H.P. University, Summerhill, Shimla

Structure and Syllabus

of

Botany

for
B.Sc. Undergraduate Programme

Based on:

U.G.C. Choice Based Credit System

(CBCS) Annual Pattern UG Courses

Model Curriculum

(Effective from Academic Session July, 2018 onwards)
Details of Courses for B.Sc. (Pass Course) Undergraduate Program
Annual Pattern

<table>
<thead>
<tr>
<th>Course</th>
<th>*Credits</th>
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<tbody>
<tr>
<td></td>
<td>Theory+ Practical</td>
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<tr>
<td>I. Discipline Specific Courses</td>
<td>12X4= 48</td>
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<tr>
<td>(12 Papers)</td>
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<tr>
<td>04 Courses from each of the</td>
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<tr>
<td>03 disciplines of choice</td>
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<tr>
<td>Discipline Specific Courses Practical / Tutorial*</td>
<td>12X2=24</td>
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<tr>
<td>(12 Practical/ Tutorials*)</td>
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<tr>
<td>04 Courses from each of the</td>
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<tr>
<td>03 Disciplines of choice</td>
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<tr>
<td>II. Discipline Specific Elective Course</td>
<td>6x4=24</td>
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<tr>
<td>(6 Papers)</td>
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<tr>
<td>Two papers from each discipline of choice</td>
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<td>including paper of interdisciplinary nature.</td>
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<tr>
<td>Discipline Specific Elective Course Practical / Tutorials*</td>
<td>6 X 2=12</td>
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III. Ability Enhancement Courses

1. Ability Enhancement Compulsory Courses
   (2 Papers of 4 credits each)
   i. Environmental Sciences
   ii. English/Hindi/SKT

2. Skill Enhancement Course
   (Skill Based)
   (4 Papers of 4 credits each)

   Total credit= 132
   Total credit= 132

Institute should evolve a system/policy about ECA/ General Interest/ Hobby/ Sports/ NCC/ NSS/ related courses on its own.

*wherever there is practical there will be no tutorials and vice-versa
## Scheme for choice based credit system in B.Sc. with Botany (Annual Pattern)

<table>
<thead>
<tr>
<th>1st year</th>
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<tbody>
<tr>
<td><strong>DISCIPLINE SPECIFIC COURSES (DSC)</strong></td>
<td><strong>Ability enhancement compulsory course (AECC)</strong></td>
</tr>
<tr>
<td>DSC-IA</td>
<td>i. Environment Science ENVS1AECC02</td>
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<tr>
<td>Biodiversity (Microbes, Algae, Fungi and Archegoniates) BOTA 101</td>
<td>ii. English ENGL 103/Hindi/SKT</td>
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<tr>
<td>DSC-IB</td>
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<tr>
<td>Plant Ecology and Taxonomy BOTA 102</td>
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<tr>
<th>IInd year</th>
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<tbody>
<tr>
<td><strong>DSC-IA</strong></td>
<td>1. Biofertilizers BOTA 203</td>
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<tr>
<td>Plant Anatomy and Embryology BOTA 201</td>
<td>2. Gardening and Floriculture BOTA 204</td>
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<th>IIIrd Year</th>
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<tbody>
<tr>
<td>1. Medicinal Botany and Ethnobotany BOTA 306</td>
<td><strong>DSE IA</strong> Economic Botany &amp; BOTA 301 or Analytical Techniques in Plant Sciences BOTA 302</td>
</tr>
<tr>
<td>2. Mushroom Cultivation Technology BOTA 307</td>
<td><strong>DSE IB</strong> Cell and Molecular Biology BOTA 303 or Bioinformatics BOTA 304 or Genetics and Plant Breeding BOTA 305</td>
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<td>Course Opted</td>
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<tr>
<td>Ability Enhancement</td>
<td>i Environmental Sciences</td>
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<tr>
<td>Compulsory Course</td>
<td>ii English/Hindi/SKT</td>
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<td>DISCIPLINE SPECIFIC</td>
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<tr>
<td>COURSES (DSC)</td>
<td><strong>DSC-IB</strong> Plant Ecology and Taxonomy</td>
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<td><strong>DSC-IA</strong> Biodiversity (Microbes, Algae, Fungi and Archegoniates) Lab</td>
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<tr>
<td>DISCIPLINE SPECIFIC</td>
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<td><strong>BOTA 203</strong></td>
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<tr>
<td>Skills enhancement courses</td>
<td>1. Biofertilizers</td>
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<tr>
<td>(SEC)-I</td>
<td>2. Gardening and Floriculture</td>
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<tr>
<td>Skill enhancement courses (SEC) -I</td>
<td>IIIrd year</td>
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**Discipline specific elective DSE**

