

THE UNIVERSITY OF BURDWAN



Curriculum and Syllabus For 3-Year B. Sc. (General)

in

Botany

Under **Choice Based Credit System (CBCS)**

(w.e.f. Academic Year 2017-2018)

Details of Courses

Core Courses –Botany

- 1A. Biodiversity (Microbes, Algae, Fungi and Archegoniate)
- 1B. Plant Ecology and Taxonomy
- 1C. Plant Anatomy and Embryology
- 1D. Plant Physiology and Metabolism

Discipline Specific Electives-Botany (Any two)

DSE 1A (any one)

1. Economic Botany and Biotechnology
or
2. Analytical Techniques in Plant Sciences
or
3. Bioinformatics

DSE 1B (any one)

1. Cell Biology, Genetics and Molecular Biology
or
2. Research Methodology
or
3. Dissertation

Ability Enhancement Compulsory Courses

1. Environmental Studies (ENVS)
2. Communicative English /MIL

Skill Enhancement Courses (SEC)-Botany

SEC –1 (any One)

1. Biofertilizers
or
2. Herbal Technology

SEC –2 (any one)

1. Medicinal Botany
Or
2. Floriculture

SEC –3 (any one)

1. Nursery and Gardening
or
2. Plant Diversity and Human Welfare

SEC –4 (any one)

1. Ethnobotany
or
2. Mushroom Cultivation Technology
or
3. Intellectual Property Right

Scheme for choice based credit system in B. Sc. with Botany

	DISCIPLINE CORE COURSE (6)	Ability Enhancement Compulsory Course (AECC) (4/2)	Skill Enhancement Course (SEC) (2)	Discipline Specific Elective DSE (6)
SEM-I	Discipline- 1 (BOT) CC- 1A: Biodiversity (Microbes, Algae, Fungi and Archegoniate)	ENVS		
	Discipline- 2 (Other)			
	Discipline- 3 (Other)			
SEM-II	Discipline- 1 (BOT) CC- 1B: Plant Ecology and Taxonomy	Communicative English /MIL		
	Discipline- 2 (Other)			
	Discipline- 3 (Other)			
SEM-III	Discipline- 1 (BOT) CC- 1C: Plant Anatomy and Embryology		SEC – 1	
	Discipline- 2 (Other)			
	Discipline- 3 (Other)			
SEM-IV	Discipline- 1 (BOT) CC- 1D: Plant Physiology and Metabolism		SEC - 2	
	Discipline- 2 (Other)			
	Discipline- 3 (Other)			
SEM-V			SEC – 3	DSE – 1A(BOT) :Economic Botany and Biotechnology/ Analytical Techniques in Plant Sciences/ Bioinformatics
				DSE – 2A(Other)
				DSE – 3A(Other)
SEM-VI			SEC – 4	DSE – 1B (BOT) :Cell and Molecular Biology/ Research Methodology/ Dissertation
				DSE – 2B (Other)
				DSE – 3B (Other)

