

Semester I

DISCIPLINE SPECIFIC CORE COURSES (DSC) SEMESTER-I

Course Code BOT-DSC-1

Course Title: **Plant Diversity and Systematics**

Total Credits: **04 (Credits: Theory 02, Practical 02)**

Total Hours: **Lectures- 30, Practical- 15 classes of 4 hours each**

Objective:

To make students aware about the diversity of plants and microbes present on the planet and their evolutionary relationships.

Learning Outcomes:

This course will be able to impart basic knowledge and understanding of:

- the diversity of plants and microbes
- the possible relationships between each group
- their general characteristics
- approaches used for identification and classification of various groups of plants

Unit 1: Diversity of Life

Lectures: 01

Classifying the diversity of life: Domains of Life –Eubacteria, Archaea and Eukaryotes

Unit 2: Microbes

Lectures: 04

Viruses: General account; Replication, Lytic and Lysogenic cycle; Bacteria: structure, wall-less forms (L-forms, Mycoplasma), asexual reproduction and genetic recombination

Unit 3: Algae

Lectures: 03

Brief introduction of major classes: Blue-green, Green, Brown and Red algae. Diagnostic features of identification; morphology, reproduction and classification with special reference to *Nostoc*, *Volvox* and *Spirogyra*.

Unit 4: Fungi

Lectures: 03

Diagnostic features of identification; morphology, reproduction and classification with special reference to *Rhizopus*, *Penicillium* and *Agaricus*; Lichens (a general account).

Unit 5: Bryophytes, Pteridophytes and Gymnosperms

Lectures: 06

Characteristic features of identification; morphology and reproduction of Bryophytes, Pteridophytes and Gymnosperms with special reference to *Marchantia*, *Funaria*, *Pteris* and *Pinus* (only morphology).

Unit 6: Angiosperms

Lectures: 02

Diagnostic features, Structure of flower, types of inflorescence

Unit 7: Systematics

Lectures: 01

Aims, fundamental components of systematics, description, identification, nomenclature, phylogeny, biosystematics.

Unit 8: Systematics in Practices

Lectures: 07

Taxonomic Hierarchy- Concept of taxa and categories, Botanical Nomenclature- principles and rules; Type method; Author citation; Valid publication; Rejection of names, Principle of priority and its limitations, names of hybrids and cultivars.

Unit 9: Systems of classification

Lectures: 03

Classification: Artificial, Natural and Phylogenetic. An outline of Bentham and Hooker's (up to series only) and Engler and Prantl's (up to Subclasses) systems of classification and their merits and Demerits. APG System.

Practicals: (60 hours)

1. **Viruses:** Electron Micrographs of TMV and Bacteriophage, Specimens of virus infected plants (any two).
2. **Bacteria:** Electron Micrographs of a bacterium, types through permanent slides/photographs, specimens of infected plants (any two).
3. **Algae:** Study of vegetative and reproductive structures of (a) *Nostoc* (b) *Volvox* (c) *Spirogyra* through temporary preparations and permanent slides.
4. **Fungi:** Study of vegetative and reproductive structures of (a) *Rhizopus*, (b) *Penicillium* and (c) *Agaricus* through temporary preparations and permanent slides/specimens/photographs.
5. **Lichens:** Crustose, Foliose and Fruticose (specimens/ digital resources)
6. **Bryophytes:** Study of (a) *Marchantia*: morphology of thallus, W.M. rhizoids and scales, V.S. thallus through gemma cup, W.M. gemmae (all temporary slides), V.S. antheridiophore, archegoniophore, L.S. sporophyte (all permanent slides), (b) *Funaria*: detailed study and classification from W.M. rhizoids, operculum, peristome, spores and permanent slides of archegonia, antheridia and capsule.
7. **Pteridophytes:** Study of *Pteris*: T. S. of Rachis, V.S. of Sporophyll and W.M. of sporangium.
8. **Gymnosperms:** Study of *Pinus* morphology of long & dwarf shoot, male and female cones (specimens) and T.S. of needle (permanent slides only).

