INDEX
DEPARTMENT OF BOTANY

Category-I
BSC (Hons.) BOTANY

DISCIPLINE SPECIFIC CORE COURSE - 10: Mycology

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		
MYCOLOGY **DSC-10**	4	**2**	**0**	**2**	Class XII pass	Nil

Learning Objectives:

- To introduce students with various fungal groups and lichens, their ecology, classification, characteristics, reproduction and economic Importance
- To introduce students to the role of fungi in biotechnology, food industry, agriculture, human health and diseases etc.

Learning Outcomes: Upon completion of this course, the students will be able to:

- understand the world of fungi, lichens and pathogens of plants
- understand characteristics the ecological and economic significance of the fungi and lichens
- understand the application of mycology in various fields of economic and ecological significance

Unit 1: Introduction **04 hours**

General characteristics; Thallus organization; Cell wall composition; Nutrition; Heterokaryosis and Parasexuality; Classification - Webster and Weber (2007) and Introduction to Phylogenetic system of classification.

Unit 2: Chytridiomycota **01 hour**

General characteristics; Life cycle of *Synchytrium*, *Allomyces*

Unit 3: Zygomycota **02 hours**

General characteristics; Distribution; Thallus organization; Classification; Life cycle of *Rhizopus* & *Mucor*.

Unit 4: Ascomycota **05 hours**

General characteristics; Distribution; Classification, Life cycles of *Saccharomyces, Penicillium, Alternaria, Neurospora* and *Peziza.*

Unit 5: Basidiomycota **05 hours**

General characteristics; Distribution; Classification, Life cycle of *Puccinia graminis tritici*, *Agaricus*; Bioluminescence, Fairy Rings, Mushroom cultivation.

Unit 6: Oomycota **02 hours**

General characteristic (with emphasis on difference with fungi); Distribution; Classification, Life cycle of *Albugo*.

Unit 7: Myxomycota **02 hours**

General characterises (with emphasis on difference with fungi); Distribution; Types of plasmodia; Types of fruiting bodies; Life cycle of *Stemonitis*.

Unit 8: Symbiotic associations **04 hours**

Lichen - Distribution; General characteristics; Growth forms and range of thalli; Economic importance of lichens. Mycorrhiza - Ectomycorrhiza, Endomycorrhiza and their significance.

Unit 9: Applied Mycology **05 hours**

Application of fungi in Food Industry- Fermentation, Organic acids, Enzymes, Mycoproteins; Introduction to Plant Pathology**,** Nematophagous fungi, Entomogenous fungi , Mycoparasites, Mycoremediation, Medical mycology and Mycotoxins.

Practicals **60 hours**

1. *Rhizopus* & *Mucor*: Study of asexual stage from temporary mounts and sexual stage through permanent slides.
2. *Saccharomyces:* Study of vegetative cell and budding from temporary mounts.
3. *Penicillium*: Study of asexual stage from temporary mounts and sexual stage from permanent slides.
4. *Peziza*: Study of sexual stage from temporary preparation of V.S of ascocarp.
5. *Alternaria solani*: Study of symptoms of early blight of Potato. Study of asexual stages through temporary mounts.
6. *Puccinia gramini tritici*: Herbarium specimens of Black stem rust of wheat and barberry leaves; sections / mounts of spores (Uredospores and Teleutospores) on wheat. Permanent slides showing spore stages on both the hosts.
7. *Agaricus:* Specimens of button stage and mature basidiocarp; V.S of gills of *Agaricus*.
8. Study of Phaneroplasmodium of *Physarum* and sporangia of *Stemonitis.*
9. *Albugo candida*: Study of symptoms of white rust on *Brassica* sp.; Asexual stage study through section / temporary mounts. Sexual structures through temporary mounts / permanent slides.
10. Lichens: Study of different types of lichens - Crustose, Foliose and Fruticose. Study of Internal structure of thallus; Apothecium through permanent slides.

Suggested Readings:

1. Agrios, George N. (2005). Plant Pathology, 5th Edition, Academic Press / Elsevier.
2. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, 4th edition, John Wiley & Sons, Singapore.

3. Moore, David et. al. (2020). 21st Century Guidebook to Fungi, 2nd Edition, Cambridge University Press.
4. Sethi, I.K. and Walia, S.K. (2018). Text book of Fungi and Their Allies, Medtech Publishers.
5. Webster, J., Weber, R. (2007). Introduction to Fungi, 3rd edition. Cambridge, U.K.: Cambridge University Press, UK.

