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Dated: 15.06.2018

No.AC.2(S)/31/18-19

NOTIFICATION

Sub: Revision of syllabus for Botany (UG) as per CBCS pattern from the academic year 2018-19.

- Ref:** 1. Decision of Board of Studies in Botany (UG) meeting held on 27.02.2018.
2. Decision of the Faculty of Science & Technology Meeting held on 21.04.2018.
3. Decision of the Deans Committee meeting held on 22.05.2018.

The Board of Studies in Botany (UG) which met on 27th February, 2018 has recommended to revise the syllabus for B.Sc. Botany as per CBCS pattern from the academic year 2018-19.

The Faculty of Science and Technology and the Deans committee meetings held on 21-04-2018 and 22-05-2018 respectively have approved the above said proposal with pending ratification of Academic Council and the same is hereby notified.

The CBCS syllabus of B.Sc. Botany course is annexed. The contents may be downloaded from the University website i.e., www.uni-mysore.ac.in.

Draft approved by the Registrar

Deputy Registrar(Academic)

To:

1. The Registrar (Evaluation), University of Mysore, Mysore.
2. The Dean, Faculty of Science & Technology, DOS in Physics, Manasagangotri, Mysore.
3. The Chairperson, BOS in Botany, DOS in Botany, Manasagangotri, Mysore.
4. The Chairperson, Department of Studies in Botany, Manasagangotri, Mysore.
5. The Director, College Development Council, Moulya Bhavan, Manasagangotri, Mysore.
6. The Principals of the Affiliated Colleges where UG Program is running in Science stream.
7. The Deputy/Assistant Registrar/Superintendent, AB and EB, UOM, Mysore.
8. The P.A. to the Vice-Chancellor/Registrar/Registrar (Evaluation), UOM, Mysore.
9. Office file.



**CHOICE BASED CREDIT SYSTEM
(CBCS) & CONTINUOUS ASSESSMENT AND
GRADING PATTERN (CGPA)
FOR UNDER GRADUATE PROGRAMS**

B.Sc., BOTANY

Syllabus and Scheme of Examination

2018-19



University of Mysore

**B. SC., BOTANY CHOICE BASED CREDIT SYSTEM (CBCS) & CONTINUOUS ASSESSMENT AND GRADING PATTERN (CGPA)
CORE SUBJECT: BOTANY – [UNDER- GRADUATE]
DEGREE: BACHELOR OF SCIENCE (B.SC.)**

Sem.	Course Code	Title of the Course/Paper	Hrs /Week	Total Credits=36
DISCIPLINE CORE COURSES (COMPUSORY)				
I	DSCB-1.1	Diversity of Microbes, Algae, Fungi, Plant Pathology & Bryophytes	4:0:4	4:0:2=6
II	DSCB-1.2	Pteridophytes & Gymnosperms; Plant Morphology & Taxonomy	4:0:4	4:0:2=6
III	DSCB-1.3	Plant Ecology; Plant Anatomy & Plant Physiology	4:0:4	4:0:2=6
IV	DSCB-1.4	Cell and Molecular Biology, Genetics; Reproductive Biology & Plant Breeding	4:0:4	4:0:2=6
* DISCIPLINE SPECIFIC ELECTIVE (DSE) / **PROJECT WORK *** SKILL ENHANCEMENT (SEC) COURSES				
V	DSEB-1.1	Taxonomy of Flowering Plants	4:0:4	4:0:2=6
	DSEB-1.2	Plant & Microbial Biotechnology	4:0:4	4:0:2=6
	DSEB-1.3	Plant Propagation Techniques	4:0:4	4:0:2=6
	SECB1.1	Medicinal & Ornamental Plants	1:0:2	1:0:1=2
	SECB-1.2	Mushroom Cultivation Technology	1:0:2	1:0:1=2
VI	DSEB-1.4	Economic Botany & Medicinal Plants	4:0:4	4:0:2=6
	DSEB-1.5	Crop Diseases & Management	4:0:4	4:0:2=6
	DSEB-1.6	Plant Diversity & Conservation	4:0:4	4:0:2=6
	SECB-1.3	Nursery & Gardening	1:0:2	1:0:1=2
	SECB-1.4	Floriculture	1:0:2	1:0:1=2
<p>*Any one of the DSE paper or in lieu of the paper, a project work can be undertaken by the student either in the V or VI semester under the guidance of a teacher. **A project report shall be submitted for evaluation. ***Skill Enhancement papers (SEC) are offered in the discipline of Botany is given. Students can choose from any two SEC course/paper in V and VI semesters from a pool of SECS available in the college campus.</p>				

TOTAL CREDITS SHALL BE EARNED BY STUDENT IN UNDER-GRADUATE PROGRAM (B.Sc. Botany)

1) 4 DSC Courses X 3 Disciplines X 24 Credits	3X 24 =72
2) 2 DSE Courses/Project Work X 3 Disciplines 12 Credits	3X 12 =36
3) 4 SEC Courses X 8 Credits	4X2 = 08
4) 4 Kan/Eng/MIL	4X6 =24
5) 2 ES/CI	2x2=04
Total	144 Credits

SCHEME OF ASSESSMENT / EXAMINATION FOR C1, C2 & C3 COMPONENTS (THEORY/PRACTICAL/PROJECT)

Theory: In CBCS-CGPA system, the following model may be followed for the continuous assessment (C1, C₂ and C3 Components). Credit means the unit by which the course work is measured. One hour session of Lecture or Tutorial per week for 16 weeks amounts to 1 credit. Two hours session of Practicals per week for 16 weeks amounts to 1 credit per semester. For continuous assessment of each course/paper weight-age is for Lecture, Tutorial and Practical classes. If a paper/course has got 100 marks, C1 is assessed for 10% marks, C2 is for 10% marks and C3- for 80 % marks (Final Exam). C1 shall be completed by 8th week, C2 - by 16th week and C3 shall be conducted during 17th week of a semesters. This model can be followed for discipline specific core courses/papers (DSC) and (DSE). **Practicals:** For each DSC/DSE course, a separate practical examination shall be conducted for 40% Marks of 3hrs duration for convenience instead of 80% marks as per the scheme of examination. SEC papers shall also be evaluated for total of 100 marks (C1-10% marks; C2-10% marks and C3- 80% marks). No practical examinations are conducted for SEC papers/courses. **Project Work:** Project report shall be assessed as follows; C1- 10 % marks (assessed for literature review, hypothesis and objectives identified, and plan of work). C2- 10% marks (assessed for bound, unedited project report (not corrected by the guide) submitted by the student). For C3-80% marks -Project report shall be assessed by internal and external examiner at the time of semester practical examination. It shall be assessed for 80% marks in the ratio of 40:20:10:10 for dissertation or project work: PPT /oral presentation: Objectives achieved: viva-voce respectively.

Component (s)	Weight-age	Assessment/Activity
C1	10%	5%-marks for Test; 5%-marks for practical skills
C2	10%	5%-marks for Test; 5%-marks for practical skills
C3	80%	Written examination by the end of semester

Component(s)	Weight-age*	Assessment/Activity
Practical Exam Proper	30%	Conducting experiments/ Demonstrations/ Critical Comments and identifications etc.
Practical record	5%	Practical record/tour report for assessment including submissions.
Viva-voce exam	5%	One- to- one interaction

**SCHEME OF EXAMINATION/ASSESSMENT
MODEL QUESTION PAPER (THEORY)
B.Sc., Degree I Semester Examination Oct/Nov-20...
BOTANY**

Course/Paper:
Course/Paper Code.....

