# UNIVERSITY OF CALCUTTA

## NotificationNo.CSR/13/2023

It is notified for information of all concerned that in terms of the provisions of Section 54 of the Calcutta University Act, 1979, (as amended), and, in exercise of his powers under 9(6) of the said Act, the Vice-Chancellor has, by an order dated 11.07.2023 approved the Syllabi of the under mentioned subjects for semester wise Four-year (Honours & Honours with Research) / Three-year (Multidisciplinary) programme of U.G. courses of studies, as applicable under CCF,2022 . under this University, as laid down in the accompanying pamphlet.

**Name of Subject:**

1.Anthropology
2.BBA
3.Bengali
4.BFAD
5.Bio Chemistry
6.Botany
7.Chemistry
8.Commerce
9.Economics
10.Education
11.English
12.Geology
13.Hindi
14.History,Islamic History & Culture
15.Home Science
16.Human Rights
17.Journalism & Mass Communication
18.Mathematics
19.Microbiology (Honours)
20.Molecular Biology .
21.Philosophy
22.Physiology
23.Political Science
24.Psychology
25.Social Science
26.Sociology
27.Urdu
28.Women's Studies
29.Zoology

The above shall be effective from the academic session 2023-2024.

12/7/2023

SENATE HOUSE

KOLKATA-700 073

Prof.(Dr.) Debasis Das

Registrar

**UNIVERSITY OF CALCUTTA**

**Course Structure- 4 yr Honours + Research (NEP 2020)**

**BOTANY**

| Programme Structure for the Bachelor of Science Degree with BOTANY as Major having Practicals | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Sem** | **DSC/Core** | **Minor** | **IDC** | **AEC** | **SEC** | **CVAC** | **Summer Internship/ Field Visit** | **Dissertation/Research work** | **Total Credit** |
| | **Level 100** | | | | | | | | |
| **1** | **BOT-H-CC1-1-Th<br>BOT-H-CC1-1-P<br>Plant diversity** | **Plant diversity (Th+Pr)** | **Integrative Palynology **** | **From Central Pool** | **BOT-H-SEC-1-Th<br>BOT-H-SEC-1-P<br>Mushroom Cultivation Technology** | **1.ENVS<br>2. CV** | | | **21** |
| **2** | **BOT-H-CC2-2-Th<br>BOT-H-CC2-2-P<br>Plant Systematics** | **Plant Systematics (Th+Pr)** | | **From Central Pool** | **BOT-H-SEC-2-Th<br>BOT-H-SEC-2-P<br>Biofertilizer & Biopesticides** | **1.ENVS<br>2.Central Pool** | **Summer Internship ***** | | **21** |
| | **Level 200** | | | | | | **Exit option** | | |
| **3** | **BOT-H-CC3-3-Th<br>BOT-H-CC3-3-P<br>Economic Botany** | **Plant diversity (Th+Pr)** | | **From Central Pool** | **BOT-H-SEC-3-Th<br>BOT-H-SEC-3-P<br>Plant Tissue Culture and Horticultural Practices** | | | | **21** |
| | **BOT-H-CC4-3-Th<br>BOT-H-CC4-3-P<br>Plant Anatomy and Embryology** | | | | | | | | |
| **4** | **BOT-H-CC5-4-Th<br>BOT-H-CC5-4-P<br>Phycology** | **Plant Systematics (Th+Pr)** | | **From Central Pool** | | | | | **22** |
| | **BOT-H-CC6-4-Th<br>BOT-H-CC6-4-P<br>Archegoniates** | | | | | | | | |
| | **BOT-H-CC7-4-Th<br>BOT-H-CC7-4-P<br>Palaeobotany** | | | | | | | | |
| | **BOT-H-CC8-4-Th<br>BOT-H-CC8-4-P<br>Pharmacognosy and Ethnobotany** | | | | | | **Summer Internship ***** | | |
| | **Level 300** | | | | | | **Exit option** | | |
| **5** | **BOT-H-CC9-5-Th<br>BOT-H-CC9-5-P<br>Mycology** | **Economic Botany (Th+Pr)** | | | | | | | **24** |
| | **BOT-H-CC10-5-Th<br>BOT-H-CC10-5-P<br>Microbiology** | | | | | | | | |
| | **BOT-H-CC11-5-Th<br>BOT-H-CC11-5-P<br>Biochemistry** | | | | | | | | |
| | **BOT-H-CC12-5-Th<br>BOT-H-CC12-5-P<br>Cell and Molecular Biology** | | | | | | | | |
| **6** | **BOT-H-CC13-6-Th<br>BOT-H-CC13-6-P<br>Phytopathology** | **Pharmacognosy and Ethnobotany (Th+Pr)** | | | | | | | **23** |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | BOT-H-CC14-6-Th<br>BOT-H-CC14-6-P<br>Plant Physiology | | | | | | | | |
| | BOT-H-CC15-6-Th<br>BOT-H-CC15-6-P<br>Genetics | | | | | | Summer Internship *** | | |
| | Level 400 | | | | | | Exit option | | |
| 7 | BOT-H-CC16-7-Th<br>BOT-H-CC16-7-P<br>Plant Geography, Ecology and Evolution | | | | | | | | 20 |
| | BOT-H-CC17-7-Th<br>BOT-H-CC17-7-P<br>Biostatistics | | | | | | | Natural Resource Management* (Th+Pr) | |
| | BOT-H-CC18-7-Th<br>BOT-H-CC18-7-P<br>Plant Biotechnology | | | | | | | | |
| | BOT-H-CC19-7-Th<br>BOT-H-CC19-7-P<br>Plant Metabolism | | | | | | | | |
| 8 | BOT-H-CC20-8-Th<br>BOT-H-CC20-8-P<br>Plant Breeding | | | | | | | Stress Biology* (Th+Pr) | 20 |
| | BOT-H-CC21-8-Th<br>BOT-H-CC21-8-P<br>Research Methodology | | | | | | | Industrial and Environmental Microbiology* (Th+Pr) | |
| | BOT-H-CC22-8-Th<br>BOT-H-CC22-8-P<br>Bioinformatics and Instrumentation | | | | | | | | |
| Credits | 88 | 32 | 9 | 8 | 12 | 8 | 3 | 12 | 172 |
| Marks | 2200# | 800# | 225## | 200 | 300# | 200 | 75 | 300 | 4300 |

*Candidates who will not pursue Dissertation/ Research work, he/she will have to study 1 additional DSC/Core paper of 4 credits in the 7th Semester & 2 DSC/Core papers of 4 Credits each in the 8th Semester.

** IDC offered from Botany to be opted in 1st or 2nd or 3rd semester.

*** Summer internship once in 2nd or 4th or 6th Semester according to the exit option.

#For 100 marks paper 75 marks for theory and 25 marks for practical.

## For 75 marks paper 50 marks for theory and 25 marks for practical.

**UNIVERSITY OF CALCUTTA**
**Course Structure- 4 yr Honours + Research (NEP 2020)**

**BOTANY SYLLABUS**

# Semester 1

**DSC/Core**
**PLANT DIVERSITY (THEORY)**
**BOT-H-CC1-1-Th**
**Total marks 75; Credits 3, Class 45 hours**

## 1. Introduction to plant kingdom.

1.1 Origin of life and evolution of plant cells, 1.2 Importance of plants as source of food, fuel and their role in ecosystem services (as carbon sink, sequestering etc.)

(3 lectures)

## 2. Algae

2.1. Salient features of Cyanophyceae, Chlorophyceae, Charophyceae, Phaeophyceae, Rhodophyceae and Bacillariophyceae 2.2 Criteria and system of classification (Fritsch, 1935) 2.3. Economic importance of algae in environment, agriculture, biotechnology and industry.

(6 lectures)

## 3. Fungi

3.1 Salient features of Myxomycota, Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina, Deuteromycotina. 3.2 System of classification up to Sub-division (Ainsworth, 1973), 3.3 Economic importance of fungi (food, medicine and agriculture), 3.4 Fungal symbioses: Mycorrhiza, Lichen and their importance.

(6 lectures)

## 4. Bryophytes

4.1 Salient features of Hepaticopsida, Anthocerotopsida and Bryopsida, 4.2. System of classification up to Class (Proskauer 1957), 4.3 Amphibian nature of bryophytes, 4.4 Economic and ecological importance.

(6 lectures)

**5. Pteridophytes**

5.1 Salient features of Psilophyta, Lycophyta, Sphenophyta and Filicophyta, 5.2 System of classification up to Division (Gifford & Foster 1989), 5.3 Economic importance (food, medicine & agriculture).

(6 lectures)

**6. Gymnosperms**

6.1 Salient features of Cycadophyta, Coniferophyta and Gnetophyta, 6.2 Outline classification up to Division: Progymnospermophyta to Gnetophyta (Gifford & Foster 1989), 6.3 Economic importance (wood, resin, essential oil & drugs).

(6 lectures)

**7. Angiosperms**

7.1 Types and morphology of leaf, stem and root, 7.2 Inflorescence types with examples, 7.3 Flower: Different parts and forms of calyx, corolla, androecium and gynoecium; aestivation and placentation, 7.4 Types with examples-fruits and seeds.

(12 lectures)

**PLANT DIVERSITY (PRACTICAL)**
**BOT-H-CC1-1-P**
**Total marks 25; Credit 1, Class 30 hours**

| | | |
|---|---|---|
| **1.** | **Work out: Morphology** | **10 marks** |
| **2.** | **Identification with reasons (other groups except angiosperms)** | **5 marks** |
| **3.** | **Class room performance (Practical notebook)** | **3 marks** |
| **4.** | **Field notebook** | **2 marks** |
| **5.** | **Viva-voce** | **5 marks** |

1. Flower- dissection, drawing and study
   a) Different parts, b) Adhesion and cohesion, c) Placentation, d) Aestivation
2. Study of ovules: types (Fresh specimens/ permanent slides/ photographs)
3. Fruits:different types- study from fresh/ preserved specimens
4. Inflorescence types: study from fresh/ preserved specimens
5. Identification on the basis of reproductive and structural features from preserved specimens/ permanent slides: Algae (*Nostoc*, *Oedogonium* and *Ectocarpus*), Fungi (*Rhizopus*, *Ascobolus* and *Agaricus*), Bryophytes (*Marchantia*, *Anthoceros* and *Funaria*), Pteridophytes (*Selaginella*, *Equisetum* and *Pteris*), Gymnosperms (male cone and female cone/ megasporophyll of *Cycas, Pinus* and *Gnetum*).
6. A field notebook supported with photographs taken during field study to be submitted giving comprehensive idea about different types of inflorescence, flowers and fruits.

**Textbook Reference:**

1. Ganguli,H.C., Das, K.S.K. & Dutta, C.T. College Botany, Vol. I, latest Ed., New Central Book Agency

2. Ganguli,H.C. and Kar, A.K. College Botany, Vol. II, latest Ed., New Central Book Agency

3. Mukherjee, S. College Botany, Vol. III, latest Ed., New Central Book Agency

4. Uno, Storey& Moore, Principles of Botany, 2001, McGraw Hill.

5. Kenrick,P. & Crane, P. The Origin & early diversification of land plants (1997), Smithsonian Institute Press.

6. Bell, P.R. & Hensley, A.R. Green plants; their Origin & Diversity (2nd ed.), 2000, Cambridge University Press

7. Frenchel, T. The origin & early Evolution of life, 2002, Oxford University Press.

8. Hait, G., Ghosh, A. and Bhattacharya, K. A Text Book of Botany (Vols. I, II & III), 2007, New Central Book Agency

9. Lock, A.J., & Evans, D.E., Plant Biology, 2001, Viva Books

10. Mitra, D., Guha, J. &Chowdhuri, S.K. Studies in Botany (Vols. I & II), Latest Ed., Das Printers

11. Chatterjee, T., Santra,S.C. and Das, A. Practical College Botany, New Central Book Agency

**IDC**(To be opted in 1st or 2nd or 3rd semester)

**INTEGRATIVE PALYNOLOGY (THEORY)**

**Total marks 50; Credits 2, Class 30 hours**

1. Basics of Palynology: 1.1 Morphology: Palynomorphs- Pollen- symmetry, shape, aperture, exine stratification and ornamentation; Non-pollen (phytoliths)- morphology, types; Major branches of palynology- neo and palaeopalynology; 1.2 Pollen adaptation, viability and storage: Pollen adaptation- pollen wall and harmomegathic adaptation, adaptation to habitat, adaptation to mode of pollination, pollen viability and storage- causes for loss of pollen viability, factors controlling pollen viability, test for pollen viability, types and significance of pollen storage.

(9 lectures)

2. Pollination biology and apiculture: 2.1 Types of pollination, pollinator groups and floral syndromes, floral attractants and rewards, pollination threats, pollen-pistil interactions and its significance; 2.2 Nectar and its transformation into honey; bee pasturage, common Indian bee plants; 2.3 Pollen analysis of honey: determination of floral source, unifloral/ bifloral/ multifloral, geographical origin, absolute pollen count, adulteration, honey quality and gradation (ICBB).

(6 lectures)

3. Past vegetation, environment analysis, hydrocarbon exploration and archaeobotany:

3.1 Palaeopalynology in biostratigraphic correlation, palaeoenvironment and depositional facies analysis of fossil fuel hydrocarbons, palaeo-shore line detection. 3.2 Application of phytoliths- domestication of crop plants from wild ancestors (rice and maize); past vegetation and environment reconstruction.

(6 lectures)

4. Human health and Forensic science:

4.1 Immunobiology: Basic mechanism of spore/pollen allergy, 4.2 common spore/pollen allergies, 4.3 Aeroallergens-common pollen-allergy causing plants of India, important pollen allergens and their chemical nature, 4.4 Trapping of airborne pollen grains- Rotorod and Burkard Volumetric Samplers, basic tests for diagnosis– skin testing (Prick test), Radio-Immuno Assay- RAST; ELISA and treatment of allergy, 4.5 Pharmaceuticals: Brief idea of pollen grains as source of health food, medicine and cosmetics; 4.6 Pollen grains as associative evidence; sources- soil, clothing and foot wear, vehicles, human bodies, animal fur and spider-web, 4.7 Limitations of forensic palynology.

(6 lectures)

5. Biotechnology:

5.1 Development of efficient pollination control system-cytoplasmic and genetic male sterility, self-incompatibility, pollen sterility by rDNA technology 5.2 Use of pollen for genetic transformation, 5.3 Pollen storage to overcome post-fertilization barriers, food security and gene pollution.

(3 lectures)

## INTEGRATIVE PALYNOLOGY (PRACTICAL)

**Total marks 25; Credit 1, Class 30 hours**

1. Work out: 15 marks
2. Class room performance (Practical notebook) 5 marks
3. Viva-voce 5 marks

1. Study of pollen type- pollen morphology (aperture and exine ornamentation).
2. Palynological study of honey sample and detection of type of honey (uni-, bi- or multi-floral)
3. Study of pollens in modern sediments.
4. Study of allergic pollens (*Parthenium*, *Cheno-Amaranthus*, *grasses, Carica papaya, Cocos nucifera*).
5. Determination of viability of pollen grains by tetrazolium test.

**Textbook References:**

1. Erdtman, G. Pollen Morphology & Plant Taxonomy, Latest Ed., Lelden, E.G. Brill
2. Faegri, K. & Iversen, Text Book of Pollen Analysis, Latest Ed., Munksgor, Copenhagen
3. Nair, P.K. Pollen Morphology of Angiosperms, Latest Ed., Scholar Publications
4. Shivanne, K.H. Pollen Biology & Biotechnology, 2003, Oxford & IBH
5. Bhattacharya, K., Majumdar, M.R. & Gupta Bhattacharya, S. A Text Book of Palynology, 2006, New Central Book Agency.
6. Abrol, D. P. Pollination Biology- Biodiversity Conservation and Agricultural Production, Springer
7. Willmer, P. Pollination and floral ecology, 2011, Princeton University Press
8. Hughes, B. Pollination Biology and Ecology, Syrawood Publication
9. Ollerton, J. Pollinators and Pollination, Pelagic Publication
10. Piperno, D.R. Phytoliths- A comprehensive guide for archaeologists and paleoecologists, 2006, AltaMira Press

**SEC**

**MUSHROOM CULTIVATION TECHNOLOGY (THEORY)**

**BOT-H-SEC-1-Th**

**Total marks 75; Credits 3, Class 45 hours**

1. 1.1 Introduction, History of mushroom cultivation,1.2 Current overview of mushroom production in the world, 1.3 Mushroom biology-classification of mushrooms, edible mushrooms in India, poisonous mushrooms,mushroom poisoning.

(6 lectures)

2. 2.1 Infrastructure-structural design and layout of mushroom farm, substrates (locally available), 2.2 Appliances- weighing balance, autoclave, laminar air flow, incubator,hot air oven, spirit lamp, bunsen burner, pH meter,laboratory heater, low-cost stoves, water bath, humidifier, water sprayer,vessels, inoculation hook and inoculation loop, sieves, culture racks,tray,polythene bags, 2.3 Methods of sterilization.

(9 lectures)

3. 3.1 Cultivation technology-overview of cultivation strategies,composting technology in mushroom production,mushroom bed preparation,culture media,pure culture, maintenance and preservation of pure culture, 3.2Production of spawn- cultivation of oyster mushroom, paddy-straw mushroom, milky mushroom and white button mushroom, 3.3 Cultivation of medicinal mushroom (Cordyceps and Ganoderma).

(12 lectures)

4. 4.1 Mushroom diseases and management strategies, 4.2 Post-harvest technology-short-term storage (Refrigeration- up to 24 hours), long-term storage (canning, pickles, papadsetc.), drying, storage in salt solutions, 4.3 Food preparations from mushrooms.

(9 lectures)

5. 5.1 Uses of spent mushroom substrate, 5.2Strain improvements in cultivated mushroom; Nutritional and medicinal value of edible mushrooms, 5.3 Research centres- National level and regional level, 5.4 Cost-benefit ratio, 5.5Mushroom based Industry, 5.6 Mushroom market in India and abroad.

(9 lectures)

**MUSHROOM CULTIVATION TECHNOLOGY (PRACTICAL)**

**BOT-H-SEC-1-P**

**Total marks 25; Credits 1, Class 30 hours**

| | | |
|---|---|---|
| 1. | Work out: | 15 marks |
| 2. | Class room performance (Practical notebook) | 5 marks |
| 3. | Viva-voce | 5 marks |

1. Macro and microscopic identification of some common edible mushrooms (*Agaricus*, *Pleurotus*)
2. Media preparation
3. Fungal tissue culture
4. Sub-culturing for maintenance of culture
5. Spawn production
6. Cultivation of Pleurotus/Calocybe

**Textbook Reference:**

1. Acharya,K., Roy, A. &Sarkar, J. Mushroom Cultivation Technology, 2020, Techno World, Kolkata.
2. Marimuthu, T., Krishnamoorthy, A. S., Sivaprakasam, K. &Jayarajan, R. Oyster Mushrooms, 1991, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.
3. Swaminathan, M. Food and Nutrition, 1990, Bappco, The Bangalore Printing & Publishing Co. Ltd.
4. Tewari, P. &Kapoor, S.C. Mushroom Cultivation, 1988, Mittal Publications, Delhi
5. Bahl, N. Handbook of Mushrooms, Ed. II, Vol I & Vol II

# Semester 2

**DSC/Core**
**PLANT SYSTEMATICS (THEORY)**
**BOT-H-CC2-2-Th**
**Total marks 75; Credits 3, Class 45 hours**

1. Introduction:

Components of Systematics: Nomenclature, Identification, Classification; 1.2. Taxonomy and its phases - Pioneer, Consolidation, Biosystematic and Encyclopaedic; alpha- and omega- taxonomy, 1.3 Nomenclature: Type method, Publication, Rank of taxa, Rules of priority, Retention and rejection of names, Author Citation, Effective and valid publication, Elementary knowledge of ICN- Principles.

