



UNIVERSITY

OF

KALYANI

**SYLLABUS
&
STRUCTURE**

for

Three Years Under Graduate
(UG) General Course of
B.Sc. with Botany

under

**CHOICE BASED
CREDIT SYSTEM
(CBCS)**

*Effective from the academic session
2018-19*

Type of courses to be offered

- *Core (CC)*
 - *Discipline Specific Elective (DSE)*
 - *Skill Enhancement (SEC)*
 - *Ability Enhancement Core (AECC)*
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PREAMBLE

The University Grants Commission (UGC) has taken various measures by means of formulating regulations and guidelines and updating them, in order to improve the higher education system and maintain minimum standards and quality across the higher educational institutions in India. The various steps that the UGC has initiated are all targeted towards bringing equity, efficiency and excellence in the higher education system of country. These steps include introduction of innovation and improvements in curriculum structure and content, the teaching-learning process, the examination and evaluation systems, along with governance and other matters. The introduction of Choice Based Credit System (CBCS) is one such attempt towards improvement and bringing in uniformity of system with diversity of courses across all higher education institutes in the country. The CBCS provides an opportunity for the students to choose courses from the prescribed courses comprising of core, elective, skill enhancement and ability enhancement courses. The courses shall be evaluated following the grading system, is considered to be better than conventional Points system. This will make it possible for the students to move across institutions within India to begin with and across countries for studying courses of their choice. The uniform grading system shall also prove to be helpful in assessment of the performance of the candidates in the context of employment.

TOTAL NUMBER OF COURSES

Type of course	Core Course (CC)	Discipline Specific Elective Course (DSE)	Ability Enhancement Course		TOTAL
			Ability Enhancement compulsory course (AECC)	Skill Enhancement course (SEC)	
No. of course	12	6	2	4	24
Credit/course	6	6	2	2	120

DETAIL OF COURSES

Sl. No.	Particulars of Course	Credit Point Theory + Practical
1.	Core Course: 12 Papers	
1. A.	Core Course: (Theory)*(12 papers)	4x12 = 48
1. B.	Core Course: (Practical)*(12 papers)	2x12 = 24

Sl. No.	Particulars of Course	Credit Point Theory + Practical
2.	Elective Courses: (6 papers)	
2. A.	DSE: (Theory)*(6 papers)	4x6 = 24
2. B.	DSE: (Practical)*(6 papers)	2x6 = 12
3.	Ability Enhancement Courses	
3. A.	Ability Enhancement compulsory course (AECC): (Theory)*(2 papers) (2 papers of 2 credits each)	2x2 = 4
3. B.	Skill Enhancement Course (SEC): (Theory)*(4 papers) (4 papers of 2 credits each)	2x4 = 8
Total Credit:		120

DESCRIPTION OF COURSE TYPES INTRODUCED IN CBCS CURRICULUM

- **Core Course (CC):** A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.
- **Discipline Specific Elective Course (DSE):** Generally a course which can 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 student's proficiency/skill is termed as an Elective Course and if the Elective courses that are offered by the main discipline/subject of study are referred to as Discipline Specific Elective.
- **Skill Enhancement Course (SEC):** These courses may be chosen from a pool of courses designed to provide value-based and/or skill-based instruction.
- **Ability Enhancement Compulsory Course (AECC):** Ability enhancement courses are the courses based upon the content that leads to Knowledge enhancement. They [(i) Environmental Science, (ii) English Communication] are mandatory for all disciplines.

SEMESTER-WISE DISTRIBUTION OF COURSES & CREDITS

Courses/ (Credits)	Semesters						Total No. of Course	Total Credit
	Sem-I	Sem-II	Sem-III	Sem-IV	Sem-V	Sem-VI		
CC-1, 2, 3 (6)	3 (1A,2A,3A)	3 (1B,2B,3B)	3 (1C,2C, 3C)	3 (1D,2D, 3D)	-	-	12	72
DSE - 1, 2, 3 (6)	-	-	-	-	3 (1A,2A,3A)	3 (1B,2B,3B)	6	36
AECC (2)	1	1	-	-	-	-	2	04
SEC (2)	-	-	1	1	1	1	4	08
Total No. of Courses/ Semester	4	4	4	4	4	4	24	-
Total Credits /Semester	20	20	20	20	20	20	-	120

STRUCTURE OF CURRICULUM

Core Courses (CC): 12 compulsory courses – 04 courses from each of the 03 disciplines of choice- to be taken in Semesters I, II, III, IV (*three in each semester*)

Semester I

- 1A: Biodiversity of Microbes, Algae, Fungi and Archegoniate
2A & 3A: from other disciplines

Semester II

- 1B: Plant Ecology, Morphology and Taxonomy
2B & 3B: from other disciplines

Semester III

- 1C: Plant Cell, Anatomy and Embryology
2C & 3C: from other disciplines

Semester IV

- 1D: Plant Physiology and Metabolism
2D & 3D: from other disciplines

Discipline Specific Elective Courses (DSE): 6 out of 12 courses offered– to be taken in Semesters V and VI (*Any one out of two courses offered in each three disciplines in each semester*)

Semester V

- 1A: Analytical Techniques in Plant Sciences

OR

- 1A: Industrial and Environmental Microbiology
2A & 3A: from other disciplines

Semester VI

- 1B: Biodiversity and Conservation

OR

- 1B: Genetics and Biotechnology
2B & 3B: from other disciplines

Ability Enhancement Compulsory Courses (AECC): 2 compulsory courses – to be taken in Semesters I and II (one in each semester)

Semester I

English Communication

Semester II

Environmental Science

Skill Enhancement Courses (SEC): 4 out of 8 courses offered – to be taken in Semesters III, IV, V and VI (Any one out of two courses offered in each semester)

Semester III

1. Biofertilizers

OR

1. Plant Diversity and Human Welfare

Semester IV

2. Medicinal Botany

OR

2. Mushroom Culture

Semester V

3. Herbal Technology

OR

3. Floriculture

Semester VI

4. Ethnobotany

OR

4. Intellectual Property Rights

SEMESTER- & COURSE-WISE CREDIT DISTRIBUTION

(6 Credits: 75 Points; L: Lecture; P: Practical)

Course Code	Course Title	Course wise Class (L+P)	Credit	Page No.
SEMESTER-I				
UG-BOT-G-CC-T-01	Biodiversity of Microbes, Algae, Fungi and Archegoniate	Core (60L+60P)	6 (4T+2P)	7-8
UG-BOT-G-CC-P-01				8-9
<i>from other discipline</i>	<i>from other discipline</i>	Core	6	---
<i>from other discipline</i>	<i>from other discipline</i>	Core	6	---
AECC-01	English Communication/ Environmental Science	AECC (30L)	2	---
Total	4 courses	210L+180P	20	7-9
SEMESTER-II				
UG-BOT-G-CC-T-02	Plant Ecology, Morphology and Taxonomy	Core (60L+60P)	6 (4T+2P)	10-11
UG-BOT-G-CC-P-02				11-12
<i>from other discipline</i>	<i>from other discipline</i>	Core	6	---
<i>from other discipline</i>	<i>from other discipline</i>	Core	6	---
AECC-02	English Communication / Environmental Science	AECC (30L)	2	---
Total	4 courses	210L+180P	20	10-12