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<tr>
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<td>Cell and Molecular Biology</td>
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**Discipline specific elective DSE: Practical**

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<thead>
<tr>
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<tr>
<td>Economic Botany &amp; Biotechnology (Lab) OR Analytical Techniques in Plant Sciences (Lab)</td>
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<tr>
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<td>Genetics and Plant Breeding (Lab)</td>
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<tbody>
<tr>
<td>BOTA 301</td>
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<tbody>
<tr>
<td>BOTA 302</td>
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<td>BOTA 305</td>
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Detail of Courses

DISCIPLINE SPECIFIC COURSES (DSC)

1. Biodiversity (Microbes, Algae, Fungi and Archegoniates)  BOTA 101
2. Plant Ecology and Taxonomy                  BOTA 102
3. Plant Anatomy and Embryology                BOTA 201
4. Plant Physiology and metabolism             BOTA 202

DISCIPLINE SPECIFIC ELECTIVE (DSE)

1. Economic Botany and Biotechnology           BOTA 301
2. Analytical Techniques in Plant Sciences     BOTA 302
3. Cell and Molecular Biology                  BOTA 303
4. Bioinformatics                              BOTA 304
5. Genetics and Plant Breeding                 BOTA 305

Ability Enhancement Compulsory Courses

1. English/Hindi/SKT
2. Environment Sciences

Skill Enhancement Courses in Botany

1. Biofertilizers                              BOTA 203
2. Gardening and Floriculture                 BOTA 204
3. Medicinal Botany and Ethnobotany           BOTA 306
4. Mushroom Cultivation Technology            BOTA 307
I Year

DSC: Botany Paper I
Biodiversity (Microbes, Algae, Fungi and Archegoniates)
(BOTA 101) (Credits: Theory-4, Practicals-2)

THEORY Lectures: 60

Unit 1: Microbes (7 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; Brief account of classification of algae; Morphology and life-cycles of the following: Nostoc, Oedogonium, Vaucheria, Ectocarpus, 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; Morphology and life cycles of Phytophthora, Rhizopus (Zygomycota) Penicillium, Venturia (Ascomycota), Puccinia, Agaricus (Basidiomycota); Symbiotic Associations- Lichens: General account, reproduction and significance.

Unit 4: Bryophytes (9 Lectures)
General characteristics, adaptations to land habit, Range of thallus organization. Classification (up to family), morphology, anatomy and reproduction of Marchantia and Funaria. (Developmental details not to be included). Ecology and economic importance of bryophytes with special mention of Sphagnum.

Unit 5: Pteridophytes (10 Lectures)
General characteristics, 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.
Unit 6: Gymnosperms

General characteristics, Classification (up to family), Morphology, anatomy and reproduction of *Cycas* and *Pinus* (Developmental details not to be included). Economic importance.

**NOTE:** The question paper will be divided into four sections as follows:

Section A: Algae, Section B- Fungi, Section C – Microbes and Bryophytes and Section D- Pteridophytes and Gymnosperms.

**Practical  (BOTA 101)**

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, Ectocarpus* and *Polysiphonia* through temporary preparations and permanent slides.
5. *Phytophthora, Rhizopus* and *Penicillium*: 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*.
9. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose)
10. Mycorrhiza: ecto mycorrhiza and endo mycorrhiza (Photographs)
11. *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).
12. *Funaria* - morphology, w.m. leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, l.s. capsule and protonema.
13. *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).
14. *Equisetum* - morphology, t.s. internode, l.s. strobilus, t.s. strobilus, w.m. sporangiophore, w.m. spores (wet and dry)(temporary slides); t.s rhizome (permanent slide).
15. **Adiantum**- morphology, t.s. rachis, v.s. sporophyll, w.m. sporangium, w.m. spores (temporary slides), t.s. rhizome, w.m. prothallus with sex organs and young sporophyte (permanent slide).

