Approved by 36th Academic Council Meeting
held on 17th May, 2023

CURRICULUM AND CREDIT FRAMEWORK FOR UNDERGRADUATE PROGRAMME

Under Graduate Syllabus

Department of Botany

Nagaland University

2023

1. Minimum Credit Requirements to Award Degree under each Category

Sl. No.	Broad Category of Course	Minimum Credit Requirement	
		3-year UG	4-year UG
1	Major (Core)	60	80
2	Minor Stream	24	32
3	Multidisciplinary	09	09
4	Ability Enhancement Courses (AEC)	08	08
5	Skill Enhancement Courses (SEC)	09	09
6	Value Added Courses common for all UG	08	08
7	Summer Internship	02	02
8	Research Project/ Dissertation	-	12
	Total Credits	120	160

2. COURSE STRUCTURE FOR CURRICULUM AND CREDIT FRAMEWORK FOR UG PROGRAMME

SEMESTER-WISE COURSE AND CREDIT DISTRIBUTION OF UG PROGRAMME

Semester	Course Categories	Credits	Remark
I	2 Major Courses (4 + 4)	8	Core papers of one discipline will be the Minor papers of other discipline
	1 Minor Course	4	
	1 Multidisciplinary Course	3	
	1 Ability Enhancement Course	2	
	1 Skill Enhancement Course	3	
	Total	20	
II	2 Major Courses	8	
	1 Minor Course	4	
	1 Multidisciplinary Course	3	
	1 Ability Enhancement Course	2	
	1 Common Value Added Course	3	
	Total	20	
Students exiting the programme after securing 40 credits will be awarded UG Certificate in the relevant Discipline / Subject provided they secure 4 credits in work based vocational courses offered during SUMMER TERM / Internship			
III	2 Major Courses	8	
	1 Minor Course	4	
	1 Multidisciplinary Course	3	
	1 Ability Enhancement Course	2	
	1 Skill Enhancement Course	3	
	Total	20	
IV	2 Major Courses	8	
	1 Minor Course	4	
	1 Ability Enhancement Course	2	
	1 Skill Enhancement Course	3	
	1 Common Value Added Course	3	
	Total	20	
Students exiting the programme after securing 80 credits will be awarded UG Diplomain			

the relevant Discipline / Subject provided they secure additional 4 credits in 'Skill based vocational courses offered' during first or second year SUMMER TERM			
Semester	**Course Categories**	**Credits**	**Remark**
V	3 Major Courses	12	
	1 Minor Course	4	
	1 Internship	2	
	1 Common Value Added Course	2	
	Total	20	
VI	4 Major Courses	16	
	1 Minor Course	4	
	Total	20	
Students who want to undertake 3-year UG programme will be awarded UG Degree in the relevant Discipline / Subject upon securing 120 Credits			
VII	3Major Courses (4 +4+4)	12	
	1 Research Methodology Paper	4	
	1 Minor Course (5)	4	
	Total	20	
VIII	1 Major	4	
	1 Minor Course	4	
	Research Project	12	
	Total	20	

3. CREDIT DISTRIBUTION

Science	Remarks	Arts (Non-experimental)	Remarks
Total Credit 4	Theory 3 + Practical 1	Total Credit 4	Theory 3 + Tutorial 1

Botany Course Structure: Core Papers

Paper Code	Course Code	Title of the Paper	Total Credit
		SEMESTER - I	
C-1	**BCC-01**	Microbiology and Phycology	4
C-2	**BCC-02**	Biomolecules and Cell Biology	4
		SEMESTER - II	
C-3	**BCC-03**	Mycology and Phytopathology	4
C-4	**BCC-04**	Archegoniate (Bryophytes, Pteridophytes and Gymnosperms)	4
		SEMESTER - III	
C-5	**BCC - 05**	Morphology and Anatomy of Angiosperms	4
C-6	**BCC - 06**	Economic Botany	4
		SEMESTER - IV	
C-7	**BCC - 07**	Genetics	4
C-8	**BCC - 08**	Molecular Biology	4
		SEMESTER - V	
C- 9	**BCC - 09**	Plant Ecology and Phytogeography	4
C-10	**BCC - 10**	Plant Systematics	4
C-11	**BCC - 11**	Reproductive Biology of Angiosperms	4
		SEMESTER - VI	
C-12	**BCC - 12**	Plant Physiology	4
C-13	**BCC - 13**	Plant Metabolism	4
C-14	**BCC - 14**	Plant Biotechnology	4
C-15*	**BDSE – 01 A**	Analytical Techniques in Plant Sciences	4
	BDSE – 01 B	Bioinformatics	
		SEMESTER - VII	
C-16*	**BDSE – 02 A**	Plant Breeding	4
	BDSE – 02 B	Biostatistics	
C-17*	**BDSE – 03 A**	Natural Resource Management	4
	BDSE – 03 B	Horticultural Practices and Post-Harvest Technology	
C-18*	**BDSE – 04 A**	Industrial and Environmental Microbiology	4
	BDSE – 04 B	Economic Botany and Plant Biotechnology	
C-19		Research Methodology	4
*** Note: For C-15, C-16, C-17 and C-18 (BDSE papers) students can chose any paper from 'A OR B'**			
		SEMESTER - VIII	
C-20			4
C-20			4
C-21			4
C-22			4