9. **Herbarium technique:** Mounting of a properly dried and pressed specimen of any wild plant on the herbarium sheet with complete herbarium label.
10. Taxonomic study of characters of one plant from each of the following families (any four): Malvaceae, Solanaceae, Asteraceae, Fabaceae, Liliaceae.

Suggested Readings:

1. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). *Introductory Mycology*, 4th edition. Singapore, John Wiley and Sons (Asia).
2. Kumar, H.D. (1999). *Introductory Phycology*, 2nd edition. Delhi, Delhi: Affiliated East-West. Press Pvt. Ltd.
3. Bhatnagar, S.P., Moitra, A. (1996). *Gymnosperms*. New Delhi, Delhi: New Age International (P) Ltd. Publishers.
4. Parihar, N.S. (1991). *An introduction to Embryophyta*. Vol. I. Bryophyta. Prayagraj: U.P.: Central Book Depot.
5. Pelczar, M.J. (2001). *Microbiology*, 5th edition. New Delhi, Delhi: Tata McGraw-Hill Co.
6. Tortora, G.J., Funke, B.R., Case. C.L. (2007). *Microbiology*. San Francisco, U.S.A: Pearson Benjamin Cummings.
7. Raven, P.H., Evert, R.F., Eichhorn, S.E. (2013). *Biology of Plants*, 8th edition, New York, NY: W.H. Freeman and Company.
8. Sethi, I.K., Walia, S.K. (2018). *Text book of Fungi and Their Allies*. (2nd Edition), Medtech Publishers, Delhi.
9. Vashishta, P.C., Sinha, A.K., Kumar, A. (2010). *Pteridophyta*. New Delhi, Delhi: S. Chand & Co Ltd.
10. Singh, G. (2020). *Plant Systematics: Theory and Practice*, 4th edition. CBS Publishers and Distributors, New Delhi.
11. Simpson, M.G. (2020). *Plant Systematics*, 3rd edition, Elsevier Academic Press, San Diego, CA, U.S.A.
12. Gupta R. 2011. *Plant Taxonomy: past, present, and future*. New Delhi: The Energy and resources Institute (TERI).
13. Judd W.S., Campbell C.S., Kellogg, E. A., Stevens, P.F., Donoghue M.J. (2015). *Plant Systematics: A Phylogenetic Approach* 4th Edition Sinauer Associates, Oxford University Press. USA.
14. <http://www.mobot.org/MOBOT/research/APweb/>. (for APG IV classification).

Keywords: Bacteria, Viruses, Bryophytes, Pteridophytes, Gymnosperms, Angiosperms, Classification

Category II
B.Sc. Life Science with Botany as one of the Core Discipline

DISCIPLINE SPECIFIC CORE COURSE – 2: Genetics and Molecular Biology

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Genetics and Molecular Biology	04	2	0	2	10+2 from any recognized Board with Biology	Nil

Learning Objective

To apprise students with the basic principles of Genetics and Molecular Biology and its applications in living systems

Learning Outcome:

Students would be able to

- understand the fundamentals of Mendelian inheritance and non-Mendelian inheritance.
- describe the concepts of linkage and crossing over and their usage in constructing genetic maps.
- gain knowledge about chromosomal aberrations and mutations.
- become familiar with structure and function of nucleic acids with reference to replication, transcription and translation.
- understand the mechanisms of gene regulation

SYLLABUS OF DSC-02

Unit 1: Mendelian genetics and extrachromosomal inheritance

06 Hours

Mendel's principles of inheritance; chromosomal theory of inheritance; incomplete dominance and co-dominance; multiple allelism; lethal alleles (dominant and recessive lethals); deviations of Mendelian dihybrid ratio (Epistatic interactions-Dominant, Recessive, Duplicate Dominant, Duplicate Recessive, Duplicate Gene Interaction, Dominant - Recessive); polygenic inheritance; numericals based on above; extrachromosomal inheritance (Chloroplast Inheritance: Variegation in Four O' clock plant; Mitochondrial inheritance: petite mutants in yeast); Maternal effect (shell coiling in snails).

Unit 2: Structure & Function of the gene

02 Hours

Classical and molecular concept of gene - Benzer's cis-trans complementation analyses & fine map of rII locus in phage. Central Dogma.

