, expression, effleurage, maceration).

**UNIT IV: Vegetable oil and sugar industry.**

4.1 Composition and uses of vegetable oils (food and medicinal).
4.2 Sunflower and mustard- agro-technology, storage and uses.
4.3 Extraction and refining of vegetable oils (oil expeller, degumming, bleaching and hydrogenation).
4.4 Sugarcane and beet sugar- agro-technology, extraction and economic importance of sugars.

**UNIT V: Plant fibres, natural dyes and paper industry.**

5.1 Plant fibres-types; agro-technology (hemp, cotton and Agave) and extraction of fibres.
5.2 Natural dyes- types, agro-technology (henna, indigo and safflower) and extraction of dye.
5.3 Dyeing with natural dyes (process, colour combinations, dye recipes- flower, leaves, bark, and roots).
5.4 Paper industry - sources and processes (mechanical and chemical).

**Note for Paper Setting**

| Theory Examination | Syllabus to be covered in the Examination | Time allotted for the Exam | % weightage (marks) |
|---|---|---|---|
| Minor Test I | Up to 20% | 1 Hr. | 20 |
| Minor Test II | 20% to 40% | 1 Hr. | 20 |
| Major Test | 41% to 100% | 2½ Hr. | 60 |

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# [Semester-III]
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**Course No.: PSBOTE304** **ENTREPRENEURSHIP IN BOTANY**

**Pattern to be followed for Major Test:**

a. Major test will have seven questions each of 15 marks.
b. One question will be compulsory and will consist of very short answer type of multiple parts spread over entire syllabus.
c. Rest of the six questions will be from the remaining 41%-100% portion of the syllabus and the candidate will have to attempt any three of them.

**Literature recommended:**


1. Alasalvar, C. and Shahidi, F. (2013). Dried fruits: phytochemical and health effects. Wiley Blackwell, USA.
2. Jhon, A. Q., Dar, G. H. and Aslam, S. (2014) Exotic Ornamental Flora of Kashmir. Dominant Publishers and Distributors (P) Ltd.
3. Bedi, Y.S., Dutt, H.C. and Kaur, H. (2011). Plants of Indian System of Medicine (Vol. I &II). Lambert Academic Publishing, Germany.
4. Bose, T.K. (1985). Fruits of India tropical and subtropical. Naya Prokash, Calcutta.
5. Bose, T.K. and Som, M.G.V. (1986). Vegetable crops in India. Naya Prokash, Calcutta
6. Cespedes et al. (2013). Natural antioxidants and biocides from wild medicinal plants. CAB International, UK.
7. Chrispeels, M.J. and Sadava, D.E. (1994). Plants, Genes and Agriculture. Jones and Bartlett Publishers, London
8. Furry, S.M. and Viemont, V.M. (1935). Home Dyeing with Natural Dyes. Thresh Publications. California
9. Gardner, et al. (2013). Physiology of crop plants. Scientific Publishers, Jodhpur.
10. Hanson, H. Borlaug N.E. and Anderson, R.G. (1982). Wheat in the Third World. Westbiew Press, Colorado.
11. Jadhav, D. (2009). Medicinal Plants of India. Vol. 1-3. Scientific Publishers, India. NIIR Board (2004).Cultivation of Fruits, Vegetables and Floriculture. NIIR.
12. Jindal, S.L. (1982). Lawns and Gardens. Ministry of Information and Broadcasting, GoI
13. Kent, N.L. (1983). Technology of Cereals. 3rd Edn. Pergamon Press, Oxford.
14. Kochar, S.L. (2009). Economic Botany in the Tropics. 3rd Edn. MacMillan Publishers Ltd.
15. Kochhar. (2016). Economic Botany. Cambridge, USA.
16. Maiti, R.K. and Singh R.K. (2006). An Introduction to Modern Economic Botany. Agrobios (India).
17. Martin J.H., Leonard, W.H., Stamp, D.L. (1976). Principles of Field Crops. Macmillan Publishers, London.
18. Metcalfse, D.S. and Elkins, D.M. (1980). Crop Production: Principles and Practices (IV ed). Macmillan Publishing Co. Inc. New York.
19. Pradhan S. (1995). Economic Botany. Har Anand Publication, New Delhi
20. Radhakrishnan, T., Anandaraja, N., Ramasubramanian, M., Nirmala, L. and Israel, M. T. (2009). Traditional Agricultural Practices: Applications and Technical Implementations. New India Publishing, India.
21. Sharma, B. D. (2014). Himalayan edible medicinal plants. Bishen Singh Mehandra Pal Singh, Dehradun.
22. Sharma, O.P. (1996). Hill's Economic Botany. Tata McGraw Hill's, Noida.
23. Singh, R. (1969). Fruits. National Book Trust, India.
24. Trivedi, P. (1996). Home Gardening. ICAR, New Delhi
25. Vardhana R. 2009. Economic Botany. Sarup Book Publishers Pvt. Ltd., New Delhi
26. Vemulpad and Jamie. (2014). Recent advances in plant based, traditional and natural medicines. Academic Press, Canada.
27. Verma, V. (2009). Textbook of Economic Botany. Ane Books Pvt. Ltd, India.
28. West, R.B. (1999). Practical Gardening in India. Discovery publishing House, New Delhi.
29. Wiart, Christophe. (2006). Ethnopharmacology of medicinal plants. Human Press, Totowa.

