UNIVERSITY OF CALCUTTA

SYLLABUS

FOR

THREE-YEAR B.Sc. HONOURS COURSE

UNDER CHOICE BASED CREDIT SYSTEM

BOTANY

FOR SESSION 2018-2019

Core courses (CC-Total 14 courses to be studied in semesters. All theoretical papers i.e., BOT-A…TH are of 4 credits each and the respective practical papers i.e., BOT-A….P of 2 credits each)

SEM I:

1. Phycology and Microbiology (BOT-A-CC-1-1-TH, BOT-A-CC-1-1-P)
2. Mycology and Phytopathology (BOT-A-CC-1-2-TH, BOT-A-CC-1-2-P)

SEM II

3. Plant anatomy (BOT-A-CC-2-3-TH, BOT-A-CC-2-3-P)
4. Archegoniate (BOT-A-CC-2-4-TH, BOT-A-CC-2-4-P)

SEM III

5. Palaeobotany and Palynology (BOT-A-CC-3-5-TH, BOT-A-CC-3-5-P)
6. Reproductive biology of Angiosperms (BOT-A-CC-3-6-TH, BOT-A-CC-3-6-P)
7. Plant systematic (BOT-A-CC-3-7-TH, BOT-A-CC-3-7-P)

SEM IV

8. Plant geography, Ecology and Evolution (BOT-A-CC-4-8-TH, BOT-A-CC-4-8-P)
9. Economic Botany (BOT-A-CC-4-9-TH, BOT-A-CC-4-9-P)
10. Genetics (BOT-A-CC-4-10-TH, BOT-A-CC-4-10-P)

SEM V

11. Cell and Molecular biology (BOT-A-CC-5-11-TH, BOT-A-CC-5-11-P)
12. Biochemistry (BOT-A-CC-5-12-TH, BOT-A-CC-5-12-P)

SEM VI

13. Plant Physiology (BOT-A-CC-6-13-TH, BOT-A-CC-6-13-P)
14. Plant Metabolism (BOT-A-CC-6-14-TH, BOT-A-CC-6-14-P)

Skill enhancement courses (SEC- 2, two papers to be selected from the list taking 1 from SEC A in 3rd SEM and 1 from SEC B in 4th SEM. Both the papers of 2 credits each and theoretical only)

SEC A (SEM III)

1. Applied Phycology, Mycology and Microbiology (BOT-A-SEC-A-3-1)
2. Biofertilizers (BOT-A-SEC-A-3-2)

SEC B (SEM IV)

3. Plant Breeding (BOT-A-SEC-B-4-3)
4. Mushroom Culture Technology (BOT-A-SEC-B-4-4)

Discipline specific elective courses (DSE, four courses to be selected from the 2 groups (A & B). A student shall choose any one paper from each of Group- A and Group- B in 5th AND 6th SEM. Each course comprises of theoretical component of 4 credits and practical ones of 2 credits)

DSE-A (Group- A)

SEM V

1. Biostatistics (BOT-A-DSE-A-5-1-TH, BOT-A-DSE-A-5-1-P)
2. Industrial and Environmental Biology (BOT-A-DSE-A-5-2-TH, BOT-A-DSE-A-5-2-P)

SEM VI

3. Medicinal and Ethnobotany (BOT-A-DSE-A-6-3-TH, BOT-A-DSE-A-6-3-P)
4. Stress Biology (BOT-A-DSE-A-6-4-TH, BOT-A-DSE-A-6-4-P)

DSE-B (Group-B)

SEM V

5. Plant Biotechnology (BOT-A-DSE-B-5-5-TH, BOT-A-DSE-B-5-5-P)
6. Horticultural practices and Post Harvest Technology (BOT-A-DSE-B-5-6-TH, BOT-A-DSE-B-5-6-P)

SEM VI

7. Research Methodology (BOT-A-DSE-B6-7-TH, BOT-A-DSE-B-6-7-P)
8. Natural resource management (BOT-A-DSE-B-6-8-TH, BOT-A-DSE-B-6-8-P)

DISSERTATION/PROJECT: A Dissertation / Project may be given in lieu of a DSE. This is considered as a special course and will be of 6 credits. (Vide page 4 of CUS/268(CIR/18, dated 07.05.2018)). However, the details of the topics, modalities of evaluation etc. to be notified latter on.

SEMESTER	COURSE OPTED	COURSE NAME	CREDIT
I	Core Course 1- BOT-A-CC-1-1-TH	Phycology and microbiology	4
	Core Course 1- BOT-A-CC-1-1-P	Phycology and microbiology Practical	2
	Core Course 2- BOT-A-CC-1-2-TH	Mycology and phytopathology	4
	Core Course 2- BOT-A-CC-1-2-P	Mycology and phytopathology Practical	2
II	Core Course 3- BOT-A-CC-2-3-TH	Plant anatomy	4
	Core Course 3- BOT-A-CC-2-3-P	Plant anatomy Practical	2
	Core Course 4- BOT-A-CC-2-4-TH	Archegoniate	4
	Core Course 4- BOT-A-CC-2-4-P	Archegoniate Practical	2
III	Core Course 5- BOT-A-CC-3-5-TH	Palaeobotany and palynology	4
	Core Course 5- BOT-A-CC-3-5-P	Palaeobotany and palynology Practical	2
	Core Course 6- BOT-A-CC-3-6-TH	Reproductive biology of angiosperms	4
	Core Course 6- BOT-A-CC-3-6-P	Reproductive biology of angiosperms Practical	2
	Core Course 7- BOT-A-CC-3-7-TH	Plant systematics	4
	Core Course 7- BOT-A-CC-3-7-P	Plant systematics Practical	2
	SEC A – BOT-A-SEC-A-3-1/ BOT-A-SEC-A-3-2	Only **ONE** paper to be selected	2
IV	Core Course 8- BOT-A-CC-4-8-TH	Plant geography, ecology and evolution	4
	Core Course 8- BOT-A-CC-4-8-P	Plant geography, ecology and evolution Practical	2
	Core Course 9- BOT-A-CC-4-9-TH	Economic botany	4
	Core Course 9- BOT-A-CC-4-9-P	Economic botany Practical	2
	Core Course 10- BOT-A-CC-4-10-TH	Genetics	4
	Core Course 10- BOT-A-CC-4-10-P	Genetics Practical	2
	SEC B – BOT-A-SEC-B-4-3/ BOT-A-SEC-B-4-4	Only **ONE** paper to be selected	2
V	Core Course 11- BOT-A-CC-5-11-TH	Cell and molecular biology	4
	Core Course 11- BOT-A-CC-5-11-P	Cell and molecular biology Practical	2
	Core Course 12- BOT-A-CC-5-12-TH	Biochemistry	4
	Core Course 12- BOT-A-CC-5-12-P	Biochemistry Practical	2
	DSE A: BOT-A-DSE-A-5-1 & 2-TH & P	Only **ONE** paper to be selected from Group A	4 & 2
	DSE B: BOT-A-DSE-B-5-5 & 6-TH & P	Only **ONE** paper to be selected from Group B	4 & 2

VI	Core Course 13- BOT-A-CC-6-13-TH	Plant physiology	4
	Core Course 13- BOT-A-CC-6-13-P	Plant physiology practical	2
	Core Course 14- BOT-A-CC-6-14-TH	Plant metabolism	4
	Core Course 14- BOT-A-CC-6-14-P	Plant metabolism Practical	2
	DSE A: BOT-A-DSE-A-6-3&4-TH & P	Only **ONE** paper to be selected Group A	4 & 2
	DSE B: BOT-A-DSE-B-6-7&8 -TH & P	Only **ONE** paper to be selected Group B	4 & 2

C.U. B.Sc. BOTANY (HONOURS)

SEMESTER I

CORE COURSE 1
PHYCOLOGY AND MICROBIOLOGY (BOT-A-CC-1-1-TH)
THEORETICAL
(Credits 4, Lectures-60)

PHYCOLOGY

1. General account :

1.1. Thallus organization, Structure of algal cell, 1.2. Ultrastructure of Plastids and Flagella, 1.3. Origin and evolution of sex, 1.4. Life cycle patterns, 1.5. Significant contributions of important phycologists (Fritsch, Smith, R. N. Singh, T.V. Desikachary, H.D. Kumar, M.O.P. Iyengar)

…….5 lectures

2. Classification:

2.1. Criteria and basis of Fritsch's classification

2.2. Classification by Lee (2008) upto phylum with examples

2.3. Salient features of Cyanobacteria, Rhodophyta, Chlorophyta , Charophyta, Bacillariophyta, Xanthophyta, Phaeophyta, Heterokantophyta.