CREDIT DISTRIBUTION

SEMESTER	COURSE OPTED	COURSE NAME	CREDIT
SEM – I Total Credit - 22	AECC – 1	ENVS	4
	Core Course -1A (BOTANY) – TH	Biodiversity (Microbes, Algae, Fungi and Archegoniate)	4
	Core Course -1A (BOTANY) – PR	Biodiversity (Microbes, Algae, Fungi and Archegoniate)	2
	Core Course -2A (OTHER) – TH		4
	Core Course -2A (OTHER) – PR		2
	Core Course -3A (OTHER) – TH		4
	Core Course -3A (OTHER) – PR		2
SEM – II Total Credit - 20	AECC –2	Communicative English /MIL	2
	Core Course -1B (BOTANY) – TH	Plant Ecology and Taxonomy	4
	Core Course -1B (BOTANY) – PR	Plant Ecology and Taxonomy	2
	Core Course -2B (OTHER) – TH		4
	Core Course -2B (OTHER) – PR		2
	Core Course -3B (OTHER) – TH		4
	Core Course -3B (OTHER) – PR		2
SEM – III Total Credit - 20	Core Course -1C (BOTANY) – TH	Plant Anatomy and Embryology	4
	Core Course -1C (BOTANY) – PR	Plant Anatomy and Embryology	2
	Core Course -2C (OTHER) – TH		4
	Core Course -2C (OTHER) – PR		2
	Core Course -3C (OTHER) – TH		4
	Core Course -3C (OTHER) – PR		2
SEM – IV Total Credit - 20	Skill Enhancement Course – 1	SEC – 1	2
	Core Course -1D (BOTANY) – TH	Plant Anatomy and Embryology	4
	Core Course -1D (BOTANY) – PR	Plant Anatomy and Embryology	2
	Core Course -2D (OTHER) – TH		4
	Core Course -2D (OTHER) – PR		2
	Core Course -3D (OTHER) – TH		4
	Core Course -3D (OTHER) – PR		2
SEM – V Total Credit - 20	Skill Enhancement Course – 2	SEC – 2	2
	Discipline Specific Elective	DSE - 1A(Botany) Theory	4
	Discipline Specific Elective	DSE - 1A(Botany) Practical	2
	Discipline Specific Elective	DSE - 2A(Other) Theory	4
	Discipline Specific Elective	DSE - 2A(Other) Practical	2
	Discipline Specific Elective	DSE - 3A (Other) Theory	4
	Discipline Specific Elective	DSE - 3A (Other) Practical	2
SEM – VI Total Credit - 20	Skill Enhancement Course – 3	SEC – 3	2
	Discipline Specific Elective	DSE - 1B (Botany) Theory	4
	Discipline Specific Elective	DSE - 1B (Botany) Practical	2
	Discipline Specific Elective	DSE - 2B (Other) Theory	4
	Discipline Specific Elective	DSE - 2B (Other) Practical	2
	Discipline Specific Elective	DSE - 3B (Other) Theory	4
	Discipline Specific Elective	DSE -3B (Other) Practical	2
Skill Enhancement Course – 4	SEC – 4	2	
TOTAL			122

Semester I

Core Course (CC-1A) : Biodiversity (Microbes, Algae, Fungi and Archegoniate)

Credits: 6 (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: *Chlamydomonas*, *Oedogonium*, *Chara*, *Fucus*, *Polysiphonia*. Economic importance of algae

Unit 3: Fungi

(12 Lectures)

Introduction- General characteristics, ecology and significance, range of thallus organization, cell wall composition, nutrition, reproduction and classification; True Fungi- General characteristics, ecology and significance, life cycle of *Rhizopus* (Zygomycota) *Ascobolus* (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 (*Rhynia*). Classification (upto family), morphology, anatomy and reproduction of *Lycopodium*, *Selaginella*, *Equisetum* and *Pteris*. (Developmental details not to be included). Heterospory, stelar evolution. economic importance of Pteridophytes.

Unit 7: Gymnosperms

(6 Lectures)

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

Practical

1. Dissection (where necessary), mounting, description, drawing and identification of the following genera:
 - a. Algae: *Nostoc*, *Oedogonium*, *Chara*.
 - b. Fungi: *Ascobolus*, *Puccinia* (Uredosorus and teleutosorus).
 - c. Bryophytes: *Riccia*, *Marchantia* and *Funaria*.
2. Dissection, mounting, description, drawing, labeling and identification of the following genera:
 - a. Pteridophytes: *Lycopodium* (stem), *Selaginella* (stem) and *Pteris* (leaflet).
 - b. Gymnosperms: *Cycas* leaflet, *Pinus* needle.
3. Identification of all above mentioned genera in theoretical syllabus from permanent slides
4. Microbiology: Sterilization techniques.; Simple staining of Bacteria with methylene blue/Carbol Fuchsin – Curd

Suggested Readings

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

Semester II

Core Course (CC- 1B) : Plant Ecology and Taxonomy

Credits: 6
(Theory-4, Practicals-2)

THEORY

Lectures: 60

Unit 1: Introduction

(2 Lectures)

Plant Ecology and Taxonomy

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. Adaptation of hydrophytes, halophytes and xerophytes.

Unit 3: Plant communities

(6 Lectures)

Characters; Ecotone and edge effect; Succession; Processes and types.

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 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

(6 Lectures)

Taxonomic evidences from palynology, cytology, phytochemistry and molecular data.

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. Classification Bentham and Hooker (upto series), Takhtajan.

Unit 12 Biometrics, numerical taxonomy and cladistics

(4 Lectures)

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

Practical

1. Study of vegetative and reproductive organs, description, drawing and labeling, floral diagram, floral formula and identification of the following families: Malvaceae, Rubiaceae, Papilionaceae, Caesalpiniaceae, Apocynaceae, Labiatae (Lamiaceae), Solanaceae.
2. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book).
3. Ecological adaptations of some species: *Ipomoea aquatica* stem, Phyllode of *Acaccia auriculiformis*, *Nerium* leaf and *Vanda* root

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 (CC- 1C): Plant Anatomy and Embryology

Credits: 6

(Theory-4, Practicals-2)

THEORY

Lectures: 60

Unit 1: Meristematic and permanent tissues

(8 Lectures)

Root and shoot apical meristems; Simple and complex tissues.