Time: 3Hrs

Max Marks: 80

**Instructions: 1. Answer all questions.
2. Draw neat and labeled diagrams wherever necessary.**

I. Define / explain or MCQ type the following: **12X 1 = 12**

- 3 from Unit I
- 3 from Unit II
- 3 from Unit III
- 3 from Unit IV

II. Answer the following: **4 X 5 = 20**

- 2 from Unit I with internal choice
- 2 from Unit II with internal choice
- 2 from Unit III with internal choice
- 2 from Unit IV with internal choice

III. Answer the following: **4 X12 = 48**

- 2 from Unit I with internal choice
- 2 from Unit II with internal choice
- 2 from Unit III with internal choice
- 2 from Unit IV with internal choice

**SCHEME OF PRACTICAL EXAMINATION/ASSESSMENT
MODEL QUESTION PAPER (PRACTICAL)
B.Sc., DegreeSemester Examination, 20.....
BOTANY**

Course/Paper:

Time: 3 Hrs

Max Marks: 40

- | | |
|---|--------|
| Q I. Conducting Experiment/Micro preparation/Identification of Plants | 08 |
| Q II. Minor experiments/ Demonstrations/ Procedure writing. | 05 |
| Q III. Critical Comments (3 items) | 3x3=09 |
| Q IV. Identifications (4 Items) | 4x2=08 |
| Q V. Viva Voce Examination/Tour Report* if Compulsory) | 05 |
| Q VI. Class Records including submissions | 05 |

(Note: Wherever tour is compulsory, 5 marks Viva -voce examination shall be considered for tour report. Tour report shall be submitted at the time of practical examination).

BOTANY - FIRST SEMESTER -DSCB- 1.1

DIVERSITY OF MICROBES, ALGAE, FUNGI, PLANT PATHOLOGY & BRYOPHYTES

(Course duration: 16 weeks with 4 hours of instruction per week)

Theory-64 Hrs

Unit-1: Diversity of Microbes: Microbial diversity and its significance; Microbes of soil, air, food and water; **Virology** - History and discovery, broad outline classification, structure and multiplication of TMV and Bacteriophage (T4); **Viroids**-general characters and fine structure of Potato Spindle Tuber Viroid (PSTVd); Prions -general characters and Prion diseases; Mycoplasma - History and general characteristics; Brief introduction to Phytoplasmas- plant infecting Phytoplasmas.

Unit-2: Bacteria: Introduction and general classification of Bacteria and Archaeobacteria, classification based on nutrition; ultra structure and reproduction of bacteria; Cyanobacteria- occurrence, structure, reproduction and economic importance; Type study-*Nostoc* and *Spirulina*; **Algae**-Introduction, general characteristics, classification, thallus organization, reproduction and economic importance; Type study- *Oedogonium*, *Vaucheria*, *Diatoms*, *Sargassum* and *Polysiphonia*.

Unit-3: Fungi- General characteristics and classification; Thallus organization, nutrition in fungi, asexual and sexual methods of reproduction; reproduction and economic importance, Type study-*Rhizopus*, *Neurospora*, *Puccinia*, *Penicillium*; Lichens- Distribution, types, structure, reproduction and economic importance.

Unit-4: Plant Pathology: Introduction, classification of plant diseases, symptoms, causal agents of plant diseases, crop protection methods; Biology and management of Downy Mildew disease of Bajra, Tikka disease of groundnut, Late blight of potato, Citrus Canker, Phloem Necrosis of Coffee, Tobacco Mosaic Disease, Sandal Spike Disease, Root Knot of Mulberry; **Bryophytes:** General characteristics and classification, thallus organization and reproduction. Economic Importance of Bryophytes. Type Study -*Marchantia*, *Anthoceros*, *Funaria*.

Practicals: One Practical of 2 Hours /Week-32 Hrs

- 1) Demonstration of microbiology instruments - Inoculation loop, Hot air oven, Incubator, Pressure cooker, Haemocytometer.
- 2) Staining and mounting of algae (Safranin) and fungi (cotton blue).
- 3) Simple staining of bacteria (Crystal violet /Nigrosine blue) / Gram staining of bacteria.
- 4) Study of *Nostoc*, *Spirulina*
- 5) Study of *Oedogonium*, *Vaucheria*, Diatoms

- 6) Study of *Sargassum*, *Polysiphonia*
- 6) Study of *Rhizopus*, *Neurospora*
- 7) Study of *Puccinia*, *Penicillium*
- 8) Study of *Agaricus* / *Pleurotus*
- 9) Study of fungal diseases: Downy Mildew disease of Bajra, Tikka disease of Groundnut, Late blight of potato, Citrus Canker, Tobacco mosaic disease, Sandal Spike Disease, Root Knot of Mulberry.
- 10) Study of lichens, study of morphology, internal structure and reproduction in *Marchantia*.
- 11) Study of morphology, internal structure and reproduction in *Anthoceros*
- 12) Study of morphology, internal structure and reproduction in *Funaria*.

BOTANY - SECOND SEMESTER -DSCB 1.2

PTERIDOPHYTA, GYMNOSPERMS, PLANT MORPHOLOGY & TAXONOMY

(Course duration: 16 weeks with 4 hours of instruction per week)

Theory-64 Hrs

Unit- 1: Pteridophyta: Introduction, general characteristics, classification, structure and reproduction. (Developmental details not required). Type Study- *Psilotum*, *Selaginella*, *Equisetum*, *Marsilea*. A brief account on Heterospory and seed habit; Stellar evolution in Pteridophytes.

Unit-2: Gymnosperms: Introduction, general characteristics and classification; Morphology and reproduction of *Cycas*, *Pinus* and *Gnetum*. (Anatomy of Root, Stem and Leaf are to be studied). Fossils and fossilization; Geological time scale; Fossil Gymnosperms; Economic importance of Gymnosperms.

Unit-3: Morphology of Angiosperms: Parts of a flowering plant; monocot and dicot plant root systems; Root modifications- fusiform, napiform, conical fasciculated, tuberous, prop, stilt, climbing, respiratory, parasitic and epiphytic; shoot system; stem modifications-rhizome, tuber, corm, bulb, runner, stolon, offset, sucker, phylloclade (*Opuntia*, *Euphorbia*), cladode (*Ruscus*, *Asparagus*); Leaf- parts, phyllotaxy, simple and compound leaves, pinnate and palmate); Leaf modifications -tendrils, spine, phyllode, pitcher. Inflorescence- racemose, cymose and special types (cyathium, thyrus, verticillaster, hypanthodium).

Unit-4: Flower : A brief account of floral morphology and floral diagram. Fruits- classification- simple (dry dehiscent, dry indehiscent, Schizocarpic and fleshy types); aggregate and composite; Structure of dicot seed and monocot seed. **Plant Taxonomy-** Plant nomenclature, binomial system, ICBN and ICN principles; Bentham and Hooker system of classification; Herbarium and its importance; Botanical gardens, floras and their importance; Study of following plant families; Malvaceae, Fabaceae, Asteraceae, Apocynaceae, Solanaceae, Euphorbiaceae, Liliaceae, Orchidaceae and Poaceae.