…….5 lectures

3. Cyanobacteria:

3.1. Ultrastructure of cell, 3.2. Heterocyst - structure and function, 3.3. Ecology.

…….4 lectures

4. Bacillariophyta:

4.1. Cell structure, 4.2. Cell division, 4.3. Auxospore formation in Centrales and Pennales.

…….6 lectures

5. Life History:

5.1. *Chlamydomonas*, 5.2. *Oedogonium*, 5.3. *Chara*, 5.4. *Ectocarpus*, 5.5. *Polysiphonia*, 5.6. Evolutionary significance of *Prochloron*.

…….10 lectures

MICROBIOLOGY

1. *Virus*:

1.1. Discovery, 1.2.Plant virus- types, 1.3. Transmission and translocation of Plant virus, 1.4. TMV-

Physicochemical characteristics and Multiplication, 1.5. One step growth curve, 1.6. Lytic cycle (T4 phage) and Lysogenic cycle (Lambda phage), Significance of lysogeny, 1.7.Viroids and Prions.

…….10 lectures

2. *Bacteria*:

2.1. Discovery, .2.2. Distinguishing features of Archaea and Bacteria, 2.3. Characteristics of some major groups: Proteobacteria (Enterobacteria), Firmicutes, Mollicutes, Actinobacteria, Spirochaetes, Chlamydiae, 2.4. Bacterial growth curve and generation time, 2.5.Flagella (ultrastructure) & Pilli, 2.6. Cell wall – chemical structure and differences between Gram +ve & Gram – ve bacteria, 2.7. Bacterial genome and plasmid, 2.8. Endospore - formation, structure and function, 2.9.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.

…….20 lectures

PRACTICAL- PHYCOLOGY AND MICROBIOLOGY (BOT-A-CC-1-1-P)
(Credits 2)

1. Work out: Algae, Bacterial staining
2. Identification with reasons: (Algae and bacteria)
3. Classroom performance (Lab notebook, submission and permanent slides)
4. Viva- voce

ALGAE

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

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

MICROBIOLOGY

1. Preparation of bacterial media – (a) Nutrient agar and nutrient broth, (b) Preparation of slants and pouring Petri-plates.

2. Sub-culturing of bacterial culture.

3. Gram staining from bacterial culture.

4. Microscopic examination of bacteria from natural habitat (curd) by simple staining.

FIELD WORK

At least one local excursion to be conducted for study and collection of algae (only 5 from natural habitat) and another local excursion should be conducted to give an introductory idea about plant diversity (Collection not required).

CLASSROOM PERFORMANCE

1. Laboratory Note Book of each section must be signed by the respective teacher with date during practical classes.

2. Slides (permanent) prepared during practical classes.

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

CORE COURSE 2
MYCOLOGY AND PHYTO-PATHOLOGY (BOT-A-CC-1-2-TH)
THEORETICAL
(Credits 4, Lectures 60)

MYCOLOGY

1. General Account:

1.1. Hyphal forms, 1.2. Fungal spore forms and mode of liberation, 1.3. Sexual reproduction and degeneration of sex, 1.4. Parasexuality and sexual compatibility, 1.5. Life cycle patterns.

…….6 lectures

2. Classification:

2.1. Classification of Fungi (Ainsworth, 1973) upto sub-division with diagnostic characters and examples. 2.2. General characteristics of Myxomycota, Oomycota, Zygomycota, Ascomycota, Basidiomycota, Deuteromycota.

…….6 lectures

3. Life history:

3.1. *Synchytrium*, 3.2. *Rhizopus*, 3.3. *Ascobolus*, 3.4. *Agaricus*.

…….10 lectures

4. *Mycorrhiza*:

4.1. Types with salient features, 4.2. Role in Agriculture & Forestry.

…….4 lectures

5. Lichen:

5.1. Types, 6.2. Reproduction, 6.3. Economic and ecological importance

…….4 lectures

PHYTO-PATHOLOGY

1. Terms and Definitions :

1.1. Disease concept, 1.2. Symptoms, 1.3. Etiology & causal complex, 1.4. Primary and secondary inocula, 1.5. Infection, 1.6. Pathogenecity and pathogenesis, 1.7. Necrotroph and Biotroph, 1.8. Koch's Postulates, 1.9. Endemic, Epidemic, Pandemic and Sporadic disease, 1.10. Disease triangle, 1.11. Disease cycle (monocyclic, polycyclic and polyetic).

…….6 lectures

2. Host – Parasite Interaction:

2.1. Mechanism of infection (Brief idea about Pre-penetration, Penetration and Post-penetration), 2.2. Pathotoxin (Definition,criteria and example), 2.3. Defense mechanism with special reference to Phytoalexin, 2.4. Resistance- Systemic acquired and Induced systemic.

…….6 lectures

3. Plant Disease Management :

3.1. Quarantine, 3.2. Chemical, 3.3. Biological, 3.4. Integrated.

…….8 lectures

4. Symptoms , Causal organism, Disease cycle and Control measures of:

4.1. Late blight of Potato, 4.2. Brown spot of rice, 4.3. Black stem rust of wheat, 4.4. Stem rot of jute.

…….10 lectures

PRACTICAL- MYCOLOGY AND PHYTO-PATHOLOGY (BOT-A-CC-1-2-P)
(Credits 2)

MYCOLOGY

1. Work out of the following fungi with reproductive structures (including microscopic measurement of Reproductive structures): *Rhizopus* (asexual), *Ascobolus* , *Agaricus* .

2. Study from permanent slides: Zygospore of *Rhizopus*, Conidia of *Fusarium*,Conidiophore of

Penicillium.

3. Morphological study of Fungi (fruit body of *Polyporus*, *Cyathus*), Lichens (fruticose and foliose).

PHYTO- PATHOLOGY

1. Preparation of fungal media (PDA).

2. Sterilization process.

3. Isolation of pathogen from diseased leaf.

4. Inoculation of fruit and subculturing.

5. Identification : Pathological specimens of Brown spot of rice, Bacterial blight of rice , Loose smut of wheat, Stem rot of jute, Late blight of potato; Slides of uredial, telial, pycnial & aecial stages of *Puccinia graminis*.

FIELD WORK

At least one local excursion to be conducted for study and collection of macrofungi (only 5).

CLASSROOM PERFORMANCE

1. Laboratory Note Book of each section must be signed by the respective teacher with date during practical classes

2. Slides (permanent) prepared during practical classes.

3. Submission (5 Macro fungi)

SEMESTER- II

CORE COURSE 3

PLANT ANATOMY (BOT-A-CC-2-3-TH)

(Credits 4, Lectures 60)

ANATOMY

1. Cell wall:

1.1. Ultrastructure & Chemical constituents, 1.2. Plasmodesmata- ultrastructure, 1.3. Concept of Apoplast and Symplast, 1.4. Growth and Thickening of cell wall.

…….8 lectures

2. Stomata:

2.1. Types (Metcalfe and Chalk, Stebbins and Khush).

…….4 lectures

3. Stele:

3.1 Leaf-trace and leaf-gap, 3.2. Stelar types & evolution

…….4 lectures

4. Primary structure of stem and root- Monocot and Dicot. Leaf- dorsiventral and isobilateral.

…….8 lectures

5. Secondary growth:

5.1. Normal (intra- & extra-stelar), 5.2. Anomalous (stem of *Bignonia*, *Boerhavia*, *Tecoma*, *Dracaena* and root of *Tinospora*).

…….12 lectures

6. Mechanical tissues and the Principles governing their distribution in plants.

……..8 lectures

7. Developmental Anatomy:

7.1. Organisation of shoot apex (Tunica–Corpus) and Root apex (Korper-Kappe), 7.2. Plastochrone.

……..8 lectures

8. Ecological Anatomy:

Adaptive anatomical features of 8.1. Hydrophytes, 8.2. Xerophytes.

