SYLLABUS

HNB GARHWAL UNIVERSITY, SRINAGAR-GARHWAL
2015-2016 ONWARDS

Department of Botany and Microbiology

Bachelor of Science

BOTANY

(Three Year Course- Semester System)

Under CBCS
Details of Courses

Core Courses – Botany

C-1 . Biodiversity (Microbes, Algae, Fungi and Archegoni ate)
C-2 . Plant Ecology and Taxonomy
C-3 . Plant Anatomy and Embryology
C-4 . Plant Physiology and Metabolism

Discipline Specific Electives-Botany (Any 02, one in Vth & one in VIth Semester 04 credits (theory) & 02 credits (Pract.)

DSE-1 . Economic Botany and Biotechnology
DSE-2 . Cell and Molecular Biology
DSE-3 . Genetics and Plant Breeding
DSE-4 . Analytical Techniques in Plant Sciences
DSE-5 . Bioinformatics
DSE-6 . Research Methodology
DSE-7 . Dissertation

Ability Enhancement Compulsory Courses 02 credits

AEC-1 . Environmental Science
AEC-2 . English/MIL Communication

Skill Enhancement Courses Botany (Any one of the following may be opted in Semester IIIrd, or IV or Vth & one more course may be opted in VIth Semester) 02 credits

SEC-1 . Biofertilizers
SEC-2 . Herbal Technology
SEC-3 . Nursery and Gardening
SEC-4 . Floriculture
SEC-5 . Medicinal Botany
SEC-6 . Plant Diversity and Human Welfare
SEC-7 . Ethnobotany
SEC-8 . Mushroom Culture Technology

Total credits (Summary)

Core courses (Th +Pr.) 6X4 = 24 X 03 (Three Subjects in BSc) =72
DSE (Th+Pr.) 6X2 =12 X 03 (Three Subjects in BSc) = 36
AEC 2X2= 04 (Commen in all the three subjects) =04
SEC 2 X 4= 08 (one courses each from 03 subjects + one course from any of the 03 subjects)=08

Total 120 credits to be earned in B.Sc
Semester I

Core Course: Botany I
C-1 Biodiversity (Microbes, Algae, Fungi and Archegoniate)

(Credits: Theory-4, Practicals-2)

THEORY

Lectures: 60

Unit 1: Microbes (10 Lectures)
Viruses – Discovery, general structure, replication (general account), DNA virus (T-phage); Lytic and lysogenic cycle, RNA virus (TMV); Economic importance; Bacteria – Discovery, General characteristics and cell structure; Reproduction – vegetative, asexual and recombination (conjugation, transformation and transduction); Economic importance.

Unit 2: Algae (12 Lectures)
General characteristics; Ecology and distribution; Range of thallus organization and reproduction; Classification of algae; Morphology and life-cycles of the following: Nostoc, Chlamydomonas, Volvox, Oedogonium, Vaucheria, Sargassum, Diatom and Polysiphonia. Economic importance of algae.

Unit 3: Fungi (12 Lectures)
Introduction- General characteristics, ecology and significance, range of thallus organization, cell wall composition, nutrition, reproduction and classification; True Fungi- General characteristics, ecology and significance, life cycle of Synchytrium, Rhizopus (Zygomycota) Alternaria (Ascomycota), Puccinia, Agaricus (Basidiomycota) Colletorichum (Deuteromycota); Symbiotic Associations-Lichens: General account, reproduction and significance; Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance.

Unit 4: Introduction to Archegoniate (2 Lectures)
Unifying features of archegoniates, Transition to land habit, Alternation of generations.

Bryophytes (10 Lectures)
General characteristics, adaptations to land habit, Classification, Range of thallus organization. Classification (up to family), morphology, anatomy and reproduction of Riccia, Marchantia, Anthocerose and Funaria. (Developmental details not to be included). Ecology and economic importance of bryophytes.

Unit 5: Pteridophytes (8 Lectures)
General characteristics, classification, Early land plants (Cooksonia and Rhynia). Classification (up to family), morphology, anatomy and reproduction of Selaginella, Equisetum and Adiantum. (Developmental details not to be included). Heterospory and seed habit, stelar evolution. Ecological and economical importance of Pteridophytes.
Gymnosperms (6 Lectures)
General characteristics, classification. Classification (up to family), morphology, anatomy and reproduction of *Cycas, Pinus* and *Ephedra*. (Developmental details not to be included). Ecological and economical importance.

Practical
1. EMs/Models of viruses – T-Phage and TMV, Line drawing/Photograph of Lytic and Lysogenic Cycle.
2. Types of Bacteria from temporary/permanent slides/photographs; EM bacterium; Binary Fission; Conjugation; Structure of root nodule.
3. Gram staining.
4. Study of vegetative and reproductive structures of *Nostoc, Chlamydomonas* (electron micrographs), *Oedogonium, Vaucheria, Fucus* and *Polysiphonia* through temporary preparations and permanent slides. (*Fucus* - Specimen and permanent slides)
5. *Synchytrium* and *Rhizopus*: Asexual stage from temporary mounts and sexual structures through permanent slides.
7. *Puccinia*: Herbarium specimens of Black Stem Rust of Wheat and infected Barberry leaves; section/tease mounts of spores on Wheat and permanent slides of both the hosts.
8. *Agaricus*: Specimens of button stage and full grown mushroom; Sectioning of gills of *Agaricus*.
10. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose)
11. *Riccia*: Morphology of thallus, w.m. rhizoids and scales, v.s./t.s. thallus, (all temporary slides), v.s. antherid, archegonia, l.s. sporophyte (all permanent slides).
12. *Marchantia*: morphology of thallus, w.m. rhizoids and scales, v.s. thallus through gemma cup, w.m. gemmae (all temporary slides), v.s. antheridiophore, archegoniophore, l.s. sporophyte (all permanent slides).
13. *Antoceros*: Morphology of thallus, w.m. rhizoids and scales, v.s./t.s. thallus, (all temporary slides), v.s. antherid, archegonia, l.s. sporophyte (all permanent slides).
14. *Funaria*: morphology, w.m. leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, l.s. capsule and protonema.
15. *Selaginella*: morphology, w.m. leaf with ligule, t.s. stem, w.m. strobilus, w.m. microsporophyll and megasporophyll (temporary slides), l.s. strobilus (permanent slide).
16. *Equisetum*: morphology, t.s. internode, l.s. strobilus, t.s. sporangiophore, w.m. spores (wet and dry)(temporary slides); t.s rhizome (permanent slide).
17. *Adiantum* - morphology, v.s. pinnule through sori, w.m. spores (temporary slides), t.s. rhizome, w.m. prothallus with sex organs and young sporophyte (permanent slide).
18. *Cycas* - morphology (coralloid roots, bulbil, leaf), t.s. coralloid root, t.s. rachis, v.s. leaflet,v.s. microsorophyll, w.m. spores (temporary slides), l.s. ovule, t.s. root (permanent slide).
19. *Pinus*: morphology (long and dwarf shoots, w.m. dwarf shoot, male and female), w.m. dwarf shoot, t.s. needle, t.s. stem, l.s./t.s. male cone, w.m. microsorophyll, w.m. microspores (temporary slides), l.s. female cone, t.l.s. & r.l.s. stem (permanent slide).
**Suggested Readings**