16. **Cycas**- morphology (coralloid roots, bulbil, leaf), t.s. coralloid root, t.s. rachis, v.s. leaflet, v.s. microsporophyll, w.m. spores (temporary slides), l.s. ovule, t.s. root (permanent slide).

16. **Pinus**- morphology (long and dwarf shoots, w.m. dwarf shoot, male and female), w.m. dwarfshoot, t.s. needle, t.s. stem, , l.s./t.s. male cone, w.m. microsporophyll, w.m. microspores(temporary slides), l.s. female cone, t.l.s. & r.l.s. stem (permanent slide).

17. **Field visits**

**Suggested Readings**


DSC Botany – Paper II
Plant Ecology and Taxonomy
(BOTA 102)

(Credits: Theory-4, Practicals-2)

THEORY

Lectures: 60

Section A

Unit 1: Introduction (2 Lecture)

Unit 2: Ecological Factors (13 Lectures)


Section B

Unit 3: Plant communities (5 Lectures)

Characters; Ecotone and edge effect; Succession; Processes and types (Hydrosere and Xerosere)

Unit 4: Ecosystem (10 Lectures)

Structure; energy flow trophic organisation; Food chains and food webs, Ecological pyramids production and productivity; Biogeochemical cycling- Cycling of Nitrogen and Phosphoros.

Section C
12

Unit 5: Introduction to plant taxonomy (3 Lectures)
Identification, Classification, Nomenclature.

Unit 6: Identification (5 Lectures)
Functions of Herbarium, important herbaria and botanical gardens of the world and India; Documentation: Flora, Keys: single access and multi-access

Unit 7: Taxonomic evidences from cytology, phytochemistry and molecular data. 6 Lectures

Unit 8: Taxonomic hierarchy (2 Lectures)
Ranks, categories and taxonomic groups

Section D

Unit 9: Botanical nomenclature (6 Lectures)
Principles and rules (ICN): ranks and names; binominal system, typification, author citation, valid publication, rejection of names, principle of priority and its limitations

Unit 10: Classification (5 Lectures)
Types of classification-artificial, natural and phylogenetic. Bentham and Hooker (upto series), Engler and Prantl (upto series), Angiosperm Phylogeny Group (APG) - general introduction

Unit 11: Biometrics, numerical taxonomy and cladistics (3 Lectures)
Characters; variations; OTUs, character weighting and coding; cluster analysis; phenograms, cladograms (definitions and differences).

Practical (BOTA 102 PR)
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, organic matter.
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 quadrat 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 flowers (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker’s system of classification):

i. Ranunculaceae: *Ranunculus/Delphinium*
ii. Brassicaceae: *Brassica/Alyssum/Iberis*
iii. Malavaceae: *Hibiscus/Abutilon*
iv. Asteraceae: *Helianthus/sonchus*
v. Fabaceae: *Lathyrus/Pisum*
vi. Rosaceae: *Rosa/Prunus*
vii. Apiaceae: *Coriandrum*
viii. Apocynaceae: *Vinca/Nerium*
ix. Solanaceae: *Solanum/Petunia*
x. Lamiaceae: *Ocimum/Salvia*
xi. Lilliaceae: *Asparagus/Allium*

8. Field visit/ Visit to nearby Botanical Garden
9. Mounting of a properly dried and pressed specimen of any wild angiosperm with herbarium label.

**Suggested Readings**

THEORY Lectures: 60

SECTION A

Unit 1: Meristematic and permanent tissues (7 Lectures)
Root and shoot apical meristems; Simple and complex tissues.

Unit 2: Organs (7 Lectures)
Structure of dicot and monocot root stem and leaf.

Unit 3: Adaptive and protective systems (4 Lectures)
Epidermis, cuticle, stomata;

SECTION B

Unit 4: Secondary Growth (8 Lectures)

Unit 5: Anomalous Secondary Growth (4 Lectures)
Boerhaavia (Dicot) and Dracaena (Monocot)

SECTION C

Unit 6: Structural organization of flower (13 Lectures)
Flower- a modified shoot, Function of floral parts; Structure of anther and pollen; Microsporogenesis, Male gametophyte, Structure and types of ovules; gasporangium, Types of embryo sacs, organization and ultra structure of mature embryo sac.