(10 lectures)

2. Systems of classification:

2.1 Broad outline of Bentham & Hooker (1862-1883) and Takhtajan (1997)- systems of classification with merits and demerits. Brief idea of angiosperm phylogeny group (APG IV classification), 2.2 Systematics in Practice: Herbaria and Botanic Gardens – their role in teaching and research; 2.3. Dichotomous keys – indented and bracketed. 2.4 Brief idea on Phenetics and cladistics: Monophyletic, polyphyletic and paraphyletic groups; Plesiomorphy and apomorphy; 2.5 Numerical taxonomy- methods and significance;

2.6 Data sources in Taxonomy: Supportive evidences from Phytochemistry, Cytology, Palynology and Molecular biology data (Protein and Nucleic acid homology).

(20 lectures)

3. Systematic study of angiosperm taxa: Diagnostic features, systematic position (Bentham & Hooker) and economically important plants (parts used and uses) of the following families:

3.1. Monocotyledons: Alismataceae, Gramineae (Poaceae), Cyperaceae, Palmae (Arecaceae), Liliaceae, Musaceae, Zingiberaceae, Cannaceae, Orchidaceae.

3.2. Dicotyledons: Nymphaeaceae, Magnoliaceae, Ranunculaceae, Leguminosae (subfamilies), Euphorbiaceae, Malvaceae, Umbelliferae (Apiaceae), Labiatae (Lamiaceae), Cruciferae (Brassicaceae), Solanaceae, Scrophulariaceae, Acanthaceae, Rubiaceae, Cucurbitaceae, Compositae (Asteraceae).

(15 lectures)

**PLANT SYSTEMATICS**
**PRACTICAL** (BOT-H-CC2-2-P)
**Total marks 25; Credit 1, Class 30 hours**

| | | |
|---|---|---|
| 1. | Work out on angiosperms | 10 marks |
| 2. | Spot Identification | 3 marks |
| 3. | Class room performance (Practical notebook) | 2 marks |
| 4. | Field records (field notebook, herbarium specimens) | 5 marks |
| 5. Viva-voce | | 5 marks |

ANGIOSPERMS

1. Work out, description, preparation of floral formula and floral diagram, identification up to genus with the help of suitable literature of wild plants and systematic position according to Benthum and Hooker system of classification from the following families: Malvaceae, Leguminosae (Papilionaceae), Solanaceae, Scrophulariaceae, Acanthaceae, Labiatae (Lamiaceae), Rubiaceae.

2. Spot identification (Binomial, Family) of common wild plants from families included in the theoretical syllabus .

FIELD WORK

At least three excursions including one excursion to Acharya Jagadish Chandra Bose Indian Botanic Garden (Shibpur, Howrah) and one to Central National Herbarium (CNH).

FIELD RECORDS

1. Field Note Book (authenticated) with field notes on the plants of the area of excursion and voucher specimen book.

2. Herbarium specimens: Preparation of 20 angiospermic specimens (identified with author citation, voucher number and arranged following Bentham and Hooker system of classification) to be submitted during examination.

**Textbook References:**

1. Paria, N.D., Plant Taxonomy & Biodiversity, 2022, Santra Publication Pvt. Ltd.

2. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. and Donoghue, M.J. Plant Systematics, A Phylogenetic Approach (4th ed.), 2016, SinauerAssociaties, Inc.

3. Jones, S.B. and Luchsinger, A.E. Plant Systematics (2nd ed.), 1987, McGraw Hill Book Company

4. Singh, G. Plant Systematics: An Integrated Approach (3rd ed.), 2016, CRC Press

5. Sambamurty, A.V.S.S. Taxonomy of Angiosperms, 2005, I.K. International Pvt. Ltd.

6. Sivaranjan, V.V. Principles of Plant Taxonomy (2nd ed.), 1991, Oxford & IBH

7. Subrahmanyam, N.S. Modern Plant Taxonomy, Latest Ed., Vikas Publishing House

8. Naik, V.N. Taxonomy of Angiosperms, Latest Ed., Tata McGraw Hill

9. Stace, C. A Plant Taxonomy & Biosystematics, Latest Ed., Arnold Publishers

10. Mitra, J.N. An Introduction to Systematic Botany & Ecology, Latest Ed., World Press

11. Dutta, S.C. Systematic Botany, Latest Ed., Wiley Eastern.

12. Lawrence, G.H.M. Taxonomy of Vascular Plants Ed., Oxford & IBH.

13. Prain, D. Bengal Plants (Vol I & II), Bishen Singh Mahendra Pal Singh.

14. Jeffrey, C. An Introduction to Plant Systematics, Latest Ed., Allied Publishers Pvt. Ltd.

15. Radford. A.B. Fundumentls of Plant Systematics, Latest Ed., Harper & Row.

16. Simpson, G. Plant Systematics, 2006, 2010, 2019, Springer.

17. Bhattacharya, B. Systematic Botany, 2006, Narosa Publishing House.

18. Heywood, V.H. Plant Taxonomy 1967, Edward Arnold, London.

19. Cronquist, A. The Evolution & Classification of Flowering Plant, 1988 (2nd ed.), New York Bot. Garden Bronx. New York.

20. Cronquist, A. An Integrated System of Classification of Flowering Plants.1981. Bishen Singh Mahendra Pal Singh.

21. Subramanyam, N.S. Laboratory Manual of Plant Taxonomy (2nd ed.) 1999, Vikas Publishing House.

22. Heywood, V.H. Flowering Plants of the World 1978, Oxford University Press.

**SEC**
**BIOFERTILIZERS AND BIOPESTICIDES (THEORY)**
**BOT-H-SEC-2-Th**
**Total marks 75; Credits 3, Class 45 hours**

1. 1.1 General account and components of organic farming; microbes used as biofertilizers, general account on mass production of biofertilizers; 1.2 Manure- Green manuring and organic fertilizers;types and methods of composting; vermicompost and field applications; recycling of biodegradable municipal, agricultural and industrial wastes.

(6 lectures)

2. Nitrogen fixing bacteria as biofertilizers: 2.1 Rhizobium- Isolation, identification, mass multiplication, carrier-based inoculant formulation, filed application; 2.2 Azospirillum- Isolation, carrier-based inoculants, mass multiplication, associative effect of different microorganisms; 2.3 Azotobacter- Classification, characteristics, crop response to Azotobacter inoculants, maintenance and mass multiplication.

(9 lectures)

3. 3.1 Cyanobacteria (Blue green algae), Azolla and Anabaena azollae association, nitrogen fixation,factors affecting growth, blue green algae and Azolla in rice cultivation. 3.2 Actinorhizal symbiosis- Actinorhizal plants, infection process, isolation of Frankia.

(6 lectures)

4. Mycorrhizal association- 4.1 Types of mycorrhizal association, phosphorus nutrition, growth and yield; 4.2 colonization of VAM – isolation and inoculum production of VAM and its influence on growth and yield of crop plants.

(6 lectures)

5. 5.1 Phosphate, Potash and Zinc Solubilizing Microbes- Isolation, characterization, mass production, field application; 5.2 Plant Growth Promoting Rhizobacteria (PGPR) as biofertilizers, mode of action of PGPR.

(6 lectures)

6. Biopesticides – 6.1 Introduction; General features of potential biopesticides; Prospect and limitation; 6.2 Trichoderma: Isolation, mass production, formulation, quality control and field application; 6.3 Pseudomonas- Isolation, beneficial Pseudomonas strains in agriculture, mode of action; 6.4 Fungi as bioinsecticide- Metarhizium anisopliae, Beauveria bassiana and Verticillium lecanii-overview, mode of action and use in agriculture; 6.5 Nematophagous fungi-overview, mode of action;

6.6 Bacteria as bioinsecticide- Bacillus thuringiensis -Characterization, mass production and field application; 6.7 Virus as bioinsecticide- Baculovirus- characterization, bioformulation, mass production and field application.

(12 lectures)

**BIOFERTILIZERS AND BIOPESTICIDES (PRACTICAL)**
**BOT-H-SEC-2-P**
**Total marks 25; Credit 1, Class 30 hours**

1. Work out: 15 marks
2. Class room performance (Practical notebook) 5 marks
3. Viva-voce 5 marks

1. Preparation of selective media for isolation of Azotobacter, phosphate- solubilizing microbes and Trichoderma.
2. Isolation and identification of phosphate-solubilizing fungi.
3. Study of Arbuscular Mycorrhizal fungi.
4. Isolation of Azotobacter and Trichoderma from the soil.
5. Evaluation of in vitro antagonistic activity of Trichoderma species in the dual culture system.

**Textbook reference**

1. Acharya, K., Sen, S. & Rai, M. Biofertilizers and Biopesticides, 2019, Techno World, Kolkata.
2. Sathe,T.V. Vermiculture and Organic Farming 2004. Daya Publishers.
3. Subha Rao, N. S. Soil Microbiology, 2000, Oxford & IBH Publishers, New Delhi.

4. Vayas, S.C. Vayas, S. & Modi, H.A Bio-fertilizers and organic Farming, 1998, Akta Prakashan, Nadiad

5. Kannaiyan, S. Biotechnology of Biofertilizers, 2003, CHIPS, Texas.

6. Rai, M.K. Hand book of Microbial Biofertilizers, 2005, The Haworth Press, Inc. New York

7. Sahayaraj, K. Basic and Applied Aspects of Biopesticides, Springer India, 2014

8. Bailey, A. Chandler, D. Grant, W.P. Greaves, J. Prince, G. Biopesticides- Pest Management and Regulation, CABI, 2010

9. Kaushik, B. D. Kumar, D. Shamim, M. Biofertilizers and Biopesticides in Sustainable Agriculture, Apple Academic Press, 2019

**UNIVERSITY OF CALCUTTA**

**Course Structure- 3 yr MDC (NEP 2020)**

**BOTANY**

| Semester | CC1 | CC2 | Minor | IDC | AEC | SEC | CVAC | Summer Internship | Credit |
|---|---|---|---|---|---|---|---|---|---|
| **Level 100** | | | | | | | | | |
| 1 | BOT-MD-CC1-1-Th<br>BOT-MD-CC1-1-P<br>Plant Diversity | | | Biostatistics*<br>(Th+Pr) | | BOT-MD-SEC-1-Th<br>BOT-MD-SEC-1-P<br>Mushroom Cultivation Technology***<br>(Th+Pr) | 1.ENVS<br>2.CV | | 21 |
| 2 | BOT-MD-CC2-2-Th<br>BOT-MD-CC2-2-P<br>Plant Systematics | | | | | | 1.ENVS<br>2.Central Pool | Summer Internship ** | 21 |
| ***Exit option*** | | | | | | | | | |
| **Level 200** | | | | | | | | | |
| 3 | BOT-MD-CC3-3-Th<br>BOT-MD-CC3-3-P<br>Economic Botany | | Plant Diversity<br>(Th+Pr) | | | | | | 21 |
| 4 | BOT-MD-CC4-4-Th<br>BOT-MD-CC4-4-P<br>Pharmacognosy & Ethnobotany | | Plant Systematics<br>(Th+Pr) | | | | | Summer Internship** | 22 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | BOT-MD-CC5-4-Th<br>BOT-MD-CC5-4-P<br>Plant Geography, Ecology & Evolution | | | | | | | | |
| ***Exit option*** | | | | | | | | | |
| **Level 300** | | | | | | | | | |
| 5 | BOT-MD-CC6-5-Th<br>BOT-MD-CC6-5-P<br>Plant anatomy & Embryology<br><br>BOT-MD-CC7-5-Th<br>BOT-MD-CC7-5-P<br>Cell Biology & Genetics | | Economic Botany (Th+Pr)<br><br>Pharmacognosy & Ethnobotany (Th+Pr) | | | | | | 20 |
| 6 | BOT-MD-CC8-6-Th<br>BOT-MD-CC8-6-P<br>Plant Physiology & Biochemistry | | Cell Biology & Genetics (Th+Pr)<br><br>Plant Physiology & Biochemistry (Th+Pr) | | | | | Summer Internship** | 20 |
| **Credits** | **8**×4=32 | **8**×4=32 | **6**×4=24 | **3**×3=9 | **4**×2=8 | **3**×4=12 | **4**×2=8 | **1**×3=3 | **128** |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Marks** | **8**×100=800 | **8**×100=800 | **6**×100=600 | **3**×75=225 | **4**×50 =200 | **3**×100=300 | **4**×50=200 | | **Total Marks = 3200** |

**Marks = 25 marks per credit.**
**Total credit = 125 + 3 (for summer internship) = 128**
*** IDC offered from Botany to be opted in 1st or 2nd or 3rd Semester**
****Summer Internship once after 2nd or 4th or 6th Semester.**
*****SEC to be opted in 1st or 2nd or 3rd Semester.**

**UNIVERSITY OF CALCUTTA**
**Course Structure- 3yr MDC (NEP 2020)**

**BOTANY SYLLABUS**

# Semester 1

**Core**
**PLANT DIVERSITY (THEORY)**
**BOT-MD-CC1-1-Th**
**Total marks 75; Credits 3, Class 45 hours**

## 1. Introduction to plant kingdom.

1.1 Origin of life and evolution of plant cells, 1.2 Importance of plants as source of food, fuel and their role in ecosystem services (as carbon sink, sequestering etc.)

(3 lectures)

## 2. Algae

2.1. Salient features of Cyanophyceae, Chlorophyceae, Charophyceae, Phaeophyceae, Rhodophyceae and Bacillariophyceae 2.2 Criteria and system of classification (Fritsch, 1935) 2.3. Economic importance of algae in environment, agriculture, biotechnology and industry.

(6 lectures)

## 3. Fungi

3.1 Salient features of Myxomycota, Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina, Deuteromycotina. 3.2 System of classification up to Sub-division (Ainsworth, 1973), 3.3 Economic importance of fungi (food, medicine and agriculture), 3.4 Fungal symbioses: Mycorrhiza, Lichen and their importance.

(6 lectures)

## 4. Bryophytes

4.1 Salient features of Hepaticopsida, Anthocerotopsida and Bryopsida, 4.2. System of classification up to Class (Proskauer 1957), 4.3 Amphibian nature of bryophytes, 4.4 Economic and ecological importance.

(6 lectures)

**5. Pteridophytes**

5.1 Salient features of Psilophyta, Lycophyta, Sphenophyta and Filicophyta, 5.2 System of classification up to Division (Gifford & Foster 1989), 5.3 Economic importance (food, medicine & agriculture).

(6 lectures)

**6. Gymnosperms**

6.1 Salient features of Cycadophyta, Coniferophyta and Gnetophyta, 6.2 Outline classification up to Division: Progymnospermophyta to Gnetophyta (Gifford & Foster 1989), 6.3 Economic importance (wood, resin, essential oil & drugs).

(6 lectures)

**7. Angiosperms**

7.1 Types and morphology of leaf, stem and root, 7.2 Inflorescence types with examples, 7.3 Flower: Different parts and forms of calyx, corolla, androecium and gynoecium; aestivation and placentation, 7.4 Types with examples-fruits and seeds.

(12 lectures)

**PLANT DIVERSITY (PRACTICAL)**
**BOT-MD-CC1-1-P**
**Total marks 25; Credit 1, Class 30 hours**

| | | |
|---|---|---|
| **1.** | **Work out: Morphology** | **10 marks** |
| **2.** | **Identification with reasons (other groups except angiosperms)** | **5 marks** |
| **3.** | **Class room performance (Practical notebook)** | **3 marks** |
| **4.** | **Field notebook** | **2 marks** |
| **5.** | **Viva-voce** | **5 marks** |

1. Flower- dissection, drawing and study
   a) Different parts, b) Adhesion and cohesion, c) Placentation, d) Aestivation
2. Study of ovules: types (Fresh specimens/ permanent slides/ photographs)
3. Fruits:different types- study from fresh/ preserved specimens
4. Inflorescence types: study from fresh/ preserved specimens
5. Identification on the basis of reproductive and structural features from preserved specimens/ permanent slides: Algae (*Nostoc*, *Oedogonium* and *Ectocarpus*), Fungi (*Rhizopus*, *Ascobolus* and *Agaricus*), Bryophytes (*Marchantia*, *Anthoceros* and *Funaria*), Pteridophytes (*Selaginella*, *Equisetum* and *Pteris*), Gymnosperms (male cone and female cone/ megasporophyll of *Cycas, Pinus* and *Gnetum*).
6. A field notebook supported with photographs taken during field study to be submitted giving comprehensive idea about different types of inflorescence, flowers and fruits.

**Textbook Reference:**

1. Ganguli,H.C., Das, K.S.K. & Dutta, C.T. College Botany, Vol. I, latest Ed., New Central Book Agency

2. Ganguli,H.C. and Kar, A.K. College Botany, Vol. II, latest Ed., New Central Book Agency

3. Mukherjee, S. College Botany, Vol. III, latest Ed., New Central Book Agency

4. Uno, Storey& Moore, Principles of Botany, 2001, McGraw Hill.

5. Kenrick,P. & Crane, P. The Origin & early diversification of land plants (1997), Smithsonian Institute Press.

6. Bell, P.R. & Hensley, A.R. Green plants; their Origin & Diversity (2nd ed.), 2000, Cambridge University Press

7. Frenchel, T. The origin & early Evolution of life, 2002, Oxford University Press.

8. Hait, G., Ghosh, A. and Bhattacharya, K. A Text Book of Botany (Vols. I, II & III), 2007, New Central Book Agency

9. Lock, A.J., & Evans, D.E., Plant Biology, 2001, Viva Books

10. Mitra, D., Guha, J. &Chowdhuri, S.K. Studies in Botany (Vols. I & II), Latest Ed., Das Printers

11. Chatterjee, T., Santra,S.C. and Das, A. Practical College Botany, New Central Book Agency

**IDC (To be opted in 1st or 2nd or 3rd Semester)**
**BIOSTATISTICS (Theory)**
**Total marks- 75, Credits 3, Class 45 hours**

1. **Biostatistics and Biometry:** Basics- Definition, statistical methods, basic principles, variables- measurements, functions, limitations and uses of statistics; Data, Sample, Population, Random sampling, Frequency distribution: Normal, Binomial and Poisson distribution.

(8 lectures)

2. **Central tendency:** Arithmetic Mean, Mode and Median; Measurement of dispersion- Coefficient of variation, Standard Deviation, Standard error of Mean.

(10 lectures)

3. **Test of significance:** Chi-square test for goodness of fit and Students' t test, Calculation of 'F' value and finding out the probability value for the 'F' value.

(12 lectures)

4. **Correlation coefficient:** Calculations of 'r' values and finding out the probability.

(3 lectures)

5. **Probability:** multiplicative and additive rules of probability: application and importance.

(5 lectures)

6. **Measurement of gene frequency:** Hardy-Weinberg equilibrium- conditions applied for its implications (simple numerical problems to calculate genotypic and allelic frequencies).

(7 lectures)

**BIOSTATISTICS (Practical)**
**Total marks-25, Credit 1, Class 30 hours**

| | |
|---|---|
| **1. Workout** | **15 marks** |
| **2. Classroom performance** | **5 marks** |
| 3. **Viva** | **5 marks** |

1. Univariate analysis of statistical data: Statistical tables, mean, mode, median, standard deviation and standard error (using seedling population/ leaflet size), graphical representation of the data (frequency polygon, bar diagram, histogram).
2. Calculation of correlation coefficient values and finding out the probability.
3. Determination of goodness of fit in Mendelian mono-and dihybrid ratios (3:1, 1:1, 9:3:3:1, 1:1:1:1) by Chi-square analysis and comment on the nature of inheritance.
4.Calculation of 'F' value and finding out the probability for the F value.

**Textbook references**


1. Chap, T. Le. Introductory Biostatistics, Wiley Publications.
2. Barley, N.T.J. Statistical Methods in Biology, Latest Ed., Cambridge University Press
3. Zar, J.H. Biostatistical Analysis (3rd ed.), 1996, Prentice Hall.
4. Kar, D.K. and Halder, S. Plant Breeding & Biometry, 2006, New Central Book Agency.
5. Prasad, S. Elements of Biostatistics, Rastogi Publications (Current Ed.)
6. Datta, A.K. Basic Biostatistics and its applications, New Central Book Agency (P) Ltd.
7. Banerjee, P.K. Introduction to Biostatistics, S. Chand and Company Pvt. Ltd.
8. Singh, B.D. Plant breeding, Principles and methods (7th Ed.) 2005. Kalyani Publishers.