Course Code	Course Title	Course wise Class (L+P)	Credit	Page No.
SEMESTER-III				
UG -BOT-G-CC-T-03	Plant Cell, Anatomy and Embryology	Core (60L+60P)	6 (4T+2P)	13-14
UG -BOT-G-CC-P-03				14
<i>from other discipline</i>	<i>from other discipline</i>	Core	6	---
<i>from other discipline</i>	<i>from other discipline</i>	Core	6	---
UG-BOT-G-SEC-T-01	A. Biofertilizers OR B. Plant Diversity and Human Welfare	SEC (30L)	2	15-16
Total	4 courses	210L+180P	20	13-16
SEMESTER-IV				
UG -BOT-G-CC-T-04	Plant Physiology and Metabolism	Core (60L+60P)	6 (4T+2P)	17
UG -BOT-G-CC-P-04				18
<i>from other discipline</i>	<i>from other discipline</i>	Core	6	---
<i>from other discipline</i>	<i>from other discipline</i>	Core	6	---
UG-BOT-G-SEC-T-02	A. Medicinal Botany OR B. Mushroom Culture	SEC (30L)	2	18-20
Total	4 courses	210L+180P	20	17-20
SEMESTER-V				
UG-BOT-G-DSE-T-01	A. Analytical Techniques in Plant Sciences OR B. Industrial and Environmental Microbiology	DSE (60L+60P)	6 (4T+2P)	21-23
UG-BOT-G-DSE-P-01				22-23
<i>from other discipline</i>	<i>from other discipline</i>	DSE	6	---
<i>from other discipline</i>	<i>from other discipline</i>	DSE	6	---
UG-BOT-G-SEC-T-03	A. Herbal Technology OR B. Floriculture	SEC (30L)	2	24-25
Total	4 courses	210L+180P	20	21-25
SEMESTER-VI				
UG—BOT-G-DSE-T-02	A. Biodiversity and Conservation OR B. Genetics and Biotechnology	DSE (60L+60P)	6 (4T+2P)	26-28
UG—BOT-G-DSE-P-02				27-28
<i>from other discipline</i>	<i>from other discipline</i>	DSE	6	---
<i>from other discipline</i>	<i>from other discipline</i>	DSE	6	---
UG -BOT-G-SEC-T-04	A. Ethnobotany OR B. Intellectual Property Rights	SEC (30L)	2	29-31
Total	4 courses	210L+180P	24	26-31
Total (All semesters)	24 courses	1260L+1080P	120	7-31

SEMESTER-I

Course: UG-BOT-G-CC-T-01 (Theory) & UG-BOT-G-CC-P-01 (Practical)
Course Title: Biodiversity of Microbes, Algae, Fungi and Archegoniate; **Core Course;**
Credit: 6 [4 (Theory) + 2 (Practical)]; **Full Points:** 75 [50 (Theory) + 25 (Practical)]

COURSE OBJECTIVES:

After completion of the course the learners will be able to:

- describe general characteristics of viruses, bacteria, algae, fungi and archegoniate with special reference to their classification, morphology, reproduction, distribution and ecology.
- explain their role in environment, human welfare and industrial applications.
- apply this knowledge in understanding the evolutionary significance of these organisms.

COURSE CONTENT (THEORY): UG-BOT-G-CC-T-01**Unit 1: Microbes****(10)**

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)**

General characteristics; Ecology and distribution; Range of thallus organization and reproduction; Classification of algae by Fritsch (1935); Morphology and life-cycles of the following: *Nostoc*, *Chlamydomonas*, *Oedogonium*, *Vaucheria*, *Fucus*, *Polysiphonia*; Economic importance of algae.

Unit 3: Fungi**(12)**

Introduction- General characteristics, ecology and significance, range of thallus organization, cell wall composition, nutrition, reproduction and classification (Alexopoulos, Mims, and Blackwell 1996); True Fungi- General characteristics, ecology and significance, life cycle of *Rhizopus* (Zygomycota) *Talaromyces* (*Penicillium*: Ascomycota), *Puccinia*, *Agaricus* (Basidiomycota); Symbiotic associations- Lichens: Genera account, reproduction and significance; Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance.

Unit 4: Introduction to Archegoniate**(2)**

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

Unit 5: Bryophytes**(10)**

General characteristics; adaptations to land habit; range of thallus organization; classification following Smith G. M. (1955); 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)**

General characteristics; Classification of vascular plants by Gifford and Foster (1989) with diagnostic features and examples (from division Rhyniophyta to Filicophyta);

Early land plants (*Cooksonia* and *Rhynia*); Systematic position, morphology, anatomy and reproduction of *Lycopodium*, *Selaginella*, *Equisetum* and *Pteris* (developmental details not to be included); Heterospory and seed habit, Stellar evolution; Ecological and economical importance.

Unit 7: Gymnosperms

(6)

General characteristics; Classification of vascular plants by Gifford and Foster (1989) with diagnostic features and examples (from division Pteridospermophyta to Gnetophyta); Systematic position, morphology, anatomy and reproduction of *Cycas* and *Pinus* (developmental details not to be included); Ecological and economical importance.

COURSE CONTENT (PRACTICAL): UG-BOT-G-CC-P-01

1. EMs/Models of viruses – T-Phage and TMV, Line drawing/Photograph of Lytic and Lysogenic Cycle.
2. Types of Bacteria from temporary/permanent slides/photographs; EM bacterium; Binary Fission; Conjugation; Structure of root nodule.
3. Gram staining.
4. Study of vegetative and reproductive structures of *Nostoc*, *Oedogonium*, *Vaucheria*, and *Polysiphonia* through temporary preparations; *Chlamydomonas* and *Fucus* through permanent slides and preserved specimens.
5. *Rhizopus* and *Penicillium*: Asexual stage from temporary mounts and sexual structures through permanent slides.
6. *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.
7. *Agaricus*: Specimens of button stage and full-grown mushroom; Sectioning of gills of *Agaricus*.
8. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose).
9. Mycorrhiza: ecto mycorrhiza and endo mycorrhiza (Photographs).
10. *Marchantia*- morphology of thallus, whole mount (WM) of rhizoids and scales, vertical section (VS) of thallus through gemma cup, WM of gemmae (all temporary slides), VS of antheridiophore, archegoniophore, longitudinal section (LS) of sporophyte (all permanent slides).
11. *Funaria*- morphology, WM of leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, LS of capsule and protonema.
12. *Lycopodium*- morphology, transverse section (TS) of stem, WM of strobilus, (temporary slides), LS of strobilus (permanent slide).
13. *Selaginella*- morphology, WM of leaf with ligule, TS of stem, WM of strobilus, WM of microsporophyll and megasporophyll (temporary slides), LS of strobilus (permanent slide).
14. *Equisetum*- morphology, TS of internode, LS of strobilus, TS of strobilus, WM of sporangiophore, WM of spores (temporary slides); TS of rhizome (permanent slide).
15. *Pteris*- morphology, TS of rachis, VS of sporophyll, WM of sporangium, WM of spores (temporary slides), TS of rhizome, WM of prothallus with sex organs and young sporophyte (permanent slides).

