JSS MAHAVIDYAPEETA

JSS COLLEGE FOR WOMEN (Autonomous)

Saraswathipuram, Mysuru-9

(Autonomous College under University of Mysore: Reaccredited by NAAC with A^+ Grade)

BOTANY

Choice Based Credit System (CBCS) - 2018

For Undergraduate Course

J.S.S. COLLEGE FOR WOMEN (AUTONOMOUS), SARASWATHIPURAM, MYSORE – 09

SCHEME OF INSTRUCTION AND EXAMINATION FOR B. Sc PROGRAMME IN BOTANY (CBCS)

DURATION OF THE COURSE: 3 YEARS (6 SEMESTER)

Year	Semester	Core Course	Title of the paper	Lecture, Practical hours per week	No. of Credits			Total Credits	Total Hours/ Week		Maximum Marks in Exam/ Assignment			Percentage			Exam Duration	
											C3		C1 + C2					
Discipline Specific Core (DSC)-Compulsory					L	T	P		Th	P	Th	P	IA	Th	P	IA	Th	P
I B.Sc.	I	DSC 1:	Microbial diversity, Algae, Fungi, Plant Pathology and Bryophytes	04 04	04	00	02	06	04	04	70	40	30	50	20	30	3h	3h
	II	DSC 2:	Pteridophytes, Gymnosperms, Anatomy of Angiosperms and Reproductive Biology	04 04	04	00	02	06	04	04	70	40	30	50	20	30	3h	3h
II B.Sc.	III	DSC-3:	Morphology and Taxonomy of Angiosperms and Plant Propagation	04 04	04	00	02	06	04	04	70	40	30	50	20	30	3h	3h
	IV	DSC-4:	Plant physiology and Evolution	04 04	04	00	02	06	04	04	70	40	30	50	20	30	3h	3h
Discipline Specific Elective (DSE)/ Skill Enhancement Courses (SEC)																		
III B.Sc.	V	DSE-1:	Cell biology, Molecular Biology and Ecology	04 04	04	00	02	06	04	04	70	40	30	50	20	30	3h	3h
		DSE-2:	Plant and Microbial Technology	04 04	04	00	02	06	04	04	70	40	30	50	20	30	3h	3h
		SEC - 1	Mushroom Cultivation Technology	02	02	00	00	02	02	-	50	-	15	35	-	15	2h	-
		SEC - 2	Medicinal and Aromatic plants	02	02	00	00	02	02	-	50	-	15	35	-	15	2h	-
	VI	DSE-:3	Genetics, Genetic Engineering, Plant Breeding and Plant Biotechnology	04 04	04	00	02	06	04	04	70	40	30	50	20	30	3h	3h
		DSE-:4	Crop Diseases and Management	04 04	04	00	02	06	04	04	70	40	30	50	20	30	3h	3h
		SEC - 3	Nursery and Gardening	02	02	00	00	02	02	-	50	-	15	35	-	15	2h	-
		SEC - 4	Floriculture	02	02	00	00	02	02	-	50	-	15	35	-	15	2h	-
				Total Credits				**40**										

BOTANY
First Semester – DSC – 1

MICROBIAL DIVERSITY, ALGAE, FUNGI, PLANT PATHOLOGY AND BRYOPHYTES

4 hours per week 64 hours

Objectives:

- Acquaint knowledge about distribution of microbes
- Importance and role of microbes
- Knowledge about diseases of economically important plants

Unit I: Microbial diversity: A general account of microbes present in soil, air and water. **Viruses:** History and discovery of viruses, classification, living and non-living characters of viruses. Ultra structure and multiplication of TMV and bacteriophage T_4.Transmission of Viruses. Viral diseases – symptoms and management of Tobacco mosaic disease, Bean Golden Yellow Mosaic disease, Papaya Ring Spot disease. Brief account of Prions and Viroids. **Mollicutes:** General account of Mycoplasma, Sandal spike disease.

12 hrs

Unit II: Bacteria: Discovery in brief, ultra structure, nutrition and reproduction-fission, budding and endospore formation. Genetic recombination: conjugation, transformation and transduction. Bacteria in agriculture (as decomposers, biofertilizers, biopesticides), industry (curing of tea, tobacco, leather, retting of fibers, alcohol and acids) and dairy. Harmful aspects in brief, Citrus canker disease. **Cyanobacteria:** A general account and economic importance. Type study: *Spirulina, Nostoc* and *Scytonema.* **Algae:** General account, Thallus organization, classification (Chapman and Chapman-1973) and life cycles – haplontic, diplontic and haplodiplontic. Economic importance. Type study: *Volvox, Oedogonium,* Diatoms*, Sargassum* and *Polysiphonia.*

20 hrs

Unit III: Fungi: A general characteristics, classification (Alexopoulos-1979) nutrition, reproduction and economic importance. Type study: *Albugo, Rhizopus, Penicillium* and *Lycoperdon.* Brief account of **Fungal diseases:** Symptoms, causal organism, disease cycle and disease management of: White rust of crucifers, Tikka disease of Ground nut, Grain smut of Sorghum, Wheat rust, Coffee rust, Red rot of Sugarcane, Blast disease of Rice, Koleroga of Arecanut, Late blight of Potato. **Botanicals and Biopesticides:** Pest and diseases control by Neem, *Trichoderma, Bacillus thuringiensis* and NPV (Nuclear Polyhedral Virus)

20 hrs

Unit IV: Lichens: Distribution, structure, reproduction, mutualistic interaction, types and economic importance. **Bryophytes:** General characteristics, classification – Thakthajan (1953) and economic importance. Structure, reproduction and alternation of generations of *Marchantia, Anthoceros and Funaria.*

12 hrs

Practicals: One practical of 4 hours/week -32 Hrs

1) Demonstration of microbiology instruments - Inoculation loop, Hot air oven, Incubator, Pressure cooker, Haemocytometer. Sterilization equipments – Hot Air Oven, Incubator, Autoclave and Laminar Air Flow.

2) Simple staining of bacteria –(crystal violet/ Nigrosine blue.) and gram staining of bacteria

3) Methods of staining and mounting of Algae by Safranin

Nostoc, Spirulina, Scytonema

4) Volvox, Oedogonium, Diatoms

5) *Sargassum, Polysiphonia*

Methods of staining and mounting fungi by cotton blue

6) *Saprolegnia***,** *Rhizopus,*

7) *Penicillium, Lycoperdon*

8) Study of Plant diseases caused by Viruses, Mycoplasma and Bacteria – Sandal spike, Tobacco Mosaic Disease, Bean Golden Yellow Mosaic disease, Papaya Ring Spot disease and citrus Canker.