**SEC (To be opted in 1st or 2nd or 3rd Semester)**

**MUSHROOM CULTIVATION TECHNOLOGY (THEORY)**

**BOT-MD-SEC-1-Th**

**Total marks 75; Credits 3, Class 45 hours**

1. 1.1 Introduction, History of mushroom cultivation,1.2 Current overview of mushroom production in the world, 1.3 Mushroom biology-classification of mushrooms, edible mushrooms in India, poisonous mushrooms, mushroom poisoning.

(6 lectures)

2. 2.1 Infrastructure-structural design and layout of mushroom farm, substrates (locally available), 2.2 Appliances- weighing balance, autoclave, laminar air flow, incubator, hot air oven, spirit lamp, Bunsen burner, pH meter, laboratory heater, low-cost stoves, water bath, humidifier, water sprayer, vessels, inoculation hook and inoculation loop, sieves, culture racks, tray, polythene bags, 2.3 Methods of sterilization.

(9 lectures)

3. 3.1 Cultivation technology-overview of cultivation strategies, composting technology in mushroom production, mushroom bed preparation, culture media, pure culture, maintenance and preservation of pure culture, 3.2Production of spawn- cultivation of oyster mushroom, paddy-straw mushroom, milky mushroom and white button mushroom, 3.3 Cultivation of medicinal mushroom (Cordyceps and Ganoderma).

(12 lectures)

4. 4.1 Mushroom diseases and management strategies, 4.2 Post-harvest technology-short-term storage (Refrigeration- up to 24 hours), long-term storage (canning, pickles, papads etc.), drying, storage in salt solutions, 4.3 Food preparations from mushrooms.

(9 lectures)

5. 5.1 Uses of spent mushroom substrate, 5.2Strain improvements in cultivated mushroom; Nutritional and medicinal value of edible mushrooms, 5.3 Research centres- National level and regional level, 5.4 Cost-benefit ratio, 5.5Mushroom based Industry, 5.6 Mushroom market in India and abroad.

(9 lectures)

**MUSHROOM CULTIVATION TECHNOLOGY (PRACTICAL)**
**BOT-MD-SEC-1-P**
**Total marks 25; Credits 1, Class 30 hours**

| | | |
|---|---|---|
| 1. | Work out: | 15 marks |
| 2. | Class room performance (Practical notebook) | 5 marks |
| 3. | Viva-voce | 5 marks |

1. Macro and microscopic identification of some common edible mushrooms (*Agaricus*, *Pleurotus*)
2. Media preparation
3. Fungal tissue culture
4. Sub-culturing for maintenance of culture
5. Spawn production
6. Cultivation of *Pleurotus*/*Calocybe*

**Textbook Reference:**

1. Acharya,K., Roy, A. &Sarkar, J. Mushroom Cultivation Technology, 2020, Techno World, Kolkata.
2. Marimuthu, T., Krishnamoorthy, A. S., Sivaprakasam, K. &Jayarajan, R. Oyster Mushrooms, 1991, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.
3. Swaminathan, M. Food and Nutrition, 1990, Bappco, The Bangalore Printing & Publishing Co. Ltd.
4. Tewari, P. &Kapoor, S.C. Mushroom Cultivation, 1988, Mittal Publications, Delhi
5. Bahl, N. Handbook of Mushrooms, Ed. II, Vol I & Vol II

**Semester 2**
**Core**
**PLANT SYSTEMATICS (THEORY)**
**BOT-MD-CC2-2-Th**
**Total marks 75; Credits 3, Class 45 hours**

1. Introduction:

Components of Systematics: Nomenclature, Identification, Classification; 1.2. Taxonomy and its phases - Pioneer, Consolidation, Biosystematic and Encyclopaedic; alpha- and omega- taxonomy, 1.3 Nomenclature: Type method, Publication, Rank of taxa, Rules of priority, Retention and rejection of names, Author Citation, Effective and valid publication, Elementary knowledge of ICN- Principles.

(10 lectures)

2. Systems of classification:

2.1 Broad outline of Bentham & Hooker (1862-1883) and Takhtajan (1997)- systems of classification with merits and demerits. Brief idea of angiosperm phylogeny group (APG IV classification), 2.2 Systematics in Practice: Herbaria and Botanic Gardens – their role in teaching and research; 2.3. Dichotomous keys – indented and bracketed. 2.4 Brief idea on Phenetics and cladistics: Monophyletic, polyphyletic and paraphyletic groups; Plesiomorphy and apomorphy; 2.5 Numerical taxonomy-methods and significance;

2.6 Data sources in Taxonomy: Supportive evidences from Phytochemistry, Cytology, Palynology and Molecular biology data (Protein and Nucleic acid homology).

(20 lectures)

3. Systematic study of angiosperm taxa: Diagnostic features, systematic position (Bentham & Hooker) and economically important plants (parts used and uses) of the following families:

3.1. Monocotyledons: Alismataceae, Gramineae (Poaceae), Cyperaceae, Palmae (Arecaceae), Liliaceae, Musaceae, Zingiberaceae, Cannaceae, Orchidaceae.

3.2. Dicotyledons: Nymphaeaceae, Magnoliaceae, Ranunculaceae, Leguminosae (subfamilies), Euphorbiaceae, Malvaceae, Umbelliferae (Apiaceae), Labiatae (Lamiaceae), Cruciferae (Brassicaceae), Solanaceae, Scrophulariaceae, Acanthaceae, Rubiaceae, Cucurbitaceae, Compositae (Asteraceae).

(15 lectures)

**PLANT SYSTEMATICS (PRACTICAL)**
**BOT-MD-CC2-2-P**
**Total marks 25; Credit 1, Class 30 hours**

| | | |
|---|---|---|
| 1. | Work out on angiosperms | 10 marks |
| 2. | Spot Identification | 3 marks |
| 3. | Class room performance (Practical notebook) | 2 marks |
| 4. | Field records (field notebook, herbarium specimens) | 5 marks |
| 5. Viva-voce | | 5 marks |

ANGIOSPERMS

1. Work out, description, preparation of floral formula and floral diagram, identification up to genus with the help of suitable literature of wild plants and systematic position according to Benthum and Hooker system of classification from the following families: Malvaceae, Leguminosae (Papilionaceae), Solanaceae, Scrophulariaceae, Acanthaceae, Labiatae (Lamiaceae), Rubiaceae.

2. Spot identification (Binomial, Family) of common wild plants from families included in the theoretical syllabus .

FIELD WORK

At least three excursions including one excursion to Acharya Jagadish Chandra Bose Indian Botanic Garden (Shibpur, Howrah) and one to Central National Herbarium (CNH).

FIELD RECORDS

1. Field Note Book (authenticated) with field notes on the plants of the area of excursion and voucher specimen book.

2. Herbarium specimens: Preparation of 20 angiospermic specimens (identified with author citation, voucher number and arranged following Bentham and Hooker system of classification) to be submitted during examination.

**Textbook References:**

1. Paria, N.D., Plant Taxonomy & Biodiversity, 2022, Santra Publication Pvt. Ltd.

2. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. and Donoghue, M.J. Plant Systematics, A Phylogenetic Approach (4th ed.), 2016, SinauerAssociaties, Inc.

3. Jones, S.B. and Luchsinger, A.E. Plant Systematics (2nd ed.), 1987, McGraw Hill Book Company

4. Singh, G. Plant Systematics: An Integrated Approach (3rd ed.), 2016, CRC Press

5. Sambamurty, A.V.S.S. Taxonomy of Angiosperms, 2005, I.K. International Pvt. Ltd.

6. Sivaranjan, V.V. Principles of Plant Taxonomy (2nd ed.), 1991, Oxford & IBH

7. Subrahmanyam, N.S. Modern Plant Taxonomy, Latest Ed., Vikas Publishing House

8. Naik, V.N. Taxonomy of Angiosperms, Latest Ed., Tata McGraw Hill

9. Stace, C. A Plant Taxonomy & Biosystematics, Latest Ed., Arnold Publishers

10. Mitra, J.N. An Introduction to Systematic Botany & Ecology, Latest Ed., World Press

11. Dutta, S.C. Systematic Botany, Latest Ed., Wiley Eastern.

12. Lawrence, G.H.M. Taxonomy of Vascular Plants Ed., Oxford & IBH.

13. Prain, D. Bengal Plants (Vol I & II), Bishen Singh Mahendra Pal Singh.

14. Jeffrey, C. An Introduction to Plant Systematics, Latest Ed., Allied Publishers Pvt. Ltd.

15. Radford. A.B. Fundumentls of Plant Systematics, Latest Ed., Harper & Row.

16. Simpson, G. Plant Systematics, 2006, 2010, 2019, Springer.

17. Bhattacharya, B. Systematic Botany, 2006, Narosa Publishing House.

18. Heywood, V.H. Plant Taxonomy 1967, Edward Arnold, London.

19. Cronquist, A. The Evolution & Classification of Flowering Plant, 1988 (2nd ed.), New York Bot. Garden Bronx. New York.

20. Cronquist, A. An Integrated System of Classification of Flowering Plants.1981. Bishen Singh Mahendra Pal Singh.

21. Subramanyam, N.S. Laboratory Manual of Plant Taxonomy (2nd ed.) 1999, Vikas Publishing House.

22. Heywood, V.H. Flowering Plants of the World 1978, Oxford University Press.

# UNIVERSITY OF CALCUTTA

## Notification No.CSR/35/2023

It is notified for information of all concerned that in terms of the provisions of Section 54 of the Calcutta University Act, 1979, (as amended), and, in exercise of her powers under 9(6) of the said Act, the Vice-Chancellor has, by an order dated 25.08.2023 approved that the **IDC** paper in the Syllabus of **Botany** (CSR/13/23, dt. 12.07.2023), are replaced by "Plants around us", as the new IDC paper for both the Four-year Honours & Three-year MDC courses of studies in **Botany** Syllabus under CCF,2022, under this University, as laid down in the accompanying pamphlet.

**The above shall take effect from the academic session 2023-2024 and onwards.**

31/8/2023

**SENATE HOUSE**

**Kolkata-700073**

**The 31st August, 2023**

**Prof.(Dr.) Debasis Das**

**Registrar**

## IDC in BOTANY (To be opted in 1st or 2nd or 3rd semester)

## PLANTS AROUND US (THEORY)

## Total marks 50; Credits 2, Class 30 hours

1. Introduction: 1.1 Introduction to plant groups: Algae, Bryophytes, Pteridophytes, Gymnosperms, Angiosperms (Monocot and Dicot); 1.2 Fungi -general characters; 1.3. Contributions of Theophrastus, Charak, Sushruta, Linnaeus, Mendel and J.C. Bose.

   (5 lectures)

   Plant body: 2.1 Plant cell and tissue; 2.2 Morphology of root, stem, leaf, flower, fruit and seed. (5 lectures)

2. Plants and ecosystem: 3.1 Phytodiversity and conservation; 3.2 Biodiversity hotspots of India; 3.3 Forest types in India; 3.4 Plant-based adaptations to climate change; 3.5 Concept of 'Carbon footprint'- role of plants in reducing carbon footprint.

   (5 lectures)

3. Plants and society: 4.1 Plants in day-to-day life (brief general information including uses)- major cereals (rice, wheat and maize); 4.2 pulses (mung and pea); 4.3 Oil (mustard and coconut); 4.4 Sugar (sugarcane and beet root); 4.5 Vegetables (potato, brinjal, ladies finger and spinach); 4.6 Fruits (apple, banana, guava, mango and jackfruit); 4.7 Beverages (tea, coffee, beer and wine); 4.8 Plants as timber (sal and teak); 4.9 Non-timber- energy (fossil and non-fossil), resin, honey and essential oil (lavender and citronella oil); 4.10 Fiber (jute and cotton); 4.11 Ornamental plants (rose, marigold, tuberose, gulmohar, jarul, kalanchoe); 4.12 Importance of bacteria (*Lactobacillus*, *E. coli* and *Rhizobium*) and Fungi (*Phytophthora*, *Agaricus* and *Penicillium*).

   (10 lectures)

4. Plants and human health: 5.1 Important medicinal plants and their uses- basak (*Justicia adhatoda*), ghritakumari (*Aloe vera*), cinchona (*Cinchona officinalis*), neem (*Azadirachta indica*), kalmegh (*Andrographis paniculata*), pudina (*Mentha arvensis*), tulsi (*Ocimum sanctum*), sarpagandha (*Rauvolfia serpentina*); 5.2 Plant-derived medicinal compounds and uses (Quinine, Reserpine, Vincristine, Curcumin, Gingerol).

   (5 lectures)

IDC for Honours and MDC

## PLANTS AROUND US (PRACTICAL)

### Total marks 25; Credit 1, Class 30 hours

| | |
|---|---|
| 1. Workout: Dissection of flower | 2+4 = 6 marks |
| 2. Identification | 3x3 = 9 marks |
| 3. Practical records/notebook | 5 marks |
| 4. Viva voce | 5 marks |

Identification: Morphological study plant specimens

Microscopic study – *Nostoc*, *Oedogonium* (with oogonium), *Rhizopus*, *Penicillium* (sporangiophore).

Macroscopic study – *Agaricus* (fruit body), *Marchantia* with gemma cup, antheridiophore/ archaegoniophore, Moss sporophyte, *Pteris* (fertile leaf/pinna), *Pinus* – male and female cone.

Fruits of tomato, peas, cucumber, citrus, apple & banana.

Work out of flower: Floral parts of *Hibiscus rosa-sinensis*, *Clitoria ternatea* & *Datura metel*.

**Textbook references:**


1. Studies in Botany (vol-I)- J.N.Mitra, Debabrata Mitra & Salil Chowdhury (Moulik Library)
2. A Textbook of Botany (Vol. I)- G. Hait, K. Bhattacharya & A. K. Ghosh (New Central Book Agency)
3. Udvid Bigyan (Vol-I) (Bengali)- S. Chowdhury, N. Datta, D. Mitra & J. Guha (Moulik Library)
4. College Botany (vol II)-H.C. Gangulee, A.K. Kar, S.C. Santra (New Central Book Agency)
5. Snatak Udvidbidya (Semester I)- Dr. Jayanta Kumar Sikdar, Dr. Kunal Sen, Dr. Pranab Giri (Santra Publication)

# UNIVERSITY OF CALCUTTA

## Notification No. CSR/43/2024

It is notified for information of all concerned that in terms of the provisions of Section 54 of the Calcutta University Act, 1979, (as amended), and, in the exercise of her powers under 9(6) of the said Act, the Vice-Chancellor has, by an order dated 10.07.2024 approved the syllabi for semester-3 & 4 of Botany for both 4-year Honours & Honours with Research and 3-year MDC courses of studies under CCF, 2022, which was introduced from the academic session 2023-2024.

The above shall take effect for Botany (4-year & 3-year) Courses of Studies under CCF which has been introduced from the academic Session 2023-2024.

19/7/2024

Prof.(Dr.) Debasis Das

Registrar

SENATE HOUSE

Kolkata-700073

19.07.2024

**University Of Calcutta**

**Course Structure – 4 years Honours + Research (NEP 2020)**

**BOTANY SYLLABUS**

**(Semester III)**

**DSC/Core**

**ECONOMIC BOTANY (THEORY)**

**BOT-H-CC3-3-Th**

**(Total Marks 75, Credits 3, Lectures 45 hours)**

1. **Origin of cultivated crops:** Concepts of centre of origin, their importance with reference to Vavilov's work. Examples of major plant introductions; crop domestication and loss of genetic diversity; evolution of new crops/ varieties, importance of germplasm diversity. **4 Lectures**

2. **Cereals, pulses, oils and rubber:**

2.1 Cereals: Rice, Wheat, Jowar and Bajra (cultivation, processing and uses), Millets as future cereals. Origin of Rice and Wheat. 2.2 Pulses and Legumes: Cultivation and uses of Gram, Mung Bean and Soyabean. Importance to man and environment, 2.3 Oil and fats: General description, Classification, Extraction, uses and health implications of Mustard, Groundnut, Sunflower, Coconut (Botanical name, family and uses). Essential oils- general account, extraction methods, comparison with fatty oils and their uses, 2.4 Rubber yielding plants: Para-rubber (*Hevea brasiliensis*), Assam rubber (*Ficus elastica*)- tapping, processing and uses, 2.5 Other natural rubber: Sources (Ceara rubber, Castilla rubber, Lagos silk rubber, Landolphia rubber, Guayule rubber, Dandelion rubber).

**12 Lectures**

3. **Sugar, starch, spices and beverages:**

3.1 Processing of sugarcane to products and byproducts. Extraction/ processing from Potato, Sugar beet and Palmyra palm. 3.2 Spices and condiments: Scientific names, family, economically important parts and uses of Ajwain, Cumin, Black Cumin, Mustard, Fenugreek, Coriander, Chillies, Bay leaf, Black Pepper, Cardamom (small and big), Clove, Cinnamon, Onion, Garlic and Ginger, 3.3 Beverages: Tea and coffee (plant habit, processing and uses).

**9 Lectures**

**4. Narcotics, timbers and fibres:**

4.1 Habit forming drugs with special reference to Poppy, *Cannabis* and Tobacco (processing, uses and health hazards), 4.2 Timber: General account with special reference to Sal, Teak, Mahogany and Sissoo, 4.3 Fibers: Classification on the basis of origin of fibres, Cotton, Flax and Jute (extraction and uses). **16 Lectures**

**5. Vegetables and fruits:**

**5.1** Vegetables: Scientific names, family and edible parts- Potato, Pointed gourd, Brinjal, Tomato, Cauliflower, Cabbage, Lady´s finger, Ridge gourd, Cucumber, Spinach, Carrot, Pea, Beans, Drumstick, Radish and Sweet potato, 5.2 Fruits: Scientific names, family, types of fruits and edible parts: Mango, Papaya, Custard apple, Pineapple, Tamarind, Jackfruit, Banana, Guava, Pomegranate, Apple, Strawberry, Wood apple, Litchi and Grapes. **4 Lectures**

## ECONOMIC BOTANY (PRACTICAL)

## BOT-H-CC3-3-P

## (Total Marks 25, Credits 2, Class 30 hours)

1. **Identification (2× 9)** **18 marks**
2. **Practical notebook** **3 marks**
3. **Field notebook** **4 marks**

1. Identification of economically important plants (as listed below) from fresh/ herbarium sheets/ preserved specimens:

   Cereals: Rice and Wheat

   Legume: Gram, Mung bean and Soybean (habit, fruit and seed structure)

   Spices and condiments: Coriander, Cumin, Bay leaf, Black pepper, Cinnamon

Tea and coffee (plant habit and parts used)

Common vegetables: Potato, Cucumber, Brinjal, Lady´s finger, Carrot, Sweet potato

Fruits (only identify the type of fruit) as listed in theoretical syllabus

Fibres: jute and cotton (plant and parts used)

2.Classroom performance: (lab records and field notebook)

4. Field visit to give an idea about cultivation of any one crop (viz. rice, jute, mustard, tea, potato)

5. Field record must be properly authenticated by escorting teacher and supported by photographs of the field

**Textbook References:**

1.Mukherjee, S. College Botany, Vol. III, latest Ed., New Central Book Agency

2. Mitra, D., Guha, J., Chowdhuri, S.K. Studies in Botany, Vol. II, latest Ed. D.N. Moulik for Moulik Library.

3. Kochhar, S.L. 2012. Economic Botany in Tropics, MacMillan & Co. New Delhi, India.

4. Simpson, B.B. and Conner-Ogorzaly, M. 1986. Economic botany: plants in our world.

5. Pandey, B.P. 1978. Economic botany for degree honours and postgraduate students.

6. Albert F. Hill 1952. Economic botany: a textbook of useful plants and plant productions, 2nd Edn.

**University Of Calcutta**

**Course Structure – 4 years Honours + Research (NEP 2020)**

**BOTANY SYLLABUS**

**(Semester III)**

**DSC/Core**

**BOT-H-CC4-3-Th**

**PLANT ANATOMY & EMBRYOLOGY (THEORY)**

**(Total Marks 75, Credits 3, Lectures 45 hours)**

## PLANT ANATOMY (50 marks)

**1. Cell and Tissues: 14 lectures**

1.1 Cell wall: ultrastructure, chemical constituents; thickening of cell wall.

1.2 Tissues: meristems, simple and complex tissues, cambium- Structure and function

1.3 Mechanical tissues and the principles governing their distribution in plants.

1.4 Stele: stelar types; leaf-trace and leaf-gap, 1.5 Stomata: origin and types (Metcalfe and Chalk, 1950; Stebbins and Khush, 1961).