**B.Sc Semester I Practical**

**Biodiversity (Microbes, Algae, Fungi, and Archigoniate)**

The practical examination will cover study as enumerated in practical of Semester I and will be of three hours duration for B.Sc. I Semester. Following would be the scheme and marks distribution for the practical examination.

**Time: 3 Hours**

<table>
<thead>
<tr>
<th>Question</th>
<th>Marks</th>
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</thead>
<tbody>
<tr>
<td>Q.1. Working out materials, making suitable preparations, drawing</td>
<td>40</td>
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<tr>
<td>diagrams and their description leading to identification of one each</td>
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<tr>
<td>Microbes, Algae, Fungi and Archigoniate (Bryophytes, Pteridophytes</td>
<td></td>
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<tr>
<td>and Gymnosperms)</td>
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<tr>
<td>Q.2. Ten spots for identification and comments.</td>
<td>20</td>
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<tr>
<td>Q.3. Viva Voce</td>
<td>05</td>
</tr>
<tr>
<td>Q.4. Sessional Records, submission of specimen, poster/chart/collection</td>
<td>05</td>
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<tr>
<td>of plant species in Herbarium sheets</td>
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</tbody>
</table>

MM 70
Semester II

Core Course Botany –II

C-2  Plant Ecology and Taxonomy
(Credits: Theory-4, Practicals-2)

THEORY
Lectures: 60

Unit 1:
Introduction (2 Lectures)

Ecological factors (10 Lectures)

Plant communities (5 Lectures)
Characters; Ecotone and edge effect; Succession; Processes and types.

Unit 2:
Ecosystem (7 Lectures)
Structure; energy flow trophic organisation; Food chains and food webs, Ecological pyramids production and productivity; Biogeochemical cycling; Cycling of carbon, nitrogen and Phosphorous.

Phytogeography (3 Lectures)
Principle biogeographical zones; Endemism

Unit 3:
Introduction to plant taxonomy (2 Lectures)
Identification, Classification, Nomenclature.

Taxonomic hierarchy (1 Lectures)
Ranks, categories and taxonomic groups

Identification (4 Lectures)
Functions of Herbarium, important herbaria and botanical gardens of the world and India;
Documentation: Flora, Keys: single access and multi-access

Taxonomic evidences from palynology, cytology, phytochemistry and molecular data . (5 Lectures)

Unit 4:
Botanical nomenclature (4 Lectures)
Principles and rules (ICN); ranks and names; binominal system, typification, author citation,
valid publication, rejection of names, principle of priority and its limitations.

**Classification (4 Lectures)**
Types of classification-artificial, natural and phylogenetic. Bentham and Hooker (upto series), Engler and Prantl (upto series).

**Biometrics, numerical taxonomy and cladistics (3 Lectures)**
Characters; variations; OTUs, character weighting and coding; cluster analysis; phenograms, cladograms (definitions and differences).

**Unit 5:**
**Taxonomy, important distinguishing characters, classification, and economic importance of the following families: (10 Lectures)**
Ranunculaceae, Papaveraceae, Caryophyllaceae, Malvaceae, Rutaceae, Fabaceae, Apiaceae, Solanaceae, Apocynaceae, Asclepiadaceae, Acanthaceae, Lamiaceae, Euphorbiaceae, Orchidaceae, Poaceae.

**Practical**
1. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter.
2. Determination of pH, and analysis of two soil samples for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency by rapid field test.
3. Comparison of bulk density, porosity and rate of infiltration of water in soil of three habitats.
4. (a) Study of morphological adaptations of hydrophytes and xerophytes (four each). (b) Study of biotic interactions of the following: Stem parasite (Cuscuta), Root parasite (Orobanche), Epiphytes, Predation (Insectivorous plants)
5. Determination of minimal quadrate size for the study of herbaceous vegetation in the college campus by species area curve method. (Species to be listed)
6. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer’s frequency distribution law
7. Study of vegetative and floral characters of the following families (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker’s system of classification): Brassicaceae - Brassica, Alyssum / Iberis; Asteraceae - Sonchus/Launaea, Vernonia/Ageratum, Eclipta/Tridax; Solanaceae - Solanum nigrum, Withania; Lamiaceae - Salvia, Ocimum; Liliaceae - Asphodelus / Lilium / Allium.
8. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book).
9. Taxonomic treatment of plant species belonging to families mentioned in the syllabus.
10. Study of taxonomic terminology
Suggested Readings

B.Sc Semester II Practical

Plant Ecology and Taxonomy
The practical examination will covers of study as enumerated in practical of Semester II and will be of three hours duration for B.Sc. II Semester. Following would be the scheme and marks distribution for the practical examination.