Unit 3: Linkage, crossing over and chromosome mapping

03 Hours

Discovery; linkage and crossing over; recombination frequency: two factor crosses; sex linkage (eye color in *Drosophila*; colour blindness and haemophilia in humans).

Unit 4: Variation in chromosome number and structure

03 Hours

Haploidy, polyploidy, autopolyploidy (examples: banana, watermelon), allopolyploidy (ancestry of wheat) and aneuploidy (Down's, Turner's and Klinefelter's syndromes); Deletion; Duplication (Bar eye in *Drosophila*); Inversion (paracentric and pericentric); Translocation (*Rhoeo*, *Oenothera*; Robertsonian translocation, Familial Down Syndrome and cancer).

Unit 5: DNA structure and replication**03 Hours**

Discovery of DNA; Watson and Crick model of DNA structure; semiconservative replication (Meselson & Stahl's experiment); DNA replication mechanism in *E. coli* (semi-discontinuous mode and Y-fork).

Unit 6: Mutations**03 Hours**

History; mutation types with examples [spontaneous and induced; somatic and germinal; biochemical mutations; point mutations (base substitutions): transition and transversion; deletion and frameshift mutations), missense and nonsense mutations]; Molecular basis of mutation; Mutagens - physical (UV and X-rays), chemical mutagens [Base analogues, deaminating, alkylating and intercalating agents] and Transposons.

Unit 7: Gene expression**06 Hours**

Genetic code; Structure and types of RNA; Transcription and Translation in Prokaryotes; Transcription, RNA processing and Translation in Eukaryotes.

Unit 8: Regulation of gene expression: Prokaryotes**04 Hours**

Inducible and repressible systems, negative and positive control of lactose operon and tryptophan operon. **Eukaryotes** - Transcriptional gene silencing - Role of chromatin, DNA methylation, histone modifications; cis-acting elements (promoters & enhancers/silencers), trans-acting factors; Post-transcriptional gene regulation (RNA interference/ PTGS), role of small RNAs, Epigenetics.

Practicals:

1. To study mitosis in *Allium cepa* through squash preparation of root tips. **04 Hours**
2. To study meiosis in *Allium cepa* through smear preparation of anthers. **08 Hours**
3. To study incomplete dominance and deviations of Mendelian dihybrid ratio (12:3:1, 9:3:4, 9:7, 15:1, 13:3) through seed samples. **08 Hours**
 - a) Human Genetics b) Study of autosomal & sex-linked dominant & recessive inheritance through pedigree analyses. c) n ABO blood group testing using kits, d) To study the syndromes (Down's, Klinefelter's, and Turner's) through karyotypes **08 Hours**
4. To study chromosomal aberrations: reciprocal translocation through squash preparations of *Rhoeo* anthers. Complex translocation ring, quadrivalents, lagging chromosomes, dicentric/inversion bridge through permanent slides. **08 Hours**
5. To prepare LB medium, inoculate and maintain (spread plate, streak plate, pour plate & serial dilution methods) *E. coli* cultures. **08 Hours**
6. To isolate genomic DNA from cauliflower and *E.coli*. Visualise using agarose gel electrophoresis. **08 Hours**
7. To estimate DNA by diphenylamine method. **04 Hours**

Suggested Readings:

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (1991). Principles of Genetics, 8th edition. New Delhi, Delhi: John Wiley & sons.
2. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2020). Introduction to Genetic Analysis, 12th edition. New York, NY: W.H. Freeman and Co.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2020). Concepts of Genetics, 12th edition. San Francisco, California: Benjamin Cummings.

Additional Resources:

1. Russell, P. J. (2010). Genetics- A Molecular Approach. 3rd Edition. Benjamin Cummings
2. Snustad, D.P., Simmons, M.J. (2016). Principles of Genetics, 7th Edition. New Delhi, Delhi: John Wiley & sons
3. Pierce, B. A. (2020). Genetics: A Conceptual Approach Seventh Edition, Macmillan

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

Category II

Botany Courses for Undergraduate Programme of study with Botany as one of the Core Disciplines

DISCIPLINE SPECIFIC CORE COURSE (DSC-.....): Plant Cell and Developmental Biology

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Plant Cell and Developmental Biology DSC	4	2	0	2	Class XII pass	Nil

Learning objectives:

To understand the basics of plant cell structure, development, growth and organisation of plant body.