**2. Primary and secondary growth: 8 lectures**

2.1 Primary structure of stem and root- monocot and dicot. Leaf- dorsiventral and isobilateral, 2.2 Secondary growth: normal (intra- & extra-stelar), anomalous (stem of *Bignonia*, *Boerhavia*, *Tecoma*, *Dracaena* and root of *Tinospora*).

3. **Developmental and Ecological Anatomy: 6 lectures**

3.1 Organisation of shoot apex (Tunica–Corpus) and root apex (Korper-Kappe), plastochron,

3.2 Adaptive anatomical features of hydrophytes, xerophytes, halophytes.

4. **Scope of plant anatomy: 2 lectures**

Application in systematics, forensics and pharmacognosy, brief idea on dendrochronology.

## EMBRYOLOGY (25 marks)

**1. Pre-fertilisation and post- fertilization changes : 10 lectures**

1.1. Microsporogenesis and Microgametogenesis, 1.2. Megasporogenesis and Megagametogenesis (monosporic, bisporic and tetrasporic), 1.3 Pollen germination, 1.4 Pollen tube- growth, entry into ovule and discharge, 1.5 Double fertilization, post-fertilization changes.

**2. Embryo development and apomixis: 5 lectures**

2.1 Embryogenesis in *Capsella*, 2.2 Development of endosperm (3 types), 2.3 Apomixis- Apospory and Apogamy, 2.4 Polyembryony- different types.

## PLANT ANATOMY& EMBRYOLOGY (PRACTICAL)

**BOT-H-CC4-3-P**

**Total Marks 25; Credit 1, Class 30 hours**

| | |
|---|---|
| **1.Workout on Plant Anatomy** | **10 marks** |
| **2. Identification with reasons** | **5 marks** |
| **3.Classroom performance: Lab records** | **3 marks** |
| **Slides** | **2 marks** |
| **4. Viva– voce** | **5 marks** |

## PLANT ANATOMY

1. Microscopic studies on: Types of stomata, sclerenchyma and parenchyma cells, sclereids, raphides (*Colocasia*), cystolith (*Ficus* leaf) starch grains, aleurone grains, laticiferous ducts, oil glands.

2. Study of anatomical details through permanent slides/ temporary stained mounts- a) Root-Monocot and dicot, b) Stem- Monocot and dicot, c) Leaf- Isobilateral and Dorsiventral, d) Stelar types.
3. Study of anomalous secondary structure in stem of *Bignonia*, *Boerhaavia*, *Tecoma*, *Dracaena* and root of *Tinospora*
4. Study of adaptive anatomical features: Hydrophytes (*Nymphaea* – petiole), Xerophytes (*Nerium* – leaf) and Halophytes (*Aegiceros corniculata*- salt gland), Epiphytic root (Orchid - velamen).

**Textbook References:**

**PLANT ANATOMY**

1. Fahn, A. Plant Anatomy (4th ed.), 1990, Wiley Eastern.
2. Eames, A.J. & Mac. Daniels, L.H. An Introduction to Plant Anatomy, Latest Ed., McGraw Hill
3. Esau, K. Anatomy of Seed Plants (2nd ed.), 1977, John Wiley & Sons
4. Pandey, B.P. Plant Anatomy, Latest Ed., S. Chand & Company
5. Tayal, M.S. Plant Anatomy, Latest Ed., Rastogi Publications
6. Roy, P. Plant Anatomy, Latest Ed., New Central Book Agency
7. Morphology and Taxonomy of Angiosperms
8. Singh, G. Plant Systematics: An Integrated Approach (3rd ed.), 2016, CRC Press
9. Sambamurty, A.V.S.S. Taxonomy of Angiosperms, 2005, I.K. International Pvt. Ltd.
10. Sivaranjan, V.V. Principles of Plant Taxonomy (2nd ed.), 1991, Oxford & IBH
11. Subrahmanyam, N.S. Modern Plant Taxonomy, Latest Ed., Vikas Publishing House
12. Naik, V.N. Taxonomy of Angiosperms, Latest Ed., Tata McGraw Hill
13. Stace, C. A Plant Taxonomy & Biosystematics, Latest Ed., Arnold Publishers
14. Mitra, J.N. An Introduction to Systematic Botany & Ecology, Latest Ed., World Press
15. Dutta, S.C. systematic Botany, Latest Ed., Wiley Eastern.
16. Lawrence, G.H.M. Taxonomy of Vascular Plants Ed., Oxford & IBH.
17. Prain, D. Bengal Plants (Vol I & II), Bishen Singh Mahendra Pal Singh.
18. Jeffrey, C. An Introduction to Plant Systematics, Latest Ed., Allied Publishers Pvt. Ltd.
19. Radford. A.B. Fundumentls of Plant Systematics, Latest Ed., Harper & Row.

20. Paria, N.D. and Chattopadhyay, S.P. Flora of Hazaribagh District, Bihar, 2000 & 2001, Vol I & II, BSI, Kolkata 16. Simpson, G. Plant Systematics, 2006, Springer.

21. Bhattacharya, B. Systematic Botany, 2006, Narosa Publishing House.

22. Subramanyam, N.S. Laboratory Manual of Plant Taxonomy (2nd ed.) 1999, Vikas Publishing House.

23. Heywood, V.H. Flowering Plants of the World 1978, Oxford University Press.

**EMBRYOLOGY**

1. Raghavan, V. Molecular Embryology of Flowering Plants, 1997, Camb. University Press.

2. Maheswari, P. An Introduction to Embryology of Angiosperm, Latest Ed., Tata McGraw Hill.

3. Raghavan, V. Embryogenesis in Angiosperms: A Development & Experimental Study, 1986, Cambridge University Press.

4. Bhojwani, S.S. & Bhatnagar, S.D. The Embryology of Angiosperms (4th ed.), 1989, Publishing House.

**University Of Calcutta**

**Course Structure – 4 years Honours + Research (NEP 2020)**

**BOTANY SYLLABUS**

**(Semester III)**

**BOT-H-SEC-3-Th**

**PLANT TISSUE CULTURE AND HORTICULTURE PRACTICES (THEORY)**

**(Total Marks 75, Credits 3, Lectures 45 hours)**

**A. Plant Tissue Culture (50 marks)**

1. **Plant Tissue Culture**: **3 Lectures**

1.1 Land mark contributions, 1.2 Importance of plant tissue culture as tools for fundamental and applied plant sciences, 1.3 Future prospects in improving cash crops, medicinal plants and forest trees.

2. **Requisites of Plant Tissue Culture and Plant regeneration: 8 Lectures**

2.1 Requirement of plant tissue culture laboratory- Equipment, instruments, glassware and plastic wares, 2.2 Aseptic technique- contaminants and sterilization, 2.3 Plant tissue culture medium: media preparation (basal medium), gelling agents and their uses, Use of plant growth regulators in plant tissue culture, 2.4 Cellular totipotency, 2.5 Organogenesis (direct and indirect), 2.6 Somatic embryogenesis and its significance, 2.7 Artificial seed (encapsulation and its potential uses).

3. **Types of culture techniques: 13 Lectures**

3.1 Plant micropropagation**:** Methods and advantages of micropropagation, Steps of general micropropagation, Important considerations and precautions, 3.2 Somaclonal variation: Types, applications of tissue culture-derived variation and crop improvement,3.3 Callus and haploid culture: Callus culture- Induction, maintenance and application, Suspension culture (introductory idea), 3.4 Haploid culture- Anther, pollen and ovary culture methods, application and utilization of haploids in agriculture 3.5 Protoplast culture- isolation and culture, protoplast

fusion (somatic hybridization), cybrid production, application, 3.6 Embryo and endosperm culture- procedure and application.

4. **Production of useful metabolites by tissue culture techniques:**

**6 Lectures**

4.1 Secondary metabolites: Techniques of production of secondary metabolites; terpenes, phenolics and alkaloids- definitions and functions, 4.2 Valuable natural compounds from plant cell and tissue culture and their uses as drugs- brief idea.

**B. Horticulture Practices (25 marks)**

**1 Horticulture: 4 Lectures**

1.1 Scope, importance and branches, 1.2 Role in rural economy and employment generation, 1.3 Harvesting and handling of fruits, vegetables and cut flower; methods of preservation and processing, 1.4 Urban horticulture and ecotourism.

**2. Horticultural techniques: 3 Lectures**

2.1 Application of manures, fertilizers, nutrients and PGRs, 2.2 Weed controls, biofertilizers, biopesticides, irrigation methods, 2.3 Hydroponics, propagation methods: vegetative (grafting, cutting, layering, budding), sexual (seed production), scope and limitations.

**3. Ornamental plants: 5 Lectures**

3.1 Types, classifications (annuals, perennials, climbers and trees), 3.2 Identification and salient features of 3.2.1 Some ornamental flowers (rose, marigold, gladiolus, carnations, rasna orchid, gerberas, tuberose, birds of paradise, pin cushion cactus and desert rose), 3.2.2 Ornamental flowering trees (Indian laburnum, gulmohar, jacaranda, jarul, fishtail palm, simul, coral tree), 3.2.3 Bonsai and their commercial use, 3.2.4 Importance of flower shows and exhibitions

**4. Fruit and vegetable crops**: **3 Lectures**

4.1 Some common fruits and vegetables- description of plants and their economically important

parts (orange, banana, mango, papaya, guava, litchi, bael, potato, cauliflower, carrot, onion, peas, brinjal, ridged gourd), 4.2 Fruit processing- scope and benefit.

**PLANT TISSUE CULTURE AND HORTICULTURE PRACTICES (PRACTICAL)**

**BOT-H-SEC-3-P**

**Total marks- 25; Credit 1, Class 30 hours**

| | |
|---|---|
| **1. Work out/ Demonstration** | **10 marks** |
| **2. Identification (ornamental flowers)** | **3 marks** |
| **3. Field report & Diary** | **5 marks** |
| **4. Class room performance (Practical notebook)** | **2 marks** |
| **5. Viva-voce** | **5 marks** |

1. Field trip (any two with report submission) - Visit to plant tissue culture laboratory, gardens, standing crop sites, nurseries, vegetable plantations, horticultural fields at IARI/AHSI and cold storage.
2. Media preparation, sterilization and aseptic inoculation of explant for seed culture.
3. Propagation of two horticulturally important plants (each student needs to propagate plants following two separate vegetative methods; records and photographs to be authenticated by respective teacher and presented in a form of field diary during examination)
4. Identification of ornamental flowers as per theoretical syllabus

**Textbook references:**

**PLANT TISSUE CULTURE**

1. Chawla, H.S. An Introduction to Plant Biotechnology (2nd ed.), 2002, Oxford & IBH

2. Borer, A., Sentos, F.R. & Bowen, D.B. Understanding Biotechnology, 2003, Pearson Education

3. Ingacimuthu, S. Plant Biotechnology, 1997, Oxford & IBH

4. Walker, J.M. & Rapley, R. Molecular Biology & Biotechnology, 2000, Royal Society of

Chemistry

5. Collin, H.A. and Edwards, S. Plant Cell Culture, 1998, Bios Scientific Publishers

6. Dixon, R.A. & Gonzales, R. A. Plant Cell Culture: A Practical Approach, 1994, Oxford University Press

7. Gamorgs, O.L. & Phillips, G.C. Plant Cell, Tissue and Organ Culture: Fundamental method, Narosa Publishing House

8. Dubey, R.C. Biotechnology, Latest Ed., S.Chand& Company Pvt. Ltd.

9. Bhojwani, S.S. & Razdan, M.I. Plant Tissue Culture: Theory and Practise, Elsevier

10. Rajdan, M.K. An Introduction to Plant Tissue Culture, Latest Ed., Oxford & IBH

11. Jha, T.B. & Ghosh, B. Plant Tissue Culture, 2003, Universities Press

12. Singh, B.D. Biotechnology Latest ed., Kalyani Publishers.

13. Mascarenhas, A.F. Handbook of Plant Tissue Culture, ICAR

14. Kar, D.K. & Halder, S. Plant Breeding, Biometry & Biotechnology, 2010, New Central Book Agency

15. Gupta, P.K. Biotechnology & Genomes, latest Ed., Rastogi Publications

16. Slatter, A., Scott, N. & Fowler, N. Plant Biotechnology, 2003, Oxford University Press

17. Dey, K.K. Plant Tissue Culture, 1992, New Central Book Agency

**HORTICULTURE**

1.Singh, D. &Manivannan, S. 2009. Genetic Resources of Horticultural Crops. Ridhi International, Delhi, India.

2. Swaminathan, M.S. and Kochhar, S.L. 2007. Groves of Beauty and Plenty: An Atlas of Major Flowering Trees in India. Macmillan Publishers, India.

3. NIIR Board 2005. Cultivation of Fruits, Vegetables and Floriculture. National Institute of Industrial Research Board, Delhi.

4. Kader, A.A. 2002. Post- Harvest Technology of Horticultural Crops. UCANR Publications, USA.

5. Capon, B. 2010. Botany for Gardeners. 3rd Edition. Timber Press, Portland, Oregon.

**University Of Calcutta**

**Course Structure – 4 years Honours + Research (NEP 2020)**

**BOTANY SYLLABUS**

**(Semester IV)**

**DSC/Core**

**BOT-H-CC5-4-Th**

**PHYCOLOGY (THEORY)**

**(Total Marks 75, Credits 3, Lectures 45 hours)**

## PHYCOLOGY

### 1. General account :

1.1. Thallus organization and evolutionary trend in algal members of different groups, structure of algal cell, pigment types and variation, 1.2. Ultrastructure of flagella and chloroplast, 1.3. Process of reproduction in algae: Isogamy, Anisogamy, Oogamy- *Chlamydomonas*, *Oedogonium*, *Vaucheria*, Conjugation- *Spirogyra*, 1.5. Life cycle pattern in algae- Haplontic: *Chara*, Diplontic: *Fucus*, Haplo-diplontic (Isomorphic): *Ectocarpus*, Haplo-diplontic (Heteromorphic): *Laminaria*, Triphasic: *Polysiphonia*, 1.6. Significant contributions of some phycologists (F. E. Fritsch, G. M. Smith, R. N. Singh, T.V. Desikachary, H.D. Kumar, M.O.P. Iyengar)

**16 Lectures**

### 2. Classification:

2.1. Classification by Lee (2018) upto phylum with examples, 2.2. Salient features of Cyanophyta (emphasis on cell ultrastructure, reproduction, structure and function of heterocyst), Rhodophyta, Chlorophyta (emphasis on phylogenetic significance of flagellar ultrastructure), Charophyta, Heterokontophyta (Phaeophyceae, Xanthophyceae; Bacillariophyceae - emphasis on cell structure, cell division, auxospore formation)

**15 Lectures**

### 3. Algal Ecology:

3.1. Role of phytoplanktons in aquatic ecosystem, 3.2. Algae in $CO_2$ sequestration, 3.3. Phytoremediation by algae

**7 Lectures**

**4. Algal Biotechnology:**

4.1. Algal culture and cultivation (Photobioreactor), 4.2. Algae as food, biofuel and biofertilizer

**7 Lectures**

## PHYCOLOGY (PRACTICAL)

## BOT-H-CC5-4-P

## (Total Marks 25, Credit 1, Class 30 hours)

**1. Work out: Algae** **10 marks**

**2. Identification with reasons: (Algae)** **4 marks**

**3. Classroom performance (Lab notebook, submission and permanent slides)**
**2+2+2=6 marks**

**4. Viva- voce** **5 marks**

### ALGAE

**1.** Workout of the following algae with reproductive structure (Free hand drawing and drawing under drawing prism with magnification): *Spirogyra, Oedogonium, Chara, Ectocarpus.*

**2.** Study of (a) Permanent slides: *Nostoc, Gloeotrichia, Volvox, Vaucheria, Coleochaete, Polysiphonia,* Centric and Pennate diatom*;* (b) Macroscopic specimen: *Sargassum.*

### FIELD WORK

At least one local excursion to be conducted for study and collection of algae (only 5 from natural habitat).

### CLASSROOM PERFORMANCE

**1.** Laboratory Note Book

**2.** Slides (permanent) prepared during practical classes.

**3.** Submission (5 algae collected from natural habitat and identified latter)

**Textbook References:**

1**.** Kumar, H.D. 1999. Introductory Phycology (2nd ed.), Affiliated East-West Press Pvt. Ltd.

2. Lee, R.E. 2018. Phycology (5th ed.), Cambridge University Press

3. Vashishta, B.R., Sinha, A.K. & Singh, V.P. 2002. Algae (9th ed.), S. Chand & Company

4. Sambamurty, A.S.S. 2005. A text book of Algae, I.K. International Pvt. Ltd. 22

5. Graham, L.E. & Wilcox, L.W. 2000. Algae, Prentice Hall

6. Smith, G.M. 1955. Cryptogamic Botany, Vol. 1 (2nd ed.), McGraw Hill

7. Prescott, G.W. 1969. Algae: A Review, Bishen Singh Mahendra Pal Singh

8. Fritsch, F.E. 1936. The Structure & Reproduction of Algae, Vols. I & II, Cambridge University Press

9. Van Den Hoek, D.G. Mann, H.M. Jahns. 1996. Algae: An Introduction to phycology, Cambridge University Press

**University Of Calcutta**

**Course Structure – 4 years Honours + Research (NEP 2020)**

**BOTANY SYLLABUS**

**(Semester IV)**

**DSC/Core**

**BOT-H-CC6-4-Th**

**ARCHAEGONIATES (THEORY)**

**(Total Marks 75, Credits 3, Lectures 45 hours)**

## BRYOPHYTES (25 marks)

**1. Introduction to Monosporangiophyta (Bryophytes):**

1.1 Unifying features of archaegoniates; transition to land habit, 1.2. Origin of Alternation of Generations (Homologous and Antithetic theory), 1.3 Evolution of sporophytes (Progressive and Regressive concept), 1.4 Origin of bryophytes, 1.5 Bryophytes as bio indicators of pollution **4 Lectures**

**2 Classification :**

2.1. Classification (Crandall-Stotler et al, 2009; Renzaglia et al, 2009,Goffinet et al, 2009;) up to class with diagnostic characters and examples. **2 Lectures**

**3. Life History:** Gametophyte structure and reproduction, development and structure of sporophyte, spore dispersal in: 3.1 *Riccia*, 3.2 *Marchantia*, 3.3.*Anthoceros*, 3.4.*Funaria.*

**4 Lectures**

## PTERIDOPHYTES (25 marks)

**1. General Account:**

1.1. Colonisation and rise of early land plants, 1.2 Origin and evolution of stellar structure, 1.3 Economic importance. **3 Lectures**

**2.Life History:**

Sporophyte structure, reproduction and structure of gametophyte in 2.1. *Psilotum*, 2.2. *Lycopodium*, 2.3. *Selaginella*, 2.4. *Equisetum*, 2.5. *Pteris*, 2.6.*Marsilea*. **6 Lectures**

**3.** Telome concept and its significance in the origin of different groups of Pteridophytes. **4 Lectures**

**4.** Heterospory and origin of seed habit. **2 Lectures**

**GYMNOSPERMS (25 marks)**

1. Progymnosperms :
   Diagnostic characters of the group, 1.1.Vegetative and reproductive features of *Archaeopteris*, 1.2. Phylogenetic importance. **6 Lectures**
2. Life History :
   Distribution in India; vegetative, anatomical and reproductive structures of sporophyte, development of gametophyte in : 2.1. *Cycas*, 2.2. *Pinus*, 2.3. *Ginkgo* and 2.4. *Gnetum*. **10 Lectures**
3. Pollination and Embryogeny of gymnosperms **2 Lectures**
4. Phylogeny: 4.1 Evolutionary significance of gymnosperms **2 Lectures**

**ARCHAEGONIATES (PRACTICAL)**

**BOT-H-CC6-4-P**

**Total Marks 25; Credit 1, Class 30 hours**

**1.Workout on Pteridophytes 10 marks**

**2. Identification with reasons (Bryophytes, Pteridophytes and Gymnosperms) 6 marks**

**3.Classroom performance: (Lab records, slides) 2+2= 4 marks**

**4. Viva 5 marks**

**BRYOPHYTES**

**1.** Study from permanent slides: *Riccia* (V.S. of thallus with sporophyte), *Marchantia* (L.S. through gemma cup, antheridiophore, archegoniophore, sporophyte), *Anthoceros* (L.S. of sporophyte), *Funaria* (L.S. of capsule).