SUGGESTED READINGS/REFERENCES:

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. Tortora G.J., Funke B.R., Case C.L. (2010). Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A. 10th edition.
8. Vashishta P.C., Sinha A.K., Kumar A. (2006). Pteridophyta, S. Chand. Delhi, India.

Course: AECC-01

Course Title: English Communication/Environmental Science

Ability Enhancement Core Course; Credit: 2; Full Points: 50

SEMESTER-II

Course: UG-BOT-G-CC-T-02 (Theory) & UG-BOT-G-CC-P-02 (Practical)
Course Title: Plant Ecology, Morphology and Taxonomy; **Core Course;**
Credit: 6 [4 (Theory) + 2 (Practical)]; **Full Points:** 75 [50 (Theory) + 25 (Practical)]

COURSE OBJECTIVES:

After completion of the course the learners will be able to:

- explain the concept of ecology and the influence of different environmental, climatic and physiographic and edaphic factors on plant life;
- comprehend the concept of phytogeography, describe botanical zones in India and explain endemism;
- describe the importance of biodiversity and relevance of conservation;
- apply morphological features in describing plants;
- discuss the essentials of plant taxonomy, explain taxonomic hierarchy and explain the classification system of Bentham and Hooker;
- explain the concepts of numerical taxonomy and cladistics.

COURSE CONTENT (THEORY): UG -BOT-G-CC-T-02

- Unit 1: Introduction** (2)
 Concept of Ecology
- Unit 2: Ecological factors** (5)
 Soil: Origin, formation, composition, soil profile. Water: States of water in the environment, precipitation types. Light and temperature. Adaptation of hydrophytes, halophytes and xerophytes.
- Unit 3: Plant communities** (6)
 Characters; Ecotone and edge effect; Succession; Processes and types.
- Unit 4: Ecosystem** (6)
 Structure; energy flow trophic organization; Food chains and food webs, ecological pyramids production and productivity; Tritrophic interactions (plant defense against herbivore) with reference to Volatile Organic Compounds (VOC) and other secondary compounds, Biogeochemical cycling; Cycling of carbon, nitrogen and phosphorous.
- Unit 5: Phytogeography** (4)
 Botanical zones in India (D. Chatterjee 1962); Present status; Endemism.
- Unit 6: Conservation of Biodiversity** (3)
 Level of Biodiversity: genetic, species and ecosystem diversity, Biodiversity hot spots-criteria, Indian hotspots, *in-situ and ex-situ* conservation, Ecological restoration, Geographic Information System and Remote Sensing (brief idea).
- Unit 7: Plant Morphology** (10)
 Variations in leaf morphology; phyllotaxy; types of inflorescence; morphology of flowers – types of flowers, modification of calyx, aestivation, floral formula and floral diagram, adhesion and cohesion of floral parts, placentation types; types of fruits and seeds.

- Unit 8: Introduction to plant taxonomy** (2)
Identification, Classification, Nomenclature.
- Unit 9: Identification** (4)
Functions of Herbarium, important herbaria and botanical gardens of the World and India; Documentation: Flora, Keys: single access and multi-access
- Unit 10: Taxonomic hierarchy** (2)
Ranks, categories and taxonomic groups
- Unit 11: Botanical nomenclature** (4)
Principles and rules (ICN); ranks and names; binominal system, typification, author citation, valid publication, rejection of names, principle of priority and its limitations (with examples).
- Unit 12: Classification** (2)
Types of classification - artificial, natural and phylogenetic. Outline of Bentham and Hooker (up to series) classification with merits and demerits.
- Unit 13: Numerical taxonomy and cladistics (brief idea)** (2)
- Unit 14: Salient features, Systematic position (Bentham & Hooker), economically important plants of the following families** (8)
Monocotyledon: Liliaceae; Arecaceae; Poaceae; Orchidaceae
Dicotyledon: Brassicaceae; Leguminosae (Papilionoidae and Caesalpinioideae); Malvaceae; Solanaceae; Lamiaceae; Cucurbitaceae; Euphorbiaceae; Asteraceae

COURSE CONTENT (PRACTICAL): UG-BOT-G-CC-P-02

1. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter.
2. Comparison of bulk density, porosity and rate of infiltration of water in soil of two habitats.
3. Study of morphological adaptations of hydrophytes, halophytes and xerophytes (four each).
4. Study of biotic interactions of the following: Stem parasite (*Cuscuta*), Root parasite (*Orobancha*)- illustration only, Epiphytes, Predation (Insectivorous plants)- illustration only.
5. Determination of minimal quadrat size for the study of herbaceous vegetation in any suitable area by species area curve method (species to be listed).
6. Quantitative analysis of herbaceous vegetation in any suitable habitat for frequency distribution and comparison with Raunkiaer's frequency distribution law.
7. Study of vegetative and floral characters of the following families of the available genera distributed locally according to Bentham and Hooker's system of classification:
 - a. Monocotyledon: Poaceae
 - b. Dicotyledon: Brassicaceae; Leguminosae (Papilionoidae and Caesalpinioideae); Malvaceae; Solanaceae; Lamiaceae; Euphorbiaceae, Asteraceae
8. Spot identification (Binomial, Family) of common wild plants from families included in theory syllabus.
9. Field visits (2 local) and submission of properly preserved herbarium specimens of at least 15 common wild plants with herbarium label, proper field record and field

notes. The herbarium specimens should be submitted during end term examination and to be arranged following Bentham and Hooker's system of classification.

SUGGESTED READINGS/REFERENCES:

1. Gurevitch J. Scheiner Samuel M. and Fox Gordon A. (2006). The Ecology of Plants. Sinauer Associates, USA.
2. Kormondy E.J. (1996). Concepts of Ecology. Prentice Hall, U.S.A. 4th edition.
3. Prain D. (1905). Bengal Plants I and II. Bishen Singh Mahendra Pal Singh, Dehradun, India.
4. Rao R.R. (1994). Biodiversity in India Floristic Aspects. Bishen Singh Mahendra Pal Singh, Dehradun, India.
5. Sharma P.D. (2010). Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.
6. Simpson M.G. (2006). Plant Systematics. Elsevier Academic Press, San Diego, CA, U.S.A.
7. Singh G. (2012). Plant Systematics: Theory and Practice. Oxford & IBH Pvt. Ltd., New Delhi. 3rd edition.