# BOTANY (CBCS)
# [Semester-III]
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## ECOLOGY AND ENVIRONMENTAL BIOLOGY

**Course No.: PSBOTC305**
**Credits: 4**
**Duration: 2½ hrs**

**Maximum Marks: 100**
**Minor Test I: 20 Marks**
**Minor Test II: 20 Marks**
**Major Test: 60 Marks**

***Objectives:***

***The course is designed to make students understand various ecological components and interconnectedness in these components of the ecosystems. Interspecific and intraspecific relations of the species with respect to dynamisms of various ecosystems are the important components of the course. The course also emphasizes on the ecological issues and various ways of solutions to these issues.***

**UNIT I: Ecosystem ecology**

1.1 Ecosystem, structure and function, energy flow, ecological efficiencies, food chain and food web, primary productivity and its measurements.
1.2 Biogeochemical cycles with particular reference to cycling of carbon, nitrogen, phosphorus and sulphur.
1.3 Ecosystem dynamics, development of ecosystem, ecosystem stability-resistance and resilience.
1.4 Role of single species in community structure, dominant, keystone, foundation, umbrella and flagship species.

**UNIT II: Population ecology**

2.1 Characteristics of a population, population growth curves and models; survivorship curves and life table analysis, Life history strategies (r and k-selection).
2.2 Concept of metapopulation-demes; dispersal; inter-demic extinctions.
2.3 Population interactions: inter and intra specific competition.
2.4 Population bottlenecks and regulations; effective population size; allelopathy.

**UNIT III: Community ecology**

3.1 Nature and concept of plant communities, community structure and attributes; life forms and biological spectrum, levels of biological diversity and its measurements.
3.2 Qualitative methods of studying plant communities, disturbance and diversity stability relationships.
3.3 Ecological Succession- types, mechanism, temporal changes (cyclic and non-cyclic).
3.4 Concept of habitat and niche, niche width and overlap, fundamental and realized niche, partitioning and ecological niche modelling (Bioclim data, DEM, geo-cordinates, GBIF, MaxENT).

**UNIT IV: Ecological concerns and solutions**

4.1 Historical perspective of invasive ecology, invasion process, impact of invasiveness on community structure, trophic levels and hydrology.
4.2 Concept of sustainable development and indicators of sustainability.
4.3 Environmental pollution -types, sources, solutions, ecological footprint.
4.4 Biosensors and their applications in environment and ecosystem, environmental degradation and environmental impact assessment.

**UNIT V: Advances in ecology**

5.1 Concepts and foundations of remote sensing (RS), energy and radiation sources, interaction of energy with atmosphere and earth surface, data acquisition and global positioning system (GPS).
5.2 Geographic Information System (GIS), coordinate system, data types and analysis, applications of RS and GIS.

5.3 Climate change (causes and consequences), Green House Gases (source and role), CO2 fertilization, carbon sequestration and carbon trading.

5.4 Bioremediation (principles, features and strategies), process of phytoremediation (phyto-extraction, phyto-stabilization and phyto-transformation).

**Note for Paper Setting**

| Theory Examination | Syllabus to be covered in the Examination | Time allotted for the Exam | %weightage (marks) |
|---|---|---|---|
| Minor Test I | Up to20% | 1Hr. | 20 |
| Minor Test II | 20%to40% | 1Hr. | 20 |
| Major Test | 41%to100% | 2½Hr. | 60 |

**Pattern to be followed for Major Test:**

a. Major test will have seven questions each of 15 marks.
b. One question will be compulsory and will consist of very short answer type of multiple parts spread over entire syllabus.
c. Rest of the six questions will be from the remaining 41%-100% portion of the syllabus and the candidate will have to attempt any three of them.