…….4 lectures

9. Scope of plant anatomy: application in systematics, forensics and pharmacognosy.

…….4 lectures

PRACTICAL- PLANT ANATOMY (BOT-A-CC-2-3-P)

(Credits 2)

1.Workout on Plant Anatomy

2. Identification with reasons

3.Classroom performance: (Lab records, slides)

4. Viva

PLANT ANATOMY

1. Microscopic studies on: Types of stomata, 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- Monocot and dicot.

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) and Xerophytes (*Nerium* – leaf).

CORE COURSE 4
ARCHAEGONIATE (BOT-A-CC-2-4-TH)
THEORITICAL
(Credits 4, Lectures 60)

BRYOPHYTES

1. General Account :

1.1. General characteristics and adaptations to land habit, 1.2. Classification (Strotler and Crandle Strotler, 2009) up to class with diagnostic characters and examples.

…….4 lectures

2. Life History: Gametophyte structure and Reproduction, Development and Structure of sporophyte, Spore dispersal in:

2.1. *Marchantia*, 2.2. *Anthoceros,* 2.3*. Funaria.*

…….6 lectures

3. Phylogeny:

3.1. Unifying features of archaegoniates; transition to land habit, 3.2. Origin of Alternation of Generations (Homologous and Antithetic theory), 3.3. Evolution of Sporophytes (Progressive and Regressive concept), 3.4. Origin of Bryophytes.

…….4 lectures

4. Importance :

Role of bryophytes in: 4.1. Plant succession, 4.2. Pollution Monitoring, 4.3. Economic importance of bryophytes with special reference to *Sphagnum*.

…….2 lectures

PTERIDOPHYTES

1. General Account:

1.1. Colonisation and rise of early land plants, 1.2. Classification of vascular plants by Gifford & Foster (1989) upto division (Rhyniophyta to Filicophyta) with diagnostic characters and examples.

…….4 lectures

2. Life History:

Sporophyte structure, Reproduction and Structure of gametophyte in 2.1. *Psilotum*, 2.2. *Selaginella*, 2.3. *Equisetum*, 2.4. *Pteris*.

…….8 lectures

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

…….4 lectures

4. Heterospory and Origin of Seed habit.

…….4 lectures

5. Economic importance as food, medicine and Agriculture.

…….2 lectures

GYMNOSPERMS

1. Classification of vascular plants by Gifford & Foster (1989) upto division (Progymnospermophyta to Gnetophyta) with diagnostic characters and examples.

…….4 lectures

2. Progymnosperms :
Diagnostic characters of the group, 2.2.Vegetative and reproductive features of Archeopteris, 2.3. Phylogenetic importance.

…….6 lectures

3. Life History :

Distribution in India; Vegetative and Reproductive structure of sporophyte, Development of gametophyte in : 3.1. *Cycas* , 3.2. *Pinus* and 3.3. *Gnetum*.

…….8 lectures

4. Economic Importance with reference to Wood, Resins, Essential oils, and Drugs.

…….4 lectures

PRACTICAL- ARCHAEGONIATE (BOT-A-CC-2-4-P)
(Credits 2)

1.Workout on Pteridophytes

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

3.Classroom performance: (Lab records, slides)

4. Field report

5. Viva

BRYOPHYTES

1. Morphological study of the plant body: Genera as mentioned in theoretical syllabus and *Riccia, Porella*.

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

PTERIDOPHYTES

1. Morphological study of the sporophytic plant body: Genera as mentioned in the theoretical syllabus and *Lycopodium, Ophioglossum* and *Marsilea*.

2. Workout of the reproductive structures: *Selaginella, Equisetum, Pteris*.

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

GYMNOSPERMS

1. Morphological study: *Cycas* (microsporophyll and megasporophyll), *Pinus* (female and male cone), *Gnetum* (female and male cone).

2. Study from permanent slides: *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).

FIELD STUDY

Botanical excursion to familiarize the students with the natural habitats of these groups is desirable. No individual collection should be allowed. Students should submit only photographs in their field report.

SEMESTER- III

CORE COURSE-5

PALAEOBOTANY AND PALYNOLOGY (BOT-A-CC-3-5-TH)

THEORETICAL

(Credits 4, Lectures 60)

PALAEOBOTANY & PALYNOLOGY

1. Geological time scale with dominant plant groups through ages.

…….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.Importance of fossil study.

…….12 lectures

3. Fossil Pteridophytes:

Structural features, Geological distribution and Evolutionary significance of 3.1. *Rhynia*, 3.2. *Lepidodendron* (Reconstructed), 3.3. *Calamites* (Reconstructed).

…….10 lectures

4. Fossil gymnosperms:

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

…….10 lectures

5. Indian Gondwana System - Three fold division with major megafossil assemblages.

…….6 lectures

6. Palynology:

6.1. Spore and Pollen, 6.2. Pollen aperture types, 6.3. NPC classification (Erdtman). 6.4. Pollen wall-Sporopollenin, Stratification and Ornamentation (sculpturing).

…….10 lectures

7. Applied Palynology:

Basic concepts of: 7.1. Palaeopalynology, 7.2. Aeropalynology, 7.3. Forensic palynology, 7.4. Melissopalynology.

…….8 lectures

PRACTICAL- PALAEOBOTANY AND PALYNOLOGY (BOT-A-CC-3-5-P)
(Credits 2)

1. Study from permanent preparations
2. Identification with reasons
3. Classroom performance: (Lab records)
4. Viva

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*).

CLASSROOM PERFORMANCE

1. Laboratory Note Book of each section must be signed by the respective teacher with date during practical classes.

CORE COURCE- 6
REPRODUCTIVE BIOLOGY OF ANGIOSPERMS (BOT-A-CC-3-6-TH)
THEORETICAL
(Credits 4, Lectures 60)

MORPHOLOGY OF ANGIOSPERMS

1. Inflorescence types with examples.

…….8 lectures

2. Flower, induction of flowering, flower development- genetic and molecular aspects.

…….14 lectures

3. Fruits and seeds - types with examples.

…….8 lectures

EMBRYOLOGY

1. **Pre-fertilisation changes :**

1.1. Microsporogenesis and Microgametogenesis, 1.2. Megasporogenesis and Megagametogenesis (monosporic, bisporic and tetrasporic).

…….6 lectures

2. **Fertilisation:**

2.1. Pollen germination, 2.2. Pollen tube- growth, entry into ovule and discharge, 2.3. Double fertilization.

…….6 lectures

3. **Post-fertilization changes :**

3.1. Embryogenesis in Capsella, 3.2. Development of Endosperm (3 types).

…….10 lectures

4. **Apomixis & Polyembryony:**

4.1. Apomixis- Apospory and Apogamy, 4.2.Polyembryony- different types.

…….8 lectures

PRACTICAL- REPRODUCTIVE BIOLOGY OF ANGIOSPERMS (BOT-A-CC-3-6-P)
(Credits 2)

1. Identification with reasons (Morphology)
2.Classroom performance: (Lab records)
3. Field Records (Field note book/ project work)
4. Viva

REPRODUCTIVE BIOLOGY OF ANGIOSPERMS

1. Inflorescence types- study from fresh/ preserved specimens
2. Flowers- study of different types from fresh/ preserved specimens
3. Fruits- study from different types from fresh/preserved specimens
4. Study of ovules (permanent slides/ specimens/photographs)- types (anatropous, orthotropous, amphitropous and campylotropous)
5. Field study desirable
6. A project supported along with photographs taken during field study to be submitted giving comprehensive idea about different types of inflorescence, flowers and fruits.

CLASSROOM PERFORMANCE

Same as above.

CORE COURSE- 7
PLANT SYSTEMATICS (BOT-A-CC-3-7-TH)
THEORETICAL
(Credits 4, Lectures 60)

TAXONOMY OF ANGIOSPERMS

1. Introduction:

1.1. Components of Systematic: Nomenclature, Identification, Classification; 1.2. Taxonomy and its phases - Pioneer, Consolidation, Biosystematic and Encyclopaedic; alpha- and omega- taxonomy.