Learning outcomes:

On completion of the course, the students will

- become familiar with the structure and functions of various components of plant cell
- understand the processes of cell growth and its regulation
- comprehend the structure, organization and functions of various tissues of the plant organs
- get acquainted with the reproductive processes in the life cycle of angiosperms
- appreciate the interactions between the developmental pathways resulting in the differentiation of plant body
- recognise the importance of plant developmental biology in the improvement and conservation of plants

Unit 1. Introduction to Plant Cell: structure and function

5 hour

Cell as the basic unit of life; differences between plant and animal cell, prokaryotic and eukaryotic cell; Cell Theory.

Structure and functions of cell wall; cell membrane; cell organelles- nucleus, chloroplast, mitochondria, dictyosomes, endoplasmic reticulum, microbodies, cytoskeleton.

Unit 2: Cell growth

3 hours

Cell cycle, regulation (in brief) and significance; mitosis and meiosis; cytokinesis.

Unit 3. Polarity in plant growth

3 hours

Plant body as a bipolar structure; apical, basal and radial patterns of body plan; growth through primary and secondary meristems; organisation of shoot and root apices.

Unit 4. Differentiation of tissues: vegetative organs

6 hours

Structure and functions of tissues (simple and complex); structure of stem, root, and leaf (dicot and monocot); principles of organ differentiation: role of transcription factors in cell, tissue, organ identity and development, cell fate determination by position, and cell-cell signalling; hormones involved in organ differentiation (very briefly).

Unit 5. Differentiation of tissues: reproductive organs

6 hours

Anther, microsporogenesis and microgametogenesis, general structure of pollen grains and male gametes, male germ unit; ovule, megasporogenesis (monosporic, bisporic, tetrasporic) and megagametogenesis (Polygonum type), ultrastructure and significance of female germ unit; Flower development (ABC model).

Unit 6. Pollination and Fertilization

3 hours

Pollination types, agents and adaptation; pollen germination; path of pollen tube in pistil; double fertilization

Unit 7. Development of Embryo and Seed

4 hours

Endosperm types, functions; development of embryo from zygote, establishment of apical-basal and radial organisation; development of seed, modes of seed dispersal.

Practicals (60 hours)

1. Study of plant cell - through peel mount (*Tradescantia*, or any other); whole mount (*Hydrilla*) - cytoplasmic streaming.
2. Study of cell components - nucleus (Feulgen/acetocarmine staining); mitochondria (Janus green B staining); cell wall (PAS staining).
3. To study mitotic index. (pictures or permanent slides -24h-period or under different temperatures/environmental conditions may be used).
4. Study tissues and organs structure through temporary preparations of macerated material and sections - T.S. of dicot stem- *Helianthus/ Cucurbita, Hydrilla/ Nymphaea petiole, Casuarina*, stem with secondary growth - *Helianthus, Salvadora/ Bignonia*; T.S. of monocot stem - *Zea mays, Dracaena*; T.S. of dicot root with and without secondary growth- *Cicer*, monocot root - *Zea mays*, V.S. of dicot leaf- *Vernonia/Hamelia*etc., *Nerium, Hydrilla*; V.S. of monocot leaf- *Zea mays, Triticum/Dracaena/Crinum*; peel mount to study epidermal structures - types of stomata, trichomes, laticifers; Shoot apex and root apex through micrographs.
5. Study Reproductive structures (i) Anther - T.S. of anther of any large flower like *Datura/ Hamelia/ Kigelia*); whole mounts of pollen grains; ii) pollen development through micrographs of T.S. anther at different stages of development (with secretory, amoeboid tapetum); (iii) types of ovule through permanent slides/specimens/ micrographs; (iv) Polygonum type of embryo sac development through micrographs; (v) ultrastructure of egg apparatus and central cell through micrographs.
6. Study (i) pollen viability (TTC/FDA); (ii) pollen germination; (iii) growth of pollen tube in cleared pistil.