SKILL ENHANCEMENT COURSES Proposed (3 Credits Each)

Semester	Course Code	Title of the Paper	Department	Remark
I	**BSEC-01**	Biofertilizers	Botany	Students can select any one from the respective semester
	BSEC-02	Floriculture	Botany	
III	**BSEC-03**	Herbal Technology	Botany	
	BSEC-04	Nursery and Gardening	Botany	
IV	**BSEC-05**	Medicinal Botany	Botany	
	BSEC-06	Mushroom Culture Technology	Botany	

Detailed Syllabus

CORE COURSES
Course Code: BCC-01: Microbiology and Phycology
(Credits: Theory-3; Practical-1)

C-1 (T): THEORY (45Lectures)

Unit 1: Introduction to Microbial World **(9 Lectures)**

General account of Darwin's theory of evolution,the evolution of population, concept of species, Mechanism of speciation; Microbial nutrition, growth and metabolism.

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

Discovery, general structure, Types of virus: DNA virus(T-phage), RNA virus and Retrovirus. Virus replication (general account): lytic (T4 phage) and lysogenic cycle(Lambda phage). Viroid and Prions.

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

Discovery, general characteristics; types-archaebacteria, 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: General Characteristics **(9 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: Algae Type Studies **(9 Lectures)**

General characters, occurrence,range of thallus organization, reproduction and life cycle of Cyanophyta (*Nostoc)*, Xanthophyta (*Vaucheria),*Chlorophyta (*Oedogonium),*Charophyta (*Chara)*, Phaeophyta*(Ectocarpus*) and Rhodophyta (*Polysiphonia*).

C-1 (P): PRACTICAL (30 Hours)

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

5. Study of vegetative and reproductive structures of *Nostoc, Oedogonium, Chara, Vaucheria, Ectocarpus and Polysiphonia, Procholoron*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.AravaliInternational,New Delhi.
5. Campbell, N.A., Reece J.B., Urry L.A., Cain M.L., Wasserman S.A. Minorsky P.V., JacksonR.B. (2008). Biology, Pearson Benjamin Cummings, USA. 8th edition.
6. Pelczar, M.J. (2001) Microbiology, 5thedition, Tata McGraw-Hill Co, New Delhi.

Course Code: BCC-02: Biomolecules and Cell Biology

(Credits: Theory-3;Practical-1)

C-2 (T): THEORY(45 Lectures)

Unit 1: Biomolecules 1 **(9 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.

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

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.

Unit 3: Bioenergetics and Enzymes **(9 Lectures)**

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

Structure of enzyme: holoenzyme, apoenzyme, cofactors, coenzymes and prosthetic group;Classification of enzymes; Features of active site, 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 **(9 lectures)**

Cell as a unit of structure and function; Characteristics of prokaryotic and eukaryotic cells; Structure and function of Plant cell wall. Cell membrane function and chemical composition; fluid mosaic model; Membrane transport – Passive, active and facilitated transport, endocytosis and exocytosis.Phases of eukaryotic cell cycle, mitosis and meiosis; Regulation of cell cycle-checkpoints, role ofprotein kinases.

Unit 5: Cell Organelles **(9 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; Semiautonomousnature 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.

C-2 (P): Practical(30 Hours)

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 ChurchillLivingstone.
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 EducationInc. U.S.A. 8th edition.
8. Cooper, G.M. and Hausman, R.E. (2009) The Cell: A Molecular Approach. 5th edition.ASMPress& 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-3, Practical-1)

C-3 (T): THEORY (45 Lectures)

Unit 1: Introduction (9 Lectures)

True Fungi: General characteristic, origin, thallus organization, cell wall composition, nutrition and classification (Ainsworth system).

Allied Fungi: General characteristics, classification, status of Slime molds in taxonomy, Occurrence, Plasmodia; types of plasmodia and types of fruiting bodies.

Symbiotic Association: *Lichen*: Occurrence, General characteristics; Nature of associations of algal and fungal partners; Reproduction*; Mycorrhiza*: Ectomycorrhiza, Endomycorrhiza and their significance.

Unit 2: Chytridiomycota, Zygomycota and Oomycota (9 Lectures)

Chytridiomycota: Characteristic features; Thallus organization; Reproduction; Life cycle with reference to *Synchytrium*

Zygomycota: Characteristic features; Thallus organization; Reproduction; Life cycle with reference to *Rhizopus*.