9) Study of Plant diseases caused by Fungi- White rust of crucifers,Tikka disease of Ground nut, Grain smut of Sorghum, Coffee rust, Wheat rust, Red rot of Sugarcane, Blast of Rice and Koleroga of Arecanut

10) Botanicals and Biopesticides: Neem, *Trichoderma, Bacillus thuringiensis*

Lichens: Structure,reproduction and types

11) Study of morphology, Internal structure and reproduction in *Marchantia*

12) Study of morphology, Internal structure and reproduction in *Anthoceros*

13) Study of morphology, Internal structure and reproduction in *Funaria*

SCHEME OF PRACTICAL EXAMINATION

First Semester Practical – DSC – 1

MICROBIAL DIVERSITY, ALGAE, FUNGI, PLANT PATHOLOGY AND BRYOPHYTES

Time: 3 hours Max. Marks = 40

1. Identify the specimens A and B with reasons
(One from cyanobacteria/ algae and one from fungi)
Identification – 1 mark, Reasons – 2 marks 3×2 = 6 marks

2. Prepare a temporary stained slide of material C. sketch, label and identify with reasons. Leave the preparation for evaluation.
(Cyanobacteria/ Algae)
Preparation – 1marks, Identification– 1 marks, Reasons – 2 marks 4 marks

3. Perform bacterial staining of a given sample D and leave the preparation for evaluation
(Preparation- 2 marks, Identification and diagram – 2 marks) 4 marks

4. Comment on E, F and G
(Instruments/ Virus/Biopesticides/Lichens/Diseases/Bryophytes)
(Identification – 1 mark, Reasons – 2 marks) 3×3 =9 marks

5. Identify and comment on H, I, J and K
(Two from Cyanobacteria/Algae/Fungi and two from Lichens/ Bryophytes)
(Identification and Diagram – 1 mark, Reasons – 2 marks) 3×4 =12 marks

6. Class Records 5 marks

Second Semester – DSC -2

PTERIDOPHYTES, GYMNOSPERMS, ANATOMY OF ANGIOSPERMS AND REPRODUCTIVE BIOLOGY

4 hours per week 64 hours

Objectives:

- Diversity of spore bearing plants
- Distribution of naked seeded plants
- Fossil formation and extinct plants
- Internal, epidermal structures of Angiosperms
- Reproductive Biology helps in understanding plant breeding, crop improvement activities

Unit I: Pteridophyta: Introduction, general characters and classification (Eames-1936 and Smith-1955). *Psilotum*-Morphology, anatomy of aerial stem and reproduction**.** *Selaginella*-Morphology, anatomy of stem and reproduction**.** *Equisetum*- Morphology, anatomy of aerial stem and reproduction**.** *Marsile*a- Morphology, anatomy of rhizome and reproduction**.** *Azolla*-Morphology and economic importance. Stelar evolution,origin and evolution of spore bearing organs, heterospory and seed habit. Medicinal and ornamental importance of Pteriodophytes.

16 hrs

Unit II: Gymnosperms: Introduction, general characters, classification (David Bierhorst-1971) and economic importance. *Cycas*-Morphology,anatomy of corolloid root ,young stem, leaflet and reproduction. *Pinus*-Morphology,anatomy of young stem, *Gnetum*-Morphology,anatomy of young stem, evolution of vessels in *Gnetum*, Leaf anatomy, anomalous secondary growth, reproduction and angiospermic characters.
Paleobotany: Geological time scale, fossilisation and types of fossils. Fossil plants - *Rhynia, Cycadeoidea.* 14 hrs

Unit III: Anatomy: Tissues**:** Meristematic tissue-Characteristics and classification based on origin, position and function. Histogen and Tunica- carpus theory. Permanent tissues-A brief account of simple tissues and complex tissues. Brief account of transfer cells. Secretory tissues-nectaries and laticifers. Epidermal structures-stomata and trichomes. Types of vascular bundles in Angiosperms. Anatomy of dicot and monocot – roots, stems and leaves. Secondary growth in dicot stem. Anomalous secondary growth in *Dracaena (*monocot stem).

18 hrs

Unit IV: Reproductive Biology: Microsporogenesis- T.S of mature anther.Types and role of tapetum. Microsporogenesis and development of male gametophyte. Megasporogenesis-Structure and development of ovule, types of ovules, development of female gametophyte

(Polygonum type) Pollination-types and contrivances. Significance of cross pollination. Pollen-pistil interaction in brief. Fertilization Porogamy,chalazogamy, mesogamy, double fertilization and its significance. Endosperm-Types. Embryo- structure of dicot(crucifer type) and monocot embryos(Grass type). Embryogeny- crucifer type. Parthenocarpy, apomixis and polyembryony - A brief account.

16 hrs

Practicals: One practical of 4 hours/week -32 Hrs

Morphology, anatomy and reproductive organs of:

1. *Psilotum* and *Selaginella*
2. *Equisetum*
3. *Marsilea* and *Azolla* (Morphology)
4. *Cycas*
5. Pinus
6. Gnetum and Morphology of *Ephedra*
7. Study of root apex and shoot apex. Study of simple and complex tissues
8. Anatomy of young dicot root – Bengal gram and Anatomy of young monocot root-Sorghum
9. Anatomy of young dicot stem– Tridax and Anatomy of monocot stem-Sorghum/grass
10. Anatomy of dicot leaf– Tridax and Anatomy of monocot leaf-Sorghum/grass
11. Study of stomata and epidermal hairs of *Tridax, Solanum, Tradescantia* and *Rhoeo.* Laticiferous tissues.
12. Study of fossil plants - *Rhynia/Lepidodendron* and *Cycadeoidea*.
13. Study of anther(T.S) and ovule(L.S),Types of ovules
14. Mounting of pollen grains in lactophenol *Hibiscus,Solanum* and V*inca,* Mounting of endosperm (*Cucumis/Croton*) and embryo (*Crotalaria or Brassica*)

SCHEME OF PRACTICAL EXAMINATION

Second Semester Practical – DSC – 2

PTERIDOPHYTES, GYMNOSPERMS, ANATOMY OF ANGIOSPERMS AND REPRODUCTIVE BIOLOGY

Time: 3 hours Max. Marks = 40

1. Identify the specimens A and B with reasons
(One from Pteridophytes/ one from Gymnosperms)
Identification – 1 mark, Reason – 2 marks 3×2 =6 marks

2. Prepare a temporary stained slide of material C. sketch, label and identify with reasons. Leave the preparation for evaluation.
(From Plant Anatomy) 5 marks
Sectioning – 2 marks, Diagram – 1 mark, Reasons – 2 marks

3. Prepare a temporary stained slide of material D. Sketch, label and identify with reasons. Leave the preparation for evaluation.
(Pollen grains/Embryo/Endosperm)
(Preparation – 1 mark, Identification – 1 mark, Reasons – 1 marks)
3 marks

4. Write critical notes on E, F and G
(One from Pteridophytes/ one from Gymnosperms/one from Paleobotany)
(Identification and Sketch- 1 mark, Reasons – 2 marks) 3×3 =9 marks