Unit 2: Organs

(4 Lectures)

Structure of dicot and monocot root stem and leaf.

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

(8 Lectures)

Structure of anther and pollen; Structure and types of ovules; Types of embryo sacs, organization and ultrastructure 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**(8 Lectures)**

Endosperm types, structure and functions; Dicot and monocot embryo; Embryo-endosperm relationship.

Unit 8: Apomixis and polyembryony**(8 Lectures)**

Definition, types and practical applications.

Practical

1. Study of meristems through permanent slides and photographs.
2. Tissues (parenchyma, collenchyma and sclerenchyma); Macerated xylary elements, Phloem (Permanent slides, photographs)
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. Types of ovules: anatropous, orthotropous, circinotropous, amphitropous/campylotropous – Through Permanent Slides/Photographs
8. Female gametophyte: *Polygonum* (monosporic) type of Embryo sac Development (Permanent slides/photographs).
9. Pollination types and seed dispersal mechanisms (including appendages, aril, caruncle) (Photographs and specimens).

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.

Skill Enhancement Course

SEC 1 (any one)

Credits 2

(1) Biofertilizers

Lectures: 30

Unit 1: General account about the microbes used as biofertilizer – *Rhizobium* – isolation, identification, mass multiplication, carrier based inoculants, Actinorrhizal symbiosis.
(4 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.
(8 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.
(4 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.
(8 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.
(6 Lectures)

Suggested Readings

1. Dubey, R.C., 2005 A Text book of Biotechnology S.Chand & Co, New Delhi.
Kumaresan, V. 2005, Biotechnology, Saras Publications, New Delhi.
2. John Jothi Prakash, E. 2004. Outlines of Plant Biotechnology. Emkay Publication, New Delhi.
3. Sathe, T.V. 2004 Vermiculture and Organic Farming. Daya publishers.
4. Subha Rao, N.S. 2000, Soil Microbiology, Oxford & IBH Publishers, New Delhi.
5. Vayas, S.C, Vayas, S. and Modi, H.A. 1998 Bio-fertilizers and organic Farming Akta Prakashan, Nadiad

(2) Herbal Technology

Lectures: 30

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.
(6 Lectures)

Unit 2: Pharmacognosy - systematic position medicinal uses of the following herbs incurring various ailments; Tulsi, Ginger and Indian Goose berry. **(6 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) and *Centella asiatica* (memory booster). **(6 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) **(8 Lectures)**

Unit 5: Medicinal plant banks micro propagation of important species (neem and tulsi- Herbal foods-future of pharmacognosy) **(4 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.

Semester IV

Core Course (CC- 1D) : Plant Physiology and Metabolism
(Theory-4, Practicals-2)

Credits: 6

THEORY

Lectures: 60

Unit 1: Plant-water relations

(8 Lectures)

Importance of water, water potential and its components; Transpiration and its significance; Factors affecting transpiration; Root pressure and guttation.

Unit 2: Mineral nutrition (8 Lectures)

Essential elements, macro and micronutrients; Criteria of essentiality of elements; Role of essential elements; Transport of ions across cell membrane, active and passive transport, carriers, channels and pumps.

Unit 3: Translocation in phloem (6 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 (6 Lectures)

Glycolysis, anaerobic respiration, TCA cycle; Oxidative phosphorylation, Glyoxylate 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

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. To study the effect of light intensity and bicarbonate concentration on O₂ evolution in photosynthesis.
6. Comparison of the rate of respiration in any two parts of a plant.

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.

Skill Enhancement Course

SEC 2 (any one)

(Credits 2)

(1) Medicinal Botany Lectures: 30

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. **(10 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. **(10 Lectures)**

Unit 3: Ethnobotany and Folk medicines. Definition; Ethnobotany in India: Methods to study ethnobotany; Applications of Ethnobotany: National interacts, folk medicines of ethnobotany, ethnomedicine, ethnic communities of India. Application of natural products to certain diseases- Jaundice, cardiac, infertility, diabetics, Blood pressure and skin diseases. **(10 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

(2) Floriculture

Lectures: 30

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 *Selaginella*; Cultivation of plants in pots; Indoor gardening; Bonsai.

(4 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.