Oomycota: Characteristic features; thallus organization; Reproduction; Life cycle with reference to *Phytophthora.*

Unit 3: Ascomycota and Basidiomycota (9 Lectures)

General characteristics (asexual and sexual fruiting bodies); Ecology, Heterokaryosis, parasexuality and Bioluminescence; Life cycle with reference to *Saccharomyces* and *Aspergillus;* Life cycle with reference to *Puccinia* and *Agaricus.*

Unit 4: Applied Mycology (9 Lectures)

Application of fungi in food industry (Flavour and texture, Fermentation, Baking, Organic acids, Enzymes; Secondary metabolites (Pharmaceutical preparations); Agriculture (Biofertilizers); Fungi in Biological control. Brief introduction to Nanotechnology; application of fungi in nanotechnology

Unit 5: Phytopathology (9 Lectures)

Terms and concepts; General symptoms, Host-Pathogen relationships, Disease cycle and environmental relation; prevention and control of plant diseases, and role of quarantine; Fungal diseases – White rust of crucifers, powdery mildew, damping off disease; Bacterial diseases – Citrus canker and bacterial leaf wilt of tomato; Viral diseases – Papaya Mosaic viruses, vein clearing.

C-3 (P): Practical (30 Hours)

1. *Rhizopus*: Study of asexual stage from temporary mounts and sexual structures through

permanent slides.

2. *Aspergillus* and *Penicillium*: Study of asexual stage from temporary mounts. Study of sexual stage from permanent slides/photographs.

3. *Phytophthora:* Specimens/photographs and temporary mounts.

4. *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.

5. *Pleurotus*: Specimens of primordia and full-grown mushroom; sectioning of gills.

6. *Albugo:* Study of symptoms of plants infected with *Albugo*; asexual phase study through section/temporary mounts and sexual structures through permanent slides.

7. 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).

8. Phytopathology: Herbarium specimens of bacterial diseases; Citrus Canker; bacterial leaf wilt of tomato.

9. 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 PublishersIndia Ltd.
5. Sharma, P.D. (2011). Plant Pathology, Rastogi Publication, Meerut, India.

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

(Credits: Theory-3; Practical-1)

C-4 (T): THEORY(45Lectures)

Unit 1: Introduction to Bryophytes and Pteridophytes (9 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 (9 Lectures)

Classification (up to family) (Proskauer, 1957), morphology, anatomy, reproduction and evolutionary trends of *Marchantia, Anthoceros and Sphagnum* (Developmental details not to be included). Ecological and economic importance of bryophytes with special reference to *Sphagnum*.

Unit 3: Type Studies- Pteridophytes (9 Lectures)

Classification (up to family), morphology, anatomy and reproduction of *Selaginella*and *Equisetum*(Developmental details not to be included).Ecological and economic importance. Heterospory and seed habit, telome theory, Stelar evolution.

Unit 4: Gymnosperms (9 Lectures)

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

Unit 5: Paleobotany (9 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.

C-4 (P): Practical (30 Hours)

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. ***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).

4. ***Equisetum***- Morphology, transverse section of internode, longitudinal section of strobilus, transverse section of strobilus, whole mount of sporangiophore, whole mount of spores (wet anddry) (temporary slide), transverse section of rhizome (permanent slide).

5. ***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).

6. ***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).

7. 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 Dept.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 UniversityPress.

Course Code: BCC - 05: Morphology and Anatomy of Angiosperms
(Credits: Theory-3; Practical-1)

C-5 (T): THEORY(45 Lectures)

Unit 1: Vegetative Morphology **(9 Lectures)**

Root: Structures, types, with reference to modification.
Stem: Habit, types, with reference to modification.
Leaf: Structures, types, with reference to modification.
Fruits: Structure, types and classification.
Seeds: Structure and types. Fruit and seeds dispersal.

Unit 2: Floral Morphology **(9 Lectures)**

Detail structure of flower, floral parts, arrangement, relative position, numeric plan, cohesion and adhesion of floral parts. Types of aestivation, placentation, floral formulae and floral diagram.

Types of inflorescence. Flower as a modified shoot.

Unit 3: Plant anatomy - Tissues **(9 Lectures)**

Classification and structure of tissue, types of cells and tissues;

Simple tissue; structure, occurrence and function. Complex tissues; structure and function (Xylem, phloem). Secretory tissue (glands, glandular hairs, nectaries, hydathodes , schizogenous and lysigenous ducts, resin ducts, mucilage ducts, kinoveins , lacticifers)

Vascular bundles: types (conjoint, collateral, bicollateral, open, closed, radial, concentric amphicribal and amphivasal). Protective Systems**:** Epidermis, cuticle, epicuticular waxes, trichomes (uni-and multicellular, glandular and non glandular).

Unit 4: Plant anatomy -Roots and Shoots **(9 Lectures)**

Shoots: theories on apical organisation (Apical cell theory, Histogen theory, Tunica-Corpus theory); Arrangement of primary tissues in the dicot and monocot stem and leaves; Roots: Organization of root apex (Apical cell theory, Korpe-kappe theory); Arrangement of primary tissues in dicot and monocot roots.

