

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)
Model Curriculum**

(Effective from Academic Session July, 2016)

HIMACHAL PRADESH UNIVERSITY

SUMMER-HILL, SHIMLA-171005

B. Sc. Botany

GENERAL INSTRUCTIONS/ GUIDELINES FOR EXECUTION OF CURRICULUM

I. The B.Sc. Botany will be of three years duration semester-based Choice Based Credit System [CBCS] course.

II. There will be broadly three types of courses for B.Sc. Botany degree program.

1. The **Core Courses** (14 courses for B.Sc. Botany; and 4 discipline specific papers) will be of 6- credits each including 2 credits assigned to the practical component. Thus a candidate will have to pass 14 courses for earning $14 \times 6 = 84$ credits during six semesters. Each of the 6-credits courses will carry 100 marks. These 100 marks will be split into marks assigned for Theory [TH]: 40 marks; Practical [P]: 30 marks and Internal Assessment [IA]: 30. The Internal Assessment [30 marks] will include one Multi Choice Questions (MCQ)-based examination of 25 marks each [25 or 50 questions of 1.0 or 0.5 mark each as the case may be]; and Classroom Attendance Incentive marks (5 marks). The Lab-based practical will be of 2-hours [One credit]. A total of $14 \times 6 = 84$ credits could be accumulated under these courses during the B.Sc. Botany degree program.

2. The **Elective Courses** will be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/ subject of study or which provides an extended scope or which enables an exposure to some other discipline/ subject/ domain or nurtures the candidate's proficiency / skill. The Elective Courses will include;

Discipline Specific Elective [DSE] Courses: A total of 4 courses offered under the main discipline/ subject of study is referred to as Discipline Specific Elective. These courses are discipline related and/ or interdisciplinary in nature. A total of $4 \times 6 = 24$ credits could be accumulated under DSE courses during the B.Sc. Botany degree program.

Generic Elective [GE] Courses: A total of 4 courses of 6-credits each including 2 credits assigned for the practical component of each of these courses *i.e.* one course per 1st to 4th semester will be studied by the candidates. An elective course chosen from an unrelated discipline/ subject, with an intention to seek exposure beyond discipline(s) of choice is called Generic Elective Course. The purpose of this category of papers is to offer the students the option to explore disciplines of interest beyond the choices they make in Core and Discipline Specific Elective papers. Further, a course offered in a discipline/ subject may be treated as an elective by other discipline/ subject and vice versa and such electives may also be referred to as Generic Elective Course. A total of $4 \times 6 = 24$ credits could be accumulated under GE courses during the Botany degree program.

- 3. Ability Enhancement Compulsory Courses [AECC]:** Ability Enhancement Courses are of two types; Ability Enhancement Compulsory Courses [AECC] and Skill Enhancement Courses [SEC]. A total of $4 \times 4 = 16$ credits could be accumulated under these courses during the B.Sc. Botany degree program *i.e.* $4 \times 2 = 8$ credits for AECC, and $4 \times 2 = 8$ credits for SEC courses.

The AECC courses are the mandatory courses based upon the content that leads to knowledge enhancement; i. Environment Science and ii. English/ Hindi/ MIL Communication. All these are mandatory courses for obtaining a B.Sc. degree in the concerned subject. These courses are mandatory for all disciplines. SEC courses are value-based and/ or skill-based and are aimed at providing hands-on-training, competencies, skills *etc.* A minimum of two such courses for obtaining an B.Sc. degree are selected amongst the courses designed to provide value-based and/ or skill-based knowledge and may contain both theory and lab/ hands-on training. The main purpose of these courses is to provide students life-skills in hands-on mode so as to increase their employability.

- III.** Practical [P] component has been included in every core and discipline/ generic specific elective paper. The list of practicals to be conducted by the candidates has been provided alongside each of such courses. The marks (30 marks) for the practical examination will be split as follows;

Write up of Practical I:	5 marks
Write up of Practical II:	5 marks
Performance of any one of these practicals:	7 marks
Practical record/ notebook:	5 marks
Viva voce:	8 marks

IV. Classroom Attendance Incentive: Those candidates who have greater than 75% attendance (for those participating in Co-curricular activities, 25% will be added to per cent attendance) will be awarded CCA marks as follows:

≥ 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

V. The admission to B.Sc. Botany programme of Himachal Pradesh University will be as per guidelines of Himachal Pradesh University, Shimla from time to time.