5. Identify the microslides H, I, J and K with reasons and labeled sketches.
(One from Pteridophytes/one from Gymnosperms/One from Paleobotany/one from Reproductive biology)
(Identification and Sketch- 1 mark, Reasons – 2 marks) 4×3 = 12 marks

6. Class Record
5 marks

Third Semester – DSC - 3

MORPHOLOGY AND TAXONOMY OF ANGIOSPERMS AND PLANT PROPAGATION

4 hours per week 64 hours

Objectives:

- Diversity of flowering plants
- Useful plants products
- Medicinal uses to cure ailments
- Learning the methods of propagation

Unit I: Morphology of angiosperms: Parts of flowering plants (Dicot and Monocot). Brief account on morphology of a flower (Dicotyledonous and Monocotyledonous): Floral parts, aestivation and placentation. Brief account on classical concept of flower and conduplicate carpel. Seed: Structure of dicot and monocot seed **Taxonomy:** Principles of taxonomy. A brief account of classical and modern systems of classification. Brief account on APG system of classification. Plant nomenclature – Binomial nomenclature, principles. Broad outline of Bentham and Hooker system of classification. Recent trends- Chemotaxonomy, Cyto-taxonomy and Numerical taxonomy. Field and herbarium techniques,importance of herbaria,Botanical gardens and flora. Botanical survey of India and its functions.

20 hrs

Unit II: Taxonomy: Study of the following families with their economic importance according to Bentham and Hooker system**.** Dicotyledonous-Magnoliaceae, Brassicaceae, Malvaceae, Rutaceae, Fabaceae, Cucurbitaceae, Apiaceae, Rubiaceae, Asteraceae, Asclepiadaceae, Solanaceae, Verbenaceae, Lamiaceae, Amaranthaceae and Euphorbiaceae. Monocotyledonous – Arecaceae, Liliaceae, Musaceae, Poaceae and Orchidaceae.

20 hrs

Unit III: Economic botany: Oils and fats:Extraction-hot,cold and solvent method.Essential oils. Fibers:Extraction and processing-Jute. Rubber: Rubber tapping and processing. Sugar: Extraction from sugarcane plant. A general account on wood. Spices: Alkaloids in Spice. Tea: Processing of Tea.

12 hrs

Unit IV: Ethnobotany: Introduction and significance. Examples under ethnobotany: *Phyllanthus niruri, P. emblica, Hemidesmus indicus, Terminalia chebula, Strichnos nux-vomica, Aloe vera, Boerhaavia diffusa* and *Withania somnifera*.Sacred grooves.

Plant propagation:Principles and advantages of Plant propagation. Methods: Cutting, Grafting and layering.

12 hrs

Practicals: One practical of 4 hours/week -32 Hrs

1. Root modifications: Fusiform (Radish), Napiform (Beetroot), Conical(Carrot), Tuberous(Sweet potato), Fasciculated (*Asparagus*), Prop (Banyan), Stilt (Maize), Climbing(Betle), Respiratory(Pnematophore),Parasitic(*Cuscuta*) and Epiphytic(*Vanda*). Stem modifications: Rhizome (Ginger), Tuber (Potato), Corm (Amorphophalus), Bulb (onion and Garlic), Runner (*Oxalis*), Offset (*Pistia)*, Sucker (*Chrysanthemum*), Tendril (*Vitis*), Phylloclade (*Opuntia,Euphorbia tirucalli)* and Cladode (*Ruscus, Asparagus*). Leaf modifications:Tendril(*Gloriosa,Smilax*),Spine(*Acacia*),Phyllode(*Acacia melanoxylon*), Insectivorous (*Nepenthes* and *Utricularia)*

2. Inflorescence: Racemose, Cymose and special types (Hypanthodium, Verticillaster, Cyathium and thyrsus), Fruits: Simple, aggregate and composite

3. Technical description of the plants and construction of floral diagrams with floral formulae.

4. Herbarium techniques.

5-12. Study of the plants belonging to the families prescribed in the theory – one or two plants representatives per family

13. Economic Botany:

- Oil and oil yielding plants: Groundnut, Coconut, Safflower, Sunflower, Eucalyptus and Sandal.
- Fibre and fibre yielding plants: Cotton, Jute and Coir.
- Rubber yielding plant: *Haevia.*Rubber tapping.
- Sugar yielding plants: Sugarcane, Sugarbeet.
- Timber yielding plants: Teak, rosewood, Indian Kino (Honne), *Acacia* and *Lagerstroemia* (Nandi)
- Cereals and millets: Rice, Wheat, Maize and Ragi
- Pulses: Pigeon pea, Bengal gram, Black gram, Green gram and horse gram.
- Spices: Cardomom, clove, *Cinnamomum*, Pepper and All spice
- Beverages: Coffee, Tea and Cocoa.
- Narcotic plants: Opium, Cannabis and Tobacco
- Biodiesel: *Jatropha* and *Pongamia*

14. **Ethno Botany**: Plants prescribed in the theory

Identification of medicinal plants: Ginger, Garlic*, Ocimum*, *Vinca*, *Vetiveria*,*Centella asiatica*, *Myristica fragrance*, Mentha, *Saraca indica, Curcuma,Tinospora* and Neem

Field trips: Field trips in the local areas to be conducted to study, identify and record the names of the plants and family.

As part of the curriculum, a botanical trip/tour of about two days shall be undertaken to study the different types of vegetation /herbal garden/Ayurvedic college/horticultural institute. A tour report should be submitted.

Two herbarium sheets should be submitted at the time of practical examinations.

SCHEME OF PRACTICAL EXAMINATION

Third Semester Practical – DSC – 3

MORPHOLOGY AND TAXONOMY OF ANGIOSPERMS AND PLANT PROPAGATION

Time: 3 hours Max. Marks = 40

1. Identify modified structures of A and B.
(From root, stem and leaf modifications)
(Identification – ½ marks, Reasons – 1 ½ marks) 2×2 =4 marks

2. Write critical notes on C & D
(One from Inflorescence and one from fruit)
(Identification – ½ marks, Reasons – 1 ½ marks) 2×2 =4 marks

3. Assign the plants E, F and G to their respective families, giving reasons
(One from Polypetalae/ One from Gamopetalae/ One from Monochlamydae/monocot)
(Family name – 1 mark, characters - 3 marks) 4×3 = 12 marks

4. Draw the floral diagram with floral formula of H
(Floral diagram – 2 marks, floral formula – 1 mark) 3 marks

5. Economic importance of I, J and K
Botanical name – ½ mark, Family – ½ mark, Parts used –1 mark 2×3 = 6 marks

6. Identify and write Ethnobotanical signifinance of L
(Botanical name – ½ mark, family – ½ mark, uses – 2 marks) 3 marks

7. Identify and write the medicinal uses of M
(Botanical name – ½ mark, family – ½ mark, uses – 2 marks) 3 marks

8. Class Record 5 marks

Fourth Semester – DSC - 4

PLANT PHYSIOLOGY AND EVOLUTION

4 hours per week 64 hours

Objectives:

- Knowledge of physiology helps in understanding the basic requirements of plants growth and development of plants.
- Unique features of plants like maintaining ecological balance by evolving oxygen and carbondiaxide etc.,
- Understand the evolving of present day plant groups

Unit I: Plant physiology: Plant and water relations-Diffusion, Imbibition, Osmosis, Cell as osmotic system, Plasmolysis, Active and passive absorption of water(apoplast and symplast). **Absorption of minerals**-Passive absorption: Mass flow, ion exchange, Donnan's equilibrium. Active absorption: carrier concept, cytochrome pump theory, protein-lecithin theory. **Ascent of sap**- Vital theories, Root pressure theory and physical force theories. **Translocation of solutes**-Path of translocation and mechanism of phloem transport: Munch's hypothesis. **Transpiration**: Definition, Types,mechanism of stomatal transpiration: Starch-sugar inter conversion theory, Potassium ion exchange theory, action of potassium transport, antitranspirants, significance of transpiration and guttation. **Mineral nutrition**: Role of mineral nutrients in physiological processes. Essential nutrients: Macronutrients-N, P, K (Primary nutrients) and Ca, Mg, S (Secondary nutrients) . Micronutrients: Zn, Fe, Mo, Mn, Cu and B. A brief account of hydroponics.

16 hrs

Unit II: Photosynthesis: Introduction, Photosynthetic apparatus, visible, active and absorptive spectra. Mechanism-Light reaction and dark reaction-Calvin cycle, Hatch-Slack pathway and CAM. Photorespiration. Factors affecting photosynthesis-a brief account of Blackmann's law of limiting factors. **Enzymes**:General characters, classification, properties and mode of action-Lock and Key theory, Induced fit theory. **Respiration:** Introduction,types. Structure of mitochondria. Aerobic respiration –Mechanism, Glycolysis, Kreb cycle, Terminal oxidation, ATP Synthesis, Chemiosmotic theory. Anaerobic respiration-alcoholic and lactic acid fermentataion.Respiratory quotient.Factors affecting respiration.

18 hrs

Unit III: Nitrogen metabolism:Nitrogen fixation-abiotic and biotic(symbiotic and non symbiotic), Mechanism-biological nitrogen fixtion, nitrogen cycle, nitrate reduction. Amino acids-transamination and reductive amination. **Growth**: Definition, phases of growth, sigmoid curve. Phytohormones: Chemical nature and Role of plant hormones (Auxin, Gibberllins, Cytokinins, Ethylene and ABA) in the field of agriculture, horticulture and tissue culture. **Plant movements**: Tropisms: Photo, Hydro, Geo and Thigmotropism. General account of photoperiodism and vernalization. 12 hrs

Unit IV: Evolution: Origin of life - Chemical evolution theory, Stanely Miller experiment. Theories of organic evolution-Lamarckism, Weismannism ,Darwinism, HugoDe vries theory, Neo Darwinism.

Practicals: One practical of 4 hours/week -32 Hrs

1. **Major experiments:**

- Determination of Osmotic potential by plasmolytic method.
- Experiment on the relationship between transpiration and absorption.
- Experiment on Oxygen evolution during photosynthesis:1)effect of light intensity, 2)Quality of light.
- Separation of pigments by paper chromatography.
- Demonstration of starch in leaf.
- Suction force due to transpiration.
- Determination of stomatal index, stomatal frequency.
- Effect of temperature on permeability of cell membrane.

2. **Minor experiments:**

- Streaming of cytoplasm
- Determination of transpiration by Ganong's Potometer
- Experiment to demonstrate fermentation (Kunhe's fermentation vessel)
- Measurement of growth by Arc Auxonometer
- Experiment to demonstrate Geotropism, phototropism and hydrotropism
- Root pressure experiment
- Ganong's respirometer experiment.
- Determination of unequal transpiration by using cobalt chloride paper.
- Effect of auxins on rooting.
- Respiration of roots.

3. Quantitative test for carbohydrates, proteins and fats
4. Seed viability test: Tetrazolium test and Paper Towel method.
5. Photographs: Mineral nutrition deficiency symptoms, Photoperiodism, Light spectrum.
6. Instruments: Spectrophotometer, Centrifuge, Calorimeter.
7. Photographs and charts – From Evolution

SCHEME OF PRACTICAL EXAMINATION

Fourth Semester Practical – DSC – 4

PLANT PHYSIOLOGY AND EVOLUTION

Time: 3 hours Max. Marks = 40

1. Perform the major experiment A
(Requirements – 1 marks, setting – 2 marks, procedure – 3 marks, results – 2 marks)
8 marks

2. Perform minor experiment B
(Requirements – 1 mark, setting – 1 marks, procedure – 2 marks, results – 2 mark)
6 marks

3. Comment on C and D
(Minor experiments) (Identification – 1 mark, Reasons – 2 marks 3×2 = 6 marks

4. Perform Biochemical test E 3 marks

5. Comment on F, G, H and I
(Physiology instruments, photoperiodism/Hormones/Nutrition deficiency/Evulution)
4×3 = 12 marks

6. Class Records 5 marks

Fifth Semester – DSE -1

CELL BIOLOGY, MOLECULAR BIOLOGY AND ECOLOGY

4 hours per week 64 hours

Objectives:

- Learning basic structural organization at molecular level
- It helps in understanding the genetic engineering techniques
- Understand nature of plants with their habitat

Unit 1: Cell Biology: Principles and uses of Compound and Electron microscopes. Ultrastructure of prokaryotic cell and eukaryotic cell. Cell organelles- Cell wall, Cell membrane, Endoplasmic reticulum, Golgi apparatus, Chloroplast, Mitochondria, Lysosomes and Ribosomes. Ultrastructure of nucleus and typical chromosome - Nucleosome model. **Cell cycle**-mitosis, meiosis and their significance. **Chromosomal aberrations**-structural and numerical variations in chromosomes; Euploidy, Aneuploidy – Structural changes in chromosome: Deletion, Inversion, Translocation. Polyploidy in plants and their role in evolution

26 hrs

Unit II: Molecular biology: Nucleic acid as genetic material- Avery et al., experiment, Fraenkel conrat's experiment. DNA and RNA - Chemistry, structure, types and functions. DNA replication in prokaryotes (Rolling circle model) and eukaryotes (Watson and Crick's model). Gene concept-classical and modern (Seymour Benzer) hypothesis.