…….6 lectures

2. 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.

…….6 lectures

3. Systems of classification:

Broad outline of Bentham & Hooker (1862-1883), Cronquist (1988), Takhatajan (1991) - system of classification with merits and demerits. Brief reference of angiosperm phylogeny group (APG III) classification.

3.1. Systematics in Practice: Herbaria and Botanical Gardens – their role in teaching and research; important Herbaria and Botanical Gardens of India and world (3 each); 3.2. Dichotomous keys – indented and bracketed.

…….20 lectures

4. Phenetics and Cladistics:

Brief idea on Phenetics, Numerical taxonomy- methods and significance; Cladistics- construction of dendrogram and primary analysis; Monophyletic, polyphyletic and paraphyletic groups; Plesiomorphy and apomorphy.

…….8 lectures

5. Data sources in Taxonomy:

Supportive evidences from: 5.1. Phytochemistry, 5.2. Cytology, 5.3. Palynology and 5.4. Molecular biology data (Protein and Nucleic acid homology).

…….8 lectures

6. Diagnostic features, Systematic position (Bentham & Hooker and Cronquist), Economically important plants (parts used and uses) of the following families:

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

6.2. Dicotyledons: Nymphaeaceae, Magnoliaceae, Leguminosae (subfamilies), Polygonaceae, Euphorbiaceae, Malvaceae, Umbelliferae (Apiaceae), Labiatae (Lamiaceae), Solanaceae, Scrophulariaceae, Acanthaceae, Rubiaceae, Cucurbitaceae, Compositae (Asteraceae).

…….12 lectures

PRACTICAL- PLANT SYSTEMATICS (BOT-A-CC-3-7-P)
(Credits 2)

1.Workout on Angiosperms

2. Spot Identification

3.Classroom performance: (Lab records)

4. Field Records (Field note book, Herbarium specimens)

5. Viva

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 Hooker system of classification from the following families: Malvaceae, Fabaceae (Papilionaceae), Solanaceae, Scrophulariaceae, Acanthaceae, Labiatae (Lamiaceae), Rubiaceae.

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

FIELD WORK

At least three excursions including one excursion to Acharya Jagadish Chandra Bose Indian Botanic Garden (Shibpur, Howrah) and 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 specimen: Preparation of 25 angiospermic specimens (identified with author citation, voucher number and arranged following Bentham & Hooker's system of classification) to be submitted during examination.

CLASSROOM PERFORMANCE

Same as above.

SEMESTER IV
CORE COURSE-8
PLANT GEOGRAPHY, ECOLOGY AND EVOLUTION (BOT-A-CC-4-8-TH)
THEORETICAL
(Credits 4, Lectures 60)

PLANT GEOGRAPHY

1. Phytogeographical regions:

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

…….8 lectures

2. Endemism:

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

…….6 lectures

ECOLOGY

1. Preliminary idea on:

1.1. Habitat and Niche, 1.2. Ecotone and edge–effect, 1.3. Microclimate, 1.4. Ecads, ecotype and ecoclines, 1.5. Carrying capacity.

…….4 lectures

2. Community ecology:

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

…….6 lectures

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

…….4 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. Seed-banks, 4.5. Cryopreservation

…….16 lectures

EVOLUTION

1.1 Introduction, 1.2. Theories of evolution: 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 speciation; Coevolution, Adaptive radiation, Reproductive isolation

…….4 lectures

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

…….6 lectures

PRACTICAL- PLANT GEOGRAPHY, ECOLOGY AND EVOLUTION (BOT-A-CC-4-8-P)

(Credits 2)

1.Workout on ecological parameters

2.Classroom performance: (Lab records)

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

4. Viva

PLANT GEOGRAPHY

1. Field visit- at least one long excursion at different 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) Frequency, density and abundance of components (to be done during excursion/ field visit).

2. Comparative anatomical studies of leaves form polluted and less polluted areas.

3. Measurement of dissolved O_2 by azide modification of Winkler's method.

4. Comparison of free CO_2 from different sources.

CORE COURSE- 9

ECONOMIC BOTANY (BOT-A-CC-4-9-TH)

THEORETICAL

(Credits 4, Lectures 60)

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.

…….6 lectures

2. Cereals: Rice and wheat (origin, morphology, processing and uses).

…….6 lectures

3. Legumes: Origin, morphology and uses of gram and mung bean. Importance to man and environment.

…….6 lectures

4. Sugar and starches: Morphology and processing of sugarcane, products and byproducts of sugarcane industry. Potato- morphology, propagation and uses.

…….5 lectures

5. Spices: Listing of important spices, their family and part used.

…….6 lectures

6. Beverages: Tea (morphology, processing and uses).

…….5 lectures

7. Oil and fats: General description, classification, extraction, their uses and health implications of mustard, soybean, coconut (Botanical name, family and uses). Essential oils- general account, extraction methods, comparison with fatty oils and their uses.

…….10 lectures

8. Drug-yielding plants: Therapeutic and habit forming drugs with special reference to Cinchona, Digitalis, Papavar, Cannabis and Tobacco (morphology, processing, uses and health hazards).

…….8 lectures

9. Timber: general account with special reference to Sal and Teak.

…….4 lectures

10. Fibers: Cotton and Jute (Morphology, extraction and uses).

…….4 lectures

PRACTICAL- ECONOMIC BOTANY (BOT-A-CC-4-9-P)

(Credits 2)

1. Workout, micro-chemical tests

2. Identification- T.S./L.S. of permanent slides

3.Classroom performance: (Lab records, permanent slides)

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

5. Field record of the visit, properly authenticated by escorting teacher

ECONOMIC BOTANY

1. Cereals: Wheat (habit sketch, L.S./T.S. of grain, starch grains, micro-chemical tests); rice (habit sketch, study of paddy and grain, starch grains, micro-chemical tests)
2. Legume: Soybean, ground nut (habit, fruit, seed structure, micro-chemical tests)
3. Source of sugars and starches: Sugarcane (habit sketch; cane juice- micro-chemical tests); potato (habit sketch, tuber morphology, T.S. of tuber to show localization of starch grains, W.M. of starch grains, micro-chemical tests.
4. Tea- tea leaves, tests for tannin
5. Mustard- plant specimen, seeds, tests for fat in crushed seeds
6. Habit sketch of *Digitalis*, *Papaver* and *Cannabis*.
7. Sal, Teak- section of young stem.
8. Jute- specimen, transverse section of stem, tests for lignin on T.S. of stem and study of fibre following maceration technique.

CORE COURSE 10
GENETICS (BOT-A-CC-4-10-TH)
THEORETICAL
(Credits 4, Lectures 60)

1. Introduction: Mendelian genetics and its extension

…….6 lectures

2. Linkage, Crossing over and Gene Mapping:

2.1.Complete and incomplete linkage (example), linked gene does not assort independently (example), linkage group, 2.2. Crossing over, crossing over produces recombination (example), detection of crossing over (McClintock's experiment), and 2.3.Molecular mechanism of crossing over (Holliday model), 2.4. Gene mapping with three point test cross, detection of middle gene in three point test cross, calculation of recombination frequencies, 2.5. Co-efficient of coincidence and

interference, mapping function, 2.6. Problems on gene mapping, 2.7. Molecular mapping – ISH, FISH (brief idea).

…….16 lectures

3. Epistasis and Polygenic inheritance in plants.

…….4 lectures

4. Aneuploidy and Polyploidy: Types, examples, meiotic behaviour and importance of: 4.1. Aneuploidy, 4.2. Polyploidy, 4.3. Speciation and evolution through polyploidy.

…….8 lectures

5. Chromosomal aberration: Types and meiotic behaviour of: 5.1. Deletion, 5.2. Duplication, 5.3. Translocation, and 5.4. Inversion.

…….6 lectures

6. Mutation :

6.1. Point mutation-Transition, Transversion and Frame shift mutation, 6.2. Molecular mechanisms (tautomerisation, alkylation, deamination, base analogue incorporation, dimerisation), 6.3. DNA repair (brief idea).

