UNIVERSITY OF CALCUTTA

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To
The Principals/T.I.C.
of all the Undergraduate Colleges
offering B.Sc. (Honours and General) in Botany
affiliated to the University of Calcutta

Sir/Madam,

The undersigned is to inform you that the proposed **revised semesterised draft Syllabus for Botany (Honours and General)** Courses of Studies under **CBCS has been uploaded in the Calcutta University website (www.caluniv.ac.in).**

The said syllabus has been prepared by the **U.G. Board of Studies in Botany, C.U.**, suppose to be implemented from the academic session 2018-2019

You are requested kindly to go through it and send your feedback within 31st January, 2018.

In this regard you may send your observation/ suggestion to the **Department of U.G. Councils, C.U.** or through email (u.g.councilsc.u@gmail.com), and you also may contact **Prof. Subir Bera,** Department of Botany through e-mail **(berasubir@yahoo.co.in).**

Your cooperation in this regard will be highly appreciated. Kindly treat the matter as urgent.

Thanking you,

Yours faithfully,

18.1.18

(Milan Kr. Pal)
O.S.D., C.U.

Dr. Milan Kumar Pal
O.S.D.
University of Calcutta

UNIVERSITY OF CALCUTTA

DRAFT SYLLABUS

FOR

THREE-YEAR B.Sc. HONOURS COURSE

UNDER CHOICE BASED CREDIT SYSTEM

BOTANY

FOR SESSION 2018-2019

Core courses (Total 14; all theoretical papers i.e., BOTTA of 4 credits each and the respective practical papers i.e., BOTPA of 2 credits each)

1. Phycology and Microbiology (BOTTA I, BOTPA II)
2. Mycology and Phytopathology (BOTTA III, BOTPA IV)
3. Plant anatomy (BOTTA V, BOTPA VI)
4. Archegoniate (BOTTA VII, BOTPA VIII)
5. Palaeobotany and Palynology (BOTTA IX, BOTPA X)
6. Reproductive biology of Angiosperms (BOTTA XI, BOTPA XII)
7. Plant systematic (BOTTA XIII, BOTPA XIV)
8. Plant geography, Ecology and Evolution (BOTTA XVI, BOTPA XVII)
9. Economic Botany (BOTTA XVIII, BOTPA XIX)
10. Genetics (BOTTA XX, BOTPA XXI)
11. Cell and Molecular biology (BOTTA XXIII, BOTPA XXIV)
12. Biochemistry (BOTTA XXV, BOTPA XXVI)
13. Plant Physiology (BOTTA XXXI, BOTPA XXXII)
14. Plant Metabolism (BOTTA XXXIII, BOTPA XXXIV)

Ability enhancement compulsory courses (AEC 2, both the papers theoretical only and of 2 credits each)

1. English communications (AEC I)
2. Environmental science (AEC II)

Skill enhancement courses (SEC 2, two papers to be selected from the list. Both the papers of 2 credits each and theoretical only)

1. Applied Phycology, Mycology and Microbiology (BOTTSECA XV)
2. Plant Breeding (BOTTSECA XXII)
3. Biofertilizers (BOTTSECA XLIII)
4. Mushroom Culture Technology (BOTTSECA XLIV)
5. Herbal Technology (BOTTSECA XLV)

6. Plant diversity and Human Welfare (BOTTSECA XLVI)
7. Integrative Palynology (XLVII)

Discipline specific elective courses (DSE 4, four courses to be selected from the list. Each course comprises of theoretical component of 4 credits and practical ones of 2 credits)

1. Medicinal and Ethnobotany (BOTTDSEA XXXV, BOTPDSEA XXXVI)
2. Biostatistics (BOTTDSEA XXVII, BOTPDSEA XXVIII)
3. Plant Biotechnology (BOTTDSEA XXIX, BOTPDSEA XXX)
4. Stress Biology (BOTTDSEA XXXVII, BOTPDSEA XXXVIII)
5. Research Methodology (BOTTDSEA XXXIX, BOTPDSEA XL)
6. Industrial and Environmental Biology (BOTTDSEA XLI, BOTPDSEA XLII)
7. Horticultural practices and Post Harvest Technology (BOTTDSEA XLVII, BOTPDSEA XLVIII)

Generic elective (GE 4), as per the recommendation of UGC, students should be encouraged to opt for at least 1 or 2 generic electives from other life sciences like Zoology/ Microbiology/ Anthropology/ Physiology/ Geology/ Biochemistry/ Biotechnology and Chemistry courses.

1. Biodiversity (BOTTGE I, BOTPGE II)
2. Plant Ecology and Taxonomy (BOTTGE III, BOTPGE IV)
3. Plant Anatomy and Embryology (BOTTGE V, BOTPGE VI)
4. Plant Physiology and Metabolism (BOTTGE VII, BOTPGE VIII)
5. Economic Botany and Plant Biotechnology (BOTTGE IX, BOTPGE X)
6. Environmental Biotechnology (BOTTGE XI, BOTPGE XII)

SEMESTER	COURSE OPTED	COURSE NAME	CREDIT
I	AEC I	English communications	2
	Core Course 1-BOTTA I	Phycology and microbiology	4
	Core Course 1-BOTPA II	Phycology and microbiology Practical	2
	Core Course 2-BOTTA III	Mycology and phytopathology	4
	Core Course 2-BOTPA IV	Mycology and phytopathology Practical	2
	Generic Elective 1	GE 1	4
	Generic Elective 1 Practical	GE 1 Practical	2
II	AEC II	Environmental science	2
	Core Course 3-BOTTA V	Plant anatomy	4
	Core Course 3-BOTPA VI	Plant anatomy Practical	2
	Core Course 4-BOTTA VII	Archegoniate	4
	Core Course 4-BOTPA VIII	Archegoniate Practical	2
	Generic Elective 2	GE 2	4
	Generic Elective 2 Practical	GE 2 Practical	2
III	Core Course 5-BOTTA IX	Palaeobotany and palynology	4
	Core Course 5-BOTPA X	Palaeobotany and palynology Practical	2
	Core Course 6-BOTTA XI	Reproductive biology of angiosperms	4
	Core Course 6-BOTPA XII	Reproductive biology of angiosperms	2
	Core Course 7-BOTTA XIII	Practical	4
	Core Course 7-BOTPA XIV	Plant systematics	2
	SEC I – BOTSECA XV	Plant systematics Practical	2
	Generic Elective 3	Applied phycology, mycology and	4
	Generic Elective 3 Practical	microbiology	2
		GE 3	
		GE 3 Practical	
IV	Core Course 8-BOTTA XVI	Plant geography, ecology and evolution	4
	Core Course 8-BOTPA XVII	Plant geography, ecology and evolution	2
	Core Course 9-BOTTA XVIII	Practical	4
	Core Course 9-BOTPA XIX	Economic botany	2

	Core Course 10-BOTTA XX Core Course 10-BOTPA XXI SEC II – BOTSECA XXII Generic Elective 4 Generic Elective 4 Practical	Economic botany Practical Genetics Genetics Practical Plant breeding GE 4 GE 4 Practical	4 2 2 4 2
V	Core Course 11-BOTTA XXIII Core Course 11-BOTPA XXIV Core Course 12-BOTTA XXV Core Course 12-BOTPA XXVI DSE 1 BOTTDSEA XXVII DSE 1 Practical BOTPDSEA XXVIII DSE 2 BOTTDSEA XXIX DSE 2 Practical BOTPDSEA XXX	Cell and molecular biology Cell and molecular biology Practical Biochemistry Biochemistry Practical Biostatistics Biostatistics Practical Plant biotechnology Plant biotechnology Practical	4 2 4 2 4 2 4 2
VI	Core Course 13-BOTTA XXXI Core Course 13-BOTPA XXXII Core Course 14-BOTTA XXXIII Core Course 14-BOTPA XXXIV DSE 3 BOTTDSEA XXXV DSE 3 Practical BOTPDSEA XXXVI DSE 4 BOTTDSEA XXXVII DSE 4 Practical BOTPDSEA XXXVIII	Plant physiology Plant physiology practical Plant metabolism Plant metabolism Practical Medicinal and ethnobotany Medicinal and ethnobotany Practical Stress biology Stress biology Practical	4 2 4 2 4 2 4 2

Students may opt for other courses (under SEC and DSE) also- here names have been marked as examples

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

SEMESTER I

CORE COURSE 1

PHYCOLOGY AND MICROBIOLOGY- BOTTA-I

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.