Unit 5: Vascular Cambium and Wood **(9 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.

C-5 (P): Practical(30 Hours)

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.
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; trichomes: non-glandular and glandular.
13. Root: monocot, dicot, secondary growth.
14. Stem: monocot, dicot - primary and secondary growth; periderm; lenticels.
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 Benjammin/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-3; Practical-1)

C-6 (T): THEORY(45Lectures)

Unit 1:Origin of Cultivated Plants and Sources of Sugars and Starches (9 Lectures)

Concept of Centres of Origin, their importance with reference to Vavilov's work. Examples ofmajor plant introductions; Crop domestication and loss of genetic diversity; evolution of newcrops/varieties, importance of germplasm diversity; Morphology and processing of sugarcane, products and by-products of sugarcane industry; Potato – morphology, propagation and uses.

Unit 2: Cereals and Legumes (9 Lectures)

Cereals:Wheat and Rice (origin, morphology, processing and uses); Brief account of millets; Pulses:Origin, morphology and uses of soybean, chick pea, pigeon pea legumes.

Unit 3: Spices and Beverages (9 Lectures)

Listing of important spices, their family and part used. Economic importance with specialreference to ginger, cardamom, cinnamon, and black pepper; Tea, Coffee (morphology, processing and uses).

Unit 4: Natural Rubber and Sources of Oils and Fats. (9 Lectures)

Natural Rubber**:**Para-rubber: tapping, processing and uses.

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

Unit 5: Drug-yielding Plants, Timber Plantand Fibres (9 Lectures)

Therapeutic and habit-forming drugs with special reference to C*inchona, Digitalis, Papaver* and *Cannabis*; General account with special reference to teak and pine.Types based on the origin of fibres; Cotton and Jute (morphology, extraction and uses).

C-6 (P): Practical (30 Hours)

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 specimens.

11. **Fibre-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 &BartlettPublishers.

Course Code: BCC - 07: Genetics

(Credits: Theory-3; Practical-1)

C-7 (T): THEORY(45 Lectures)

Unit 1: Mendelian Genetics and Its Extension **(9 Lectures)**

Mendelism: Principles of inheritance; Chromosome theory of inheritance; Autosomes and sex chromosomes; Probability and pedigree analysis; Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Polygenic inheritance, Penetrance and Expressivity.

Unit 2: Extra-chromosomal Inheritance **(9 Lectures)**

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

Unit 3: Linkage, Crossing Over and Chromosome Mapping **(6 Lectures)**

Linkage and crossing over: Cytological basis of crossing over; Recombination frequency, two factor and three factor crosses; Interference and coincidence; Sex Linkage.

Unit 4: **Chromosomal Aberrations and Structure of Gene** **(15 Lectures)**

Mutation: Types; Point or gene mutation (base substitution), Chromosomal mutations/aberrations; Molecular basis of Mutations. Mutagens; physical and chemical mutagens; Role of Transposons in mutation; DNA repair mechanisms.

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

Unit 5: Population and Evolutionary Genetics **(6 Lectures)**

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

C-7 (P): Practical(30 Hours)

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.

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

(Credits: Theory -3;Practical -1)

C-8 (T): THEORY (45 Lectures)

Unit 1: Nucleic Acids: Carriers of Genetic Information (12 Lectures)

DNA as the carrier of genetic information (Griffith's, Hershey & Chase, Avery, McLeod & McCarty experiments). Types of genetic material; DNA Structure (Watson and Crick), Denaturation and Renaturation; Organization of DNA in Prokaryotes, Viruses & Eukaryotes; Structure of RNA; Mitochondria & Chloroplast DNA; Chromatin structure; Euchromatin & Heterochromatin

Unit 2: Central Dogma and Genetic Code (6 Lectures)

The Central Dogma (Adaptor hypothesis and discovery of mRNA template), Genetic code (deciphering & salient features)

Unit 3: Replication of DNA (6 Lectures)

Types of DNA replication; Replication of DNA in prokaryotes and eukaryotes; RNA priming

Unit 4: Transcription (6 Lectures)

Mechanism of Transcription in Prokaryotes and Eukaryotes; Regulation of gene expression in prokaryotes- lac operon and tryptophan synthesis in *E.coli.*

Unit 5: RNA Processing and Translation (15 Lectures)

RNA processing - Concept of introns and exons, removal of introns,splicing pathways, pre-mRNA Processing, spliceosome machinery, alternative splicing, RNA editing and mRNA transport.

Translation- Various steps involved in translation/protein synthesis (aminoacylation of tRNA, translation, fidelity of translation); Inhibitors of protein synthesis; Post-translational modifications of proteins.

C-8 (P): Practical(30 hours)

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. 3rdedition.