Practicals: One Practical of 2 Hours /Week-32 Hrs

- 1) Study of morphology, anatomy and reproductive organs of *Psilotum*, *Selaginella*.
- 2) Study of morphology, anatomy and reproductive organs of *Equisetum*, *Marselia*
- 3) Study of morphology, anatomy and reproductive organs of *Cycas*
- 4) Study of morphology, anatomy and reproductive organs of *Pinus*
- 5) Study of morphology, anatomy and reproductive organs of *Gnetum*
- 6) Modifications of root.
- 7) Modifications of stem.
- 8) Modifications of leaf
- 9) Study of Inflorescences: Racemose, Cymose and Special types.
- 10) Study of Fruits-simple, aggregate and composite type
- 11-14) Scientific description of the following plant families: Malvaceae, Fabaceae, Asteraceae, Apocynaceae, Solanaceae, Euphorbiaceae, Liliaceae and Poaceae.

Field Visits: Field trips to the local areas to study identify and record the Flora. Field visit report shall be submitted at the time of practical examination.

BOTANY - THIRD SEMESTER -DSCB- 1.3

PLANT ECOLOGY, PLANT ANATOMY AND PLANT PHYSIOLOGY

(Course duration: 16 weeks with 4 hours of instruction per week)

Theory-64 Hrs

Unit-1: Plant Ecology: Introduction, definition and concept; Ecological factors-brief account of climatic, edaphic, topographic and biotic factors; Structure and function of Ecosystem; Energy flow in an ecosystem; Food chains and food webs; Ecological pyramids; Plant adaptations-hydrophytes, xerophytes, halophytes, parasites, epiphytes; Plant succession, steps of succession; hydrosere and xerosere; Phytogeography - vegetation of Karnataka.

Unit -2: Plant Anatomy: Structure of a plant body; Tissue and organ system; Meristems - types, Tissues -simple tissues, parenchyma, collenchyma and sclerenchyma and their characteristics; Complex tissues: xylem, phloem, vascular bundle, types; Tissue system- epidermal, trichomes and stomata, structure and types; Anatomy of dicot and monocot root, stems and leaf; Secondary growth in dicot stem; Anomalous secondary growth in *Dracaena*; Laticifers - structure, types and functions.

Unit-3: Plant Physiology: Water relations- diffusion, imbibitions, osmosis, cell as an osmotic system; short distance transport-active and passive absorption of water; Long distance transport-ascent of sap; TCT Theory; Absorption of mineral salts- carrier concept; Transpiration-definition, types, mechanism of stomatal movement (K^+ ion concept); Guttation; hydroponics and aeroponics; phloem transport - Munch's hypothesis; plant growth - definition, phases of growth, sigmoid curve; phyto-hormones- application of auxins, gibberellins, cytokinins,

ethylene, and ABA; Tropic movements- phototropism, thigmotropism, geotropism and hydrotropism; photoperiodism, Vernalisation.

Unit-4: Enzymes-classification, properties, and mode of action; Photosynthesis-photosynthetic apparatus and pigments; Mechanism of light and dark reactions - C₃, C₄, CAM Pathway and C₂ Cycle (Photorespiration); Respiration- aerobic respiration - Glycolysis, Krebs' cycle, Terminal Oxidation; Anaerobic respiration -alcoholic and lactic acid fermentation; Nitrogen metabolism-biological nitrogen fixation, nitrate reduction, synthesis of amino acids.

Practicals: One Practical of 2 Hours /Week-32 Hrs

- 1) Morphological characters of hydrophytes: *Elodea*. Halophytes- Vivipary and Pneumatophores; Xerophytes-*Casuarina*; Epiphytes-Orchids; *Parasites- Cuscuta*.
- 2) Anatomical characters (Slides only): *Elodea*, *Casuarina* stem, Orchid root (T.S.), *Cuscuta*-T.S. of host stem with parasite.
- 3) Study of Ecological Instruments: Hygrometer, Anemometer, Rain Gauge, Altimeter.
- 4) Study of Tissue systems: Parenchyma, Collenchyma and Sclerenchyma, Xylem and Phloem.
- 5) Anatomy of dicot and monocot-Stems.
- 6) Anatomy of dicot and monocot-Roots.
- 7) Anatomy of dicot and monocot- Leaves.

Major Experiments

- 8) (a) Suction force due to Transpiration, (b) Experiment on oxygen evolution during photosynthesis. Effect of light intensity; quality of light (Red, Blue, Green)
- 9) Separation of chloroplast pigments by paper chromatography and demonstration of starch in the leaf.

Minor Experiments

- 10) Streaming of cytoplasm (*Hydrilla* leaf) and Experiment to demonstrate fermentation (Kuhne's vessel). Measurement of growth by using Auxanometer.
- 11) Determination of unequal transpiration by using cobalt chloride paper.
- 12) Biochemical tests for carbohydrates, fats and proteins.

Note: An ecological field study shall be conducted for 1-2 days.

BOTANY - FOURTH SEMESTER -DSCB- 1.4

CELL AND MOLECULAR BIOLOGY, GENETICS; REPRODUCTIVE BIOLOGY AND PLANT BREEDING

(Course duration: 16 weeks with 4 hours of instruction per week)

Theory-64 Hrs

Unit-1: Cell and Molecular Biology: Cell structure and function- prokaryotic and eukaryotic cell; Cell organelles - cell wall, cell membrane, nucleus, mitochondrion, chloroplast, endoplasmic reticulum, Golgi apparatus, lysosomes and ribosome; Chromosome- structure, nucleosome concept; mitosis and meiosis; Nucleic acids; DNA- Chemistry, structure, types and

functions; RNA-Chemistry, structure, types and functions; Mechanism of DNA replication; Gene concept; Genetic code; Protein synthesis.

Unit-2: Cell Biology and Genetics: Numerical variation in chromosomes; Euploidy-induction of polyploidy in plants; Aneuploidy- structural changes in chromosomes: deletion, duplication, inversion and translocation; Mendel's law of inheritance; Test cross, backcross, incomplete dominance; Interaction of genes- Complementary gene action -flower color in sweet pea; Supplementary interaction; Anthocyanin pigmentation in *Snapdragon*, epistasis - fruit color in summer squashes; Multiple factor inheritance - ear size in maize; linkage and crossing over - linkage in maize.

Unit-3: Reproductive Biology (Embryology): Structure of anther; Development of male gametophyte; Role of tapetum; Structure of ovule and types; Development of female gametophyte (*Polygonum* type); Pollination biology- types, contrivances and significance of cross pollination; Fertilization- A general account; Parthenocarpy -a brief account; Endosperm and types; Embryo-Crucifer type with development ; Apomixis; Polyembryony, Palynology and its applications. Experimental embryology (Tissue culture- Techniques, differentiation, totipotency, Organogenesis, Somatic hybridization, synthetic seeds; Anther culture - haploid production and its significance)

Unit-4: Evolution and Plant Breeding: A brief account on origin of life, Theories - Lamarckism, Darwinism, Neo-Darwinism. A brief history, aims and objectives of Plant breeding. Hybridization technique (intergeneric and interspecific), Hybrid vigour and hybrid seed production; Germplasm maintenance, pollen banks, quarantine measures; Plant breeding work done in India- paddy and cotton, Plant breeding institutes in India.