…….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 –BOTPAII

(Credits 2)

1. Work out: Algae, Bacterial staining
2. Identification with reasons: (Algae and bacteria)
3. Classroom performance (Attendance, 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. Attendance: A certificate of percentage of attendance in practical classes from the concerned teacher should be attached with lab note books.

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

3. Slides (permanent) prepared during practical classes.

4. Submission (5 algae)

CORE COURSE 2

MYCOLOGY AND PHYTO-PATHOLOGY- BOTTA-III

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 -BOTPA-IV (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. Attendance: A certificate of percentage of attendance in practical classes from the concerned teacher should be attached with lab note books.

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

3. Slides (permanent) prepared during practical classes.

4. Submission (5 Macro fungi)

SEMESTER- II

CORE COURSE 3

PLANT ANATOMY- BOTTA- V

(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– BOTPA-VI (Credits 2)

1.Workout on Plant Anatomy

2. Identification with reasons

3.Classroom performance: (Attendance, 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- BOTTA-VII

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) upto 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 archaegoneates; 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 – BOTPA-VIII (Credits 2)

1.Workout on Pteridophytes

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

3.Classroom performance: (Attendance, 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- BOTTA –IX

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-BOTPA-X

(Credits 2)

1. Study from permanent preparations
2. Identification with reasons
3. Classroom performance: (Attendance, 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. Attendance: A certificate of percentage of attendance in practical classes from the concerned teacher should be attached with lab note books.
2. 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- BOTTA-XI

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- BOTPA-XII

(Credits 2)

1. Identification with reasons (Morphology)
2. Classroom performance: (Attendance, 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 along supported 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- BOTTA-XIII

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 - BOTPA-XIV

(Credits 2)

1.Workout on Angiosperms

2. Spot Identification

3.Classroom performance: (Attendance, 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- BOTTA-XVI

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, 4.6. Geographic Information System and Remote Sensing (brief idea).

…….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- BOTPA-XVII (Credits 2)

1.Workout on ecological parameters

2.Classroom performance: (Attendance, 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. Estimation of solid waste generated by a domestic system (biodegradable and non-biodegradable) and its impact on land degradation.

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

4. Estimation of foliar dust deposition.

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

6. Comparison of free CO_2 from different sources.

7. Determination of total solid in water (TDS)

8. Determination of chemical properties of soil by rapid spot test (carbonate, iron, nitrate)

9. Estimation of organic carbon percentage present in soil sample.

CORE COURSE- 9

ECONOMIC BOTANY- BOTTA-XVIII

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- BOTPA-XIX

(Credits 2)

1. Workout, micro-chemical tests
2. Identification- T.S./L.S. of permanent slides
3. Classroom performance: (Attendance, lab records, permanent slides)
4. Field visit to 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

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 fibre

CORE COURSE 10

GENETICS- BOTTA-XX

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-BOTPA-XXI (Credits 2)

1. Genetics
2. Identification
3. Classroom performance (Attendance, 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- BOTTA-XXIII

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 -BOTPA-XXIV (Credits 2)

1. Work out

2.Identification

3.Classroom performance (Attendance, 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- BOTTA-XXV

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-BOTPA-XXVI

(Credits 2)

1. Workout on Plant Biochemistry (Quantitative & Qualitative)
2. Classroom performance (Attendance, 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- BOTTA-XXXI

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-BOTPA-XXXII (Credits 2)

1. Plant Physiology
2. Classroom performance (Attendance and 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 Q10.

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 15

PLANT METABOLISM-BOTTA-XXXIII

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-BOTPA-XXXIV

(Credits 2)

1. Workout on Plant metabolism
2. Classroom performance (Attendance, 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-1

APPLIED PHYCOLOGY, MYCOLOGY AND MICROBIOLOGY- BOTTSECA-XV

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

SEC-2

PLANT BREEDING- BOTTSECA-XXII

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

SEC-3

BIOFERTILIZERS – BOTTSECA XLIII

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- 4

MUSHROOM CULTURE TECHNOLOGY- BOTTSECA- XLIV

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

SEC-V

PLANT DIVERSITY AND HUMAN WELFARE- BOTTSECA- XLV

THEORETICAL

(Credits 2, Lectures 30)

1. Plant diversity and its scope- genetic diversity, species diversity, plant diversity at ecosystem level. Agrobiodiversity and cultivated plant taxa, wild taxa, values and uses of biodiversity: ethical and asthetic values.

…….8 lectures

2. **Loss of biodiversity:** loss of genetic, species and ecosystem diversity, loss of agrobiodiveristy. Projected scenario of biodiversity loss.

…….4 lectures

3. **Management of plant biodiversity:** organizations associated with biodiversity management- methodology for execution- IUCN, UNEP, UNESCO, WWF, NBPGR; biodiversity legislation and conservations. Biodiversity information management and communication.

…….4 lectures

4. **Conservation of biodiversity:** conservation genetic, species and ecosystem biodiversity, *in-situ* and *ex-situ* conservation, social approaches to conservation, biodiversity awareness programme, sustainable development.

…….8 lectures

5. **Role of plants in relation to human welfare:** a) importance of forestry, their utilization and

commercial aspects. b) Avenue trees. c) Ornamental plants of India. d) Alcoholic beverages through ages. e) Fruits and nuts: important fruit crops and their commercial importance. f) Wood and its uses.

…….6 lectures

SEC-6

HERBAL TECHNOLOGY- BOTTSECA- XLVI

THEORETICAL

(Credits 2, Lectures 30)

1. **Herbal medicines:** history and scope- definition of medical terms. Role of medicinal plants in Siddha systems of medicine: cultivation, harvesting, processing- storage- marketing and utilization of medicinal plants.

   …….6 lectures

2. **Pharmacognosy:** systematic position and medicinal uses of the following herbs- tulsi, zinger, fenugreek, Indian goose berry and ashoka.

   …….6 lectures

3. **Phytochemistry:** active principles and methods of their testing- identification and utilization of the medicinal herbs- *Ctharanthus roseus* (cardio tonic), *Withania somifera (*drugs acting on nervous system), Clerodendron phlomoides (anti-rheumatic) and *Bacopa moneri* (memory booster).

   …….6 lectures

4. **Analytical pharmacognosy:** Drug adulteration- types, methods of drug evaluation. Biological testing of herbal drugs- phytochemical screening test for secondary metabolites (alkaloids, flavonoids, steroids, triterpinoids, phenolic compounds).

   …….8 lectures

5. **Medicinal plant banks-** micropropagation of important species (*Withania somnifera*, *Rauwolfia* and *Aloe*). Herbal foods- future of pharmacognosy.

   …….4 lectures

SEC-7

INTEGRATIVE PALYNOLOGY-BOTTSECA-XLVII

THEORETICAL

(Credits 2, Lectures 30)

1. Major branches of palynology- Neo and paleopalynology: historical background and scopes.

Apiculture and honey industry: Nectar and its transformation into honey; bee pasturage, common Indian bee plants; pollen analysis of honey: determination of floral source, unifloral / bifloral/ multifloral, geographical origin, absolute pollen count, honey quality and typification (ICBB).