Time: 3 Hours

Q.1. To undertake the ecological experiment/To solve the ecological problem. 20
Q.2. Using semi technical language description of the characteristics features of two plants, giving their floral formulae and floral diagrams and to assign them to any recognized system of classification. 20
Q.3. Ten spots for identification and comments. 20
Q.4. Viva Voce 05
Q.5. Sessional Records, submission of specimen, poster/chart/collection of plant species in Herbarium sheets. 05

Semester III

Core Course Botany –III
C-3 Plant Anatomy and Embryology
(Credits: Theory-4, Practicals-2)

THEORY
Lectures: 60

Unit 1:
Meristematic and permanent tissues (8 Lectures)
Root and shoot apical meristems; Simple and complex tissues.
Unit 2:
**Organs (4 Lectures)**
Structure of dicot and monocot root stem and leaf.

**Secondary Growth (8 Lectures)**

Unit 3:
**Adaptive and protective systems (8 Lectures)**
Epidermis, cuticle, stomata; General account of adaptations in xerophytes and hydrophytes.

Unit 4:
**Structural organization of flower (8 Lectures)**
Structure of anther and pollen, introductory account of palynology, Structure and types of ovules; Types of embryo sacs, organization and ultrastructure of mature embryo sac.

**Pollination and fertilization (8 Lectures)**
Pollination mechanisms and adaptations; Double fertilization; Seed-structure appendages and dispersal mechanisms.

Unit 5:
**Embryo and endosperm (8 Lectures)**
Endosperm types, structure and functions; Dicot and monocot embryo; Embryoendosperm relationship.

**Apomixis and polyembryony (8 Lectures)**
Definition, types and practical applications.

Practical
1. Study of meristems through permanent slides and photographs.
2. Tissues (parenchyma, collenchyma and sclerenchyma); Macerated xylary elements, Phloem (Permanent slides, photographs)
5. Leaf: Dicot and Monocot leaf (only Permanent slides).
6. Adaptive anatomy: Xerophyte (*Nerium* leaf); Hydrophyte (*Hydrilla* stem).
7. Structure of anther (young and mature), tapetum (amoeboid and secretory) (Permanent slides).
8. Types of ovules: anatropous, orthotropous, circinotropous, amphitropous/ campylotropous.
10. Ultrastructure of mature egg apparatus cells through electron micrographs.
11. Pollination types and seed dispersal mechanisms (including appendages, aril, caruncle) (Photographs and specimens).
12. Dissection of embryo/endosperm from developing seeds.
13. Calculation of percentage of germinated pollen in a given medium.

**Suggested Readings**

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**B.Sc. Semester III Practical**

**Plant Anatomy and Embryology**
The practical examination will covers of study as enumerated in practical of Semester III and will be of three hours duration for B.Sc. III Semester. Following would be the scheme and marks distribution for the practical examination.

**Time: 3 Hours**

<table>
<thead>
<tr>
<th>Question</th>
<th>Description</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q.1</td>
<td>Study of morphology, section cutting and making stained preparation of the material and to comment upon the anatomical features.</td>
<td>20</td>
</tr>
<tr>
<td>Q.2</td>
<td>Dissection and mounting of young embryo/endosperm from developing seeds.</td>
<td>05</td>
</tr>
<tr>
<td>Q.3</td>
<td>Calculation of percentage of germinated pollen in a given medium.</td>
<td>15</td>
</tr>
<tr>
<td>Q.4</td>
<td>Ten spots for identification and comments.</td>
<td>20</td>
</tr>
<tr>
<td>Q.5</td>
<td>Viva Voce</td>
<td>05</td>
</tr>
<tr>
<td>Q.6</td>
<td>Sessional Records, submission of specimen, poster/chart/collection of plant species in Herbarium sheets.</td>
<td>05</td>
</tr>
</tbody>
</table>
Semester IV

Core Course Botany -IV

C-4: Plant Physiology and Metabolism
(Credits: Theory-4, Practicals-2)

THEORY

Lectures: 60

Unit 1:
*Plant-water relations (8 Lectures)*
Importance of water, water potential and its components; Transpiration and its significance; Factors affecting transpiration; Root pressure and guttation.

Unit 2:
*Mineral nutrition (8 Lectures)*
Essential elements, macro and micronutrients; Criteria of essentiality of elements; Role of essential elements; Transport of ions across cell membrane, active and passive transport, carriers, channels and pumps.

*Translocation in phloem (6 Lectures)*
Composition of phloem sap, girdling experiment; Pressure flow model; Phloem loading and unloading.

Unit 3:
*Photosynthesis (12 Lectures)*
Photosynthetic Pigments (Chl a, b, xanthophylls, carotene); Photosystem I and II, reaction center, antenna molecules; Electron transport and mechanism of ATP synthesis; C3, C4 and CAM pathways of carbon fixation; Photorespiration.

Unit 4:
*Respiration (6 Lectures)*
Glycolysis, anaerobic respiration, TCA cycle; Oxidative phosphorylation, Glyoxylate, Oxidative Pentose Phosphate Pathway.

Unit 5:
*Enzymes (4 Lectures)*
Structure and properties; Mechanism of enzyme catalysis and enzyme inhibition.

*Nitrogen metabolism (4 Lectures)*
Biological nitrogen fixation; Nitrate and ammonia assimilation.

*Plant growth regulators (6 Lectures)*
Discovery and physiological roles of auxins, gibberellins, cytokinins, ABA, ethylene. 

**Plant response to light and temperature (6 Lectures)**

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

**Practical**

1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. To study the effect of two environmental factors (light and wind) on transpiration by excised twig.
3. Calculation of stomatal index and stomatal frequency of a mesophyte and a xerophyte.
4. Demonstration of Hill reaction.
5. Demonstrate the activity of catalase and study the effect of pH and enzyme concentration.
6. To study the effect of light intensity and bicarbonate concentration on O2 evolution in photosynthesis.
7. Comparison of the rate of respiration in any two parts of a plant.
8. Separation of amino acids by paper chromatography.