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-3; Practical-1)

C-9 (T): THEORY (45 Lectures)

Unit 1: Introduction: Soil and Water (9 Lectures)

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

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

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

Unit 2: Light, Temperature, Wind and Fire, Biotic Interaction (9 Lectures)

Light, temperature, wind and fire- adaptation of plants to their variation.

Biotic interactions- Trophic organization, basic source of energy, autotrophy, heterotrophy; symbiosis, commensalism, parasitism

Unit 3: Population Ecology and Plant Communities (9 Lectures)

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

Unit 4: Ecosystem and functional aspects of ecosystem (9 Lectures)

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

Functional aspects of ecosystem- Principles and models of energy flow; Production and productivity; Ecological efficiencies; Biogeochemical cycles; Cycling of Nitrogen and Phosphorus

Unit 5: Phytogeography (9 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.

C-9 (P): Practical (30 Hours)

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 fromtwo 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(*Orobanche*) Epiphytes, Predation (Insectivorous plants).

8. Determination of minimal quadrate size for the study of herbaceous vegetation in the collegecampus, by species area curve method (species to be listed).

9. Quantitative analysis of herbaceous vegetation in the college campus for frequency andComparison 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-3; Practical-1)

C-10 (T):THEORY (Lectures: 45 Hours)

Unit 1: Significance of Plant Systematics (9 Lectures)

Introduction to plant systematics; Evidences from cytology. Functions of Herbarium; Important herbaria and botanical gardens of the world and India; Virtual herbarium; Documentation: Flora, Monographs, Taxonomical Keys: Single access and Multi-access.

Unit 2: Angiosperm Taxonomy (9 Lectures)

Critical study of the following families with emphasis on identification of local members using flora, economic importance, interrelationship and evolutionary trends- Dicots; Magnoliaceae, Brassicaceae, Ranunculaceae, Rutaceae, Fabaceae, Meliaceae, Lamiaceae, Euphorbiaceae, Solanaceae, Cucurbitaceae, Asteraceae. Monocots; Orchidaceae, Poaceae, Zingiberaceae

Unit 3: Taxonomic Hierarchy and Botanical Nomenclature (9 Lectures)

Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concept (taxonomic, biological, evolutionary). Principles and rules (ICN); Ranks and names of taxa; Typification, author citation, effective & valid publication, principle of priority and its limitations.

Unit 4: Systems of Classification (9 Lectures)

Brief contributions of Linnaeus, Contribution of Hutchinson and Takhtajan in Taxonomy; Classification system of Bentham and Hooker (up to family); Brief reference of Angiosperm Phylogeny Group classification.

Unit 5: Phylogeny of Angiosperms (9 Lectures)

Terms and concepts (primitive and advanced, homology and analogy, parallelism and convergence, monophyly, Paraphyly, polyphyly and clades). Origin and evolution of angiosperms.

C-10 (P): PRACTICAL (30 Hours)

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 and Hooker's system of classification):

Ranunculaceae - *Ranunculus, Delphinium*

Brassicaceae - *Brassica / Iberis*

Asteraceae – *Bidens /Launaea, Vernonia/Ageratum, Eclipta/Tridax*

Solanaceae - *Solanum nigrum/Withania*

Lamiaceae - *Salvia/Ocimum*

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

Orchidaceae- *Dendrobium / Cymbidium*

Liliaceae - *Asphodelus/Lilium/Allium*

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.3rdedition.

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-3; Practical-1)

C-11 (T): THEORY (45 Lectures)

Unit 1: Introduction to Reproductive Biology and Anther Biology (9 Lectures)

History and scope of embryology; Flower as a modified shoot; Structure of stamen; Microsporogenesis; Microgametogenesis; Pollen viability, storage and germination; Abnormal features: Pseudomonads, polyads, massulae, pollinia; Dehiscence

Unit 2: Ovule and Embryogeny (9 Lectures)

Structure of carpel; Types of Ovule; Megasporogenesis (monosporic, bisporic and tetrasporic types); Megagametogenesis; Structure of typical embryosac; Types of embryo sac (Polygonum, Allium and Adoxa type); Special structures–endothelium, obturator, aril, caruncle and hypostase

Unit 3: Pollination and Fertilization (9 Lectures)

Pollination types and significance; Structure of stigma and style; Pollen tube entry; Double fertilization; Development of Endosperm

Unit 4: Post-Fertilization (9 Lectures)

Structure and types of endosperm; General pattern of development of dicot and monocot embryo and endosperm; Suspensor- structure and function; Embryo-endosperm relationship; Nutrition of embryo; Seed structure, importance and dispersal mechanisms; Polyembryony; Apomixis

Unit 5: Self-Incompatibility (9 Lectures)

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

C-11 (P): PRACTICAL (30 HOURS)

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 PublishingHouse. 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. l (1984). Embryology of Angiosperms, Springer-Verlag, Netherlands.