7. Study (i) dicot and monocot embryo development (through permanent slides); (ii) structure of seed (L.S. of seed)

Suggested Readings:

1. Beck, C.B. (2010). An Introduction to Plant Structure and Development. Second edition. Cambridge University Press, Cambridge, UK.
2. Dickison, W.C. (2000). Integrative Plant Anatomy. Harcourt Academic Press, USA
3. Fahn, A. (1974). Plant Anatomy. Pergamon Press, USA
4. Mauseth, J.D. (1988). Plant Anatomy. The Benjamin/Cummings Publisher, USA
5. Esau, K. (1977). Anatomy of Seed Plants. John Wiley & Sons, Inc., Delhi.
6. Taiz, L., Zeiger, E., Moller, I.M., Murphy, A. (2015). Plant Physiology. 6th edition. Sinauer Associates, Sunderland. USA.
7. Hopkins, W.G., Huner, N.P.A. (2009). Introduction to Plant Physiology. Fourth edition, John Wiley & Sons, Inc. USA.
8. Bhojwani, S.S., Bhatnagar, S.P., Dantu, P.K. (2015). The Embryology of Angiosperms, 6th edition. New Delhi, Delhi: Vikas Publishing House.
9. Johri, B.M. (1984). Embryology of Angiosperms. Netherlands: Springer-Verlag.
10. Raghavan, V. (2000). Developmental Biology of Flowering plants. Netherlands: Springer.
11. Shivanna, K.R. (2003). Pollen Biology and Biotechnology. New Delhi, Delhi: Oxford and IBH Publishing Co. Pvt. Ltd.

Additional Resources:

1. Cutler, D.F., Botha, T., Stevenson, D.W. (2007). Plant Anatomy - An Applied Aspect. Blackwell Publishing, USA
2. Bahadur, B. Rajam, M.V., Sahijram, L., Krishnamurthy, K.V. (2015). Plant Biology and Biotechnology. Volume 1: Plant Diversity, Organization, Function and Improvement. Springer (India) Pvt. Ltd. New Delhi, Heidelberg, New York, Dordrecht, London.
3. Shivanna, K.R., Tandon, R. (2014). Reproductive Ecology of Flowering Plants: A Manual. Springer (India) Pvt. Ltd. New Delhi, Heidelberg, New York, Dordrecht, London
4. Moza M. K., Bhatnagar A.K. (2007). Plant reproductive biology studies crucial for conservation. Current Science 92:1907.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

Category II

Botany Courses for Undergraduate Programme of study with Botany as one of the Core Disciplines BSc Life Sciences – Botany Component

DISCIPLINE SPECIFIC CORE COURSE – 4: Ecology and Evolution

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Ecology and Evolution LS-BOT-DSC-04	4	2	0	2	Class XII pass with Biology/ Biotechnology	Nil

Learning objectives:

- To understand basic ecological concepts, processes, inter-relation between the living world and abiotic environment.
- To make students understand the basic concept of evolution and natural selection.

Learning outcomes:

- After successful completion of the course the student shall have adequate knowledge about the basic principles of ecology and evolution.

Unit 1: Introduction to fundamental concepts in Ecology 02 hours

Inter-relation between the living world and abiotic environment. Fundamental concepts: Abiotic and biotic components; Levels of ecological organization: species, population, community, ecosystems, biomes.

Unit 2: Ecological factors

04 hours

Soil: Origin, formation, composition, soil profile. Water: States of water in the environment, precipitation types; Light, Temperature (Thermal stratification in water bodies and atmosphere) and Wind; Ecological amplitude; Leibig's law of minimum; Shelford law of tolerance.

Unit 3: Population Ecology

04 hours

Population Characteristics (dispersion, natality, mortality, survivorship curve, age pyramids); growth rates (density-dependent/independent); Interactions: mutualism, symbiosis, commensalism, competition, parasitism, predation, ammensalism, antibiosis.