…….4 lectures

2. Human health:

Immunobiology: Basic mechanism of spore/pollen allergy; common spore/pollen allergies; aeroallergens-common pollen-allergy causing plants of India, important pollen allergens and their chemical nature; trapping of airborne pollen grains- Rotorod and Burkard Volumetric Samplers, basic tests for diagnosis– skin testing (Prick test), Radio-Immuno Assay (RAST) and ELISA and treatment.

Pharmaceuticals: Brief idea of pollen grains as source of health food, medicine and cosmetics.

…….6 lectures

3. Hydrocarbon exploration: Kerogen – origin and types; coal and petroleum basins of India; palaeopalynology in biostratigraphic correlation, and analyses of palaeoenvironment and depositional facies including palaeo- shore line detection.

…….5 lectures

4. Animal diet and migration: Spores and pollen grains from modern/ancient animal/human dung as source of information- food habit, grazing and land use pattern, migratory route.

…….2 lectures

5. Biotechnology: Development of efficient pollination control system-cytoplasmic and genic male sterility, self incompatibility, pollen sterility by r-DNA technology; use of pollen for genetic transformation; pollen storage to overcome post fertilization barriers.

…….5 lectures

6. Ecology: Basic concept of pollination ecology: types of pollination-autogamy, geitonogamy, xenogamy; pollinator groups and floral syndromes; floral attractants and rewards-role of pollen grains.

…….4 lectures

7. Forensic Science: How does forensic palynology work; Pollen grains as associative evidence; sources of Pollen evidence – plants and soil, clothing and foot wear, vehicles, human bodies and others; limitations of forensic palynology.

…….4 lectures

DISCIPLINE SPECIFIC ELECTIVE COURSES

DSE-1

MEDICINAL AND ETHNOBOTANY- BOTTDSEA-XXXV

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- BOTPDSEA-XXXVI (Credits 2)

1. Workout and chemical tests
2. Classroom performance (Attendance, 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*).

DSE-2

BIOSTATISTICS- BOTTDSEA-XXVII

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 - BOTPDSEA-XXVIII

(Credits 2)

1. Workout
2. Classroom performance (Attendance, 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.

DSE-3

PLANT BIOTECHNOLOGY- BOTTDSEA-XXIX

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- BOTPDSEA-XXIX

(Credits 2)

1. Field report on a visit to a tissue culture lab.
2. Classroom performance (Attendance, 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-4

STRESS BIOLOGY – BOTTDSEA-XXXVII

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 – BOTPDSEA-XXXVIII

(Credits 2)

1. Workout
2. Classroom performance (Attendance, 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-5

RESEARCH METHODOLOGY - BOTTDSEA-XXXIX

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 - BOTPDSEA-XL

(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.

DSE-6

INDUSTRIAL AND ENVIRONMENTAL MICROBIOLOGY - BOTTDSEA-XLI

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 - BOTPDSEA-XLII

(Credits 2)

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.

DSE 7

HORTICULTURAL PRACTICES AND POST- HARVEST TECHNOLOGY- BOTTDSEA XLV

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- BOTPDSEA XLVI

(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.

GENERIC ELECTIVE (GE 4)

GE 1

BIODIVERSITY (BOTTGE I)

(Credits 4, Lectures 60)

Unit 1: Microbes

Viruses – Discovery, general structure, replication (general account), DNA virus (T-phage); Lytic and lysogenic cycle, RNA virus (TMV); Economic importance; Bacteria – Discovery, General characteristics and cell structure; Reproduction – vegetative, asexual and recombination (conjugation, transformation and transduction); Economic importance.

…….10 lectures

Unit 2: Algae

General characteristics; Ecology and distribution; Range of thallus organization and reproduction; Classification of algae; Morphology and life-cycles of the following: *Nostoc*, *Chlamydomonas, Oedogonium, Vaucheria, Fucus, Polysiphonia*. Economic importance of algae.

…….12 lectures

Unit 3: Fungi

Introduction- General characteristics, ecology and significance, range of thallus organization, cell wall composition, nutrition, reproduction and classification; True Fungi- General characteristics, ecology and significance, life cycle of *Rhizopus* (Zygomycota), *Penicillium,Alternaria* (Ascomycota), *Puccinia, Agaricus* (Basidiomycota); Symbiotic Associations-Lichens: General account, reproduction and significance; Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance.

…….12 lectures

Unit 4: Introduction to Archegoniate

Unifying features of archegoniates, Transition to land habit, Alternation of generations.

…….2 lectures

Unit 5: Bryophytes

General characteristics, adaptations to land habit, Classification, Range of thallus organization.Classification (up to family), morphology, anatomy and reproduction of *Marchantia* and *Funaria*.(Developmental details not to be included).Ecology and economic importance of bryophytes with special mention of Sphagnum.

…….8 lectures

Unit 6: Pteridophytes

General characteristics, classification, Early land plants (*Cooksonia* and *Rhynia*). Classification (up to family), morphology, anatomy and reproduction of *Selaginella*, *Equisetum* and *Pteris* (Developmental details not to be included). Heterospory and seed habit, stellar evolution. Ecological and economical importance of Pteridophytes.

…….10 lectures

Unit 4: Gymnosperms

General characteristics; Classification (up to family), morphology, anatomy and reproduction of *Cycas* and *Pinus* (Developmental details not to be included). Ecological and economical importance.

…….6 lectures

PRACTICAL- BIODIVERSITY (BOTTGE I, BOTPGE II) (Credits 2)

1. Study of vegetative and reproductive structures of *Nostoc*, *Chlamydomonas* (electron micrographs), *Oedogonium*, *Vaucheria*, *Fucus** and Polysiphonia through temporary preparations and permanent slides. (* *Fucus* - Specimen and permanent slides)
2. *Rhizopus* and *Penicillium*: Asexual stage from temporary mounts and sexual structures through permanent slides.
3. *Alternaria*: Specimens/photographs and tease mounts.
4. *Puccinia*: Herbarium specimens of Black Stem Rust of Wheat and infected Barberry leaves; section/tease mounts of spores on Wheat and permanent slides of both the hosts.
5. *Agaricus*: Specimens of button stage and full grown mushroom; Sectioning of gills of *Agaricus*.
6. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose)
7. *Marchantia*- morphology of thallus, w.m. rhizoids and scales, v.s. thallus through gemma cup, w.m. gemmae (all temporary slides), v.s. antheridiophore, archegoniophore, l.s. sporophyte (all permanent slides).
8. *Funaria*- morphology, w.m. leaf, rhizoids, operculum, peristome, annulus, spores(temporary slides); permanent slides showing antheridial and archegonial heads, l.s. capsule and protonema.
9. *Selaginella*- morphology, w.m. leaf with ligule, t.s. stem, w.m. strobilus, w.m. microsporophyll and megasporophyll (temporary slides), l.s. strobilus (permanent slide).
10. *Equisetum*- morphology, t.s. internode, l.s. strobilus, T.S. strobilus, w.m. sporangiophore, w.m. spores (wet and dry)(temporary slides); T.S rhizome (permanent slide).
11. *Pteris*- morphology, T.S. rachis, v.s. sporophyll, w.m. sporangium, w.m. spores (temporary slides), T.S. rhizome, w.m. prothallus with sex organs and young sporophyte (permanent slide).
12. *Cycas*- morphology (coralloid roots, bulbil, leaf), v.s. leaflet, v.s. microsporophyll.
13. *Pinus*- morphology (long and dwarf shoots, w.m. dwarf shoot), w.m.dwarf shoot, T.S. needle, l.s./T.S. male cone, l.s. female cone.

GE 2

PLANT ECOLOGY AND TAXONOMY (BOTTGE III)

(Credits 4, Lectures 60)

Unit 1: Introduction

…….2 lectures

Unit 2: Ecological factors

Soil: Origin, formation, composition, soil profile. Water: States of water in the environment, precipitation types. Light and temperature: Variation Optimal and limiting factors; Shelford law of tolerance. Adaptation of hydrophytes and xerophytes

…….10 lectures

Unit 3: Plant communities

Characters; Ecotone and edge effect; Succession; Processes and types

…….6 lectures

Unit 4: Ecosystem

Structure; energy flow trophic organisation; Food chains and food webs, Ecological pyramids production and productivity; Biogeochemical cycling; Cycling of carbon, nitrogen and Phosphorous

…….8 lectures

Unit 5: Phytogeography

Principle biogeographical zones; Endemism

…….4 lectures

Unit 6 Introduction to plant taxonomy

Identification, Classification, Nomenclature.