**Demonstration experiments (any four)**

1. Bolting.
2. Effect of auxins on rooting.
3. Suction due to transpiration.
4. R.Q.
5. Respiration in roots.

**Suggested Readings**


**B.Sc. Semester IV Practical**

**Plant physiology and Metabolism**

The practical examination will covers of study as enumerated in practical of Semester IV and will be of three hours duration for B.Sc. IV Semester. Following would be the scheme and marks distribution for the practical examination.
**Time: 3 Hours**

Q.1. To perform the physiological experiment and interpreting the results.  
Q.2. Comment upon the physiological set up.  
Q.3. To undertake micro tests and interpretation of the results.  
Q.4. Ten spots for identification and comments.  
Q.5. Viva Voce

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**Skill Enhancement Course**

(Student is required to select any one paper during semester III to V and may choose one paper again in VI semester from the list of following nine papers)

- **SEC-1. Biofertilizers**
- **SEC-2. Herbal Technology**
- **SEC-3. Nursery and Gardening**
- **SEC-4. Floriculture**
- **SEC-5. Medicinal Botany**
- **SEC-6. Plant Diversity and Human Welfare**
- **SEC-7. Ethnobotany**
- **SEC-8. Mushroom Culture Technology**
- **SEC-9. Intellectual Property Right**

**SEC-1. Biofertilizers**

**Lectures: 30**

(Credits 2)

**Unit 1: (4 Lectures)**

General account about the microbes used as biofertilizer – Rhizobium – isolation, identification, mass multiplication, carrier based inoculants, Actinorrhizal symbiosis.

**Unit 2: (8 Lectures)**

*Azospirillum:* isolation and mass multiplication – carrier based inoculant, associative effect of different microorganisms.  
*Azotobacter:* classification, characteristics – crop response to *Azotobacter* inoculum, maintenance and mass multiplication.

**Unit 3: (4 Lectures)**

Cyanobacteria (blue green algae), *Azolla* and *Anabaena azollae* association, nitrogen fixation, factors affecting growth, blue green algae and *Azolla* in rice cultivation.
Unit 4: (8 Lectures)

Unit 5: (6 Lectures)

Suggested Readings

SEC-2 Herbal Technology
Lectures: 30
(Credits 2)

Unit 1: (6 Lectures)
Herbal medicines: history and scope - definition of medical terms - role of medicinal plants in Ayurveda/Siddha systems of medicine; cultivation - harvesting - processing - storage - marketing and utilization of medicinal plants.

Unit 2: (6 Lectures)
Pharmacognosy - systematic position medicinal uses of the following herbs in curing various ailments; Tulsi, Ginger, Fenugreek, Indian Goose berry and Ashoka.

Unit 3: (6 Lectures)
Phytochemistry - active principles and methods of their testing - identification and utilization of the medicinal herbs; Catharanthus roseus (cardiotonic), Withania somnifera (drugs acting on nervous system), Clerodendron phlomoides (anti-rheumatic) and Centella asiatica (memory booster).
Unit 4: (8 Lectures)
Analytical pharmacognosy: Drug adulteration - types, methods of drug evaluation - Biological testing of herbal drugs - Phytochemical screening tests for secondary metabolites (alkaloids, flavonoids, steroids, triterpenoids, phenolic compounds)

Unit 5: (4 Lectures)
Medicinal plant banks micro propagation of important species (Withania somnifera, neem and tulsi- Herbal foods-future of pharmacognosy)

Suggested Readings

SEC-3 Nursery and Gardening
Lectures: 30
(Credits 2)

Unit 1: (4 Lectures)
Nursery: definition, objectives and scope and building up of infrastructure for nursery, planning and seasonal activities - Planting - direct seeding and transplants.

Unit 2: (6 Lectures)
Seed: Structure and types - Seed dormancy; causes and methods of breaking dormancy - Seed storage: Seed banks, factors affecting seed viability, genetic erosion - Seed production technology - seed testing and certification.

Unit 3: (6 Lectures)
Vegetative propagation: air-layering, cutting, selection of cutting, collecting season,
treatment of cutting, rooting medium and planting of cuttings - Hardening of plants - greenhouse - mist chamber, shed root, shade house and glass house.

**Unit 4: (8 Lectures)**
- Gardening: definition, objectives and scope - different types of gardening - landscape and home gardening - 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.

**Unit 5: (6 Lectures)**
- 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.

**Suggested Readings**

**SEC-4 Floriculture**
**Lectures: 30**
**(Credits 2)**

**Unit 1: (2 Lectures)**
Introduction: History of gardening; Importance and scope of floriculture and landscape gardening.

**Unit 2: (8 Lectures)**
- 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.

**Unit 3: (4 Lectures)**

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.

**Unit 4: (8 Lectures)**

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.

**Unit 5: (8 Lectures)**

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, Gladiolous, Marigold, Rose, Lilium, Orchids). Diseases and Pests of Ornamental Plants.

**Suggested Readings**

Conservation of endangered and endemic medicinal plants. Definition: endemic and endangered medicinal plants, Red list criteria; In situ conservation: Biosphere reserves, sacred groves, National Parks; Ex situ conservation: Botanic Gardens, Ethnomedicinal plant Gardens.

Unit 4: (05 Lectures)
Propagation of Medicinal Plants: Objectives of the nursery, its classification, important components of a nursery, sowing, pricking, use of green house for nursery production, propagation through cuttings, layering, grafting and budding.

Unit 5: (10 Lectures)
Ethnobotany and Folk medicines. Definition; Ethnobotany in India: Methods to study ethnobotany; Applications of Ethnobotany: National interacts, Palaeo-ethnobotany. folk medicines of ethnobotany, ethnomedicine, ethnoecology, ethnic communities of India. Application of natural products to certain diseases- Jaundice, cardiac, infertility, diabetics, Blood pressure and skin diseases.

Suggested Readings
Unit 3: (6 Lectures)
**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, Sustainable development.

Unit 4: (6 Lectures)
**Role of plants in relation to Human Welfare:** (a)
- Cereals- Wheat, Rice
- Pulses- A general account
- Fruits- A general account
- Alcoholic beverages.

Unit 5: (6 Lectures)
**Role of plants in relation to Human Welfare:** (b)
Importance of forestry its utilization and commercial aspects, Wood, Ornamental plants of India.