14 hrs

Unit III: Genetic code -Triplet codon, Protein synthesis-transcription and translation. Gene regulation in prokaryotes(Operon concept),and eukaryotes(Britten's hypothesis)**.** Genetic disorders-Sickle Cell Anaemia,Thallasemia(symptoms and remedies)

12 hrs

Unit IV: Ecology: Introduction and scope of ecology. Ecological factors-Biotic: Man as a biotic factor, Edaphic: Soil features, Climatic: Light, wind, rainfall, fire and temperature. Special morphological and anatomical features of Hydrophytes, Xerophytes, Halophytes, epiphytes and Parasites. Plant succession: Process of succession, characteristics of pioneer and climax vegetation: xerosere and hydrosere. Red data book,Hot spots of India-Western Ghats and Eastern Himalayas. **Phytogeography:** Introduction, Endemism and vegetation types of Karnataka. Floristic regions of India.

12 hrs

Practicals: One practical of 4 hours/week -32 Hrs

1. Preparation of fixatives and stains - FAA, Carnoy's, Acetocarmine, Acetoarcine, Safranine, Crystal violet.

2-3. Study of Mitosis - Onion root tip

4-5. Study of Meiosis - Onion flower bud/ Chlorophytum flower bud

6. Micrometry

7. Karyotype

8. Photographs and charts - Molecular biology and Cell Biology and Ecology

9. Special morphological and anatomical features of Hydrophytes (*Hydrilla*), Xerophytes (*Euphorbia tirucalli, Opuntia*, *Casuarina and Ficus*), Halophytes (*Rhizophora, Avicinnia*), epiphytes(*Vanda*) and Parasites (*Cuscuta*).

10. Ecological instruments-Wet and dry thermometer, Anemometer, Rain gauge, Hygrometer and Altimeter.

Water analysis

11. Estimation of Dissolved oxygen(DO)
12. Estimation of Chemical oxygen demand (COD)

SCHEME OF PRACTICAL EXAMINATION

Fifth Semester Practical – DSE – 1

CELL BIOLOGY, MOLECULAR BIOLOGY AND ECOLOGY

Time: 3 hours Max. Marks = 40

1. Make a temporary squash preparation of given material **A**. Identify, sketch and label with reasons. Leave the preparation for evaluation.
   (preparation-3 marks, identification with reasons-3 marks) 6 marks

2. Estimation of DO in given water sample **B.**
   (procedure-3 marks, Result-1 marks) 4 marks

3. Micro preparation of material **C.**
   (sectioning -2 marks, Reasons-2 marks) 4 marks

4. Write ecological features of **D**
   (From Hydrophytes, Xerophytes, epiphytes and Parasites) 3 marks

5. Comment on **E, F** and **G.**
   (Ecological instrument, fixation/stain, forest type, molecular biology photography)
   3×3 = 9 marks

6. Calibrate the ocular micrometer using stage micrometer, write the procedure and measure the length and breadth of **H.**
   (Calibrations and measurement-1 marks, procedure-2 marks) 3 marks

7. Identify the slides I and J
   (Meiosis and Ecological anatomy) 3×2 = 6 marks

8. Class Record 5 marks

Fifth Semester – DSE - 2

PLANT AND MICROBIAL TECHNOLOGY

4 hours per week 64 hours

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. Purification of fermentated products – Downstream processing.

18 hrs

Unit-2: Microbial production of Industrial Chemicals – Alcohol (ethanol), acid (citric, acidic), solvents (acetone-butanol), 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.

14 hrs

Unit-3: Bio-inoculants – bio-insecticides and Biofertilizers – Algal and Fungal (mycorrhizae), Bacterial rhizobial, free living N2 fixers and phosphate solulilizing bacteria, their significance; Bioremediation, Advantages and disadvantages microbial bioremediation; In-situ and ex-situ bioremediation; slurry bioremediation; Bio-remediation of contaminated ground water, Microbiology of degradation of xenobiotics.

16 hrs

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.

16 hrs

Practicals: One Practical of 4Hours/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.

10-11) Production of *Rhizobium* inoculants and testing root nodule ability on legumes.

11-12) Visit to fermentation Lab and studying various types fermenters, bioprocess simulation and control.

SCHEME OF PRACTICAL EXAMINATION

Fifth Semester Practical – DSE – 2

PLANT AND MICROBIAL TECHNOLOGY

Time: 3 hours Max. Marks = 40

1. Isolation of antibiotic producing microorganisms from soil by crowded plate method. (Enzyme producing/ Organic acid producing) 10 marks

2. Isolation of rhizobium in root nodules**.** 10 marks

3. Critical notes on **C, D** and **E.**
   (Enzyme, Cheese, Ammino acids, Organic acids, Antibiotics, Formentors)
   5×3 = 15 marks
4. Class Record 5 marks

FIFTH SEMESTER- SEC-1

MUSHROOM CULTIVATION TECHNOLOGY

Theory:18 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 (Thatched house) water sprayer, small polythene bag. Pure culture: Medium, sterilization, preparation of spawn, mulitiplication. Mushroom bed preparation – paddy straw, sugarcane trash, maize straw, banana leaves. Factors affecting the production; Storage and nutrition; Short- term storage(Refrigeration- upto 24 hours) Long term acids, mineral elements nutrition – Carbohydrates, Crude fiber content – Vitamins; Food Preparation : Types of foods prepared from mushroom. Research Centres – National level and Regional level. Cost benefit ration – Marketing in India and abroad, Export Value.

Practicals: One Practical of 2 Hours / Week -14 Hrs

1-2) Design and construction of spawn producing and mushroom cultivation facilities.

3-4) Culturing of mycelia from mushroom fruiting bodies and establishing spwan.

5) Preparation of mother spwans for mushroom cultivation.

6-7) Cuiltivation of Oyster mushroom /Paddy straw mushrrom.

8-9) Cultivation of white button mushroom.

10) Harvesting and drying of mushroom.

11) Pickling of mushrooms.

12) Visit to mushroom production units.

FIFTH SEMESTER- SEC-2

MEDICINAL AND AROMATIC PLANTS

Theory:18 Hrs

Unit 1: Brief history, Scope and Importance of Medicinal Plants. Pharmacognosy, 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 azadiracthta (Azadirachta indica), Terminalia chebula, T. bellarica, Withania somnifera, Curcuma longa, Zingiber officinale, Cinnamomum zeylanicum, Saraca asoca, Aloe vera, Phyllanthus emblica, P. Amarus, Piper longum, P. nigraum, Catharanthus roseus, Tinospora cardifolia, Asparagus racemosus, Boerhaavia diffusa, Centella asiatica, Ocimum sanctum, Plectranthus amboinicus*, Ornamental plants: Flowering annuals; Herbaceous perennials; Divine vines; Shades 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 arrangement; Methods to prolong vase life; Cultivation of Important cut flowers (Carnation, Aster, Chrysanthemum, Dahlia, Gerbera, Gladiolous, Marigold, Rose, Lilium, Orchids); Bonsai and Terrariums.

Practicals: One Practical of 2 Hours / Week - 14 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* and *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 and photographs of plants are tobe pasted to the record book.

