

Approved by the ___ th Academic Council Meeting (AC:)

Under Graduate CBCS Syllabus

Botany

Nagaland University

(Honours and Pass Course)

2022

Outline of B. Sc. Honours Course Structure

Course Code

AECC: Ability Enhancement Compulsory Course; BCC: Botany Core Course; BGE: Botany Generic Elective; BDSE: Botany Discipline Specific Elective; BSEC: Botany Skill Enhancement Course

Semester	Core Course (BCC) (14)	Ability Enhancement Compulsory Course (AECC) (2)	Skill Enhancement Course (SEC) (2)	Discipline Specific Elective (DSE) (4)	Generic Elective (GE) (4)
I	BCC-01: Microbiology and Phycology	AEC-01 English Communication			BGE - 01
	BCC-02: Biomolecules and Cell Biology				
II	BCC-03: Mycology and Phytopathology	AEC-02 Environmental Science			BGE - 02
	BCC-04: Archegoniate				
III	BCC-05: Morphology and Anatomy of Angiosperms		BSEC - 01		BGE - 03
	BCC-06: Economic Botany				
	BCC-07: Genetics				
IV	BCC-08: Molecular Biology		BSEC - 02		BGE - 04
	BCC-09: Plant Ecology and Phytogeography				
	BCC-10: Plant Systematics				
V	BCC-11: Reproductive Biology of Angiosperms			BDSE - 01	
	BCC-12: Plant Physiology			BDSE - 02	
VI	BCC-13: Plant Metabolism			BDSE - 03	
	BCC-14: Plant Biotechnology			BDSE - 04	

Outline of Course Structure of B. Sc. with Botany (General)

Semester	Discipline Specific Core Course (DSC) (12 papers)	Ability Enhancement Compulsory Course (AECC) (2 papers)	Skill Enhancement Course (SEC) (4 papers)	Discipline Specific Elective (DSE) (4)
I	DSC -1: Botany: Biodiversity (Microbes, Algae, Fungi and Archegoniate (BGE-01)	English Communication		
	DSC-2 (Paper 1)			
	DSC-3 (Paper 1)			
II	DSC -1: Botany: Plant Anatomy and Embryology (BGE-02)	Environmental Science		
	DSC-2 (Paper 2)			
	DSC-3 (Paper 2)			
III	DSC -1: Botany: Economic Botany and Biotechnology (BGE-03)		BSEC-01 Biofertilizer (BSEC-01.A)	
	DSC-2 (Paper 3)			
	DSC-3 (Paper 3)			
IV	DSC -1: Botany: Environmental Biotechnology (BGE-04)		BSEC-02 Herbal Technology (BSEC-02.D)	
	DSC-2 (Paper 4)			
	DSC-3 (Paper 4)			
V			BSEC-03 Nursery and Gardening	DSE-Botany Paper I: A. Analytical Techniques in Plant Sciences (BDSE-01.A) OR B. Bioinformatics (BDSE-01.B)
VI			BSEC-04 Plant Diversity and Human Welfare	DSE-Botany Paper II: A. Research Methodology (BDSE-04.A) OR Industrial and Environmental Microbiology (BDSE-04.B)

B. Sc. Honours Course Distribution
Note: (T): Theory Paper; (P): Practical Paper

SEMESTER	COURSE CODE	PAPAR CODE	COURSE TITLE	CREDITS
I	BAEC-01	AEC-01	English Communication	2
	BCC-01	CC-01 (T)	Microbiology and Phycology	4
		CC-01 (P)	Microbiology and Phycology	2
	BCC-02	CC-02 (T)	Biomolecules and Cell Biology	4
		CC-02 (P)	Biomolecules and Cell Biology	2
	BGE-01	GE-01 (T)	Biodiversity (Microbes, Algae, Fungi and Archegoniate)	4
GE-01 (P)		Biodiversity (Microbes, Algae, Fungi and Archegoniate)	2	
II	BAEC-02	AEC-02	Environmental Science	2
	BCC-03	CC-03 (T)	Mycology and Phytopathology	4
		CC-03 (P)	Mycology and Phytopathology	2
	BCC-04	CC-04 (T)	Archegoniate	4
		CC-04 (P)	Archegoniate	2
	BGE-02	GE-02 (T)	Plant Anatomy and Embryology	4
GE-02 (P)		Plant Anatomy and Embryology	2	
III	BCC-05	CC-05 (T)	Morphology and Anatomy of Angiosperms	4
		CC-05 (P)	Morphology and Anatomy of Angiosperms	2
	BCC-06	CC-06 (T)	Economic Botany	4
		CC-06 (P)	Economic Botany	2
	BCC-07	CC-07 (T)	Genetics	4
		CC-07 (P)	Genetics	2
	BSEC-01	SEC-01	<i>Any ONE from the following:</i> A. Biofertilizers B. Floriculture C. Intellectual Property Rights.	2
	BGE-03	GE-03 (T)	Economic Botany and Biotechnology	4
GE-03 (P)		Economic Botany and Biotechnology	2	
IV	BCC-08	CC-08 (T)	Molecular Biology	4
		CC-08 (P)	Molecular Biology	2
	BCC-09	CC-09 (T)	Plant Ecology and Phytogeography	4
		CC-09 (P)	Plant Ecology and Phytogeography	2
	BCC-10	CC-10 (T)	Plant Systematics	4
		CC-10 (P)	Plant Systematics	2
BSEC-02	SEC-02	<i>Any ONE from the following:</i> A. Medicinal Botany B. Mushroom Culture Technology C. Ethnobotany D. Herbal Technology	2	

	BGE-04	GE-04 (T)	Environmental Biotechnology	4
		GE-04 (P)	Environmental Biotechnology	2
V	BCC-11	CC-11 (T)	Reproductive Biology of Angiosperms	4
		CC-11 (P)	Reproductive Biology of Angiosperms	2
	BCC-12	CC-12 (T)	Plant Physiology	4
		CC-12 (P)	Plant Physiology	2
	BDSE-01	DSE-01 (T)	A. Analytical Techniques in Plant Sciences OR B. Bioinformatics	4
		DSE-01 (P)	A. Analytical Techniques in Plant Sciences OR B. Bioinformatics	2
	BDSE-02	DSE-02 (T)	A. Plant Breeding OR B. Biostatistics	4
		DSE-02 (P)	A. Plant Breeding OR B. Biostatistics	2
VI	BCC-13	CC-13 (T)	Plant Metabolism	4
		CC-13 (P)	Plant Metabolism	2
	BCC-14	CC-14 (T)	Plant Biotechnology	4
		CC-14 (P)	Plant Biotechnology	2
	BDSE-03	DSE-03 (T)	A. Natural Resource Management OR B. Horticultural Practices and Post-Harvest Technology	4
		DSE-03 (P)	A. Natural Resource Management OR B. Horticultural Practices and Post-Harvest Technology	2
	BDSE-04	DSE-04 (T)	A. Research Methodology OR B. Industrial and Environmental Microbiology	4
		DSE-04 (P)	A. Research Methodology OR B. Industrial and Environmental Microbiology	2
Total Credit				140

Detailed Syllabus

CORE COURSES for B. Sc. Honours

Course Code: BCC-01: Microbiology and Phycology

(Credits: Theory-4, Practical-2)

Paper Code: CC-01 (T): THEORY (Lectures: 60)

Unit 1: Introduction to microbiology

(8 Lectures)

Three Domains of life and its evolutionary relationship. Introduction to bacteria, viruses, algae. Microbial nutrition, growth and metabolism.

Unit 2: Viruses

(8 Lectures)

Introduction to virus. Types of virus: DNA virus, RNA virus and Retrovirus. Virus replication: lytic and lysogenic cycle. Viroid and Prions.

Unit 3: Bacteria

(8 Lectures)

Discovery, general characteristics; types-archaeobacteria, eubacteria, wall-less forms (mycoplasma and spheroplasts); Cell structure; Nutritional types; Reproduction-vegetative, asexual and recombination (conjugation, transformation and transduction). Economic importance of bacteria.

Unit 4: Algae

(10 Lectures)

General characteristics, Range of thallus organization; Cell structure and components; cell wall, pigment system, reserve food (of only groups represented in the syllabus), flagella, methods of reproduction. Classification system (Fritsch) and Economic importance of algae.

Unit 5: Cyanophyta and Xanthophyta

(8 Lectures)

Ecology and occurrence; Range of thallus organization; Cell structure; Reproduction, Morphology and life-cycle of *Nostoc* and *Vaucheria*.

Unit 6: Chlorophyta and Charophyta

(8 Lectures)

General characteristics; Occurrence; Range of thallus organization; Cell structure; Reproduction. Morphology and life-cycles of *Oedogonium* and *Chara*. Evolutionary significance of *Prochloron*.

Unit 7: Phaeophyta and Rhodophyta

(10 Lectures)

Characteristics; Occurrence; Range of thallus organization; Cell structure; Reproduction. Morphology and life-cycles of *Ectocarpus* and *Polysiphonia*.

Paper Code: CC-01 (P) PRACTICAL

Microbiology

1. Electron micrographs/Models of viruses – T-Phage and TMV, Line drawings/ Photographs of Lytic and Lysogenic Cycle.
2. Types of Bacteria to be observed from temporary/permanent slides/photographs. Electron micrographs of bacteria, binary fission, endospore, conjugation, root Nodule.
3. Gram staining.
4. Study of Root nodules and its importance

Phycology

1. Study of vegetative and reproductive structures of *Nostoc*, *Oedogonium*, *Chara*, *Vaucheria*, *Ectocarpus* and *Polysiphonia*, *Prochloron* through electron micrographs, temporary preparations and permanent slides.

Suggested Readings

1. Lee, R.E. (2008). **Phycology**, Cambridge University Press, Cambridge. 4th edition.
2. Wiley JM, Sherwood LM and Woolverton CJ. (2013) **Prescott's Microbiology. 9th Edition.** McGrawHill International.
3. Kumar, H.D. (1999). **Introductory Phycology**. Affiliated East-West Press, Delhi.
4. Sahoo, D. (2000). **Farming the ocean: seaweeds cultivation and utilization.** Aravali International, New Delhi.
5. Campbell, N.A., Reece J.B., Urry L.A., Cain M.L., Wasserman S.A. Minorsky P.V., Jackson R.B. (2008). **Biology**, Pearson Benjamin Cummings, USA. 8th edition.
6. Pelczar, M.J. (2001) **Microbiology, 5th edition**, Tata McGraw-Hill Co, New Delhi.