Unit 7: Pollination (4 Lectures)
Pollination mechanisms and adaptations.

SECTION D

Unit 8: Fertilization (7 Lectures)
Double fertilization; Seed-structure, appendages and dispersal mechanisms.

Unit 9: Embryo and endosperm (6 Lectures)
Endosperm types, structure and functions; Dicot and monocot embryo; Embryo-endosperm relationship, polyembryony
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. Study of various types of pollen grains.

Suggested Readings

DSC Botany – Paper IV
Plant Physiology and Metabolism (BOTA 202)
(Credits: Theory-4, Practicals-2)
THEORY Lectures: 60

SECTION A

Unit 1: Introduction
Applications of plant physiology in agriculture & horticulture.

Plant-water relations (8 Lectures)
Importance of water, Diffusion, Osmosis, water potential and its components; Transpiration and its significance; Factors affecting transpiration; Root pressure and guttation, Mechanism of Stomatal movements.

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.

SECTION B

Unit 3: Translocation in phloem (4 Lectures)
Composition of phloem sap, girdling experiment; Pressure flow model; Phloem loading and unloading.

Unit 4: 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; C_3, C_4 and CAM pathways of carbon fixation; Photorespiration.

SECTION C

Unit 5: Respiration (8 Lectures)
Glycolysis, anaerobic respiration, TCA cycle; Oxidative phosphorylation, Glyoxylate, Oxidative Pentose Phosphate Pathway.

Unit 6: Enzymes (4 Lectures)
Structure and properties; Mechanism of enzyme catalysis and enzyme inhibition.

Unit 7: Nitrogen metabolism (4 Lectures)
Biological nitrogen fixation; Nitrate and ammonia assimilation.

SECTION D

Unit 8: Plant growth regulators (6 Lectures)
Discovery and physiological roles of auxins, gibberellins, cytokinins, ABA, ethylene.
Unit 9: Plant response to light and temperature

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

Practical (BOTA 202)

1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. Demonstration of transpiration with the help of photometers.
3. Calculation of stomatal index and stomatal frequency of a mesophyte and a xerophyte.
4. Demonstration of activity of catalase and study of effect of pH and enzyme concentration.
5. To study the effect of light intensity and bicarbonate concentration on O₂ evolution in photosynthesis.
6. Comparison of the rate of respiration in any two parts of a plant.
7. Separation of photosynthetic pigments by paper chromatography.
8. To determine the RQ of different respiratory substances.

Demonstration experiments (any four)

1. Bolting.
2. Effect of auxins on rooting.
3. Hydroponics

Suggested Readings

Discipline Specific Elective Courses Two (2) be selected from each of the three disciplines
Discipline Specific Elective Botany

Economic Botany and Biotechnology

(BOTA 301)
(Credits: Theory-4, Practicals-2)

THEORY Lectures: 60

SECTION A

Unit 1: Cultivated Plants (3 Lectures)
Introduction, Research centres, Concept of centres of origin, their importance with reference to Vavilov’s work

Unit 2: Cereals (5 Lectures)
Wheat and Rice -Origin, morphology, uses

Unit 3: Pulses & Vegetables (4 Lectures)
General account with special reference to Gram, soybean and Potato

Unit 4: Spices (3 Lectures)
General account with special reference to clove, black pepper, cinnamon, Ginger and Turmeric (Botanical name, family, part used, morphology and uses)

SECTION B

Unit 5: Beverages (4 Lectures)
Tea and Coffee (morphology, processing, uses)

Unit 6: Oils and Sugar (4 Lectures)
General description with special reference to groundnut and sugarcane

Unit 7: Fibre Yielding Plants (4 Lectures)
General description with special reference to Cotton (Botanical name, family, part used, morphology and uses)

Unit 8: Medicinal Plants
Brief account of Ocimum, Tinospora, Aloe, Rauwolfia, Emblica and Catharanthus (3 Lecture)