Course: AECC-01

Course Title: English Communication/Environmental Science

Ability Enhancement Core Course; Credit: 2; Full Points: 50

SEMESTER-III**Course:** UG-BOT-G-CC-T-03 (Theory) & UG-BOT-G-CC-P-03 (Practical)**Course Title:** Plant Cell, Anatomy and Embryology; **Core Course;****Credit:** 6 [4 (Theory) + 2 (Practical)]; **Full Points:** 75 [50 (Theory) + 25 (Practical)]**COURSE OBJECTIVES:**

After completion of the course the learners will be able to:

- identify, describe and differentiate plant cells and cell organelles and their functions;
- apply plant anatomical features for correct identification;
- explain the developmental patterns of both vegetative and reproductive organs of plants;
- apply the knowledge gained in taxonomical studies and evolutionary biology and ontogeny studies;
- analyze and comprehend wood structure.
- apply knowledge about embryological characters in explaining plant reproductive biology.

COURSE CONTENT (THEORY): UG -BOT-G-CC-T-03**Plant Cell****Unit 1: Cell as a unit of life (2)**

The cell theory, Prokaryotic and Eukaryotic cells.

Unit 2: Cell organelles (8)

Membrane bound: Mitochondrion (structure, semiautonomous nature, mitochondrial DNA); Chloroplast (structure, semiautonomous nature, chloroplast DNA); Endoplasmic Reticulum (E.R.), Golgi body, Lysosome (structure and role); Peroxisome and Glyoxysome (structure, composition and function), Nucleus; Non-membrane bound: Ribosome (brief structure and function).

Unit 3: Cell membrane and Cell wall (4)

Structure and function of membrane, fluidity of membrane; Cell wall-structure and function (in brief).

Unit 4: Cell cycle (2)

Overview of cell cycle, Mitosis and Meiosis.

Unit 5: Genetic material and protein synthesis (4)

DNA: structure, types, replication: protein synthesis (brief idea).

Anatomy**Unit 6: Meristematic tissues, permanent tissues and organs (8)**

Root and shoot apical meristems; simple and complex tissues; structure of dicot and monocot root, stem and leaf.

Unit 7: Secondary growth, adaptive and protective systems (8)

Vascular cambium – structure and functions, seasonal activities, secondary growth in root and stem; wood (heartwood and sapwood).

Embryology**Unit 8: Structural organization of flower (8)**

Structure of anther and pollen grains; structure and type of ovules; type of embryo sacs, organization and ultra-structure of mature embryo sac.

Unit 9: Pollination and fertilization (6)

Pollination mechanisms and adaptations; double fertilization; structure of typical monocotyledonous and dicotyledonous seeds.

Unit 10: Embryo and endosperm (6)

Endosperm types, structure and functions; dicot and monocot embryo; embryo – endosperm relationship.

Unit 11: Apomixis and polyembryony (4)

Definition, types and practical applications.

COURSE CONTENT (PRACTICAL): UG -BOT-G-CC-P-03**Plant Cell**

1. Study of prokaryotic cells (bacterial), viruses, eukaryotic cells with the help of light and electron micrographs.
2. Study of the photomicrographs of cell organelles.
3. Study of the structure of plant cells through temporary mounts.
4. Study of mitosis and meiosis (temporary mounts and permanent slides).
5. Study of plasmolysis and deplasmolysis on *Rhoeo* leaf.
6. Measurement of cell size (either length or breadth/diameter) by micrometry.

Anatomy

7. Study of meristems through permanent slides and photographs.
8. Tissues (parenchyma, collenchyma and sclerenchyma); Macerated xylary elements, Phloem (permanent slides, photographs).
9. Stem: Monocot (*Zea mays*); Dicot (*Helianthus*); Secondary: *Helianthus* (only permanent slides).
10. Root: Monocot (*Zea mays*); Dicot (*Helianthus*); Secondary: *Helianthus* (only permanent slides).
11. Leaf: Dicot and Monocot leaf (only permanent slides).

Embryology

12. Structure of young and mature anther (permanent slides).
13. Types of ovules: anatropous, orthotropous, circinotropous, amphitropous, campylotropous (from permanent slides).
14. Female gametophyte: *Polygonum* (monosporic), type of embryo sac development (permanent slides/photographs).
15. Dissection of embryo/endosperm from developing seeds.
16. Determination of germination percentage of pollen grains.

SUGGESTED READINGS/REFERENCES:

1. Bhojwani S.S. and Bhatnagar S.P. (2011). Embryology of Angiosperms. Vikas Publication House Pvt. Ltd., New Delhi, 5th edition.
2. Karp G. (2010). Cell and Molecular Biology. Concepts and Experiments, 6th. Edition, John Wiley and Sons Inc.
3. Mauseth J.D. (1988). Plant Anatomy. The Benjamin and Cummings Publisher, USA.
4. Pandey B.P. (2001). Plant Anatomy. S. Chand and Company Ltd., New Delhi.

Course: UG-BOT-G-SEC-T-01 (Theory)
Course Title: A. Biofertilizers; **Skill Enhancement Course;**
Credit: 2; **Full Points:** 50

COURSE OBJECTIVES:

After completion of the course the learners will be able to:

- elucidate different types of fertilizers using biological organisms;
- apply the knowledge gained in utilization of biofertilizers in organic farming.

COURSE CONTENT (THEORY): UG -BOT-G-SEC-T-01**Unit 1: (4)**

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

Unit 2: (8)

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

Unit 3: (4)

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

Unit 4: (8)

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

Unit 5: (6)

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.

SUGGESTED READINGS/REFERENCES:

1. Dubey R.C. (2005). A Text book of Biotechnology S. Chand and 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 and IBH Publishers, New Delhi.
6. Vayas S.C, Vayas S. and Modi H.A. (1998). Bio-fertilizers and organic Farming, Akta Prakashan, Nadiad.

Course: UG-BOT-G-SEC-T-01 (Theory)

Course Title: B. Plant Diversity and Human Welfare; **Skill Enhancement Course;**

Credit: 2; **Full Points:** 50

COURSE OBJECTIVES:

After completion of the course the learners will be able to:

- explain the concept and value of biodiversity, threats to biodiversity, need for conservation and environmental stewardship;
- apply and implement conservation strategies for biodiversity management.

COURSE CONTENT (THEORY): UG -BOT-G-SEC-T-01

Unit 1: Plant diversity and its scope (8)

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.

Unit 2: Loss of Biodiversity and its management (8)

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.

Unit 3: Conservation of Biodiversity (8)

Conservation of genetic diversity, species diversity and ecosystem diversity, *in situ* and *ex situ* conservation, social approaches to conservation, Biodiversity awareness programmes, Sustainable development.

Unit 4: Role of plants in relation to Human Welfare (6)

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 and their commercial importance; Wood and its uses.