Course Code: BCC-02: Biomolecules and Cell Biology
(Credits: Theory-4, Practical-2)

Paper Code: CC-02 (T) THEORY (Lectures: 60)

Unit 1: Biomolecules (20 Lectures)

Types and significance of chemical bonds; Structure and properties of water; pH and buffers.

Carbohydrates: Nomenclature and classification; Monosaccharides; Disaccharides; Oligosaccharides and polysaccharides.

Lipids: Definition and major classes of storage and structural lipids; Fatty acids structure and functions; Essential fatty acids; Triacyl glycerols structure, functions and properties; Phosphoglycerides.

Proteins: Structure of amino acids; Levels of protein structure-primary, secondary, tertiary and quaternary; Protein denaturation and biological roles of proteins.

Nucleic Acids: Structure of nitrogenous bases; Structure and function of nucleotides; Types of nucleic acids; Structure of DNA, structure of A, B, Z types of DNA. Types of RNA, structure of tRNA and mRNA.

Unit 2: Bioenergetics (4 Lectures)

Laws of thermodynamics, concept of free energy, endergonic and exergonic reactions, coupled reactions, redox reactions. ATP: structure, its role as an energy currency molecule.

Unit 3: Enzymes (6 Lectures)

Structure of enzyme: holoenzyme, apoenzyme, cofactors, coenzymes and prosthetic group; Classification of enzymes; Features of active site, substrate specificity, mechanism of action (activation energy, lock and key hypothesis, induced-fit theory), Michaelis–Menten equation, enzyme inhibition and factors affecting enzyme activity.

Unit 4: The Cell (4 Lectures)

Cell as a unit of structure and function; Characteristics of prokaryotic and eukaryotic cells; Origin of eukaryotic cell (Endosymbiotic theory).

Unit 5: Cell wall and Plasma Membrane (4 Lectures)

Chemistry, structure and function of Plant cell wall. Overview of membrane function; fluid mosaic model; Membrane transport – Passive, active and facilitated transport, endocytosis and exocytosis.

Unit 6: Cell Organelles (16 Lectures)

Nucleus: Structure-nuclear envelope, nuclear pore complex, nuclear lamina, molecular organization of chromatin; nucleolus.

Cytoskeleton: Role and structure of microtubules, microfilaments and intermediary filament.

Chloroplast, Mitochondria and Peroxisomes: Structural organization; Function; Semiautonomous nature of mitochondria and chloroplast.

Endomembrane System: Endoplasmic Reticulum – Structure, targeting and insertion of proteins in the ER, protein folding, processing; Smooth ER and lipid synthesis, export of proteins and lipids; Golgi Apparatus – organization, protein glycosylation, protein sorting and export from Golgi Apparatus; Lysosomes

Unit 7: Cell Division

(6 Lectures)

Phases of eukaryotic cell cycle, mitosis and meiosis; Regulation of cell cycle- checkpoints, role of protein kinases.

Paper Code: CC-02 (P) Practical

1. Qualitative tests for carbohydrates, reducing sugars, non-reducing sugars, lipids and proteins.
2. Study of plant cell structure with the help of epidermal peel mount of Onion/*Rhoeo*/*Crinum*.
3. Demonstration of the phenomenon of protoplasmic streaming in *Hydrilla* leaf.
4. Measurement of cell size by the technique of micrometry.
5. Cytochemical staining of: DNA- Feulgen and cell wall in the epidermal peel of onion using Periodic Schiff's (PAS) staining technique.
6. Study the phenomenon of plasmolysis and deplasmolysis.
7. Study of different stages of mitosis
8. Study of different stages of meiosis.

Suggested Readings

1. Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning
2. Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone
3. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H. Freeman
4. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H. Freeman and Company
5. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company.
6. Karp, G. (2010). Cell Biology, John Wiley & Sons, U.S.A. 6th edition.
7. Hardin, J., Becker, G., Skliensmith, L.J. (2012). Becker's World of the Cell, Pearson Education Inc. U.S.A. 8th edition.
8. Cooper, G.M. and Hausman, R.E. (2009) The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
9. 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.

Course Code: BCC-03: Mycology and Phytopathology
(Credits: Theory-4, Practical-2)

Paper Code: CC-03 (T) THEORY (Lectures: 60)

Unit 1: Introduction to Fungi

(6 Lectures)

General characteristics; origin, thallus organization; Cell wall composition; Nutrition; Classification (Ainsworth system).

Unit 2: Chytridiomycota and Zygomycota

(5 Lectures)

Characteristic features; Thallus organization; Reproduction; Life cycle with reference to *Synchytrium*, *Rhizopus*.

Unit 3: Ascomycota

(10 Lectures)

General characteristics (asexual and sexual fruiting bodies); Ecology; Life cycle, Heterokaryosis and parasexuality; Life cycle and classification with reference to *Saccharomyces*, *Penicillium*, *Aspergillus*, and *Alternaria*.

Unit 4: Basidiomycota

(8 Lectures)

General characteristics; Life cycle and Classification with reference to *Puccinia* and *Agaricus*; Bioluminescence.

Unit 5: Allied Fungi

(3 Lectures)

General characteristics; Status of Slime molds, Classification; Occurrence; Types of plasmodia; Types of fruiting bodies.

Unit 6: Oomycota

(4 Lectures)

General characteristics; Life cycle and classification with reference to *Phytophthora* and *Albugo*.

Unit 7: Symbiotic Associations

(4 Lectures)

Lichen – Occurrence; General characteristics; Nature of associations of algal and fungal partners; Reproduction; Mycorrhiza-Ectomycorrhiza, Endomycorrhiza and their significance.

Unit 8: Applied Mycology

(10 Lectures)

Application of fungi in food industry (Flavour & texture, Fermentation, Baking, Organic acids, Enzymes; Secondary metabolites (Pharmaceutical preparations); Agriculture (Biofertilizers); Mycotoxins; Biological control (Mycofungicides, Mycoherbicides, Mycoinsecticides, Myconematicides).

Unit 9: Phytopathology

(10 Lectures)

Terms and concepts; General symptoms, Host-Pathogen relationships, Disease cycle and environmental relation; prevention and control of plant diseases, and role of quarantine.

Bacterial diseases – Citrus canker and bacterial leaf wilt of tomato.

Viral diseases – Papaya Mosaic viruses, vein clearing.

Fungal diseases – Early blight of potato, Black stem rust of wheat, White rust of crucifers, powdery mildew, damping off disease.

Paper Code: CC-03 (P) Practical

1. Introduction to the world of fungi (Unicellular, coenocytic /septate mycelium, ascocarps and basidiocarps).
2. *Rhizopus*: study of asexual stage from temporary mounts and sexual structures through permanent slides.
3. *Aspergillus* and *Penicillium*: study of asexual stage from temporary mounts. Study of Sexual stage from permanent slides/photographs.
5. *Alternaria*: Specimens/photographs and temporary mounts.
6. *Puccinia*: Herbarium specimens of Black Stem Rust of Wheat and infected Barberry leaves; sections/ mounts of spores on wheat and permanent slides of both the hosts.
7. *Pleurotus* specimens of button stage and full-grown mushroom; sectioning of gills.
8. *Albugo*: Study of symptoms of plants infected with *Albugo*; asexual phase study through section/temporary mounts and sexual structures through permanent slides.
9. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose) on different substrates. Study of thallus and reproductive structures (soredia and apothecium) through permanent slides. Mycorrhizae: ectomycorrhiza and endomycorrhiza (Photographs)
10. Phytopathology: Herbarium specimens of bacterial diseases; Citrus Canker; bacterial leaf wilt of tomato.
11. Viral diseases in the locality.

Suggested Readings

1. Agrios, G.N. (1997) Plant Pathology, 4th edition, Academic Press, U.K.
2. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley & Sons (Asia) Singapore. 4th edition.
3. Webster, J. and Weber, R. (2007). Introduction to Fungi, Cambridge University Press, Cambridge. 3rd edition.
4. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, Macmillan Publishers India Ltd.
5. Sharma, P.D. (2011). Plant Pathology, Rastogi Publication, Meerut, India.

Course Code: BCC-04: Archegoniate (Bryophytes, Pteridophytes and Gymnosperms)

(Credits: Theory-4, Practical-2)

Paper Code: CC-04 (T) THEORY Lectures: 60

Unit 1: Introduction to Bryophytes and Pteridophytes (12 Lectures)

Unifying features of archegoniates; Alternation of generations. Bryophytes-General characteristics; Classification; Pteridophytes- General characteristics; Classification; Early land plants (*Rhynia*).

Unit 2: Type Studies- Bryophytes (12 Lectures)

Classification (up to family) (Proskauer, 1957), morphology, anatomy, reproduction and evolutionary trends of *Marchantia*, *Anthoceros*, *Sphagnum* and *Funaria*; Ecological and economic importance of bryophytes with special reference to *Sphagnum*.

Unit 3: Type Studies- Pteridophytes (12 Lectures)

Classification (up to family), morphology, anatomy and reproduction of *Selaginella*, *Equisetum* and *Pteris* (Developmental details not to be included). Apogamy and apospory, heterospory and seed habit, telome theory, Stejar evolution.

Unit 4: Gymnosperms (12 Lectures)

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

Unit 5: Paleobotany (12 Lectures)

Geological time scale; fossil types and their formation; general account of dominant fossil flora of different ages; paleobotany in relation to exploration of fossil fuels.