Unit 4: Plant communities **05 hours**

Characters; Ecotone and edge effect; Succession; Processes and types (autogenic, allogenic, autotrophic, heterotrophic, primary and secondary)

Unit 5: Ecosystem **05 hours**

Structure; niche and habitats; Food chains and food webs, Ecological pyramids production and productivity; energy flow (single channel and Y-shaped); trophic organisation; Biogeochemical cycling; Cycling of nitrogen and Phosphorous

Unit 6: Introduction to Evolution **03 hours**

Origin and history of life; Macro and microevolution; Phylogeny and the tree of life.

Unit 7: Evolution of Species **04 hours**

Lamarckism and Neo-Lamarckism; Darwinism – selection (natural and artificial), Neo-Darwinism; Species concept and modes of speciation.

Unit 8: Phytogeography **03 hours**

Phytogeographical regions of India; Endemism (definition, factors and types).

Practicals **60 hours**

1. Principle and operation of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter.
2. Determination of pH and detection of carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from atleast two soil samples by rapid field tests.
3. Study of ecological adaptations of hydrophytes and xerophytes (four each).
4. Study of biotic interactions of the following: Stem parasite (*Cuscuta*), Root parasite (*Orobanche*), Epiphytes (Orchids), Predation (Insectivorous plants).
5. Determination of minimal quadrat size and number for the study of herbaceous vegetation in the college campus, by species area curve method (species to be listed).
6. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law.
7. Study of ecological speciation (allopatric and sympatric) with the help of examples.
8. Study phylogenetic relationships among taxa with the help of exercises.

9. Construct phylogenetic tree using MEGA and interpret evolutionary relationships.

Suggested Readings:

1. Douglas J. Futuyma (1998). *Evolutionary Biology* (3rd Edition), Sinauer Associates.
2. Kormondy, E.J. (1996). *Concepts of Ecology*. Prentice Hall, U.S.A. 4th edition.
3. Mark Ridley (2003) *Evolution* (3rd edition), Blackwell.
4. Odum, E.P. (2005). *Fundamentals of Ecology*. New Delhi, India: Cengage Learning India Pvt. Ltd., 5th edition.
5. Reece, J. B., Urry, L. A., Cain, M. L., Wasserman, S. A., Minorsky, P. V., Jackson, R. B. (2014). *Campbell biology* (Vol. 9). Boston: Pearson.

Additional Resources:

1. Rosenbaum, P.E. (2010). *Volpe's Understanding Evolution*. McGraw-Hill, New York.
2. Schulze, E. D., Beck, E., Müller-Hohenstein, K. (2005). *Plant Ecology*. Springer Science & Business Media.
3. Singh, J.S., Singh, S.P., Gupta, S.R. (2014). *Ecology, Environmental Science and Conservation*. New Delhi, India: S. Chand.
4. Smith, R. L., Smith, T. M., Hickman, G. C., Hickman, S. M. (1998). *Elements of ecology*.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

COURSES OFFERED BY DEPARTMENT OF BOTANY

Category II

**Botany Courses for Undergraduate Programme of study with Botany as one of the
Core Disciplines
(B.Sc. Life Sciences with Botany as one of the Core discipline)**

DISCIPLINE SPECIFIC CORE (LS-BOT-DSC-05)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Plant Physiology and Metabolism LS-BOT-DSC-05	4	2	0	2	Class XII pass with Biology/ Biotechnology	Nil

Learning Objectives:

4. To make students realize how plants function, the importance of water, minerals, phytohormones, and role of light in plant growth and development;
5. To understand mechanisms of carbon assimilation, nitrogen metabolism, phloem transport and translocation.

Learning Outcomes: At the end of this course, students will be able to:

- correlate physiological and metabolic processes with functioning of the plants.
- establish the link between theoretical principles and experimental evidence.

Unit 1: Plant-water relations

03 hours

Water potential and its components, pathway of water movement, ascent of sap (include root pressure and guttation), transpiration and its significance, stomatal movements – only ion theory.

Unit 2: Mineral nutrition

03 hours

Classification of mineral elements: Essential elements (macro- and micronutrients) and beneficial elements, General role of essential elements, transport of ions across membrane, active and passive transport (brief account of carriers, channels and pumps).

Unit 3: Translocation in phloem **02 hours**
Composition of phloem sap, girdling experiments, Pressure Flow Model, phloem loading and unloading.