- i. The candidate should have passed 10+2 (class XII) Examination or its equivalent from a recognized Board/University with any of the three subjects out of Physics, Chemistry and Biology or any other science subjects with 50% or equivalent grade (for SC/ST candidates marks of eligibility will be 45% or equivalent grade).
- ii. In case of candidates who are studying in University/ Board/ College/ Schools in any of the foreign countries the eligibility/ Qualifying marks will be the same as recognized/equivalent to 10+2 by the University or the association of the Indian University with 50% marks of equivalent grade (for SC/ST candidates, eligibility will be 45% marks or equivalent grade).
- iii. The candidate who has appeared in the qualifying examination but whose result has so far not been declared can also apply but his/her eligibility for the entrance test will be purely provisional subject to the condition that he/she has to produced a passing certificate scoring at least the minimum percentage of marks as prescribed for the qualifying examination on the day and the specified time of counseling.
- iv. The candidate shall not be more than 22 years of age as on 01st July of the year of admission. Date of birth as recorded in the Secondary Education Board/ University Certificate Only will be considered as authentic.

Details of Courses for B.Sc. Undergraduate Program

Course	*Credits	
	Theory+ Practical	Theory+Tutorials
<u>I. Core Course</u>	12X4= 48	12X5=60
(12 Papers)		
04 Courses from each of the 03 disciplines of choice		
Core Course Practical / Tutorial*	12X2=24	12X1=12
(12 Practical/ Tutorials*)		
04 Courses from each of the 03 Disciplines of choice		
<u>II. Elective Course</u>	6x4=24	6X5=30
(6 Papers)		
Two papers from each discipline of choice including paper of interdisciplinary nature.		
Elective Course Practical / Tutorials*	6 X 2=12	6X1=6
(6 Practical / Tutorials*)		
Two Papers from each discipline of choice including paper of interdisciplinary nature		
<ul style="list-style-type: none">• Optional Dissertation or project work in place of one Discipline elective paper (6 credits) in 6th Semester		

III. Ability Enhancement Courses

1. **Ability Enhancement Compulsory** 2 X 4=8 2X4=8

(2 Papers of 4 credits each)

Environmental Science

English/MIL Communication

2. **Skill Enhancement Course** 4 X 4=16 4 X 4=16

(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**

Proposed scheme for choice based credit system in B. Sc. with Botany

	DISCIPLINE CORE COURSE (12)	Ability Enhancement Compulsory Course (AECC) (2)	Skill Enhancement Co urse (SEC) (2)	Discipline Elective DSE (6)	Specific
I	Discipline-1 Botany Paper I: Biodiversity (Microbes, Algae, Fungi and Archegoniate) (BOTA 101) DSC- 2 Paper I DSC- 3 Paper 1	(English/MIL Communication)/ Environmental Science EVSC 101/201			
II	Discipline-1 Botany Paper II: Plant Ecology and Taxonomy (BOTA 201) DSC- 2 Paper II DSC- 3 Paper II	Environmental Science /(English/MIL Communication) EVSC 101/201			
III	Discipline-1 Botany Paper III: Plant Anatomy and Embryology (BOTA 301) DSC- 2 Paper III DSC- 3 Paper III		Bio-Fertilizers (BOTA 302) or Herbal Technology (BOTA 303)		
IV	Discipline-1 Botany				

	Paper IV: Plant Physiology and Metabolism (BOTA401)		Nursery and Gardening (BOT A402) or Floriculture (BOTA 403)	
	DSC- Discipline 2 Paper IV			
	DSC- Discipline 3 Paper IV			
V			Medicinal Botany (BOTA 504) or Ethnobotany (BOTA 505)	Economic Botany & Biotechnology (BOT A501) or Analytical Techniques in Plant Sciences (BOTA 502) or Research Methodology (BOTA 503)
				DSE-Discipline 2 Paper I
				DSE- Discipline 3 Paper I
VI			Plant Diversity and Human Welfare (BOT A604) or Mushroom Cultivation Technology (BOTA 605) or Intellectual Property rights (BOTA606)	Cell and Molecular Biology (BOTA 601) or Bioinformatics (BOTA 602) or Genetics and Plant Breeding (BOTA 603)
				DSE- Discipline 2 Paper II
				DSE- Discipline 3 Paper II

SEMESTER	COURSE OPTED	COURSE NAME	Course Code	Credits
I	Ability Enhancement Compulsory Course-I	English/MIL communications/ Environmental Science		4
	Core course - Botany Paper I	Biodiversity (Microbes, Algae, Fungi and Archegoniate)	BOTA 101 TH	4
	Core Course - Paper I Practical/Tutorial	Biodiversity (Microbes, Algae, Fungi and Archegoniate) Lab	BOT A101 PR	2
	Discipline- 2 Paper I	DSC- 2 Paper I		4
	Discipline- 2 Paper I Practical	DSC- 2 Paper I Practical		2
	Discipline - 3 Paper I	DSC- 3 Paper I		4
	Discipline - 3 Paper I Practical	DSC- 2 Paper I Practical		2
II	Ability Enhancement Compulsory Course-II	English/MIL communications/ Environmental Science		4
	Core course-Botany Paper II	Plant Ecology and Taxonomy	BOTA 201 TH	4
	Core Course- Botany Paper II Practical/Tutorial	Plant Ecology and Taxonomy Lab	BOTA 201 PR	2
	Discipline - 2 Paper II	DSC- 2 Paper 2		4
	Discipline - 2 Paper II Practical	DSC- 2 Paper 2 Practical		2
	Discipline - 3 Paper II	DSC- 3 Paper 2		4
	Discipline - 3 Paper II Practical	DSC- 3 Paper 2 Practical		2
III	Core course- Botany Paper III	Plant Anatomy and Embryology	BOT A301 TH	4
	Core Course- Botany Paper III Practical/Tutorial	Plant Anatomy and Embryology Practical	BOT A301 PR	2
	Discipline - 2 Paper III	DSC- 2 Paper III		4
	Discipline - 2 Paper III Practical	DSC- 2 Paper III Practical		2
	Discipline - 3 Paper III	DSC- 3 Paper III		4
	Discipline - 3 Paper III Practical	DSC- 3 Paper III Practical		2
	Skill Enhancement Course -1	Biofertilizers or Herbal Technology	(BOTA 302) or (BOT A303)	4