…….8 lectures

7. Structural organisation of Gene:

7.1. One Gene–one polypeptide concept, 7.2. Split gene, 7.3. Overlapping gene, 7.4. Repetitive DNA-tandem and interspersed, 7.5. Transposon (Ac-Ds system), 7.6. Homoeotic gene in plants (ABCE Quartet model of flowering).

…….12 lectures

PRACTICAL- GENETICS (BOT-A-CC-4-10-P)

(Credits 2)

1. Genetics

2. Identification

3. Classroom performance (Laboratory Records and slides)

4 Viva- voce

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 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 two pollutants/ pesticides etc.

5. Study of meiotic chromosome: 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- early separation, late separation, multipolarity, sticky bridge, laggard, fragmentation, (ii) pollen mitosis.

SEMESTER V

CORE COURSE- 11
CELL AND MOLECULAR BIOLOGY (BOT-A-CC-5-11-TH)
THEORETICAL
(Credits 4, Lectures 60)

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, si RNA, mi RNA- brief idea, 1.4.Organellar DNA (cp- and mt- DNA).

…….6 lectures

2. Nucleus and Chromosome:

2.1. Nuclear envelope, Nuclear lamina and Nuclear pore complex, 2.2. Nucleolus-ultrastructure and ribosome biogenesis, 2.3. Chromatin ultrastructure and DNA packaging in eukaryotic chromosome, 2.4. Centromere: types, structure and function.

…….6 lectures

3. Cell cycle and its regulation:

3.1. Kinetochore and spindle apparatus-structural organization and functions, 3.2.Microtubules-structure, organization and function, 3.3. Mechanism of cell cycle control in Yeast (checkpoints and role of MPF), Apoptosis (Brief idea).

…….6 lectures

MOLECULAR BIOLOGY

1. DNA Replication, Transcription and Translation (Prokaryotes & Eukaryotes):

1.1. Central Dogma, 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, replication at the end chromosome telomere, telomerase concept, 1.4. Fidelity of DNA replication- prokaryote: nucleotide selection, proof reading, mismatch repair; eukaryote: through selection of error prone DNA polymerase, 1.5.Transcription, 1.6 RNA processing, 1.7. Aminoacylation of tRNA, 1.8. Translation.

…….20 lectures

2. Gene Regulation:

2.1 Concept of Lac-operon, 2.2. Positive and negative control.

…….4 lectures

3. Genetic Code:

3.1 Properties-evidences & exceptions, 3.2. Decipherence of codon (Binding technique).

…….4 lectures

4. Recombinant DNA Technology:

4.1. Restriction endonuclease, - types and roles, 4.2. Vector (plasmid pBR 322), 4.3. Marker gene, 4.4. Steps of cloning technique, 4.5. PCR and its application, 4.6. Genomic DNA and cDNA library.

…….10 lectures

5. Development and causes of Cancer (in general and brief), tumor suppressor gene and oncogene.

…….4 lectures

PRACTICAL- CELL BIOLOGY (BOT-A-CC-5-11-P)
(Credits 2)

1. Work out

2.Identification

3.Classroom performance (Laboratory Records and slides)

4.Preparation of models/charts

5. Viva-voce

CELL BIOLOGY

1. Study of plant cell structure with the help of epidermal peal mount of Onion/*Rhoeo*/*Crinum*
2. Measurement of cell size by the technique of micrometry.
3. Counting cells per unit volume with the help of haemocytometer (Yeast/pollengrains)
4. Cytochemical staining of DNA- Pyronine-methyl green staining.

5. Estimation of DNA content through DPA staining.
6. Estimation of RNA through orcinol method.
7. Study of nucleolus through hematoxylin/ orcin staining and determination of nucleolar frequency.
8. Preparation of models/ charts: rolling circle, theta replication, semi-discontinuous replication, prokaryotic RNA polymerase and eukaryotic RNA polymerase II, assembly of spliceosome mechinary, splicing mechanism in group I and group II introns, ribozyme and alternative splicing.

CORE COURSE- 12
BIOCHEMISTRY (BOT-A-CC-5-12-TH)
THEORETICAL
(Credits 4, Lectures 60)

1. Biochemical Foundations:

1.1. Covalent and non-covalent bonds; hydrogen bond; Van der Waal's forces; 1.2. Structure and properties of water; 1.3. pH and buffer (inorganic and organic); 1.4. Handerson-Hasselbalch equation; 1.5. Isoelectric point.

…….6 lectures

2. Molecules of life:

2.1. Nucleic Acids – structure of nucleosides and nucleotides ; oligo- and poly nucleotides , B & Z form of DNA, RNA- different forms; nucleotide derivatives (ATP, NADP), 2.2. Proteins – structure and classification of amino acids; primary, secondary, tertiary and quaternary structure of proteins; 2.3. Carbohydrates - structure of mono-, di- and polysaccharide; stereoisomers, enantiomers and epimers; 2.4. Lipids - structure of simple lipid and compound lipid (phospholipids and glycolipids), fatty acids- saturated and unsaturated.

…….24 lectures

3. Energy flow and enzymology:

3.1. Bioenergetics-Thermodynamic principles; free energy; energy rich bonds- phosphoryl group transfer and ATP; redox potentials and Biological redox reactions, 3.2. Enzymes – classification and nomenclature (IUBMB); Co-factors and co-enzymes; isozymes, 3.3. Mechanism of enzyme action; enzyme inhibition; 3.4. Enzyme kinetics (Michaelis- Menten equation) and simple problems.

…….18 lectures

4. Cell membrane:

4.1. Membrane chemistry, 4.2. Membrane transport (uniport, symport, antiport), mechanism of ion

uptake.

…….6 lectures

5. Phosphorylation: ATP Synthesis- Chemiosmotic model, Oxidative and Photophosphorylation- Mechanism and differences.

…….6 lectures

PRACTICAL- BIOCHEMISTRY (BOT-A-CC-5-12-P)
(Credits 2)

1. Workout on Plant Biochemistry (Quantitative & Qualitative)
2. Classroom performance (Laboratory Records and slides)
3. Viva

PLANT BIOCHEMISTRY

Qualitative:

1. Detection of organic acids: citric, tartaric, oxalic and malic 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 titratable acidity from lemon.
5. Estimation of catalase activity in plant samples and effect of substrate, enzyme concentration and pH on enzyme activity.
6. Estimation of urease activity in plant samples.
7. Colorimetric estimation of protein by Folin phenol reagent.

SEMESTER VI

CORE COURSE-13
PLANT PHYSIOLOGY (BOT-A-CC-6-13-TH)
THEORETICAL (Credits 4, Lectures 60)

1. Plant-water relations:

1.1 Concept of water potential, components of water potential in plant system, 1.2. Soil-plant-Atmosphere continuum concept, Cavitation in xylem and embolism, 1.3. Stomatal physiology-mechanism of opening and closing, Role of carbon di-oxide, potassium ion, abscisic acid and blue light in stomatal movement, Antitranspirants.

…….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.

…….6 lectures

3. Organic Translocation:

3.1. Phloem sap, P-protein, 3.2. Phloem loading and unloading, 3.3. Mass-flow (pressure flow) hypothesis and its critical evaluation.

…….6 lectures

4. Plant Growth Regulators:

4.1. Physiological roles of Auxin, Gibberellin, Cytokinin, Abscisic acid, Ethylene, 4.2. Chemical nature – IAA, GA3, Kinetin, 4.3. Biosynthesis and bioassay of IAA, 4.4. Mode of action of IAA, 4.5. Brassinosteroids and Polyamines as PGRs (brief idea).

…….18 lectures

5. Photomorphogenesis:

5.1. Concept of photomorphogenesis, 5.2. Photoperiodism and plant types, 5.3. Perception of photoperiodic stimulus, 5.4. Critical day length, concept of light monitoring, 5.5. Phytochrome, cryptochrome and phototropins- chemical nature and role in photomorphogenesis, 5.6. Role of GA in flowering, 5.7. Vernalisation – role of low temperature in flowering, 5.8. Concept of biological clock and biorhythm.