Paper Code: CC-04 (P) Practical

1. **Marchantia**- Morphology of thallus, whole mount of rhizoids & Scales, vertical section of thallus through Gemma cup, whole mount of Gemmae (all temporary slides), vertical section of Antheridiophore, Archegoniophore, longitudinal section of Sporophyte (all permanent slides).
2. **Anthoceros**- Morphology of thallus, dissection of sporophyte (to show stomata, spores, pseudoelaters, columella) (temporary slide), vertical section of thallus (permanent slide).
3. **Sphagnum**- Morphology of plant, whole mount of leaf (permanent slide only).
4. **Funaria**- Morphology, whole mount of leaf, rhizoids, operculum, peristome, annulus, spores(temporary slides); permanent slides showing antheridial and archegonial heads, longitudinal section of capsule and protonema.
5. **Selaginella**- Morphology, whole mount of leaf with ligule, transverse section of stem, wholemount of strobilus, whole mount of microsporophyll and megasporophyll (temporary slides), longitudinal section of strobilus (permanent slide).
6. **Equisetum**- Morphology, transverse section of internode, longitudinal section of strobilus, transverse section of strobilus, whole mount of sporangiophore, whole mount of spores (wet and dry) (temporary slide), transverse section of rhizome (permanent slide).
7. **Pteris**- Morphology, transverse section of rachis, vertical section of sporophyll, wholemount of sporangium, whole mount of spores (temporary slides), transverse section of rhizome, wholemount of prothallus with sex organs and young sporophyte (permanent slide).
8. **Cycas**- Morphology (coralloid roots, bulbil, leaf), whole mount of microsporophyll, transverse section of coralloid root, transverse section of rachis, vertical section of leaflet, vertical section of microsporophyll, whole mount of spores (temporary slides), longitudinal section of ovule, transverse section of root (permanent slide).
9. **Pinus**- Morphology (long and dwarf shoots, whole mount of dwarf shoot, male and female cones), transverse section of Needle, transverse section of stem, longitudinal section of /transverse section of male cone, whole mount of microsporophyll, whole mount of Microspores(temporary slides), longitudinal section of female cone, tangential longitudinal section & radial longitudinal sections stem (permanent slide).
10. **Gnetum**- Morphology (stem, male & female cones), transverse section of stem, vertical section of ovule (permanent slide)
11. **Botanical excursion.**

Suggested Readings

1. Vashistha, P.C., Sinha, A.K., Kumar, A. (2010). **Pteridophyta**. S. Chand. Delhi, India.
2. Bhatnagar, S.P. & Moitra, A. (1996). **Gymnosperms**. New Age International (P) Ltd Publishers, New Delhi, India.
3. Parihar, N.S. (1991). **An introduction to Embryophyta**: Vol. I. Bryophyta. Central Book Depot. Allahabad.
4. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005). **Biology**. Tata McGraw Hill, Delhi.
5. Vanderpoorten, A. & Goffinet, B. (2009) **Introduction to Bryophytes**. Cambridge University Press.

Course Code: BCC - 05: Morphology and Anatomy of Angiosperms

(Credits: Theory-4, Practical-2)

Paper Code: CC-05 (T) THEORY Lectures: 60

Unit 1: Root, Stem and Leaf Morphology (8 Lectures)

: Structures, types, with reference to modification with examples.

Unit 2: Flowers, Fruits and Seeds Morphology (8 Lectures)

Characteristics, structure, types, classification, types and function.

Unit 3: Introduction to Structure and Development of Plant Body and Tissues (10 Lectures)

Internal organization of plant body: The three tissue systems, types of cells and tissues. Development of plant body: Polarity.

Classification of tissues; Simple and complex tissues; Wall ingrowths and transfer cells, Ergastic substances. Hydathodes, cavities, lithocysts and laticifers.

Unit 3: Apical Meristems (12 Lectures)

Evolution of concept of organization of shoot apex (Apical cell theory, Histogen theory, TunicaCorpus theory, Types of vascular bundles; Structure of dicot and monocot stem. Development, arrangement and diversity in size and shape of leave; Structure of dicot and monocot leaf, Kranz anatomy. Organization of root apex (Apical cell theory, Histogen theory, Korper-Kappe theory); Quiescent centre; Root cap; Structure of dicot and monocot root.

Unit 4: Vascular Cambium and Wood (12 Lectures)

Structure, function and seasonal activity of cambium; Secondary growth in root and stem. Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood, tyloses; Dendrochronology. periderm, rhytidome and lenticels.

Unit 5: Adaptive and Protective Systems (10 Lectures)

Epidermal tissue system, cuticle, epicuticular waxes, trichomes (uni-and multicellular, glandular and non glandular, two examples of each), stomata (classification); Anatomical adaptations of xerophytes and hydrophytes. Adcrustation and incrustation.

Paper Code: CC-05 (P) Practical

1. Study of vegetative and floral characters of some plant species.
2. Study of root and its modifications
3. Study of stem and its modifications
4. Study of leaf and its modifications
5. Study of floral morphology and inflorescences
6. Study of fruits
7. Study of anatomical details through permanent slides/temporary stain mounts/macerations/museum specimens with the help of suitable examples.
8. Distribution and types of aerenchyma, parenchyma, collenchyma and sclerenchyma.
9. Xylem: tracheary elements-tracheids, vessel elements; thickenings; perforation plates; xylem fibres.
10. Wood: ring porous; diffuse porous; tyloses; heart- and sapwood.
11. Phloem: Sieve tubes-sieve plates; companion cells; phloem fibres.
12. Epidermal system: cell types, stomata types; trichomes: non-glandular and glandular.
13. Root: monocot, dicot, secondary growth.
14. Stem: monocot, dicot - primary and secondary growth; periderm; lenticels.
15. Leaf: isobilateral, dorsiventral, C4 leaves (Kranz anatomy).
16. Adaptive Anatomy: xerophytes, hydrophytes.
17. Secretory tissues: cavities, lithocysts and laticifers.

Suggested Readings

1. Dickison, W.C. (2000). Integrative Plant Anatomy. Harcourt Academic Press, USA.
2. Fahn, A. (1974). Plant Anatomy. Pergmon Press, USA.
3. Mauseth, J.D. (1988). Plant Anatomy. The Benjamin/Cummings Publisher, USA.
4. Evert, R.F. (2006) Esau's Plant Anatomy: Meristems, Cells, and Tissues of the Plant Body: Their Structure, Function and Development. John Wiley and Sons, Inc.
5. Bhattacharaya, K., Hait, G., Ghosh, A.K. (2008). A Text Book of Botany, Vol. 2, New Central Book Agency (P) Ltd. Kolkata.
6. Bhattacharaya, K., Ghosh, A.K., Hait, G. (2017). A Text Book of Botany, Vol. 4. New Central Book Agency (P) Ltd. Kolkata.
7. Pandey B.P. (2002). Plant Anatomy. S. Chand & Company Ltd., New Delhi.

Course Code: BCC - 06: Economic Botany

(Credits: Theory-4, Practical-2)

Paper Code: CC-06 (T) THEORY Lectures: 60

Unit 1: Origin of Cultivated Plants (6 Lectures)

Concept of Centres of Origin, their importance with reference to Vavilov's work. Examples of major plant introductions; Crop domestication and loss of genetic diversity; evolution of new crops/varieties, importance of germplasm diversity.

Unit 2: Cereals (6 Lectures)

Wheat and Rice (origin, morphology, processing and uses); Brief account of millets.

Unit 3: Legumes (6 Lectures)

Origin, morphology and uses of soybean, phaseolus legumes. Importance to man.

Unit 4: Sources of sugars and starches (4 Lectures)

Morphology and processing of sugarcane, products and by-products of sugarcane industry. Potato – morphology, propagation and uses.

Unit 5: Spices (6 Lectures)

Listing of important spices, their family and part used. Economic importance with special reference to ginger, cardamom, cinnamon, and black pepper

Unit 6: Beverages (4 Lectures)

Tea, Coffee (morphology, processing and uses).

Unit 7: Sources of oils and fats (10 Lectures)

General description, classification, extraction, their uses and health implications groundnut, sesame, coconut, linseed, mustard and coconut (Botanical name, family and uses).

Unit 8: Natural Rubber (3 Lectures)

Para-rubber: tapping, processing and uses.

Unit 9: Drug-yielding plants (8 Lectures)

Therapeutic and habit-forming drugs with special reference to *Cinchona*, *Digitalis*, *Papaver* and *Cannabis*;

Unit 10: Timber plants (3 Lectures)

General account with special reference to teak and pine.

Unit 11: Fibers (4 Lectures)

Types based on the origin of fibers; Cotton and Jute (morphology, extraction and uses).

Paper Code: CC-06 (P) Practical

1. **Cereals:** Wheat (habit sketch, L. S/T.S. grain, starch grains), Rice(habit sketch, study of paddy and grain, starch grains).
2. **Legumes:** Groundnut, (habit, fruit, seed structure).
3. **Sources of sugars and starches:** Sugarcane (habit sketch),Potato (habit sketch, tuber morphology, T.S. tuber to show localization of starch grains)
4. **Spices:** Black pepper, ginger (habit and sections).
5. **Beverages:** Tea (plant specimen, tea leaves), Coffee (plant specimen, beans).
6. **Sources of oils and fats:** Coconut, Mustard–plant specimen, seeds
7. **Essential oil-yielding plants:** Habit sketch of *Rosa*, *Vetiveria*, *Santalum* and *Eucalyptus* (specimens/photographs).
8. **Rubber:** specimen, photograph/model of tapping, samples of rubber products.
9. **Drug-yielding plants:** collection and herbarium
10. **Woods:** collection of specimen
11. **Fiber-yielding plants:** Cotton and jute: collection

Suggested Readings

1. Kochhar, S.L. (2012). Economic Botany in Tropics, MacMillan & Co. New Delhi, India.
2. Wickens, G.E. (2001). Economic Botany: Principles & Practices. Kluwer Academic Publishers,The Netherlands.
3. Chrispeels, M.J. and Sadava, D.E. 1994 Plants, Genes and Agriculture. Jones & Bartlett Publishers.

Course Code: BCC - 07: Genetics

(Credits: Theory-4, Practical-2)

Paper Code: CC-07 (T) THEORY (Lectures: 60)

Unit 1: Mendelian Genetics and its Extension (16 Lectures)

Mendelism: History; Principles of inheritance; Chromosome theory of inheritance; Autosomes and sex chromosomes; Probability and pedigree analysis; Incomplete dominance and codominance; Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Recessive and Dominant traits, Numericals; Polygenic inheritance.

Unit 2: Extrachromosomal Inheritance (6 Lectures)

Chloroplast mutation: Variegation in Four o'clock plant; Mitochondrial mutations in yeast; Maternal effects-shell coiling in snail; Infective heredity- Kappa particles in *Paramecium*.

Unit 3: Linkage, crossing over and chromosome mapping (12 Lectures)

Linkage and crossing over-Cytological basis of crossing over; Recombination frequency, two factor and three factor crosses; Interference and coincidence; Numericals based on gene mapping; Sex Linkage.

Unit 4: Variation in Chromosome Number and Structure (8 Lectures)

Deletion, Duplication, Inversion, Translocation, Position effect, Euploidy and Aneuploidy.

Unit 5: Gene Mutations (6 Lectures)

Types of mutations; Molecular basis of Mutations; Mutagens – physical and chemical (Baseanalogues, deaminating, alkylating and intercalating agents) Role of Transposons in mutation. DNA repair mechanisms.