## PTERIDOPHYTES

**1.** Morphological study of the sporophytic plant body: *Psilotum*, *Lycopodium, Ophioglossum* and *Marsilea*.

**2.** Work out of the reproductive structures: *Lycopodium*, *Selaginella*, *Equisetum, Pteris*.

**3.** Study from permanent slides: *Psilotum* (T.S. of synangium), *Ophioglossum* (L.S. of spike), *Dryopteris* (sorus and gametophyte), *Marsilea* (L.S. of sporocarp).

## GYMNOSPERMS

**1.** Study from permanent slides: T.S. of leaf and wood anatomy of *Cycas* and *Pinus*, *Cycas* (L.S. of ovule), *Pinus* (L.S. of male and female cone), *Ginkgo* (L.S. of female strobilus), *Gnetum* (L.S. of male cone and ovule).

**Textbook References:**

**Bryophytes**

1. Parihar, N.S. Introduction to Embryophyta (Vol. 1 Bryophyta), Central Book Distributors
2. Shaw, A. J. & Bernard, G. 2009. Bryophyte Biology, Cambridge University Press
3. Rashid, A. 1998. An Introduction to Bryophyta, Vikas Publishing House
4. Chopra, R.N. & Kumar, P.K. Biology of Bryophyta, Latest Ed., Wiley Eastern
5. Puri, P. Bryophyte, Latest Ed., Atmaram& Sons
6. Vashista, B.R. Bryophyta, Latest Ed., S. Chand & Company

**Pteridophytes**

1. Spore, K.R. The Morphology of Pteridophyte, Latest Ed.,Huchinson& Co. Ltd.
2. Rashid, A. An Introduction to Pteridophyte, Latest Ed., Vani Educational Books.
3. Vashista, P.C. Pteridophyta, Latest Ed., S. Chand & Company Pvt. Ltd.
4. Gifford, E. M. & Foster, A. S. 1998. Morphology & Evolution of Vascular Plants (3rd ed.), Freeman and Co.

**9. Gymnosperms**

1. Sporne, K.R. The Morphology of Gymnosperms, Latest Ed., Hutchinson &Co. Ltd.

2. Vashishta, P.C. Gymnosperm, Latest Ed., S. Chand & Company Pvt.

3. Karkar, R.K. &Karkar, R. The Gymnosperms, Latest Ed.

4. Bhatnagar, S.P. &P.Moitra, 1997. Gymnosperm, New Age International

5. Biswas, C. &Johri, P.M. 1997. The Gymnosperm, Narosa Publishing House

6. Dutta, S.C. 1984. An Introduction to Gymnosperms (3rd ed.), Kalyani Publishers

7. Gifford, E.M. and Foster, A.S. 1989. Morphology & Evolution of Vascular Plants (3rd ed.), Freeman & Co.

# University Of Calcutta

**Course Structure – 4 years Honours + Research (NEP 2020)**

**BOTANY SYLLABUS**

**(Semester IV)**

**DSC/Core**

**BOT-H-CC7-4-Th**

**PALAEOBOTANY AND PALYNOLOGY (THEORY)**

**(Total Marks 75, Credits 3, Lectures 45 hours)**

**PALAEOBOTANY (50 marks)**

1. Geological time scale with dominant plant groups through ages and major important evolutionary events (development of vascular tissue, origin of roots, and leaves and seeds)

**4 lectures**

2. Plant Fossil :

2.1. Types: Body fossil (micro- and megafossils), Trace fossil, Chemical fossil, Index fossil, 2.2. Different modes of preservation (Schopf, 1975), 2.3. Conditions favouring fossilization, 2.4. Nomenclature and Reconstruction, 2.5. Principle of fossil dating (a brief idea), 2.6. Relative (biostratigraphy and index fossil) and Absolute dating ($^{238}U$-$^{206}Pb$, $^{14}C$ Method), 2.7. Importance of fossil study.

**8 lectures**

3. Fossil Pteridophytes :

Structural features, geological distribution and evolutionary significance of 3.1. *Rhynia*, 3.2. *Lepidodendron* (Reconstructed), 3.3. *Calamites* (Reconstructed). **6 lectures**

4. Fossil Gymnosperms:

Structural features and geological distribution of reconstructed genera: 4.1. *Lyginopteris*, 4.2. *Williamsonia*, 4.3.*Cordaites* **6 lectures**

Indian Gondwana System – Brief idea of Gondwana; Three fold division of Indian Gondwana with major megafossil assemblages. **4 lectures**

**PALYNOLOGY (25 marks)**

6. Introduction, 6.1 Pollen and non-pollen palynomorphs (spores and phytoliths), types of phytoliths, 6.2. Pollen aperture types, 6.3. NPC classification (Erdtman). 6.4. Pollen wall- sporopollenin, stratification and ornamentation (sculpturing).

**5 lectures**

7. Applied Palynology:

Basic concepts of: 7.1. Palaeopalynology (definition, role of fossil spore/ pollen/ phytolith in vegetation and climate reconstruction), 7.2. Aeropalynology- basic mechanism of spore/pollen allergy, 7.3 Common spore/pollen allergies, pollen calendar 7.4 Aeroallergens-common pollen-allergy causing plants of India, brief idea of basic tests for diagnosis– skin testing (Prick Test), Radioallergosorbent-Test (RAST) and Enzyme-Linked Immuno- Sorbent - Assay (ELISA), 7.5 Forensic palynology-definition, sources of pollen as forensic evidence– soil, clothing and foot wear, vehicles, human bodies, animal fur, spider web, 7.6 Applications and limitations of forensic palynology, 7.7 Pollination biology and melissopalynology- types of pollination, pollinator groups, pollen-pistil interactions and its significance; common Indian bee plants, types of honey, botanical and geographical origin of honey, absolute pollen count; bee keeping.

**12 lectures**

**PALAEOBOTANY AND PALYNOLOGY (PRACTICAL)**

**BOT-H-CC7-4-P**

**(Total Marks 25, Credit 1, Class 30 hours)**

1. **Morphological study of mega fossils** **3 marks**
2. **Identification with reasons from permanent preparations (Anatomy + Pollen)** **3+3+3= 9 marks**
3. **Palynological study** **5 marks**
4. **Classroom performance: ( Lab records)** **3 marks**
5. **Viva- voce** **5 marks**

## PALAEOBOTANY AND PALYNOLOGY

1. Morphological study: *Ptilophyllum* and *Glossopteris* leaf fossils.
2. Study from permanent slides: T.S. of stem of *Rhynia*, *Lepidodendron*, *Calamites*, *Lyginopteris*, *Cordaites*.
3. Study of pollen types (colpate, porate and colporate) from permanent slides.
Slides may be prepared from specimens: colpate (*Leonurus sibiricus*/ *Brassica* sp.), porate (*Hibiscus rosa-sinensis*), colporate (*Cassia sophera*/ *C. tora*).
4. Detection of honey type (uni/ bi/ multifloral) based on microscopic analysis.
5. Visit to a palaeobotanical/palynological laboratory/ institute/ museum.

## CLASSROOM PERFORMANCE

**1.** Laboratory note Book and report of each section must be signed by the respective teacher with date.

**Textbook References:**

1. Stewart, W.N. & Rothwell, G.W. Palaeobotany & Evolution of Plants, Latest Ed., Cambridge University Press
2. Agashe, S.N. Palaeobotany, Latest Ed., Oxford & IBH
3. Thomas, B.A. & Spicer, R.A. The Evolution & Palaeobotany of Land Plants, Latest Ed., Croomhelm
4. Nair, P.K. Pollen Morphology of Angiosperms, Latest Ed., Scholar Publications
5. Shivanne, K.H. 2003. Pollen Biology & Biotechnology, Oxford & IBH
6. Bhattacharya, K., Majumdar, M.R. & Gupta Bhattacharya, S. 2006. A Text Book of Palynology, New Central Book Agency.
7. Taylor, T.N. and Taylor, E.L. 1993. The biology and evolution of fossil plants, First Ed. Englewood Cliffs: Prentice Hall.

**University Of Calcutta**

**Course Structure – 4 year Honours + Research (NEP 2020)**

**BOTANY SYLLABUS**

**(Semester IV)**

**DSC/Core**

**BOT-H-CC8-4-Th**

**PHARMACOGNOSY & ETHNOBOTANY (THEORY)**

**(Total Marks 75, Credits 3, Lectures 45 hours)**

1. **Medicinal botany:** History, scope and importance of medicinal plant in herbal drug industry, a brief idea about traditional systems of medicine- ayurveda, siddha and unani, Polyherbal formulations.

**4 lectures**

2. **Pharmacognosy**- General account :

2.1 Pharmacognosy and its introduction and importance in modern medicine, 2.2 Crude drugs, 2.3 Classification of plant drugs- chemical and pharmacological action, 2.4 Drug evaluation– organoleptic, microscopic, chemical, physical and biological, 2.5. Major pharmacological groups of plant drugs and their uses, 2.6. Conservation of endangered and endemic medicinal plants.

**8 lectures**

3. **Secondary metabolites:**

3.1 Secondary metabolites and their differences with primary metabolites, 3.2 Interrelationship of basic metabolic pathways (Shikimate, Mevalonate, Acetate & MEP) with secondary metabolite biosynthesis (outlines only), 3.3 Major types and classification–terpenoids, phenolics, flavonoids, alkaloids and their pharmacological importance.

**8 lectures**

4. **Pharmacologically active constituents:**

Source plants (one example) parts used and uses of: 4.1 Steroids (Solasodin, Diosgenin, Digitoxin), 4.2 Tannin (Catechin), 4.3 Resins (Gingerol, Curcuminoids), 4.4 Alkaloids (Quinine, Atropine. Pilocarpine, Strychnine, Reserpine, Vinblastine, Taxol, Pyrolizidine), 4.5. Phenols (Sennoside and Capsaicin). **5 Lectures**

**5. Ethnobotany and folk medicine:** Definition, methods of study, application, Indian scenario, national interacts, folk medicines in ethnobotany, ethnomedicine, ethnoecology, ethnic communities of India, sacred groves, application of natural products to certain diseases- jaundice, cardiac, infertility, diabetics, blood pressure and skin diseases, challenges in application of ethno medicines with reference to modern medicines.

**12 lectures**

6. **Neutraceuticals:** General introduction, classification, inorganic mineral supplements, multivitamins, digestive enzymes, probiotics, prebiotics, dietary fibres, health drinks, antioxidants, polyunsaturated fatty acids, herbs as functional foods- future of pharmacognosy.

**8 lectures**

## PHARMACOGNOSY & ETHNOBOTANY (PRACTICAL)

**BOT-H-CC8-4-P**

**Total Marks 25; Credit 1, Class 30 hours**

1. **Workout (Items 1-4)** **5+6 = 11 marks**
2. **Identification of common medicinal plants from fresh specimen/ herbarium** **6 marks**
3. **Classroom performance (Laboratory Records)** **3 marks**
4. **Viva-voce** **5 marks**

**PHARMACOGNOSY/ MEDICINAL PLANTS**

1. Chemical tests for (a) Tannin (*Camellia sinensis* / *Terminalia chebula*), (b) Alkaloid (*Catharanthus roseus*).
2. Powder microscopy – *Zingiber* and *Holarrhena*.
3. Histochemical tests of (a) Curcumin (*Curcuma longa*), (b) Starch in non-lignified vessel (*Zingiber*), (c) Alkaloid (stem of *Catharanthus* and bark of *Holarrhena*).
4. Determination of palisade ratio and vein-islet number of Vasak leaves.

5. Identification from fresh specimen/ herbarium of some commonly used medicinal plants:

a. *Azadirachta indica* (Neem), b. *Justicia adhatoda* (Vasak), c. *Andrographis paniculata* (Kalmegh), d. *Saraca asoca* (Ashoka), e. *Holarrhena pubescens* (Kurchi), f. *Centella asiatica* (Thankuni), g. *Zingiber officinale* (Ginger), h. *Catharanthus roseus* (Nayantara), i. *Phyllanthus emblica* (Amla), j. *Terminalia chebula* (Haritaki),k. *Terminalia arjuna* (Arjun), l. *Piper longum* (Long pepper), m. *Curcuma longa* (Turmeric), n. *Bacopa monnieri* (Brahmi)

**Textbook References:**

1. Trease & Evans. Pharmacognosy, Saunders.

2. Trivedi P.C. 2006. Medicinal Plants: Ethnobotanical approach, Agrobios India

3. S.K. Jain, 1995. Manual of Ethnobotany, Scientific Publishers, Jodhpur.

**University Of Calcutta**

**Course Structure – 3 year MDC (NEP 2020)**

**BOTANY SYLLABUS**

**(Semester III)**

**DSC/Core**

**ECONOMIC BOTANY (THEORY)**

**BOT-MD-CC3-3-Th**

**(Total Marks 75, Credits 3, Lectures 45 hours)**

1. **Introduction:** Concepts of centre of origin, their importance with reference to Vavilov's work, Importance of germplasm diversity. **4 Lectures**

2. **Cereals, pulses and oils:**

2.1 Cereals: Rice and Wheat- cultivation, processing and uses, Millets as future cereals. 2.2 Pulses and Legumes: Cultivation and uses of Gram and Mung Bean - Importance to man and environment, 2.3 Oil and fats: General description, classification, extraction, uses and health implications of Mustard and Coconut (Botanical name, family and uses). Essential oils- general account, extraction methods and their uses.

**12 Lectures**

3. **Sugar, starch, spices and beverages:**

3.1 Processing of sugarcane to products and byproducts. Extraction/ processing from Potato and Sugar beet. 3.2 Spices and condiments: Scientific names, family, economically important parts and uses of Ajwain, Cumin, Black Cumin, Mustard, Fenugreek, Coriander, Chillies, Bay leaf, Black Pepper, Cardamom (small and big), Clove, Cinnamon, Onion, Garlic and Ginger, 3.3 Beverages: Tea and coffee (plant habit, processing and uses).

**9 Lectures**

3. **Narcotics, timbers and fibres:**

4.1 Habit forming drugs with special reference to *Cannabis* and Tobacco (processing, uses and health hazards), 4.2 Timber: General account with special reference to Sal and Teak, 4.3 Fibers: Cotton and Jute - (extraction and uses). **16 Lectures**

**5. Vegetables and fruits:**

5.1 Vegetables: Scientific names, family and edible parts- Potato, Pointed gourd, Brinjal, Tomato, Cauliflower, Cabbage, Lady´s finger, Ridge gourd, Cucumber, Spinach, Carrot, Pea, Beans, Drumstick, Radish and Sweet potato, 5.2 Fruits: Scientific names, family, types of fruits and edible parts: Mango, Papaya Custard apple, Pineapple, Tamarind, Jackfruit, Banana, Guava, Pomegranate, Apple, Strawberry, Wood apple, Litchi and Grapes.

**4 Lectures**

## ECONOMIC BOTANY (PRACTICAL)

## BOT-MD-CC3-3-P

## (Total Marks 25, Credits 2, Class 30 hours)

1. **Identification (2× 9)** **18 marks**
2. **Practical notebook** **3 marks**
3. **Field notebook** **4 marks**

1. Identification of economically important plants (as listed below) from fresh/ herbarium sheets/ preserved specimens:

Cereals: Rice and Wheat

Legume: Gram, Mung bean and Soybean (habit, fruit and seed structure)

Spices and condiments: Coriander, Cumin, Bay leaf, Black pepper, Cinnamom

Tea and coffee (plant habit and parts used)

Common vegetables: Potato, Cucumber, Brinjal, Lady´s finger, Carrot, Sweet potato

Fruits (only identify the type of fruit) as listed in theoretical syllabus

Fibres: jute and cotton (plant and parts used)

2.Classroom performance: (lab records and field notebook)

3. Field visit to give an idea about cultivation of any one crop (viz. rice, jute, mustard, tea, potato)

4. Field record must be properly authenticated by escorting teacher and supported by photographs of the field

**TextbookReferences:**

1.Mukherjee, S. College Botany, Vol. III, latest Ed., New Central Book Agency

2. Mitra, D., Guha, J., Chowdhuri, S.K. Studies in Botany, Vol. II, latest Ed. D.N. Moulik for Moulik Library.

3. Kochhar, S.L. 2012. Economic Botany in Tropics, MacMillan & Co. New Delhi, India.

4. Simpson, B.B. and Conner-Ogorzaly, M. 1986. Economic botany: plants in our world.

5. Pandey, B.P. 1978. Economic botany for degree honours and postgraduate students.

6. Albert F. Hill 1952. Economic botany: a textbook of useful plants and plant productions, 2nd Edn.

**University Of Calcutta**

**Course Structure – 3 year MDC (NEP 2020)**

**BOTANY SYLLABUS**

**(Semester IV)**

**DSC/Core**

**BOT-MD-CC4-4-Th**

**PHARMACOGNOSY & ETHNOBOTANY (THEORY)**

**(Total Marks 75, Credits 3, Lectures 45 hours)**

**7. Medicinal botany:** History, scope and importance of medicinal plant in herbal drug industry, a brief idea about traditional systems of medicine- ayurveda, siddha and unani, Polyherbal formulations.

**4 lectures**

**8. Pharmacognosy**- General account :

8.1 Pharmacognosy and its introduction and importance in modern medicine, 2.2 Crude drugs, 2.3 Classification of plant drugs- chemical and pharmacological action, 2.4 Drug evaluation– organoleptic, microscopic, chemical, physical and biological, 2.5. Major pharmacological groups of plant drugs and their uses, 2.6. Conservation of endangered and endemic medicinal plants.

**12 lectures**

**9. Secondary metabolites:**

9.1 Secondary metabolites and their differences with primary metabolites, 3.2 Interrelationship of basic metabolic pathways (Shikimate, Acetate, Mevalonate & MEP) with secondary metabolite biosynthesis (outlines only), 3.3 Major types and classification–terpenoids, phenolics, flavonoids, alkaloids and their pharmacological importance.

**10 lectures**

**10. Pharmacologically active constituents:**

Source plants (one example) parts used and uses of: 4.1 Steroids (Solasodin, Diosgenin, Digitoxin), 4.2

Tannin (Catechin), 4.3 Resins (Gingerol, Curcuminoids), 4.4 Alkaloids (Quinine, Atropine. Pilocarpine, Strychnine, Reserpine, Vinblastine, Taxol, Pyrolizidine), 4.5. Phenols (Sennoside and Capsaicin). **4 lectures**

**11. Ethnobotany and folk medicine:** Definition, methods of study, application, Indian scenario, national interacts, folk medicines in ethnobotany, ethnomedicine, ethnoecology, ethnic communities of India, sacred groves, application of natural products to certain diseases- Jaundice, cardiac, infertility, diabetes, blood pressure and skin diseases.

**15 lectures**

## PHARMACOGNOSY & ETHNOBOTANY (PRACTICAL)

**BOT-MD-CC4-4-P**

**Total Marks 25; Credit 1, Class 30 hours**

1. **Workout (powder microscopy and histochemical tests) and chemical tests 5+6 = 11 marks**
2. **Identification of common medicinal plants from fresh specimen/ herbarium 6 marks**
3. **Classroom performance (Laboratory Records) 3 marks**
4. **Viva-voce 5 marks**

**PHARMACOGNOSY/ MEDICINAL PLANTS**

1. Chemical tests for (a) Tannin (*Camellia sinensis* / *Terminalia chebula*), (b) Alkaloid (*Catharanthus roseus*).

2. Powder microscopy – *Zingiber* and *Holarrhena*.

3. Histochemical tests of (a) Curcumin (*Curcuma longa*), (b) Starch in non-lignified vessel (*Zingiber*), (c) Alkaloid (stem of *Catharanthus* and bark of *Holarrhena*).