…….12 lectures

6. Seed dormancy: 6.1. Types, Causes and Methods of breaking seed dormancy, 6.2. Biochemistry of seed germination.

…….6 lectures

7. Physiology of Senescence and Ageing.

…….6 lectures

PRACTICAL- PLANT PHYSIOLOGY (BOT-A-CC-6-13-P)
(Credits 2)

1. Plant Physiology

2. Classroom performance (Laboratory records)

3. Viva- voce

PLANT PHYSIOLOGY

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. To study the phenomenon of seed germination (effect of light).

8. To study the induction of amylase activity in germinating grains.

9. To study the effect of different concentrations of IAA on *Avena* coleopotile elongation (IAA bioassay)

CORE COURSE 14
PLANT METABOLISM (BOT-A-CC-6-14-TH)
THEORETICAL
(Credits 4, Lectures 60)

1. Concept of metabolism: Introduction, Anabolic and catabolic metabolic pathways, regulation of metabolism, role of regulatory enzymes (allosteric, covalent modulation and isozymes)

…….4 lectures

2. Photosynthesis:

2.1.Chemical structure of chlorophyll a and b, absorption and action spectra, biological significance of carotenoid pigments, 2.2. Red drop and Emerson effect, Components of photosystems (light harvesting complex), photochemical reaction centres, Cyclic and noncyclic electron transport, Water splitting mechanism, 2.3. Calvin cycle – Biochemical reactions & stoichiometry, 2.4. HSK Pathway– three variants of the pathway, 2.5. Photosynthetic efficiency of C_3 and C_4 plants and crop

productivity, 2.6. Photorespiration – mechanism and significance, 2.7. Crassulacean Acid Metabolism– mechanism and ecological significance.

…….16 lectures

3. Respiration:

3.1. EMP pathway, regulation and its anabolic role, 3.2. Conversion of Pyruvic acid to Acetyl CoA, 3.3. TCA-cycle and its amphibolic role, 3.4. Oxidative pentose phosphate pathway and its significance, 3.5. Mitochondrial electron transport system, uncouplers, 3.6. Oxidation of cytosolic $NADH+H^+$, 3.7. Stoichiometry of glucose oxidation (aerobic).

…….12 lectures

4. Nitrogen Metabolism:

4.1. Assimilation of nitrate by plants, 4.2. Biochemistry of dinitrogen fixation in Rhizobium, 4.3. General principle of amino acid biosynthesis (including GS and GOGAT enzyme system).

…….10 lectures

5. Lipid metabolism:

5.1. synthesis and breakdown of triglycerides, ß-oxidation, glyoxalate cycle, gluconeogenesis and its role in mobilization of the lipids during seed germinbations, α- oxidation.

…….8 lectures

6. Mechanism of signal transduction: receptor-ligand interactions, second messenger concept, calcium-calmodilin, G protein, MAP-kinase cascade.

…….10 lectures

PRACTICAL- PLANT METABOLISM (BOT-A-CC-6-14-P)

(Credits 2)

1. Workout on Plant metabolism

2. Classroom performance (Laboratory Records)

3. Viva

PLANT METABOLISM

1. A basic idea of chromatography: Principle, paper chromatography and column chromatography; demonstration of column chromatography.

2. Separation of plastidial pigments by solvent and paper chromatography.

3. Estimation of total chlorophyll content from different chronologically aged leaves (young, mature and senescence) by Arnon method.

4. Effect of HCO_3 concentration on oxygen evolution during photosynthesis in an aquatic plant and to find out the optimum and toxic concentration (either by volume measurement or bubble counting).

5. Measurement of oxygen uptake by respiring tissue (per g/hr.)

6.. Determination of the RQ of germinating seeds.

7. Test of seed viability by TTC method.

SKILL ENHANCEMENT COURSE- ELECTIVE (SEC)

SEC-A

APPLIED PHYCOLOGY, MYCOLOGY AND MICROBIOLOGY (BOT-A-SEC-A-3-1)

THEORETICAL

(Credits 2, Lectures 30)

APPLIED PHYCOLOGY

1. Algae as food and source of phycocolloid (Agar-agar, Algin, Carrageenan), 2. Diatomite, 3. Algal toxin, 4. Algal Biotechnology – potential of microalgae for SCP, β-carotene, Biodiesel, bioplastics from algae.

…….10 lectures

APPLIED MYCOLOGY

1. Fungi as food, 2. Cheese and Ethanol- Industrial production (brief outline), 3. Fungal sources and uses of Enzyme (Cellulase), Amino acid (Tryptophan), Vitamin (Riboflavin), Antibiotic (Griseofulvin), Pharmaceuticals (Cyclosporin-A). 4. Aflatoxin

…….10 lectures

APPLIED MICROBIOLOGY

1. Industrial Production of Vinegar and Streptomycin (brief outline), 2. Microbial sources and uses of Enzyme (Amylase, Protease), Amino acid (Glutamic acid, Lysine), Polysaccharides (Dextran), 3. Use of microbes as Biofertilizer and Biopesticides, 3.4. Use of microbes in mineral processing.

…….10 lectures

BIOFERTILIZERS (BOT-A-SEC-A-3-2)

THEORETICAL

(Credits 2, Lectures 30)

1. General account about the microbes used as biofertilizers- *Rhizobium*- isolation, identification, mass multiplication, carrier based inoculants, actinorrhizal symbiosis.

…….4 lectures

2. ***Azospirillum*:** isolation and mass multiplication- carrier based inoculants, associative effect of different microorganisms.

…….4 lectures

3. ***Azotobacter*:** classification, characteristics- crop response to *Azetobacter* inoculants, maintenance and mass multiplication.

…….4 lectures

4. Cyanobacteria (Blue green algae), *Azolla* and *Anabaena azollae* association, nitrogen fixation. Factors affecting growth, blue green algae and *Azolla* in rice cultivation.

…….4 lectures

5. *Mycorrhizal* association, types of mycorrhizal association, phosphorus nutrition, growth and yield- colonisation of VAM – isolation and inoculum production of VAM and its influence on growth and yield of crop plants.

…….8 lectures

6. **Organic farming**- green manuring and organic fertilizers, recycling of biodegradable municipal, agricultural and industrial wastes- biocompost making methods, types and methods of vermicomposting- field application.

…….6 lectures

SEC-B

PLANT BREEDING (BOT-A-SEC-B-4-3)

THEORITICAL

(Credits 2, Lectures 30)

1. **Plant breeding:** introduction and objectives, breeding systems- modes of reproduction in crop plants, important achievements and undesirable consequence of plant breeding.

…….4 lectures

2. **Methods of crop improvement:** Introduction- centres of origin and domestication of crop plants, plant genetics resources; acclimatization, selection methods- for self pollination, cross pollinated and vegetatively propagated plants, hybridization- for self, cross and vegetatively propagated plants, procedure, advantages and limitations.

…….6 lectures

3. Maintenance of germplasm, 3.1. Mass selections and Pure line selection, 3.2. Back cross method.

…….6 lectures

4. Heterosis and hybrid seed production, 4.1. Male sterility and its use in plant breeding.

…….2 lectures

5. Inbreeding and inbreeding depression, effect of outcrossing- a very brief idea.

…….4 lectures

6. Molecular Breeding (use of DNA markers in plant breeding).

…….2 lectures

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

…….6 lectures

MUSHROOM CULTURE TECHNOLOGY (BOT-A-SEC-B-4-4)
THEORETICAL
(Credits 2, Lecture 30)

1. Introduction, nutritional and medicinal value of edible mushrooms; poisonous mushrooms, types of edible mushrooms available in India- *Volvariella volvacea, Pleurotus citrinopileatus*, *Agaricus bisporus*.

…….5 lectures

2. **Cultivation technology:** infrastructure: substrates (locally available), polythene bags, vessels, inoculation hook, inoculation loop, low cost stoves, sieves, culture racks, mushroom unit (thatched house), water sprayer, tray, small polythene bag. Pure culture: medium, sterilization, preparation of spawn, multiplication. Mushroom bed preparation- paddy straw, sugarcane trash, maize straw, banana leaves,. Factors affecting the mushroom bed preparation- low cost technology, composting technology in mushroom production.

…….12 lectures

3. **Storage and nutrition:** short term storage (Refrigeration- upto 24 hours), long term storage (canning, pickels, papads), drying, storage in salt solutions. Nutrition- proteins- amino acids, mineral elements nutrition- carbohydrates, crude fibre content- vitamins.