IV	Core course- Botany Paper IV	Plant Physiology and Metabolism	BOTA 401 TH	4
	Course- Botany Paper IV Practical	Plant Physiology and Metabolism Practical	BOT A401 PR	2
	Discipline - 2 Paper IV	DSC- 2 Paper IV Theory		4
	Discipline - 2 Paper IV Practical	DSC- 2 Paper IV Practical		2

	Discipline - 3 Paper IV	Plant Diversity and Human Welfare DSC- 3 Paper IV Theory	(BOTA 604)	4
	Discipline - 3 Paper IV Practical	DSC- 3 Paper IV or Nursery and Gardening	(BOTA402)	2
	Skill Enhancement Course -2 Skill Enhancement Course - 4	or Floriculture Mushroom Cultivation	or (BOTA 403) (BOTA 605)	4
V VI	Skill Enhancement Course - 3	Technology Medicinal Botany or Ethnobotany	(BOTA 504) or (BOT A505) (BOTA 606)	4
		Intellectual Property Right	(BOTA 606)	4
		Economic Botany and	(BOTA 501TH)	4
	Discipline Specific Elective –Botany Paper I	Biotechnology or Analytical Techniques in Plant Sciences or Research Methodology	or (BOTA 502TH) or (BOT A503TH)	4
	Discipline Specific Elective –Botany Paper I Practical	Economic Botany and Biotechnology Practical or Analytical Techniques in Plant Sciences Practical or Research Methodology Practical	(BOTA 501PR) or (BOTA 502PR) or (BOT A503PR)	2
	Discipline Specific Elective – Discipline 2 Paper I	DSE-Discipline 2 Paper I		4
	Discipline Specific Elective – Discipline 2 Paper I Practical	DSE-Discipline 2 Paper I Practical		2
	Discipline Specific Elective – Discipline 3 Paper I	DSE- Discipline 3 Paper I		4
Discipline Specific Elective – Discipline 3 Paper I Practical	DSE-Discipline 3Paper I Practical		2	

	Discipline Specific Elective –Botany	Cell and Molecular Biology or Bioinformatics or Genetics & Plant Breeding	(BOT A601TH) or (BOTA 602TH) or (BOTA603TH)	4
Paper II				
	Discipline Specific Elective –Botany	Cell and Molecular Biology Practical or Bioinformatics Practical or Genetics & Plant Breeding Practical	(BOT A601PR) or (BOTA 602PR) or (BOTA603PR)	2
	Paper II Practical			
	Discipline Specific Elective – Discipline 2 Paper II	DSE-Discipline 2 Paper II		4
	Discipline Specific Elective – Discipline 2 Paper II Practical	DSE-Discipline 3 Paper II Practical		2
	Discipline Specific Elective – Discipline 3 Paper II	DSE- Discipline 3 Paper II		4
	Discipline Specific Elective – Discipline 3 Paper II Practical	DSE- Discipline 3 Paper II Practical		2
Total Credits				132

Details of Courses

Core Courses –Botany

- | | |
|---|----------|
| 1. Biodiversity (Microbes, Algae, Fungi and Archegoniate) | BOTA 101 |
| 2. Plant Ecology and Taxonomy | BOTA 201 |
| 3. Plant Anatomy and Embryology | BOT A301 |
| 4. Plant Physiology and Metabolism | BOTA 401 |

Discipline Specific Electives-Botany (Any two)

- | | |
|--|----------|
| 1. Economic Botany and Biotechnology | BOTA 501 |
| 2. Analytical Techniques in Plant Sciences | BOTA 502 |
| 3. Research Methodology | BOT A503 |
| 4. Cell and Molecular Biology | BOT A601 |
| 5. Bioinformatics | BOTA 602 |
| 6. Genetics & Plant Breeding | BOTA 603 |