Practicals: One Practical of 2 Hours /Week

- 1) Preparation of fixatives and stains.
- 2) Study of mitosis-Onion root tip.
- 3) Study of meiosis- Onion/ *Chlorophytum* flower bud.
- 4) Micrometry.
- 5) Photographs and charts from Cell biology and molecular biology.
Cell organelles, DNA replication; Lac operon. H.G.Khorana. Miller's experiment.
- 6) Study of Anther (T.S.) and Ovule of different types (L.S.) (Slides)
- 7) - 8) Genetic Problems: monohybrid cross-2; dihybrid cross – 2; interaction of Genes- 4
- 9) Mounting of different pollen grains in Lactophenol- *Hibiscus*, *Catharanthus*, *Solanum*, *Lycopersicum*, Honey- Sample.
- 10) Mounting of Endosperm (*Cucumis*); Mounting of embryo (*Crotalaria*).
- 11) Hybridization Techniques - Emasculation and bagging.
- 12) Vegetative methods of propagations-Cutting, Grafting and Layering
- 13) Preparation of Synthetic seeds

BOTANY - FIFTH SEMESTER - DSEB- 1.1

TAXONOMY OF FLOWERING PLANTS

(Course duration: 16 weeks with 4 hours of instruction per week)

Theory-64 Hrs

Unit-1: Principles of Taxonomy: A brief account of classical and modern Taxonomy; Systems of classification; Broad outline of Engler and Prantl's, Hutchinson's and Cronquist System of classifications with merits and demerits. A brief account of APG system of classification; Plant Nomenclature-Binomial system, ICBN /ICN – Principles, rules, Typification, Ranks, categories and taxonomic hierarchy; author citation, valid publication, rejection of names, principle of priority and its limitations.

Unit-2: Important Botanical gardens of India and World; Botanical Survey of India- Aims and objectives; Taxonomy in relation to palynology, cytology, embryology, phytochemistry, anatomy; Numerical taxonomy; Field and herbarium; Techniques - important herbaria; Hortus Malabaricus.

Unit-3: Study of general characters, morphological peculiarities, systematic position (Bentham and Hooker) and economic importance of the following plant families - Annonaceae, Magnoliaceae, Nymphaeaceae Brassicaceae, Rutaceae, Meliaceae, Rosaceae, Myrtaceae, Cucurbitaceae, Apiaceae, Rubiaceae, Apocynaceae, Solanaceae Convolvulaceae, Bignoniaceae.

Unit-4: Study of general characters, morphological peculiarities, systematic position and economic importance of the following plant families - Acanthaceae, Verbenaceae, Scropulariaceae, Lamiaceae, Amaranthaceae, Cuscutaceae, Nyctaginaceae, Euphorbiaceae, Moraceae, Orchidaceae, Musaceae, Cannaceae, Zingiberaceae and Arecaceae,.

Practicals: One Practical of 2 Hours /Week-32 Hrs

1 -12) Study of vegetative and floral characters of the Annonaceae, Magnoliaceae, Brassicaceae, Rutaceae, Rosaceae, Myrtaceae, Cucurbitaceae, Apiaceae, Rubiaceae, and Convolvulaceae, Acanthaceae, Verbenaceae, Scropulariaceae, Lamiaceae, Amaranthaceae, Nyctaginaceae, Loranthaceae, Moraceae, Orchidaceae, Musaceae, Cannaceae, Zingiberaceae, Arecaceae.

13). Mounting of a properly dried and pressed specimen of any wild plant on herbarium sheet. (The herbarium sheet shall be submitted with record book at the time of examination). **Note:** Field trip of 2-3 days to a floristically rich area is compulsory.

BOTANY - FIFTH SEMESTER - DSEB- 1.2

PLANT AND MICROBIAL BIOTECHNOLOGY

(Course duration: 16 weeks with 4 hours of instruction per week)

Theory-64 Hrs

Unit-1: Microbial Biotechnology: Fermentation - the concept and range of fermentation processes; Industrially important microorganisms (Bacteria, Algae, Fungi); Preservation of industrially important microbes; Bioreactors and Fermentation processes; Media for Fermentation; Types of Fermentation- Continuous and batch Fermentation.

Unit-2: Microbial production of Industrial Chemicals- Alcohol (ethanol), acids (citric acid), solvents (acetone), antibiotics (penicillin), amino acids (lysine). Microbial enzymes; Industrial production of beer (brewing); Microbial production of fuels- hydrogen and methane; Food fermentation; Cheese and other fermented dairy products.

Unit-3: Bio-inoculants, bio-pesticides and Biofertilizers - Algal and fungal (mycorrhizae), Rhizobium Bacteria, N₂ fixers and phosphate solubilizing bacteria, their significance; Bioremediation, *in-situ* and *ex-situ* bioremediation; Microbial Bioremediation, Bioremediation of contaminated ground water. Microbiology of degradation of xenobiotics. Advantages and disadvantages bioremediation.

Unit-4: Tissue Culture: Techniques, differentiation, totipotency, organogenesis, somatic hybridization, somatic embryos and synthetic seeds; Anther culture - haploid production and its significance; Industrial production of single cell proteins; Concept of single cell proteins, probiotics and their application; Biomass feed stocks to fermentation; Mycoproteins and Phycoproteins; Transgenic plants in crop improvement.

Practicals: One Practical of 2 Hours /Week-32 Hrs

1-4) Isolation and screening of industrially important microorganisms.

- a) Organic acid.
- b) Amino acid.
- c) Antibiotic.
- d) Enzymes.

5-6) Microbial production of Citric acid using *A. niger*.

7-8) Microbial production of antibiotics (Penicillin)

9-10) Microbial production of cheese.

11) Production of *Rhizobium* inoculant and testing root nodule ability on legumes.

12) Visit to Fermentation Lab and studying various types of fermenters, bioprocess simulation and control.

BOTANY - FIFTH SEMESTER - DSEB- 1.3

PLANT PROPAGATION TECHNIQUES

(Course duration: 16 weeks with 4 hours of instruction per week)

Theory-64 Hrs

Unit-1: Introduction - Scope and importance of plant propagation; Green house, Net house, Poly house techniques, garden tools, pots, implements and media; Organic manure and substrates- farmyard manure, leaf mould, bone meal, oil cakes, wood ash, charcoal, liquid manure, peat moss, sphagnum moss, vermiculite, compost and vermi-compost.

Unit-2: Watering and Fertilizers: Irrigation methods - drip irrigation, sprinkler irrigation, bucket kit drip irrigation and drum kit irrigation; Application of fertilizers, fertilizer grade; Organic fertilizers; Bio-fertilizers and chemical fertilizers; Phyto-hormones ; Growth regulators; Rooting hormones, sex modification hormones, flower induction, application.

Unit-3: Vegetative propagation: Cuttings-stem cuttings -soft, hard wood and herbaceous, leaf cuttings, root cuttings; Grafting- whip and tongue, wedge and cleft, bark, side grafting, approach; Budding- patch, chip, ring and T- budding; Layering - simple, compound, tip, mound, air and trench layering; Aftercare of plants- disbudding, defoliation, de fruiting, pruning, shaping and topiary.