Unit 6: Fine Structure of Gene (6 Lectures)

Classical vs molecular concepts of gene; Cis-Trans complementation test for functional allelism.

Unit 7: Population and Evolutionary Genetics (6 Lectures)

Allele frequencies, Genotype frequencies, Hardy-Weinberg Law, role of natural selection, mutation, genetic drift. Genetic variation and Speciation.

Paper Code: CC-07 (P) Practical

1. Meiosis through temporary squash preparation.
2. Mendel's laws through seed ratios. Laboratory exercises in probability and chi-square.
3. Chromosome mapping using point test cross data.
4. Pedigree analysis for dominant and recessive autosomal and sex linked traits.
5. Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1,9:3:4).
6. Blood Typing: ABO groups & Rh factor.
7. Study of aneuploidy: Down's, Klinefelter's and Turner's syndromes.
8. Photographs/Permanent Slides showing Translocation Ring, Laggards and Inversion Bridge.
9. Study of human genetic traits: Sickle cell anemia, Xeroderma Pigmentosum, Albinism, red-green Colour blindness, Widow's peak, Rolling of tongue, Hitchhiker's thumb and Attached ear lobe.

Suggested Readings

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (1991). Principles of Genetics, John Wiley & sons, India. 8th edition.
2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics, John Wiley & Sons Inc., India. 5th edition.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings, U.S.A. 9th edition.
4. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.

Course Code: BCC - 08: Molecular Biology

Paper Code: CC-08 (T) THEORY (Lectures: 60)

Unit 1: Nucleic Acids: Carriers of Genetic Information (4 Lectures)

DNA as the carrier of genetic information (Griffith's, Hershey & Chase, Avery, McLeod & McCarty experiments).

Unit 2: The Structures of DNA and RNA / Genetic Material (10 Lectures)

DNA Structure: Salient features of double helix (Watson and Crick), Types of genetic material, denaturation and renaturation; Organization of DNA- Prokaryotes, Viruses, Eukaryotes. RNA Structure, mitochondria and chloroplast DNA. The Nucleosome, Chromatin structure- Euchromatin, Heterochromatin- Constitutive and Facultative heterochromatin.

Unit 3: The Replication of DNA (10 Lectures)

General principles – bidirectional, semi-conservative and semi discontinuous replication, RNA priming; replication of DNA in prokaryotes and eukaryotes; Enzymes involved in DNA replication.

Unit 4: Central Dogma and Genetic Code (2 Lectures)

Key experiments establishing-The Central Dogma (Adaptor hypothesis and discovery of mRNA template), Genetic code (deciphering & salient features).

Unit 5: Transcription (18 Lectures)

Transcription in prokaryotes and eukaryotes. Principles of transcriptional regulation; Prokaryotes: Regulation of lactose metabolism and tryptophan synthesis in *E.coli*. Gene silencing.

Unit 6: Processing and Modification of RNA (8 Lectures)

Split genes-concept of introns and exons, removal of introns, spliceosome machinery, splicing pathways, group I and group II intron splicing, alternative splicing eukaryotic mRNA processing (5' cap, 3' polyA tail); RNA editing and mRNA transport.

Unit 7: Translation (8 Lectures)

Ribosome structure and assembly, mRNA; Charging of tRNA, aminoacyl tRNA synthetases; various steps in protein synthesis, proteins involved in initiation, elongation and termination of polypeptide; Inhibitors of protein synthesis; Post-translational modifications of proteins.

Paper Code: CC-08 (P) Practical

1. DNA isolation from any plant.
2. DNA estimation by diphenylamine reagent/UV- Spectrophotometry.
3. Study of DNA replication mechanisms through photographs
4. Study of structures of prokaryotic RNA polymerase and eukaryotic RNA polymerase II through photographs.
5. Photographs establishing nucleic acid as genetic material (Messelson and Stahl's, Avery et al, Griffith's, Hershey & Chase's and Fraenkel & Conrat's experiments)
6. Study of the following through photographs: Assembly of Spliceosome machinery; Splicing mechanism in group I & group II introns; Ribozyme and Alternative splicing.

Suggested Readings

1. Watson J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., Losick, R. (2007). Molecular Biology of the Gene, Pearson Benjamin Cummings, CSHL Press, New York, U.S.A. 6th edition.
2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons Inc., U.S.A. 5th edition.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings. U.S.A. 9th edition.
4. Russell, P. J. (2010). Genetics- A Molecular Approach. Benjamin Cummings, U.S.A. 3rd edition.
5. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.

Course Code: BCC - 09: Plant Ecology and Phytogeography
(Credits: Theory-4, Practical-2)

Paper Code: CC-09 (T) THEORY (Lectures: 60)

Unit 1: Introduction

(4 Lectures)

Basic concepts; Levels of organization. Inter-relationships between the living world and the environment, the components and dynamism, homeostasis.

Unit 2: Soil

(8 Lectures)

Origin; Formation; Composition (Physical; Chemical and Biological components), Soil profile.

Unit 3: Water

(4 Lectures)

Importance: States of water in the environment; Atmospheric moisture; Precipitation types (rain, fog, snow, hail, dew); Hydrological Cycle; Water in soil; Water table.

Unit 4: Light, Temperature, Wind and Fire

(6 Lectures)

Variations; adaptations of plants to their variation.

Unit 5: Biotic Interactions

(2 Lectures)

Trophic organization, basic source of energy, autotrophy, heterotrophy; symbiosis, commensalism, parasitism; food chains and webs; ecological pyramids; biomass, standing crop.

Unit 6: Population Ecology

(4 Lectures)

Characteristics and Dynamics. Ecological Speciation.

Unit 7: Plant Communities

(8 Lectures)

Concept of ecological amplitude; Habitat and niche; Characters: analytical and synthetic; Ecotone and edge effect; Dynamics: succession – processes, types; climax concepts.

Unit 8: Ecosystems

(4 Lectures)

Structure; Processes; Trophic organization; Food chains and Food webs; Ecological pyramids.

Unit 9: Functional Aspects of Ecosystem

(8 Lectures)

Principles and models of energy flow; Production and productivity; Ecological efficiencies; Biogeochemical cycles; Cycling of Nitrogen and Phosphorus.

Unit 10: Phytogeography

(12 Lectures)

Principles; Continental drift; Theory of tolerance; Endemism; Brief description of major terrestrial biomes (one each from tropical, temperate & tundra); Phytogeographical division of India; Local Vegetation.

Paper Code: CC-09 (P) Practical

1. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter.
2. Determination of pH of various soil and water samples (pH meter, universal indicator/Lovibond comparator and pH paper)
3. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid field tests.
4. Determination of organic matter of different soil samples by titration method.
5. Comparison of bulk density, porosity and rate of infiltration of water in soils of three habitats.
6. Determination of dissolved oxygen of water samples from polluted and unpolluted sources.
7. (a). Study of morphological adaptations of hydrophytes and xerophytes.
(b). Study of biotic interactions of the following: Stem parasite (*Cuscuta*), Root parasite (*Orobanch*) Epiphytes, Predation (Insectivorous plants).
8. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus, by species area curve method (species to be listed).
9. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law.
10. Quantitative analysis of herbaceous vegetation for density and abundance in the college campus.
11. Field visit to familiarise students with ecology of different sites.

Suggested Readings

1. Odum, E.P. (2005). Fundamentals of Ecology. Cengage Learning India Pvt. Ltd., New Delhi. 5th edition.
2. Singh, J.S., Singh, S.P., Gupta, S. (2006). Ecology Environment and Resource Conservation. Anamaya Publications, New Delhi, India.
3. Sharma, P.D. (2010). Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.
4. Wilkinson, D.M. (2007). Fundamental Processes in Ecology: An Earth Systems Approach. Oxford University Press. U.S.A.
5. Kormondy, E.J. (1996). Concepts of Ecology. PHI Learning Pvt. Ltd., Delhi, India. 4th edition.

Course Code: BCC - 10: Plant Systematics
(Credits: Theory-4, Practical-2)

Paper Code: CC-10 (T) THEORY (Lectures: 60)

Unit 1: Significance of Plant Systematics (15 Lectures)

Introduction to systematics; Plant identification, Classification, Nomenclature. Evidences from palynology. Field inventory; Functions of Herbarium; Important herbaria and botanical gardens of the world and India; Virtual herbarium; E-flora; Documentation: Flora, Monographs, Journals; Keys: Single access and Multi-access.

Unit 2: Taxonomic hierarchy (8 Lectures)

Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concept (taxonomic, biological, evolutionary).

Unit 3: Botanical Nomenclature (12 Lectures)

Principles and rules (ICN); Ranks and names; Typification, author citation, valid publication, rejection of names, principle of priority and its limitations; Names of hybrids.

Unit 4: Systems of classification (13 Lectures)

Major contributions of Linnaeus, Hutchinson; Classification systems of Bentham and Hooker (upto series) and Engler and Prantl (upto series); Brief reference of Angiosperm Phylogeny Group (APG III) classification.

Unit 5: Phylogeny of Angiosperms (12 Lectures)

Terms and concepts (primitive and advanced, homology and analogy, parallelism and convergence, monophyly, Paraphyly, polyphyly and clades). Origin and evolution of angiosperms; Methods of illustrating evolutionary relationship (phylogenetic tree, cladogram).

Paper Code: CC-10 (P) Practical

1. Study of vegetative and floral characters of the following families (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification):

Ranunculaceae - *Ranunculus*, *Delphinium*

Brassicaceae - *Brassica*, *Alyssum* / *Iberis*

Myrtaceae - *Eucalyptus*, *Callistemon*

Umbelliferae - *Coriandrum* / *Anethum* / *Foeniculum*

Asteraceae - *Sonchus/Launaea*, *Vernonia/Ageratum*, *Eclipta/Tridax*

Solanaceae - *Solanum nigrum/Withania*

Lamiaceae - *Salvia/Ocimum*

Euphorbiaceae - *Euphorbia hirta/E.milii*, *Jatropha*

Liliaceae - *Asphodelus/Lilium/Allium*

Poaceae - *Triticum/Hordeum/Avena*

2. Field visit (local) – Subject to grant of funds from the university.

3. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book).

Suggested Readings

1. Singh, (2012). Plant Systematics: Theory and Practice Oxford & IBH Pvt. Ltd., New Delhi. 3rd edition.

2. Jeffrey, C. (1982). An Introduction to Plant Taxonomy. Cambridge University Press, Cambridge.

3. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. (2002). Plant Systematics-A Phylogenetic Approach. Sinauer Associates Inc., U.S.A. 2nd edition.