4. Identification from fresh specimen/ herbarium of some commonly used medicinal plants:

a. *Azadirachta indica* (Neem), b. *Justicia adhatoda* (Vasak), c. *Andrographis paniculata* (Kalmegh), d. *Saraca asoca* (Ashoka), e. *Centella asiatica* (Thankuni), f. *Catharanthus roseus* (Nayantara), g. *Phyllanthus emblica* (Amla), h. *Terminalia chebula* (Haritaki),i. *Bacopa monnieri* (Brahmi).

**Textbook References:**

1. Trease & Evans. Pharmacognosy, Saunders.
2. Trivedi P.C. 2006. Medicinal Plants: Ethnobotanical approach, Agrobios India
3. S.K. Jain, 1995. Manual of Ethnobotany, Scientific Publishers, Jodhpur.

# University Of Calcutta

**Course Structure – 3 year MDC (NEP 2020)**

**BOTANY SYLLABUS**

**(Semester IV)**

**DSC/Core**

**Plant Geography, Ecology and Evolution (THEORY)**

**BOT-MD-CC5-4-Th**

**(Total Marks 75, Credits 3, Lectures 45 hours)**

## PLANT GEOGRAPHY (15 marks)

**1. Phytogeographical regions:**

1.1Phytogeographical regions of India (Chatterjee 1960); 1.2. Dominant flora of Eastern Himalaya, Western Himalaya, Indian deserts and Sundarban.

**5 lectures**

2. **Endemism:**

2.1.Endemism types and Factors; 2.2. Age & Area hypothesis and Epibiotic theory; 2.3. Endemism in Indian flora.

**4 lectures**

## ECOLOGY (30 marks)

1. **Preliminary idea on:**

1.1. Habitat and Niche (fundamental and realized), 1.2. Ecotone and Edge–effect, 1.3. Microclimate, 1.4. Ecads, Ecotypes and Ecoclines, 1.5. Carrying capacity.

**3 lectures**

2. **Community ecology:**

2.1. Community- Characteristics and diversity (α, β, γ), 2.2. Ecological succession –Primary and secondary, Seral stages (with reference to Lithosere and Hydrosere), autogenic and allogenic

succession, Climax community.

**4 lectures**

3.1. Plant indicators (metallophytes); 3.2. Phytoremediation.

**3 lectures**

4. **Conservation of Biodiversity:**

4.1. Level of Biodiversity: genetic, species & ecosystem diversity, 4.2. Biodiversity hot spots- criteria, Indian hotspots, 4.3. *In- situ* and *ex-situ* conservation, 4.4. Causes of extinction, 4.5. IUCN Red List categories, 4.6. Seed-banks, 4.7. Cryopreservation, 4.8. Geographic Information System and Remote Sensing (brief idea).

**10 lectures**

**EVOLUTION (30 marks)**

1.1 Introduction, 1.2. Theories of evolution: Evidences, Natural selection, Group selection, Neutral theory of molecular evolution, 1.3. Phyletic gradualism, Punctuated equilibrium and Stasis

**6 lectures**

2.1 Brief idea on: Stabilizing directional, disruptive and sexual selection; Speciation: Sympatric and Allopatric; Coevolution, Adaptive radiation, Reproductive isolation

**6 lectures**

3.1. Simplified phylogeny of bacteria, algae, fungi, bryophyte, pteridophyte and gymnosperm, 3.2. Phylogenetic tree.

**4 lectures**

## PLANT GEOGRAPHY, ECOLOGY AND EVOLUTION (PRACTICAL)

**BOT-MD-CC5-4-P**

**(Total Marks 25, Credit 1, Class 30 hours)**

**1.Work out on ecological parameters** **10 marks**

**2.Classroom performance: (lab records)** **5 marks**

**3. Field Records (Field note book of phytogeographical study and ecological study)** **5 marks**

**4. Viva-voce** **5 marks**

### PLANT GEOGRAPHY

1. Field visit- at least one long excursion at any phytogeographical region of India.
2. Study of local flora and submission of a project report highlighting phytogeographical characteristics of the region.

### ECOLOGY

1. Study of community structure by quadrat method and determination of (i) Minimal size of the quadrat, (ii) Estimation of frequency, density and abundance (to be done during excursion/ field visit).
2. Estimation of foliar dust deposition.
3. Measurement of dissolved $O_2$ by azide modification of Winkler's method.
4. Determination of chemical properties of soil by rapid spot test (carbonate, iron, nitrate)
5. Estimation of organic carbon percentage present in soil sample.

## Textbook References

### Ecology & Plant Geography

1. Chapman and Riss. Ecology: Principles and Applications, Latest Ed., Cambridge University Press

2. Shukla, R.S. &Chandel, P.S. Plant Ecology, Latest Ed., S. Chandel and Co.

3. Kumar, H.D. Modern Concept of Ecology, Latest Ed. Vikas Publishing House

4. Begon, M., Herper, J.L. and Townsend, C.R. Ecology- Individuals, Populations and Communities (3rd ed.), Oxford Blackwell Science

5. Verma, P.S. & Agarwal, U.K. Concept of Ecology, Latest Ed., S. Chand & Company

6. Odum, F.P. Fundamentals of Ecology, Latest Ed., Saunders

7. Sharma, P.D. Elements of Ecology, Latest Ed., Rastogi Publications

8. Ambasht, R.S. & Ambasht, N.K. A Text Book of Plant Ecology, Latest Ed., CBS Publication & Distributors

9. Mani, M.S. Bio-Geography of India, Latest Ed., Springer-Verlag.

10. Mackenzie et al. Ecology, Latest Ed., Viva Books.

11. Gurevitch, J. (et al.)., The Ecology of plants, 2002, Sinauer Associates.

12. Kimar, U. &Asija, M.J. Bio-diversity: Principles & Conservation, 2005, Student Edition, Agrobios (India)

13. Krishnamurthy, K.V. An Advanced Text Book on Biodiversity, 2003, Oxford & IBH Publishing Co. Ltd.

14. Mitra, D., Guha, J.K., Chowdhury, S.K. Studies in Botany, Vol. II (7th ed.) Moulik Library.

15. Primack, R.B. Essentials of Conservation Biology, 1993, Sinauer Associates.

16. Lo, C.P. & Yeung, A.K.W. Concepts and Techniques of Geographic Information Systems, 2002, Printice-Hall of India.

17. Cain, Bowman, Hacker. Ecology. 2014. 3rd Ed. Sinauer Associates

### Evolution

1. Futuyma., D. Evolution. 2015. (3rd Ed.) Sinauer Associates

2. Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, Jane B. Reece. Campbell Biology. 2017. 11th Ed. Pearson

# UNIVERSITY OF CALCUTTA

## Notification No. CSR/63/2025

It is notified for information of all concerned that in terms of the provisions of Section 54 of the Calcutta University Act, 1979, (as amended), and, in the exercise of her powers under 9(6) of the said Act, the Vice-Chancellor has, by an order dated 04.09.2025 approved the revised Course Structure for 4-Year Honours and Honours with Research & Syllabus for semester-5 & 6 of Botany, (4-year Honours & Honours with Research/ 3-year MDC) under CCF.

**The above shall take effect from the Odd semester examinations, 2025 and onwards.**

12/9/2025

Prof.(Dr.) Debasis Das

Registrar

SENATE HOUSE

Kolkata-700073

12.09.2025

# UNIVERSITYOFCALCUTTA

## Course Structure 4-year Honours+Research (NEP 2020) BOTANY

| Programme Structure for the Bachelor of Science Degree with BOTANY as Major having Practicals | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Sem** | **DSC/Core** | **Minor** | **IDC** | **AEC** | **SEC** | **CVAC** | **SummerInternship/ Field Visit** | **Dissertation/ Research work** | **Total Credit** |
| | **Level100** | | | | | | | | |
| **1** | **BOT-H-CC1-1-ThBOT-H-CC1-1-P Plantdiversity** | **Plant diversity (Th+Pr)** | **Plants Around Us**** | **From Central Pool** | **BOT-H-SEC-1-ThBOT-H-SEC-1-P MushroomCultivation Technology** | **1. ENVS 2. CV** | | | **21** |
| **2** | **BOT-H-CC2-2-ThBOT-H-CC2-2-P PlantSystematics** | **Plant Systematics (Th+Pr)** | | **From Central Pool** | **BOT-H-SEC-2-ThBOT-H-SEC-2-P Biofertilizer & Biopesticides** | **1. ENVS 2. Central Pool** | **SummerInternship***** | | **21** |
| | **Level200** | | | | | | **Exitoption** | | |
| **3** | **BOT-H-CC3-3-ThBOT-H-CC3-3-P EconomicBotany** | **Plant diversity (Th+Pr)** | | **From Central Pool** | **BOT-H-SEC-3-ThBOT-H-SEC-3-P PlantTissueCultureandHorticulturalPractices** | | | | **21** |
| | **BOT-H-CC4-3-ThBOT-H-CC4-3-P PlantAnatomyandEmbryology** | | | | | | | | |
| **4** | **BOT-H-CC5-4-ThBOT-H-CC5-4-P Phycology** | **Plant Systematics (Th+Pr)** | | **From Central Pool** | | | | | **22** |
| | **BOT-H-CC6-4-ThBOT-H-CC6-4-P Archegoniates** | | | | | | | | |
| | **BOT-H-CC7-4-ThBOT-H-CC7-4-P Palaeobotany** | | | | | | | | |
| | **BOT-H-CC8-4-ThBOT-H-CC8-4-P Pharmacognosyand Ethnobotany** | | | | | | **SummerInternship***** | | |
| | **Level300** | | | | | | **Exitoption** | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 5 | BOT-H-CC9-5-ThBOT-H-CC9-5-P Mycology | Economic Botany (Th+Pr) & Pharmacognosy and Ethno botany (Th+Pr) | | | | | | | 24 |
| | BOT-H-CC10-5-ThBOT-H-CC10-5-P Microbiology | | | | | | | | |
| | BOT-H-CC11-5-ThBOT-H-CC11-5-P Biochemistry | | | | | | | | |
| | BOT-H-CC12-5-ThBOT-H-CC12-5-P CellandMolecularBiology | | | | | | | | |
| 6 | BOT-H-CC13-6-ThBOT-H-CC13-6-P Phytopathology | EconomicBotany (Th+Pr) & Pharmacognosy and Ethno botany (Th+Pr) | | | | | | | 23 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | BOT-H-CC14-6-ThBOT-H-CC14-6-P PlantPhysiology | | | | | | | | |
| | BOT-H-CC15-6-ThBOT-H-CC15-6-P Genetics | | | | | | SummerInternship *** | | |
| | Level 400 | | | | | | Exitoption | | |
| 7 | BOT-H-CC16-7-Th BOT-H-CC16-7-P PlantGeography,Ecologyand Evolution | | | | | | | | 20 |
| | BOT-H-CC17-7-Th BOT-H-CC17-7-P PlantBreeding | | | | | | | Natural Resource Management*(Th+Pr) | |
| | BOT-H-CC18-7-Th BOT-H-CC18-7-P PlantBiotechnology | | | | | | | | |
| | BOT-H-CC19-7-Th BOT-H-CC19-7-P PlantMetabolism | | | | | | | | |
| 8 | BOT-H-CC20-8-Th BOT-H-CC20-8-P Biostatistics | | | | | | | Stress Biology* (Th+Pr) | 20 |
| | BOT-H-CC21-8-Th BOT-H-CC21-8-P ResearchMethodology-1 | | | | | | | Industrial Microbiology*(Th+Pr) | |
| | BOT-H-CC22-8-Th BOT-H-CC22-8-P ResearchMethodology-2 | | | | | | | | |
| Credits | 88 | 32 | 9 | 8 | 12 | 8 | 3 | 12 | 172 |
| Marks | 2200# | 800# | 225## | 200 | 300# | 200 | 75 | 300 | 4300 |

***Candidates who will not pursue Dissertation/ Research work, he/she will have to study 1 additional DSC/Core paper of 4credits in the 7thSemester & 2DSC/Core papers of 4Credits each in the 8thSemester.**

****IDC offered from Botany to be opted in 1st or 2nd or 3rd semester.**

*****Summer internship once in 2nd or 4th or 6th Semester according to the exit option.**

**#For 100 marks paper 75 marks for theory and 25 marks for practical.**

**## For 75 marks paper 50 marks for theory and 25 marks for practical.**

Minor courses will come from two subjects of same broad discipline as Major (m1 & m2)
Students shall study two papers from a single Minor subject (both either from m1 or from m2) in semester-V and shall study two papers from another Minor subject (both either from m1 or from m2) in semester VI.

# Semester V

## MYCOLOGY (THEORY)
## BOT-H-CC9-5-Th

**Total marks 75; Credits 3, Class 45 hours**

1. Hyphal forms; Thallus organization; fungal cell structure; Reproduction (Asexual and sexual) and degeneration of sex; Fungal spore forms and mode of liberation; Life cycle patterns; Affinities with plants and animals; Classification proposed by Hawksworth et al. (1995) and Hibbett et al. (2007) (A brief outline); Fungal DNA Barcoding – a tool for molecular identification. **…….8 lectures**

2. Chytridiomycota: General characteristics; Zygomycota: General characteristics; Ascomycota: General characteristics, types of ascocarps, sexual reproduction and development of ascus and ascospores; Basidiomycota: General characteristics, phenomenon of dikaryotization, development of basidiocarps, basidia and basidiospores; Allied Fungi: occurrence, General characteristics, types of plasmodia; Oomycota: General characteristics; Life cycle of *Synchytrium*, *Rhizopus*, *Ascobolus*, *Agaricus*, and *Phytophthora*. **…….12 lectures**

3. Physiology of spore dormancy, activation, and germination; Fungal nutrition; Nutrition uptake; Growth of Fungi, Environmental factors influencing growth; Chitin and Trehalose synthesis in fungi; Fungal secondary metabolites; An outline of polyketides biosynthesis. **…….8 lectures**

4. Mitotic and meiotic cell division in fungi; Tetrad analyses (Neurospora), sexual compatibility; Sex hormones in fungi; Parasexual cycle; Linear plasmid in fungi (Structure and function); Fungal protoplast, Genetic transformation of filamentous fungi. **…….9 lectures**

5. Food and beverages from fungi (fungi to enhance food value- Cheese, Soy sauce; wine, beer and spirit, Fungi as functional food and nutraceuticals); Mycoprotein (*Fusariumvenenatum*); Industrial Production of alcohol and citric acid; Mycoremediation. **…….8 lectures**

**MYCOLOGY (PRACTICAL)**

**BOT-H-CC9-5-P**

**Total marks 25; Credit 1, Class 30 hours**

| | |
|---|---|
| **1. Work out** | **10 marks** |
| **2. Identification with reasons** | **5 marks** |
| **3. Classroom performance (Practical notebook)** | **3 marks** |
| **4. Field notebook** | **2 marks** |
| **5. Viva-voce** | **5 marks** |

1. Introduction to basic Mycological Techniques and Laboratory Safety; Methods of sterilization, media preparation and culturing.
2. Isolation of fungi from soil/air by the culture plate technique.
3. Work out the following fungi with reproductive structures (including microscopic measurement of Reproductive structures): *Rhizopus*, *Ascobolus*, *Agaricus*, *Aspergillus*, *Alternaria/ Fusarium*.
4. Hyphal types from poroid fungi.
5. Ethanol production.
6. Identification of specimens from the field trip.

**CLASSROOM PERFORMANCE**

1. Laboratory Note book,
2. Slides (permanent) prepared during practical classes.
3. Submission of 5 Macrofungi and field note book.

**Suggested Readings**


1. Webster, J. and Weber, R. (2007) Introduction to Fungi. 3rd edition. Cambridge University Press, Cambridge.
2. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (2007) Introductory Mycology, 4th edition, John Wiley & Sons (Asia) Singapore.
3. Chelin Rani Gnanam (2021) Introduction to Mycology, MJP Publisher
4. Jim Deacon (2005) Fungal Biology, Wiley-Blackwell
5. Punshi S. K. Fungal infections with Color Atlas, 1st Edition, Jaypee Brothers Medical Publishers Pvt. Ltd
6. Duane R. Hospenthal, Michael G. Rinaldi, Thomas J. Walsh (2023) Diagnosis and Treatment of Fungal Infections, Springer Nature
7. Aneja, K.R. and Mehrotra R.S. (2015) An Introduction to Mycology, New Age International Private Limited

8. Gopinath Hait (2017) A Textbook of Mycology, New Central Book Agency
9. Thomas Carrey (2022) Mycology: A Comprehensive Approach, States Academic Press
10. Deacon, J. W. (1988). Introduction to Modern mycology, Wiley–Blackwell.
11. Dube, H.C. (2013). A Text Book of Fungi, 4th Edition. Scientific Publishers (India)
12. Moore, C.J.– Landecker (1996) Fundamentals of the Fungi, 4th Edition (1996), Prentice Hall.
13. Sethi, I.K. and Walia, S.K. (2011). Textbook of Fungi and Their Allies, Macmillan Publishers India Ltd.
14. Zhiqiang An (2004) Handbook of Industrial Mycology, Taylor & Francis Inc
15. Kale, V and Bhusari, K (2021). Applied Microbiology. Himalaya Publishing House, Mumbai.

**MICROBIOLOGY (Theory)**

**(BOT-H-CC10-5-Th)**

**Total marks 75; Credits 3, Class 45 hours**

1. Introduction to Microbiology: Introduction to microbial world. Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming, Martinus William Beijerinck, Sergei N. Winogradsky, Selman A.Waksman, Paul Ehrlich, Elie Metchnikoff, Edward Jenner;

Systems of bacterial classification, Numerical taxonomy, Identifying characters for classification, General properties and principles of classification of microorganisms, Systematics of bacteria, Nutritional types [Definition and examples]. Isolation of pure cultures, Types of culture media, maintenance and preservation of bacterial cultures. Distinguishing features of Archaea and Bacteria. Characteristics of some major groups: Proteobacteria (Enterobacteria), Firmicutes, Mollicutes, Actinobacteria, Spirochaetes, Chlamydiae, mycoplasma. **…….8 lectures**

**2.** General Microbiology:Bacterial growth curve and generation time, Methods of Measurement of bacterial growth, batch, fed batch, continuous and synchronous growth. Physico-chemical factors influencing bacterial growth.Cell wall – chemical structure and differences between Gram +ve& Gram – ve bacteria,Endospore - formation, structure and function, Flagella (ultrastructure) & Pilli,

Genetic Recombination (a) Transformation – with special emphasis on Natural and Induced competence and DNA uptake, (b) Conjugation─ F- factor, $F^+$ X $F^-$, Hfr X $F^-$, concept of F', chromosome mobilization, (c) Transduction– Generalised and specialized.Plasmids, types and function, their application in modern biology. CRISPR-CAS. **…….10 lectures**

3. Economic Importance: Bio-ethanol and bio-diesel production: commercial production from lignocellulosic waste, Biogas production: Methane and hydrogen production using microbial culture. Microorganisms in bioremediation: Degradation of xenobiotics, mineral recovery, removal of heavy metals from aqueous effluents.

Microbes in phyllosphere, water- fresh and marine and air. Microbial interactions- symbiosis, synergism, commensalism, parasitism, amensalism, antagonism and predation. A general account of Endophytes and their interaction with host.

Microbial spoilage of foods – meat, milk, fruits, vegetables and their products; Food poisoning and Food borne pathogenic bacteria- Salmonellosis, Botulism, Cholera, E.coli –poisoning. **…….10 lectures**

4. Medical Microbiology: Control of Microbes: Physical agents- Sunlight, Temperature, steam at atmospheric pressure and steam under pressure, irradiation, filtration.

Chemical Agents- Alcohol, aldehyde, Dyes, Halogens, Phenols, Ethylene oxide.

Principles of chemotherapy, general mode of action of various chemotherapeutic agents: Sulfa drugs, antibiotics- classification and mode of action.