**Literature recommended:**

1. Ambasht, R. S. and Ambasht N. K. (1995) A Textbook of Plant Ecology. 11th Edn. Students Friends & Co. Varanasi, India.
2. Begon, M., Townsend, C.R. and Harper, J.L. (2006). Ecology from Individuals to Ecosystems. 4thEdn. Blackwell publishing, USA.
3. Chapman, J. L. and Reiss, M. J. (1998). Ecology: Principles and Applications. Cambridge University Press.
4. Claude, F., Christiane, F., Medori, P. and Devaux, J. (2001). Ecology: Science and Practice.Oxford and IBH publishing Co. Pvt. Ltd. New Delhi.
5. Dash, M. (1999). Fundamentals of Ecology. Tata Mc-Graw-Hill Publishing Company Ltd. New Delhi.
6. Daubernmire R. (1974) Plants and environment. John Wiley & Sons
7. Eisner, T. and Meinwald, J. (1995). Chemical Ecology: The Chemistry of Biotic Interaction, National Academies Press.
8. Hacker S.D. and Bowman WD (2020). Ecology: International Edition. Oxford Press.
9. Jørgensen SE (2009) Ecological Modelling- an introduction, WIT Press.
10. Kormondy, E.J. (1996). Concepts of Ecology. Prentice Hall of India Pvt. Ltd. New Delhi.
11. Odum, E. P. (1971). Fundamentals of Ecology. Saunders, Philadelphia.
12. Subrahmanyan, N. S and Sambamurty A.V.S.S. (2006). Ecology. 2nd Edn. Narosa, New Delhi.
13. Townsend CR., and Begon M (2021) Ecology: From Individuals to Ecosystems. 5th edition. Wiley Blackwell
14. Trevor, B. and Graham, R. (2005). An Introduction to Molecular Ecology. Oxford University Press.
15. Ussiri, D.A.N. and Lal R. (2017) Carbon Sequestration for Climate Change Mitigation and Adaptation. Springer
16. Whittaker R.H. (1975) Communities and Ecosystem, Macmillan.

**Course No. PSBOPC306 (Based on PSBOTC301 and PSBOTC305)**

**Credits: 4** **Maximum Marks:100**
**Daily evaluation of practical records /Assignment test / Viva voce etc.: 50**
**Final Practical performance +viva voce: 50**

**Laboratory Exercises based on PSBOTC301**

1. Extraction of chloroplast pigments from leaves and preparation of the absorption spectrum of chlorophylls and carotenoids.
2. Determination of chlorophyll a and chlorophyll b ratio in C3 and C4 plants.
3. Extraction of seed proteins depending upon the solubility.
4. Determination of the respiratory quotient (RQ) for germinating seeds by Ganong'sRespirometer.
5. Desalting of proteins by gel filtration chromatography employing Sephadex G25.
6. Preparation of the standard curve of protein (BSA) and estimation of the protein content inextracts of plant material by Lowry's and Bradford's method.
7. Fractionation of proteins using gel filtration chromatography by Sephadex G100 or SephadexG200.
8. Extraction and qualitative estimation of amino acids from plant tissue by using paperchromatography.
9. Extraction and qualitative estimation of sugars and organic acids by paper chromatography.
10. Ascorbic acid extraction and quantitative estimation from plant tissues.
11. Determination of effect of time and enzyme concentration on the rate of reaction of enzyme.eg. acid phosphatase, nitrate reductase, catalase.
12. Determination of effect of substrate concentration of activity of an enzyme.
13. Determination of the effect of anaesthetics, temperature and high pressure on the permeability of beet root tissue.
14. Principles of colorimeter, spectrophotometer and fluorimeter.
15. Separation of isozymes i.e. esterase, peroxidase using PAGE.
16. tudy of degree of dissociation of an electrolyte by plasmolytic method.
17. Determination of temperature coefficient ($Q_{10}$) of water absorption by wheat seeds and potato tubers.

**Laboratory Exercises based on PSBOTC305**

1. Determination of the Minimum requisite size of a sampling unit for vegetation study and calculation of Importance Value Index of herbaceous flora.
2. Determination of the plant density through plotless sampling methods.
3. Determination of $\alpha$ , $\beta$ and $\gamma$ diversity and various diversity indices.
4. Determining primary productivity in terms of biomass and chlorophyll content.
5. Estimation of the gross and net primary productivity of an aquatic ecosystem by light and dark bottle method.
6. Determination of phytoclimate and biological spectrum.
7. Determination of dissolved oxygen in the aquatic water body.
8. Determination of Ca++ and Mg++ ions in polluted and unpolluted water samples.
9. Determination of the water holding capacity and cation exchange complex of different soils.
10. Determination of the stomatal index in the plants grown in polluted and unpolluted water samples.
11. Detection of different components of ecosystem from colour signatures in the False Colour Composite (FCC) spatial data acquired using Sentinel.
12. Study of changes in land use pattern by temporal comparison of the spatial data of a satellite scene acquired over a reasonable time period.