SECTION C

Unit 9: Introduction to Biotechnology (15 Lectures)
Tissue culture techniques, Micropropagation; haploid production through androgenesis and gynogenesis; brief account of embryo & endosperm culture; Applications of plant tissue culture in agriculture, horticulture and forestry.
SECTION D

Unit 10: Biotechnological Techniques (15 Lectures)
Introduction to r-DNA, Cloning vehicles, Gene transfer techniques in plants, Transgenic plants, Agarose electrophoresis, Blotting techniques: Northern, Southern and Western Blotting, DNA Fingerprinting; Molecular DNA markers i.e. RAPD, RFLP, SNPs; DNA sequencing, PCR and Reverse Transcriptase-PCR. ELISA, Hybridoma and monoclonal antibodies, ELISA and Immunodetection. Molecular diagnosis of human disease, Human gene Therapy.

Practical (BOTA 301)

1. Study of economically important plants: Wheat, Rice, Gram, Soybean, Potato, Black pepper, Clove, Cinnamon, Ginger, Turmeric, Tea, Coffee, Cotton, Groundnut, Sugarcane and Medicinal plants through specimens, sections and microchemical tests.
2. Familiarization with basic equipment used in tissue culture through videos, images or visit to nearby research Institute.
3. Study through photographs: Anther culture, somatic embryogenesis, endosperm and embryo culture; micropropagation.
4. Study of equipments used in PCR, Blotting techniques and PAGE with the help of photographs or videos.

Suggested Readings

Discipline Specific Elective
Analytical Techniques in Plant Sciences
(BOTA 302)
(Credits: Theory-4, Practicals-2)

THEORY Lectures: 60

SECTION A

Unit 1: Imaging and related techniques (15 Lectures)

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.

SECTION B

Unit 2: Cell fractionation (5 Lectures)
Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, CsCl₂ gradient, analytical centrifugation, ultracentrifugation, marker enzymes.

Unit 3: Radioisotopes
Use in biological research, auto-radiography, pulse chase experiment. (6 Lectures)

Unit 4: Spectrophotometry
Principle and its application in biological research. (6 Lectures)

SECTION C

Unit 5: Chromatography (8 Lectures)
Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ionexchange chromatography; Molecular sieve chromatography; Affinity chromatography.

Unit 6: Characterization of proteins and nucleic acids (6 Lectures)
Mass spectrometry; X-ray diffraction; X-ray crystallography; Characterization of proteins and nucleic acids; Electrophoresis: AGE, PAGE, SDS-PAGE
Unit 7: Biostatistics  (15 Lectures)

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  (BOTA 302)

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

3. Ausubel, F., Brent, R., Kingston, R. E., Moore, D.D., Seidman, J.G., Smith, J.A.,


**Discipline Specific Elective Botany**  
**Cell and Molecular Biology**  
(BOTA 303)  
(Credits: Theory-4, Practicals-2)

**THEORY Lectures: 60**

**SECTION A**

**Unit 1: Techniques in Biology (8 Lectures)**

Principles of microscopy; Light Microscopy; Phase contrast microscopy; Fluorescence microscopy; Electron microscopy (EM) - Scanning EM and Scanning Transmission EM (STEM); Sample; X-ray diffraction analysis.

**Unit 2: Cell as a unit of Life (2 Lectures)**

The Cell Theory; Prokaryotic and eukaryotic cells; Cell size and shape; Eukaryotic Cell components.

**Unit 3: Cell Organelles (20 Lectures)**

Mitochondria: Structure, marker enzymes, composition; Semiautonomous nature; Symbiont hypothesis; Proteins synthesized within mitochondria; mitochondrial DNA.

Chloroplast Structure, marker enzymes, composition; semiautonomous nature, chloroplast DNA.

**SECTION B**

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 4: Cell Membrane and Cell Wall (6 Lectures)**

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.
**SECTION C**

**Unit 5:** Cell Cycle  (6 Lectures)

Overview of Cell cycle, Mitosis and Meiosis; Molecular controls.

**Unit 6:** Genetic material  (6 Lectures)

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.

A replication rokaryotes and eukaryotes bidirectional replication, semi–conservative, semi discontinuous R A priming, Ô theta mode of replication, replication of linear, ds- A, replicating the end of linear chromosome including replication enzymes.