Course Code: BCC - 12: Plant Physiology

(Credits: Theory-3; Practical-1)

C-12 (T)THEORY (45 Lectures)

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, criteria for essentiality, roles of essential elements, deficiency symptoms.

Unit 3: Nutrient Uptake and Translocation in the Phloem **(9 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.

Translocation in the phloem- Flow Model; Phloem loading and unloading; Source–sink relationship.

Unit 4: Plant Growth Regulators **(9 Lectures)**

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

Unit 5: Physiology of Flowering **(9 Lectures)**

Photoperiodism, flowering stimulus, florigen concept, vernalization, seed dormancy; Phytochrome, Crytochromes and Phototropins-Discovery, chemical nature, role in photomorphogenesis, low energy responses (LER) and highirradiance responses (HIR), mode of action.

C-12 (P)Practical (30 Hours)

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 amesophyte and xerophyte.

5. To calculate the area of an open stoma and percentage of leaf area open through stomata in amesophyte 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. NarosaPublishing House, New Delhi.

Course Code: BCC - 13:Plant Metabolism

(Credits: Theory-3; Practical-1)

C-13 (T)THEORY: (45 Lectures)

Unit 1: Concept of Metabolism and Carbohydrate Metabolism (9 Lectures)

Introduction, anabolic and catabolic pathways, regulation of metabolism, role of regulatory enzymes (allosteric, covalent modulation and isozymes); Carbohydrate Metabolism**:** Synthesis and catabolism of sucrose and starch.

Unit 2: Carbon Assimilation (9Lectures)

Photosynthetic pigments, role of photosynthetic pigments (chlorophylls and accessory pigments), antenna molecules and reaction centres, photochemical reactions, photosynthetic electron transport, PSI, PSII, Q cycle, CO_2 reduction, photorespiration, C_4 pathways; Crassulacean acid metabolism; Factors affecting CO_2 reduction.

Unit 3: Carbon Oxidation (9 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 4: ATP-Synthesis and Mechanisms of Signal Transduction (9 Lectures)

Mechanism of ATP synthesis, chemiosmotic mechanism (oxidative and photophosphorylation), ATP synthase.Receptor-ligand interactions; Second messenger concept, Calcium calmodulin.

Unit 5: Lipid and Nitrogen Metabolism (9 Lectures)

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

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

C-13 (P)Practical (30 Hours)

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.

Course Code: BCC - 14: Plant Biotechnology

(Credits: Theory-3; Practical-1)

C-14 (T)THEORY (45 Lectures)

Unit 1: Plant Tissue Culture (9Lectures)

Plant biotechnology; Composition of media; Nutrient and hormone requirements; Totipotency; Organogenesis; Embryogenesis; Protoplast isolation, culture and fusion; Tissue culture applications

Unit 2: Recombinant DNA Technology (9 Lectures)

Restriction Endonucleases; Restriction Mapping (Linear and Circular); Cloning Vectors: Prokaryotic Vectors (pUC 18, pUC19, pBR322,Ti plasmid); Lambda phage, M13 phagemid, Shuttle vector; Eukaryotic Vectors-(YAC).

Unit 3: Gene Cloning (9 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.

Unit 4: Methods of Gene Transfer (9 Lectures)

Agrobacterium-mediatedgene transfer; Direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment; Selection of transgenic– selectable marker and reporter genes

Unit 5: Applications of Biotechnology (9 Lectures)

Pest and herbicide resistant plants; 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; Biosafety concerns.

C-14 (P)Practical (30 Hours)

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. Demonstration of PCR technique.

Suggested Readings

1. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. ElsevierScience Amsterdam. The Netherlands.
2. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications ofrecombinant DNA. ASM Press, Washington.
3. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms. Vikas PublicationHousePvt. 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 andApplications. John Wiley & Sons Inc. U.S.A.

Discipline Specific Elective Courses

Course Code: BDSE – 01: A. Analytical Techniques in Plant Sciences

(Credits: Theory-3; Practical-1)

C-15 (T) THEORY (45 Lectures Hours)

Unit 1: Imaging and Related Techniques **(9 Lectures)**

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

Unit 2: Cell Fractionation and Chromatography **(9 Lectures)**

Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, $CsCl_2$gradient, analytical centrifugation, ultracentrifugation, marker enzymes.

Chromatography: Principle; Paper chromatography; Column chromatography, TLC, HPLC, Ion-exchange chromatography; Molecular sieve chromatography; Affinity chromatography.

Unit 3: Radioisotopes and Spectrophotometry **(9 Lectures)**

Use in biological research, auto-radiography, pulse chase experiment; Spectrophotometry: Principle and its application in biological research.

Unit 4:Characterization of Proteins and Nucleic Acids **(9Lectures)**

Mass spectrometry; X-ray diffraction; X-ray crystallography; Characterization of proteins and nucleic acids; Electrophoresis: AGE, PAGE, SDS-PAGE.