**Course No. PSBOPC306 (Based on PSBOTC302 and PSBOTC303)**

**Credits: 4**

**Maximum Marks: 100**
**Daily evaluation of practical records /Assignment test / Viva voce etc.: 50**
**Final Practical performance +viva voce: 50**

**Laboratory Exercises based on PSBOTC302**

1. Calculation of mean, mode, median, standard deviation and coefficient of variation.
2. Skewness and Kurtosis- coefficients and probability.
3. Frequency and probability distributions.
4. Students't-test, F-test, one way and two way ANOVA.
5. Correlation and regression analysis.
6. Cluster analysis.
7. Study of natural modes of vegetative propagation using appropriate methods (bulb, corm, tuber, runner and sucker).
8. Attempt different types of grafts using proper stock and scion.
9. Demonstrate various types of layering.
10. Study the floral characters, pollen-ovule ratio and pollen stigma interactions in any self- pollinated crop preferably legumes.
11. Study various contrivances for out-crossing in common cross-pollinated crops available in the season (maize, bajra, jowar, trifoliums).
12. Demonstration of various steps involved in carrying out hand/manual pollinations.

**Laboratory Exercises based on PSBOTC303**

1. Classification of the medicinal plants growing in botanical garden in accordance with IUCN categories.
2. Determination of the percentage of conservation value of soil and water for an herbaceous community.
3. Estimation of possible biological threats on the existence of *Allium roylei* and *Eremostachys superba* on the basis of provided meiotic spread and flower respectively.
4. Analysis of the biotic components of a man-made wetland and graphically represent the studied aquatic ecosystem.
5. Determination of seed viability of highly threatened medicinal plants by tetrazolium chloride test.
6. Comparison of the seed morphology and viability of variously temperature treated seeds for seed storage practice.
7. Comparison of the germplasm diversity in economic traits of provided vegetable material.
8. Determination of the spatial and temporal distribution of plants through herbarium upholding.
9. Determination of the percentage of species association using Jaccard's index.
10. RET plants growing in the botanical garden in respect of morphology and physiognomy.
11. Pharmacognostic details (morphology, anatomy and organoleptic characters) of the provided crude drugs of Indian system of medicine.
12. Determination of organoleptic characters of different tea samples and determine the presence of tannins and flavonoids in the provided tea samples.
13. Comparison of the percentage of protein bodies in the provided pulses.
14. reparation of temporary mount using iodine solution as stain and compare type, shape, structure, and size of starch granules in the provided plant material.
15. Determination the presence of phlobatannins, flavonoids, steriods and glycosides in the provided drug samples.
16. Preparation of soap from vegetable oil.
17. Extraction and characterization of the plant fibers from provided plant material.

## DISSERTATION/PROJECT WORK

**Course No.: PSBODC401**
**Maximum Marks: 150**
**Credits: 6**
***Objectives:***
***The dissertation/project work has been introduced with an aim to expose the students to handling of research problems. They will develop first-hand knowledge right from proposing a hypothesis to planning, designing and executing the experiments to finally managing and interpreting the data, and drawing inferences.***

**Pattern to be followed for Evaluation:**
**The Dissertation will be based on field work and / or lab work that will be evaluated after submission in the form of presentation and viva-voce.**

# BOTANY (CBCS)
# [Semester-IV]
# For examinations to be held in May 2023, 2024 & 2025

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## MYCOLOGY AND PLANT PATHOLOGY

**Course No.: PSBOTC402**
**Credits: 4**
**Duration: 2½hours**

**Maximum Marks: 100**
**Minor Test I: 20 Marks**
**Minor Test II: 20 Marks**
**Major Test: 60 Marks**

***Objectives:***
***This course has been conceived to equip students with the knowledge of various characteristics and groups of fungi, highlighting their significance, means of their dispersal, survival and entry in plants. Besides, the course also deals with plant defense mechanisms, chemical weapons of pathogenesis and methods generally adopted for their management.***

**UNIT I: Characteristic features of fungi**

1.1 Fungal hyphae growth, branching, septation and aggregations; nutritional types of fungi (necrotrophic, biotrophic, symbiotic); ultrastructure and composition of fungal cells.
1.2 Reproduction and hormonal regulation of mating in fungi; sexual cycles.
1.3 Homothallism and major types of heterothallism.
1.4 Heterokaryosis and parasexuality.

**UNIT II: Classification, diversity and significance of fungi**

2.1 Classification of fungi (Alexopolous and Mims, 1979; Alexopolous et al., 1996 and Hibbett et al., 2007)
2.2 General characters and reproduction in Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina and Deuteromycotina.
2.3 Significance of fungi in industries with reference to production of antibiotics, organic acids (citric acid) and food (Cultivation of yeasts, button mushroom and oyster mushrooms).
2.4 Fungal infection of man (types of mycoses); important fungal diseases of crop plants (brown spot of rice, stripe rust of wheat, red rot of sugarcane, tikka disease of groundnut, white blister of crucifers, downy mildew of vegetables, powdery mildew of wheat).

**UNIT III: Disease inoculum and pathogenesis**

3.1 Concept of pre-and post-harvest diseases, significance, disease triangle.
3.2 Types and survival of inocula of plant pathogens, their dispersal (active and passive), forecasting of epiphytotic diseases.
3.3 Pre-penetration activities of the pathogens, penetration through natural openings, wounds and through intact plant surfaces.
3.4 Post-penetration activity of the pathogens involving growth (inter- and intra-cellular) and reproduction.