Additional Resources:

1. Kavanagh, Kevin (2017). Fungi: Biology and Applications, 3rd Edition, Wiley-Blackwell.
2. Maheshwari, Ramesh (2012). Fungi: Experimental Methods in Biology, 2nd Edition, CRC Press.
3. Ownley, Bonnie and Trigiano, Robert N. (2017). Plant Pathology: Concepts and Laboratory Exercises, 3rd Edition, CRC Press.
4. Watkinson, Sarah et. al. (2015). The Fungi, 3rd Edition, Academic Press / Elsevier.

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

DISCIPLINE SPECIFIC CORE COURSE – 11: Ecology and Conservation

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 Conservation **DSC – 11**	**4**	**2**	**0**	**2**	Class XII pass	**Nil**

Learning Objectives:

- To introduce the students with environmental factors affecting the plants, the basic principles of ecology and phytogeography.
- To make them understand community patterns and processes, and ecosystem functioning.

Learning Outcomes:

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

- the interrelationship between organisms and environment.
- methods to study vegetation, community patterns and processes, ecosystem functions, and principles of phytogeography.
- evolving strategies for sustainable natural resource management and biodiversity conservation.

Unit 1: Introduction **01 hour**

Basic concepts, Interrelationships between the living world and the environment

Unit 2: Soil **05 hours**

Origin & Formation; physical, chemical and organic components; soil profile; forms of water in soil

Unit 3: Water **02 hours**

Importance; States of water in the environment; Atmospheric moisture; Water table

Unit 4: Abiotic interactions **03 hours**

Abiotic factors and plant adaptations, variations in light, temperature & wind conditions.

Unit 5: Biotic interactions **02 hours**

Definition; types of positive and negative biotic interactions

Unit 6: Population ecology **02 hours**

Characteristics of populations; population growth models and introduction to population regulation (density-dependent and independent); ecotypes; metapopulation (history, concept and applications to conservation)

Unit 7: Plant Communities **04 hours**

Community characters (General account of analytical and synthetic characters); Ecotone; Succession: processes, types (Lithosere, Hydrosere, Xerosere, Psammosere)

Unit 8: Ecosystems **04 hours**

Types, components, trophic organisation; food chain & food webs, ecological pyramids. models of energy flow; production and productivity; a brief outline of biogeochemical cycles (Carbon and Nitrogen)

Unit 9: Phytogeography **04 hours**

Principles; Continental drift; Theory of tolerance; Endemism; Phytogeographical division of India

Unit 10: Conservation **03 hours**

In-situ, ex-situ; gene banks, institutions - National & International; sacred groves, on-farm conservation.

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. Determination of pH & dissolved oxygen from polluted and unpolluted water samples.
4. Determination of soil organic carbon and organic matter of different soil samples by Walkley & Black rapid titration method.
5. Study of ecological adaptations of hydrophytes and xerophytes (four each).
6. Study of biotic interactions of the following: Stem parasite (*Cuscuta*), Root parasite (*Orobanche*), Epiphytes, Predation (Insectivorous plants).
7. 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).
8. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law.

9. Quantitative analysis of herbaceous vegetation for density and abundance in the college campus.
10. Species distribution pattern based on A/F ratio (regular, random, clumped).
11. Field visit to familiarize students with ecology/conservation of different sites.

Suggested Readings:

1. Daubenmire, R.F. (1975). Plant and Environment. London: J. Wiley and Sons Inc.
2. Kormondy, E.J. (1996). Concepts of Ecology. New Delhi, India: PHI Learning Pvt. Ltd. 4th edition.
3. Odum, E.P. (2005). Fundamentals of Ecology. New Delhi, India: Cengage Learning India Pvt. Ltd., 5th edition.
4. Sharma, P.D. (2010). Ecology and Environment. Meerut, India: Rastogi Publications. 8th edition.
5. Singh, J.S., Singh, S.P., Gupta, S.R. (2014). Ecology, Environmental Science and Conservation. New Delhi, India: S. Chand.