(4 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, Liliun, Orchids).

(6 Lectures)

Unit 7: Diseases and Pests of Ornamental Plants.

(2 Lectures)

Suggested Readings

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

Semester V

Discipline Specific Elective

DSE 1A (any one) : Economic Botany and Biotechnology

Credits: 6
(Theory-4, Practicals-2)
Lectures: 60

THEORY

Unit 1: Origin of Cultivated Plants

(4 Lectures)

Concept of centres of origin, their importance with reference to Vavilov's work

Unit 2: Cereals

(4 Lectures)

Wheat -Origin, morphology, uses

Unit 3: Legumes

(4 Lectures)

General account with special reference to Gram and soybean

Unit 4: Spices

(6 Lectures)

General account with special reference to clove and black pepper (Botanical name, family, part used, morphology and uses)

Unit 5: Beverages

(4 Lectures)

Tea (morphology, processing, uses)

Unit 6: Oils and Fats**(4 Lectures)**

General description with special reference to groundnut

Unit 7: Fibre Yielding Plants**(4 Lectures)**

General description with special reference to Cotton (Botanical name, family, part used, morphology and uses)

Unit 8: Introduction to biotechnology**(2 lecture)**

History, Derinition, aim and scope, Contribution of Indian Scientist

Unit 9: Plant tissue culture**(8 Lectures)**

Micropropagation; haploid production through androgenesis and gynogenesis; brief account of embryo& endosperm culture with their applications

Unit 10: Recombinant DNA Technique**(18 Lectures)**

Enzymes in Recombinant DNA Technology, cloning vector, DNA library, PCR, DNA Fingerprinting and application of Recombinant DNA Technique

Practical

1. Study of economically important plants: Wheat, Gram, Black pepper, Clove, Groundnut through specimens and sections.
2. Familiarization with basic equipments in tissue culture.
3. Study through photographs: Anther culture, somatic embryogenesis, endosperm and embryo culture; micropropagation.
4. Basic Conception generation about molecular techniques: PCR, Blotting techniques, AGE and PAGE- Protocol

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.

(2)Analytical Techniques in Plant Sciences

Credits: 6
(Theory-4, Practicals-2)
Lectures: 60

THEORY

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 (4 Lectures)

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

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.

Practical

1. Study of Blotting techniques: Southern, Northern and Western, DNA fingerprinting, DNA sequencing, PCR - through photographs only.
2. Conceptualization of ELISA.
3. To separate nitrogenous bases by paper chromatography – Protocol study.
4. To separate sugars by thin layer chromatography - Demonstration.
5. To separate proteins using PAGE – Protocol study.
6. To separate DNA (marker) using AGE – Protocol study.
7. Study of different microscopic techniques using photographs/micrographs (freeze fracture, freeze etching, negative staining, positive staining, fluorescence and FISH).
8. 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.

(3) Bioinformatics

Credits: 6

(Theory-4, Practicals-2)

Lectures: 60

THEORY

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

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

5. Study of 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.

Skill Enhancement Course

SEC 3 (any one)

(1) Nursery and Gardening

Credits 2

Lectures: 30

Unit 1: Nursery: definition, objectives and scope and building up of infrastructure for nursery, planning and seasonal activities - Planting - direct seeding and transplants. **(4 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. **(6 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 – greenhouse - mist chamber, shed root, shade house and glass house. **(6 Lectures)**

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. **(8 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. **(6 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.

(2) Plant Diversity and Human Welfare (Credits 2)

Lectures: 30

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. **(8 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. **(8 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. **(8 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. **(6 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

Semester VI

Discipline Centric Elective

DSE 1B (any one)

Credits: 6

(Theory-4, Practicals-2)

(1) Cell Biology, Genetics and Molecular Biology

THEORY

Lectures: 60

Unit 1: Techniques in Biology

Principles of microscopy; Light Microscopy; Phase contrast microscopy; Fluorescence microscopy; Confocal microscopy; Sample Preparation for light microscopy; Electron microscopy (EM)- Scanning EM and Scanning Transmission EM (STEM); Sample Preparation for electron microscopy; X-ray diffraction analysis. **(4 Lectures)**

Unit 2: Cell as a unit of Life

The Cell Theory; Prokaryotic and eukaryotic cells; Cell size and shape; Eukaryotic Cell components. **(2 Lectures)**

Unit 3: Linkage and Crossing over

Linkage: concept & history, complete & incomplete linkage, bridges experiment, coupling & repulsion, recombination frequency, linkage maps based on two and three factor crosses. Crossing over: concept and significance, cytological proof of crossing over. **(4 Lectures)**