4. Radford, A.E. (1986). Fundamentals of Plant Systematics. Harper and Row, New York.

Course Code: BCC - 11: Reproductive Biology of Angiosperms
(Credits: Theory-4, Practical-2)

Paper Code: CC-11 (T) THEORY (Lectures: 60)

Unit 1: Introduction and Reproductive Development (6 Lectures)

History and scope of embryology. Induction of flowering; flower as a modified determinate shoot.

Unit 2: Anther and Pollen Biology (10 Lectures)

Anther wall: Structure and functions, micro sporogenesis, callose deposition and its significance. Micro gametogenesis, Pollen wall proteins; Pollen viability, storage and germination; Abnormal features: Pseudomonads, polyads, massulae, pollinia.

Unit 3: Ovule (10 Lectures)

Structure; Types; Special structures—endothelium, obturator, aril, caruncle and hypostase; Female gametophyte—megasporogenesis (monosporic, bisporic and tetrasporic) and megagametogenesis. details of *Polygonum* type); Organization and ultrastructure of mature embryo sac.

Unit 4: Pollination and Fertilization (8 Lectures)

Pollination types and significance; adaptations; structure of stigma and style; path of pollen tube in pistil; double fertilization.

Unit 5: Self Incompatibility (10 Lectures)

Basic concepts (interspecific, intraspecific, homomorphic, heteromorphic, GSI and SSD); Modification of stigma surface. Parasexual hybridization, cybrids, *in vitro* fertilization.

Unit 6: Embryo, Endosperm and Seed (10 Lectures)

Structure and types; General pattern of development of dicot and monocot embryo and endosperm; Suspensor: structure and functions; Embryo-endosperm relationship; Nutrition of embryo. Seed structure, importance and dispersal mechanisms.

Units 7: Polyembryony and Apomixis (6 Lectures)

Introduction; Classification; Causes and applications.

Paper Code: CC-11 (P) Practical

1. Anther: Wall and its ontogeny; Tapetum (amoeboid and glandular); MMC, spore tetrads, uninucleate, bicelled and dehisced anther stages through slides/micrographs
2. Pollen grains: Fresh and acetolyzed showing ornamentation and aperture, pseudomonads, polyads, pollinia (slides/photographs, fresh material).
3. Pollen viability: Tetrazolium test, germination: Calculation of percentage germination in different media using hanging drop method.
4. Ovule: Types-anatropous, orthotropous, amphitropous/campylotropous, circinotropous, unitegmic, bitegmic; Tenuinucellate and crassinucellate.
5. Female gametophyte through permanent slides/ photographs: Types, ultra structure of mature egg apparatus.
6. Intra-ovarian pollination; Test tube pollination through photographs.
7. Endosperm: Dissections of developing seeds for endosperm with free-nuclear haustoria.
8. Embryogenesis: Study of development of dicot embryo through permanent slides; dissection of developing seeds for embryos at various developmental stages; Study of suspensor through electron micrographs.

Suggested Readings

1. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms, Vikas Publishing House. Delhi. 5th edition.
2. Shivanna, K.R. (2003). Pollen Biology and Biotechnology. Oxford and IBH Publishing Co. Pvt.Ltd. Delhi.
3. Raghavan, V. (2000). Developmental Biology of Flowering plants, Springer, Netherlands.
4. Johri, B.M. I (1984). Embryology of Angiosperms, Springer-Verlag, Netherlands.

Course Code: BCC - 12: Plant Physiology
(Credits: Theory-4, Practical-2)

Paper Code: CC-11 (P) THEORY (Lectures: 60)

Unit 1: Plant-water Relations

(10 Lectures)

Water Potential and its components, water absorption by roots, pathway of water movement, symplast, apoplast, transmembrane pathways, root pressure, guttation. Ascent of sap-cohesion-tension theory. Transpiration and factors affecting transpiration, antitranspirants, mechanism of stomatal movement.

Unit 2: Mineral Nutrition

(8 Lectures)

Essential and beneficial elements, macro and micronutrients, methods of study and use of nutrient solutions, roles of essential elements, deficiency symptoms.

Unit 3: Nutrient Uptake

(8 Lectures)

Soil as a nutrient reservoir, transport of ions across cell membrane, passive absorption, electrochemical gradient, facilitated diffusion, active absorption, role of ATP, carrier systems, proton ATPase pump and ion flux, uniport, co-transport, symport, antiport.

Unit 4: Translocation in the Phloem

(8 Lectures)

Pressure-Flow Model; Phloem loading and unloading; Source-sink relationship.

Unit 5: Plant Growth Regulators

(14 Lectures)

Physiological roles of Auxin, Gibberellins, Cytokinin, Abscisic acid, Ethylene, Brassinosteroids and Jasmonic acid.

Unit 6: Physiology of Flowering

(6 Lectures)

Photoperiodism, flowering stimulus, florigen concept, vernalization, seed dormancy.

Unit 7: Phytochrome, Cryptochromes and Phototropins

(6 Lectures)

Discovery, chemical nature, role in photomorphogenesis, low energy responses (LER) and high irradiance responses (HIR), mode of action.

Paper Code: CC-12 (P) Practical

1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. Determination of water potential of given tissue (potato tuber) by weight method.
3. Study of the rate transpiration by Ganong's photometer.
4. Calculation of stomatal index and stomatal frequency from the two surfaces of leaves of mesophyte and xerophyte.
5. To calculate the area of an open stoma and percentage of leaf area open through stomata in mesophyte and xerophyte (both surfaces).
6. To study the phenomenon of seed germination (effect of light).

Suggested Readings

1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons. U.S.A. 4th edition.
2. Taiz, L., Zeiger, E., Møller, I.M. and Murphy, A. (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.
3. Bajracharya D. (1999). Experiments in Plant Physiology-A Laboratory Manual. Narosa Publishing House, New Delhi.

Course Code: BCC - 13: Plant Metabolism

(Credits: Theory-4, Practical-2)

Paper Code: CC-13 (T) THEORY (Lectures: 60)

Unit 1: Concept of metabolism

(6 Lectures)

Introduction, anabolic and catabolic pathways, regulation of metabolism, role of regulatory enzymes (allosteric, covalent modulation and isozymes).

Unit 2: Carbon Assimilation

(14 Lectures)

Photosynthetic pigments, role of photosynthetic pigments (chlorophylls and accessory pigments), antenna molecules and reaction centres, photochemical reactions, photosynthetic electron transport, PSI, PSII, Q cycle, CO₂ reduction, photorespiration, C₄ pathways; Crassulacean acid metabolism; Factors affecting CO₂ reduction.

Unit 3: Carbohydrate Metabolism

(2 Lectures)

Synthesis and catabolism of sucrose and starch.

Unit 4: Carbon Oxidation

(10 Lectures)

Glycolysis, fate of pyruvate, oxidative pentose phosphate pathway, oxidative decarboxylation of pyruvate; TCA cycle, amphibolic role, anaplerotic reactions, mitochondrial electron transport, oxidative phosphorylation.

Unit 5: ATP-Synthesis

(8 Lectures)

Mechanism of ATP synthesis, chemiosmotic mechanism (oxidative and photophosphorylation), ATP synthase.

Unit 6: Lipid Metabolism

(8 Lectures)

Synthesis and breakdown of triglycerides, β -oxidation and its role in mobilisation of lipids during seed germination.

Unit 7: Nitrogen Metabolism

(8 Lectures)

Nitrate assimilation, biological nitrogen fixation (examples of legumes and non-legumes); Physiology and biochemistry of nitrogen fixation; Ammonia assimilation and transamination.

Unit 8: Mechanisms of Signal Transduction

(4 Lectures)

Receptor-ligand interactions; Second messenger concept, Calcium calmodulin.

Paper Code: CC-13 (P) Practical

1. Chemical separation of photosynthetic pigments.
2. To study the effect of light intensity on the rate of photosynthesis.
3. Effect of carbon dioxide on the rate of photosynthesis.
4. Demonstration of absorption spectrum of photosynthetic pigments.

Suggested Readings

1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons. U.S.A. 4th edition.
2. Taiz, L., Zeiger, E., Møller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.
3. Harborne, J.B. (1973). Phytochemical Methods. John Wiley & Sons. New York.

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Course Code: BCC - 14: Plant Biotechnology
(Credits: Theory-4, Practical-2)

Paper Code: CC-14 (T) THEORY (Lectures: 60)

Unit 1: Plant Tissue Culture (16 Lectures)

Composition of media; Nutrient and hormone requirements (role of vitamins and hormones); Totipotency; Organogenesis; Embryogenesis (somatic and zygotic); Protoplast isolation, culture and fusion; Tissue culture applications (micropropagation, Cryopreservation; Germplasm Conservation).

Unit 2: Recombinant DNA Technology (12 Lectures)

Restriction Endonucleases (Types I-IV, biological role and application); Restriction Mapping (Linear and Circular); Cloning Vectors: Prokaryotic (pUC 18 and pUC19, pBR322, Tiplasmid, BAC); Lambda phage, M13 phagemid, Shuttle vector; Eukaryotic Vectors- (YAC).

Unit 3: Gene Cloning (10 Lectures)

Recombinant DNA, Bacterial Transformation and selection of recombinant clones, PCR mediated gene cloning; Gene Construct; construction of genomic and cDNA libraries, screening DNA libraries to obtain gene of interest by genetic selection; complementation, colony hybridization; PCR.

Unit 4: Methods of Gene Transfer (8 Lectures)

Agrobacterium-mediated, Direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment; Selection of transgenics– selectable marker and reporter genes (Luciferase, GUS, GFP).

Unit 5: Applications of Biotechnology (14 Lectures)

Pest resistant (Bt-cotton); herbicide resistant plants (RoundUp Ready soybean); Transgenic crops with improved quality traits (FlavrSavr tomato, Golden rice); Improved horticultural varieties (Moon dust carnations); Role of transgenic in bioremediation (Superbug); edible vaccines; Industrial enzymes (Aspergillase, Protease, Lipase); Genetically Engineered Products; Humulin; Biosafety concerns.

Paper Code: CC-14 (P) Practical

1. (a) Preparation of MS medium.
(b) Demonstration of *in vitro* sterilization and inoculation methods using leaf and nodal explants
2. Study of anther, embryo and endosperm culture, micropropagation, somatic embryogenesis & artificial seeds through photographs.
3. Isolation of protoplasts.
4. Study of methods of gene transfer through photographs: *Agrobacterium*-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment.
5. Study of steps of genetic engineering for production of Bt cotton, Golden rice, FlavrSavr tomato through photographs.
6. Isolation of plasmid DNA.
7. Restriction digestion and gel electrophoresis of plasmid DNA.