**UNIT IV: Host defense mechanisms and chemical weapons of the pathogens**

4.1 Morphological and histological defense structures (pre-existing and formed in response to infection).
4.2 Biochemical defense mechanism (pre-existing and post-infectional including phytolexins and PR proteins).
4.3 Microbial enzymes (degradation of cell wall and other cell components) and toxins (host specific and non-host specific) involved in pathogenesis.
4.4 Microbial growth regulators and polysaccharides involved in pathogenesis.

**Course No.: PSBOTC402 MYCOLOGY AND PLANT PATHOLOGY**

**UNIT V: Management of plant diseases**

5.1 Regulatory and biological methods–quarantine and inspection, antibiosis, fungistasis.
5.2 Cultural methods-eradication of secondary hosts, crop rotation, rogueing, tillage, sanitation, creating conditions unfavourable to the pathogens, nutritional and soil amendments.
5.3 Chemical methods–requisites of a good fungicide, seed and soil treatment by fungicides.
5.4 Protective and systemic fungicides (types)

**Note for Paper Setting**

| Theory Examination | Syllabus to be covered in the Examination | Time allotted for the Exam | % weightage (marks) |
|---|---|---|---|
| Minor Test I | Up to 20% | 1 Hr. | 20 |
| Minor Test II | 20% to 40% | 1 Hr. | 20 |
| Major Test | 41% to 100% | 2½Hr. | 60 |

**Pattern to be followed for Major Test:**

a. Major test will have seven questions each of 15 marks.
b. One question will be compulsory and will consist of very short answer type of multiple parts spread over entire syllabus.
c. Rest of the six questions will be from the remaining 41%-100% portion of the syllabus and the candidate will have to attempt any three of them.

**Literature Recommended:**

1. Agrios, G.N. (2012). Plant Pathology. 5th Edn. Academic Press, London.
2. Mehrotra, R.S. and Aneja, K.R. (1990). An Introduction to Mycology. Wiley
3. Nene, Y.L. and Thapiyal, P.N. (1971). Fungicides in Plant Diseases Control.
4. Sumbali G. (2010). The Fungi. 2nd Edn. Narosa Publishing House, New Delhi.
5. Vyas, S.C. (1993). Handbook of Systemic Fungicides. Vol. I, II & III. Tata McGraw Hill Publishing Co., New Delhi.
6. Waller J. M., Lenne, J. M. and Waller S. J. (2001). Plant Pathologist's Pocket Book, CAB International, UK
7. Alexopoulos, C. J. and Mims, C. W. (1979). Introduction to Mycology. John Wiley & Sons, New York.
8. Alexopoulos, C. J., Mims, C. W. and Blackwell, M. M. (1996). Introductory Mycology.4th Edition. John Wiley & Sons, New York.
9. Borkar S.G. and Patil. N. (2020) Mushroom: A nutritive food and its cultivation. Daya Publishing House.
10. Dube, H. C. (2013). An Introduction to Fungi. 4th rev ed. Scientific Publishers, New Delhi. Eastern Ltd. New Delhi Graw Hill Publ. Co.
11. Hibbett et al. (2007). A higher level of phylogenetic classification of the fungi. Mycological Research. Vol3: 509-547.
12. Chand, G and Kumar S (2018). Techniques of mushroom cultivation. Astral International (P) Ltd. New Delhi.
13. Mehrotra, R. S. and Aggarwal, Ashok. (2017). Plant Pathology. 3rd ed. McGraw Hill, Chennai.
14. Mishra, A. (2012). Plant Pathology: diseases and management. Agrobios, New Delhi. Oxford & IBH Publishing Co. Pvt. Ltd.
15. Roberts, P. and Evans, S. (2011). Book of Fungi. Ivy Press, Great Britain.
16. Sethi, I. K. and Walia, S. K. (2018). Textbook of fungi and their allies. 2nd ed. MedTech, New Delhi.
17. Singh, R. S. (2018). Introduction to principles of plant pathology. 5th ed. MEDTECH, New Delhi.
18. Sreekumar, S., Remya, R. and Nair, K. Vijayakumaran. (2016). Microbiology, Phycology, Mycology, Lichenology and Plant Pathology. MEDTECH, New Delhi.

19. Strange, Richard N. (2014). Introduction to plant pathology. Wiley, New Delhi.
20. Tedersoo et al. (2018). High level classification of the fungi and a tool for evolutionary ecological analysis. Fungal diversity, 90: 135-159.
21. Turland, N. (2013). The Code Decoded: a user's guide to the International Code of Nomenclature for algae, fungi and plants. Koeltz Scientific Books, Germany.
22. Webster, John & Roland, W. S. (2007). Introduction to Fungi. 3rd ed. Cambridge University Press, New Delhi.