**SECTION D**

**Unit 7:** Transcription (Prokaryotes and Eukaryotes)  (6 Lectures)

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

**Unit 8:** Regulation of gene expression (6 Lectures)

Prokaryotes:Lac operon and Tryptophan operon ; and in Eukaryotes.

**Practical (BOTA 303)**

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. Study of mitosis and meiosis (temporary mounts and permanent slides).
5. Study the effect of temperature, organic solvent on semi permeable membrane.
6. Demonstration of dialysis of starch and simple sugar.
7. Study of plasmolysis and deplasmolysis on Rhoeo leaf.
8. Measure the cell size (either length or breadth/diameter) by micrometry.
9. Study the structure of nuclear pore complex by photograph (from Gerald Karp) Study of special chromosomes (polytene & lampbrush) either by slides or photographs.
10. Study DNA packaging by micrographs.
11. Preparation of the karyotype and ideogram from given photograph of somatic metaphase chromosome.
Suggested Readings


Discipline Specific Elective Botany
Bioinformatics
(BOTA 304)
(Credits: Theory-4, Practicals-2)

THEORY Lectures: 60

SECTION A

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

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

SECTION B

Unit 3: Biological Sequence Databases
(25 Lectures)
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.
SECTION C

Unit 4: Sequence Alignments (10 Lectures)

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: Molecular Phylogeny (8 Lectures)

Methods of Phylogeny, Software for Phylogenetic Analyses, Consistency of Molecular Phylogenetic Prediction.

SECTION D

Unit 6: Applications of Bioinformatics (7 Lectures)

Structural Bioinformatics in Drug Discovery, Quantitative structure-activity relationship (QSAR) techniques in Drug Design, Microbial genome applications, Crop improvement.

Practical (BOTA 304)

1. Nucleic acid and protein databases.
2. Sequence retrieval from databases.
3. Sequence alignment.
4. Sequence homology and Gene annotation.

Suggested Readings

Discipline Specific Elective Botany
Genetics and Plant Breeding
(BOTA 305)
(Credits: Theory-4, Practical-2)

THEORY Lectures: 60

SECTION A

Unit 1: Heredity (20 Lectures)
Brief life history of Mendel
1. Terminologies
2. Laws of Inheritance
4. Chi Square
5. Pedigree Analysis
7. Multiple allelism
8. Pleiotropism

SECTION B

Unit 2: Sex-determination and Sex-linked Inheritance (4 Lectures)

Unit 3: Linkage and Crossing over (8 Lectures)
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 4: Mutations and Chromosomal Aberrations (4 Lectures)
Types of mutations, effects of physical & chemical mutagens. Numerical chromosomal changes: Euploidy, Polyploidy and Aneuploidy; Structural chromosomal changes: Deletions, Duplications, Inversions & Translocations.

SECTION C

Unit 5: Plant Breeding (4 lectures)

Unit 6: Methods of crop improvement (8 lectures)
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.
Unit 7: Quantitative inheritance (4 lectures)

Concept, mechanism, examples. Monogenic vs polygenic Inheritance.

**SECTION D**

Unit 8: Inbreeding depression and heterosis (4 lectures)

History, genetic basis of inbreeding depression and heterosis; Applications.

Unit 9: Crop improvement and breeding (4 lectures)

Role of mutations; Polyploidy; Distant hybridization and role of biotechnology in crop improvement.

**Practical (BOTA 305)**

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 own’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**


2nd edition.
Skill Enhancement Courses
30
SKILL ENHANCEMENT COURSES
Biofertilizers (BOTA 203)
(Credits 4)  Lectures: 45

SECTION A
Unit 1: Fertilizers: Introduction, Types of fertilizers and their advantages and disadvantages, Brief account of microbes used as biofertilizer, Marketable forms of biofertilizers.
(5 Lectures)

Unit 2. Rhizobium: General account, Isolation, Identification, Mass multiplication, Carrier based inoculants, Application, Crop response
(5 Lectures)

Unit 3. Actinorrhizal Symbiosis- Frankia, Host-microsymbiont relationship, Isolation, Culture, Application and Advantages
(2 Lectures)