Suggested Readings

1. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
2. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
3. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms. Vikas Publication House Pvt. Ltd., New Delhi. 5th edition.
4. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons, U.K. 5th edition.
5. Stewart, C.N. Jr. (2008). Plant Biotechnology & Genetics: Principles, Techniques and Applications. John Wiley & Sons Inc. U.S.A.

Discipline Specific Elective Courses

Course Code: BDSE – 01: A. Analytical Techniques in Plant Sciences
(Credits: Theory-4, Practical-2)

Paper Code: DSE -01 (T): THEORY (Lectures: 60)

Unit 1: Imaging and Related Techniques

(15 Lectures)

Principles of microscopy; Light microscopy; Fluorescence microscopy; Confocal microscopy; Use of fluorochromes: (a) Flow cytometry (FACS); (b) Applications of fluorescence microscopy; Chromosome banding, FISH, chromosome painting. SEM and TEM;

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

(4 Lectures)

Principle and its application in biological research.

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.

Paper Code: DSE -01 (P): Practical

1. PCR (demonstration).
2. To separate sugars by thin layer chromatography.
- 3 To separate chloroplast pigments by column chromatography.
4. To estimate protein
5. 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.

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Course Code: BDSE – 01: B. Bioinformatics
(Credits: Theory-4, Practical-2)

Paper Code: DSE -01 (T): THEORY (Lectures: 60)

Unit 1: Introduction to Bioinformatics (6 Lectures)

Introduction, Branches of Bioinformatics, Aim, Scope and Research areas of Bioinformatics.

Unit 2: Databases in Bioinformatics (6 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 (13 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 (10 Lectures)

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

Paper Code: DSE -01 (P): Practical

1. Nucleic acid and protein databases.
2. Sequence retrieval from databases.
3. Sequence alignment.
4. Sequence homology and Gene annotation.
5. Construction of phylogenetic tree.

Suggested Readings

1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. OxfordUniversity 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.

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Course Code: BDSE – 02: A. Plant Breeding
(Credits: Theory-4, Practical-2)

Paper Code: DSE -02 (T): THEORY (Lectures: 60)

Unit 1: Plant Breeding

(10 Lectures)

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

Unit 2: Methods of Crop Improvement

(20 Lectures)

Introduction: Centres of origin and domestication of crop plants, plant genetic resources; Acclimatization; Selection methods: For self pollinated, cross pollinated and vegetative propagated plants; Hybridization: For self, cross and vegetative propagated plants– Procedure, advantages and limitations.

Unit 3: Quantitative Inheritance

(10 Lectures)

Concept, mechanism, examples of inheritance of Kernel colour in wheat, Skin colour in humanbeings. Monogenic vs polygenic Inheritance.

Unit 4: Inbreeding Depression and Heterosis

(10 Lectures)

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

Unit 5: Crop Improvement and Breeding

(10 Lectures)

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

Paper Code: DSE -02 (P): PRACTICALS

1. Perform hand pollination in some locally available flowers or vegetables. Note the detailed process and the results obtained.
2. Perform emasculation and cross pollination on some plants.
3. Visit agriculture research institutes/stations/centres, prepare a report on the accessions of vegetables/seeds/crops available.

Suggested Readings

1. Singh, B.D. (2005). Plant Breeding: Principles and Methods. Kalyani Publishers. 7th edition.
2. Chaudhari, H.K. (1984). Elementary Principles of Plant Breeding. Oxford – IBH. 2nd edition.
3. Acquaah, G. (2007). Principles of Plant Genetics & Breeding. Blackwell Publishing.

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Course Code: BDSE – 02: B. Biostatistics
(Credits: Theory-4, Practical-2)

Paper Code: DSE -02 (T): THEORY (Lectures: 60)

Unit 1: Biostatistics (12 Lectures)

Definition - statistical methods - basic principles. Variables - measurements, functions, limitations and uses of statistics.

Unit 2: Collection of Data (Primary and Secondary) (12 Lectures)

Types and methods of data collection procedures - merits and demerits. Classification - tabulation and presentation of data - sampling methods.

Unit 3: Measures of Central Tendency (14 Lectures)

Mean, median, mode, geometric mean - merits & demerits. Measures of dispersion - range, standard deviation, mean deviation, quartile deviation - merits and demerits; Co-efficient of variations.

Unit 4: Correlation (12 Lectures)

Types and methods of correlation, regression, simple regression equation, fitting prediction, similarities and dissimilarities of correlation and regression.

Unit 5: Statistical Inference (10 Lectures)

Hypothesis - simple hypothesis – student '*t*' test and *chi* square test.

Paper Code: DSE -02 (P): Practical

- 1) Calculation of mean, standard deviation and standard error
- 2) Calculation of correlation coefficient values and finding out the probability
- 3) Calculation of 'F' value and finding out the probability value for the F value.

Suggested Readings

1. Danniel, W.W., 1987. **Biostatistic**, New York, John Wiley Sons.
2. Sundarrao, P.S.S and Richards, J. Christian. **An introduction to Biostatistics, 3rd edition**, Medical College, Vellore
3. Selvin, S., 1991. **Statistical Analysis of epidemiological data**. New York University Press.
4. Boston, Bishop, O.N. Houghton, **Statistics for Biology**. Mifflin.
5. Freedman, P. New York, . **The Principles of scientific research**. Pergamon Press.
6. Campbell, R.C., 1998. **Statistics for Biologists**. Cambridge University Press.

Course Code: BDSE – 03: A. Natural Resource Management
(Credits: Theory-4, Practical-2)

Paper Code: DSE -03 (T): THEORY (Lectures: 60)

Unit 1: Natural Resources

(2 Lectures)

Definition and types.

Unit 2: Sustainable Utilization

(8 Lectures)

Concept, approaches (economic, ecological and socio-cultural).

Unit 3: Land (8 lectures)

Utilization (agricultural, pastoral, horticultural, silvicultural); Soil degradation and management.

Unit 4: Water

(8 Lectures)

Fresh water (rivers, lakes, groundwater, aquifers, watershed); Marine; Estuarine; Wetlands; Threats and management strategies.

Unit 5: Biological Resources

(12 Lectures)

Biodiversity-definition and types; Significance; Threats; Management strategies; Bioprospecting; IPR; CBD; National Biodiversity Action Plan).

Unit 6: Forests

(6 Lectures)

Definition, Cover and its significance (with special reference to India); Major and minor forest products; Depletion; Management.

Unit 7: Energy

(6 Lectures)

Renewable and non-renewable sources of energy.

Unit 8: Contemporary Practices in Resource Management

(8 Lectures)

EIA, GIS, Ecological Footprint with emphasis on carbon footprint; Waste management.

Unit 9: National and International Efforts in Resource Management and Conservation

(4 Lectures)

Paper Code: DSE -03 (P): Practical

1. Estimation of solid waste generated by a domestic system (biodegradable and nonbiodegradable) and its impact on land degradation.
2. Collection of data on forest covers of specific area.
3. Measurement of dominance of woody species by DBH (diameter at breast height) method.
4. Ecological modeling.

Suggested Readings

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

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Course Code: BDSE – 03: B. Horticultural Practices and Post-Harvest Technology (Credits: Theory-4, Practical-2)
Paper Code: DSE -03 (T): THEORY (Lectures: 60)

Unit 1: Introduction (4 Lectures)

Scope and importance, Branches of horticulture; Role in rural economy and employment generation; Importance in food and nutritional security; Urban horticulture and ecotourism.

Unit 2: Ornamental Plants (4 Lectures)

Types, classification (annuals, perennials, climbers and trees); Identification and salient features of some ornamental plants [rose, marigold, gladiolus, carnations, orchids, poppies, gerberas, tuberose, sages, cacti and succulents (opuntia, agave and spurges)] Ornamental flowering trees (Indian laburnum, gulmohar, Jacaranda, Lagerstroemia, fishtail and areca palms, semul, coral tree).

Unit 3: Fruit and Vegetable Crops (4 Lectures)

Production, origin and distribution; Description of plants and their economic products; Management and marketing of vegetable and fruit crops; Identification of some fruits and vegetable varieties (citrus, banana, mango, chillies and cucurbits).

Unit 4: Horticultural Techniques (8 Lectures)

Application of manure, fertilizers, nutrients and PGRs; Weed control; Biofertilizers, biopesticides; Irrigation methods (drip irrigation, surface irrigation, furrow and border irrigation); Hydroponics; Propagation Methods: asexual (grafting, cutting, layering, budding), Sexual (seed propagation), Scope and limitations.

Unit 5: Landscaping and Garden Design (6 Lectures)

Planning and layout (parks and avenues); gardening traditions - Ancient Indian, European, Mughal and Japanese Gardens; Urban forestry; policies and practices.

Unit 6: Floriculture (6 lectures)

Cut flowers, bonsai, commerce (market demand and supply); Importance of flower shows and exhibitions.

Unit 7: Post-harvest Technology (10 Lectures)

Importance of post-harvest technology in horticultural crops; Evaluation of quality traits; Harvesting and handling of fruits, vegetables and cut flowers; Principles, methods of preservation and processing; Methods of minimizing losses during storage and transportation; Food irradiation - advantages and disadvantages; food safety.

Unit 8: Disease Control and Management (8 Lectures)

Field and post-harvest diseases; Identification of deficiency symptoms; remedial measures and nutritional management practices; Crop sanitation; IPM strategies (genetic, biological and chemical methods for pest control); Quarantine practices; Identification of common diseases and pests of ornamentals, fruits and vegetable crops.

Unit 9: Horticultural crops - conservation and management (10 Lectures)

Documentation and conservation of germplasm; Role of micropropagation and tissue culture techniques; Varieties and cultivars of various horticultural crops; IPR issues; National, international and professional societies and sources of information on horticulture.

Paper Code: DSE -03 (P): Practical

1. Field visits to gardens, standing crop sites, nurseries, vegetable gardens and horticultural fields at IARI or other suitable locations.
2. Grow some ornamental/horticultural plants in nurseries. Make a detailed report of the same.