Additional Resources:

1. Ambasht, R.S. and Ambasht, N.K. (2008). A text book of Plant Ecology, CBS Publishers & Distributors PVT. LTD.
2. Majumdar, R and Kashyap, R (2019). Practical Manual of Ecology and Environmental Science, New Delhi, India: Prestige Publishers
3. Singh, J.S., Singh, S.P., Gupta, S. R. (2006). Ecology, Environment and Resource Conservation. New Delhi, India: Anamaya Publications.
4. Wilkinson, D.M. (2007). Fundamental Processes in Ecology. USA: An Earth Systems Approach. Oxford University Press.
5. Hanski, I.A., & Gilpin, M.E. (1997). Metapopulation biology: Ecology, genetics, and evolution. Academic Press.

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

DISCIPLINE SPECIFIC CORE COURSE – 12: Developmental Biology of Angiosperms: Form, Anatomy & Function

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		
Developmental Biology of Angiosperms: Form, Anatomy & Function DSC-12	**4**	**2**	**0**	**2**	Class XII pass	**Nil**

Learning Objectives:

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

Learning Outcomes:

Upon completion of the course, the students will

- become familiar with the structure and functions of various components of plant cell
- understand the process of cell growth and its regulation
- comprehend the structure and functions of tissues organising the various plant organs
- get acquainted with the reproductive processes involved in the life cycle of angiosperms
- be able to 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 diversity of plant forms **05 Hours**

Historical perspective, methods/tools and techniques (fixation, sectioning, macerations); terms for describing plant cells; basic plant growth-meristems and cell differentiation; Primary and Secondary plant body (introduce terms); Classification of tissues; Simple and complex tissues, Vascular system.

Unit 2: Tissue organisation in stem **05 Hours**

Organization of shoot apex -Apical cell theory, Histogen theory, Tunica Corpus theory, Neuman's Theory of Continuing Meristematic Residue, Cyto-Histological Zonation Theory; Types of vascular bundles; Structure of dicot and monocot stem; Shoot Chimeras

Unit 3: Tissue organisation in leaf **03 Hours**

Initiation and development of leaf; leaf lamina, venation and vascular differentiation in leaf; dermal tissue system, cuticles and special epidermal cells - cuticle; epicuticular waxes; trichomes (uni-and multicellular, glandular and non-glandular, two examples of each); stomata (classification); structure of dicot and monocot leaf, Kranz anatomy

Unit 4: Tissue organisation in root **04 Hours**

Organisation of root apex -Apical cell theory, Histogen theory, Korper - Kappe theory; structure and function of root apex- quiescent centre; root cap; Structure of dicot and monocot root; Endodermis, exodermis and origin of lateral root.

Unit 5: Vascular Cambium **03 Hours**

Structure (Axially and radially oriented elements); function and seasonal activity of cambium; Secondary growth in root and stem, Cambial variants in secondary growth in stem: Included phloem and Phloem wedges.

Unit 6: Wood and Periderm **04 Hours**

Types of rays and axial parenchyma; Cyclic aspects and reaction wood; Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood, tyloses; Pits and plasmodesmata; Wall ingrowths and transfer cells; Ergastic substances; Development and composition of periderm; rhytidome and lenticels.

Unit 7: Adaptive and Defensive Systems **03 Hours**

Anatomical adaptations of xerophytes and hydrophytes.; Adcrustation and incrustation;

Unit 8: Secretory System **02 Hours**

Hydathodes, cavities, lithocysts and laticifers.

Unit 9: Application of Plant Anatomy 0**1 hour**

Applications in systematics, plant development, physiology, forensics and pharmacognosy. Dendrochronology and dendroclimatology.

Practicals **60 Hours**

1. Prepare temporary whole mounts/ sections to study organisation of apical meristem of root, shoot and vascular cambium.
2. Distribution and types of parenchyma, collenchyma and sclerenchyma through temporary preparations / digital resources/ permanent slides.
3. Prepare temporary stained mounts (maceration, sections) to observe xylem: tracheary elements-tracheids, vessel elements; thickenings; perforation plates; xylem fibres.
4. Study the types and features of wood: ring porous; diffuse porous; tyloses; heartwood and sapwood through specimens, permanent slides and digital resources.

