



# UNIVERSITY OF CALCUTTA

## Notification No. 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.

SENATE HOUSE

KOLKATA-700 073

 12/7/2023  
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
<b>Level 100</b>									
1	BOT-H-CC1-1-Th BOT-H-CC1-1-P Plant diversity	Plant diversity (Th+Pr)	Integrative Palynology **	From Central Pool	BOT-H-SEC-1-Th BOT-H-SEC-1-P Mushroom Cultivation Technology	1.ENVS 2. CV			21
2	BOT-H-CC2-2-Th BOT-H-CC2-2-P Plant Systematics	Plant Systematics (Th+Pr)		From Central Pool	BOT-H-SEC-2-Th BOT-H-SEC-2-P Biofertilizer & Biopesticides	1.ENVS 2. Central Pool	Summer Internship ***		21
<b>Level 200</b>									
<b>Exit option</b>									
3	BOT-H-CC3-3-Th BOT-H-CC3-3-P Economic Botany BOT-H-CC4-3-Th BOT-H-CC4-3-P Plant Anatomy and Embryology	Plant diversity (Th+Pr)		From Central Pool	BOT-H-SEC-3-Th BOT-H-SEC-3-P Plant Tissue Culture and Horticultural Practices				21
4	BOT-H-CC5-4-Th BOT-H-CC5-4-P Phycology BOT-H-CC6-4-Th BOT-H-CC6-4-P Archegoniates BOT-H-CC7-4-Th BOT-H-CC7-4-P Palaeobotany BOT-H-CC8-4-Th BOT-H-CC8-4-P Pharmacognosy and Ethnobotany	Plant Systematics (Th+Pr)		From Central Pool			Summer Internship ***		22
<b>Level 300</b>									
<b>Exit option</b>									
5	BOT-H-CC9-5-Th BOT-H-CC9-5-P Mycology BOT-H-CC10-5-Th BOT-H-CC10-5-P Microbiology BOT-H-CC11-5-Th BOT-H-CC11-5-P Biochemistry BOT-H-CC12-5-Th BOT-H-CC12-5-P Cell and Molecular Biology	Economic Botany (Th+Pr)							24
6	BOT-H-CC13-6-Th BOT-H-CC13-6-P Phytopathology	Pharmacognosy and Ethnobotany (Th+Pr)							23

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

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

\*\* IDC offered from Botany to be opted in 1<sup>st</sup> or 2<sup>nd</sup> or 3<sup>rd</sup> semester.

\*\*\* Summer internship once in 2<sup>nd</sup> or 4<sup>th</sup> or 6<sup>th</sup> Semester according to the exit option.

<sup>#</sup>For 100 marks paper 75 marks for theory and 25 marks for practical.

<sup>##</sup> 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**

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

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. Frenkel, 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

## 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, 3.2 Production 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, papad etc.), drying, storage in salt solutions, 4.3 Food preparations from mushrooms.

(9 lectures)

5. 5.1 Uses of spent mushroom substrate, 5.2 Strain 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, 5.5 Mushroom 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**   
**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 Bentham and Hooker system of classification from the following families: Malvaceae, Leguminosae (Papilionaceae), Solanaceae, Scrophulariaceae, Acanthaceae, Labiales (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, Sinauer Associates, 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. Sambamurthy, 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. Fundamentals 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, field 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**

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

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

<b>Marks</b>	<b>8×100=800</b>	<b>8×100=800</b>	<b>6×100=600</b>	<b>3×75=225</b>	<b>4×50 =200</b>	<b>3×100=300</b>	<b>4×50=20 0</b>		<b>Total Marks = 3200</b>
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**Marks = 25 marks per credit.**

**Total credit = 125 + 3 (for summer internship) = 128**

**\* IDC offered from Botany to be opted in 1<sup>st</sup> or 2<sup>nd</sup> or 3<sup>rd</sup> Semester**

**\*\*Summer Internship once after 2<sup>nd</sup> or 4<sup>th</sup> or 6<sup>th</sup> Semester.**

**\*\*\*SEC to be opted in 1<sup>st</sup> or 2<sup>nd</sup> or 3<sup>rd</sup> 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**

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

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 1<sup>st</sup> or 2<sup>nd</sup> or 3<sup>rd</sup> 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**

<b>1. Workout</b>	<b>15 marks</b>
<b>2. Classroom performance</b>	<b>5 marks</b>
<b>3. Viva</b>	<b>5 marks</b>

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 (3<sup>rd</sup> 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 (7<sup>th</sup> 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, 3.2 Production 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, 5.2 Strain 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, 5.5 Mushroom 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 Bentham 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, Sinauer Associates, 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. Sambamurthy, 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. Fundamentals 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.