Suggested Readings

SEC-7  Ethnobotany
Lectures: 30
(Credits 2)

Unit 1: (6 Lectures)
**Ethnobotany**
Introduction, concept, scope and objectives; Ethnobotany as an interdisciplinary science. The relevance of ethnobotany in the present context; Major and minor ethnic groups or Tribals of India, and their life styles. Plants used by the tribals: a) Food plants b) intoxicants and beverages c) Resins and oils and miscellaneous uses.

Unit 2: (6 Lectures)
**Methodology of Ethnobotanical studies**
a) Field work b) Herbarium c) Ancient Literature d) Archaeological findings e) temples and sacred places.
Unit 3: (07 Lectures)
Role of ethnobotany in modern Medicine
Medico-ethnobotanical sources in India; Significance of the following plants in ethnobotanical practices (along with their habitat and morphology) a) Azadiractha indica b) Ocimum sanctum c) Vitex negundo d) Gloriosa superba e) Tribulus terrestris f) Pongamia pinnata g) Cassia auriculata h) Indigofera tinctoria. Role of ethnobotany in modern medicine with special example Rauvolfia sepentina, Trichopus zeylanicus, Artemisia, Withania.

Unit 4: (03 Lectures)
Role of ethnic groups in conservation of plant genetic resources. Endangered taxa and forest management (participatory forest management).

Unit 5: (8 Lectures)
Ethnobotany and legal aspects
Ethnobotany as a tool to protect interests of ethnic groups. Sharing of wealth concept with few examples from India. Biopiracy, Intellectual Property Rights and Traditional Knowledge.

Suggested Readings
Unit 1: (5 Lectures)
Introduction, history. Nutritional and medicinal value of edible mushrooms;
Poisonous mushrooms. Types of edible mushrooms available in India- Volvariella volvacea, Pleurotus citrinopileatus, Agaricus bisporus.

Unit 2: (5 Lectures)
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, tray, small polythene bag.

Unit 3: (7 Lectures)
Pure culture: Medium, sterilization, preparation of spawn, multiplication. Mushroom bed preparation - paddy straw, sugarcane trash, maize straw, banana leaves. Factors affecting the mushroom bed preparation - Low cost technology, Composting technology in mushroom production.

Unit 4: (8 Lectures)

Unit 5: (5 Lectures)
Food Preparation_: Types of foods prepared from mushroom. Research Centre National level and Regional level. Cost benefit ratio - Marketing in India and abroad, Export Value.

Suggested Readings
In this era of liberalization and globalization, the perception about science and its practices has undergone dramatic change. The importance of protecting the scientific discoveries, with commercial potential or the intellectual property rights is being discussed at all levels – statutory, administrative, and judicial. With India ratifying the WTO agreement, it has become obligatory on its part to follow a minimum acceptable standard for protection and enforcement of intellectual property rights. The purpose of this course is to apprise the students about the multifaceted dimensions of this issue.

Unit 1: (05 Lectures)
Introduction to Intellectual Property:
Historical Perspective, Different Types of IP, Importance of protecting IP.

Copyrights
Introduction, How to obtain, Differences from Patents.
Historical Perspective, Basic and associated right, WIPO, PCT system, Traditional Knowledge, Patents and Healthcare – balancing promoting innovation with public health, Software patents and their importance for India.

Unit 2: (03 Lectures)
Trade Marks
Introduction, How to obtain, Different types of marks – Collective marks, certification marks, service marks, Trade names, etc.
Differences from Designs.

Unit 3: (04 Lectures)
Patents
Historical Perspective, Basic and associated right, WIPO, PCT system, Traditional Knowledge, Patents and Healthcare – balancing promoting innovation with public health, Software patents and their importance for India.

Unit 4: (05 Lectures)
Geographical Indications
Definition, rules for registration, prevention of illegal exploitation, importance to India.
Trade Secrets
Introduction and Historical Perspectives, Scope of Protection, Risks involved and legal aspects of Trade Secret Protection.
Unit 5: (13 Lectures)
Different International agreements
(a) Word Trade Organization (WTO):
(i) General Agreement on Tariffs & Trade (GATT), Trade Related Intellectual Property Rights (TRIPS) agreement
(ii) General Agreement on Trade related Services (GATS)
(iii) Madrid Protocol
(iv) Berne Convention
(v) Budapest Treaty

(b) Paris Convention
WIPO and TRIPS, IPR and Plant Breeders Rights, IPR and Biodiversity

Reference Books:

Discipline Specific Elective Courses
(Student will select one paper in semester V and one paper in semester VI)

DSE-1 . Economic Botany and Biotechnology
DSE-2 . Cell and Molecular Biology
DSE-3 . Genetics and Plant Breeding
DSE-4 . Analytical Techniques in Plant Sciences
DSE-5 . Bioinformatics
DSE-6 . Research Methodology
DSE-7 . Dissertation
THEORY
Lectures: 60

Unit 1: (4 Lectures)
Origin of Cultivated Plants
Concept of centres of origin, their importance with reference to Vavilov’s work

Unit 2: (10 Lectures)
Cereals
Wheat and Rice - Origin, morphology, uses
Legumes
General account with special reference to Gram and soybean

Unit 3: (10 Lectures)
Spices
General account with special reference to clove and black pepper (Botanical name, family, part used, morphology and uses)
Beverages
Tea (morphology, processing, uses)

Unit 4: (08 Lectures)
Oils and Fats
General description with special reference to groundnut
Fibre Yielding Plants
General description with special reference to Cotton (Botanical name, family, part used, morphology and uses)

Unit 5: (28 Lectures)
Introduction to biotechnology
Plant tissue culture
Micropropagation; haploid production through androgenesis and gynogenesis; brief account of embryo & endosperm culture with their applications
Recombinant DNA Techniques
Blotting techniques: Northern, Southern and Western Blotting, DNA Fingerprinting; Molecular DNA markers i.e. RAPD, RFLP, SNPs; DNA sequencing, PCR and Reverse Transcriptase-PCR. Hybridoma and monoclonal antibodies, ELISA and Immunodetection. Molecular diagnosis of human disease, Human gene Therapy.
Practical
1. Study of economically important plants: Wheat, Gram, Soybean, Black pepper, Clove Tea, Cotton, Groundnut through specimens, sections and microchemical tests
2. Familiarization with basic equipments in tissue culture.
3. Study through photographs: Anther culture, somatic embryogenesis, endosperm and embryo culture; micropropagation.
4. Study of molecular techniques: PCR, Blotting techniques, AGE and PAGE.