Unit 5:Biostatistics **(9Lectures)**

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.

C-15 (P)Practical(30 Hours)

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-HillPublishing Co. Ltd. New Delhi. 3rd edition.
2. Ruzin, S.E. (1999). Plant Microtechnique and Microscopy, Oxford UniversityPress, 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.

Course Code: BDSE – 01: B. Bioinformatics

(Credits: Theory-3; Practical-1)

C-15 (T)THEORY(45 Lectures)

Unit 1: Introduction to Bioinformatics and Databases in Bioinformatics (9 Lectures)

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

Introduction to Biological Databases, Classification format of Biological Databases, Biological Database Retrieval System.

Unit 2:Biological Sequence Databases I (9Lectures)

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.

Unit 3: Biological Sequence Databases II (9 Lectures)

EMBL Nucleotide Sequence Database (EMBL-Bank): Introduction, Sequence Retrieval,Sequence Submission to EMBL, Sequence analysis tools.Introduction, Resources at DDBJ, Data Submission at DDBJ. Protein Information Resource (PIR): About PIR, Resources of PIR, Databases of PIR, Data Retrieval in PIR.

Unit 4: Sequence Alignments (9 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 (9 Lectures)

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

C-15 (P) Practical (30 Hours)

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.

Course Code: BDSE – 02: A. Plant Breeding

(Credits: Theory-3; Practical-1)

C-16 (T)THEORY (45 Lectures)

Unit 1: Plant Breeding **(9Lectures)**

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 **(12 Lectures)**

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

Unit 3: Quantitative Inheritance **(9 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 **(6 Lectures)**

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

Unit 5: Crop Improvement and Breeding **(9 Lectures)**

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

C-16 (P) PRACTICAL (60 Hours)

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. 7thedition.

2. Chaudhari, H.K. (1984). Elementary Principles of Plant Breeding. Oxford – IBH.2ndedition.

3. Acquaah, G. (2007). Principles of Plant Genetics & Breeding. Blackwell Publishing.

Course Code: BDSE – 02: B. Biostatistics

(Credits: Theory-3; Practical-1)

C-16 (T)THEORY (45 Lectures)

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

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

Unit 2: Collection of Data (Primary and Secondary) **(9 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 **(9Lectures)**

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 **(9 Lectures)**

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

Unit 5: Statistical Inference **(9 Lectures)**

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

C-16 (P)Practical(60 Hours)

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-3; Practical-1)

C-17 (T)THEORY(45 Lectures)

Unit 1: Natural Resources &: Sustainable Utilization **(9 Lectures)**

Definition and types.Sustainable Utilization-Concept, approaches (economic, ecological and socio-cultural).

Unit 2: Land and Water **(9Lectures)**

Utilization (agricultural, pastoral, horticultural, silvicultural); Soil degradation and management. Water-Fresh water (rivers, lakes, groundwater, aquifers, watershed); Marine; Estuarine; Wetlands; Threats and management strategies.

Unit 3: Biological Resources **(9 Lectures)**

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

Unit 4: Forests and Energy **(9 Lectures)**

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

Energy- Renewable and non-renewable sources of energy.

Unit 5: Contemporary Practices in Resource Management **(9 Lectures)**

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

National and International Efforts in Resource Management and Conservation.

C-17 (P) Practical (60 Hours)

1. Estimation of solid waste generated by a domestic system (biodegradable and non-biodegradable) 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 modelling.

5. Field report

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 ResourceConservation. Anamaya Publications, New Delhi.
3. Rogers, P.P., Jalal, K.F. and Boyd, J.A. (2008). An Introduction to SustainableDevelopment. Prentice Hall of India Private Limited, New Delhi.

Course Code: BDSE – 03: B. Horticultural Practices and Post-Harvest Technology

(Credits: Theory-3; Practical-1)

C-17 (T)THEORY (45 Lectures)

Unit 1: Introduction to Horticulture, Landscaping and Garden Designs (9 Lectures)

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

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

Unit 2: Ornamental Plants , Fruits and Vegetable (9 Lectures)

Types, classification (annuals, perennials, climbers and trees); Identification and salient features of some ornamental plants [rose, marigold, gladiolus, carnations, orchidsand succulents (opuntia and agave)] Ornamental flowering trees (Gulmohar, Jacaranda, fishtail palm,coraltree).

Fruit and Vegetable Crops- origin and distribution; Description of plants and their economic products; Identification of some fruits and vegetable varieties (citrus, banana,chillies and cucurbits).

Unit 3: Horticultural Techniques (9 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).

