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

Course	***Credits**	
	Theory+ Practical	**Theory+Tutorials**
I.Discipline Specific Courses **(12 Papers)** 04 Courses from each of the 03 disciplines of choice	12X4= 48	12X5=60
Discipline Specific CoursesPractical / Tutorial* **(12 Practical/ Tutorials*)** 04 Courses from each of the 03 Disciplines of choice	12X2=24	12X1=12
II. Discipline Specific Elective Course **(6 Papers)** Two papers from each discipline of choice including paper of interdisciplinary nature.	6x4=24	6X5=30
Discipline Specific Elective Course Practical / Tutorials* (6 Practical / Tutorials*) Two Papers from each discipline of choice including paper of interdisciplinary nature	6 X 2=12	6X1=6

III. Ability Enhancement Courses

1. Ability Enhancement Compulsory Courses (2 Papers of 4 credits each)	2 X 4=8	2X4=8
i. Environmental Sciences		
ii. **English/Hindi/SKT**		
2. Skill Enhancement Course (Skill Based) (4 Papers of 4 credits each)	4 X 4=16	4 X 4=16
	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)

Ist year			
DISCIPLINE SPECIFIC COURSES (DSC)	**Ability enhancement compulsory course (AECC)**	**Skill enhancement courses (SEC)**	**Discipline specific elective DSE**
DSC-IA Biodiversity (Microbes, Algae, Fungi and Archegoniates) BOTA 101 **DSC-IB** Plant Ecology and Taxonomy BOTA 102	i. Environment Science ENVS1AECC02 ii. English ENGL 103/Hindi/SKT		
IInd year			
DSC-IA Plant Anatomy and Embryology BOTA 201 **DSC- IB** Plant Physiology and Metabolism BOTA 202		1. Biofertilizers BOTA 203 2. Gardening and Floriculture BOTA 204	
IIIrd Year			
		1. Medicinal Botany and Ethnobotany BOTA 306 2.Mushroom Cultivation Technology BOTA 307	**DSE IA** Economic Botany & BOTA 301 or Analytical Techniques in Plant Sciences BOTA 302 **DSE IB** Cell and Molecular Biology BOTA 303 or Bioinformatics BOTA 304 or Genetics and Plant Breeding BOTA 305

Ist year			
Course Opted	**Course Name**	**Course Code**	**Credits**
Ability Enhancement Compulsory Course	i Environmental Sciences ii English/Hindi/SKT		2×4= 8
DISCIPLINE SPECIFIC COURSES (DSC)	**DSC-IA** Biodiversity (Microbes, Algae, Fungi and Archegoniates) **DSC-IB** Plant Ecology and Taxonomy	BOTA 101 BOTA 102	4 4
DISCIPLINE SPECIFIC COURSES (DSC) Practical/Tutorial	**DSC-IA** Biodiversity (Microbes, Algae, Fungi and Archegoniates) Lab **DSC-IB** Plant Ecology and Taxonomy	BOTA 101 BOTA 102	2 2
IInd year			
DISCIPLINE SPECIFIC COURSES (DSC)	**DSC-IA** Plant Anatomy and Embryology **DSC- IB** Plant Physiology and Metabolism	BOTA 201 BOTA 202	4 4
DISCIPLINE SPECIFIC COURSES (DSC) Practical/Tutorial	**DSC-IA** Plant Anatomy and Embryology (Lab) **DSC- IB** Plant Physiology and Metabolism (Lab)	BOTA 201 BOTA 202	2 2
Skill enhancement courses (SEC)-I	1. Biofertilizers	BOTA 203	4
Skill enhancement courses (SEC)-II	2. Gardening and Floriculture	BOTA 204	4

IIIrd year			
Skill enhancement courses (SEC) –I	3. Medicinal Botany and Ethnobotany	BOTA 306	4
Skill enhancement courses (SEC) -II	4. Mushroom Cultivation Technology	BOTA 307	4
Discipline specific elective DSE	**DSE IA** Economic Botany & Biotechnology or Analytical Techniques in Plant Sciences **DSE IB** Cell and Molecular Biology OR Bioinformatics OR Genetics and Plant Breeding	 BOTA 301 BOTA 302 BOTA 303 BOTA 304 BOTA 305	 4 4
Discipline specific elective DSE : Practical	**DSE IA** Economic Botany & Biotechnology (Lab) OR Analytical Techniques in Plant Sciences (Lab) **DSE IB** Cell and Molecular Biology (Lab) OR Bioinformatics (Lab) OR Genetics and Plant Breeding (Lab)	 BOTA 301 BOTA 302 BOTA 303 BOTA 304 BOTA 305	 2 2

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 (10 Lectures)

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 LysogenicCycle.
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 throughpermanent slides.
6. *Venturia:* Specimens/photographs
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

1. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley and Sons (Asia), Singapore. 4th edition.
2. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
3. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 2nd edition.
4. Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad.
5. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R., (2005). Biology. Tata McGraw Hill, Delhi, India.
6. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi & Their Allies, MacMillan Publishers Pvt. Ltd., Delhi.
7. Thakur, A.K. and Bassi, S.K. (2008). Diversity of Microbes and Cryptogams. S. Chand & Co., Delhi.
8. Tortora, G.J., Funke, B.R., Case, C.L. (2010). Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A. 10th edition.
9. Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Pteridophyta, S. Chand. Delhi, India.