5. Prepare temporary whole mounts/ sections to observe phloem: sieve tubes-sieve plates; companion cells; phloem fibres.
6. Study epidermal system: cell types, stomata types; trichomes: non-glandular and glandular through temporary whole mounts/peels/using enamel.
7. Prepare temporary whole mounts/ sections to study organisation of root: monocot, dicot, secondary growth in roots.
8. Prepare temporary whole mounts/ sections to study organisation of monocot, dicot - primary and secondary growth; phloem wedges in *Bignonia*, included phloem in *Leptadenia/Salvadora*; periderm; lenticels.
9. Prepare temporary whole mounts/ sections to study organisation of leaf: isobilateral, dorsiventral, Kranz anatomy.
10. Study the adaptive anatomy in xerophytes and hydrophytes (two each) through temporary preparations / digital resources/ permanent slides.
11. Study secretory tissues: cavities, lithocysts and laticifers through permanent slides / digital resources.
12. Project: submission of permanent slides

Suggested Reading:

1. Beck, C.B. (2010). Plant Structure and Development. Second edition. Cambridge University Press, Cambridge, UK, New York, USA.
2. Dickison, W.C. (2000). Integrative Plant Anatomy. Harcourt Academic Press, USA.
3. Esau, K. (1977). Anatomy of Seed Plants. John Wiley & Sons, Inc., Delhi.
4. Fahn, A. (1974). Plant Anatomy. Pergmon Press, USA.
5. Mauseth, J.D. (1988). Plant Anatomy. The Benjammin/Cummings Publisher, USA.

Additional Resources:

1. Bahadur, B. Rajam, M.V., Sahijram, L., Krishnamurthy, K.V. (2015). Plant Biology and Biotechnology. Volume 1: Plant Diversity, Organization, Function and Improvement.
2. Crang, R., Lyons-Sobaski, S., Wise, R. (2018) Plant Anatomy: A Concept-Based Approach to the Structure of Seed Plants 1st ed. Springer
3. Cutler, D.F., Botha, T., Stevenson, D.W. (2007). Plant Anatomy - An Applied Aspect. Blackwell Publishing, USA
4. Evert, R.F. (2017) Esau's Plant Anatomy; Meristems, Cells and Tissues Of The Plant Body- Their Structure, Function And Development. 3rd Edn Wiley India.
5. Moza M. K., Bhatnagar A.K. (2007). Plant reproductive biology studies crucial for conservation. Current Science 92:1907.
6. Shivanna, K.R., Tandon, R. (2014). Reproductive Ecology of Flowering Plants: A Manual. Springer (India) Pvt. Ltd. New Delhi, Heidelberg, New York, Dordrecht, London

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DISCIPLINE SPECIFIC ELECTIVE COURSE – 03 Applied Phycology

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		
Applied Phycology BOT-DSE-03	**4**	**2**	**0**	**2**	Class XII pass	**Nil**

Learning Objective:

- To gain knowledge about diversity, life forms, life cycles, morphology and economic importance of algae.

Learning Outcomes:
On completion of the course the students will be able to understand:

- use of algae for environment, human welfare and industries.
- algal culture techniques and their commercial production

Unit 1: Scope of phycology **01 hour**
In emerging research areas, environment and industries.

Unit 2: Algae as food, feed and fodder **03 hours**
Nutritional value of algae; Common edible algae; Algae as food, feed and fodder with suitable examples.

Unit 3: Algae in industry **06 hours**
Phycocolloids (Agar-agar, Alginic acid and Carrageenan) and secondary metabolites: Sources and Applications; Pharmaceutical and Nutraceutical uses of algae; Algae in cosmetics; Diatomaceous Earth.

Unit 4: Algae in agriculture **03 hours**
Algae as soil conditioners and biofertilizers; Seaweed liquid extract; Seaweed powder; Algal biorefinery residues.

Unit 5: Role of Algae in environment **06 hours**
Algae as pollution indicators; wasteland reclamation; Role of algae in wastewater treatment; Ecological importance of Symbiotic associations of algae; Harmful algal blooms; Red tides; Algal toxins.

Unit 6: Algae in biotechnology and research **05 hours**

Gene sequencing and algal systematics; Algae as a model organism (*Chlamydomonas*, *Chlorella*, *Acetabularia*, *Ectocarpus*, *Porphyra*); Bioluminescent forms; Algae in nanotechnology.

Unit 7: Algae as emerging source of bioenergy **02 hours**

Biofuels (Bioethanol, Biodiesel, Biohydrogen); Algal Biorefinery.

Unit 8: Algal culture techniques and commercial production **04 hours**

Isolation, purification and sterilisation of algae; Freshwater and marine culture media (BG-11 and Provasoli ES medium); Photobioreactors and large-scale production of microalgae; Seaweed farming.