Unit 4: Plant growth regulators **04 hours**
Physiological roles and bioassays of auxins, gibberellins, cytokinins, ethylene and ABA.

Unit 5: Plant response to light and temperature **02 hours**
Photoperiodism - discovery (SDP, LDP, day neutral plants), concept of florigen; phytochrome (discovery and physiological role), vernalization.

Unit 6: Enzymes **02 hours**
Classification, Structure and properties, mechanism of enzyme catalysis and enzyme inhibition.

Unit 7: Carbon metabolism **06 hours**
Photosynthetic pigments (chlorophyll *a* and chlorophyll *b*, xanthophyll, carotene); photosystem I and II, Light reactions (electron transport and photophosphorylation), Dark reactions: C3 pathway; C4 and CAM pathways (no chemical structures); photorespiration. Metabolite pool and exchange of metabolites, synthesis and degradation of sucrose and starch.

Unit 8: Respiration **02 hours**
Basic differences in animal and plant respiration, Cyanide resistant respiration.

Unit 9: Nitrogen metabolism **04 hours**
Nitrate assimilation (NR and NiR), biological nitrogen fixation in legumes (nodulation and role of dinitrogenase) Ammonia assimilation: GS-GOGAT, reductive amination and transamination.

Unit 10: Stress physiology in plants **02 hours**
ROS, RNS and anti-oxidative defence strategies.

Practicals **60 hours**

- Determination of osmotic potential of plant cell sap by plasmolytic method.
 - To study the effect of the environmental factor light on transpiration by excised twig.
 - Calculation of stomatal index and stomatal frequency of a mesophyte and a xerophyte.
 - To study the activity of catalase and study the effect of pH on the activity of enzyme.
 - To Study Hill's reaction.
 - To study the effect of light intensity on O₂ evolution in photosynthesis.
 - Comparison of the rate of respiration in any two parts of a plant.
 - To separate photosynthetic pigments by paper chromatography.
 - Bolting / Effect of auxins on rooting.
 - To demonstrate the delay of senescence by cytokinins/ effect of ethylene on fruit ripening
20. To study the phenomenon of seed germination (effect of light and darkness).
21. To demonstrate Respiratory Quotient (RQ)

Suggested Readings:

- Taiz, L., Zeiger, E., Moller, I. M., Murphy, A. (2018). *Plant Physiology and Development*, International 6th edition, Oxford University Press, Sinauer Associates, New York, USA.
- Bajracharya, D. (1999). *Experiments in Plant Physiology: A Laboratory Manual*, Narosa Publishing House, New Delhi.
- Hopkins, W. G., Huner, N. P. A. (2009). *Introduction to Plant Physiology*, 4th edition, Wiley India Pvt. Ltd, New Delhi.

Additional Resources:

- Jones, R., Ougham, H., Thomas, H., Waaland, S. (2013). *The molecular life of plants*. Chichester, England: Wiley-Blackwell.
- Kochhar, S.L. & Gujral, S.K. 2020. *Plant Physiology: Theory and Applications*, 2nd Edition. Cambridge University Press, UK.
- Bhatla, S.C., Lal, M.A. (2018). *Plant Physiology, Development and Metabolism*. Singapore: Springer.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

Category II

Botany Courses for Undergraduate Programme of study with Botany as one of the Core Disciplines

DISCIPLINE SPECIFIC CORE COURSE (DSC-6.): Economic Botany and Biotechnology

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Economic Botany and Biotechnology LS-DSC-BOT - 6	4	2	0	2	Class XII pass with Biology/ Biotechnology	Nil

Learning Objectives:

- To understand the economic importance of plants as cash crops - cereals, legumes, spices, non-alcoholic beverages, oils and fibres.
- To understand the concepts and applications of the techniques of Plant Tissue Culture and Recombinant DNA Technology in enhancing economic value of plants

Learning Outcomes: At the end of the course the students will have:

- knowledge of the nutritive and commercial / medicinal value of various plants and plant parts used as sources of carbohydrates, proteins, spices, oil and beverages.
- practice the methods / techniques of Plant Tissue Culture and apply tools of Biotechnology in improvement of crops for economic potential.