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)**

Soil: Origin, formation, composition, soil profile. Water: States of water in the environment, precipitation types. Light and temperature, Shelford law of tolerance. General account of adaptations in xerophytes and hydrophytes.

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

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 s(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. Ranunculacaceae: *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*
xii. Poaceae: *Zea mays/Triticum aestivum*

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

1. Kormondy, E.J. (1996). Concepts of Ecology. Prentice Hall, U.S.A. 4th edition. 2.Sharma, P.D. (2010) Ecology and Environment. Rastogi Publications, Meerut, India.
2. Simpson, M.G. (2006). *Plant Systematics.* Elsevier Academic Press, San Diego, CA,

   U.S.A.
3. Singh, G. (2012). *Plant Systematics:* Theory and Practice. Oxford & IBH Pvt. Ltd., New Delhi. 3rd edition.

DSC Botany –Paper III
Plant Anatomy and Embryology
(BOTA 201)
(Credits: Theory-4, Practicals-2)

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 (8Lectures)
Vascular cambium – structure and function, seasonal activity. Secondary growth in root and stem, Wood (heartwood and sapwood).

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

Practical (BOTA 201 PR)

1. Study of meristems through permanent slides and photographs.
2. Tissues (parenchyma, collenchyma and sclerenchyma); Macerated xylary elements, Phloem (Permanent slides, photographs)
3. Stem: Monocot: *Zea mays;* Dicot: *Helianthus*; Secondary: *Helianthus* (only Permanent slides).
4. Root: Monocot: *Zea mays*; Dicot: *Helianthus*; Secondary: *Helianthus* (only Permanent slides).
5. Leaf: Dicot and Monocot leaf (only Permanent slides).
6. Adaptive anatomy: Xerophyte (*Nerium* leaf); Hydrophyte (*Hydrilla* stem).
7. Structure of anther (young and mature), tapetum (amoeboid and secretory) (Permanent slides).
8. Types of ovules: anatropous, orthotropous, circinotropous, amphitropous/ campylotropous.
9. Female gametophyte: *Polygonum* (monosporic) type of Embryo sac Development (Permanent slides/photographs).
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

1.Bhojwani, S.S. & Bhatnagar, S.P. (2011). Embryology of Angiosperms. Vikas Publication House Pvt. Ltd. New Delhi. 5th edition.

2.Mauseth, J.D. (1988). Plant Anatomy. The Benjamin/Cummings Publisher, USA.

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 (6 Lectures)

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 O_2 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

1. Taiz, L., Zeiger, E., (2010). Plant Physiology. Sinauer Associates Inc., U.S.A. 5th Edition.
2. Hopkins, W.G., Huner, N.P., (2009). Introduction to Plant Physiology. John Wiley & Sons, U.S.A. 4th Edition.
3. Bajracharya, D., (1999). Experiments in Plant Physiology- A Laboratory Manual. Narosa Publishing House, New Delhi.

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 (3Lectures)

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, partused, morphology and uses)

Unit 8: Medicinal Plants

Brief account of *Ocimum*, *Tinospora*, *Aloe*, *Rauvolfia*, *Emblica* and *Cathranthus* **(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 an tibodies, 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

1. Kochhar, S.L. (2017). Economic Botany, Cambridge University Press.
2. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.

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, $CsCl_2$ 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

SECTION D

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

1. Plummer, D.T. (1996). An Introduction to Practical Biochemistry. Tata McGraw-

   Hill Publishing Co. Ltd. New Delhi. 3rd edition.

2. Ruzin, S.E. (1999). Plant Microtechnique and Microscopy, Oxford University Press, New York. U.S.A.

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

Struhl, K. (1995). Short Protocols in Molecular Biology. John Wiley & Sons. 3rd edition.

4. Zar, J.H. (2012). Biostatistical Analysis. Pearson Publication. U.S.A. 4th edition.

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, Ó 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

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

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.
5. Construction of phylogenetic tree.

Suggested Readings

1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.
2. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. WileyBlackwell.
3. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings.

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
3. Modified Mandelian Ratios: 2:1- lethal Genes; 1:2:1- Co-dominance, incomplete dominance; 9:7; 9:4:3; 13:3; 12:3:1.
4. Chi Square
5. Pedigree Analysis
6. Cytoplasmic Inheritance: Shell Coiling in Snail, Kappa particles in Paramecium, leaf variegation in Mirabilis jalapa, Male sterility.
7. Multiple allelism
8. Pleiotropism
9. Chromosome theory of Inheritance.

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)

Introduction and objectives. Breeding systems: modes of reproduction in crop plants. Important achievements and undesirable consequences of plant breeding.