Practicals **60 hours**

1. Isolation and identification of algal species (any three) in water samples from polluted and non-polluted sources through temporary mounts.
2. Nutritional analysis (protein and carbohydrates) of *Spirulina/ Chlorella/* any other available edible algae.
3. Study of algal symbiosis (*Azolla* fronds) through sectioning or tease mount.
4. Phycocolloid (Agar-agar/ Alginates/ Carrageenan) extraction (demonstration/ digital resources).
5. Microalgal culture - maintain cultures of species isolated in Experiment 1(any three).
6. Commercial applications of algae through photographs/products (edible, cosmetics, biofuels, pharmaceutical, nutraceutical, phyco-remediation).
7. Study of algae as a model organism (any 2) through digital resources.
8. Project work on any applied aspect of algae/ Visit to any Institute or Industry (Report to be submitted).

Suggested Readings:

1. Bold, H.C. and Wynne, M.J. (1985) Introduction to the Algae: Structure and Reproduction, 2nd edition. Prentice-Hall International INC.
2. Chapman, D.J. and Chapman, V.J. (1980) Seaweeds and their uses. 3rd edn. British Library.
3. Kumar, H.D. (1999) Introductory Phycology, 2nd edition. Affiliated East-West Press, New Delhi.
4. Lee, R.E. (2008) Phycology, 4th edition: Cambridge University Press, Cambridge.
5. Sahoo, D. (2000) Farming the Ocean*:* Seaweed Cultivation and Utilization. Aravali Book International, New Delhi.

Additional Resources:

1. Andersen, R.A. (2005) Algal Culturing Techniques*.* Elsevier Academic Press.
2. Chapman, D.J. and Chapman, V.J. (1973) The Algae. 2nd edn. Macmillan, London.

3. Fleurence, J. and Levine, I. (2016) Seaweed in Health and Disease Prevention. Academic Press publications.
4. Sahoo, D (2010). Common seaweeds of India. IK International Pvt Ltd.
5. Sahoo, D. and Seckbach, J. (2015) The Algae World. Vol 26 Cellular Origin, Life in Extreme Habitats and Astrobiology. Springer, Dordrecht.
6. Van den Hoek, C. Mann, D.G. and Jahans H.M. (1995) Algae: An Introduction to Phycology. Cambridge University Press.

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

DISCIPLINE SPECIFICELECTIVE COURSE – 04 Industrial and Environmental Microbiology

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		
Industrial and Environmental Microbiology **BOT-DSE-04**	**4**	**2**	**0**	**2**	Class XII pass	**Nil**

Learning Objectives:

- To introduce students to the concepts, principles, scope and applications of industrial and environmental microbiology.

Learning Outcomes:

Upon successful completion of the course, students will be able to:

- understand how microbiology is applied in manufacturing of industrial products
- know about design of bioreactors
- understand the rationale in medium formulation, design for microbial fermentation, sterilization of medium and air
- comprehend the techniques and the underlying principles in upstream and down-stream processing
- learn the occurrence, abundance and distribution of microorganism in the environment and their role in the environment and also learn different methods for their detection
- understand the basic principles of environment microbiology and application of the same in solving environmental problems - waste water treatment and bioremediation
- comprehend the various methods to determine the quality of water

Unit 1: Microbes and quality of environment **04 hours**

Introduction and scope of microbes in industry and environment; Distribution and isolation of microorganisms from soil, air and water.

Unit 2: Bioreactors/ Fermenters and fermentation processes **08 hours**

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

Unit 3: Microbial production of industrial products **10 hours**

Microorganisms generally regarded as safe (GRAS); Downstream processing and uses; Filtration, centrifugation, cell disruption, solvent extraction, precipitation and ultrafiltration, lyophilization; Production of industrially important products: enzyme (amylase); organic acid (citric acid); alcohol (ethanol); antibiotic (penicillin)

Unit 4: Microbial enzymes of industrial importance **03 hours**

Applications of industrially important enzymes (protease, lipase, and penicillin acylase); Methods of immobilisation and its advantages.

Unit 5: Microbial flora of water **05 hours**

Water pollution: various sources and control measures; Role of microbes in sewage and domestic wastewater treatment systems. Microorganisms as indicators of water quality: coliforms and faecal coliforms.