Unit 1: Origin of Cultivated Plants **02 hours**
Concept of centres of origin, their importance with reference to Vavilov's work.

Unit 2: Cereals and millets **04 hours**
Wheat, Rice and Maize: Origin, description of the part used, economic importance. Major and minor millets (Pearl millet, Sorghum, Kodo millet and Finger millet).

Unit 3: Pulse crops **02 Hours**
General account and economic importance with special reference to chickpea and pigeon pea.

Unit 4: Spices **03 Hours**

General account, part used and economic importance with special reference to cardamom, clove and black pepper.

Unit 5: Beverage **02 Hours**
Tea; morphology, types, processing, uses.

Unit 6: Oils and Fats **02 Hours**
General account; Classification, Difference between essential oils and fatty oils, uses (Sunflower, Soybean, Mint)

Unit 7: Fibre Yielding Plants **02 Hours**
Classification of fibres. Cotton and Jute, description of part used and uses.

Unit 8: Plant Tissue Culture Technology **05 Hours**
Introduction; nutrient media; aseptic and culture conditions, organogenesis (direct and indirect) and somatic embryogenesis; androgenesis, embryo culture, endosperm culture, protoplast culture Applications: micropropagation, generation of somaclonal variants, synthetic seeds and germplasm conservation.

Unit 9: DNA Recombinant Technology **08 Hours**
Introduction, Blotting techniques (Southern and Northern); PCR; Molecular DNA markers (RAPD, RFLP) and DNA fingerprinting in plants. Genetic Engineering Techniques: Gene cloning vectors (pUC18, Ti plasmid); enzymes (nuclease, polymerase, kinase, ligase); screening for gene of interest by DNA probe hybridisation, Insertion of genes into plant (*Agrobacterium* mediated, biolistics); selection of recombinants by selectable marker and reporter genes (GUS). Applications: Bt cotton, Golden rice, Flavr-Savr tomato, Edible vaccines.

Practicals: **60 Hours**

- Study of economically important plants through: specimens (Millets, Pigeon pea, Chickpea, Tea, and Cotton), Sections (Wheat, Maize, Black pepper, Clove), Micro-chemical Tests (Wheat, Soybean, Groundnut and Cotton).
- Principle and working of equipment used in Tissue culture: Laminar air flow cabinet, Autoclave.
- Preparation of culture medium (MS medium), sterilisation and inoculation of explants (Demonstration)
- Study of Micropropagation, Anther culture, Somatic embryogenesis, Endosperm and Embryo culture
- Study of Molecular techniques: PCR, Blotting techniques

22. Extraction and separation of DNA.
23. Visit to any tissue culture/biotechnology laboratory

Suggested reading:

14. Bhojwani, S.S., Razdan, M.K. (1996). Plant Tissue Culture: Theory and Practice. Amsterdam, Netherlands: Elsevier Science.
15. Bhojwani, S. S. and Dantu, P. K. (2013). Plant Tissue Culture: An Introductory Text. Springer

16. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications. Washington, U.S.: ASM Press.
17. Kochhar, S.L. (2011). Economic Botany in the Tropics, 4th edition. New Delhi, Delhi: MacMillan Publishers India Ltd.
18. Newmann, Karl-Hermann (2020). Plant Cell and Tissue Culture: A Tool in Biotechnology, Springer
19. Wickens,G.E. (2012) Economic Botany: Principles and Practices. Springer

Additional Resources:

11. Park, S. (2021). Plant Tissue Culture: Techniques and Experiments, 4th Edition. Elsevier
12. Ranabhatt, H. and Kapur, R. (2018). Plant Biotechnology {Woodhead Publishing}
13. Razdan, M. K. (2019). Introduction to Plant Tissue Culture, 3rd Edition {CBS / Oxford & IBH}
14. Smith, R. H. (2013). Plant Tissue Culture: Techniques and Experiments, 3rd Edition {Elsevier}.
15. Stewart, C. Neal (2016). Plant Biotechnology and Genetics, 3rd Edition {Wiley-Blackwell}
16. Trigiano, R. N., Dannis, J. Gray (2019). Plant Tissue Culture, Development, and Biotechnology {CRC Press}

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.