…….8 lectures

4. **Food preparation:** type of foods prepared from mushroom. Research centres- National level and regional level. Cost benefit ratio- marketing in India and abroad. Export value.

…….5 lectures

DISCIPLINE SPECIFIC ELECTIVE COURSES
DSE-A
BIOSTATISTICS (BOT-A-DSE-A-5-1-TH)
THEORETICAL
(Credits 4, Lectures 60)

1. **Biostatistics:** Definition, statistical methods, basic principles, variables- measurements, functions, limitations and uses of statistics.

…….12 lectures

2. **Biometry:** Data, Sample, Population, Random sampling, Frequency distribution- definition only.

…….12 lectures

3. **Central tendency–** Arithmetic Mean, Mode and Median; Measurement of dispersion–

Coefficient of variation, Standard Deviation, Standard error of Mean.

…….10 lectures

4. **Test of significance:** chi- square test for goodness of fit.

…….6 lectures

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

…….6 lectures

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

…….14 lectures

PRACTICAL- BIOSTATISTICS (BOT-A-DSE-A-5-1-P)
(Credits 2)

1. Workout
2. Classroom performance (Laboratory Records)
3. Viva

BIOSTATISTICS

1. Univariate analysis of statistical data: Statistical tables, mean, mode, median, standard deviation and standard error (using seedling population / leaflet size).
2. Calculation of correlation coefficient values and finding out the probability.
3. Determination of goodness of fit in Mendellian and modified mono-and dihybrid ratios (3:1, 1:1, 9:3:3:1, 1:1:1:1, 9:7, 13:3, 15:1) by Chi-square analysis and comment on the nature of inheritance.
4. Calculation of 'F' value and finding out the probability value for the F value
5. Basic idea of computer programme for statistical analysis of correlation coefficient,'t' test, standard error, standard deviation.

INDUSTRIAL AND ENVIRONMENTAL MICROBIOLOGY (BOT-A-DSE-A-5-2-TH)
THEORETICAL
(Credits 4, Lectures 60)

1. Scope of microbes in industry and environment.

…….6 lectures

2. Bioreactors/ Fermenters and fermentation process: solid- state and liquid-state (stationary and submerged) fermentations; batch and continuous fermentations. Components of a typical

bioreactors, types of bioreactors- laboratory, pilot scale and production fermenters. Constantly stirred fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air- lift Fermenter.

…….12 lectures

3. Microbial production of industrial products: microorganisms involved, media, fermentation conditions, down stream processing and uses; filtration, centrifugation, cell disruption, solvent extraction, precipitation and ultrafiltration, liophilisation, spray drying, hands on microbial fermentations for the production and estimation of enzymes amylase or lipase activity, organic acids (citric or glutamic acid), alcohol (ethanol) and antibiotic (Penicillin).

…….12 lectures

4. Microbial enzymes of industrial interest and enzyme immobilization: microorganisms for industrial applications. Methods of immobilization, advantages and applications of immobilization, large scale application of immobilized enzymes (glucose isomerase and penicillin acylase).

…….8 lectures

5. Microbes and quality of environment: distribution of microbes in air, isolation of microorganisms from soil, air and water.

…….8 lectures

6. Microbial flora of water: water pollution, role of microbes in sewage and domestic waste water treatment systems. Determination of BOD, COD of water samples. Microorganisms as indicators of water quality, check coliform and fecal coliform in water samples.

…….8 lectures

7. Microbes in agriculture and remediation of contaminated soils: biological fixation, mycorrhizae, bioremediation of contaminated soils, isolation of root nodulating bacteria, arbuscular mycorrhizal colonization in plant roots.

…….8 lectures

PRACTICAL- INDUSTRIAL AND ENVIRONMENTAL MICROBIOLOGY (BOT-A-DSE-A-5-2-P)
(Credits 2)

1. Workout
2. Classroom performance (Laboratory Records)
3. Viva

INDUSTRIAL AND ENVIRONMENTAL MICROBIOLOGY

1. Principals and functioning of instruments in microbiology laboratory
2. Hands on sterilization techniques and preparation of culture media.
3. Preparation of slant, stab and pouring petriplate.

4. A visit to any educational institute/ industry to see an industrial fermenter, and other down-stream processing operations.

MEDICINAL AND ETHNOBOTANY (BOT-A-DSE-A-6-3-TH)
THEORETICAL
(Credits 4, Lectures 60)

1. Medicinal botany: History, scope and importance of medicinal plant, a brief idea about indigenous medicinal sciences- ayurveda, siddha and unani. Polyherbal formulations.

…….14 lectures

2. Pharmacognosy- General account :

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

…….12 lectures

3. Secondary metabolites:

3.1 Definition of secondary metabolites and difference with primary metabolites , 3.2 Interrelationship of basic metabolic pathways with secondary metabolite biosynthesis (outlines only), 3.3 Major types–terpenoids, phenolics, flavonoids, alkaloids and their protective action against pathogenic microbes and herbivores.

…….14 lectures

4. Pharmacologically active constituents:

Source plants (one example) parts used and uses of: 3.1 Steroids (Solasodin, Diosgenin, Digitoxin), 3.2 Tannin (Catechin), 3.3 Resins (Gingerol, Curcuminoids), 3.4 Alkaloids (Quinine, Atropine. Pilocarpine, Strychnine, Reserpine, Vinblastine), 3.5. Phenols (Sennocide and Capsaicin).

…….4 lectures

5. Ethnobotany and folk medicine: Definition, methods of study, application, Indian scenario, national interacts, Palaeo-ethnobotany, folk medicines in ethnobotany, ethnomedicine, ethnoecology, ethnic communities of India, application of natural products to certain diseases- Jaudice, cardiac, infertility, diabetics, blood pressure and skin diseases.

…….16 lectures

PRACTICAL- MEDICINAL AND ETHNOBOTANY (BOT-A-DSE-A-6-3-P)
(Credits 2)

1. Workout and chemical tests

2. Classroom performance (Laboratory Records)

3. Viva

MEDICINAL AND ETHNOBOTANY

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*).

STRESS BIOLOGY (BOT-A-DSE-A-6-4-TH)
THEORETICAL
(Credits 4, Lectures 60)

1. Plant stress- definition. Acclimation and adaptation.

…….2 lectures

2. Environmental factors- water stress, salinity stress and temperature stress- plant response. Pathogenesis- related (PR) proteins, systemic acquired resistance; mediation of insect and disease resistance by jasmonates.

…….20 lectures

3. Stress sensing mechanism in plants: calcium modulation, phospholipid signaling.

…….20 lectures

4. Developmental and physiological mechanisms that protect plants against environmental stress: adaptation of plants, changes in root-shoot ratios, aerenchyma development; osmotic adjustment, compatible solute production.

…….12 lectures

5. Reactive oxygen species- production and scavenging mechanism.

…….6 lectures

PRACTICAL- STRESS BIOLOGY (BOT-A-DSE-A-6-4-P)
(Credits 2)

1. Workout

2. Classroom performance (Laboratory Records)

3. Viva

STRESS BIOLOGY

1. Quantitative estimation of peroxidase activity in the seedlings in the absence and presence of salt stress.

2. Superoxide dismutase activity in the absence and presence of stress.

3. Catalase activity in the presence and absence of stress.

4. Comparative study of plants/seedlings subjected to different degree of stress/ pollutants.

5. To study the effect of stress (salt/ water/ heavy metal) on seed germination and seedling growth (any commonly available specimen)

DSE-B

PLANT BIOTECHNOLOGY (BOT-A-DSE-B-5-5-TH)

THEORETICAL

(Credits 4, Lectures 60)

1. **Plant tissue culture** –Introduction:
   1.1. Basic concept and milestones, 1.2. Cellular totipotency, 1.3. Tissue culture media, 1.4. Aseptic manipulation, 1.5. Cyto-differentiation and dedifferentiation.

   …….10 lectures
2. **Callus culture:**
   2.1. Callus induction, maintenance and application, 2.2. Suspension culture- introductory idea.