Ability Enhancement Compulsory Courses

1. Environmental Science
2. English/MIL Communication

Skill Enhancement Courses (Any four)

Botany

- | | |
|--------------------------------------|----------|
| 1. Biofertilizers | BOTA 302 |
| 2. Herbal Technology | BOT A303 |
| 3. Nursery and Gardening | BOT A402 |
| 4. Floriculture | BOTA 403 |
| 5. Medicinal Botany | BOTA 504 |
| 6. Ethnobotany | BOT A505 |
| 7. Plant Diversity and Human Welfare | BOTA 604 |
| 8. Mushroom Cultivation Technology | BOTA 605 |
| 9. Intellectual Property Right | BOTA 606 |

Core Courses

Semester I

Core Course: Botany Paper I Biodiversity (Microbes, Algae, Fungi and Archegoniate) (BOTA 101 TH) (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*, *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; Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance

Unit 4: Introduction to Archegoniate (2 Lectures)

Unifying features of archegoniate, Transition to land habit, Alternation of generations.

Unit 5: Bryophytes (10 Lectures)

General characteristics, adaptations to land habit, Classification, 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 6: 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.

Unit 7: Gymnosperms

(6 Lectures)

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

Practical (BOTA 101 PR)

5. EMs/Models of viruses – T-Phage and TMV, Line drawing/Photograph of Lytic and Lysogenic Cycle.
6. Types of Bacteria from temporary/permanent slides/photographs; EM bacterium; Binary Fission; Conjugation; Structure of root nodule.
7. Gram staining
8. Study of vegetative and reproductive structures of *Nostoc*, *Chlamydomonas* (electron micrographs), *Oedogonium*, *Vaucheria*, *Ectocarpus* and *Polysiphonia* through temporary preparations and permanent slides.
9. *Phytophthora*, *Rhizopus* and *Penicillium*: Asexual stage from temporary mounts and sexual structures through permanent slides.
10. *Venturia*: Specimens/photographs
11. *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.
12. *Agaricus*: Specimens of button stage and full grown mushroom; Sectioning of gills of *Agaricus*.
13. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose)
14. Mycorrhiza: ecto mycorrhiza and endo mycorrhiza (Photographs)
15. ***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).
16. ***Funaria***- morphology, w.m. leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, l.s. capsule and protonema.
17. ***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).
18. ***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).
19. ***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).
20. ***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).

21. ***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. microsporophyll, w.m. microspores (temporary slides), l.s. female cone, t.l.s. & r.l.s. stem (permanent slide).

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.

Semester II

Core Course Botany –Paper II Plant Ecology and Taxonomy

(BOTA 201 TH)

(Credits: Theory-4, Practicals-2)

THEORY

Lectures: 60

- Unit 1: Introduction** (2 Lectures)
- Unit 2: Ecological factors** (10 Lectures)
Soil: Origin, formation, composition, soil profile. Water: States of water in the environment, precipitation types. Light and temperature: Variation Optimal and limiting factors; Shelford law of tolerance. Adaptation of hydrophytes and xerophytes.
- Unit 3: Plant communities** (6 Lectures)
Characters; Ecotone and edge effect; Succession; Processes and types (Hydrosere and Xerosere)
- Unit 4: Ecosystem** (8 Lectures)
Structure; energy flow trophic organisation; Food chains and food webs, Ecological pyramids production and productivity; Biogeochemical cycling; Cycling of carbon, nitrogen and Phosphorous
- Unit 5: Phytogeography** (4 Lectures)
Principle biogeographical zones; Endemism
- Unit 6 Introduction to plant taxonomy** (2 Lectures)
Identification, Classification, Nomenclature.
- Unit 7 Identification** (4 Lectures)
Functions of Herbarium, important herbaria and botanical gardens of the world and India; Documentation: Flora, Keys: single access and multi-access
- Unit 8 Taxonomic evidences from palynology, cytology, phytochemistry and molecular data.** (6 Lectures)
- Unit 9 Taxonomic hierarchy** (2 Lectures)
Ranks, categories and taxonomic groups
- Unit 10 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 11 Classification

(6 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 12 Biometrics, numerical taxonomy and cladistics

(4 Lectures)

Characters; variations; OTUs, character weighting and coding; cluster analysis; phenograms, cladograms (definitions and differences).

Practical (BOTA 201 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, 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 (Orobanchae), 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 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).

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. 8th edition.
3. Simpson, M.G. (2006). *Plant Systematics*. Elsevier Academic Press, San Diego, CA, U.S.A.
4. Singh, G. (2012). *Plant Systematics: Theory and Practice*. Oxford & IBH Pvt. Ltd., New Delhi. 3rd edition.