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.
4. Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4).
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

1. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India.
2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics, John Wiley &th
   Sons Inc., India. 5 edition.
3. Klug WS, Cummings MR, Spencer, C, Palladino, M (2011). Concepts of Genetics, 10th Ed., Benjamin Cummings
4. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to th
   Genetic Analysis. W. H. Freeman and Co., U.S.A. 10 edition.
5. Pierce BA (2011) Genetics: A Conceptual Approach, 4th Ed., Macmillan Higher Education Learning
6. Singh, B.D. (2005). Plant Breeding: Principles and Methods. Kalyani Publishers.

   7^{th} edition.
7. Chaudhari, H.K. (1984). Elementary Principles of Plant Breeding. Oxford – IBH.

   2^{nd} edition.

Skill Enhancement Courses

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)

Unit 6: Phosphate Solubilizing Organisms: Introduction, Isolation, Culture and Applications.

(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

1. Dubey, R.C., 2005 A Text book of Biotechnology S. Chand& Co, New Delhi.
2. Kumaresan, V. 2005, Biotechnology, Saras Publications, New Delhi.
3. John Jothi Prakash, E. 2004. Outlines of Plant Biotechnology. Emkay Publication, New Delhi.
4. Sathe, T.V. 2004 Vermiculture and Organic Farming. Daya publishers.
5. Subha Rao, N.S. 2000, Soil Microbiology, Oxford & IBH Publishers, New Delhi.
6. Thakur, A.K., Bassi, S.K. and Singh, K.J. 2017. Biofertilizers. S. Dinesh & Co., Jalandhar.
7. Vayas, S.C, Vayas, S. and Modi, H.A. 1998. Biofertilizers and Organic Farming Akta Prakashan, Nadiad

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

Unit 3: Garden Designs, Principles, Types and Features: Principles and Elements of Garden Designs, Formal and Informal gardens, English, Mughal and Japanese gardens; Features of a garden (Garden wall, Fencing, Steps, Hedge, Edging, Lawn, Flower beds, Shrubbery, Borders, Rock garden, Water garden. Some Famous gardens of India. **(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

1. Bose T.K. & Mukherjee, D., 1972, Gardening in India, Oxford & IBH Publishing Co., New Delhi.
2. Edmond Musser & Andres, Fundamentals of Horticulture, McGraw Hill Book Co., New Delhi.
3. Janick Jules. 1979. Horticultural Science. (3rd Ed.), W.H. Freeman and Co., San Francisco, USA.
4. Hartmann and Kester, 2010. Plant Propagation: Principles and Practices. Pearson Publisher.
5. Randhawa, G.S. and Mukhopadhyay, A. 1986. Floriculture in India. Allied Publishers.
6. Sandhu, M.K., 1989, Plant Propagation, Wile Eastern Ltd., Bangalore, Madras.
7. Thakur, A.K., Kashyap, B., Bassi, S.K. and Sharma, M. 2018. Floriculture. S. Dinesh & Co., Jalandhar.

Medicinal Botany and Ethnobotany

(BOTA 306)

(Credits 4) **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)

Suggested Readings

1. Abdin, M.Z. and Y.P. Abrol, Y.P. 2006. Traditional Systems of Medicine. Narosa Publishing House, New Delhi.
2. Balick, M.J. and Cox, P.A. 1996. Plants, People and Culture: The Science of Ethnobotany. Scientific American Library.
3. Bera, S., Mukherji , D. and D'Rozario, A. 2004. A Hand Book of Ethnobotany. Kalyani Publishers.
4. Colton C.M. 1997. Ethnobotany: Principles and Applications. John Wiley and Sons.
5. Jain, S.K. (ed.) 1981. Glimpses of Indian. Ethnobotany. Oxford and I B H, New Delhi.
6. Jain, S.K. (ed.). 1989. Methods and Approaches in Ethnobotany. Society of Ethnobotanists, Lucknow.
7. Jain, S.K. 1990. Contributions to Indian Ethnobotany. Scientific publishers, Jodhpur.
8. Jain, S.K. 1995. Manual of Ethnobotany, Scientific Publishers, Jodhpur
9. Martin, G.J. 2008. Ethnobotany: A Methods Manual. Chapman and Hall

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 termStorage (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

1. Biswas, S., Datta, M. and Ngachan, S.V. 2012. Mushrooms: A Manual for Cultivation. PHI Learning Private Limited, New Delhi.
2. Kapoor, J.N. 2010. Mushroom Cultivation. ICAR, New Delhi.
3. Nita Bahl (2000) Hand book of Mushrooms. Oxford & IBH Publishing Co. Pvt. Ltd.
4. Singh, M., Vijay, B., Kamal, S. and Wakchaure (Eds.) 2011. Mushrooms: Cultivation, Marketting and Consumption. Directi\orate of Mushroom Reseaerch (ICAR), Solan
5. Tewari, Pankaj and Kapoor, S.C., (1988). Mushroom cultivation, Mittal Publications, Delhi.

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.