…….2 lectures

Unit 7 Identification

Functions of Herbarium, important herbaria and botanical gardens of the world and India; Documentation: Flora, Keys: single access and multi-access

…….4 lectures

Unit 8 Taxonomic evidences from palynology, cytology, phytochemistry and molecular

data.

…….6 lectures

Unit 9 Taxonomic hierarchy

Ranks, categories and taxonomic groups

…….2 lectures

Unit 10 Botanical nomenclature

Principles and rules (ICN); ranks and names; binominal system, typification, author citation, valid publication, rejection of names, principle of priority and its limitations.

…….6 lectures

Unit 11 Classification

Types of classification-artificial, natural and phylogenetic. Bentham and Hooker (upto series), Engler and Prantle (upto series).

…….6 lectures

Unit 12 Biometrics, numerical taxonomy and cladistics

Characters; variations; OTUs, character weighting and coding; cluster analysis; phenograms, cladograms (definitions and differences).

…….4 lectures

PRACTICAL- PLANT ECOLOGY AND TAXONOMY (BOTPGE IV)

(Credits 2)

1. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter.
2. Determination of pH, and analysis of two soil samples for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency by rapid field test.
3. (a) Study of morphological adaptations of hydrophytes and xerophytes (four each). (b)Study of biotic interactions of the following: Stem parasite (*Cuscuta)*, Root parasite (*Orobanche*), Epiphytes, Predation (Insectivorous plants)
4. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus by species area curve method. (species to be listed)

5. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law

6. Study of vegetative and floral characters of the following families (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification):Brassicaceae - *Brassica, Alyssum / Iberis;* Asteraceae -*Sonchus/Launaea, Vernonia/Ageratum, Eclipta/Tridax;* Solanaceae- *Solanum nigrum;* Lamiaceae -*Salvia, Ocimum*; Liliaceae - *Asphodelus / Lilium / Allium.*

7. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book).

GE 3

PLANT ANATOMY AND EMBRYOLOGY (BOTTGE V)

(Credits 4, Lectures 60)

Unit 1: Meristematic and permanent tissues

Root and shoot apical meristems; Simple and complex tissues.

…….8 lectures

Unit 2: Organs

Structure of dicot and monocot root stem and leaf.

…….4 lectures

Unit 3: Secondary Growth

Vascular cambium – structure and function, seasonal activity. Secondary growth in root and stem, Wood (heartwood and sapwood)

…….8 lectures

Unit 4: Adaptive and protective systems

Epidermis, cuticle, stomata; General account of adaptations in xerophytes and hydrophytes.

…….8 lectures

Unit 5: Structural organization of flower

Structure of anther and pollen; Structure and types of ovules; Types of embryo sacs, organization and ultrastructure of mature embryo sac.

…….8 lectures

Unit 6: Pollination and fertilization

Pollination mechanisms and adaptations; Double fertilization; Seed-structure appendages and dispersal mechanisms.

…….8 lectures

Unit 7: Embryo and endosperm

Endosperm types, structure and functions; Dicot and monocot embryo; Embryo endosperm Relationship.

…….8 lectures

U nit 8: Apomixis and polyembryony

Definition, types and Practical applications

…….8 lectures

PRACTICAL- PLANT ANATOMY AND EMBRYOLOGY (BOTPGE VI)

(Credits 2)

1. Study of meristems through permanent slides.

2. Tissues (parenchyma, collenchyma and sclerenchyma); Macerated xylary elements, Phloem (Permanent slides)

3. Stem: Monocot: *Zea mays;* Dicot: *Helianthus*; Secondary: *Helianthus* (only Permanent slides).

4. Root: Monocot: *Zea mays*; Dicot: *Helianthus*; Secondary: *Helianthus* (only Permanent slides).

5. Leaf: Dicot and Monocot leaf (only Permanent slides).

6. Adaptive anatomy: Xerophyte (*Nerium* leaf); Hydrophyte (*Hydrilla* stem).

7. Calculation of percentage of germinated pollen in a given medium.

GE 4

PLANT PHYSIOLOGY AND METABOLISM (BOTTGE VII)

(Credits 4, Lectures 60)

Unit 1: Plant-water relations

Importance of water, water potential and its components; Transpiration and its significance; Factors affecting transpiration; Root pressure and guttation.

…….8 lectures

Unit 2: Mineral nutrition

Essential elements, macro and micronutrients; Criteria of essentiality of elements; Role of essential elements; Transport of ions across cell membrane, active and passive transport, carriers, channels and pumps.

…….8 lectures

Unit 3: Translocation in phloem

Composition of phloem sap, girdling experiment; Pressure flow model; Phloem loading and Unloading

…….6 lectures

U nit 4: Photosynthesis

Photosynthetic Pigments (Chl a, b, xanthophylls, carotene); Photosystem I and II, reaction center, antenna molecules; Electron transport and mechanism of ATP synthesis; C3, C4 and CAM pathways of carbon fixation; Photorespiration.

…….12 lectures

Unit 5: Respiration

Glycolysis, anaerobic respiration, TCA cycle; Oxidative phosphorylation, Glyoxylate, Oxidative Pentose Phosphate Pathway.

…….6 lectures

U nit 6: Enzymes

Structure and properties; Mechanism of enzyme catalysis and enzyme inhibition.

…….4 lectures

U nit 7: Nitrogen metabolism

Biological nitrogen fixation; Nitrate and ammonia assimilation.

…….4 lectures

Unit 8: Plant growth regulators

Discovery and physiological roles of auxins, gibberellins, cytokinins, ABA, ethylene.

…….6 lectures

Unit 9: Plant response to light and temperature

Photoperiodism (SDP, LDP, Day neutral plants); Phytochrome (discovery and structure), red and far red light responses on photomorphogenesis; Vernalization.

…….6 lectures

PRACTICAL- PLANT PHYSIOLOGY AND METABOLISM (BOTPGE VIII)

(Credits 2)

1. Determination of osmotic potential of plant cell sap by plasmolytic method.

2. To study the effect of two environmental factors (light and wind) on transpiration by excised twig.

3. Calculation of stomatal index and stomatal frequency of a mesophyte and a xerophyte.

4. Demonstration of Hill reaction.

5. Demonstrate the activity of catalase and study the effect of pH and enzyme concentration.

6. To study the effect of light intensity and bicarbonate concentration on O_2 evolution in photosynthesis.

7. Comparison of the rate of respiration in any two parts of a plant.

8. Separation of amino acids by paper chromatography.

GE 5

ECONOMIC BOTANY AND PLANT BIOTECHNOLOGY (BOTTGE IX)

(Credits 4, Lectures 60)

Unit 1: Origin of Cultivated Plants

Concept of centres of origin, their importance with reference to Vavilov's work.

…….4 lectures

Unit 2: Cereals

Wheat -Origin, morphology, uses.

…….4 lectures

Unit 3: Legumes

General account with special reference to Gram and soybean.

…….6 lectures

Unit 4: Spices

General account with special reference to clove and black pepper (Botanical name, family, part used, morphology and uses).

…….6 lectures

U nit 5: Beverages

Tea (morphology, processing, uses).

…….4 lectures

Unit 6: Oils and Fats

General description with special reference to groundnut.

…….4 lectures

Unit 7: Fibre Yielding Plants

General description with special reference to Cotton (Botanical name, family, part used,morphology and uses).