Semester III

Core Course Botany –Paper III Plant Anatomy and Embryology (BOTA 301 TH) (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** (6 Lectures)
Structure of dicot and monocot root stem and leaf.
- Unit 3: Secondary Growth** (8 Lectures)
Vascular cambium – structure and function, seasonal activity. Secondary growth in root and stem, Wood (heartwood and sapwood).
- Unit 4: Adaptive and protective systems** (8 Lectures)
Epidermis, cuticle, stomata; General account of adaptations in xerophytes and hydrophytes.
- Unit 5: Structural organization of flower** (12 Lectures)
Flower- a modified shoot, Function of floral parts; Structure of anther and pollen; Microsporogenesis, Male gametophyte, Structure and types of ovules; Megasporangium, Types of embryo sacs, organization and ultra structure of mature embryo sac.
- Unit 6: Pollination and fertilization** (8 Lectures)
Pollination mechanisms and adaptations; Double fertilization; Seed-structure appendages and dispersal mechanisms.
- Unit 7: Embryo and endosperm** (6 Lectures)
Endosperm types, structure and functions; Dicot and monocot embryo; Embryo-endosperm relationship.
- Unit 8: Apomixis and polyembryony** (4 Lectures)
Definition, types and practical applications.

Practical (BOTA 301 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. Calculation of percentage of germinated pollen in a given medium.

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.

Semester IV

Core Course Botany –Paper IV Plant Physiology and Metabolism (BOTA 401 TH) (Credits: Theory-4, Practicals-2)

THEORY Lectures: 60

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.

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; C₃, C₄ and CAM pathways of carbon fixation; Photorespiration.

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.

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 (BOTA 401 PR)

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

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 Centric Elective Courses

Two (2) be selected from each of the three disciplines

Discipline Specific Elective Botany
Economic Botany and Biotechnology
(BOTA 501 TH)
(Credits: Theory-4, Practicals-2)

THEORY
Lectures: 60

- Unit 1: Cultivated Plants** (4 Lectures)
Introduction, Research centres, Concept of centres of origin, their importance with reference to Vavilov's work
- Unit 2: Cereals** (6 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)
- 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 *Cathranthus* (3 Lectures)
- Unit 9: Introduction to Biotechnology** (10 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.

Unit 10: Biotechnological Techniques

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.

(18 Lectures)

Practical (BOTA 501PR)

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 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

1. Kochhar, S.L. (2011). Economic Botany in the Tropics, MacMillan Publishers India Ltd., New Delhi. 4th edition.
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 Botany

Analytical Techniques in Plant Sciences (BOTA 502 TH) (Credits: Theory-4, Practicals-2)

THEORY

Lectures: 60

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.

Unit 2: Cell fractionation (8 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. (4 Lectures)

Unit 4: Spectrophotometry

Principle and its application in biological research. (4 Lectures)

Unit 5: Chromatography (8 Lectures)

Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ion-exchange 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 502 PR)

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

Research Methodology (BOTA 503 TH) (Credits: Theory-4, Practicals-2)

THEORY Lectures: 60

Unit 1: Basic concepts of research (10 Lectures)

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: General laboratory practices (12 Lectures)

Common calculations in botany laboratories. Understanding the details on the label of reagent bottles. Molarity and normality of common acids and bases. Preparation of solutions. Dilutions. Percentage solutions. Molar, molal and normal solutions. Technique of handling micropipettes; Knowledge about common toxic chemicals and safety measures in their handling.

Unit 3: Data collection and documentation of observations (6 Lectures)

Maintaining a laboratory record; Tabulation and generation of graphs. Imaging of tissuespecimens and application of scale bars. The art of field photography.

Unit 4: Overview of Biological Problems (6 Lectures)

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 5: Methods to study plant cell/tissue structure (6 Lectures)

Whole mounts, peel mounts, squash preparations, clearing, maceration and sectioning; Tissue preparation: living vs fixed, physical vs chemical fixation, coagulating fixatives, non-coagulant fixatives; tissue dehydration using graded solvent series; Paraffin and plastic infiltration; Preparation of thin and ultrathin sections.

Unit 6: Plant microtechniques (12 Lectures)

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 7: The art of scientific writing and its presentation (8 Lectures)

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 (BOTA 503 PR)

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

1. Dawson, C. (2002). Practical research methods. UBS Publishers, New Delhi.
2. Stapleton, P., Yondeowei, A., Mukanyange, J., Houten, H. (1995). Scientific writing for agricultural research scientists – a training reference manual. West Africa Rice Development Association, Hong Kong.
3. Ruzin, S.E. (1999). Plant microtechnique and microscopy. Oxford University Press, New York, U.S.A.

Discipline Centric Elective Botany

Cell and Molecular Biology

(BOTA 601 TH)

(Credits: Theory-4, Practicals-2)

THEORY

Lectures: 60

Unit 1: Techniques in Biology

(8 Lectures)

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: 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.

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.

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.

DNA replication (Prokaryotes and eukaryotes): bidirectional replication, semi-conservative, semi discontinuous RNA priming, θ (theta) mode of replication, replication of linear, ds-DNA, replicating the 5' end of linear chromosome including replication enzymes.