Unit 4: Plant Tissue Culture Techniques: Definition, scope, sterilization of materials, media, equipments and laboratory; Plant tissue culture media, the plant growth regulators, culture types, shoot tip, callus, cell suspension cultures, root cultures and embryo culture.

Practicals: One Practical of 2 Hours /Week

- 1) Implements used in plant propagation.
- 2) Organic manure and substrates, compost preparation.
- 3) Preparation of Vermi-compost.
- 4) Vegetative propagation: Types of Cuttings and Grafting.
- 5) Vegetative propagation: Types of Budding and Layering.
- 6) Potting, repotting, transplantation.
- 7) Biofertilizers, Chemical fertilizers.
- 8) Tissue culture – Equipment sterilization, media preparation.
- 9) Explants culture.
- 10) Micro propagation.
- 11) Visit to a nursery, Tissue culture Laboratory and horticulture garden
- 12) Soil health testing.

BOTANY - FIFTH SEMESTER - SECB- 1.1

MEDICINAL AND ORNAMENTAL PLANTS

(Course duration: 16 weeks with 1 hour of instruction per week)

Theory- 16 Hrs

Unit-1: Medicinal Plants: Brief history, scope and importance of medicinal plants; Pharmacognosy and Pharmacology; Indigenous medicinal sciences- Definition and Scope; Ayurveda, Siddha and Unani; Classification of drugs based on the source; Common medicinal plants, parts used and their uses-*Melia azadirachta* (*Azadirachta indica*), *Terminalia chebula*, *T. bellirica*, *Withania somnifera*, *Curcuma longa*, *Zingiber officinale*, *Cinnamomum zeylanicum*, *Saraca asoca*, *Aloe vera*, *Phyllanthus emblica*, *P. amarus*, *Piper longum*, *P. nigrum*, *Catharanthus roseus*, *Tinospora cardifolia*, *Asparagus racemosus*, *Boerhaavia diffusa*, *Centella asiatica*, *Ocimum sanctum*, *Plectranthus amboinicus*.

Unit 2: Ornamental Plants: Flowering annuals; Herbaceous perennials; Shade and ornamental trees; Ornamental bulbous and foliage plants; Cacti and succulents; Palms and Cycads; Ferns and Selaginellas; Cultivation of plants in pots; Indoor gardening; Floriculture: Factors affecting flower production; Production and packaging of cut flowers; Flower arrangements; Methods to prolong vase life; Cultivation of Important cut flowers (Carnation, Aster, Chrysanthemum, Dahlia, Gerbera, Gladiolus, Marigold, Rose, Liliun, Orchids); Bonsai & Terrariums.

Practicals: One Practical of 2 Hours /Week 32 Hrs

1-2) Identification of medicinal plants/products/parts of the plant body used.

3-4) Cultivation of any two medicinal plants in the pot/garden.

5) Preparation of Trikatu choorna (*Zingiber officinale*, *Piper longum* & *P. nigrum*) and Triphala choorna (*Terminalia chebula*, *T. bellirica*, *Phyllanthus emblica*).

6-8) Cultivation of ornamental flowering plants. Potting, repotting.

9-11) Bonsai, Terrarium, Ikebana making

12) Visit to Medicinal and Ornamental plant garden.

Note: Students need not draw the diagrams of plants. Photographs of plants/product are to be pasted to the record book.

BOTANY - FIFTH SEMESTER - SECB- 1.2

MUSHROOM CULTIVATION TECHNOLOGY

(Course duration: 16 weeks with 1 hour of instruction per week)

Theory- 16 Hrs

Unit 1: Introduction; Nutritional and medicinal value of edible mushrooms; Poisonous mushrooms and their characteristics; Types of edible mushrooms available in India - *Volvariella volvacea*, *Pleurotus citrinopileatus*, *Agaricus bisporus*; Cultivation Technology -infrastructure, substrates (locally available) polythene bag, vessels, inoculation hook, inoculation loop, low cost stove, sieves, culture rack, mushroom unit, 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.

Unit 2: Factors affecting the mushroom bed preparation - low cost technology, composting technology in mushroom production; 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; Food Preparation- types of foods prepared from mushroom; Research Centres - National level and Regional level; Cost benefit ratio - Marketing in India and abroad, Export Value.

Practicals: One Practical of 2 Hours /Week 32 Hrs

- 1-2) Design and construction of spawn producing and mushroom cultivation facilities.
- 3-4) Culturing of mycelia from mushroom fruiting bodies and establishing spawn.
- 5) Preparation of mother spawns for mushroom cultivation.
- 6-7) Cultivation of Oyster mushroom/Paddy straw mushroom.
- 8-9) Cultivation of white button mushroom.
- 10) Harvesting and drying of mushroom.
- 11) Pickling of mushrooms.
- 12) Visit to mushroom production units.

BOTANY - SIXTH SEMESTER - DSEB- 1.4

ECONOMIC BOTANY AND MEDICINAL PLANTS

(Course duration: 16 weeks with 4 hour of instruction per week)

Theory-64 Hrs

Unit-1: Economic Botany: Introduction, origin, distribution, cultivation, botanical name, family, part used and uses of the following group of plants; cereals and millets-rice, wheat, maize, barley, sorghum, finger millet, pearl millet, foxtail millet, kodo millet; Pulses- Pigeon pea, Bengal gram, Green gram, Black gram, Soya bean, Pea; Spices- Pepper, Cardamom, Clove, Nutmeg, Chilly, Cinnamon, Cumin, Turmeric, Ginger, Coriander, Saffron.

Unit-2: Economic Botany- Fibres- Classification, extraction and processing of fibres. Cotton, Jute, Linen, Coir, Agave; Wood- Features and properties of wood. Principal wood trees of India- Rosewood, Teak, Sal, Honne, Acacia. Wood conversion products- Veneer, Plywood, Lamin board and Paper; Beverages- Coffee, Tea-Types of tea, processing of tea leaves, Cocoa-processing; Fumitories and masticatories- Tobacco- curing of tobacco leaf. Betel nut, betel leaf; Narcotics – harvesting, chemical constitution; Opium, Cannabis-Bhang, Ganja and Hashish.

Unit -3: Economic Botany- Oils and fats- Classification, extraction methods; Ground nut, Coconut, Safflower, Sunflower, Mustard and Olive oil, Hydrogenation of oil, Vanaspathi Essential oils- Extraction methods; Important essential oil yielding plants - Eucalyptus, Jasmine, Geranium, Lavender, Lemongrass, Mint, Sandalwood, Patchouli and Rose; Rubber –processing of rubber; Havea- gums and resins; Gum Arabic, Copals, turpentine, Asafoetida; Sugars- Sugar cane, preparation of sugar; Stevia and beet sugar.

