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** **BOT-H-CC1-1-P** **Plant diversity**	**Plant diversity (Th+Pr)**	**Plants Around Us****	**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**
	Level 200						**Exit option**		
3	**BOT-H-CC3-3-Th** **BOT-H-CC3-3-P** **Economic Botany**	**Plant diversity (Th+Pr)**		**From Central Pool**	**BOT-H-SEC-3-Th** **BOT-H-SEC-3-P** **Plant Tissue Culture and Horticultural Practices**				**21**
	BOT-H-CC4-3-Th **BOT-H-CC4-3-P** **Plant Anatomy and Embryology**								
4	**BOT-H-CC5-4-Th** **BOT-H-CC5-4-P** **Phycology**	**Plant Systematics (Th+Pr)**		**From Central Pool**					**22**
	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**						**Summer Internship *****		
	Level 300						**Exit option**		
5	**BOT-H-CC9-5-Th** **BOT-H-CC9-5-P** **Mycology**	**Economic Botany (Th+Pr)**							**24**
	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**								
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 ***		
	Level 400						Exit option		
7	BOT-H-CC16-7-Th BOT-H-CC16-7-P Plant Geography, Ecology and Evolution								20
	BOT-H-CC17-7-Th BOT-H-CC17-7-P Biostatistics							Natural Resource Management* (Th+Pr)	
	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							Stress Biology* (Th+Pr)	20
	BOT-H-CC21-8-Th BOT-H-CC21-8-P Research Methodology							Industrial and Environmental Microbiology* (Th+Pr)	
	BOT-H-CC22-8-Th BOT-H-CC22-8-P 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 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)

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