SUGGESTED READINGS/REFERENCES:

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

SEMESTER-IV**Course:** UG-BOT-G-CC-T-04 (Theory) & UG-BOT-G-CC-P-04 (Practical)**Course Title:** Plant Physiology and Metabolism; **Core Course;****Credit:** 6 [4 (Theory) + 2 (Practical)]; **Full Points:** 75 [50 (Theory) + 25 (Practical)]**COURSE OBJECTIVES:**

After completion of the course the learners will be able to:

- explain plant water relations and elucidate mineral nutrients that plants require, how they are obtained, metabolized and transported;
- describe physiological details of photosynthesis and respiration in plants;
- describe enzymes, hormones, environmental responses and nitrogen metabolism required for plant growth and development.

COURSE CONTENT (THEORY): UG-BOT-G-CC-T-04

- Unit 1: Plant-water relations (8)**
Properties of water and its role in cells, Osmosis, Absorption of water by roots, Transpiration (mechanisms) and its significance.
- Unit 2: Mineral nutrition (8)**
Concept of Essential elements, macro and micronutrients; Physiological Role of essential elements; Movement of solutes through conducting tissues active and passive transport, carriers, channels and pumps.
- Unit 3: Translocation in phloem. (6)**
Concept of phloem, composition; Pressure flow model; Phloem loading and unloading, source – sink concept.
- Unit 4: Photosynthesis (12)**
Photosynthetic Pigments (chlorophyll a, b, xanthophyll, 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 (6)**
Aerobic and anaerobic respiration, Glycolysis and TCA cycle; Oxidative phosphorylation, ATP synthesis and its balance sheet. Oxidative Pentose Phosphate Pathway, significance.
- Unit 6: Enzymes (4)**
Structure and properties; Mechanism of enzyme catalysis, coenzymes, co-factors, effects of temperature and pH
- Unit 7: Nitrogen metabolism (4)**
Biological nitrogen fixation; Nitrate and ammonia assimilation.
- Unit 8: Plant growth regulators (6)**
Properties of plant growth regulators and function: auxins, gibberellins, cytokinins, ABA, ethylene.
- Unit 9: Plant response to light and temperature (6)**
Definition of Photoperiodism, types, (SDP, LDP, Day neutral plants); Phytochrome: structure and function of red and far red-light responses on photomorphogenesis; Vernalization.

COURSE CONTENT (PRACTICAL): UG-BOT-G-CC-P-04

1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. Effect of two environmental factors (light and humidity) on transpiration by excised twig.
3. Determination of stomatal index and stomatal frequency.
4. Effect of bicarbonate concentration on O₂ evolution in photosynthesis.
5. Comparison of the rate of respiration in different plant parts.
6. Separation of amino acids by paper chromatography.

Demonstration experiments

1. Effect of IAA on rooting.
2. Demonstration of suction due to transpiration.
3. Demonstration of R.Q. in germinating seeds.

SUGGESTED READINGS/REFERENCES:

1. Gangulee H.C., Das K.S., Dutta C. and Kar A.K. (2011). College Botany, Vol. I. New Central Book Agency, Kolkata, India.
2. Mitra, D, Guha, J. Chowdhuri, S.K. (2009). Studies in Botany, Vol. II. Moulik Library, Kolkata, India.
3. Mukherjee S. and Ghosh A.K. (2009). Plant Physiology (2nd Edition), New Central Book agency.
4. Taiz L., Zeiger E., Møller I.M. and Murphy A. (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.

Course: UG-BOT-G-SEC-T-02 (Theory)

Course Title: A. Medicinal Botany; **Skill Enhancement Course;**

Credit: 2; Full Points: 50

COURSE OBJECTIVES:

After completion of the course the learners will be able to:

- discuss the history, scope and importance of plants as sources of medicines;
- describe the methods for sustainable utilization of plant herbal resources;
- apply the knowledge gained in utilizing plants used as traditional/ folk medicines and strategies for their conservation.

COURSE CONTENT (THEORY): UG -BOT-G-SEC-T-02**Unit 1: History, Scope and Importance of Medicinal Plants (10)**

Indigenous Medicinal Sciences; Definition and Scope of 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.

Unit 2: Conservation of endangered and endemic medicinal plants (10)

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.

Unit 3: Ethnobotany and Folk medicines (10)

Definition; Ethnobotany in India: Methods to study ethnobotany; Applications of Ethnobotany: National interacts, Palaeo-ethnobotany; Ethnomedicine; Ethnoecology; Ethnic communities of India; Application of natural products to certain diseases- Jaundice, cardiac, infertility, diabetics, blood pressure and skin diseases.

SUGGESTED READINGS/REFERENCES:

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

Course: UG-BOT-G-SEC-T-02 (Theory)

Course Title: B. Mushroom Culture; **Skill Enhancement Course;**

Credit: 2; **Full Points:** 50

COURSE OBJECTIVES:

After completion of the course the learners will be able to:

- describe nutritional and medicinal values of edible mushrooms and their cultivation strategies;
- apply the knowledge gained in storage and food preparation.

COURSE CONTENT (THEORY): UG-BOT-G-SEC-T-02**Unit 1: Introduction (5)**

Introduction and history; Nutritional and medicinal value of edible mushrooms; Poisonous mushrooms; Types of edible mushrooms available in India – *Volvariella volvacea*, *Pleurotus citrinopileatus*, *Agaricus bisporus*.

Unit 2: Cultivation Technology (12)

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; Mushroom bed preparation - paddy straw, sugarcane trash, maize straw, banana leaves. Factors affecting the mushroom bed preparation - Low cost technology, composting technology in mushroom production.

Unit 3: Storage and nutrition**(8)**

Short term storage (Refrigeration – up to 24 hours), long term storage (canning, pickles, papads), drying, storage in salt solutions; Nutrition: proteins, amino acids, mineral elements, carbohydrates, crude fibre content, vitamins.

Unit 4: Food Preparation**(5)**

Types of foods prepared from mushroom; Research centres: National level and Regional level; Cost benefit ratio: Marketing in India and abroad, export value.

SUGGESTED READINGS/REFERENCES:

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

SEMESTER-V

Course: UG-BOT-G-DSE-T-01 (Theory) & UG-BOT-G-DSE-P-01 (Practical)
Course Title: A. Analytical Techniques in Plant Sciences; **Discipline Specific Elective Course;**
Credit: 6 [4 (Theory) + 2 (Practical)]; **Full Points:** 75 [50 (Theory) + 25 (Practical)]

COURSE OBJECTIVES:

After completion of the course the learners will be able to:

- describe various imaging related techniques;
- give an overview of the principle of spectrophotometry and its application in biological research;
- characterize proteins and nucleic acids;
- analyze statistical data and perform chi-square test for goodness of fit.

COURSE CONTENT (THEORY): UG-BOT-G-DSE-T-01**Unit 1: Imaging and related techniques (15)**

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, cryo-fixation, negative staining, shadow casting, freeze fracture, freeze etching.

Unit 2: Cell fractionation (8)

Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, CsCl₂ gradient, analytical centrifugation, ultracentrifugation, marker enzymes.

Unit 3: Radioisotopes (4)

Use in biological research, auto-radiography, pulse chase experiment.