Practicals **60 hours**

1. Principles and functioning of instruments: autoclave, laminar air flow, incubators, types of fermenters.
2. Preparation of different culture media (Nutrient medium/ Luria Bertani medium/Potato dextrose medium/Czapek Dox medium).
3. Hydrolysis of casein and starch by microorganisms.
4. Alcohol production by yeast using sugar/ jaggery.
5. Serial dilution method for isolation of microorganisms from water and soil and study of aero-microflora.
6. To determine the BOD of sewage water.
7. To qualitatively check the enzyme activity (phosphatase/amylase/cellulase) in soil samples.
8. To determine the microbial activity in soil by Triphenyltetrazolium chloride (TTC) assay or by measuring the CO_2 evolution.
9. Determination of coliforms in water samples using eosin methylene blue (EMB) medium.
10. Visit to any educational institute/ industry and a report to be submitted

Suggested Readings:

1. Bertrand, Jean-Claude, Caumette, P., Lebaron, P, Matheron, R., Normand, P., Sime• Ngando, T. (2015). Environmental Microbiology: Fundamentals and Applications. Amesterdam, Netherlands, Springer.
2. Joe, S., Sukesh (2010). Industrial Microbiology. S.Chand & Company Pvt. Ltd. New Delhi, Delhi.
3. Mohapatra. P.K. (2008). Textbook of Environmental Microbiology. I.K. International Publishing House Pvt.Ltd. New Delhi, Delhi.

4. Okafer, Nduka (2007). Modern Industrial Microbiology & Biotechnology. Science Pubishers, Enfield, NH, USA.
5. Pelzar, M.J. Jr., Chan E.C. S., Krieg, N.R. (2010). Microbiology: An application based approach. New Delhi, Delhi: McGraw Hill Education Pvt. Ltd., Delhi.

Additional Resources:

1. Alef K, and Nannipieri P (1995). Methods in Applied Soil Microbiology and Biochemistry, First Edition Academic Press, USA.
2. Atlas, Bartha. (1997). Microbial Ecology: Fundamentals and Applications. San Fransisco, SF. Pearson.
3. Casida, J.R. (2016). Industrial Microbiology. New Delhi, Delhi, New Age International Publishers.
4. Hurst C.J., Crowford R.L., Garland J.L. and Lipson D.A. (2007). Manual of Environmental Microbiology, American Society of Microbiology, USA.
5. Patel, A.H. (2008). Industrial Microbiology, Bangalore, India: McMillan India Limited.
6. Sharma, P.D. (2005). Environmental Microbiology. Meerut, UP: Alpha Science International, Ltd.
7. Stanbury, P.F., Whitaker, A., Hall, S.J. (2016). Principles of Fermentation Technology. Amesterdam, NDL:Elsevier Publication.
8. Tortora, G.J., Funke, B.R., Case. C.L. (2007). Microbiology (9th edition). San Francisco, SF: Pearson Benjamin Cummings.

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. Programmes with Botany as Major discipline)

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	**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 Leaming 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 III:

B.Sc. programme in Applied Life Sciences with Agrochemicals and Pest Management Botany (H) Courses for Undergraduate Programme of study with Botany as a Single Core Discipline

DISCIPLINE SPECIFIC CORE COURSE (DSC 04)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the core course			Eligibility criteria	Pre-requisite of the course (If any)
		Lecture	Tutorial	Practical/ Practice		
Plant Pathology ALS BOT DSC 04	**4**	**2**	**0**	**2**	Class XII pass	**NIL**

Learning Objectives:

The learning objectives of this course are as follows:

- to introduce students with various fungi, fungus like organisms, bacteria and viruses.
- to give an understanding of their characteristics, reproduction and ecology.
- to introduce students with the principles and concepts of plant pathology.
- to acquaint with various plant diseases, symptomatology, causal organisms and their control measures.

Learning Outcomes:

By studying this course, students will be able to:

- understand the world of different types of pathogens of plants.
- identify the characteristic symptoms of different groups of plant pathogens in the fields.
- understand the ecological and economical impact of plant diseases.
- identify common plant diseases and their control measures.
- understand the application and significance of integrated disease management.
- explicate the economic and pathological importance of fungi, bacteria and viruses.

Unit 1: Introduction **3 Hours**

Definition, Concepts and Terminology; General symptoms; Classification of diseases.

Unit 2: **Key events of Disease development** **6 Hours**

Disease cycle; Host pathogen relationships; Plant defence mechanism (Structural and biochemical); Epidemiology and Disease forecasting.