Suggested Readings

B.Sc. Semester V Practical

DSW-1 Economic Botany and Biotechnology
The practical examination will covers of study as enumerated in practical of Semester V and will be of three hours duration for B.Sc. V Semester. Following would be the scheme and marks distribution for the practical examination.

Time: 3 Hours
Q.1. To study the mixture and comment upon the products of economic importance. 15
Q.2. Section cutting and micro chemical tests of the product of economic importance. 15
Q.3. To study and comment upon the given molecular technique. 10
Q.4. Ten spots for identification and comments. 20
Q.5. Viva Voce 05
Q.6. Sessional Records, submission of specimen, poster/chart/collection of plant species in Herbarium sheets. 05

MM 70
DSE-2        Cell and Molecular Biology
(Credits: Theory-4, Practicals-2)
THEORY
Lectures: 60

Unit 1: (8 Lectures)
Techniques in Biology
Principles of microscopy; Light Microscopy; Phase contrast microscopy; Fluorescence microscopy; Confocal microscopy; Sample Preparation for light microscopy; Electron microscopy (EM)- Scanning EM and Scanning Transmission EM (STEM); Sample Preparation for electron microscopy; X-ray diffraction analysis.

Unit 2: (22 Lectures)
Cell as a unit of Life
The Cell Theory; Prokaryotic and eukaryotic cells; Cell size and shape; Eukaryotic Cell components.
Cell Organelles
Mitochondria: Structure, marker enzymes, composition; Semiautonomous nature; Symbiont hypothesis; Proteins synthesized within mitochondria; mitochondrial DNA. Chloroplast Structure, marker enzymes, composition; semiautonomous nature, chloroplast DNA. ER, Golgi body & Lysosomes: Structures and roles. Peroxisomes and Glyoxisomes: Structures, composition, functions in animals and plants and biogenesis. Nucleus: Nuclear Envelope- structure of nuclear pore complex; chromatin; molecular organization, DNA packaging in eukaryotes, euchromatin and heterochromatin, nucleolus and ribosome structure (brief).

Unit 3: (12 Lectures)
Cell Membrane and Cell Wall
The functions of membranes; Models of membrane structure; The fluidity of membranes; Membrane proteins and their functions; Carbohydrates in the membrane; Faces of the membranes; Selective permeability of the membranes; Cell wall. Cell Cycle, Overview of Cell cycle, Mitosis and Meiosis; Molecular controls.

Unit 4: (6 Lectures)
Genetic material
DNA: Miescher to Watson and Crick- historic perspective, Griffith’s and Avery’s
transformation experiments, Hershey-Chase bacteriophage experiment, DNA structure, types of DNA, types of genetic material.
DNA replication (Prokaryotes and eukaryotes): bidirectional replication, semi–conservative, semi discontinuous RNA priming, (theta) mode of replication, replication of linear, ds-DNA, replicating the 5 end of linear chromosome including replication enzymes.

Unit 5: (12 Lectures)

Transcription (Prokaryotes and Eukaryotes)
Types of structures of RNA (mRNA, tRNA, rRNA), RNA polymerase- various types;
Translation (Prokaryotes and eukaryotes), genetic code.

Regulation of gene expression
Prokaryotes: Lac operon and Tryptophan operon; and in Eukaryotes.

Practical
1. To study prokaryotic cells (bacteria), viruses, eukaryotic cells with the help of light and electron micrographs.
2. Study of the photomicrographs of cell organelles
3. To study the structure of plant cell through temporary mounts.
4. To study the structure of animal cells by temporary mounts-squamous epithelial cell and nerve cell.
5. Preparation of temporary mounts of striated muscle fiber
6. To prepare temporary stained preparation of mitochondria from striated muscle cells /cheek epithelial cells using vital stain Janus green.
7. Study of mitosis and meiosis (temporary mounts and permanent slides).
8. Study the effect of temperature, organic solvent on semi permeable membrane.
9. Demonstration of dialysis of starch and simple sugar.
10. Study of plasmolysis and deplasmolysis on Rhoeo leaf.
11. Measure the cell size (either length or breadth/diameter) by micrometry.
12. Study the structure of nuclear pore complex by photograph (from Gerald Karp)Study of special chromosomes (polytene & lampbrush) either by slides or photographs.
13. Study DNA packaging by micrographs.
14. Preparation of the karyotype and ideogram from given photograph of somatic metaphase chromosome.

Suggested Readings
DSE-2 Cell and Molecular Biology Practical

The practical examination will cover study as enumerated in the practical of Semester V and will be of three hours duration for B.Sc. V Semester. Following would be the scheme and marks distribution for the practical examination.

**Time: 3 Hours**

<table>
<thead>
<tr>
<th>Q.</th>
<th>Description</th>
<th>MM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q.1.</td>
<td>Using smear or squash technique to slow one stage of mitosis or meiotic cell division and comment upon.</td>
<td>15</td>
</tr>
<tr>
<td>Q.2.</td>
<td>To comment upon cell organelle in a micro slide, slide/photograph.</td>
<td>10</td>
</tr>
<tr>
<td>Q.3.</td>
<td>Problem on molecular biology as given in practical syllabus.</td>
<td>15</td>
</tr>
<tr>
<td>Q.4.</td>
<td>Ten spots for identification and comments.</td>
<td>20</td>
</tr>
<tr>
<td>Q.5.</td>
<td>Viva Voce</td>
<td>05</td>
</tr>
<tr>
<td>Q.6.</td>
<td>Sessional Records, submission of specimen, poster/chart/etc.</td>
<td>05</td>
</tr>
</tbody>
</table>

DSE-3 Genetics and Plant Breeding
(Credits: Theory-4, Practical-2)

**THEORY**
Lectures: 60

**Unit 1: (20 Lectures)**

**Heredity**
1. Brief life history of Mendel
2. Terminologies
3. Laws of Inheritance
5. Chi Square
6. Pedigree Analysis
8. Multiple allelism
9. Pleiotropism
Unit 2: (12 Lectures)
Sex-determination and Sex-linked Inheritance
Linkage and Crossing over
Linkage: concept & history, complete & incomplete linkage, bridges experiment, coupling & repulsion, recombination frequency, linkage maps based on two and three factor crosses.
Crossing over: concept and significance, cytological proof of crossing over.