Suggested Readings

1. Singh, D. & Manivannan, S. (2009). Genetic Resources of Horticultural Crops. Ridhi International, Delhi, India.
2. Swaminathan, M.S. and Kochhar, S.L. (2007). Groves of Beauty and Plenty: An Atlas of Major Flowering Trees in India. Macmillan Publishers, India.
3. NIIR Board (2005). Cultivation of Fruits, Vegetables and Floriculture. National Institute of Industrial Research Board, Delhi.
4. Kader, A.A. (2002). Post-Harvest Technology of Horticultural Crops. UCANR Publications, USA.
5. Capon, B. (2010). Botany for Gardeners. 3rd Edition. Timber Press, Portland, Oregon.

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Course Code: BDSE – 04: A. Research Methodology
(Credit: Theory 4; Practical 2)

Paper Code: DSE -04 (T): THEORY (Lectures: 60)

Unit 1: Basic Concepts of Research (12 Lectures)

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

Unit 2: General Laboratory Practices (15 Lectures)

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

Unit 3: Data Collection and Documentation of Observations (7 Lectures)

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

Unit 4: Methods to Study Plant Cell/Tissue Structure (10 Lectures)

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

Unit 5: Plant Microtechniques (6 Lectures)

Staining procedures, classification and chemistry of stains. Staining equipment. Cytogenetic techniques with squashed plant materials.

Unit 6: The Art of Scientific Writing and its Presentation (10 Lectures)

Numbers, units, abbreviations and nomenclature used in scientific writing. Writing references. PowerPoint presentation. Poster presentation. Scientific writing and ethics, Introduction to copyright-academic misconduct/plagiarism.

Paper Code: DSE -04 (P): Practical

1. Experiments based on chemical calculations.
2. Plant microtechnique experiments.
3. The art of imaging of samples through microphotography and field photography.
4. Poster presentation on defined topics.
5. Technical writing on topics assigned.

Suggested Readings

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

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**Course Code: BDSE – 04: B. Industrial and Environmental
Microbiology (Credits: Theory-4, Practical-2)**

Paper Code: DSE -04 (T): THEORY (Lectures: 60)

Unit 1: Scope of Microbes in Industry and Environment. (6 Lectures)

Unit 2: Bioreactors/Fermenter and Fermentation Processes (12 Lectures)

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 Fermenter; Constantly stirred tank Fermenter, tower Fermenter, fixed bed and fluidized bed bioreactors and air-lift Fermenter.

Unit 3: Microbial Production of Industrial Products (12 Lectures)

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.

Unit 4: Microbial Enzymes of Industrial Interest and Enzyme Immobilization

(8 Lectures)

Microorganisms for industrial applications and hands on screening microorganisms for caseinhydrolysis; 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 Lectures)

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

Unit 6: Microbial Flora of Water (8 Lectures)

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, check coliform and faecal coliform in water samples.

Unit 7: Microbes in Agriculture and Remediation of Contaminated Soils (8 Lectures)

Biological fixation; Mycorrhizae; Bioremediation of contaminated soils. Isolation of root nodulating bacteria, arbuscular mycorrhizal colonization in plant roots.

Paper Code: DSE -04 (P): Practical

1. Principles and functioning of instruments in microbiology laboratory
2. Hands on sterilization techniques and preparation of culture media.
3. A visit to any educational institute/ industry to see an industrial Fermenter, and other downstream processing operations.
- 4.

Suggested Readings

1. Pelzar, M.J. Jr., Chen E.C. S., Krieg, N.R. (2010). Microbiology: An application-based approach. Tata McGraw Hill Education Pvt. Ltd., Delhi.
2. Tortora, G.J., Funke, B.R., Case. C.L. (2007). Microbiology. Pearson Benjamin Cummings, San Francisco, U.S.A. 9th edition.
3. Dubey R.C. & Maheshwari D.K. A textbook of Microbiology. S.Chand, New Delhi India.

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Generic Elective Courses

Course Code: BGE– 01: Biodiversity (Microbes, Algae, Fungi and Archegoniate)

(Credits: Theory-4, Practical-2)

Paper Code: GE-01 (T): THEORY (Lectures: 60)

Unit 1: Microbes (10 Lectures)

Viruses – Discovery, general structure, replication (general account), DNA virus (T-phage); Lytic and lysogenic cycle, RNA virus (TMV); Economic importance; Bacteria – Discovery, General characteristics and cell structure; Reproduction – vegetative, asexual and recombination (conjugation, transformation and transduction); Economic importance.

Unit 2: Algae (12 Lectures)

General characteristics; Ecology and distribution; Range of thallus organization and reproduction; Classification of algae; Morphology and life-cycles of the following: *Nostoc*, *Chlamydomonas*, *Oedogonium*, *Vaucheria*, *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), *Penicillium*, *Alternaria* (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 archegoniates, Transition to land habit, Alternation of generations.

Unit 5: Bryophytes (10 Lectures)

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

Unit 6: Pteridophytes (8 Lectures)

General characteristics, classification, Early land plants (*Cooksonia* and *Rhynia*). Classification (up to family), morphology, anatomy and reproduction of *Selaginella*, *Equisetum* and *Pteris*. (Developmental details not to be included). Heterospory and seed habit, stellar evolution. Ecological and economical importance of Pteridophytes.

Unit 7: Gymnosperms (6 Lectures)

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

Paper Code: GE-01 (P): Practical

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, Structure of root nodule.
3. Gram staining
4. Study of vegetative and reproductive structures of *Nostoc*, *Chlamydomonas*, *Oedogonium*, *Vaucheria*, *Fucus** and *Polysiphonia* through temporary preparations and permanent slides. (* *Fucus* - Specimen and permanent slides)
5. *Rhizopus* and *Penicillium*: Asexual stage from temporary mounts and sexual structures through permanent slides.
6. *Alternaria*: Specimens/photographs and tease mounts.
7. *Puccinia*: Herbarium specimens of Black Stem Rust of Wheat and infected Barberry leaves; section/tease mounts of spores on Wheat and permanent slides of both the hosts.
8. *Agaricus*: Specimens of button stage and full grown mushroom; Sectioning of gills of *Agaricus*.
9. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose)
10. Mycorrhiza: Ecto mycorrhiza and endo mycorrhiza (Photographs)
11. *Marchantia*- Morphology of internal and external structures (vegetative and reproductive organs).
12. *Funaria*- Morphology of internal and external structures (vegetative and reproductive organs).
13. *Selaginella*- Morphology of internal and external structures (vegetative and reproductive organs).
14. *Equisetum*- Morphology of internal and external structures (vegetative and reproductive organs).
15. *Pteris*- Morphology of internal and external structures (vegetative and reproductive organs).
16. *Cycas*- Morphology of internal and external structures (vegetative and reproductive organs).
17. *Pinus*- Morphology of internal and external structures (vegetative and reproductive organs).

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.

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Course Code: BGE– 02: Plant Anatomy and Embryology
(Credits: Theory-4, Practical-2)

Paper Code: GE-02 (T): 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 ultra structure of mature embryo sac.
- Unit 6: Pollination and Fertilization** (8 Lectures)
Pollination mechanisms and adaptations; Double fertilization; Seed-structure appendages and dispersal mechanisms.
- Unit 7: Embryo and Endosperm** (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.

Paper Code: GE-02 (P): 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 and Dicot (Permanent slides).
4. Root: Monocot, Dicot and secondary (Permanent slides).
5. Leaf: Dicot and Monocot leaf (only Permanent slides).
6. Adaptive anatomy: Xerophyte (*Nerium* leaf); Hydrophyte (*Hydrilla* stem).
7. Structure of anther (young and mature), tapetum (amoeboid and secretory) (Permanent slides).
8. Types of ovules: anatropous, orthotropous, circinotropous, amphitropous/campylotropous.
9. Female gametophyte: *Polygonum* (monosporic) type of Embryo sac Development (Permanent slides/photographs).
11. Pollination types and seed dispersal mechanisms (including appendages, aril, caruncle) (Photographs and specimens).
12. Dissection of embryo/endosperm from developing seeds.
13. Calculation of percentage of germinated pollen in a given medium.

Suggested Readings

1. Bhojwani, S.S. & Bhatnagar, S.P. (2011). Embryology of Angiosperms. Vikas Publication House Pvt. Ltd. New Delhi. 5th edition.
2. Mauseth, J.D. (1988). Plant Anatomy. The Benjamin/Cummings Publisher, USA.

**Course Code: BGE– 03: Economic Botany and Plant
Biotechnology**

(Credits: Theory-4, Practical-2)

Paper Code: GE-03 (T): THEORY (Lectures: 60)

- 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** (6 Lectures)
General account with special reference to phaseolus, Dolichos.
- 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: Plant Tissue Culture** (10 Lectures)
Micropropagation; haploid production through androgenesis; callus.
- Unit 9: Recombinant DNA Techniques** (18 Lectures)
Blotting techniques: Northern, Southern and Western Blotting, DNA Fingerprinting; Molecular DNA markers i.e. RAPD, RFLP; DNA sequencing, PCR and Reverse Transcriptase-PCR.

Paper Code: GE-03 (P): Practical

1. Study of economically important plants-legume, cereals and spices
2. Familiarization with basic equipments in tissue culture.
3. Study through photographs: Anther culture, somatic embryogenesis, endosperm and embryo culture; micropropagation.
4. Study of molecular techniques: PCR.

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.

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Course Code: BGE– 04: Environmental Biotechnology
(Credits: Theory-4, Practical-2)

Paper Code: GE-04 (T): THEORY (Lectures: 60)

Unit 1: Environment

(4 Lectures)

Basic concepts and issues, global environmental problems - ozone depletion, greenhouse effect and acid rain due to anthropogenic activities.

Unit 2: Environmental Problems

(6 Lectures)

Environmental pollution - types of pollution, sources of pollution, measurement of pollution, Bio-concentration, bio/geo-magnification.

Unit 3: Microbiology of Waste Water Treatment

(8 Lectures)

Aerobic process - activated sludge, oxidation ponds, trickling filter, Anaerobic process-anaerobic digestion, anaerobic filters. Treatment for waste waters.

Unit 4: Immobilized Cells/Enzymes in Treatment of Toxic Compounds (6 Lectures)

Biopesticides, bioreactors, bioleaching, biomining, biosensors, biotechniques for air pollution abatement and odour control.

Unit 5: Sustainable Development

(8 Lectures)

Economics and Environment: Economic growth, Gross National Productivity and the quality of life, Tragedy of Commons, Economics of Pollution control, Cost-benefit and cost effectiveness analysis, WTO and Environment, Corporate Social Responsibility, Environmental awareness and Education; Environmental Ethics.