…….4 lectures

Unit 8: Introduction to biotechnology

…….2 lectures

U nit 9: Plant tissue culture

Micropropagation ; haploid production through androgenesis and gynogenesis; brief account of embryo and endosperm culture with their applications.

…….8 lectures

Unit 10: Recombinant DNA Techniques

Blotting techniques: Northern, Southern and Western Blotting, DNA Fingerprinting; Molecular DNA markers i.e. RAPD, RFLP, SNPs; DNA sequencing, PCR and Reverse Transcriptase-PCR. Hybridoma and monoclonal antibodies, ELISA and Immunodetection.Molecular diagnosis of human disease, Human gene Therapy.

…….18 lectures

PRACTICAL- ECONOMIC BOTANY AND PLANT BIOTECHNOLOGY (BOTPGE X)

(Credits 2)

1. Study of economically important plants : Wheat, Gram, Soybean, Jute, Tea, Cotton, Groundnut through specimens, sections and microchemical tests.
2. Familiarization with basic equipments in tissue culture.
3. Study through photographs: Anther culture, somatic embryogenesis, endosperm and embryo culture; micropropagation

GE 6

ENVIRONMENTAL BIOTECHNOLOGY (BOTTGE XI)

(Credits 4, Lectures 60)

Unit 1: Environment

Basic concepts and issues, global environmental problems - ozone depletion, UV-B, greenhouse effect and acid rain due to anthropogenic activities, their impact and biotechnological approaches for management.

…….4 lectures

Unit 2: Environmental problems

Environmental pollution - types of pollution, sources of pollution, measurement of pollution, methods of measurement of pollution, fate of pollutants in the environment, Bioconcentration, bio/geomagnification.

…….6 lectures

Unit 3:Microbiology of waste water treatment

Aerobic process - activated sludge, oxidation ponds, trickling filter, towers, rotating discs, rotating drums, oxidation ditch. Anaerobic process - anaerobic digestion, anaerobic filters, upflow anaerobic sludge blanket reactors. Treatment schemes for waste waters of dairy, distillery, tannery, sugar and antibiotic industries.

…….8 lectures

Unit 4:Xenobiotic compounds

Organic (chlorinated hydrocarbons, substituted simple aromatic compounds, polyaromatic hydrocarbons, pesticides, surfactants) and inorganic (metals, radionuclides, phosphates, nitrates). Bioremediation of xenobiotics in environment - ecological consideration, decay behavior and degradative plasmids, molecular techniques in bioremediation.

…….10 lectures

Unit 5:Role of immobilized cells/enzymes in treatment of toxic compounds

Biopesticides, bioreactors, bioleaching, biomining, biosensors, biotechniques for air pollution abatement and odour control.

…….6 lectures

Unit 6: Sustainable Development

Economics and Environment: Economic growth, Gross National Productivity and the quality of life, Tragedy of Commons, Economics of Pollution control, Cost-benefit and cost effectiveness analysis, WTO and Environment, Corporate Social Responsibility, Environmental awareness and Education; Environmental Ethics.

…….8 lectures

Unit 7: **International Legislations, Policies for Environmental Protection**

Stockholm Conference (1972) and its declaration, WCED (1983) and Brundtland Report (1987), Rio Earth Summit-UNCED (1992) and its declaration, Montreal Protocol - 1987, Basel Convention (1989), Kyoto Protocol- 1997, Ramsar Convention 1971.

…….6 lectures

Unit 8: **National Legislations, Policies for Pollution Management**

Salient features of Wild life protection act 1972, Water Pollution (Prevention and Control) Act-1974, Forest conservation act 1980, Air Pollution (Prevention and Control) Act-1981, National Environmental Policy -2006, Central and State Pollution Control Boards: Constitution and power.

…….6 lectures

Unit 9: **Public Participation for Environmental Protection**

Environmental movement and people's participation with special references to Gandhamardan, Chilika and Narmada Bachao Andolan, Chipko and Silent valley Movement; Women and

Environmental Protection, Role of NGO in bringing environmental awareness and education in the society.

…….6 lectures

PRACTICAL- ENVIRONMENTAL BIOTECHNOLOGY (BOTPGE XII)

(Credits 2)

1. Water/Soil analysis – DO, salinity, pH, chloride, total hardness, alkalinity, acidity, nitrate, calcium, magnesium and phosphorus.

2. Gravimetric analysis-Total solid, dissolved solid, suspended solid in an effluent.

3. Microbial assessment of air (open plate and air sample) and water.

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UNIVERSITY OF CALCUTTA

SYLLABUS (DRAFT)

FOR

THREE-YEAR B.Sc. PROGRAMME IN

BOTANY (GENERAL COURSE)

UNDER CHOICE BASED CREDIT SYSTEM

BOTANY

Syllabus for three-year B.Sc. Botany Programme (With effect from 2018-2019)

CORE COURSES (4)

Theoretical courses of 4 credits and practicals of 2 credits.

1. **Plant diversity I (Phycology, Mycology, Phytopathology, Bryophytes and Anatomy) – a) Theoretical- BOTTG I b) Practical- BOTPG II**
2. **Plant diversity II (Pteridophytes, Gymnosperms, Palaeobotany, Morphology and Taxonomy) – a) Theoretical- BOTTG III b) Practical- BOTPG IV**
3. **Cell biology, Genetics and Microbiology – a) Theoretical- BOTTG V b) Practical- BOTPG VI**
4. **Plant physiology and metabolism – a) Theoretical- BOTTG VII b) Practical- BOTPG VIII**

Ability enhancement compulsory courses (AEC 2, both the papers theoretical only and of 2 credits each)

1. English communications (AEC I)
2. Environmental science (AEC II)

Skill enhancement courses (SEC 4, four papers to be selected from the list. Each paper of 2 credits and theoretical only)

1. Plant breeding and biometry (BOTSECG IX)
2. Plant biotechnology (BOTSECG X)
3. Biofertilizers (BOTSECG XI)
4. Plant diversity and human welfare (BOTSECG XII)
5. Mushroom culture technology (BOTSECG XIII)
6. Nursery and gardening (BOTSECG XIV)
7. Ethnobotany (BOTSECG XV)

Discipline specific elective courses (DSE 2, two courses to be selected from the list. Each course comprises of theoretical component of 4 credits and practical ones of 2 credits)

1. Phytochemistry and medicinal botany- a) Theoretical- BOTTDSEG XVI, b) Practical- BOTPDSEG XVII
2. Economic botany- a) Theoretical- BOTTDSEG XVIII, b) Practical- BOTPDSEG XIX
3. Horticultural practices and post harvest technology - a) Theoretical- BOTTDSEG XX, b) Practical- BOTPDSEG XXI
4. Natural resource management- a) Theoretical- BOTTDSEG XXII, b) Practical- BOTPDSEG XXIII

SEMESTER	CORE COURSES (CC-4)	ABILITY ENHANCEMENT COMPULSORY COURSE (AEC-2)	SKILL ENHANCEMENT COURSE (SEC-4)	DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE-2)
I	PLANT DIVERSITY I (PHYCOLOGY, MYCOLOGY, PHYTOPATHOLOGY, BRYOPHYTES AND ANATOMY) BOTTG-I	AEC-I ENGLISH COMUUNICATION		
	PRACTICALS BOTPG-II			
	OTHER DESCIPLINES (2)			
II	PLANT DIVERSITY II (PTERIDOPHYTES, GYMNOSPERMS, PALAEOBOTANY, MORPHOLOGY AND TAXONOMY) BOTTG-III	AEC-II ENVIRONMENTAL SCIENCE		
	PRACTICALS BOTPG-IV			
	OTHER DESCIPLINES (2)			
III	CELL BIOLOGY, GENETICS AND MICROBIOLOGY BOTTG-V		SEC-I	
	PRACTICALS BOTPG-VI			
	OTHER DESCIPLINES (2)			
IV	PLANT PHYSIOLOGY AND METABOLISM BOTTG-VII		SEC-II	
	PRACTICALS BOTPG-VIII			
	OTHER DESCIPLINES (2)			
V			SEC-III	DSE-I THEORY
				PRACTICAL
				OTHER DESCIPLINES (2)
VI			SEC-IV	DSE-II THEORY
				PRACTICAL
				OTHER DESCIPLINES (2)

SEMESTER I

CORE COURSE 1
PLANT DIVERSITY I (PHYCOLOGY, MYCOLOGY, PHYTOPATHOLOGY, BRYOPHYTES AND ANATOMY) - BOTTG-I
THEORETICAL
(Credits 4, Lectures 60)

1. Introduction to different plant groups

…….2 lectures

2. Phycology

2.1. Diagnostic characters and examples of Cyanophyceae, Rhodophyceae, Chlorophyceae, Charophyceae and Phaeophyceae, 2.2 Classification: Criteria and system of Fritsch, 2.3. Life histories of *Chlamydomonas*, *Chara* and *Ectocarpus*, 2.4. Role of algae in the environment, agriculture, biotechnology and industry.