Unit 3: Fungal Diseases **5 Hours**

General symptoms; Disease cycle and Control measures - Powdery mildew of Pea. Black stem Rust of Wheat; Smut of Barley (Loose and Covered smut).

Unit 4: Diseases caused by Oomycota **3 Hours**

General symptoms; Disease cycle and Control measures – White rust of Crucifers; Late blight of Potato.

Unit 5: Bacterial Diseases **3 Hours**

General symptoms; Disease cycle and Control measures - Citrus canker; Angular leaf spot of Cotton.

Unit 6: Viral Diseases **3 Hours**

General symptoms; Mode of transmission and Control measures-- Tobacco mosaic disease; Vein clearing of Bhindi.

Unit 7: Plant Disease Control **7 Hours**

Quarantine, Cultural practices, Physical methods, Chemical methods, Biological control (Antibiosis, Hyper-parasitism, Predation, Induced Systemic Resistance).

Practicals **60 Hours**

1. Study of White rust of crucifers, Symptoms on leaves and hypertrophy with the help of live or preserved specimens. Study of causal organism (*Albugo candida*) with the help of temporary tease/section mount. Permanent section mount of somatic and reproductive phases.
2. Study of Late blight of Potato through specimens, temporary mounts (V.S. of leaf showing infection) and permanent slides.
3. Study of Powdery mildew of Pea, Symptoms on leaves and stem of Pea with the help of live or preserved specimens. Study of *Erysiphe* asexual stage with the help of temporary tease/ section mount and sexual stage through permanent slides.
4. Study of Black stem Rust of Wheat, Symptoms on both Wheat and Barberry with the help of live or preserved specimens/photographs. Study of *Puccinia graminis tritici* with the help of temporary tease/section mount of Wheat . Permanent slides of somatic and reproductive phases on both the hosts.
5. Study of Smut of Barley, Symptoms of Loose and Covered smut through live or preserved specimens. Study of teliospores through temporary mount.
6. Study of Bacterial Diseases through the specimens - Citrus canker; Angular leaf spot of Cotton.
7. Study of Viral Diseases through specimens - Tobacco mosaic Disease; Vein clearing of Bhindi.
8. Study of Phylloplane Mycoflora through cellotape method.

9. Study through digital images / photographs – Chlorosis, Tuber rot, Apple scab, Mycoparasite, Predaceous fungi.

Essential/ Recommended readings:

1. Singh, R.S. (2021). Plant Diseases 10th revised edition, Medtech, New Delhi.
2. Schumann, G.L. and D'Arcy C.J. (2009). Essential Plant Pathology 2nd edition, American Phytopathological Society, U.S.A.
3. Agrios, G.N. (2005). Plant Pathology 5th edition, Elsevier Academic Press, Amsterdam.
4. Oliver, R. (2023). Agrios' Plant Pathology 6th edition, Academic Press.
5. Sharma, P.D. (2014). Plant Pathology Rastogi Publications, Meerut, U.P.

Suggestive readings:

1. Gupta, R. and Chugh, G. (2022). *Plant, Microbes and Diseases*. I.K. International Pvt. Ltd., Delhi.
2. Ownley B.H. and Trigiano R.N. (2016. *Plant Pathology Concepts and Laboratory Exercises* 3rd edition, CRC Press.
3. Singh, R.S. (2017). Introduction to Principles of Plant Pathology, 5th edition, Medtech, New Delhi.
4. Tronsmo A.M., Munk L., Anika D., Tronsmo A., Yuen J and Collinge D.B. (2020). Plant Pathology and Plant Diseases. CABI Publishing, U.S.A.

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

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE 02)

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		
Crop Genetics and Plant Breeding ALS BOT DSE 02	**4**	**2**	**0**	**2**	Class XII pass	**NIL**

Learning Objectives:

The Learning Objectives of this course are as follows:

- to develop an understanding of the concepts of plant breeding and its applications.
- to provide adequate knowledge on the natural breeding systems of different agriculturally important plant and strategies employed for crop improvement.
- to impart skills on plant genome analysis and gene mapping using DNA markers and their use in increasing efficiency of plant breeding.
- to understand the genetic basis of hybrid vigour and development of hybrid varieties.
- to make students familiar with the concept of varietal release and rights of a farmer and plant breeder.