Unit 3: (4 Lectures)
Mutations and Chromosomal Aberrations Types of mutations, effects of physical & chemical mutagens. Numerical chromosomal changes: Euploidy, Polyploidy and Aneuploidy; Structural chromosomal changes: Deletions, Duplications, Inversions & Translocations.

Unit 4: (16 Lectures)
Plant Breeding
Important achievements and undesirable consequences of plant breeding.
Methods of crop improvement
Introduction: Centres of origin and domestication of crop plants, plant genetic resources;
Acclimatization; Selection methods: For self pollinated, cross pollinated and vegetatively propagated plants; Hybridization: For self, cross and vegetatively propagated plants – Procedure, advantages and limitations.
Quantitative inheritance
Concept, mechanism, examples. Monogenic vs polygenic Inheritance.

Unit 5: (8 Lectures)
Inbreeding depression and heterosis
History, genetic basis of inbreeding depression and heterosis; Applications.
Crop improvement and breeding
Role of mutations; Polyploidy; Distant hybridization and role of biotechnology in crop improvement.

Practical
1. Mendel’s laws through seed ratios. Laboratory exercises in probability and chisquare.
2. Chromosome mapping using point test cross data.
3. Pedigree analysis for dominant and recessive autosomal and sex linked traits.
5. Study of aneuploidy: Down’s, Klinefelter’s and Turner’s syndromes through photographs.
6. Photographs/Permanent Slides showing Translocation Ring, Laggards and Inversion Bridge.
7. Hybridization techniques - Emasculation, Bagging (For demonstration only).
8. Induction of polyploidy conditions in plants (For demonstration only).

**Suggested Readings**

**DSE-3 Genetics and plant Breeding Practical**
The practical examination will cover study as enumerated in practical of Semester VI and will be of three hours duration for B.Sc. VI Semester. Following would be the scheme and marks distribution for the practical examination.

**Time: 3 Hours**

<table>
<thead>
<tr>
<th>Question</th>
<th>MM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q.1. Two problems based on Genetics(Gene interaction and Chromosome mapping)</td>
<td>20</td>
</tr>
<tr>
<td>Q.2. Problem on Plant Breeding (demonstration of hybridization techniques Emasculation, Bagging, etc.)</td>
<td>10</td>
</tr>
<tr>
<td>Q.3. Floral Biology of any local crop, giving objectives for the improvement, floral characters and breeding programme)</td>
<td>10</td>
</tr>
<tr>
<td>Q.4. Ten spots for identification and comments.</td>
<td>20</td>
</tr>
<tr>
<td>Q.5. Viva Voce</td>
<td>05</td>
</tr>
<tr>
<td>Q.6. Sessional Records, submission of specimen, poster/chart/ etc.</td>
<td>05</td>
</tr>
</tbody>
</table>
DSE-4   Analytical Techniques in Plant Sciences
(Credits: Theory-4, Practicals-2)

THEORY
Lectures: 60

Unit 1: (15 Lectures)
**Imaging and related techniques**
Principles of microscopy; Light microscopy; Fluorescence microscopy; Confocal microscopy; Use of fluorochromes: (a) Flow cytometry (FACS); (b) Applications of fluorescence microscopy; Chromosome banding, FISH, chromosome painting; Transmission and Scanning electron microscopy – sample preparation for electron microscopy, cryofixation, negative staining, shadow casting, freeze fracture, freeze etching.

Unit 2: (8 Lectures)
**Cell fractionation**
Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, CsCl2 gradient, analytical centrifugation, ultracentrifugation, marker enzymes.

Unit 3: (8 Lectures)
**Radioisotopes**
Use in biological research, autoradiography, pulse chase experiment.

**Spectrophotometry**
Principle and its application in biological research.

Unit 4: (14 Lectures)
**Chromatography**
Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ionexchange chromatography; Molecular sieve chromatography; Affinity chromatography.

**Characterization of proteins and nucleic acids**
Mass spectrometry; X-ray diffraction; X-ray crystallography; Characterization of proteins and nucleic acids; Electrophoresis: AGE, PAGE, SDS-PAGE

Unit 5: (15 Lectures)
**Biostatistics**
Statistics, data, population, samples, parameters; Representation of Data: Tabular, Graphical; Measures of central tendency: Arithmetic mean, mode, median; Measures of dispersion: Range, mean deviation, variation, standard deviation; Chi-square test for goodness of fit.
Practicals
1. Study of Blotting techniques: Southern, Northern and Western, DNA fingerprinting, DNA sequencing, PCR through photographs.
2. Demonstration of ELISA.
3. To separate nitrogenous bases by paper chromatography.
4. To separate sugars by thin layer chromatography.
5. Isolation of chloroplasts by differential centrifugation.
6. To separate chloroplast pigments by column chromatography.
7. To estimate protein concentration through Lowry’s methods.
8. To separate proteins using PAGE.
9. To separate DNA (marker) using AGE.
10. Study of different microscopic techniques using photographs/micrographs (freeze fracture, freeze etching, negative staining, positive staining, fluorescence and FISH).
11. Preparation of permanent slides (double staining).

Suggested Readings

DSE-4 Analytical Techniques in Plants Sciences Practical
The practical examination will cover the study as enumerated in practical of Semester VI and will be of three hours duration for B.Sc. VI Semester. Following would be the scheme and marks distribution for the practical examination.