Uni-4: Medicinal plants: Brief history, scope and importance of medicinal plants. Pharmacognosy and Pharmacology; Classification of drugs based on the source; Indigenous Medicinal Sciences- Definition and Scope-Ayurveda, Siddha and Unani, Common medicinal plants, parts used and their uses- *Rauwolfia serpentina*, *Aconitum heterophyllum*, *Hemidesmus indicus*, *Cinchona officinalis*, *Atropa belladonna*, *Digitalis purpurea*, *Strychnos nux-vomica*, *Melia azadirachta*(*Azadirachta indica*), *Terminalia chebula*, *T. bellirica*, *T. arjuna*, *Withania somnifera*, *Curcuma longa*, *Zingiber officinale*, *Cinnamomum zeylanicum*, *Saraca asoca*, *Aloe vera*, *Tylophora asthamatica*, *Emblica officinalis*, *Piper longum*, *P. nigrum*, *Catharanthus roseus* *Tinospora cardifolia*. *Vetiveria zizanioides*.

Practicals: One Practical of 2 Hours /Week-32 Hrs

- 1) Study of Cereals and Millets – Rice, wheat, Maize, Barley, Sorghum, Finger Millet, pearl millet, foxtail millet, kodo millet.
- 2) Study of Pulses- Pigeon pea, Bengal gram, Green gram, Black gram, Soya bean, Pea.

- 3) Study of Spices- Pepper, Cardamom, Clove, Nutmeg, Chilly, Cinnamon, Cumin, Turmeric, Ginger, Coriander, Saffron.
- 4) Study of fibre yielding plants-.Cotton, Jute, Linen, Coir, Agave.
- 5) Study of Wood- Rosewood, Teak, Honne, Acacia. Rubber- Havea. Gums and resins- Gum Arabic, turpentine, Hing.
- 6) Study of Beverages yielding plants- Coffee, Tea-Types of tea, Cocoa. Sugars- Saccharum.
- 7) Study of Fumitories and Masticatories- Tobacco- Betel nut, betel leaf. Narcotics –Opium, Cannabis.
- 8) Study of Oils and fats- Ground nut, Coconut, Safflower, Sunflower, Mustard and Olive oil.
- 9) Study of Essential oils- Eucalyptus, Jasmine, Geranium, Lavender, Lemongrass, Mint, Sandalwood, Patchouli, Rose.
- 10-12) Study of important medicinal plants and their uses.

BOTANY - SIXTH SEMESTER - DSEB- 1.5

CROP DISEASES AND MANAGEMENT

(Course duration: 16 weeks with 4 hour of instruction per week)

Theory-64 Hrs

Unit-1: Introduction to Plant pathology: Historical developments; An overview crop losses due to diseases caused by Fungi, Bacteria, Viruses, Nematodes and Angiosperm parasites; Classification of Plant Diseases; Pathogens- Biotic and abiotic stress; Koch's postulates; Disease triangle; Infection and Disease development in plants; Effect on physiology of host; Defense mechanism in plants; Plant disease epidemiology and disease forecasting.

Unit-2: Principles of disease management: Physical methods; Cultural Methods; Chemical methods; Breeding for disease resistance; Biotechnological methods of Plant disease management; Integrated disease management; Precautions during and after application of insecticides and pesticides.

Unit-3: Study of fungal diseases-Damping off diseases of seedlings; Downey mildew of maize; White rust of Crucifer; Powdery mildew of cucurbits; Smut of Sorghum; False Smut of paddy; Rust of Coffee; Wilt of Tomato; Brown spot of maize; Blast of Rice; Principles of disease management: Physical methods; Cultural Methods; Chemical methods; Breeding for disease resistance; Club root of cabbage; Ergot of Bajra.

Unit-4: Study of plant diseases- Citrus Canker; Little leaf Brinjal; Leaf curl of Tomato; Bunchy Top of Banana; Root Knot of Mulberry; Disease caused by *Striga*; Seed-borne diseases; Post-harvest diseases; Non-parasitic diseases of crop plants.

Practicals: One Practical of 2 Hours /Week-32 Hrs

- 1) Isolation and identification of fungal plant pathogens from seeds/ infected plant materials.
- 2) Spore germination study to know the germ tube formation.
- 3) Conducting Koch's postulates-Testing infection of *Uromyces* / *Alternaria* on French bean or Tomato.
- 4) Estimation of phenol content in diseased and healthy leaf.
- 5-8) Study of Downey mildew of maize; White rust of Crucifer; Powdery mildew of cucurbits; Smut of Sorghum; False Smut of paddy; Rust of Coffee; Wilt of Tomato; Brown spot of maize; Blast of Rice; Club root of cabbage; Ergot of Bajra; Citrus Canker; Little leaf Brinjal; Leaf curl of Tomato; Bunchy Top of Banana; Root Knot of Mulberry; Disease caused by *Striga*.
- 9) Study of Non parasitic diseases of plants.
- 10) Study of Bio and organic pesticides
- 11) Study of Chemical pesticides and insecticides
- 12) Visit to Agricultural University/farm/research station.

BOTANY - SIXTH SEMESTER - DSEB- 1.6

PLANT DIVERSITY AND CONSERVATION

(Course duration: 16 weeks with 4 hour of instruction per week)

Theory-64 Hrs

Unit-1: Biodiversity; Definition, concept and scope; Global Biodiversity and mega diversity centers of the world; Endemism and hot Spots of biodiversity; Types of Biodiversity; Uses and importance of plant diversity; Agro biodiversity- origin and evolution of cultivated species, Vavilov's centres of biodiversity; Diversity in domesticated species; Feral plants.

Unit-2: Biodiversity Estimation: Conventional and molecular methods of estimation of biodiversity; Species richness, species evenness, species abundance; Ecosystem Diversity- Measuring ecosystem diversity, major ecosystem types of the world; Values and uses of biodiversity.

Unit-3: Values of Plant Diversity: Ethical and aesthetic values, uses of plants and microbes; Loss of Biodiversity- Loss of genetic diversity, loss of species diversity, loss of ecosystem diversity; Loss of agro-biodiversity, projected scenario for biodiversity loss; Invasive species.

Unit-4: Conservation of Biodiversity: Conservation of genetic diversity, species diversity and ecosystem diversity, *In situ* and *ex situ* conservation; Social approaches to conservation; Biodiversity awareness programmes; Organizations associated with biodiversity management- IUCN, UNEP, UNESCO, WWF, NBPGR; Biodiversity legislation and conservations.

Practicals: One Practical of 2 Hours /Week -32Hrs

- 1) Study of local vegetation to record species diversity by quadrat / line-transect method.
- 2) Study of cultivated and feral plants.
- 3) Study of *in-situ* and *ex-situ* Conservation methods.
- 4) Study of major Agrobiodiversity crops.
- 5) Study of major forest products.
- 6) Study of minor forest products.
- 7-12) A visit to Botanic Gardens, Zoological Parks, Biosphere Reserves, National Parks and Sanctuaries, Sacred grooves.

BOTANY - SIXTH SEMESTER - SECB- 1.3

NURSERY AND GARDENING

(Course duration: 16 weeks with 1 hour of instruction per week)

Theory-16 Hrs

Unit 1: Nursery: definition, objectives and scope and building up of infrastructure for nursery, planning and seasonal activities - Planting - direct seeding and transplants; Seed: Structure and types-Seed dormancy; causes and methods of breaking dormancy - Seed storage: Seed banks, factors affecting seed viability, - Seed production technology - seed testing and certification; Vegetative propagation: air-layering, cutting, selection of cutting, collecting season, treatment of cutting, rooting medium and planting of cuttings - Hardening of plants - green house - mist chamber, shade house and glass house.