…….14 lectures

3. Mycology

3.1 Diagnostic characters and examples of Oomycotina, Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina, Deuteromycotina (Ainsworth, 1973). 3.2 Life histories of *Rhizopus* and *Ascobolus*, 3.3. Economic importance of fungi, 3.4 Fungal symbioses: *Mycorrhiza*, Lichen and their importance.

…….12 lectures

4. Phytopathology

4.1 Symptoms - necrotic, hypoplastic and hyperplastic, 4.2 Koch's postulates, 4.3 Biotrophs and Necrotrophs, 4.4 Disease triangle, 4.5 Pathotoxins and phytoalexins (brief concept), 4.6 Symptoms, causal organism, disease cycle and control measures of plant diseases (Late blight of potato, Brown spot of Rice, Stem rot of jute).

…….10 lectures

5. Bryophytes

5.1 Unifying features of archaegoniates and transition to land habit, 5.2 Amphibian nature of bryophytes, 5.3 Diagnostic characters and examples of Hepaticopsida, Anthocerotopsida and Bryopsida (Proskauer 1957), 5.4 Life histories of *Marchantia* and *Funaria*, 5.5 Ecological and economic importance.

…….10 lectures

6. Anatomy

6.1 Stomata - Types (Metcalfe & Chalk), 6.2 Anatomy of root, stem and leaf of monocots and dicots, 6.3 Stelar types and evolution, 6.4 Secondary growth – normal in dicot stem and anomaly in stem of *Tecoma* & *Dracaena*.

…….12 lectures

PRACTICAL- PLANT DIVERSITY I (PHYCOLOGY, MYCOLOGY, PHYTOPATHOLOGY, BRYOPHYTES AND ANATOMY) - BOTPG-II
(Credits 2)

1. Work out: Microscopic preparation, drawing and labeling of *Chlamydomonas*, *Chara*, *Ectocarpus*, *Rhizopus* and *Ascobolus*

2. Anatomical studies (following double staining method) of: 2a. Stem- *Cucurbita*, sunflower and maize. 2b. Root- *Colocassia*, gram and orchid. 2c. Leaf- Nerium

3. Identification with reasons: 3a. Cryptogamic specimens (macroscopic/microscopic as prescribed in the theoretical syllabus. 3b. Pathological specimens (herbarium sheets) of Late blight of potato, Brown spot of rice and stem rot of jute.

4. Laboratory records: Laboratory note books (regularly signed) and slides (prepared in class) are to be submitted at the time of Practical Examination. Regular attendance in the class must be credited.

5. Atleast one local excursion to be conducted to give an idea of plant diversity, habitat of algae and fungi

SEMESTER II

CORE COURSE 2
PLANT DIVERSITY II (PTERIDOPHYTES, GYMNOSPERMS, PALAEOBOTANY, MORPHOLOGY AND TAXONOMY) - BOTTG III
THEORETICAL
(Credits 4, Lectures 60)

1. Pteridophytes

1.1 Diagnostic characters and examples of Psilophyta, Lycophyta, Sphenophyta & Filicophyta (Gifford & Foster 1989). 1.2 Life histories of *Selaginella* and *Pteris*, 1.3 Economic importance.

…….12 lectures

2. Gymnosperms

2.1 Progymnosperms (brief idea), 2.2 Diagnostic characters and examples of Cycadophyta, Coniferophyta and Gnetophyta (Gifford & Foster 1989), 2.3 Life histories of *Cycas* and *Pinus*, 2.4 *Williamsonia* (reconstructed), 2.5 Economic importance of Gymnosperms.

…….12 lectures

3. Paleobotany & Palynology

3.1 Fossil, fossilization process and factors of fossilization, 3.2 Importance of fossil study. 3.3 Geological time scale, 3.4 Palynology - Definition, spore & pollen (brief idea), Applications.

…….10 lectures

4. Angiosperm Morphology

4.1 Inflorescence types with examples, 4.2 Flower, 4.3 Fruits and seeds- type and examples.

…….12 lectures

5. Taxonomy of Angiosperms

5.1 Artificial, Natural and Phylogenetic systems of c1assificaiton with one example each, 5.2 Diagnostic features of following families- Malvaceae, Leguminosae (Fabaceae), Cucurbitaceae, Rubiaceae, Compositae (Asteraceae), Solanaceae, Acanthaceae, Labiatae (Lamiaceae), Orchidaceae, Gramineae (Poaceae).

…….14 lectures

PRACTICAL- PLANT DIVERSITY II (PTERIDOPHYTES, GYMNOSPERMS, PALAEOBOTANY, MORPHOLOGY AND TAXONOMY) - BOTPG IV (Credits 2)

1. Dissection, drawing and labelling, description of angiospermic plants and floral parts, floral formula and floral diagram, identification (family) from the following families: Leguminosae (Fabaceae), Malvaceae, Solanaceae, Labiatea (Lamiaceae), Acanthaceae.

2. Identification with reasons:

Macroscopic specimens of *Selaginella* and *Pteris*, male and female strobilus of *Cycas* and *Pinus*, Anatomical slides (stellar types, transfusion tissue, sieve tube, sunken stomata, lenticels), inflorescence types.

3. Spot identification of the following Angiospermic plants (scientific names and families): *Sida rhombifolia* (Malvaceae), *Abutilon indicum* (Malvaceae), *Cassia sophera* (Fabaceae), *Tephrosia halimtonii* (Fabaceae), *Crotolaria palida* (Fabaceae), *Coccinia grandis* (Cucurbitaceae), *Solanum indicum* (Solanaceae), *Nicotiana plumbagenifolia* (Solanaceae), *Leucas aspera* (Lamiaceae), *Leonurus sibiricus* (Lamiaceae), *Parthenium hysterophorus* (Asteraceae), *Tridax procumbense* (Asteraceae), *Eclipta prostrate* (Asteraceae), *Eragrostis tenella* (Poaceae), *Chrysopogon aciculantus* (Poaceae), *Eleusine indica* (Poaceae), *Vanda taesellata* (Orchidaceae).

4. Laboratory records: Laboratory note books (regularly signed) and slides (prepared in class) are to e submitted at the time of Practical Examination. Regular attendance in the class must be credited.

5. Field excursion: Local Excursions (at least two including one to Acharya Jagadish Chandra Bose Botanic Garden, Shibpur, Howrah)

6. Field Records: Field note book and 15 herbarium sheets of common Angiospermic weeds are to be prepared and submitted at the time of Practical Examination. Regular attendance in the class must be credited.

SEMESTER III

CORE COURSE 3
CELL BIOLOGY, GENETICS AND MICROBIOLOGY- BOTTG-V
THEORETICAL
(Credits 4, Lectures 60)

1. Cell Biology and Genetics

1.1 Ultrastructure of nuclear envelope, nucleolus and their functions, 1.2 Molecular organisation of metaphase chromosome (Nucleosome concept).