Unit 4: Mutations and Chromosomal Aberrations

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

Unit 5: Cell Organelles

Mitochondria: Structure, marker enzymes, composition; Semiautonomous nature; Symbiont hypothesis; Proteins synthesized within mitochondria; mitochondrial DNA. Chloroplast Structure, marker enzymes, composition; semiautonomous nature, chloroplast DNA. ER, Golgi body & Lysosomes: Structures and roles. Peroxisomes and Glyoxisomes: Structures, composition, functions in animals and plants and biogenesis. Nucleus: Nuclear Envelope-structure of nuclear pore complex; chromatin; molecular organization, DNA packaging in eukaryotes, euchromatin and heterochromatin, nucleolus and ribosome structure (brief).

(16 Lectures)

Unit 6: Cell Membrane and Cell Wall

The functions of membranes; Models of membrane structure; The fluidity of membranes; Membrane proteins and their functions; Carbohydrates in the membrane; Faces of the membranes; Selective permeability of the membranes; Cell wall. **(6 Lectures)**

Unit 7: Cell Cycle

Overview of Cell cycle, Mitosis and Meiosis; Molecular controls. **(6 Lectures)**

Unit 8: Genetic material

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

(6 Lectures)

Unit 9: Transcription (Prokaryotes and Eukaryotes)

Types of structures of RNA (mRNA, tRNA, rRNA), RNA polymerase- various types; Translation (Prokaryotes and eukaryotes), genetic code. **(6 Lectures)**

Unit 10: Regulation of gene expression

Prokaryotes: Lac operon and Tryptophan operon ; and in Eukaryotes. **(6 Lectures)**

Practical

1. To study prokaryotic cells (bacteria), viruses, eukaryotic cells with the help of light and electron micrographs.
2. Study of the photomicrographs of cell organelles
3. To study the structure of plant cell through temporary mounts.

4. To study the structure of animal cells by temporary mounts-squamous epithelial cell
5. Study of mitosis and meiosis (temporary mounts and permanent slides).
6. Study of plasmolysis and deplasmolysis on *Rhoeo* leaf.
7. Measure the cell size (either length or breadth/diameter) by micrometry.
8. Study the structure of nuclear pore complex by photograph (from Gerald Karp) Study of special chromosomes (polytene & lampbrush) either by slides or photographs.
9. Study DNA packaging by micrographs.
10. 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.

(2) Research Methodology

Credits: 6

(Theory-4, Practicals-2)

THEORY

Lectures: 60

Unit 1: Basic concepts of research

Research-definition and types of research (Descriptive vs analytical; applied vs fundamental; quantitative vs qualitative; conceptual vs empirical). Research methods vs methodology. Literature-review and its consolidation; Library research; field research; laboratory research.

(10 Lectures)

Unit 2: General laboratory practices

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. **(12 Lectures)**

Unit 3: Data collection and documentation of observations

Maintaining a laboratory record; Tabulation and generation of graphs. Imaging of tissuespecimens and application of scale bars. The art of field photography. **(6 Lectures)**

Unit 4: Overview of Biological Problems

History; Key biology research areas, Model organisms in biology (A Brief overview): Genetics, Physiology, Biochemistry, Molecular Biology, Cell Biology, Genomics, Proteomics-Transcriptional regulatory network. **(6 Lectures)**

Unit 5: Methods to study plant cell/tissue structure

Whole mounts, peel mounts, squash preparations, clearing, maceration and sectioning; Tissue preparation: living vs fixed, physical vs chemical fixation, coagulating fixatives, non-coagulant fixatives; tissue dehydration using graded solvent series; Paraffin and plastic infiltration; Preparation of thin and ultrathin sections. **(6 Lectures)**

Unit 6: Plant microtechniques

Staining procedures, classification and chemistry of stains. Staining equipment. Reactivedyes and fluorochromes (including genetically engineered protein labeling with GFP and other tags). Cytogenetic techniques with squashed plant materials. **(12 Lectures)**

Unit 7: The art of scientific writing and its presentation

Numbers, units, abbreviations and nomenclature used in scientific writing. Writing references. Powerpoint presentation. Poster presentation. Scientific writing and ethics, Introduction to copyright-academic misconduct/plagiarism. **(8 Lectures)**

Practical

1. Study on experiments based on chemical calculations.
2. Study on plant micro-technique experiments.
3. Study on the art of imaging of samples through microphotography and field photography.