Unit 2: Gardening: definition, objectives and scope - different types of gardening – roof top, kitchen, vertical and herbal; Landscaping - parks and its components - plant materials and design, computer applications in landscaping - Gardening operations: soil laying, manuring, watering, management of pests and diseases and harvesting; Sowing/raising of seeds and seedlings - Transplanting of seedlings - Study of cultivation of different vegetables: cabbage, brinjal, lady's finger, onion, garlic, tomatoes, and carrots - Storage and marketing procedures.

Practicals: One Practical of 2 Hours /Week 32 Hrs

- 1) Design and construction of nursery garden for growing all seasonal plants.
- 2) Study of implements used in nursery and gardening.
- 3) Organic manure and substrates, compost preparation and preparation of potting mixtures.
- 4) Preparation of Vermi-compost.
- 5) Vegetative propagation: Types of Cuttings and Grafting.
- 6) Vegetative propagation: Types of Budding and Layering.
- 7) Standard blotter method (SBM) for seed health testing / Seed viability test (MTT assay)
- 8) Potting, repotting, transplantation.
- 9) Biofertilizers and chemical fertilizer application.
- 10-12) Visit to a nursery, Tissue culture Laboratory and horticulture garden

BOTANY - SIXTH SEMESTER - SECB- 1.4

FLORICULTURE

(Course duration: 16 weeks with 1 hour of instruction per week)

Theory-16 Hrs

Unit 1: Introduction: History of gardening; Importance and scope of floriculture and landscape gardening; Nursery Management and Routine Garden Operations: Sexual and vegetative methods of propagation; Soil sterilization; Seed sowing; Pricking; Planting and transplanting; Shading; Stopping or pinching; Defoliation; Wintering; Mulching; Topiary; Role of plant growth regulators; Ornamental Plants: Flowering annuals; Herbaceous perennials; Divine vines; Shade and ornamental trees; Ornamental bulbous and foliage plants; Cacti and succulents; Palms and Cycads; Ferns and Selaginellas.

Unit 2: Cultivation of Flowering Plants: Cultivation of plants in pots; Indoor gardening; Bonsai; Principles of Garden Designs: English, Italian, French, Persian, Mughal and Japanese gardens; Features of a garden (Garden wall, Fencing, Steps, Hedge, Edging, Lawn, Flower beds, Shrubbery, Borders, Water garden. Some Famous gardens of India; Landscaping Places of Public Importance: Landscaping highways and Educational institutions; Commercial Floriculture: Factors affecting flower production; Production and packaging of cut flowers; Flower arrangements; Methods to prolong vase life; Cultivation of Important cut flowers (Carnation, Aster, Chrysanthemum, Dahlia, Gerbera, Gladiolus, Marigold, Rose, Lilium, Orchids); Diseases and Pests of Ornamental Plants.

Practicals: One Practical of 2 Hours /Week 32 Hrs

- 1-2) Landscape gardening.
- 3-4) Study of different ornamental plants-seed sowing, germination, pricking, planting and Transplantation.
- 5) Cultivation of annual flowering plants, herbaceous perennials.
- 6) Cultivation of succulents.
- 7-9) Study of indoor Gardening.
- 10) Harvesting and packing of flowers.
- 11) Cultivation of important cut flowers.
- 12) Visit to floriculture facility in and around Mysore and Bangalore.

Prof. G. R. JANARDHANA

Sd/-

CHAIRMAN

BOARD OF STUDIES IN BOTANY (UG)

SUGGESTED READINGS

VIRUSES AND BACTERIA

R.C. Dubey and D.K. Maheshwari	A text book of Microbiology	S. Chand & company, Ramnagar N.Delhi-110005.
P.D. Sharma	Microbiology	Rastogi Publications; Shivaji road Meerat; 250002; India
P. D. Sharma	Microbiology and Plant pathology	Rastogi Publications; Shivaji road Meerat; 250002; India
H. C. Dube	Text book of fungi, Bacteria & Virus	Vani Educational Books ,Vikas house 20/4, Industrial area, Sahidabad, 201010, Ghaziabad, UP.
Power & Dagainawala	General Microbiology. Vol. I	Himalaya Publishing house, Bombay
Power & Dagainawala	General Microbiology. Vol.II	Himalaya Publishing house, Bombay
Pelzar Michael.Jr	Text Book of Microbiology	
Prescott, Lansing and Others	Microbiology	
Ananthanarayana .R .	Text Book of Microbiology	Orient and Longman, New Delhi.
Jayaram Panicker .	Functional Principles of Bacteriology	Tata McGraw Hill
Vinita Kale and Kishore Bhusari	Applied Microbiology.	Himalaya Publishing house, Bombay
Frazier William. C.	Food Microbiology	
Cruckishank	Text book of Medical Microbiology	ELBS Publisher , New Delhi
Rangaswamy. G.	Diseases of crop plants in India.	Prentice Hall of India New Delhi

Sundar Rajan	College Microbiology	Vardaman Publishers , Bangalore. Vol. III & Vol. IV.
William. C. Frazier and Dennis C. Westhoff	Food Microbiology	Tata McGraw Hill Publishing company.

ALGAE

K.N. Bhatia	A Treatise on Algae	R. Chand & company, Publishers, N.Delhi.
Chopra. G.L	A Text book of Algae	Pradeep Pub., Jalandhar.
G. M. Smith	Cryptogamic Botany Vol. I	Mc graw Hill , New york. Thomas, Nelson and Sons
Prescott, G.W	The Algae to Review	Rastogi Publications
Kumar, M.A and Kashyap. A.K.	Recent advances in physiology	
Fritsch. F. E.	Structure and Reproduction of Algae Vol. I & Vol. II	Cambridge University Press
Chapman V.J&Chapman D.J.	The Algae 2nd edn.	
Singh, Pande , Jain.	A text book of Botany	Mac Milan, Publishing New York. Rastogi Publications; Shivaji Road Meerat; 250002; India
B. P. Pandey	Simplified course in Botany	S. Chand & company, Ltd. Ramnagar N. Delhi-110005.
Darley. M. W.	Algal Biology	Blackwell Publishers.

FUNGI

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Allexopolos. C. J. and Mims. C. W.	Introduction to Mycology	Wiley Eastern Ltd. New Delhi.

Chopra G. L. and Verma. V	Text Book of Fungi	Pradeep Publications, Jalandar
Mundkur, B. B.	Fungi & Plant diseases	Mac Milan & Co Calcutta
Rangaswamy, G.	Diseases of India 3rd Edition	Prentice Hall of India New Delhi.
Sharma, P. D.	The fungi	Rastogi Publications
Vashista, R.R	Fungi	S. Chand and Company, New Delhi.