Unit 6: International Legislations, Policies for Environmental Protection (6 Lectures)

Stockholm Conference (1972) and its declaration, WCED (1983), Rio Earth Summit-UNCED (1992) and its declaration, Montreal Protocol - 1987, Kyoto Protocol- 1997, Ramsar Convention 1971.

Unit 7: National Legislations, Policies for Pollution Management (6 Lectures)

Salient features of Wild life protection act 1972, Water Pollution (Prevention and Control) Act-1974, Forest conservation act 1980, Air Pollution (Prevention and Control) Act-1981, National Environmental Policy -2006

Unit 8: Public Participation for Environmental Protection (6 Lectures)

Environmental movement and people's participation with special references to Chilika and Narmada Bachao Andolan, Chipko and Silent valley Movement; Women and Environmental Protection, Role of NGO in bringing environmental awareness and education in the society.

Paper Code: GE-04 (P): Practical

1. Water/Soil analysis - DO, salinity, pH, chloride, total hardness, alkalinity, acidity, nitrate, calcium, Magnesium and phosphorus.
2. Microbial assessment of air (open plate and air sample) and water.

Suggested Readings

1. Metcalf and Eddy Inc., Waste water engineering - treatment, disposal and reuse TataMcGraw Hill, New Delhi.
2. AK. De, Environmental Chemistry Wiley Eastern Ltd, New Delhi.
3. D.Allsopp and K.J. Seal, Introduction to Biodeterioration ELBS / Edward Arnold.
4. Baaker, KH and Herson D.S., 1994. Bioremediation. Mc.GrawHill Inc, New York.
5. Nuzhat Ahmed, Fouad M. Qureshi and Obaid Y. Khan, 2006. Industrial and Environmental Biotechnology Horizon Press.
6. Paul A, Rochelle, Environmental Molecular Biology, 2001. Horizon Press.
7. Jadhav and Bhosale, Environmental Protection and Laws V.M.Himalaya publ.House.
8. PC Trivedi, Biodiversity Assessment and Conservation Agrobios publ.

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Skill Enhancement Courses
Course Code: BSEC-01
Paper Code SEC-01: A. Biofertilizers
(Credits 2; Lectures: 30)

Unit 1: (4 Lectures)

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

Unit 2: (8 Lectures)

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 Lectures)

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

Unit 4: (8 Lectures)

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

Unit 5: (6 lectures)

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

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

Paper Code SEC-01: B. Floriculture
(Credits 2; Lectures: 30)

Unit 1: Importance and scope of floriculture and landscape gardening. (2 Lectures)

Unit 2: (8 Lectures)

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.

Unit 3: (6 Lectures)

Ornamental Plants: Flowering annuals; Herbaceous perennials; Climbing 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: Landscaping Places of Public Importance. (4 Lectures)

Unit 5: (8 lectures)

Commercial Floriculture: Factors affecting flower production; Production and packaging of cut flowers; Flower arrangements; Methods to prolong vase life; Cultivation of Important cut flowers (Anthurium, Liliium, Carnations, Orchids).

Unit 6: Diseases and Pests of Ornamental Plants. (2 Lectures)

Suggested Readings

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

Paper Code SEC-01: C. Intellectual Property Rights

(Credits 2; Lectures: 30)

Unit 1: Introduction to intellectual property right (IPR) (2 Lectures)

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

Unit 2: Patents, Copyrights and Trademarks (9 Lectures)

Patents: Objectives, Rights, Patent Act 1970 and its amendments. Procedure of obtaining patents, working of patents. Infringement; Copyrights: Introduction, Works protected under copyright law, Rights, Transfer of Copyright, Infringement; Trademarks: Objectives, Types, Rights, Protection of goodwill, Infringement, Passing off, Defences, Domain name.

Unit 3: Geographical Indications and Protection of Traditional Knowledge (7 Lectures)

GI: Objectives, Justification, International Position, Multilateral Treaties, National Level, Indian Position; PTK: Objective, Concept of Traditional Knowledge, Holders, Issues concerning, Bio-Prospecting and Bio-Piracy, Alternative ways, Protectability, need for a Sui-Generis regime, Traditional Knowledge on the International Arena, at WTO, at National level, Traditional Knowledge, Digital Library.

Unit 4: Industrial Designs (2 Lectures)

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

Unit 5: Protection of Plant Varieties (2 Lectures)

Plant Varieties Protection-Objectives, Justification, International Position, Plant varieties protection in India. Rights of farmers, Breeders and Researchers. National gene bank, Benefit sharing. Protection of Plant Varieties and Farmers' Rights Act, 2001.

Unit 6: Information Technology Related Intellectual Property Rights (4 lectures)

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

Unit 7: Biotechnology and Intellectual Property Rights. (4 Lectures)

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

Suggested Readings:

1. N.S. Gopalakrishnan & T.G. Agitha, (2009) **Principles of Intellectual Property** Eastern Book Company, Lucknow.
2. **Kerly's Law of Trade Marks and Trade Names** (14th Edition) Thomson, Sweet & Maxwell.
3. Ajit Parulekar and Sarita D' Souza, (2006) **Indian Patents Law – Legal & Business Implications**; Macmillan India Ltd.
4. B.L. Wadehra (2000) **Law Relating to Patents, Trade Marks, Copyright, Designs & Geographical Indications**; Universal law Publishing Pvt. Ltd., India.
5. P. Narayanan (2010) **Law of Copyright and Industrial Designs**; Eastern law House, Delhi.

Course Code: BSEC-02
Paper Code SEC-02: A. Medicinal Botany
(Credits 2; Lectures: 30)

Unit 1: (10 Lectures)

Scope and Importance of Medicinal Plants. Indigenous Medicinal Sciences; Definition and Scope- Ayurveda: History, origin, plants used in ayurvedic treatments, Unani: History, concept.

Unit 2: (10 Lectures)

Conservation of endangered and endemic medicinal plants. Definition: endemic and endangered medicinal plants, Red list criteria; In situ conservation: Biosphere reserves, sacred groves, National Parks; *Ex situ* conservation: Botanic Gardens, Ethnomedicinal plant. Gardens. Propagation of Medicinal Plants: Objectives of the nursery, its classification, important components of a nursery, sowing, pricking, use of green house for nursery production, propagation through cuttings, layering, grafting and budding.

Unit 3: (10 Lectures)

Ethnobotany and folk medicines. Definition; Ethnobotany in India: methods and applications of Ethnobotany, Folk medicines and, ethnomedicine.

Suggested Readings

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

Paper Code SEC-02: B. Mushroom Culture Technology
(Credits 2; Lectures: 30)

Unit 1: (5 Lectures)

Introduction, 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: (12 Lectures)

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

Unit 3: (8 Lectures)

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.

Unit 4: (5 Lectures)

Food Preparation; Types of foods prepared from mushroom. Research Centers, National level and Regional level. Cost benefit ratio - Marketing in India and abroad, Export Value.

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.

Paper Code SEC-02: C. Ethnobotany
(Credits 2; Lectures: 30)

Unit 1: Ethnobotany **(6 Lectures)**

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.

Unit 2: Methodology of Ethnobotanical Studies **(6 Lectures)**

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 Lectures)**

Medico-ethnobotanical sources in India; Significance of the following plants in ethno botanical practices (along with their habitat and morphology) a) *Azadiractha indica*, b) *Ocimum sanctum*, c) *Vitex negundo* d) *Gloriosa superb*, e) *Tribulus terrestris*, f) *Pongamia pinnata*, g) *Cassia auriculata*, h) *Indigofera tinctoria*. Role of ethnobotany in modern medicine with special example *Rauwolfia serpentina*, *Trichopus zeylanicus*, *Artemisia*, *Withania*. Role of ethnic groups in conservation of plant genetic resources. Endangered taxa and forest management (participatory forest management).

Unit 4: Ethnobotany and Legal Aspects **(8 Lectures)**

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:

- 1) S.K. Jain, Manual of Ethnobotany, Scientific Publishers, Jodhpur, 1995.
- 2) S.K. Jain (ed.) Glimpses of Indian. Ethnobotny, Oxford and I B H, New Delhi 1981
- 3) Lone et al., Palaeoethnobotany
- 4) S.K. Jain (ed.) 1989. Methods and approaches in ethnobotany. Society of ethnobotanists, Lucknow, India.
- 5) S.K. Jain, 1990. Contributions of Indian ethnobotany. Scientific publishers, Jodhpur.
- 6) Colton C.M. 1997. Ethnobotany -Principles and applications. John Wiley and sons Chichester
- 7) Rama Ro, N and A.N. Henry (1996). The Ethnobotany of Eastern Ghats in Andhra Pradesh, India. Botanical Survey of India. Howrah.
- 8) Rajiv K. Sinha – Ethnobotany The Renaissance of Traditional Herbal Medicine – INA – SHREE Publishers, Jaipur-1996
- 9) Faulks, P.J. 1958. An introduction to Ethnobotany, Moredale pub. Ltd.

Paper Code SEC-02: D. Herbal Technology
(Credits 2; Lectures: 30)

Unit 1: (6 Lectures)

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.

Unit 2: (6 Lectures)

Pharmacognosy - systematic position; medicinal uses of the following herbs in curing various ailments; Tulsi, Ginger, Fenugreek, Indian Goose berry and Ashoka.

Unit 3: (6 Lectures)

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

Unit 4: (8 Lectures)

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).

Unit 5: (4 Lectures)

Medicinal plant banks micro propagation of important species (*Withania somnifera*, neem and tulsi- Herbal foods-future of pharmacognosy).

Suggested Readings

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

BSEC-03: Nursery and Gardening

(Credits 2; Lectures: 30)

(Pass Course only)

Unit 1: (4 Lectures)

Nursery: definition, objectives and scope and building up of infrastructure for nursery, planning and seasonal activities - Planting - direct seeding and transplants.

Unit 2: (6 Lectures)

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.

Unit 3: (6 lectures)

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.

Unit 4: (8 Lectures)

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.

Unit 5: (6 Lectures)

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.

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.

Paper Code BSEC-04: Plant Diversity and Human Welfare

(Credits 2; Lectures: 30)

(Pass Course only)

Unit 1: (8 Lectures)

Plant diversity and its scope- Genetic diversity, Species diversity, Plant diversity at the ecosystem level, Agro-biodiversity 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: (8 Lectures)

Loss of Biodiversity: Loss of genetic diversity, Loss of species diversity, Loss of ecosystem diversity, Loss of agro-biodiversity, 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: (8 Lectures)

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.

Unit 4: (6 Lectures)

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.

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.