SECTION B
Unit 4: Azospirillum: Isolation and mass multiplication, Carrier based inoculant, Crop response
(4 Lectures)

Unit 5: Azotobacter: Characteristics, Isolation and mass multiplication, Application and Crop response.
(4 Lectures)

(3 Lectures)

SECTION C
Unit 7: Cyanobacteria (Blue Green Algae): Azolla and Anabaena azollae association, Nitrogen fixation, Factors affecting growth, Blue green algae and Azolla in rice cultivation.
(6 Lectures)

Unit 8: Mycorrhizal Association: Types of mycorrhizal association, Taxonomy, Occurrence and distribution, Phosphorus nutrition, Growth and yield; VAM – Isolation and inoculum production, Influence on growth and yield of crop plants.
(6 Lectures)

SECTION D
Unit 9: Organic Farming – Green manuring and organic fertilizers, Recycling of biodegradable municipal, agricultural and Industrial wastes; Biocompost making methods, Types and method of vermicomposting, field Application.
(10 Lectures)
Suggested Readings


Gardening and Floriculture

(BOTA 204)  
(Credits 4)  
Lectures: 45 

SECTION A

Unit 1: Landscape Gardening and Floriculture: Definitions of Landscape Gardening and Floriculture, history of gardening, importance, status and scope of Floriculture and Landscaping; landscaping of homes, educational institutions, highways and public parks.  
(6 Lectures)

Unit 2: Gardening operations: Soil laying, Manuring, Watering, Management of pests and diseases; Soil sterilization; Seed sowing; Pricking; Planting and transplanting; Shading; Stopping or pinching; Defoliation; Mulching; Pruning, Topiary making.  
(4 Lectures)

SECTION B

(7 Lectures)

Unit 4: Propagation of Garden Plants: Sexual and vegetative methods of propagation; Role of plant growth regulators.  
(5 Lectures)
SECTION C

Unit 5: Ornamental Plants: Flowering annuals; Herbaceous perennials; Shrubs, Climbers; Ornamental trees; Ornamental bulbous plants; Palms and Cycads; Potted plants and indoor gardening; Bonsai.

(10 Lectures)

SECTION D

Unit 6: Commercial Floriculture: Factors affecting growth and flower production of ornamentals; Cultivation of Important flower crops (Carnation, Chrysanthemum, Gerbera, Gladiolus, Marigold, Rose, Lilium) (9 Lectures)

Unit 7. Post Harvest Management: Post- harvest handling of important flower crops, methods to prolong vase life, packaging, storage and transport of flower crops, Flower arrangements and other floral crafts. (4 lectures)

Suggested Readings

Medicinal Botany and Ethnobotany  
(BOTA 306)  
(Lectures 45)  

SECTION A  

Unit 1: Traditional Systems of Medicine: Brief history of use of medicinal herbs; Introduction to indigenous systems of medicines- Ayurveda, Unani and Siddha system of medicine.  
(5 Lectures)  

Unit 2: 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.  
(5 Lectures)  

SECTION B  

Unit 3: Plants Used by the Tribals: a) Food plants b) intoxicants and beverages c) Resins and oils and miscellaneous uses. d) Sacred plants  
(4 Lectures)  

Unit 4: Methodology of Ethnobotanical Studies: a) Field work b) Herbarium c) Ancient Literature d) Archaeological findings e) temples and sacred places.  
(7 Lectures)  

SECTION C  

Unit 5: Role of ethnobotany in modern Medicine  
Medico-ethnobotanical sources in India; Significance of the following plants in ethno botanical 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, Taxus wallichiana, Trichopus zeylanicus, Artemisia, Withania.  
(13 Lectures)  

SECTION D  

Unit 6: Role of ethnic groups in conservation of plant genetic resources. Endangered taxa and forest management (participatory forest management).  
(3 Lectures)  

Unit 7: 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.  
(8 Lectures)

**Mushroom Cultivation Technology**

(BOTA 307)

(Credits 4)  
Lectures: 45

**SECTION A**

**Unit 1:** Introduction, history. Nutritional and medicinal value of edible mushrooms; Nutrition and nutraceuticals – Proteins, amino acids, mineral elements nutrition, carbohydrates, crude fibre content, vitamins; Poisonous mushrooms.  
(10 Lectures)