Unit 4: Spectrophotometry (4)

Principle and its application in biological research.

Unit 5: Chromatography (8)

Principle; Paper chromatography; Column chromatography, Thin Layer Chromatography (TLC), Gas Liquid Chromatography (GLC), High Performance Liquid Chromatography (HPLC), Ion-exchange chromatography; Molecular sieve chromatography; Affinity chromatography.

Unit 6: Characterization of proteins and nucleic acids (6)

Mass spectrometry; X-ray diffraction; X-ray crystallography; Characterization of proteins and nucleic acids; Electrophoresis: Agarose Gel Electrophoresis (AGE), Polyacrylamide Gel Electrophoresis (PAGE), Sodium Dodecyl Sulfate - Polyacrylamide Gel Electrophoresis (SDS-PAGE)

Unit 7: Biostatistics (15)

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.

COURSE CONTENT (PRACTICAL): UG-BOT-G-DSE-P-01

1. Study of Blotting techniques: Southern, Northern and Western, DNA fingerprinting, DNA sequencing, PCR through photographs.
2. Separation of amino acid by paper chromatography
3. Demonstration of pigment separation by column chromatography.
4. Estimation of protein concentration through Lowry's method.
5. Study of different microscopic techniques using photographs/micrographs (freeze fracture, freeze etching, negative staining, positive staining, fluorescence and FISH).
6. Preparation of permanent slides by double staining method (*Helianthus* stem, *Nerium* leaf, Maize root) (double staining).

SUGGESTED READINGS/REFERENCES:

1. 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 and Sons. 3rd edition.
2. Plummer D.T. (1996). An Introduction to Practical Biochemistry. Tata McGraw-Hill Publishing Co. Ltd. New Delhi. 3rd edition.
3. Ruzin S.E. (1999). Plant Microtechnique and Microscopy, Oxford University Press, New York. U.S.A.
4. Zar J.H. (2012). Biostatistical Analysis. Pearson Publication. U.S.A. 4th edition.

Course: UG-BOT-G-DSE-T-01 (Theory) & UG-BOT-G-DSE-P-01 (Practical)
Course Title: B. Industrial and Environmental Microbiology; **Discipline Specific Elective;**
Credit: 6 [4 (Theory) + 2 (Practical)]; **Full Points:** 75 [50 (Theory) + 25 (Practical)]

COURSE OBJECTIVES:

After completion of the course the learners will be able to:

- apply the basics of microbiology to build a foundation for studies in microbiology and use of microbes in industry to manufacture food or products in large quantities;
- introduce microbial processes of environmental and geochemical significance;
- utilize microorganisms as tools in environmental remediation.

COURSE CONTENT (THEORY): UG-BOT-G-DSE-T-01**Unit 1: Scope of microbes in industry and environment (6)**

General concepts of industrial and environmental microbiology, principles of exploration of microorganisms of their products; Microbes in different habitats with special reference to extremophiles.

Unit 2: Bioreactors/ Fermenters and fermentation processes (12)

Solid-state and liquid-state (stationary and submerged) fermentations; Batch and continuous fermentations; Components of a typical bioreactor; Types of bioreactors: laboratory, pilot scale and production fermenters; Constantly stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air-lift fermenter.

Unit 3: Microbial production of industrial products (12)

Microorganisms involved, media, fermentation conditions, downstream processing and uses; Filtration, centrifugation, cell disruption, solvent extraction, precipitation and ultrafiltration, lyophilization, spray drying; Hands on microbial fermentations for the production and estimation (qualitative and quantitative) of enzyme: amylase or lipase activity, Organic acid (citric acid or glutamic acid), alcohol (ethanol) and antibiotic (penicillin).

Unit 4: Microbial enzymes of industrial interest and enzyme immobilization (8)

Microorganisms for industrial applications and hands on screening microorganisms for casein hydrolysis; starch hydrolysis; cellulose hydrolysis; methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase).

Unit 5: Microbes and quality of environment (6)

Distribution of microbes in air: Isolation of microorganisms from soil, air and water.

Unit 6: Microbial flora of water (8)

Water pollution, role of microbes in sewage and domestic waste water treatment systems; determination of BOD, COD, TDS and TOC of water samples; microorganisms as indicators of water quality, coliform and fecal coliform in water sample.

Unit 7: Microbes in agriculture and remediation of contaminated soils (8)

Biological fixation: bioremediation of contaminated soils; isolation of root nodulating bacteria; mycorrhizae with special reference to arbuscular mycorrhizal colonization in plant roots.

COURSE CONTENT (PRACTICAL): UG-BOT-G-DSE-P-01

1. Principles and functioning of instruments in microbiological laboratory.
2. Hands on sterilization techniques and preparation of culture media (Nutrient broth and Nutrient agar).
3. Preparation of slant, stab and pouring Petriplates.
4. Isolation of lactic acid bacteria from curd.
5. Isolation of *Rhizobium* from root nodules.
6. Isolation of microbes from soil.
7. A visit to any educational institute/ industry to see an industrial fermenter, and other downstream processing operations.

SUGGESTED READINGS/REFERENCES:

1. Casida L.E. Jr. (2016). Industrial Microbiology. New Age International, New Delhi.
2. Maier, R.M., Pepper, I.L. and Gerba, C.P. (2009). Environmental Microbiology, 2nd Edition, Academic Press.
3. Patel A.H. (2016). Industrial Microbiology. 2nd Edition. Laxmi Publications.
4. Pelczar M.J. Jr., Chen E.C.S and Krieg, N.R. (2010). Microbiology: An application-based approach. Tata McGraw Hill Education Pvt. Ltd., New Delhi.
5. Tortora G.J., Funke B.R., Case C.L. (2007). Microbiology. 9th edition, Pearson Benjamin Cummings, San Francisco, USA.

Course: UG-BOT-G-SEC-T-03 (Theory)

Course Title: A. Herbal Technology; **Skill Enhancement Course;**

Credit: 2; **Full Points:** 50

COURSE OBJECTIVES:

After completion of the course the learners will be able to:

- plan, analyze, and, solve the problems associated with herbal science and technology and related fields.
- design plant-wise processes including unit operations leading to a professional qualification that will serve the herbal or phytochemical industry.

COURSE CONTENT (THEORY): UG -BOT-G-SEC-T-03

Unit 1: Herbal medicines (6)

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.

Unit 2: Pharmacognosy (6)

Systematic position and medicinal uses of the following herbs in curing various ailments: Tulsi, Ginger, Fenugreek, Indian Goose berry and Ashoka.

Unit 3: Phytochemistry (6)

Active principles and methods of their testing: identification and utilization of the medicinal herbs- *Catharanthus roseus* (cardiotonic), *Withania somnifera* (drugs acting on nervous system), *Clerodendrum phlomoides* (anti-rheumatic) and *Centella asiatica* (memory booster).