SIXTH SEMESTER – DSE - 3

GENETICS, GENETIC ENGINEERING, PLANT BREEDING AND PLANT BIOTECHNOLOGY

4 hours per week 64 hours

Objectives:

- Learning gene action in plants
- Importance of genetic engineering in the field of agriculture, medicine etc.,
- Knowledge about bringing new varieties of crop plants by plant breeding centres particularly in India

Unit I: Genetics: Introduction and contributions of Mendel. Mendel's laws of Inheritance. Deviation from Mendelian laws- Incomplete dominance-Flower colour in 4 O' clock plant**.** Interaction of genes- 1. Complementary gene action-Flower color in sweet Pea 2. Supplementary gene action-Anthocyanin pigmentation in Snapdragon plants 3. Epistasis-Fruit color in Summer squash 4. Multiple factor inheritance-Ear size in Maize Linkage and crossing over-Linkage in Maize and 2 point test cross**.** Cytoplasmic inheritance *Mirabilis/*male sterility in maize**.** Mutations: Types-Spontaneous and Induced,mutagenic agents ,factors affecting mutations and significance. Neo-mendalism-T H Morgan.

20 hrs

Unit II: Genetic engineering: A concise account of methods used in rDNA Technology - tools: restriction enzymes, ligases and cloning vectors. A brief account of genomics and proteomics. A brief account of Human Genome Project. Bioethics.

12 hrs

Unit III: Plant breeding: Aims of plant breeding. Techniques: Traditional and modern (in brief).Hybridization technique in self and cross pollinated plants. Hybrid vigour, Cryopreservation, pollen banks and gene banks. Quarantine measures. Plant breeding work in India:Wheat, Paddy, Cotton and Sugarcane (Breeding centers should be mentioned).

12 hrs

Unit IV: Plant biotechnology: Introduction and scope. Tissue culture-technique. Application in Agriculture, Horticulture and Medicine. Protoplast culture.Somatic hybridization, somatic embryos, Somaclonal variations and its significance, synthetic seeds their importance. Anther culture –haploid production and its significance. Gene transfer methods- *Agrobacterium* mediated gene transfer, Electroporation and Shot gun method. Transgenic plants: Herbicide tolerant crops, Bt-cotton, Bt-Brinjal ,Production of enzymes, alcohol and SCP. A brief account of IPR.

20 hrs

Practicals: One Practical of 4 Hours / Week 32 Hrs

1. Solving the genetic problems related to theory portion(Monohybrid, Dihybrid and Interaction of genes)
2. Construction of linkage maps-2 point test cross
3. Hybridization techniques- Emasculation and Bagging
4. Estimation of pollen viability - Tetrazolium staining and hanging drop methods
5. Tissue culture equipments
6. Transgenic plant, callus, multiple shoots
7. MS Media Preparation
8. Callus Culture
9. Biotechnology products- Antibiotics, Alcohol, SCP, Vaccines, Humulin.
10. Preparation of synthetic seeds

SCHEME OF PRACTICAL EXAMINATION

Sixth Semester Practical – DSE – 3

GENETICS, GENETIC ENGINEERING, PLANT BREEDING AND PLANT BIOTECHNOLOGY

Time: 3 hours Max. Marks = 40

1. Estimation of pollen germination of **A**.
   (procedure-3 marks, preparation- 3 marks) 6 marks

2. Solve the genetic problems **B** and **C.**
   (From monohybrid, dihybrid, interaction of genes and 2 point test cross)
   4×2 = 8 marks

3. Perform experiment D.
   (Preparation of synthetic seeds)
   (Requirments-1 marks, procedure-2 marks, preparation- 2 marks) 5 marks

4. Comment on E, F, G and H. 4×4 = 16 marks

5. Class Record 5 marks

SIXTH SEMESTER – DSE - 4

CROP DISEASES AND MANAGEMENT

4 hours per week 64 hours

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

16 hrs

Unit-2: Principles of disease management: Biological Methods; 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.

14 hrs

Unit-3: Study of fungal diseases- Damping off diseases of seedlings; Downy 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; Ergot of Bajra.

20 hrs

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

14 hrs

Practicals: One Practical of 4 Hours / Week 32 Hrs

1) Isolation and identification of fungal plant pathogens from seeds/infected plant materials.

2) Spore germination study to know the germtube formation.

3) Conducting Koch's postulates – Testing infection of *Alternaria* on Tomato.

4) Estimation of phenol content in diseased and healthy leaf.

5-8) Study of Downy mildew of maize; White rust of Crucifer; Powdery mildew of cucurbits; Smut of Sorghum: False Smut of paddy; Rust of coffee; Bacterial Wilt of Tomato; Blast of Rice; Principles of disease management: Biological methods; Physical methods: Cultural Methods; Chemical methods; Breeding for disease resistance; Downey Mildew of Bajra; Leaf curl of Tomato; Root knot of Mulberry; Disease caused by *Striga;* Sheath blight of Rice.

9) Study of non-parasitic disease.

10) Study of Bio and organic pesticides

11) Study of pecticides

12) Visit to Agricultural University/ farm/ research station.

SCHEME OF PRACTICAL EXAMINATION

Sixth Semester Practical – DSE – 4

CROP DISEASES AND MANAGEMENT

Time: 3 hours Max. Marks = 40

1. Isolation of fungal plant pathogen of **A**.
   (procedure-5 marks, preparation- 5 marks) 10 marks

2. Spore germination test of **B**
   (Preparation- 4 marks, Procedure – 4 marks)
   8 marks

3. Estimation of Phenol content in a given sample **C**.
   (Procedure-3 marks, Preparation- 2 marks) 5 marks

4. Comment on diseased plants **D** and **E** 4×2 = 8 marks

5. Comment on **F**
   (From Biopesticides and Chemical pesticides) 4 marks

6. Class Record 5 marks

BOTANY – SIXTH SEMESTER – SEC - 3

NURSERY AND GARDENING

Theory – 18 Hrs

Unit-1: Nursery; definition, objectives and scope and building up of infrastructure for nursery, planning and seasonal activities – planting – dirct seeding and transplants; Seed: Structure and types- seed dormancy; causes and methods of breaking dormany – Seed storage: Seed banks, factors affecting seed viability, genetic erosion- 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; Gardening operations: soil laying, manuring, watering, management of pests and diseases and harvesting; Sowing/raising of seeds and seedlings – Transplanting of seedlings – cultivation of different vegetables; cabbage, brinjal, lady's finger, onion, garlic, tomato and carrot – Storage and marketing procedures.

Practicals: One Practical of 2 Hours / Week -14 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) Prepartion of Vermi-compost

5) Vegetative propagation: Types of Cuttings and Grafting.

6) Vegetative propagation: Types of Budding and Layering

7) Standard blotter method, Sand method, Brick method for seed health testing and

8) Seed viability test (TTC).

9) Potting, Re-potting, Transplantation

10) Biofertilizers and chemical fertilizer application.