…….6 lectures

2. Chromosomal aberrations- 2.1 deletion, duplication, inversion & translocation, 2.2 Aneuploidy & Polyploidy-types, importance and role in evolution.

…….6 lectures

3. Central Dogma, 3.1 Transcription and Translation.

…….10 lectures

4. Genetic Code- properties.

…….4 lectures

5. Linkage group and Genetic map (three-point test cross).

…….6 lectures

6. Mutation – 6.1 Point mutation (tautomerisation; transition, transversion and frame shift), 6.2 Mutagen-physical and chemical.

…….8 lectures

7. Brief concept of Split gene, Transposons.

…….4 lectures

2. Microbes

2.1 Viruses- Discovery, general structure, replication (general account), DNA virus (T-phage); Lytic and lysogenic cycle, RNA virus (TMV); Economic importance; 2.2 Bacteria- discovery, general characteristics and cell structure; reproduction- vegetative, asexual and recombination (conjugation, transformation and transduction); Economic importance.

……. 16 lectures

PRACTICAL- CELL BIOLOGY, GENETICS AND MICROBIOLOGY- BOTPG-VI
(Credits 2)

1. Cell Biology:

Staining (Aceto-orcein) and squash preparation of onion root tip: study of mitotic stages. Determination of mitotic index (from onion root tip).

2. Microbiology:

Workout gram staining (curd/any natural source)

3. Identification with reasons:
Cytological slides of different mitotic and meiotic stages.
Different forms of bacteria (*Coccus*, *Bacillus*, *Spiral*)
4. Laboratory Records: Laboratory note books (regularly signed) and slides (prepared in class) are to be submitted at the time of Practical Examination. Regular attendance in the class must be credited

SEMESTER IV

CORE COURSE 4
PLANT PHYSIOLOGY AND METABOLISM- BOTTG-VII
THEORETICAL (Credits 4, Lectures 60)

1. Proteins
1.1 Primary, secondary and tertiary structure, 1.2 Nucleic acid- DNA structure, RNA types, 1.3 Enzyme- Classifications with examples (IUBMB), Mechanism of action.

…….8 lectures

2. Transport in plants
2.1 Ascent of sap and Xylem cavitation , 2.2 Phloem transport and source-sink relation.

…….4 lectures

3. Transpiration
3.1 Mechanism of stomatal movement, significance.

…….4 lectures

4. Photosynthesis
4.1 Pigments, Action spectra and Enhancement effect, 4.2 Electron transport system and Photophosphorylation, 4.3 C3 and C4 photosynthesis, CAM- Reaction and Significance.

…….12 lectures

5. Respiration
5.1 Glycolysis & Krebs cycle— Reactions and Significance, 5.2 ETS and oxidative phosphorylation.

…….8 lectures

6. Nitrogen metabolism
6.1 Biological dinitrogen fixation, 6.2 Amino acid synthesis (reductive amination and transamination).

…….6 lectures

7. Plant Growth regulators
7.1 Physiological roles of Auxin, Gibberellin, Cytokinin, Ethylene, ABA.

…….10 lectures

8. Photoperiodism (Plant types, Role of phytochrome and GA in flowering) and Vernalization.

…….6 lectures

9. Senescence (brief idea).

…….2 lectures

PRACTICAL- PLANT PHYSIOLOGY AND METABOLISM- BOTPG VIII
(Credits 2)

Plant Physiology:

i) Experiment on Plasmolysis.

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

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

iv) Evolution of O_2 during photosynthesis (using graduated tube).

v) Evolution of CO_2 during aerobic respiration and measurement of volume.

SEC 1
PLANT BREEDING AND BIOMETRY- BOTTSECG IX
(Credits 2, Lectures 30)

1. Plant breeding:

1.1 Introduction and objective, 1.2 Techniques of hybridisation.

…….2 lectures

2. Mass and Pure line selection:

2.1 Procedure, 2.2 Advantages and limitations.

…….8 lectures

3. Heterosis and hybrid seed production.

…….4 lectures

4. Role of mutation, polyploidy, distant hybridization and role of biotechnology in crop improvement.

…….8 lectures

5. Biometry:

5.1 Measures of central tendency (Mean, Median and Mode), 5.2 Standard error and standard deviation, 5.3 Test of significance: Chi-square test for goodness of fit.

…….8 lectures

SEC 2
PLANT BIOTECHNOLOGY- BOTTSECG X
(Credits 2, Lectures 30)

1. Plant tissue culture- 1.1 Introduction and basic concepts, 1.2 Cellular potency, 1.3 Callus culture and plant regeneration.

…….4 lectures

2. Micropropagation- 2.1 Somatic embryogenesis and artificial seed.

…….4 lectures

3. Protoplast culture and its application.

…….6 lectures

4. Recombinant DNA technology- 4.1 Recombinant DNA, 4.2 Restriction enzymes, 4.3 Plasmids as vectors.

…….8 lectures

5. Gene cloning (basic steps).

…….4 lectures

6. Achievements in crop biotechnology- 6.1 Pest resistant plant (Bt cotton), 6.2 Transgenic crops with improved quality (flavr tomato and golden rice).

…….4 lectures

SEC 3
BIOFERTILIZERS- BOTTSECG XI
(Credits 2, Lectures 30)

1. **Biofertilizers:** General account about microbes used as biofertilisers; *Rhizobium*- identification, mass multiplication. Actinorrhizal symbiosis.

   …….4 lectures

2. ***Azospirillum***- identification, mass multiplication, associative effect of different microorganisms. *Azotobacter* and crop response to *Azotobacter* inoculums.

   …….6 lectures

3. Cyanobacteria, *Azolla*, *Anabaena* and *Azolla* association, blue green algae and *Azolla* in rice cultivation.

   …….6 lectures

4. **Mycorrhizal association:** 4.1 Types of Mycorrhizal association- Brief idea, 4.2 Its influence on growth and yield of crop plants.

   …….6 lectures

5. **Organic farming:** 5.1 Green manuring and organic fertilizers, 5.2 Biocompost and vermicompost- making methods and field applications. 5.3 Recycling of biodegradable

municipal, industrial and agricultural wastes.

…….8 lectures

SEC 4
PLANT DIVERSITY AND HUMAN WELLFARE- BOTTSECG XII
(Credits 2, Lectures 30)

1. **Plant diversity:** 1.1 Its scope, 1.2 Genetic diversity, 1.3 Species diversity, 1.4 Plant diversity at the ecosystem level.

   …….8 lectures
2. **Loss of biodiversity-** 2.1 Loss of genetic diversity, 2.2 Loss of species diversity, 2.3 Loss of ecosystem diversity.

   …….8 lectures
3. **Management of plant biodiversity-** 3.1 Organisations associated with biodiversity management, 3.2 Conservation of genetic, species and ecosystem diversity, 3.3 *In situ* and *ex situ* conservation.

   …….8 lectures
4. Idea of sustainable development.

   …….2 lectures
5. Role of plants in human welfare.

   …….4 lectures

SEC 5
MUSHROOM CULTURE TECHNOLOGY- BOTTSECG XIII
(Credits 2, Lectures 30)

1. **Mushroom**- nutritional and medicinal value of mushrooms. Poisonous mushrooms.

   …….4 lectures
2. Cultivation techniques/ technology of edible mushrooms in India: *Volvarealla volvacea, Pleuretus citrinopyrineatus, Agaricus bisporus*.

   …….12 lectures
3. **Storage**- short term and long term, storage, drying.

   …….6 lectures
4. **Food preparation**- types of foods prepared from mushroom. Cost and benefit ratio.

   …….6 lectures
5. **Research centres**- national and regional.

…….2 lectures

SEC 6
NURSERY AND GARDENING- BOTTSECG XIV
(Credits 2, Lectures 30)

1. **Nursery** – definition, objective and scope. Planting direct seeding and transplants.