# BOTANY (CBCS)
# [Semester-IV]
# For examinations to be held in May 2023, 2024 & 2025

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## GENETIC ENGINEERING AND PLANT TISSUE CULTURE

**Course No.:PSBOTC403**
**Credits: 4**
**Duration: 2½ hrs**

**Maximum Marks: 100**
**Minor Test I: 20 Marks**
**Minor Test II: 20 Marks**
**Major Test: 60 Marks**

***Objectives:***
***Genetic Engineering is one of the most important and controversial field of genetic research. Making students knowledgeable about the methods involved in modifying and manipulating genes within and between species, creating new medicines, producing disease resistant plants and diagnosing human diseases is the main aim of this course. The component of tissue culture has been deliberately clubbed with genetic engineering, since for culturing genetically modified plants; one should know the tissue culture techniques.***

**UNIT I: Recombinant DNA technology**

1.1 Principles and techniques of gene cloning; use of vectors (plasmids, phage, phagemids and cosmids) and enzymes therein.
1.2 Genomic and cDNA libraries – construction, different methods of screening and choice of vectors
1.3 DNA synthesis and amplifications; Polymerase Chain Reaction and its variations (RT-PCR, Real-time –PCR).
1.4 DNA sequencing techniques- Maxam-Gilbert, Sanger sequencing and Pyro-sequencing; DNA fingerprinting technique and applications.

**UNIT II: Genetic engineering of plants and microbes**

2.1 Aims and strategies for development of transgenic plants. Transgenic plants for herbicide tolerance, pest (insect and viral) resistance and molecular farming.
2.2 Agrobacterium – mediated gene transfer and direct gene transfer methods.
2.3 Genetic improvement of important industrial microbes and nitrogen fixers.
2.4 Intellectual property rights with reference to genetically engineered organisms; possible ecological risks and ethical concerns.

**UNIT III: Genomics and proteomics**

3.1 Genetic and physical mapping of genes, molecular markers for introgression of useful traits.
3.2 Artificial chromosomes – BAC, YAC and PAC.
3.3 Human genome project–aims, objectives, achievements and risks; genome editing through CRISPR/Cas system, introductory bioinformatics
3.4 Proteomics: general concept; microarrays; protein profiling and its significance.

**UNIT IV: Plant tissue culture and organogenesis**

4.1 History and concept of cell differentiation and totipotency.
4.2 Tissue culture media; suspension cultures and testing growth and viability of cultured cells.
4.3 Factors affecting single cell culture, plant cell reactors, their types and utility.
4.4 Factors affecting organogenic differentiation, loss of morphogenetic potential in long term cultures.

**UNIT V: Somatic hybridization, micropropagation, variant selection and secondary metabolite production**

5.1 Protoplast isolation, culture and regeneration, somatic hybridization and selection, genetic consequences of protoplast fusion, hybrids versus cybrids.
5.2 Factors affecting in-vitro stages of micropropagation, rooting, hardening of micro-propagated plants; applications and limitations of micropropagation.
5.3 Origin of somaclonal variation, mechanisms underlying genetic variation and selection of variants at plant and cell levels.

5.4 Strategies used for production of useful compounds through cell culture, factors affecting yield of products in culture, applications of in vitro production of secondary metabolites.

**Note for Paper Setting**

| Theory Examination | Syllabus to be covered in the Examination | Time allotted for the Exam | % weightage (marks) |
|---|---|---|---|
| Minor Test I | Up to 20% | 1 Hr. | 20 |
| Minor Test II | 20% to 40% | 1 Hr. | 20 |
| Major Test | 41% to 100% | 2½Hr. | 60 |

**Pattern to be followed for Major Test:**

a. Major test will have seven questions each of 15 marks.
b. One question will be compulsory and will consist of very short answer type of multiple parts spread over entire syllabus.
c. Rest of the six questions will be from the remaining 41%-100% portion of the syllabus and the candidate will have to attempt any three of them.