11) Micropropagation

12) Visit to nursery, Tissue culture laboratory and horticulture garden

BOTANY – SIXTH SEMESTER – SEC - 4

FLORICULTURE

Theory – 18 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 pr 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; 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, Gencing, 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 packing of cut flowers; Flower arrangements; Methods of prolong vase life; Cultivation of Important cut flowers (Carnation, Aster, Chrysanthemum, Dahlia, Gerbera, Gladiolous, Marigold, Rose, Lilium, Orchids); Diseases and Pests of Ornamental Plants.

Practicals: One Practical of 2 Hours / Week -14 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.

THEORY QUESTION PAPER PATTERN

FOR DSC AND DSE PAPERS

Time: 3 hours **Max. marks=70**

I. Explain or define the following: **1X5=5**

1.

2.

3.

4.

5.

II Write short notes on any FIVE (out of seven): **3X5=15**

6.

7.

8.

9.

10.

11.

12.

III Write critical notes on any FOUR (out of six): **5X4=20**

13.

14.

15.

16

17.

18.

IV Write a detailed account of any THREE (out of four): **10X3=30**

19.

20.

21.

22.

THEORY QUESTION PAPER PATTERN

FOR SEC PAPERS

Time: 3 hours **Max. marks = 50**

I. Explain or define the following: **1X3=3**

1.

2.

3.

II Write short notes on any FOUR (out of six): **3X4=12**

4.

5.

6.

7.

8.

9.

III Write critical notes on any THREE (out of five): **5X3=15**

10.

11.

12.

13.

14.

IV Write a detailed account of any TWO (out of three): **10X2=20**

15.

16.

17.

Suggested readings and references

	Author	Title of the book	Publisher
	VIRUSES AND BACTERIA		
1	R.C.Dubey and D.K.Maheswari	A Text book of Microbiology	S.Chand & Company, Ramnagar, New Delhi 110005
2	P.D.Sharma	Microbiology	Rastogi Publication, Meerut
3	P.D.Sharma	Microbiology and Plant pathology	Rastogi Publication, Meerut
4	H.C.Dubey	Textbook of fungi , bacteria & virus	Vani educational books, Ghaziabad, UP
5	Pawar & Daginawala	General Microbiology vol-I	Himalaya publication home , Bombay
6	Pawar & Daginawala	General Microbiology vol-II	Himalaya publication home , Bombay
7	Pelzar Michael J	Text book of Microbiology	
8	Presscott,Lansing and others	Microbiology	
9	Ananthanarayana.R	Text book of Microbiology	Orient and Longman, New Delhi
10	Jayaram Panicker and Salle.A.J.	Functional principles of Bacteriology	Tata Mcgraw hill publications
11	Vinitha kale and Kishore Bhusari	Applied Microbiology	Himalaya publication home , Bombay
12	Frazier William C.	Food microbiology	
13	Cruckishank	Text book of microbiology	ELBSP Publisher, New Delhi
14	Rangaswamy.G.	Disease of crop plants in India	Prentice Hall of India, New Delhi
15	SundarRajan	College Microbiology	Vardaman Publishers, Bangalore
16	Frazier William.C. and Dennis.C. West Hoff.III Ed	Food Microbiology	Tata Mcgraw hill
	ALGAE		
17	K.N.Bhatia	A Treatise on Algae	R.Chand & Company, Publishers New Delhi 110005
18	Chopra G.L.	A Text book on Algae	Pradeeep Publication, Jalandhar
19	G.M.Smith	Crytogamic Botany Vol I	Mcgraw hill ,New York
20	Presscott G.W.	The Algae of Review	Rastogi Publication, Meerut
21	Kumar.M.A. & Kashyap	Recent Advances in Physiology	
22	Fritsch.F.E.	Algae	Cambridge University press
23	Chapman.V.J. & Chapman D.J.	The Algae II Ed	Mac Millan Publishing, New York
24	Singh,Pande,Jain	A Textbook of Botany	Rastogi Publications, Meerut

25	B.P.Pandey	Simplified course in Botany	S.Chand & Company, Ramnagar, New Delhi 1100005
26	Darley .M.W.	Algal Biology	Blackwell Publishers
	FUNGI		
27	Smith.G.M.	Crytogamic Botany Vol I	Mc graw hill ,New York
28	Alexopolous.C.J. and Mims.C.W.	Introduction to Mycology	Wiley Eastern Ltd. New Delhi
29	Chopra G.L. and Verma.V	Textbook of fungi	Pradeep Publications, New York
30	Mundkar.B.B.	Fungi and Plant diseases	Mc graw hill , New York
31	Rangaswamy .G.	Diseases of crop plants in India III Edition	Prentice Hall of India, New Delhi
32	Sharma.P.D.	The fungi	Rastogi publications, Meerut
33	Vashista.R.R.	Fungi	S.Chand & Company, Ramnagar, New Delhi 110005
	BRYOPHYTES AND GYMNOSPERMS		
34	Pandey.B.P.	Bryophyta	S.Chand & Company, Ramnagar, New Delhi 110005
35	Vashista.B.P.	Bryophyta	S.Chand & Company, Ramnagar, New Delhi 110005
36	Parihar.N.S.	Bryophyta	Central book Depot, Allahbad
37	Smith.G.M.	CryptogamicBotany Vol I	Mc graw hill publications, New York
38	G.L.Chopra	Class book and Pteridophytes	Pradeep Publications, Jalandhar
39	Chauhan D.K.S.	Bryophytes and pteridophytes	
	GYMNOSPERMS		
40	Botany for Degree students (Gymnosperms)	B.C.Vasishta,A.K.Sinha & B.AnilKumar	
41	Gymnosperms	B.C.Vasishta	
42	Diversity and Systems of seed plants	Dr.V.Singh,P.C.Pandey and Dr.D.K.Jain	
	ANATOMY		
43	Eames.A.J. and Mac Daniels.L.H.	Introduction to Plant Anatomy	Mc graw hill , New York
44	Katherien Esau	Anatomy of Seed Plants	Wiley Eastern Ltd. New Delhi
45	Pandey.B.P.	Introduction to Plant Anatomy	S.Chand & Company, Ramnagar, New Delhi 110005
46	Singh.V.Pandey.P.C. & Jain.D.K.	Anatomy of Seed Plants	Rastogi Publications, Meerut
47	Tayal.M.S.	Plant Anatomy	Rastogi Publications, Meerut
48	Ganguli,Das and Dutta	College Botany Vol I	