…….2 lectures

2. **Seed**- structure and types, seed dormancy, causes and methods of breaking dormancy. Seed storage. Seed viability- factors. Seed testing and certifications.

…….6 lectures

3. Seed bank. Vegetative propagation and hardening of plants.

…….4 lectures

4. **Gardening**: Definition, objectives, scope and types. Gardening operations.

…….4 lectures

5. Sowing/ raising of seeds and seedlings- trnsplanting of seedlings.

…….4 lectures

6. Study of cultivation of different vegetables- cabbage, brinjal, lady's finger, onion, garlic, tomato and carrots.

…….10 lectures

SEC 7
ETHNOBOTANY- BOTTSECG XV
(Credits 2, Lectures 30)

1. Ethnobotany- as an inter-disciplinary science, relevance in the present context. Plant used by the tribals: a) food plants, b) intoxicants and bevarages, c) resins and oils and d) miscellaneous uses.

…….8 lectures

2. Medico-ethnobotanical sources in India. significance of the following plants in ethnobotanical practices (along with their habitat and morphology) *Azadirecta indica, Oscimum sanctum, Vitex negundo, Cassia auriculata* and *Indigofera tictoria.*

…….8 lectures

3. Role of ethnobotany in modern medicine with special reference to *Rauvolfia serpentine, Artemisia* and *Withania*.

…….6 lectures

4. Role of ethnic groups, temples and sacred placesin conservation of plant genetic resources.

…….4 lectures

5. Ethnobotany and legal aspects: ethnobotany as a tool to protect interest of ethnic groups. Biopiracy, intellectual property rights and traditional knowledge.

…….4 lectures

DSE 1
PHYTOCHEMISTRY AND MEDICINAL BOTANY- BOTTDSEG XVI
THEORETICAL
(Credit 4, Lectures 60)

1. **Medicinal botany-** History, scope and importance of medicinal plants, a broef idea about indigenous medicinal sciences- Ayurbeda, Siddha and Unani. Polyherbal formulations.

…….14 lectures

2. **Phramacognosy**- 2.1 Scope and its importance, 2.2 Primary metabolites, 2.3 Secondary metabolites- alkaloids, terpenoids, phenolics and their functions.

…….10 lectures

3. **Organoleptic** evaluation of crude drugs.

…….10 lectures

4. **Pharmcologically active constituents:** Source plants (one example), parts used and uses of: 4.1 Steroids (Diosgenin, Digitoxin), 4.2 Tannin (Catechin), 4.3 Resins (Gingerol, Curcumnoids), 4.4 Alkaloids (Strychnine, Reserpine, Vinblastine), 4.5 Phenols (Capsaicin).

…….6 lectures

5. **Ethnobotany and folk medicine:** 5.1 Brief idea, 5.2 Applications of ethnobotany, 5.3 Application of natural product to certain diseases- Jaundice, Cardiac and Diabetics.

…….20 lectures

PRACTICAL- PHYTOCHEMISTRY AND MEDICINAL BOTANY- BOTPDSEG XVII
(Credit 2)

1. Preparations of solution and buffers
2. Acquaintance with laboratory instruments- Autoclave, Incubator, Clinical centrifuge, Analytical balance, pH meter, Colorimeter, Water bath, Distillation plant, Laminar air flow.
3. Qualitative test for proteins and carbohydrates, reducing and non reducing sugar (glucose, fructose and sucrose)
4. Tests (chemical) for tannin and alkaloid
5. Identification of medicinal plants (list to be provided)
6. Field study (local) and listing of medicinal plants. Records to be substantiated with photographs

and description.

DSE 2
ECONOMIC BOTANY- BOTTDSEG XVIII
THEORETICAL (Credits 4, Lectures 60)

1. Origin of cultivated plants: 1.1 Concepts of centres of origin and their importance with reference to Vavilov's work.

…….12 lectures

2. Rice- origin, morphology and uses.

…….12 lectures

3. Legumes: General account with special reference to *Vigna.*

…….8 lectures

4. Beverages: Tea- morphology, processing and uses.

…….12 lectures

5. Study of the following economically important plants (Scientific names, families, parts used and importance): 5.1 Cereals- Rice, wheat, 5.2 Pulses- Mong, gram, 5.3 Spices- Ginger, cumin, 5.4 Beverages- Tea, coffee, 5.5 Medicinal plants- Cinchona, neem, Ipecac, Vasaka, 5.6 Oil yielding plants- Mustard, groundnut, coconut, 5.7 Vegetables- Potato, raddish, bottle groud, cabbage, 5.8 Fibre yielding plants- Cotton, jute, 5.9 Timber yielding plants- Teak, Sal 5.10 Fruits- Mango, apple, 5.11 Sugar yielding plant- Sugarcane.

…….16 lectures

PRACTICAL- ECONOMIC BOTANY- BOTPDSEG XIX
(Credits 2)

1. Study of economically important plants (rice/jute/ tea) through herbarium specimens and field study.
2. Study of cultivation practices in field and submission of report.
3. Study of local economically important plants and submission of report with photographs.

DSE 3
HORTICULTURAL PRACTICES AND POST HARVEST TECHNOLOGY- BOTTDSEG XX
THEORETICAL
(Credits 4, Lectures 60)

1. Horticulture- role in rural economy and employment generation. Urban horticulture- its scope and importance.

…….6 lectures

2. Ornamental plants- identification and salient features of some ornamental plants (rose, marigold, gladiolus, gerberas, tube rose, carnations, cacti and succulents). Ornamental flowering trees (Gulmohor, Lagerstromia, Shimul, Coral tree and jacaranda).

…….12 lectures

3. Identification of some fruits and vegetable plants- Citrus, Banana, Papaya, Mango, Jackfruit, Chillies and cucurbits. Fruit processing- scope and benefits.

…….10 lectures

4. Horticultural techniques- propagation methods, application of manure, fertilizers, nutrients and PGR. Weed control. Biofertilizers and biopesticides.

…….12 lectures

5. Post harvest technology- importance of post harvest technology in horticultural practices. Harvesting and handling of fruits, vegetables and cut flower. Methods of preservation and processing.

…….10 lectures

6. Disease control and management- field and post harvest diseases of common crops. Crop sanitation, quarantine practices. Identification of common diseases and pest of fruits and vegetable crops.

…….10 lectures

PRACTICAL- HORTICULTURAL PRACTICES AND POST HARVEST TECHNOLOGY - BOTPDSEG XX
(Credits 2)

1. Field trips to gardens, standing crop sites, nurseries, vegetable gardens, horticultural fields and cold storages.

DSE 4
NATURAL RESOURCE MANAGEMENTS- BOTTDSEG XXII
THEORETICAL
(Credits 4, Lectures 60)

1. Natural resources- definition and types.

…….2 lectures

2. Sustainable utilization- concept, approaches (economic, ecological and socio-cultural).

…….10 lectures

3. Land utilization. Soil degradation and management.

…….8 lectures

4. Water, fresh water marine, estuarine. Wetlands- threats and management.

…….10 lectures

5. Biological resources, biodiversity- definition and types. Significance, threats and management strategies.

…….10 lectures

6. Forests- definition, cover and its significance (with special reference to India). Major and minor forest products.

…….8 lectures

7. Energy- renewable and non-renewable source of energy.

…….8 lectures

8. EIA and waste management.

…….4 lectures

PRACTICAL- NATURAL RESOURCE MANAGEMENTS- BOTPDSEG XXIII (Credits 2)

1. Estimation of solid waste generated by a domestic system (biodegradable and non-biodegradable) and its impact on land degradation.
2. Measurement of dominant woody species by DBH (diameter at breast height)
3. Study of community structure by Quadrat method and determination of minimal size of quadrat, frequency density and abundance of components to be done during field visit.
4. Measurement of dissolved O_2 by azide modification of Winkler's method.
5. Determination of chemical properties of soil by rapid spot test (carbonate, iron, nitrate)

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