**SECTION B**

**Unit 2:** 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. Pure culture: Medium, Sterilization, Preparation of spawn, Multiplication.  
(12 Lectures)

**SECTION C**

**Unit 3:** Cultivation practices of *Agaricus bisporus*, *Pleurotus* sp. and *Volvoriella volvacea*. Composting technology in mushroom production, Low cost technology, Mushroom bed preparation - paddy straw, sugarcane trash, maize straw, banana leaves. Factors affecting the mushroom bed preparation.  
(12 Lectures)
SECTION D

Unit 4: Storage: Short-term storage (Refrigeration - upto 24 hours) Long term Storage (canning, pickels, papads), drying, storage in salt solutions. (4 Lectures)

Unit 5: Food Preparation: Types of foods prepared from mushroom. Research Centres - National level and Regional level. Cost benefit ratio - Marketing in India and abroad, Export Value (4 Lectures)

Unit 6 Diseases and Pests of Mushrooms (3 Lectures)

Suggested Readings

END SEMESTER EXAMINATION (ESE) OF BOTANY IN B.Sc. PROGRAMME THEORY EXAMINATION

SCHEME OF EXAMINATION

1. English shall be the medium of instruction and examination.
2. Examinations shall be conducted at the end of each semester as per the Academic Calendar notified by Himachal Pradesh University.
3. Each course will carry **100 marks** and will have following components

1. **Theory Paper End-Semester examination**  
   50 Marks
2. **Practicals**  
   20 Marks
3. **Internal Assessment**  
   30 Marks

**Theory Paper + Practicals + Internal Assessment**  
(50+20+30) =100 marks

Distribution of Internal Assessment /CCA:

(i) Class Attendance = 5 Marks
(ii) Class test to be taken on completion of 40% syllabus by the class teacher = 5 Marks
(iii) House test to be taken on completion of 75 % of Syllabus = 10 Marks
(iv) Assignment, tutorials, general behavior of students = 10 Marks

**Marks for Class attendance**

- 75% but < 80%  
  1 marks
- 80% but <85%  
  2 marks
- 85 but <90%  
  3 marks
- 90% but < 95%  
  4 marks
- 95% To 100%  
  5 marks

**Scheme of Examination for every course (Core Course, Discipline Specific Elective Course, Generic Elective Course):**

- **End Semester Examination**  
  50 Marks  
  Time 3 hrs
- **Practical for every course**  
  20 Marks  
  Time 3 hrs
- **Internal Assessment**  
  30 Marks

**Skill Enhancement Course & Ability Enhancement Compulsory Course: 100 Marks**

Skill Enhancement Course = 100 Marks  
(Theory 70 + CCA 30)

**Ability Enhancement Compulsory Course:**
1. Environment Science = 100 Marks  
2. English/Hindi/SKT= 100 Marks (Theory 70 + CCA30)
Instructions for Setting of Question Papers

I. Discipline Specific Courses and Discipline Specific Electives (Theory Papers)  
Max Marks: 50

1. Each question paper will contain 9 questions (divided into five parts A, B, C, D and E) of 10 marks each.
2. Question number 1 in Part A will be compulsory and will contain ten fill in the blanks, multiple choice questions, definitions or terms of one mark each.
3. Rest of the eight questions will be divided into four Parts (B, C, D and E containing questions from Section A, B, C and D of the syllabus) with each Part containing two questions. Students will be required to attempt only one question from each Part. Each question may be divided into 2 parts.
4. Questions should be taken from the whole syllabus.

II. Skill Enhancement Courses (SEC)  
Max Marks: 70

1. Each question paper will contain 9 questions (divided into five Parts- A, B, C, D and E) of 14 marks each.
2. Question number 1 in Part A will be compulsory and will contain ten fill in the blanks, multiple choice questions, definitions or terms of one mark each.
3. Rest of the eight questions will be divided into four Parts (B, C, D and E containing questions from Section A, B, C and D of the syllabus) with each Part containing two questions. Students will be required to attempt only one question from each Part.
4. Questions should be taken from the whole syllabus.