**Literature recommended:**

1. Bhojwani, S.S. and Razdan, M. K. (2017) Plant Tissue Culture: Theory and Practice: Bio Green Books.
2. Bhojwani, S.S. (2013). Plant Tissue Culture: Applications and Limitations. Elsevier Science Publishers, New York, USA.
3. Bhojwani, S.S. and Razdan, M.K. (2005). Plant Tissue Culture: Theory and Practice. Revised Edn. Elsevier Science Publication, Netherlands.
4. Brown, T. A. (2016). Gene cloning and DNA analysis. 7th ed. Wiley Blackwell, UK.
5. Brown, T. A. (2018). Genomes 4. Garland Science, New York.
6. Brown, T.A. (1998). Genetics: A Molecular Approach. Chapman and Hall, London.
7. Brown, T.A. (2010). Gene cloning and DNA Analysis- An introduction. 6th Edn. Wiley Blackwell.
8. Brown, T.A. (2010). Genomes. John Wiley and Sons Pvt. Ltd., Singapore.
9. Chrispeels, M.J. and Sadava, D.E. (1994). Plants, Genes and Agriculture. Jones & Bartlett Publishers, Boston, USA.
10. Das, H.K. (2007). A Textbook of Biotechnology. 3rd Edn. Wiley India Pvt. Ltd. U.P., India.
11. Daugherty, E. (2017) Biotechnology: Science for the New Millennium, EMC Paradigm, US.
12. Glezer, A.N. and Nikaido, H. (1995). Microbial Biotechnology. W.H. Freeman and Company, New York, USA.
13. Glick, B.R., Pasternak J.J. and Patten, C.L. (2010). Molecular Biotechnology: Principles and Applications of Recombinant DNA. 4th Edn. A.S.M. Press, Washington, DC.
14. Gupta, S. Dutta. (2006). Plant Tissue Culture Engineering. Springer, USA.
15. Henry, R.J. (1997). Practical Applications of Plant Molecular Biology. Chapman & Hall, London, UK.
16. Jain, S.M., Sopory, S.K. and Veilleux, R.E. (1996). In vitro Haploid Production in Higher Plants-Fundamental Aspects and Methods. Vols. 1-5. Kluwer Academic Publishers, Dordrecht, the Netherlands.
17. Jolles, O. and Jornvall, H. (2000). Proteomics in Functional Genomics. Birkhauser Verlag, Basel, Switzerland.
18. Kartha, K.K. (1985). Cryopreservation of Plant Cells and Organs. CRC Press, Boca Raton, Florida, USA.
19. Primose, S. B. and Twyman, R. M. (2014). Principles of Gene Manipulation and Genomics. 7th ed. Wiley Blackwell, New Delhi.
20. Primrose, S.B. (1995). Principles of Genome Analysis. Blackwell Science Ltd., Oxford, UK.
21. Raghavan, V. (1997). Molecular Biology of Flowering Plants. Cambridge University Press, New York, USA.
22. Razdan, M. K. (2018). Introduction to Plant Tissue Culture. 3rd ed. Oxford & IBH, New Delhi.
23. Vasil, I.K. and Thorpe, T.A. (1994). Plant Cell and Tissue Culture. Kluwer Academic Publishers. The Netherlands.

# BOTANY (CBCS)
# [Semester-IV]
# For examinations to be held in May 2023, 2024 & 2025

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## PLANT PROPAGATION

**Course No.: PSBOTE404**
**Credits: 4**
**Duration: 2½ hrs**

**Maximum Marks: 100**
**Minor Test I: 20 Marks**
**Minor Test II: 20 Marks**
**Major Test: 60 Marks**

***Objectives:***
***Basic and applied tools of plant propagation are of immense commercial utility. Thus, this course is formulated to introduce the students to various means of propagation, their advantages and disadvantages.***

**UNIT I: Seed production in plants**

1,1 Biology of propagation in plants- General account of sexual and asexual means and their correlation with genetic variability; seedlings versus clonal propagation.
1.2 Sexual seed - structure, development, ripening and dissemination.
1.3 Apomixis - phenomenon and implications; concept of asexual seeds and polyembryony.
1.4 Propagation from seeds - germination process, dormancy- its types and control, methods to break dormancy.

**UNIT II: Modes of vegetative propagation**

2.1 Vegetative propagation- advantages and limitations, natural and artificial means.
2.2 Propagation by specialized vegetative structures- bulbs, tubers corms, rhizomes, runners andsuckers.
2.3 Propagation by cutting and layering- types of cuttings and layering, description of adventitious root and bud formations; processes in layering.
2.4 Grafting and budding- concept and types, formation of graft union, graft incompatibility, top budding and micro-budding.

**UNIT III: Breeding systems and methods**

3.1 Concept of breeding systems, cross and self-pollination; contrivances for cross pollination, concept of sex expression, dichogamy and self- incompatibility.
3.2 Breeding methods for self-pollinated crops; selection methods- mass and pure line selection.
3.3 Breeding methods for cross pollinated crops, concept of inbreeding depression and hybrid vigour.
3.4 Hybridization methods-hybrid and synthetic varieties, selection after hybridization, pedigree selection and bulk population.

**UNIT IV: *in vitro* multiplication**

4.1 Concept of cellular differentiation and totipotency, Culture media- composition and effects of media component;
4.2 Phytohormones- effects in tissue culture; sterilization methods
4.3 Advantages and limitations of in-vitro propagation, various stages in micropropagation acclimatization of in vitro raised plants.
4.4 Technique and applications of cryopreservation; micrografting

**UNIT V: Micropropagation and its utility**

5.1 Propagation of plants by organogenesis-factors affecting indirect and direct organogenesis.
5.2 Propagation of plants by somatic embryogenesis-factors affecting indirect and direct somatic embryogenesis, Synthetic seed production
5.3 Micropropagation of fruits, vegetables and ornamental plants.
5.4 Industrial potential of micropropagation in India.