49	Venkateshvarulu	Cytology and Anatomy	
50	Bhojwani S.S. & Bhatnagar S.P.	The Embryology of Angiosperms	Vikas publishing house
51	Singh,Pande,Jain	The Embryology of Angiosperms	Rastogi Publications Meerut
52	Maheswari.P.	The Embryology of Angiosperms	Mc graw hill ,New York
53	Johri.B.M.	Comparitive Embyology of Angiosperms	Ind. Sci. Acad.Bull No41,N.Delhi
54	Eames.A.J.	Morphology of Angiosperms	Mc graw hill ,New York
55	Reinert.J. and Yeoman .M.M.	Plant cell & tissue Culture	Narosa publishing House, New Delhi
56	Vashista	Plant Anatomy	
57	George.H.M.Lawrance	Taxonomy of Vascular Plants	
58	R.N.Sutaria	A textbook of systematic boatny	
59	A.C.Dutta	Botany for Degree students	
	PTERIDOPHYTES		
57	Bold H.C. Alexopolous and Delevoryas.T.	Morphology of plants and Fungi	Harper C.Row, New York
58	Eames A.J.	Morphology of vascular plants (lower groups)	Mc graw Hill, New York
59	Parihar N.S. 1977	The Biology and Morphology of Pteridophytes	Central Book Depot, Allahabad
60	Pandey S.N.	Text Book of Botany Vol II	Vikas publishing house, New Delhi
61	Rashid.A. 1986	An introduction to Pterdophytes	Vani Educational book, New Delhi
62	Sprone.K.R. 1970	Morphology of Pteridophytes	Hutchinson University Library, London
63	Vashista.P.C.1987	Pteridopytes	S.Chand & Co. New Delhi
	GYMNOSPERMS		
64	Datta.S.C.	An Introduction to Gymnosperms	Asia Publishing house, NewDelhi
65	Pandey.B.P.	Gymnosperms	K.Nath & Co.
66	Ramaswamy S.N. 1984	Anavrutha beeja sasyagalu (Gymnosperms)	Prasaranga, University of MYSURU
67	Saxena and Sarbhai 1993	Text book of Botany VOl II	Ratna Prakashana Mandir ,Agra

68	Sprone.K.R. 1969	The Morphology of Gymnosperms	Hutchinson University library ,London
69	Trivedi.B.S. & Singh.D.K.	An introduction to Gymnosperms	Shashidar Malaviya Prakashana
70	Vashista	Gymnosperms	S.Chand & Co.New.Delhi
71	Andrews .H.N. 1961	Studies in Paleobotany	Wiley New York
72	Hiswas.C. & Johri.B.M. 1997	The Gymnosperms	Narosa New Delhi
	PLANT PHYSIOLOGY		
74	Conn.E.E, and Stumpf P.K. 1976	Outline of biochemistry	Wiley Eastern Ltd. N.Delhi
75	Datta.S.C.	Plant Physiology	Central book Depot, Allahbad
76	Delvin.R.M. 1969	Plant Physiology	Affiliated East West, New Delhi
77	Delvin.R.M & BarkerA.V. 1971	Photosynthesis	Affiliated East West, New Delhi
78	Jain.V.K. 1990	Fundamentals of Plant Physiology	S.Chand & Co. New Delhi
79	Kumar.H.D. & Singh.H.N. 1975,1993	Plant metabolism Ed I & II	East west press pvt Ltd.
80	Krishnamurthy.H.N.	Physiology of Plant Growth and Development	Atma Ram & Sons New Delhi
81	Leininger.A.L. 1978	Biochemistry	
82	Noggle.G.R. & Fritz George.J 1977	Introduction to Plant Physiology	Prentice hall of India, New Delhi
83	Rao.K.N. Sudhakar Rao and Bharatan.S.	The function of plant	S.Vishwanatha.Pvt.ltd
84	Rabinowitch .E.& Govindjee	Photosynthesis	Wiley Eastern Ltd. New Delhi
85	Salisbury.E.E. &Ross C.W. 1986	Plant Physiology	First Indian Edition. CBZ Publishers and Distributers, New Delhi
	ECOLOGY		
86	Aarne besilid.P. & Jeffrey pierce.J. 1983	Environmental Pollution and control	Ann Arbor Science Michigan
87	Benton Alln.H. & Warner.W.E.	Field Biology and Ecology	Mc graw Hill, New York
88	Conlivaux Paul.A. 1973	Introduction to ecology	John Wiley and Sons, New York
89	Dash.M.C.	Fundamentals of ecology	Tata Mcgraw hill
	GENETICS and EVOLUTION		
90	Gardener.E.J & Snustad.D.P 1984 & 1990	Principles of Genetics	John Wiley and sons
91	Gupta.P.K 1987	Genetics	Rastogi publications, Meerut
92	Hexter.W. & Yost Henry.T. 1977	The science of genetics	Prentice Hall of India, New York.
93	Jha.A.P 1993	Genes and evolution	Mac Millan India, New Delhi
94	Huxley.J 1974	Evolution	George Allen & Unwin London

95	Kochhar.P.L.1994	Genetics and evolution	15th Ed Rattan Prakashan Mandir Agra
	CELL BIOLOGY and EVOLUTION		
96	Lowey ariel & Philip Siekevitz 1974	Cell structure and function	Amerind Publishing Co, New Delhi
97	Marril David.J 1962	Evolution and Genetics	Holt, Reinhart and Winston, New York
98	Nair.P.G.K.,Prabhakar Achar.K.	A text book of Genetics and Evolution	Konark Publishers Ltd, New Delhi
99	Fair banks, D.J and Anderson.W.R.1999	Genetics- the community of life.	Brooks Cole California
100	Pawar.C.B.1983	Essentials of Cytology	Himalaya publishing house, Bombay
101	Savage.J.M 1969	Evolution	Oxford and IBH, New Delhi
102	Stansfieles.W.D 1977	The science of Evolution	California polytechnic state university and Mc Millan, New York
103	Sinnot.E.w.Dunn.L.C & Dobzhansky.T 1958	Principles of Genetics	Mc graw hill, New York
104	Snustad.D.P Simmons.M.J & Jenskins 1997	Principles of Genetics	John Wiley ,New York
105	Swanson Carl.P 1963	Cytology and Cytogenetics	Mac Millan & Co Ltd
106	Swanson Carl.P & Webster Peter.L	The cell	Prentice Hall of India Pvt Ltd New Delhi.
107	Stickberger Monroe.W 1968	Genetics	Mac Milan &Co, New York
108	Stickberger Monroe.W 1996	Evolution	John & Barlet Sandburry
109	Winchester.A.M 1996	Genetics	Mac Milan &Co, New York
	Plant Breeding		
110	Allard.R.W 1960	Principles of Plant Breeding	John Wiley, New York
111	Bailey L.H 1996	Manual of cultivated plants	Mac Milan &Co, New York
112	Chandrashekharan S.N Parthasarathy.S.V	Cytogenetics and Plant breeding	Varadachary &Co, Madras
113	Hartman H.T & Kester D.E 1976	Plant breeding-principles and practices	Prentice Hall of India Pvt Ltd New Delhi.
114	Chaudari H.K	Elementary principles of plant breeding	Oxford and IBH Publishing Co, New Delhi
	Taxonomy and Ecoomic Botany		
115	Hill Albert	Economic Botany	Tata MacGraw Hill
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