   …….6 lectures
3. **Plant regeneration:**
   3.1. Organogenesis (direct and indirect), 3.2. Somatic embryogenesis, 3.3. Significance of organogenesis and somatic embryogenesis, 3.4. Artificial seed.

   …….8 lectures
4. **Haploid Culture:**
   4.1. Anther and Pollen culture methods, 4.2. Applications.

   …….6 lectures
5. **Protoplast Culture:**
   5.1. Protoplast isolation and culture, 5.2. Protoplast fusion (somatic hybridization), 5.3. Significance.

   …….6 lectures
6. **Plant Genetic Engineering:**
   6.1. Brief concept of different gene transfer methods, special emphasis on *Agrobacterium* mediated gene transfer, Role of Reporter gene, 6.2. Achievements in crop biotechnology,

environment and industry (suitable example)- pest resistant plants (BT cotton), herbicide resistance, disease and stress tolerance, transgenic crop with improved quality (flavr tomato, golden rice), role of transgenic in population degradation (super-bug), leaching of minerals, production of industrial enzymes, oil, edible vaccine.

…….24 lectures

PRACTICAL- PLANT BIOTECHNOLOGY (BOT-A-DSE-B-5-5-P)
(Credits 2)

1. Field report on a visit to a tissue culture lab.
2. Classroom performance (Laboratory Records, charts/ models)
3. Viva

PLANT BIOTECHNOLOGY

1. Familiarization of basic equipments in plant tissue culture

2. Study through photographs/ charts/ models of anther culture, somatic embyogenesis, endosperm and embryo culture, micropropagation.

3. Preparation of basal media. Sterilization techniques.

4. Demonstration of any tissue culture technique during visit in a plant tissue culture lab.

DSE B
HORTICULTURAL PRACTICES AND POST- HARVEST TECHNOLOGY (BOT-A-DSE-B-5-6-TH)
THEORETICAL
(Credits 4, Lectures 60)

1. **Horticulture** –scope, importance and branches. Role in rural economy and employment generation; importance in food and nutritional security; urban horticulture and ecoturism.

   …….4 lectures
2. **Ornamental plants:** types, classifications (annuals, perennials, climbers and trees), identification and salient features of some ornamental plants (rose, marigold, gladiolus, carnations, orchids, poppies, gerberas, tuberose, sages, cacti and succulants). Ornamental flowering trees (Indian laburnum, gulmohor, jacaranda, Lagerostoemia, fishtail and Erica palms, simul, coral tree).

   …….4 lectures
3. **Fruit and vegetable crops:** production, origin and distribution; description of plants and their

economic products; management and marketing of vegetables and fruit crops; identification of some fruits and some vegetables varieties (citrus, banana, mango, chillis and cucurbits).

…….4 lectures

4. **Horticultural techniques:** application manures, fertilizers, nutrients and PGRs; weed controls, biofertilizers, biopesticides, irrigation methods. Hydroponics, propagation methods; vegetative (grafting, cutting, layering, budding), sexual (seed production), scope and limitations.

…….8 lectures

5. Landscaping and garden designing: planning and lay out (parks and gardens).

…….6 lectures

6. **Floriculture:** cut flowers, bonsai, commerce (market demand and supply), importance of flower shows and exhibitions.

…….6 lectures

7. **Post harvest technology:** Importance of post harvest technology in horticultural crops, evaluation of quality, traits; harvesting and handling of fruits, vegetables, cut flower; principles, methods of preservation and processing, methods of minimizing losses during storage and transportation; food irradiation- advantages and disadvantages; food safety.

…….10 lectures

8. **Disease control and management:** field and post harvest diseases, identification of deficiency symptoms, remedial measures and nutritional management practices; crop sanitation; IPM strategies (genetic, biological and chemical methods for pest control); quarantine practices; identification of common diseases and pest of ornamental fruits and vegetable crops.

…….8 lectures

9. **Horticultural crops-** conservation and management: documentation and conservation of germplasm. Role of micropropagation and tissue culture techniques; varieties and cultivars of various horticultural crops; IPR issues, national international and professional societies and sources of information on horticulture.

…….10 lectures

PRACTICAL- HORTICULTURAL PRACTICES AND POST- HARVEST TECHNOLOGY (BOT-A-DSE-B-5-6-P)
(Credits 2)

Field trip- field visits to gardens, standing crop sites, nurseries, vegetable gardens, horticultural fields at IARI/AHSI or other suitable locations and if possible to cold storage.

RESEARCH METHODOLOGY (BOT-A-DSE-B-6-7-TH)
THEORETICAL
(Credits 4, Lectures 60)

1. Basic concepts of research: research- definition and types of research (Descriptive vs. analytical, applied vs. fundamental, quantitative vs. qualitative, conceptual vs. emperical), research methods vs. methodology; literature- review and its consolidation; library research; field research; laboratory research.

…….10 lectures

2. General laboratory techniques: common calculations in botany laboratories; understanding the details on the label of reagent bottles; molarity and normality of common amino acids and bases; preparation of solutions. Dilution, percentage, molar, molal and normal solutions. Techniques of handling micropipettes; knowledge about common toxic chemicals and safety measures in their handling.

…….12 lectures

3. Data collection and documentation of observations. Maintaining of laboratory records, tabulation and generation of graphs. Imaging of tissue specimens and application of scale bars. The art of field photography.

…….6 lectures

4. Overview of biological problems: plant science research key areas, model organisms in research.

…….6 lectures

5. Methods to study plant cells/ tissue structure: whole mounts, peal mounts, squash preparations, clearing, maceration and sectioning, tissue preparation- fixation, dehydration etc., paraffin and plastic infiltration, preparation of thin and ultra-thin sections.

…….6 lectures

6. Plant micro-techniques: staining procedures, classification and chemistry of stains, staining equipments. Cytogenetic techniques with squashed plant materials.

…….12 lectures

7. The art of scientific writing and its presentation: numbers, units, abbreviations and nomenclature used in scientific writing. Writing references. Power point presentation. Poster presentation. Scientific writing ethics. Introduction to copy write- academic misconduct/ plagiarism.

…….8 lectures

PRACTICAL- RESEARCH METHODOLOGY (BOT-A-DSE-B-6-7-P)
(Credits 2)

1. Experiments based on calculations
2. Plant microtechnique experiments

3. The art of imaging of samples through photomicrography and field photography
4. Poster/ power point presentation on defined topics
5. Technical writing on topics assigned.

Natural resource management (BOT-A-DSE-B-6-8-TH)

THEORETICAL

(Credits 4, Lectures 60)

Unit 1: Natural resources
Definition and types.

…….. 2 lectures

Unit 2: Sustainable utilization
Concept, approaches (economic, ecological and socio-cultural).

…… 8 lectures

Unit 3: Land
Utilization (agricultural, pastoral, horticultural, silvicultural); Soil degradation and management.

…….. 8 lectures

Unit 4: Water
Fresh water (rivers, lakes, groundwater, aquifers, watershed); Marine; Estuarine; Wetlands; Threats and management strategies.

…… 8 lectures

Unit 5: Biological Resources
Biodiversity-definition and types; Significance; Threats; Management strategies; Bioprospecting; IPR; CBD; National Biodiversity Action Plan).

…….. 12 lectures

Unit 6: Forests
Definition, Cover and its significance (with special reference to India); Major and minor Forest products; Depletion; Management.

…… 6 lectures

Unit 7: Energy
Renewable and non-renewable sources of energy.

…… 6 lectures

Unit 8: Contemporary practices in resource management
EIA, GIS, Participatory Resource Appraisal, Ecological Footprint with emphasis on carbon footprint, Resource Accounting; Waste management.

…… 8 lectures

Unit 9: National and international efforts in resource management and conservation

…… 4 lectures

PRACTICAL- Natural resource management (BOT-A-DSE-B-6-8-P)
(Credits 2)

1. Estimation of solid waste generated by a domestic system (biodegradable and non-biodegradable) and its impact on land degradation.
2. Estimation of foliar dust deposition.
3. Determination of total solid in water (TDS)
4. Determination of chemical properties of soil by rapid spot test (carbonate, iron, nitrate)
5. Estimation of organic carbon percentage present in soil sample.
6. Collection of data on forest cover of specific area.

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