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 601 PR)

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

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 Centric Elective Botany

Bioinformatics (BOTA 602 TH) (Credits: Theory-4, Practicals-2)

THEORY Lectures: 60

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.

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.

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.

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 602 PR)

11. Nucleic acid and protein databases.
12. Sequence retrieval from databases.
13. Sequence alignment.
14. Sequence homology and Gene annotation.
15. 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. Wiley-Blackwell.
3. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings.

Discipline Centric Elective Botany

Genetics and Plant Breeding (BOTA 603 TH) (Credits: Theory-4, Practical-2)

THEORY Lectures: 60

Unit 1: Heredity (20 Lectures)

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

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.

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.

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 603 PR)

1. Mendel's laws through seed ratios. Laboratory exercises in probability and chi-square.
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: 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

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 & Sons Inc., India. 5th 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 Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th 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. 7th edition.
7. Chaudhari, H.K. (1984). Elementary Principles of Plant Breeding. Oxford – IBH. 2nd edition.
8. Acquaah, G. (2007). Principles of Plant Genetics & Breeding. Blackwell Publishing.

Skill Enhancement Courses

Skill Enhancement Course

Biofertilizers

(BOTA 302)

(Credits 4; 3 Theory + 1 Tutorial)

Lectures: 45

Unit 1: General account about the microbes used as biofertilizer – *Rhizobium* – isolation, identification, mass multiplication, carrier based inoculants, Actinorrhizal symbiosis.

(6 Lectures)

Unit 2: *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. (12 Lectures)

Unit 3: 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 4: Mycorrhizal association, types of mycorrhizal association, taxonomy, occurrence and distribution, phosphorus nutrition, growth and yield – colonization of VAM – isolation and inoculum production of VAM, and its influence on growth and yield of crop plants.

(12 Lectures)

Unit 5: Organic farming – Green manuring and organic fertilizers, Recycling of bio-degradable municipal, agricultural and Industrial wastes – biocompost making methods, types and method of vermicomposting – field Application. (9 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. Vayas, S.C, Vayas, S. and Modi, H.A. 1998 Bio-fertilizers and organic Farming Akta Prakashan, Nadiad

Skill Enhancement Course

Herbal Technology

(BOTA 303)

(Credits 4; 3 Theory + 1 Tutorial)

Lectures: 45

Unit 1: Herbal medicines: history and scope - definition of medical terms - role of medicinal plants in Siddha systems of medicine; cultivation - harvesting - processing - storage - marketing and utilization of medicinal plants. **(9 Lectures)**

Unit 2: Pharmacognosy - systematic position and medicinal uses of the following herbs in curing various ailments; Tulsi, Ginger, Fenugreek, Indian Goose berry and Ashoka. **(9 Lectures)**

Unit 3: 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). **(9 Lectures)**

Unit 4: 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) **(12 Lectures)**

Unit 5: Medicinal plant banks micro propagation of important species (*Withania somnifera*, neem and tulsi- Herbal foods-future of pharmacognosy) **(6 Lectures)**

Suggested Readings

1. Glossary of Indian medicinal plants, R.N.Chopra, S.L.Nayar and I.C.Chopra, 1956. C.S.I.R, New Delhi.
2. The indigenous drugs of India, Kanny, Lall, Dey and Raj Bahadur, 1984. International Book Distributors.
3. Herbal plants and Drugs Agnes Arber, 1999. Mangal Deep Publications.
4. Ayurvedic drugs and their plant source. V.V. Sivarajan and Balachandran Indra 1994. Oxford IBH publishing Co.
5. Ayurveda and Aromatherapy. Miller, Light and Miller, Bryan, 1998. Banarsidass, Delhi.
6. Principles of Ayurveda, Anne Green, 2000. Thomsons, London.
7. Pharmacognosy, Dr.C.K.Kokate et al. 1999. Nirali Prakashan.

Skill Enhancement Course
Nursery and Gardening
(BOTA 402)
(Credits 4; 3 Theory + 1 Tutorial)

Lectures: 45

Unit 1: Nursery: definition, objectives and scope and building up of infrastructure for nursery, planning and seasonal activities - Planting - direct seeding and transplants. **(8 Lectures)**

Unit 2: 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. **(9 Lectures)**

Unit 3:Vegetative propagation: air-layering, cutting, selection of cutting, collecting season, treatment of cutting, rooting medium and planting of cuttings - Hardening of plants - green house - mist chamber, shed root, shade house and glass house. **(9Lectures)**

Unit 4: 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. **(12 Lectures)**

Unit 5: 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 **(9 Lectures)**

Suggested Readings

1. Bose T.K. & Mukherjee, D., 1972, Gardening in India, Oxford & IBH Publishing Co., New Delhi.
2. Sandhu, M.K., 1989, Plant Propagation, Wile Eastern Ltd., Bangalore, Madras.
3. Kumar, N., 1997, Introduction to Horticulture, Rajalakshmi Publications, Nagercoil.
4. Edmond Musser & Andres, Fundamentals of Horticulture, McGraw Hill Book Co., New Delhi.
5. Agrawal, P.K. 1993, Hand Book of Seed Technology, Dept. of Agriculture and Cooperation, National Seed Corporation Ltd., New Delhi.
6. Janick Jules. 1979. Horticultural Science. (3rd Ed.), W.H. Freeman and Co., San Francisco, USA.