Unit 4: Post-harvest Technology and Floriculture (9 Lectures)

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

Floriculture-Cut flowers, bonsai, Importance of flower shows, exhibitions and marketing

Unit 5: Disease Control and Management of Horticultural Crops (9 Lectures)

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

C-17 (P)Practical (60 Hours)

1. Field visits to gardens, standing crop sites, nurseries, vegetable gardens and horticultural fields at IARI or other suitable locations.
2. Propagation of horticultural crops and seeds
3. Preparation of potting mix for saplings

4. 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 ofIndustrial 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

Course Code: BDSE – 04: B. Industrial and Environmental Microbiology

(Credits: Theory-3; Practical-1)

C-18 (T) THEORY (45 Lectures)

Unit 1: Microbes and Fermentation Processes (9Lectures)

Scope of Microbes in Industry and Environment.

Solid-state and liquid-state (stationary and submerged) fermentations; Batch and continuous fermentations. 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 2: Microbial Production of Industrial Products (9 Lectures)

Microorganisms involved, media, fermentation conditions, downstream processing and uses; Filtration, centrifugation, cell disruption, solvent extraction, precipitation and ultra filtration, lyophilization, spray drying; Hands on microbial fermentations for the production and estimation (qualitative and quantitative) of Enzyme: amylase or lipase activity.

Unit 3: Industrial Important Microbial Enzymesand Enzyme Immobilization(9 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 4: Microbes and Quality of Environment (9Lectures)

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

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 ofwater quality, check coliform and faecal coliform in water samples.

Unit 5: Microbes in Agriculture and Remediation of Contaminated Soils (9 Lectures)

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

C-18 (P) Practical(30 Hours)

1. Principles and functioning of instruments in microbiology laboratory
2. Hands on sterilization techniques and preparation of culture media.
3. Isolation of root nodulating bacteria.

4. Arbuscular mycorrhizal colonization in plant roots.
5. Study of the methods for staining of microorganism.
6. A visit to any educational institute/ industry to see an industrial Fermenter, and other downstream processing operations.

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 BenjaminCummings, San Francisco, U.S.A. 9th edition.
3. Dubey R.C. & Maheshwari D.K. A textbookof Microbiology. S.Chand, New Delhi India.

Course Code: BDSE 04 B: Economic Botany and Plant Biotechnology

(Credits: Theory-3; Practical-1)

C-18 (T)THEORY (45 Lectures)

Unit 1: Origin of Cultivated Plants: Cereals, Legumes & Spices (9 Lectures)

Concept of centres of origin, their importance with reference to Vavilov's work.General account of cereals with special reference to wheat -Origin, morphology, uses. General account of Legumes with special reference to *Phaseolus* and *Dolichos*.

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

Unit 2: Beverages, Fats and Oils and Fibre Plants (6 Lectures)

Tea (morphology, processing, uses); General description of fats and oils with special reference to groundnut; General description of Fibre plants with special reference to Cotton (Botanicalname, family, part used, morphology and uses).

Unit 3: Plant Tissue Culture (10 Lectures)

Meristem culture, Organ culture; Callus culture; Cell suspension culture; Protoplast culture, Isolation of protoplasts, somatic hybridization and its significance; Somatic embryogenesis and synthetic seeds. Haploid production - Anther and pollen culture, its significance; Embryo culture and Embryo rescue Micropropagation - Multiple shoot culture and large scale propagation of crop plants.

Unit 4: Recombinant DNA Technology (10 Lectures)

Enzymes- Exonucleases; Endonucleases; Restriction endonucleases, Ligases; Reverse Transcriptase, Terminal transferase, Polymerase, Alkaline phosphatase; Vectors- General account of plasmids, cosmids, bacteriophages, cDNA library, genomic DNA library; Polymerase chain reaction - Principle, types of primers, T*aq* polymerase, Application and problems.

Unit 5: Gene Manipulation (10 Lectures)

Direct methods of gene transfer - Biolistics, Lipofection, Electroporation, microinjection; Vector mediated gene transfer-*Agrobacterium* mediated gene transfer - T DNA, Ti plasmid and

Riplasmid derived vector systems; Southern, Northern and Western blotting; Molecular markers - RAPD, RFLP, AFLP, Brief account of DNA Finger printing and Barcoding of plants.

Practical(60 Hours)

1. Study of economically important plants-legume, cereals and spices
2. Study of economically important fats and oil yielding plants
3. Study of economically important Fibre yielding plants
4. Familiarization with basic equipment in tissue culture.
5. Study through photographs: Anther culture, somatic embryogenesis, endosperm and embryo culture
6. Preparation of MS medium
7. Micropropagation.
8. Artificial seeds
9. Study of molecular techniques: PCR.

Isolation of DNA by gel electrophoresis

Suggested Readings

1. Kochhar, S.L. (2011). Economic Botany in the Tropics, MacMillan Publishers IndiaLtd., 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
4. Reinert, J. and Bajaj, Y.P.S. 1997 Applied and Fundamental Aspects of Plant Cell, Tissueand Organ Culture. Narosa Publishing House.
5. Slater, A., Scott, N.W. & Fowler, M.R. 2008 Plant Biotechnology: The Genetic
6. Manipulation of Plants, Oxford University Press.