Unit 4: Analytical pharmacognosy (8)

Drug adulteration: types, methods of drug evaluation; Biological testing of herbal drug: phytochemical screening tests for secondary metabolites (alkaloids, flavonoids, steroids, triterpenoids, phenolic compounds).

Unit 5: Medicinal plant banks (4)

Micro propagation of important species (*Withania somnifera*, neem and tulsi- herbal foods, future of pharmacognosy).

SUGGESTED READINGS/REFERENCES:

1. Arber A. (1999). Herbal plants and Drugs, Mangal Deep Publications.
2. Chopra R.N., Nayar S.L. and Chopra I.C. (1956). Glossary of Indian medicinal plants, C.S.I.R, New Delhi.
3. Dey K.L. (1984). The indigenous drugs of India, International Book Distributors.
4. Green A. (2000). Principles of Ayurveda, Thompsons, London.
5. Kokate C.K., Purohit A.P. and Gokhale S.B. (2002). Pharmacognosy, 13th edition, Nirali Prakashan.
6. Miller L. and Miller B. (1998). Ayurveda and Aromatherapy. Banarsidass, Delhi.
7. Sivarajan V.V. and Balachandran Indra (1994). Ayurvedic drugs and their plant source. Oxford IBH Publishing Co.

Course: UG-BOT-G-SEC-T-03 (Theory)
Course Title: B. Floriculture; **Skill Enhancement Course;**
Credit: 2; **Full Points:** 50

COURSE OBJECTIVES:

After completion of the course the learners will be able to:

- apply the assimilated knowledge and skills in production, processing, and distribution of flowers, cut flowers, foliage, and related plant materials;
- prescribe best management practices in field and greenhouse production of flowers and related plant materials and the arrangement of plant materials for ornamental purposes.

COURSE CONTENT (THEORY): UG -BOT-G-SEC-T-03

- Unit 1: Introduction (2)**
History of gardening; Importance and scope of floriculture and landscape gardening.
- Unit 2: Nursery Management and Routine Garden Operations (8)**
Sexual and vegetative methods of propagation; Soil sterilization; Seed sowing; Pricking; Planting and transplanting; Shading; Stopping or pinching; Defoliation; Wintering; Mulching; Topiary; Role of plant growth regulators.
- Unit 3: Ornamental Plants (4)**
Flowering annuals; Herbaceous perennials; Divine vines; Shade and ornamental trees; Ornamental bulbous and foliage plants; Cacti and succulents; Palms and Cycads; Ferns and Selaginellas; Cultivation of plants in pots; Indoor gardening; Bonsai.
- Unit 4: Principles of Garden Designs (4)**
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.
- Unit 5: Landscaping at Places of Public Importance (4)**
Landscaping at highways and educational institutions.
- Unit 6: Commercial Floriculture (6)**
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, Gladiolus, Marigold, Rose, Lily, Orchids).
- Unit 7: Diseases and Pests of Ornamental Plants (2)**

SUGGESTED READINGS/REFERENCES:

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

SEMESTER-VI

Course: UG-BOT-G-DSE-T-02 (Theory) & UG-BOT-G-DSE-P-02 (Practical)
Course Title: A. Biodiversity and Conservation; **Discipline Specific Elective;**
Credit: 6 [4 (Theory) + 2 (Practical)]; **Full Points:** 75 [50 (Theory) + 25 (Practical)]

COURSE OBJECTIVES:

After completion of the course the learners will be able to:

- demonstrate an advanced understanding of the application of fundamental principles of ecological studies to the conservation of biodiversity.
- discuss and cite theories and case studies as prerequisites for success in sustainable utilization and effective species conservation.
- translate theoretical aspects of contemporary practices to recommendations for environmental management.
- communicate effectively in the form of written reports and spoken presentations

COURSE CONTENT (THEORY): UG-BOT-G-DSE-T-02

Unit 1: Natural resources	(2)
Definition, types and distribution.	
Unit 2: Sustainable utilization	(8)
Concept, approaches (economic, ecological and socio-cultural).	
Unit 3: Land	(8)
Utilization (agricultural, pastoral, horticultural, silvicultural); Soil degradation, restoration, conservation and management.	
Unit 4: Water	(8)
Fresh water (rivers, lakes, groundwater, aquifers, watershed); Marine; Estuarine; Wetlands; Threats and management strategies.	
Unit 5: Biological Resources	(12)
Biodiversity: definition and types; Significance; Threats; Management strategies; Bioprospecting; Intellectual Property Regime (IPR); Convention on Biological Diversity (CBD); National Biodiversity Action Plan.	
Unit 6: Forests	(6)
Definition, Cover and its significance (with special reference to India); Major and minor forest products; Depletion; Management.	
Unit 7: Energy	(6)
Renewable and non-renewable sources of energy	
Unit 8: Contemporary practices in resource management	(8)
Environmental Impact Assessment (EIA), Geographical Information System (GIS), Participatory Resource Appraisal, Ecological Footprint with emphasis on carbon footprint; Resource Accounting; Waste management.	
Unit 9: National and international efforts in resource management and conservation	(4)
National legislations: The Biological Diversity Act, 2002; Forest Conservation Act, 1980; Case studies relevant to resource management and conservation.	

COURSE CONTENT (PRACTICAL): UG-BOT-G-DSE-P-02

1. Collection of data (qualitative and quantitative) on forest cover.
2. Collection of data (qualitative and quantitative) on a specific area under Protected Area Network.
3. Collection of data (qualitative and quantitative) on a specific area exhibiting urban diversity.
4. Measurement of dominance of woody species by diameter at breast height (DBH) method.
5. Calculation and analysis of ecological footprint.

SUGGESTED READINGS/REFERENCES:

1. Rogers P.P., Jalal K.F. and Boyd J.A. (2008). An Introduction to Sustainable Development. Prentice Hall of India Private Limited, New Delhi.
2. Singh J.S., Singh S.P. and Gupta S. (2006). Ecology, Environment and Resource Conservation. Anamaya Publications, New Delhi.
3. Vasudevan N. (2006). Essentials of Environmental Science. Narosa Publishing House, New Delhi.

Course: UG-BOT-G-DSE-T-02 (Theory) & UG-BOT-G-DSE-P-02 (Practical)
Course Title: B. Genetics and Biotechnology; **Discipline Specific Elective;**
Credit: 6 [4 (Theory) + 2 (Practical)]; **Full Points:** 75 [50 (Theory) + 25 (Practical)]

COURSE OBJECTIVES:

After completion of the course the learners will be able to:

- explain Mendel's theory of inheritance.
- understand the mechanism of genetic recombination.
- get an overview of the principle, culture methods, importance and applications of plant tissue culture.
- understand different gene transfer techniques.

COURSE CONTENT (THEORY): UG-BOT-G-DSE-T-02**Unit I: Mendelian Genetics and its Extension (10)**

Mendelism: Principles of Inheritance, Chromosome theory of inheritance, Laws of Probability, Pedigree analysis, Incomplete dominance and co-dominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Environmental effects on phenotypic expression, sex linked inheritance.