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.

(3) **DISSERTATION** (Credits: 6)

Poster presentation on defined topics / Technical writing on topics assigned.

[Topic of Poster/Technical writing will be given by concerned department. While selecting the topic current advances in sciences should be emphasized, environmental issues or Botanical issues may also be selected. Poster / Writing to be submitted to the Departmental Concerned Teacher on due date. The matter have to be duly signed with date and departmental/college seal. The matter will be finally evaluated by external examiner]

Skill Enhancement Course

SEC 4 (any one)

(Credits 2)

(1) Ethnobotany

Lectures: 30

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. **(6 Lectures)**

Unit 2: Methodology of Ethnobotanical studies

a) Field work b) Herbarium c) Ancient Literature d) Archaeological findings e) Sacred groves. **(6 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*. 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). **(10 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. **(8 Lectures)**

Suggested Readings

1. S.K. Jain, Manual of Ethnobotany, Scientific Publishers, Jodhpur, 1995.
2. S.K. Jain (ed.) Glimpses of Indian Ethnobotany, 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 ethnobotany. Scientific publishers, Jodhpur.
6. Colton C.M. 1997. Ethnobotany – Principles and applications. John Wiley and sons – Chichester
7. Rama Rao, 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)

(2) Mushroom Cultivation Technology

Lectures: 30

Unit 1: Introduction, history. Nutritional and medicinal value of edible mushrooms; Poisonous mushrooms. Types of edible mushrooms available in India - *Volvariella volvacea*, *Pleurotus* sp., *Agaricus bisporus*.
(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. Mushroom bed preparation - paddy straw. Factors affecting the mushroom bed preparation - Low cost technology, Composting technology in mushroom production.
(12 Lectures)

Unit 3: Storage and nutrition: Short-term storage (Refrigeration - upto 24 hours) Long term Storage (canning, pickles, papads), drying, storage in salt solutions. Nutrition - Proteins - amino acids, mineral elements nutrition - Carbohydrates, Crude fibre content - Vitamins.
(8 Lectures)

Unit 4: 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)

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

(3) Intellectual Property Rights

Lectures :30

Unit 1. : Introduction to Intellectual Property right (IPR)

Concept and kinds. Economic importance. IPR in India and world: Genesis and scope, some important examples. IPR and WTO (TRIPS, WIPO). **(2 lectures)**

Unit 2: Patents

Objectives, Rights, Patent Act 1970 and its amendments. Procedure of obtaining patents, Working of patents. Infringement. **(3 Lectures)**

Unit 3: Copyrights

Introduction, Works protected under copyright law, Rights, Transfer of Copyright, Infringement. **(3 Lectures)**

Unit 4: Trademarks

Objectives, Types, Rights, Protection of goodwill, Infringement, Passing off, Defences, Domain name. **(3 Lectures)**

Unit 5: Geographical Indications

Objectives, Justification, International Position, Multilateral Treaties, National Level, Indian Position. **(3 Lectures)**

Unit 6: Protection of Traditional Knowledge

Objective, Concept of Traditional Knowledge, Holders, Issues concerning, Bio-Propecting 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. **(4 Lectures)**

Unit 7: Industrial Designs

Objectives, Rights, Assignments, Infringements, Defenses of Design Infringement **(2 Lectures)**

Unit 8: Protection of Plant Varieties

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. **(2 Lecture)**

Unit 9: Information Technology Related Intellectual Property Rights

Computer Software and Intellectual Property, Database and Data Protection, Protection of Semiconductor chips, Domain Name Protection **(4 Lectures)**

Unit 10: Biotechnology and Intellectual Property Rights.

Patenting Biotech Inventions: Objective, Applications, Concept of Novelty, Concept of inventive step, Microorganisms, Moral Issues in Patenting Biotechnological inventions. **(4 Lectures)**

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, MichealH.Davis; Intellectual Property: Patents, Trademarks and Copyright in a Nutshell, West Group Publishers (2000).
- 5.JayashreeWatal, Intellectual property rights in the WTO and developing countries, Oxford University Press, Oxford.

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Regarding UGC guidelines of framing CBCS syllabus a curriculum for awareness of disability/challenged to be incorporated for all the students at UG level which was discussed during the workshop of UGBS in Botany (General) for framing syllabus. As there is no scope to incorporate this subject in Botany (general) syllabus, one separate compulsory subject (like compulsory subject Environmental Sciences) to be framed and incorporated in UG curriculum for the said awareness of disability/challenged.