Time: 3 Hours
Q.1. To perform the given experiment and interpretation of the results. 20
Q.2. To solve the given Biostatistical problem. 20
Q.3. Ten spots for identification and comments. 20
Q.4. Viva Voce 05
Q.5. Sessional Records, submission of specimen, poster/chart etc. 05
DSE-5  Bioinformatics
(Credits: Theory-4, Practicals-2)

THEORY
Lectures: 60

Unit 1: (5 Lectures)
Introduction to Bioinformatics
Introduction, Branches of Bioinformatics, Aim, Scope and Research areas of Bioinformatics.

Unit 2: (5 Lectures)
Databases in Bioinformatics
Introduction, Biological Databases, Classification format of Biological Databases, Biological Database Retrieval System.

Unit 3: (25 Lectures)
Biological Sequence Databases
National Center for Biotechnology Information (NCBI): Tools and Databases of NCBI, Database Retrieval Tool, Sequence Submission to NCBI, Basic local alignment search tool (BLAST), Nucleotide Database, Protein Database, Gene Expression Database. EMBL Nucleotide Sequence Database (EMBL-Bank): Introduction, Sequence Retrieval, Sequence Submission to EMBL, Sequence analysis tools. DNA Data Bank of Japan (DDBJ): Introduction, Resources at DDBJ, Data Submission at DDBJ. Protein Information Resource (PIR): About PIR, Resources of PIR, Databases of PIR, Data Retrieval in PIR, Swiss-Prot: Introduction and Salient Features.

Unit 4: (10 Lectures)
Sequence Alignments
Introduction, Concept of Alignment, Multiple Sequence Alignment (MSA), MSA by CLUSTALW, Scoring Matrices, Percent Accepted Mutation (PAM), Blocks of Amino Acid Substitution Matrix (BLOSUM).

Unit 5: (15 Lectures)
Molecular Phylogeny
Methods of Phylogeny, Software for Phylogenetic Analyses, Consistency of Molecular Phylogenetic Prediction.

Applications of Bioinformatics
Structural Bioinformatics in Drug Discovery, Quantitative structure-activity relationship (QSAR) techniques in Drug Design, Microbial genome applications, Crop improvement.
Practical
1. Nucleic acid and protein databases.
2. Sequence retrieval from databases.
3. Sequence alignment.
4. Sequence homology and Gene annotation.

Suggested Readings

DSE-5 Bioinformatics Practical
The practical examination will covers of study as enumerated in practical of Semester VI and will be of three hours duration for B.Sc. VI Semester. Following would be the scheme and marks distribution for the practical examination.

Time: 3 Hours
Q.1. To perform the sequence retrieval of given gene using bioinformatics database. 20
Q.2. To write an essay on use of bioinformatics in the field of Life Sciences. 20
Q.3. Ten spots for identification and comments. 20
Q.4. Viva Voce 05
Q.5. Sessional Records, submission of specimen, poster/chart etc. 05

DSE-6 Research Methodology
(Credits: Theory-4, Practicals-2)

THEORY
Lectures: 60

Unit 1: (10 Lectures)
Basic concepts of research
Research-definition and types of research (Descriptive vs analytical; applied vs fundamental; quantitative vs qualitative; conceptual vs empirical). Research methods vs methodology. Literature-review and its consolidation; Library research; field research; laboratory research.
Unit 2: (12 Lectures)
General laboratory practices

Unit 3: (12 Lectures)
Data collection and documentation of observations Maintaining a laboratory record; Tabulation and generation of graphs. Imaging of tissuespecimens and application of scale bars. The art of field photography. Overview of Biological Problems History; Key biology research areas, Model organisms in biology (A Brief overview): Genetics, Physiology, Biochemistry, Molecular Biology, Cell Biology, Genomics, Proteomics-Transcriptional regulatory network.

Unit 4: (18 Lectures)
Methods to study plant cell/tissue structure Whole mounts, peel mounts, squash preparations, clearing, maceration and sectioning; Tissue preparation: living vs fixed, physical vs chemical fixation, coagulating fixatives, noncoagulant fixatives; tissue dehydration using graded solvent series; Paraffin and plastic infiltration; Preparation of thin and ultrathin sections. Plant microtechniques Staining procedures, classification and chemistry of stains. Staining equipment. Reactive dyes and fluorochromes (including genetically engineered protein labeling with GFP and other tags). Cytogenetic techniques with squashed plant materials.

Unit 5: (08 Lectures)
The art of scientific writing and its presentation Numbers, units, abbreviations and nomenclature used in scientific writing. Writing references. Powerpoint presentation. Poster presentation. Scientific writing and ethics, Introduction to copyright-academic misconduct/plagiarism.

Practical
1. Experiments based on chemical calculations.
2. Plant microtechnique experiments.
3. The art of imaging of samples through microphotography and field photography.
4. Poster presentation on defined topics.
5. Technical writing on topics assigned.

Suggested Readings

DSE-6 Research Methodology Practical
The practical examination will covers of study as enumerated in practical of Semester VI and will be of three hours duration for B.Sc. VI Semester. Following would be the scheme and marks distribution for the practical examination.

<table>
<thead>
<tr>
<th>Time: 3 Hours</th>
<th>MM 70</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q.1. To perform the prescribed experiment based on plant micro techniques.</td>
<td>25</td>
</tr>
<tr>
<td>Q.2. Explain the elements of technical writing.</td>
<td>25</td>
</tr>
<tr>
<td>Q.3. Sessional Records, submission of specimen, poster/chart/etc.</td>
<td>05</td>
</tr>
<tr>
<td>Q.4. Viva Voce</td>
<td>05</td>
</tr>
</tbody>
</table>

DSE-7 Dissertation
Topics suggested by the Department.

DSE-8 Project Work
DSE-7 Project Work
The project work will be based on any topic approved by the departmental committee. The final examination will be of three hours duration and it shall be evaluated jointly by the supervisor and one external examiner. Following would be the scheme and marks distribution for the final examination.

| Periodical presentation       | Sessional 30 |
| Project Report                | End-Term 50  |
| Viva                          | End Term 20   |