Skill Enhancement Course
Floriculture
(BOTA 403)

(Credits 4; 3 Theory + 1 Tutorial)

Lectures: 45

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

Unit 2: 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.

(8 Lectures)

Unit 3: 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. **(14 Lectures)**

Unit 4: 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. **(6 Lectures)**

Unit 5: Landscaping Places of Public Importance: Landscaping highways and Educational institutions. **(4 Lectures)**

Unit 6: 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). **(8 Lectures)**

Unit 7: Diseases and Pests of Ornamental Plants. **(3 Lectures)**

Suggested Readings

1. Randhawa, G.S. and Mukhopadhyay, A. 1986. Floriculture in India. Allied Publishers.

Skill Enhancement Course

Medicinal Botany

(BOTA 504)

(Credits 4; 3 Theory + 1 Tutorial)

Lectures: 45

Unit 1: History, Scope and Importance of Medicinal Plants. Indigenous Medicinal Sciences; Definition and Scope-Ayurveda: History, origin, panchamahabhutas, saptadhatu and tridosha concepts, Rasayana, plants used in ayurvedic treatments, Siddha: Origin of Siddha medicinal systems, Basis of Siddha system, plants used in Siddha medicine. Unani: History, concept: Umoor-e- tabiya, tumors treatments/ therapy, polyherbal formulations. **(15 Lectures)**

Unit 2: 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. 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. **(15 Lectures)**

Unit 3: 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. **(15 Lectures)**

Suggested Readings

1. Trivedi P C, 2006. Medicinal Plants: Ethnobotanical Approach, Agrobios, India.
2. Purohit and Vyas, 2008. Medicinal Plant Cultivation: A Scientific Approach, 2nd edn. Agrobios, India.

Skill Enhancement Course

Ethnobotany (BOTA 505) (Credits 4; 3 Theory + 1 Tutorial Lectures: 45

Unit 1: 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. **(9 Lectures)**

Unit 2: Methodology of Ethnobotanical studies

a) Field work b) Herbarium c) Ancient Literature d) Archaeological findings e) temples and sacred places. **(9 Lectures)**

Unit 3: 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) *Azadirachta 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 *Rauwolfia serpentina*, *Trichopus zeylanicus*, *Artemisia*, *Withania*.

Role of ethnic groups in conservation of plant genetic resources. Endangered taxa and forest management (participatory forest management). **(15 Lectures)**

Unit 4: 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. **(12 Lectures)**

Suggested Readings

- 1) S.K. Jain, Manual of Ethnobotany, Scientific Publishers, Jodhpur, 1995.
- 2) S.K. Jain (ed.) Glimpses of Indian. Ethnobotny, Oxford and I B H, New Delhi – 1981
- 3) Lone et al., Palaeoethnobotany
- 4) S.K. Jain (ed.) 1989. Methods and approaches in ethnobotany. Society of ethnobotanists, Lucknow, India.
- 5) S.K. Jain, 1990. Contributions of Indian ethnobotny. Scientific publishers, Jodhpur.
- 6) Colton C.M. 1997. Ethnobotany – Principles and applications. John Wiley and sons – Chichester
- 7) Rama Ro, N and A.N. Henry (1996). The Ethnobotany of Eastern Ghats in Andhra Pradesh, India. Botanical Survey of India. Howrah. 8) Rajiv K. Sinha – Ethnobotany The Renaissance of Traditional Herbal Medicine – INA –SHREE Publishers, Jaipur-1996 9)

Skill Enhancement Course
Plant Diversity and Human Welfare
(BOTA 604)
(Credits 4; 3 Theory + 1 Tutorial)

Lectures: 45

Unit 1: Plant diversity and its scope- Genetic diversity, Species diversity, Plant diversity at the ecosystem level, Agrobiodiversity and cultivated plant taxa, wild taxa. Values and uses of Biodiversity: Ethical and aesthetic values, Precautionary principle, Methodologies for valuation, Uses of plants, Uses of microbes. **(12 Lectures)**

Unit 2: Loss of Biodiversity: Loss of genetic diversity, Loss of species diversity, Loss of ecosystem diversity, Loss of agrobiodiversity, Projected scenario for biodiversity loss, **Management of Plant Biodiversity:** Organizations associated with biodiversity management-Methodology for execution-IUCN, UNEP, UNESCO, WWF, NBPGR; Biodiversity legislation and conservations, Biodiversity information management and communication. **(12 Lectures)**