Unit II: Linkage, Crossing Over and Chromosomal Mapping (10)

Linkage and crossing over, Cytological basis of crossing over, Molecular mechanism of crossing over, Recombination frequency as a measure of linkage intensity, two factors and three factor crosses gene mapping, Interference and coincidence.

Unit III: Mutations: Chromosomal Mutations (10)

Deletion, Duplication, Inversion, Translocation, Aneuploidy and Polyploidy; Gene mutations: Induced versus Spontaneous mutations, Molecular basis of mutations in

relation to UV light and chemical mutagens, Detection of mutations: CLB method, Attached X method, DNA repair mechanisms.

Unit IV: Plant Tissue Culture (5)

Concept: Differentiation, dedifferentiation, re-differentiation, cellular totipotency; Tissue culture media (brief idea); Aseptic techniques.

Unit V: Concept, culture methods, importance and application (15)

Embryo culture; Callus culture, characteristics of callus; Suspension culture; Organogenesis and plant regeneration; Somatic embryogenesis, difference with zygotic embryogenesis; Artificial seeds; Micropropagation; Haploid production through androgenesis; Protoplast culture – isolation and culture; Protoplast Fusion-Somatic hybridization; Cybridization.

Unit VI: Genetic transformation (10)

Transformation techniques (basic idea): transformation technique using *Agrobacterium* system, Direct DNA transfer method; Basic idea on selectable reporter gene and marker gene; Mechanism of integration and expression of foreign DNA in plant cells; Application in crop improvement.

COURSE CONTENT (PRACTICAL): UG-BOT-G-DSE-P-02

1. Study of different stages of mitosis and meiosis (from permanent slides / photographs).
2. Determination of mitotic index (*Allium cepa*).
3. Familiarization with basic equipments used in tissue culture
4. Demonstration of MS medium preparation, *in vitro* sterilization and inoculation
5. Study through photographs: Anther culture, somatic embryogenesis, endosperm and embryo culture; micropropagation

SUGGESTED READINGS/REFERENCES:

1. Gardner E.J., Simmons M.J., Snustad D.P. (1991). Principles of Genetics, John Wiley and Sons, India. 8th edition.
2. Klug W.S., Cummings M.R., Spencer C.A. (2009). Concepts of Genetics. Benjamin Cummings, U.S.A. 9th edition.
3. Snustad D.P. and Simmons M.J. (2010). Principles of Genetics, John Wiley & Sons Inc., India. 5th edition.
4. Bhojwani S.S. and Razdan M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier, Science Amsterdam. The Netherlands.
5. Chawla H.S. (2017). Introduction to Plant Biotechnology, Oxford & IBH. 3rd edition.
6. Ramawat K.G. (2012). Plant Biotechnology, S. Chand Publication.
7. Singh B.D. (2012). Plant Biotechnology, Kalyani publisher.

Course: UG-BOT-G-SEC-T-04 (Theory)
Course Title: A. Ethnobotany; **Skill Enhancement Course;**
Credit: 2; **Full Points:** 50

COURSE OBJECTIVES:

After completion of the course the learners will be able to:

- explain the traditional and indigenous knowledge, utilization, and conservation of plants by ethnic people;
- describe the interactions between cultural practices, ecosystems, and modern science.

COURSE CONTENT (THEORY): UG -BOT-G-SEC-T-04**Unit 1: Ethnobotany (6)**

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 d) miscellaneous uses.

Unit 2: Methodology of Ethnobotanical studies (6)

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

Unit 3: Role of ethnobotany in modern medicine (10)

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 reference to *Rauwolfia serpentina*, *Trichopus zeylanicus*, *Artemisia* spp., *Withania somnifera*. Role of ethnic groups in conservation of plant genetic resources. Endangered taxa and forest management (participatory forest management).

Unit 4: Ethnobotany and legal aspects (8)

Ethnobotany as a tool to protect interests of ethnic groups. Sharing of wealth concept with few examples from India. Biopiracy, Intellectual Property Rights and Traditional Knowledge.

SUGGESTED READINGS/REFERENCES:

1. Colton C.M. (1997). Ethnobotany – Principles and applications. John Wiley and sons – Chichester.
2. Faulks P.J. (1958). An introduction to Ethnobotany, Moredale pub. Ltd.
3. Jain S.K. (ed.) (1981). Glimpses of Indian. Ethnobotany, Oxford and IBH, New Delhi
4. Jain S.K. (ed.) (1989). Methods and approaches in ethnobotany. Society of ethnobotanists, Lucknow, India.
5. Jain S.K. (1990). Contributions of Indian ethnobotany. Scientific publishers, Jodhpur.

6. Jain S.K. (1995). Manual of Ethnobotany, Scientific Publishers, Jodhpur.
7. Rama Rao, N. and Henry A.N. (1996). The Ethnobotany of Eastern Ghats in Andhra Pradesh, India. Botanical Survey of India. Howrah.
8. Sinha R.K. (1996). Ethnobotany: The Renaissance of Traditional Herbal Medicine, INA Shree Publishers, Jaipur.

Course: UG-BOT-G-SEC-T-04 (Theory)

Course Title: B. Intellectual Property Rights; Skill Enhancement Course;

Credit: 2; Full Points: 50

COURSE OBJECTIVES:

After completion of the course the learners will be able to:

- identify different types of Intellectual Properties (IPs), right of ownership, scope of protection of IP and ways to create and extract value from IP;
- recognize the role of IP in different sectors for promoting product and technology development;
- identify activities that constitute IP infringements and the remedies available to the IP owner and describe the steps to be taken to prevent infringement of such rights in products and technology development;
- discuss the processes and various approaches of Intellectual Property Management (IPM).

COURSE CONTENT (THEORY): UG -BOT-G-SEC-T-04

Unit 1: Introduction to intellectual property rights (IPR) (2)

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

Unit 2: Patents (3)

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

Unit 3: Copyrights (3)

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

Unit 4: Trade Points (3)

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

Unit 5: Geographical Indications (3)

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

Unit 6: Protection of Traditional Knowledge (4)

Objective, Concept of Traditional Knowledge, Holders, Issues concerning, Bio-Prosping 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 (2)

Objectives, Rights, Assignments, Infringements, Defenses of Design Infringement.

Unit 8: Protection of Plant Varieties (2)

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 (4)

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

Unit 10: Biotechnology and Intellectual Property Rights (4)

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

SUGGESTED READINGS/REFERENCES:

1. Gopalakrishnan N.S. and Agitha T.G. (2009). Principles of Intellectual Property. Eastern Book Company, Lucknow.
2. Narayanan P. (2010). Law of Copyright and Industrial Designs; Eastern law House, Delhi.
3. Parulekar A. and D'Souza S. (2006). Indian Patents Law – Legal & Business Implications; Macmillan India Ltd.
4. Wadehra B.L. (2000). Law Relating to Patents, Trade Points, Copyright, Designs & Geographical Indications; Universal law Publishing Pvt. Ltd., India.