BRYOPHYTA

Pandey, B.P.	Bryophyta	S. Chand and Company, New Delhi.
Vashista. B. P.	Bryophyta	S. Chand and Company, New Delhi.
Parihar. N.S.	Bryophyta	Central book depot, Allahabad.
G. M. Smith	Cryptogamic Botany vol. I	Mc Grawhill, New York
G. L. Chopra	Class Book and Pteridophytes	Pradeep Publications, Jalandar.
Chauhan D.K.S	Bryophytes and Pteridophytes	

ANATOMY

Eames A.J. and Mac Daniels, L. H	Introduction to Plant Anatomy	McGraw Hill, New York.
Katherien Esau	Anatomy of seed plants	Wiley Eastern, New Delhi.
Pandey. B. P	Introduction to Plant Anatomy	S. Chand and Company.
Singh. V., Pandey, P.C and Jain, D.K.	Anatomy of seed plants	Rastogi publications, Meerat.
Tayal M. S. Ganguli Das L Datta	Plant anatomy College Botany Vol. I	Rastogi publications, Meerat.

EMBRYOLOGY OF ANGIOSPERMS & TAXANOMY

Bhojwani. S. S. & Bhatnagar, S. P.	The Embryology of Angiosperms	Vikas publishing HOUSE, New Delhi.
Singh, Pandey, Jain	The Embryology of Angiosperms	Rastogi publications, Shivaji Road, Meerat, 250002.
Maheshwari , P	The Embryology of Angiosperms	MC Graw Hill publishing Company, New Delhi.
Johri, B.M.	Comparative Embryology of Angiosperms	Ind. Sci. Acad. Bull. No.41, New Delhi.
Eames, A. J.	Morphology of Angiosperms	MC Graw Hill, New York.
Reinert . J and Yeoman M.M	Plant cell and Tissue culture.	Narosa publishing House New Delhi.

PTERIDOPHYTA

Bold , H.C., Alexopoulos, C.J & Delevoryas, T.	Morphology of plants and Fungi	Harper C Row, New York.
Eames, Arthur, J.	Morphology of vascular plants	Mc Graw Hill, New York.
Parihar, N.S. 1977	The Biology and Morphology of Pteridophytes.	Central book depot. Allahabad.
Pandey, S.N.& Others	Text book of Botany, Vol. II	Vikas publishing House, New Delhi.
Rashid, A.1986	An introduction to Pteridophyta.	Vani educational books, New Delhi.

Sporne, K. R.1970	The Morphology of Pteridophytes	Hutchinson university library, London.
Vashista, P.C. 1987	Pteridophyta	S. Chand and Co., New Delhi.

GYMNOSPERMS

Datta, S.C.	An Introduction to Gymnosperms.	Asia publishing house, New Delhi.
Pandey, B.P.	Gymnosperms.	K. Nath and Co.
Ramaswamy, S.N. 1984	Anavrutha beeja sasyagalu (Gymnosperms)	Prasaranga, University of Mysore, Mysore.
Saxena and Sarabhai 1993	Text book of Botany Vol. II.	Ratna Prakashana Mandir, Agra
Sporne, K.R.1969	The Morphology of Gymnosperms.	Hutchinson university library, London.
Trivedi, B.S.& Singh, D.K	An Introduction to Gymnosperms.	Shashidhar Malaviya Prakashan.
Vashista, B.R.	Gymnosperms.	S.Chand & Co. New Delhi.
Andrews, H.N. 1961	Studies in Palaeobotany.	Wiley, New York.
Biswas, C. & Johri, B.M. 1997	The Gymnosperms.	Narosa, New Delhi.

PLANT PHYSIOLOGY

Conn, E.E. and Stumpf,P.K.1976	Outline of Biochemistry	Wiley-Estern, New Delhi.
Datta, S.C.	Plant physiology	Centar book Depot, Allahabad.
Delvin, R.M. 1969	Plant physiology	Affiliated East West, New Delhi.
Delvin, R.M. & Barker, A.V. 1971	Photosynthesis	Affiliated East West, New Delhi.
Jain, V.K. 1990	Fundamentals of Plant physiology	S.Chand & Co. New Delhi.

Kumar, H.D. & Singh, H.N 1975, 1993	Plant Metabolism	East West Press Pvt. Ltd. New Delhi.
Krishnamurthy, H.N.	Physiology of plant Growth and Development.	Atma Ram & Sons, New Delhi.
Lehninger, A.L. 1978	Biochemistry	
Noggle, G.R. and Fritz George, J. 1977.	Introductory Plant physiology	Prentice Hall of India Pvt. Ltd.
Rao, K.N. Sudhakar Rao and Bharatan, S. 1987	The function of plant.	S.Vishwanatha, Pvt. Ltd.
Rabinowitch, E. & Govindjee. 1970	Photosynthesis	Wiley Eastern, New Delhi.
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ECOLOGY & ENVIRONMENTAL BIOLOGY

Aarne Vesilid, P & Jeffrey Pierce, J. 1983	Environmental Pollution and Control	Ann Arbor Science, Michigan.
BentonAllen.H & Warner,WE	Field Biology an Ecology	McGraw Hill.
Colinvaux Paul, A. 1973	Introduction to Ecology	John Wiley and Sons, New York.
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Dara, S.S. 1993	A Text book of Environmental Chemistry and Pollution Control.	S.Chand & Co, New Delhi.
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Kochhar, P.L. 1990	Plant Ecology	Ratna Prakashan Mandir, Agra.

Kotpal, R.L. 7 Bali, N.P. 1987	Concept of Ecology	Vishal Publications, Jalandar.
Kumar, H. D. 1990	Concept of Ecology	Vikas, New Delhi.
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Mason, C.E.1981	Biology of fresh water Pollution	Longman Inc., New York.
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Vashista, P.C. 1989	Plant Ecology	Vishal Publications jalandhar.
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CYTOLOGY, GENETICS AND ELOLUTION

Ahluwalia Kavita, B. 1985.	Genetics	Wiley Eastern Ltd.
Booker, R.J 1999	Genetics-Analysis and Principles	Addiison Wesley Longman, California.
Archana Sharma, 1990	The Chromosomes	Oxford and IBH, New Delhi
Ayala, F.J. and Klug, Jr. 1984	Modern Genetics	Benjamin Cummings.

Cherayil, J.D. 1974	Gene and Genetics	Tata McGraw Hill, New Delhi
De Robertis, E.D.P. Solez, F.A & Nowinski, W.W.1966	Cell Biology	W. B. Saunders and Co. Philadelphia
Dobzhansky, T., Ayala, J., Stebbins	Evolution	Surjeet Publications, New Delhi
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Gupta, P.K 1987	Genetics	Rastogi Publications,Meerut.
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Jha, A.P. 1993.	Genes and Evolution	Macmillan, India, New Delhi
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Nair, P.G.K. Prabhakar Achar, K.	A Text book of Genetics & Evolution	Konark Publishers pvt.Ltd. A. 149, Main Vikar Marg, New Delhi
Fair Banks, D.J. and Anderson, W.R. 1999	Genetics – the community of life	Brooks-Cole, California.
Pawar, C.B.1983	Essentials of Cytology	Himalayan publishing house, Bombay.

Savage, J.M. 1969	Evolution	Oxford and IBH, New Delhi
Stansfields, W.D.1977	The Science of Evolution	Calif Polytechnic state University and Macmillan, New York.
Sinnot, E.W., Dunn, L.C., & Dobzhansky, T 1958	Principles of Genetics	McGraw Hill, New York
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Swanson Carl, P. 1963	Cytology and Cytogenetics	Macmillan & Co., Ltd. London.
Swanson Carl, P & Webster Peter, L.	The Cell	Prentice Hall of India Pvt. Ltd., New Delhi
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