Unit 3: 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. **(12 Lectures)**

Unit 4: Role of plants in relation to Human Welfare; a) Importance of forestry their utilization and commercial aspects b) Avenue trees, c) Ornamental plants of India. d) Alcoholic beverages through ages. Fruits and nuts: Important fruit crops their commercial importance. Wood and its uses. **(9 Lectures)**

Suggested Readings

1. Krishnamurthy, K.V. (2004). An Advanced Text Book of Biodiversity - Principles and Practices. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi

Skill Enhancement Course
Mushroom Cultivation Technology
(BOTA 605)
(Credits 4; 3 Theory + 1 Tutorial)

Lectures: 45

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. **(5 Lectures)**

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)**

Unit 3: Cultivation practices of *Agaricus bisporus*, *Pleurotus* sp. and *Volvariella 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)**

Unit 4: Storage : Short-term storage (Refrigeration - upto 24 hours) Long term Storage (canning, pickels, papads), drying, storage in salt solutions. **(6 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 **(5 Lectures)**

Unit: 6 Diseases and pests of mushrooms **(5 Lectures)**

Suggested Readings

1. Marimuthu, T. Krishnamoorthy, A.S. Sivaprakasam, K. and Jayarajan. R (1991) Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.
2. Swaminathan, M. (1990) Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore - 560018.
3. Tewari, Pankaj Kapoor, S.C., (1988). Mushroom cultivation, Mittal Publications, Delhi.
4. Nita Bahl (1984-1988) Hand book of Mushrooms, II Edition, Vol. I & Vol. II.

Skill Enhancement Course

Intellectual Property Rights

(BOTA 606)

(Credits 4; 3 Theory + 1 Tutorial)

Lectures: 45

Unit 1: Introduction to intellectual property right (IPR) (3 lectures)

Concept and kinds. Economic importance. IPR in India and world: Genesis and scope, some important examples. IPR and WTO (TRIPS, WIPO).

Unit 2 : Patents (5 Lectures)

Objectives, Rights, Patent Act 1970 and its amendments. Procedure of obtaining patents, Working of patents. Infringement.

Unit 3: Copyrights (4 Lectures)

Introduction, Works protected under copyright law, Rights, Transfer of Copyright, Infringement.

Unit4: Trademarks (5 Lectures)

Objectives, Types, Rights, Protection of goodwill, Infringement, Passing off, Defences, Domain name.

Unit 5: Geographical Indications (4 Lectures)

Objectives, Justification, International Position, Multilateral Treaties, National Level, Indian Position.

Unit 6: Protection of Traditional Knowledge (6 Lectures)

Objective, Concept of Traditional Knowledge, Holders, Issues concerning, Bio-Prospecting and Bio-Piracy, Alternative ways, Protectability, need for a Sui-Generis regime, Traditional Knowledge on the International Arena, at WTO, at National level, Traditional Knowledge Digital Library.

Unit 7: Industrial Designs (3 Lectures)

Objectives, Rights, Assignments, Infringements, Defences of Design Infringement

Unit 8: Protection of Plant Varieties (3 Lectures)

Plant Varieties Protection-Objectives, Justification, International Position, Plant varieties

protection in India. Rights of farmers, Breeders and Researchers. National gene bank, Benefit sharing. Protection of Plant Varieties and Farmers' Rights Act, 2001.

Unit 9: Information Technology Related Intellectual Property Rights (6 Lectures)

Computer Software and Intellectual Property, Database and Data Protection, Protection of Semi-conductor chips, Domain Name Protection

Unit 10: Biotechnology and Intellectual Property Rights. (6 Lectures)

Patenting Biotech Inventions: Objective, Applications, Concept of Novelty, Concept of inventive step, Microorganisms, Moral Issues in Patenting Biotechnological inventions.

Suggested Readings

1. N.K. Acharya: Textbook on intellectual property rights, Asia Law House (2001).
2. Manjula Guru & M.B. Rao, Understanding Trips: Managing Knowledge in Developing Countries, Sage Publications (2003).
3. P. Ganguli, Intellectual Property Rights: Unleashing the Knowledge Economy, Tata McGraw-Hill (2001).
4. Arthur Raphael Miller, Micheal H. Davis; Intellectual Property: Patents, Trademarks and Copyright in a Nutshell, West Group Publishers (2000).
5. Jayashree Watal, Intellectual property rights in the WTO and developing countries, Oxford University Press, Oxford.

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

Theory Paper + Practical + Internal Assessment **(50+30+ 20) =100 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	30 marks	Time 3 hrs
Internal Assessment	20 Marks	

Skill Enhancement Course & Ability Enhancement Compulsory Course:

Theory Paper End Semester Examination	100 marks
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