Normal microbial flora of the human body. **…….. 7 lectures**

5. Virus: Viruses:- Discovery, physiochemical and biological characteristics; One step growth curve.Baltimore Classification, General structure with special reference to viroids and prions;

Replication (general account); Lytic cycle (T4 phage) and Lysogenic cycle (Lambda phage), Significance of lysogeny,

Plant virus- types, Transmission and translocation of Plant virus, *Symptoms, Causal organism, Disease cycle and Control measures of Potato Virus Y (PVY), Cauliflower Mosaic Virus (CaMV)*

Economic importance of viruses with reference to vaccine production, role in research, medicine and diagnostics. **…….10 lectures**

**MICROBIOLOGY (Practical)**

**(BOT-H-CC10-5-P)**

**Total marks 25; Credit 1, Class 30 hours**

| | |
|---|---|
| **1. Work out** | **10 marks** |
| **2. Identification with reasons** | **5 marks** |
| **3. Classroom performance (Practical notebook)** | **5 marks** |
| **4. 5. Viva-voce** | **5 marks** |

1. Principles and application of Laboratory instruments- laminar air flow, incubator, autoclave, and incubator shaker.
2. Preparation of Nutrient agar slant, stab, agar plate and nutrient broth and inoculation of bacteria
3. Pure culture techniques: streaking and serial dilution of bacteria from soil, air / water.
4. Bacterial staining- single and mixture of bacteria: Grams staining and negative staining. Study of morphology, Gram Identification and comparison of the results.
5. Pure culture techniques: streaking and serial dilution of bacteria from soil, air / water.
6. Growth curve of bacteria by colorimeter.
7. Antibiotic sensitivity assay disc diffusion method.
8. Microbiological analysis of milk by MBRT assay
9. Biochemical characterization: Starch hydrolysis, Casein hydrolysis.

**Suggested Readings**

1. General Microbiology by R.Y. Stanier, JL Ingrahm, ML Wheelis and PR Painter.

2. Microbiology: Fundamentals and Applications by RM Atlas.

3. General Microbiology by HG Schlegel

4. Introduction to Modern Virology by NJ Dimmock, A J Easton and K N Leppard

5. Basic Virology by EK Wagner, MJ Hewlett, DC Bloom and D Camerini.

6. Microbiology by Prescott L, Harley J, Klein D.

7. Microbiology by pelczarchan and krieg

**Biochemistry (Theory)**

**BOT-H-CC11-5-Th**

**Total marks 75; Credits 3, Class 45 hours**

**1**. Biochemical Foundations:1.1. Covalent and non-covalent bonds; hydrogen bond; Van der Waals forces; 1.2. Structure andproperties of water; 1.3. pH and buffer ( inorganic and organic ); 1.4. Handerson-Hasselbalchequation; 1.5. Isoelectric point. …….6 lectures

2. Molecules of life:2.1. Nucleic Acids – structure of nucleosides and nucleotides ; oligo- and polynucleotides , A, B & Zform of DNA, RNA- different forms; nucleotide derivatives (ATP, NADP),Hoogstein base pairing of nucleic acids, Concept of sugar puckering and base stacking; torsion angle and supercoiling of nucleic acid, 2.2. Proteins – structure and classification of amino acids; primary, secondary, tertiary and quaternary structure of proteins;Protein folding: Leventhal paradox; principles of protein purification, 2.3.Carbohydrates -, Structure of Carbohydrate: stereochemistry – Fischer projection, Haworth perspective, boat and chair conformation, enantiomers and epimers; inverted sugar, derivative sugar 2.4. Lipids - structure of simple lipid and compound lipid (phospholipids and glycolipids), major classes of storage and structural lipids; fatty acids- saturated and unsaturated; Essential fatty acids; Triacylglycerols structure, functions and properties. …….20 lectures

3. Enzymology:3.1. Enzymes – classification and nomenclature (IUBMB); Co-factors and co-enzymes; isozymes, 3.2. Enzyme activity and specificity, active site, activation energy, Reaction rate, Mechanism of enzyme action; enzyme inhibition; 3.3. Enzyme kinetics (Michaelis- Menten equation and Lineweaver Burk plot), simple problems on enzyme kinetics. ……10 lectures

4. Cell membrane:4.1. Membrane chemistry, 4.2. Membrane transport (uniport, symport, antiport), mechanism of ion uptake. ……5 lectures

5. Signal transduction: Basic concept of signal transduction, receptor-ligand interactions, calcium signalling, Cyclic AMP, G protein, MAP-kinase cascade. …….5 lectures

6. Bioenergenetics - Laws of thermodynamics, concept of free energy, endergonic and exergonic reactions, coupled reactions, redox reactions. ATP: structure, its role as energy currency molecule**.** Energy rich bonds- phosphoryl group transfer. ……5 lectures

**Biochemistry (Practical)**

**BOT-H-CC11-5-P**

**Total marks 25; Credit 1, Class 30 hours**

**1. Workout on Plant Biochemistry: Quantitative (10) & Qualitative(5)**

**2. Laboratory notebook (5)**

**3. Viva (5)**

**Qualitative:**

1. Detection of organic acids: citric, tartaric, oxalic and malic acid from laboratory samples.

2. Detection of carbohydrate and protein from plant samples.

3. Detection of the nature of carbohydrate – glucose, fructose, sucrose and starch from laboratory samples.

4. Detection of Ca, Mg, Fe, S from plant ash sample.

**Quantitative:**

1. Preparation of solutions and buffers.

2. Estimation of amino-nitrogen by formol titration method (glycine) .

3. Estimation of glucose by Benedicts quantitative reagent.

4. Estimation of catalase activity in different plant samples..

5. Estimation of urease activity in plant samples.

6. Determination of Km value of Urease.

7. Colorimetric estimation of protein by Folin phenol reagent.

**Suggested Readings**

1.Taiz, L., & Zeiger, E. Plant Physiology (4th ed.), 2006, Sinauer Associates, Inc. Publishers.

2. Hopkins, W.G. &Hiiner, N.P. Introduction to Plant Physiology (3rd ed.) 2004, John Wiley & Sons.

3. Salisbury, F.B. & Ross, C.W. Plant Physiology (4th ed.), 19992, Wadsoworth Publishing Company.

4. Mukherjee, S. & Ghosh, A. Plant Physiology (2nd ed.), 2005, New Central Book Agency.

5. Hames, B.D. Bio-Chemistry (2nd ed.) Viva Books.

6. Sackheim, G. Chemistry for Biology Students (5th ed.) 1996, Benjamin/Cummings

7. Heldt, Hans-Walter. Plant Bio-Chemistry (3rd ed.), 2005. Elsevier Academic Press.

8. Chaudhuri, D., Kar, D.K., and Halder, S.A. Handbook of Plant Biosynthetic Pathways 2008, New Central BookAgencies.

9. Mehta, S.L., Lodha, M.L. & Bane, P.V. Recent Advances in Plant Biochemistry, 1989. I.C.A.R.

10. Conn, E.E. and Stumpf, R.R. Outlines of Bio-Chemistry, Latest Ed., Wiley Eastern.

11. Lehninger Principles of Biochemistry. Sixth Edition. 2013. David L. Nelson, Michael M. Cox. Freeman,Macmillan.

12. Berg, J.M., Tymoczko, J.L., &Stryer, L., Bio-Chemistry, Latest Ed., Freeman Publ.

**Cell and Molecular Biology**

**BOT-H-CC12-5-Th**

**Total marks 75; Credits 3, Class 45 hours**

## Cell Biology

1. Origin and Evolution of Cells:1.1. Evolution of nucleic acid (from PNA to DNA), Concept of RNA world, Ribozymes, First cell, 1.2. Origin of eukaryotic cell (endosymbiotic theory), 1.3. Small RNA-riboswitch, RNA interference, siRNA, miRNA, snRNA, hnRNA- brief idea, 1.4. Organellar DNA (cp- and mt- DNA)……2 lectures

2. Techniques of Study:2.1 Microscopy (Simple, Compound, Fluorescence,Electron-SEM and TEM), 2.2 Spectrophotometry, 2.3 Electrophoresis (Principle and applications of native polyacrylamide gel electrophoresis and SDS PAGE). 2.4 Western blot, Southern blot and Northern blot. 2.5 FISH and GISH

…….6 lectures

3. Nucleus and Chromosome:3.1 Nuclear envelope, nuclear lamina and nuclear pore complex. 3.2 Nucleolus-ultrastructure and ribosome biogenesis. 3.3 Chromatin ultrastructure and DNA packaging in eukaryotic chromosomes (Nucleosome Model). 3.4 Centromere: types, structure and function.

…….4 lectures

4. Cell cycle and its regulation:4.1 Basic introduction to cell cycle: Mitosis and cytokinesis; comparison between plant, animal and yeast cell cycle; chromosome and chromatids positions, structures during pro-meta-ana- telo phase in detail; Spindle pole body organization, duplication, maturation in yeast cell cycle; mitotic check points and role of MPF; proteins involved in cytokinesis- how actomyosin contractile ring forms, matures and constricts in yeast cytokinesis followed by septum formation and generation of two daughter cells.

4.2 Apoptosis, Autophagy and Necrosis: Definition and concept; apoptosis: extrinsic and intrinsic pathways

4.3 Cancer: Development and causes of cancer, Types of cancer. Proto Oncogene, oncogenes-Ras, BCL-2, Tumour suppressor genes-p53, p21 and DNA Repair Gene. …….8 lectures

## Molecular Biology

1. DNA Replication, Transcription and Translation (Prokaryotes & Eukaryotes): 1.1 Central Dogma concept, 1.2 Semiconservative DNA replication – mechanism, enzymes involved in DNA replication- DNA polymerase, DNA gyrase, Helicase, Ligase, primase and other accessory proteins, 1.3. Eukaryotic replication with special reference to replication licensing factor, assembly of new nucleosome, telomerase concept, 1.4. Fidelity of DNA replication- prokaryote: nucleotide selection, proofreading, mismatch repair, 1.5 Transcription: concept of prokaryotic and eukaryotic transcription. Steps of initiation, elongation and termination in prokaryotes, RNA editing, Guide RNA, Aminoacylation of tRNA, 1.6 Translation: Difference between prokaryotic and eukaryotic translation. Prokaryotic translation steps- initiation,

elongation and termination. Concept of genetic code- wobble hypothesis; Descipherence of codon.

…….6 lectures

2. Gene Regulation:2.1 Operon: Concept of Lac-operon, 2.2. Positive and negative control.

…….2 lectures

3. Recombinant DNA Technology: 3.1. Recombinant DNA technology, Restriction endonuclease, types and roles, 3.2. Vector (plasmid pBR 322), 3.3. Marker gene and Reporter gene, 3.4. Steps of cloning technique, 3.5. PCR and its application, 3.6. Genomic DNA and cDNA library, DNA fingerprinting and role of DNA Fingerprinting in Forensic Science. …….4 lectures

## Cell and Molecular Biology (Practical)

**BOT-H-CC12-5-P**

**Total marks 25; Credits 1, Class 30 hours**

| | | |
|---|---|---|
| **1.** | **Work out (Major +Minor)** | **10+5=15** |
| **2.** | **Laboratory Records** | **5** |
| **3.** | **Viva-voice** | **5** |

**1. Introduction to basic instruments:**

1.1 Introduction to light compound microscope: Identify each part and their usage in the microscope; how to focus live cells (plant cells from onion peels/leaf-like secretia or spinach / E coli/ yeast) under the microscope and perform measurements; use of oil immersion lens; microscopic resolution and numerical apertures.

1.2 Counting cells per unit volume with the help of a haemocytometer (Yeast/pollen grains)

1.3 Accurate pipetting and weighing scale usage: practicing accurate pipetting by setting up different reaction volumes of solution A (water) and solution B (any solution like calcium chloride, magnesium chloride, etc) and then use the weighing scale to check their accuracy.

2. Isolation of plant genomic DNA by the C-TAB method and DNA estimation by UV/colorimetric.

3. Study of the nucleolus through hematoxylin/orcein staining and determination of nucleolar frequency.

4. Estimation of DNA content through DPA staining.

5. Estimation of RNA through the orcinol method.

6. Preparation of models/charts: rolling circle, theta replication, semi-discontinuous replication, prokaryotic RNA polymerase and eukaryotic RNA polymerase II, assembly of spliceosome machinery, splicing mechanism in group I and group II introns, ribozyme and alternative splicing.

**Suggested Readings**

Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene, 6th edition, Cold Spring Harbour Laboratory Press, Pearson Publication.

Brown TA. Gene Cloning and DNA Analysis. Wiley.

David Freifelder. Molecular Biology.

Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. 5th Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.

Sharma, V. K. (1991). Techniques in microscopy and cell biology. Tata McGraw-Hill.

Nelson D. L. and Cox M.M. (2008) Lehninger Principles of Biochemistry, 5th Edition.

W.H. Freeman and Company.

Scott F Gilbert. Developmental Biology, 6th edition. Sunderland (MA): SinauerAssociates; 2000. ISBN-10: 0-87893-243-7

Cell and Molecular Biology: Concepts and Experiments. Gerald Karp.

# Semester VI

## PHYTOPATHOLOGY (THEORY)

**BOT-H-CC13-6-Th**

**Total marks 75; Credits 3, Class 45 hours**

1. The history and development of plant pathology; Disease concept; signs and symptoms; Etiology and causal complex; Primary and secondary inoculum; Infection; Pathogenicity and pathogenesis; Necrotroph and Biotroph; Koch's Postulates; Endemic, Epidemic, Pandemic and Sporadic disease; Disease triangle and pyramid; Disease cycle (monocyclic, polycyclic and polyetic); Plant disease epidemiology. ..…..**10 lectures**

2. Pathogenesis- Inoculation; Attachment; Appressorium formation and maturation; Penetration; Role of chemical weapons in pathogenesis (enzymes, toxins and growth regulators); Genetics of plant disease and resistance- Genes and disease; Specialized mechanisms of variability in pathogens; Gene-for-Gene concept. ..…..**10 lectures**

3. Plant defense- Preexisting and induced structural and biochemical defense; Recognition of the pathogen by the plant- Elicitors and Plant receptors; Rapid ion flash; Active oxygen species; Pathogenesis-related proteins; Defense through the production of secondary metabolites; Hypersensitive reactions; PTI and ETI. ..…..**10 lectures**

4. Symptoms, Causal organism, Disease cycle and Control measures of:
Late blight of Potato; Brown spot of rice; Black stem rust of wheat; Stem rot of jute; Citrus canker; Tobacco Mosaic Disease. ..…..**6 lectures**

5. Control of plant diseases: Molecular diagnosis of plant diseases; Plant health legislation; Cultural, chemical and biological control of plant diseases; Integrated pest management; Biotechnology for plant disease control. ..…..**9 lectures**

## PHYTOPATHOLOGY (PRACTICAL)

**BOT-H-CC13-6-P**

**Total marks 25; Credit 1, Class 30 hours**

| | |
|---|---|
| **1. Work out** | **10 marks** |
| **2. Identification with reasons** | **5 marks** |
| **3. Classroom performance (Practical notebook)** | **3 marks** |
| **4. Herbarium specimens of diseases** | **2 marks** |
| **5. Viva-voce** | **5 marks** |

1. Sterilization and incubation - principles and uses of instruments, Culture media and their preparation, Preparation of stabs, slants, and pouring of plates.

2. Isolation of the pathogen from diseased tissues.
3. Preparation of pure culture and subculturing.
4. Inoculation of tuber/stem/fruit.
5. Histopathology of Rust of *Justicia*, Loose smut of wheat/False smut of rice, Powdery mildew of cucurbits, White rust of *Amaranthus*. Slides of uredial, telial, pycnial and aecial stages of *Puccinia graminis*.
6. Study of symptoms from herbarium specimens - bacterial diseases: Citrus Canker; Viral diseases: Vein clearing; Fungal diseases: Early and Late blight of potato, Brown spot and blast of rice, Red rot of sugarcane,White rust of *Amaranthus*, Leaf Spot of *Basella*, Powdery mildew of Cucurbits.

**CLASSROOM PERFORMANCE**

1. Laboratory Note Book of each section must be signed by the respective teacher with the date during practical classes
2. Slides (permanent) prepared during practical classes.
3. Submission (5 Herbarium specimens of diseases)

## Suggested Books:


1. Agrios, G.N. (1997). Plant Pathology, 4th edition, Academic Press, U.K.
2. Mehrotra, R.S. and Aggarwal A. (2017). Plant Pathology. McGraw Hill India.
3. Singh, R.S. (2017) Introduction To Principles Of Plant Pathology, Medtech Publishers.
4. Rangaswami, G. (1988) Diseases of crop Plants of India, 3rd edition, Prentice Hall, India.
5. Sethi, I.K. and Walia, S.K. (2011). Textbook of Fungi and Their Allies, Macmillan Publishers India Ltd.
6. Persley, GJ (1996). Biotechnologies and Integrated Pest Management. CAB International, U.K.
7. Sambamurty, AVSS (2006). A Text Book of Plant Pathology. IK International Publishing House Pvt. Ltd., New Delhi.
8. BalajiAglave (2018) Handbook of Plant Disease Identification and Management, CRC Press
9. Tripathi, SK, Bhale, MS, Yadav, VK and Shrivastava, A (2022). Fundamentals of Plant Pathology. Scientific Publishers, India
10. M. Elangovan, Rashmi Nigam, Sankarganesh E, GeetikaSrivastava (2024) Plant Diseases: Diagnosis, Management, and Control, AGPHBooks
11. Gupta, V. K. (2011) Integrated Disease Management And Plant Health, Scientific (Publication)
12. Meena A.K. (2022) Detection And Diagnosis Of Plant Diseases, Scientific Publishers
13. PrahladMasurkar, Adesh Kumar, Vipul Kumar (2025) Applications of Biotechnology in Plant Pathology, CRC Press

# Plant Physiology (Theory)

## BOT-H-CC14-6-Th

**Total marks—75, Credits-3, Class—45 hours**

**1. Plant-water relations:**

Water Potential and its components, water absorption by roots, aquaporins, pathway of water movement, symplast, apoplast, transmembrane pathways, root pressure, guttation. Ascent of sap–cohesion-tension theory. Transpiration and factors affecting transpiration, antitranspirants, mechanism of stomatal movement. Role of carbon di-oxide, potassium ion, abscisic acid and blue light in stomatal movement. ..…..6 lectures

**2. Mineral nutrition:** Essential and beneficial elements, macro and micronutrients, methods of study and use of nutrient solutions, criteria for essentiality, mineral deficiency symptoms, roles of essential elements, chelating agents. …….5 lectures

**3. Nutrient Uptake andOrganic Translocation:** Nutrient Uptake --Soil as a nutrient reservoir, transport of ions across cell membrane, passive absorption, electrochemical gradient, facilitated diffusion, active absorption, role of ATP, carrier systems, proton ATPase pump and ion flux, uniport, co-transport, symport, antiport. ……..5 lectures

Translocation in the phloem -- Experimental evidence in support of phloem as the site of sugar translocation. Pressure–Flow Model and its critical evaluation; Phloem loading and unloading; Source–sink relationship. …….6 lectures

**4. Plant Growth Regulators and Physiology of flowering:** Plant growth regulators --Discovery, chemical nature (basic structure), bioassay and physiological roles of Auxin, Gibberellins, Cytokinin, Abscisic acid, Ethylene. Mode of action of IAA. Brassinosteroids ,Jasmonic acid and Polyamines as PGRs (brief idea). ……10 lectures

4.2. Physiology of flowering --Photoperiodism, flowering stimulus, Phytochrome, cryptochrome and phototropins- chemical nature and role in photomorphogenesis. low energy responses (LER) and high irradiance responses (HIR), mode of action. Vernalisation – role of low temperature in flowering, Concept of biological clock and biorhythm. ……8 lectures

**5.Dormancy and Senescence:** **5**.1.Dormancy- Types, Causes and Methods of breaking seed dormancy, Biochemistry of seed germination. Acid growth hypothesis and starch statolith concept of IAA, GA and ABA mediated hormonal regulation of dormancy and germination, Physiology of Senescence and Ageing. ……5 lectures

## Plant Physiology (Practical)

**BOT-H-CC14-6-P**

**(Full marks—25, Credit-1)**

1. Plant Physiology experiment ( 1 major and 1 minor) 10 +5 =15

**2.** Classroom performance (Laboratory records) 5

**3.** Viva- voce 5

**Major experiments:**

**1.** Determination of loss of water per stoma per hour.

**2.** Relationship between transpiration and evaporation.

**3.** Measurement of osmotic pressure of storage tissue by weighing method.

**4.** Measurement of osmotic pressure of *Rhoeo*leaf by plasmolytic method.

**5.** Effect of temperature on absorption of water by storage tissue and determination of $Q_{10}$.

**6.** Rate of imbibition of water by starchy, proteinaceous and fatty seeds and effect of seed coat.

7. Determination of rate of transpiration by two surfaces of a leaf.

**Minor experiments**:

1.Determination of the temperature at which beet root cells lose their permeability.