# BOTANY (CBCS)
# [Semester-IV]
# For examinations to be held in May 2023, 2024 & 2025

**Course No.: PSBOTE404** **PLANT PROPAGATION**

**Note for Paper Setting**

| Theory Examination | Syllabus to be covered in the Examination | Time allotted for the Exam | % weightage (marks) |
|---|---|---|---|
| Minor Test I | Up to 20% | 1 Hr. | 20 |
| Minor Test II | 20% to 40% | 1 Hr. | 20 |
| Major Test | 41% to 100% | 2½ Hr. | 60 |

**Pattern to be followed for Major Test:**

a. Major test will have seven questions each of 15 marks.
b. One question will be compulsory and will consist of very short answer type of multiple parts spread over entire syllabus.
c. Rest of the six questions will be from the remaining 41%-100% portion of the syllabus and the candidate will have to attempt any three of them.

**Literature recommended:**


1. Allard, R.W. (2010). Principles of Plant breeding. Wiley India Pvt. Ltd.
2. Beyl, C. A. and Trigiano, R. N. eds. (2008). Plant propagation, Concepts and Laboratory Exercises. CRC Press,
3. Bhojwani, S.S. (2013). Plant Tissue Culture: Applications and Limitations. Elsevier Science Publishers, New York, USA.
4. Bhojwani, S.S. and Razdan, M.K. (2005). Plant Tissue Culture: Theory and Practice. Elsevier Science Publication, Netherlands.
5. Das, H.K. (2007). A Textbook of Biotechnology. 3rd Edn. Wiley India Pvt. Ltd. U.P., India.
6. Hartman, H.T., Kester, D.E., Davies, F.T. and Genevre, R.L. (1997). Plant Propagation – Principles and Practices. Prentice Hall of India Pvt. Ltd., New Delhi.
7. Hvoslef-Eide, A. K. and Preil, W. ed. (2005). Liquid culture systems for in vitro plant propagation. Springer, Netherlands.
8. McMillan-Browse, P.D. A. (1979). Plant Propagation. New York: Simon and Schurter.
9. Nanda, K.K. and Kochar, V.K. (1985). Vegetative Propagation of Plants. Kalyani Publishers, New Delhi.
10. Razdan M.K. (1993). An Introduction to Plant Tissue Culture. Oxford & BDH Publishing Co. Pvt. Ltd.
11. Sadhu, M.K. (1999). Plant Propagation. New Age International (P) Limited Publishers, New Delhi.
12. Singh, B. D. (2010) Plant Breeding: Principles and Methods. Kalyani Publishers, New Delhi.
13. Trigiano, R. N. and Gray, O.J. (2000). Plant Tissue Culture: Concepts and Laboratory Exercises. CRC Press. BOCA Raton. London, U.K.

**Course No. PSBOPC407 (Based on PSBOTC402 and PSBOTC403)**

**Credits: 4**

**Maximum Marks: 100**
**Daily evaluation of practical records/Assignment test/Viva voce etc.: 50**
**Final Practical performance + viva voce: 50**

**Laboratory Exercises based on PSBOTC402**

1. Preparation of Potato Dextrose Agar medium, sterilization, plating and making of PDA slants.
2. Isolation, purification, culturing and sub-culturing of fungal pathogens.
3. Methods of preservation and maintenance of fungal cultures.
4. Field diseases of local crop plants.
5. Post-harvest fungal diseases of fruits and vegetables.

**Laboratory Exercises based on PSBOTC403**

1. Isolation of plasmid DNA from *E .coli* by alkaline lysis method and its quantization using spectrophotometer.
2. Restriction digestion of the plasmid and estimation of the size of various DNA fragments.
3. Cloning of a DNA fragment in a plasmid vector, transformation of the given bacterial population and Selection of recombinants.
4. Demonstration of DNA sequencing by Sanger's dideoxy method.
5. DNA isolation from microbial cultures and plant tissues.
6. Isolation of plasmid from *E.coli* by alkaline lysis method.
7. Preparation of agarose gel and preparation of buffers.
8. Southern blotting of DNA from agarose gel.
9. Study of restriction digestion of DNA.
10. DNA sequencing studies from autoradiographs of sequencing gels and construction of autoradiographs of sequencing gels from provided template sequence.
11. DNA fingerprinting studies from data on various cases of disputed parentage and forensic applications.
12. Organogenesis and somatic embryogenesis using appropriate explants and preparation of artificial seed.
13. Demonstration of axillary shoots proliferation method for micropropagation.
14. Isolation of protoplasts from various plant tissues and testing their viability.
15. Demonstration of the technique of micropropagation by using different explants e.g. axillary buds, shoot meristems.
16. Demonstration of the technique of anther culture.
17. Demonstration of root and shoot formation from the apical and basal portion of stem segments in liquid medium containing different hormones.