2. Measurement of Relative water content of a leaf.

3.Determination of seed viability by tetrazolium test

4. Preparation of different concentration of Molar, Molal, Normal and Percent solutions from Stock solution.

5. Determination of stomatal frequency of a leaf.

6. Preparation of buffer ( Acetate buffer and Phosphate buffer).

## Suggested Books:


1.Taiz, L., & Zeiger, E. Plant Physiology (4th ed.), 2006, Sinauer Associates, Inc. Publishers.

2. Lincoln Taiz, Eduardo Zeiger, Ian M. Møller, and Angus Murphy. Plant Physiology and Development. ($6^{th}$ ed.)Sinauer Associates.

3. Hopkins, W.G. & Hiiner, N.P. Introduction to Plant Physiology (3rd ed.) 2004, John Wiley & Sons.

4. Salisbury, F.B. & Ross, C.W. Plant Physiology (4th ed.), 19992, Wadsoworth Publishing Company.

5. Wilkins, M.B. Advances Plant Physiology. 1984, ELBS Longman.

6. Davies P.J. (ed.) Plant Physiology: Physiology, Bio-Chemistry & Molecular Biology, Academic Press.
7. Mukherjee, S. & Ghosh, A. Plant Physiology (2nd ed.), 2005, New Central Book Agency.
8. Raman, H. Transport Phenomenon in Plants, 1997. Narosa Publishing House.
9. Voet, D. and Voet, J.G., Bio-Chemistry (3rd ed.), 2005, John Wiley & Sons.
10. Lehninger Principles of Biochemistry. Sixth Edition. 2013. David L. Nelson, Michael M. Cox. Freeman, Macmillan.
11. Singhal, G.S. Concepts of Photobiology: Photosynthesis & Photomorphogenesis, 1999. Narosa Publishing House.
12. Buchanon, Gruissen and Jones. Plant Physiology & Biochemistry: Biochemistry and Molecular Biology of plants, 2000, I.K. International.

**Genetics (Theory)**

**BOT-H-CC15-6-Th**

**Total marks 75; Credits 3, Class 45 hours**

**1. Introduction:** Mendelian genetics and its extension (Modification of Mendelian ratios) .....2 lectures

**2. Linkage, Crossing Over, and Gene Mapping:** 2.1. Sex Chromosomes and Chromosomal Aberrations. - Deletion, Duplication, Translocation, and Inversion, 2.2 Linkage and chromosome mapping in Eukaryotes-Complete and incomplete linkage (example), linked gene does not assort independently(example), linkage group, Crossing over, crossing over produces recombination (example), and Molecular mechanism of crossing over(Holliday model), Gene mapping with three-point test cross, detection of middle gene in three-point test cross, calculation of recombination frequencies, Co-efficient of coincidence and interference, mapping function, Problems on gene mapping. .....5 lectures

**3.Eukaryotic transcription and translation:** 3.1 Transcription factors and functions, 3.2 Steps of transcription, 3.3 Post-translational modifications (5' capping, polyadenylation, RNA splicing), 3.4 Steps of translation including initiation, elongation, termination, 3.5post Post-translational modifications (phosphorylation, glycosylation, ubiquitination, acetylation, methylation), Importance of PTM in disease. .....4 lectures

**4. Mutation, DNA repair and transposition:** 4.1 Point Mutation-Transition, Transversion and Frame shift mutation, 4.2 Molecular mechanisms (tautomerisation, alkylation, deamination, base analogue incorporation, dimerization), DNA repair, transposon (AC-DS system). .....2 lectures

**5. Epistasis and Polygenic inheritance in plants:** 5.1 Incomplete inheritance and Codominance; Inter allelic- Complementary gene interaction (9:7) Ex: *Lathyrusodoratus*; Supplementary gene interaction (9:3:4) eg. Grain colour in Maize and (12:3:1); Epistasis - Dominant e.g.: Fruit colour in *Cucurbitapepo*, 5.2 Polygenic inheritance in plants, 5.3 QTL Mapping. .....3 lectures

**6.Aneuploidy and Polyploidy:** Types, examples, meiotic behaviour and importance of: Aneuploidy, Polyploidy, Speciation and evolution through polyploidy. .....2 lectures

7. **Autosomal and Sex-linked inheritance:** 7.1 Autosomal dominant and recessive pattern of genetic inheritance with examples, 7.2 X-linked inheritance (recessive and dominant with examples and phenotypes. 7.3 Y-linked disorders. .....2 lectures

**8. Genomics and Bioinformatics:** 8.1 Basic idea on Whole genome sequencing (WGS), Gene sequencing (dideoxy method and pyrosequencing) 8.2 Use of databases: GenBank, NCBI, 8.3. Introduction to data analysis tools (e.g., BLAST), structure prediction of protein from amino acid sequence through alpha fold, 8.4 Sequence alignment (pairwise and MSA) 8.5.Basic idea on molecular docking. .....4 lectures

**9.Population and evolutionary genetics:** Gene pool, Allele frequency, Evolution, Natural selection, Genetic drift, Gene flow. .....2 lectures

**10.Special topics:** Genetic testing (carrier screening, prenatal screening), Gene therapy, forensics, GMOs and precision medicine.Transcriptomics and metabolomics. .....3 lectures

**Genetics(Practical)**

**BOT-H-CC15-6-P**

**Total marks 25; Credits 1, Class 30 hours**

| | |
|---|---|
| 1. Genetics Workout | 8 +4 |
| 2. Identification | 3 |
| 3. Classroom performance (Laboratory Records and slides) | 5 |
| 4.Viva-voice | 5 |

**Genetics**

**1.** Introduction to chromosome preparation: Pre-treatment, Fixation, Staining, Squash and Smear preparation, Preparation of permanent slides.

**2.** Determination of mitotic index and frequency of different mitotic stages in pre-fixed root tips of *Allium cepa*.

**3.** Study of mitotic chromosome: Metaphase chromosome preparation, free hand drawing under high power objective, drawing with drawing prism under oil immersion lens, determination of 2n number, and comment on the chromosome morphology of the following specimens from root tips: *Allium cepa, Aloe vera, Lens esculenta*.

**4.** Study of chromosomal aberrations developed due to exposure to any one pollutants/ pesticides, etc.

**5.** Study of meiotic chromosomes: Smear preparation of meiotic cells, identification of different stages and free-hand drawing of the following specimens from flower buds: *Allium cepa*and *Setcreasea*sp.

**6.** Identification from permanent slides: Meiosis – (i) normal stages (ii) abnormal stages – laggard, anaphase bridge, ring chromosome (*Rhoeo discolor*); Mitosis – (i) normal stages, (ii) abnormal stages earlyseparation, late separation, multipolarity, sticky bridge, laggard, fragmentation, (ii) pollen mitosis.

**7.** Bioinformatics:

7.1 Gene sequence search from gene bank, primer design through benchling or snapgene and virtual gel run on a computer. Search for homologous gene lists using NCBI BLAST, 7.2. Structural prediction of protein by AlphaFold3 free online website.

## Suggested Books:


1. Pierce, Benjamin A. Genetics (2nd ed.), 2005, W.H. Freeman & Company.

2. Atherly, A.G., Girton, J.R. & McDonald, J.F. Science of Genetics, 1999, Saunders College Publications.

3. Hartwell, L.H., Hood, L., Goldberg, M.L., Reynolds, A.E., Silver, L.M. & Veres, R.C. Genetics (2nd ed.), 2004, McGraw-Hill.

4. Tamarin, Robert H. Principles of Genetics (7th ed., 2002, Tata McGraw-Hill.

5. Elrod, S.K. & Stanfield, W. Schuam's Outlines Genetics (4th ed.), 2002, Tata McGraw-Hill.

6. Hartl, D.L. & Jones, E.W. Genetics, 2005, Jones & Bartlett Publishers.

7. Lewin, B. Genes VIII, 2004, Pearson Educational International.

8. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. & Losick, R. Molecular Biology of the Gene (5th ed.)2004. Pearson Education Inc.

9. Griffiths, A.I.F., Miller, J.H., Suzuki, D.T., Lewentin, C.R. & Gilbert, M.W. An Introduction to Genetic Analysis,2005 (8th ed.), W.H. Freeman & Company.

10. Brown, T.A. Genomes, 1999, John Wiley & Sons.

11. Brown, T.A. Genomes 3, 2007, Garland Science Publishing.

12. Snustad, D.P. & Simmons, M.J. Principles of Genetics (2nd ed.), 2000, (4th ed.), 2006, John Wiley & Sons.

13. Klug, W.S. & Cummings, M.R. Concepts of Genetics, 2003, Pearson Education.

# Semester V

## PLANT ANATOMY & EMBRYOLOGY (Theory)

## MBOT-CC6-5-Th (MDC)

## (Total Marks 75, Credits 3, Lectures 45 hours)

**PLANT ANATOMY (50 marks)**

**1. Cell and Tissues: 14 lectures**

1.1 Cell wall: ultrastructure,chemical constituents; thickening of cell wall.

1.2 Tissues: meristems, simple and complex tissues, cambium- Structure and function

1.3 Mechanical tissues and the principles governing their distribution in plants.

1.4 Stele: stelar types; leaf-trace and leaf-gap, 1.5 Stomata types (Metcalfe and Chalk, 1950; Stebbins and Khush, 1961).

**2. Primary and secondary growth: 8 lectures**

2.1 Primary structure of stem and root- monocot and dicot. Leaf- dorsiventral and isobilateral, 2.2 Secondary growth: normal (intra- & extra-stelar),

3. **Developmental and Ecological Anatomy: 6 lectures**

3.1 Organization of shoot apex (Tunica–Corpus) and root apex (Korper-Kappe), plastochron, 3.2 Adaptive anatomical features of hydrophytes, xerophytes, halophytes.

4. **Scope of plant anatomy: 2 lectures**

Application in systematics, forensics and pharmacognosy.

**EMBRYOLOGY (25 marks)**

**1. Pre-fertilisationand post- fertilization changes : 10 lectures**

1.1. Microsporogenesis and Microgametogenesis, 1.2. Megasporogenesis and Megagametogenesis (monosporic, bisporic and tetrasporic), 1.3 Pollen germination,1.4 Double fertilization, post-fertilization changes.

**2. Embryo development and apomixis: 5 lectures**

2.1 Embryogenesis in *Capsella,* 2.2 Development of endosperm (3 types),2.3 Apomixis-Apospory and Apogamy, 2.4 Polyembryony- different types.

**PLANT ANATOMY& EMBRYOLOGY (PRACTICAL)**

**MBOT-CC6-P (MDC)**

**Total Marks 25; Credit 1, Class 30 hours**

| | |
|---|---|
| 1.Workout on Plant Anatomy | 10 marks |
| 2. Identification with reasons5 marks | |
| 3.Classroom performance: Lab records | 3 marks |
| Slides | 2 marks |
| 4. Viva– voce5 marks | |

**PLANT ANATOMY**

1. Microscopic studies on: Types of stomata, sclerenchyma and parenchyma cells,sclereids, raphides (*Colocasia*), cystolith (*Ficus* leaf) starch grains, aleurone grains, laticiferous ducts, oil glands.
2. Study of anatomical details through temporary stained mounts- a) Root-Monocot and dicot, b) Stem- Monocot and dicot, c) Leaf- Isobilateral and Dorsiventral,
3. Study of adaptive anatomical features: Hydrophytes (*Nymphaea* – petiole), Xerophytes (*Nerium* – leaf)and Epiphytic root (Orchid -velamen).

**Textbook References:**

**PLANT ANATOMY**

1. Fahn, A. Plant Anatomy (4th ed.), 1990, Wiley Eastern.
2. Eames, A.J. & Mac. Daniels, L.H. An Introduction to Plant Anatomy, Latest Ed., McGraw Hill
3. Esau, K. Anatomy of Seed Plants (2nd ed.), 1977, John Wiley & Sons
4. Pandey, B.P. Plant Anatomy, Latest Ed., S. Chand & Company
5. Tayal, M.S. Plant Anatomy, Latest Ed., Rastogi Publications
6. Roy, P. Plant Anatomy, Latest Ed., New Central Book Agency

**EMBRYOLOGY**

1. Raghavan, V. Molecular Embryology of Flowering Plants, 1997, Camb. University Press.
2. Maheswari, P. An Introduction to Embryology of Angiosperm, Latest Ed., Tata McGraw Hill.

3. Raghavan, V. Embryogenesis in Angiosperms: A Development & Experimental Study, 1986, Cambridge University Press.
4. Bhojwani, S.S. &Bhatnagar, S.D. The Embryology of Angiosperms (4th ed.), 1989, Publishing House.

# Semester V (CC1)/ VI (CC2)

**Cell biology and Genetics (Theory)**

**MBOT CC7-5-Th (MDC)**

**(Candidates can opt for this paper either in Sem V as CC1 or in Sem VI as CC2)**

**Theoretical – 3 credits (marks 75) 45 lectures**

**Cell Biology**

1.Nucleus and Chromosome:

1.1.Ultrastructure of nuclear envelope, nucleolus and their functions, 1.2. Chromatin ultrastructure and DNA packaging in eukaryotic chromosome (Nucleosome concept). Centromere: types, structure and function. 1.3. Ultrastructure of mitochondria, chloroplast, golgi complex, endoplasmic reticulum and their functions ……8 lectures

2. Cell cycle and its regulation:

2.1. Kinetochore and spindle apparatus-structural organization and functions, 2.2.Microtubules-structure, organization and function, 2.3. Mechanism of cell cycle control in Yeast (checkpoints and role of MPF), 2.4.Apoptosis (Brief idea). ……6 lectures

**Genetics :**

1.Introduction:

1.1.Mendelian genetics and its extension (incomplete dominance, codominance, multiple alleles), 1.2. Epistasis (Dominant and Recessive epistasis) and polygenic inheritance in plants.

… 4 lectures

2. Linkage, Crossing over and Gene Mapping

2.1.Complete and incomplete linkage, ), linkage group, 2.2. Crossing over, detection of crossing over (McClintock's experiment), 2.3.Molecular mechanism of crossing over (Holliday model), 2.4.Calculation of recombination frequencies, Gene mapping with three point test cross, 2.5. Molecular mapping – ISH, FISH (brief idea ) …… 8 lectures

3. Chromosomal aberrations-

3.1 Deletion, Duplication, Inversion & Translocation, 3.2 Aneuploidy & Polyploidy-types, importance and role in evolution……4 lectures

4. Central Dogma

4.1 Transcription and Translation. 4.2.Genetic Code – properties. …… 4 lectures

5. Mutation

5.1 Point mutation (tautomerisation; transition, transversion and frame shift), 5.2 Mutagen-physical and chemical. …….4 lectures

6. Structural organisation of Gene:

6.1. One Gene–one polypeptide concept, 6.2. Split gene, Overlapping gene, 6.3. Repetitive DNA tandem and interspersed, 6.4.Transposon (Ac-Ds system), 6.5.Homoeotic gene in plants (ABCE Quartet model of flowering). …….....7 lectures

## CELL BIOLOGY and GENETICS (PRACTICAL)

## MBOT CC7-5-PR (MDC)

| | |
|---|---|
| 1. Work out | 10 |
| 2.Identification | 5 |
| 3.Classroom performance (Laboratory Records and slides) | 3+2 |
| 4. Viva-voce | 5 |

**Cell Biology**

1. Study of plant cell structure with the help of epidermal peel mount of Onion/Rhoeo

2. Measurement of cell size by the technique of micrometry.

3. Study of nucleolus through hematoxylin staining and determination of nucleolar frequency

**Genetics**

1. Introduction to chromosome preparation: Pre-treatment, Fixation, Staining, Squash and Smear preparation, Preparation of permanent slides.

2. Study of mitotic and meiotic chromosome: Identification of different stages and free hand drawings from the permanent slides of roots and flower buds*: Allium cepa*

3. Determination of mitotic index and frequency of different mitotic stages in pre-fixed root tips of *Allium cepa.*

**Suggested Books:**


1. Gupta, P.K. Cytogenetics, Rastogi Publications
2. Guha. J. &Chaudhuri, S.K. , Udvidbigyan: vol. II, Moulik Library (Bengali Version)
3. Jain, H.K. , Genetics , Oxford & IBH Publishing House
4. Kar, D.K. &Halder, S. Cell Biology, Genetics & Molecular Biology , New Central Book Agency

5. Sikdar, J.K., Sen, K. &Giri, P. , PrarambhikUdbhidbidya , Vol II, ( Biomolecules and Cell Biology Genetics) , Santra Publication (Bengali Version)
6. Sen, S. &Kar, D. K., Cytology & Genetics , Narosa Publishing House
7. Santra. S.C. , Practical Botany, Vol II, New Central Book Agency

# Semester VI

## PLANT PHYSIOLOGY AND BIOCHEMISTRY (THEORY)

## MBOT-CC8-6-Th (MDC)

**(Total Marks 75, Credits 3, Lectures 45 hours)**

### Plant Physiology

**1. Transport in plants and Transpiration**

1.1 Ascent of sap and Xylem cavitation, 1.2 Phloem transport and source-sink relation. 1.3 Transpiration-Types, Mechanism of stomatal movement, significance. …….8 lectures

**2. Photosynthesis and Respiration**

2.1 Photosynthesis:Pigments, Action spectra and Enhancement effect, Electron transport system andPhotophosphorylation, $C_3$, $C_4$and CAM photosynthesis, - Reaction and Significance. 2.2 Respiration: Glycolysis & Krebs cycle— Reactions and Significance, ETS and Oxidativephosphorylation. …….10 lectures

**3. Nitrogen metabolism**

Biological dinitrogen fixation, Amino acid synthesis (reductive amination andtransamination). ……4 lectures

**4. Plant Growth regulators**

Physiological roles of Auxin, Gibberellin, Cytokinin, Ethylene, ABA. ….5 lectures

**5. Photoperiodism:** Plant types, Role of phytochrome and GA in flowering and Vernalization.…….4 lectures

**6. Senescence** (brief idea).…….2 lectures

### Biochemistry

**1. Molecules of life:**

1.1 Proteins- Primary, secondary and tertiary structure, classification of amino acids.

1.2 Nucleic acid- DNA structure and types, RNA types,

1.3 Carbohydrates - structure of mono-, di- and polysaccharide; stereoisomers, enantiomers and epimers.

1.4 Lipids - Simple lipid and compound lipid (phospholipids and glycolipids),fatty acids-saturated and unsaturated. …….8 lectures

2. **Enzyme** -- Classifications with examples (IUBMB), Mechanism of action.…4 lectures

## PLANT PHYSIOLOGY AND BIOCHEMISTRY (PRACTICAL)

## MBOT-CC8-6-PR(MDC)

Total Marks 25; Credit 1

| | |
|---|---|
| 1.Experiment on Plant Physiology | 15 marks |
| 2.Classroom performance: Lab records | 5 marks |
| 3. Viva voce | 5 marks |

**Plant Physiology:**

i) Experiment on Plasmolysis.

ii) Measurement of leaf area (graphical method) and determination of transpiration rate per unitarea by weighing method.

iii) Imbibition of water by dry seeds -starchy, proteinaceous and fatty seeds.

iv) Determination of evolution of $O_2$ during photosynthesis (using graduated tube).

v) Determination of evolution of $CO_2$ during aerobic respiration.

**Suggested Books:**

1. Salisbury, F.B. & Ross, C.W. Plant Physiology (4th ed.), 19992, Wadsoworth Publishing Company.

2. Mukherjee, S. &Ghosh, A. Plant Physiology (2nd ed.), 2005, New Central Book Agency.

3. Mehta, S.L., Lodha, M.L. & Bane, P.V. Recent Advances in Plant Biochemistry, 1989. I.C.A.R.

4. Conn, E.E. and Stumpf, R.R. Outlines of Bio-Chemistry, Latest Ed., Wiley Eastern.

5. Lehninger Principles of Biochemistry.Sixth Edition. 2013. David L. Nelson, Michael M. Cox. Freeman, Macmillan.