Learning Outcome:

By studying this course, the students will be able to:

- gain knowledge on the importance of plant breeding for developing new cultivars and use of breeding strategies for improvement of crop plants.
- understand the concept of gene pool and germplasm resources that are fundamental to crop improvement.
- explicate the breeding methods for commercially important crop plants.

Unit 1: Introduction **(2 Hours)**

Importance of plant breeding and its history; Breeding systems in crop plants; Self-incompatibility, male sterility and apomixis, Important achievements in plant breeding.

Unit 2: Sources of Variation (4 Hours)

Plant genetic resources- their management and conservation, utilization of gene pools in breeding programs. Chromosome manipulation- induced mutations, haploidy, polyploidy, somatic hybridization, somaclonal variation.

Unit 3: Conventional Breeding Methods (8 Hours)

Selection methods for self-pollinated, cross-pollinated and vegetatively propagated crop plants; Hybridization for self-pollinated, cross-pollinated and vegetatively propagated crop plants-procedure, advantage and limitations.

Unit 4: Heterosis Breeding (3 Hours)

Genetic and molecular basis of heterosis (hybrid vigour); Development of hybrid varieties through exploitation of hybrid vigour. Inbreeding depression.

Unit 5: Molecular Genetics and Plant Breeding (10 Hours)

Molecular markers as tools in plant breeding; Principle of genetic linkage; Concept of genetic distance; Development and choice of mapping populations (F_2, NILs, RILs, BC etc); Linkage map construction; Quantitative traits - Principles and methods of QTL mapping, QTL Introgression; Marker-assisted breeding- Gene tagging; Marker-aided selection (foreground and background selection); Elimination of linkage drags; Marker assisted recurrent selection (MARS). Novel Plant Breeding Tools (TALEN's, CRISPR-Cas9, Base editing).

Unit 6: Intellectual Property Rights and Varietal Release

(3 Hours)

IPR, Patenting; Breeder's Right; Release of New Varities-Trials & their evaluation, Prerelease, Notification and its Release; Plant variety protection; Farmer's Right.

PRACTICAL (60 Hours)

1. Introduction to open/controlled pollinations in field and laboratory (Breeders kit; temporal details of anthesis, anther dehiscence, CMS, stigma receptivity, emasculation, bagging).
2. Analysis of the breeding system of chosen crop species by calculating pollen:ovule ratio.
3. Calculation of Index of self-incompatibility (ISI).
4. Study of dominant/ codominant nature of different molecular markers.
5. Assessment of phenotypic diversity in different accessions of given plant material using morphological markers.

6. Assessment of genetic diversity and construction of dendrogram using molecular markers.
7. Phenotypic screening of a mapping population/ land races for biotic stress resistance and calculating the log of percentage severity and symptom score.
8. Study of floral biology, emasculation and hybridization techniques in self-pollinated and cross-pollinated crops.
9. Estimation of heterosis, inbreeding depression and heritability.
10. Project: Case study based on gene mapping.
11. Field trip to plant breeding station.

Essential/recommended readings

1. Acquaah, G. (2012). *Principles of Plant Genetics & Breeding*. 2nd edition. Hoboken, NJ, Wiley.
2. Allard, R.W. (1999). *Principles of Plant Breeding*. John Wiley, New York.
3. Singh, B.D. (2022). *Plant Breeding: Principles and Methods*, 12th edition. New Delhi, Delhi: Kalyani Publishers.
4. Frey, K. J. (1982). *Plant Breeding II.* Kalyani Publishers, New Delhi.

Suggestive readings:

1. Chopra, V.L. (2023). *Plant Breeding: Theory and Practice* 2nd Restructured Edition, New India Publishing Agency, New Delhi.
2. Poehlman J. M. and Sleper D. A. (1995). *Breeding Field Crops,* 4th Ed. Panima Publishing Corporation, New Delhi.
3. Welsh, J. R. (1981). *Fundamentals of Plant Genetics and Breeding*. John Wiley and Sons, New York.

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

GENERIC ELECTIVE (BOT-GE-16)

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 Health & Disease Diagnostics BOT-GE-16	4	2	0	2	Class XII pass	**Nil**

Learning Objectives:

- understand the challenges and importance of plant pathogen diagnosis
- understand methods for reducing/minimizing risk of the spread of pathogens and pests.
- understand principles and tools for early warning systems to protect plant health.

Learning Outcomes:

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

- diagnose the cause of a plant disease and identify the causal agent
- select appropriate methods and strategy for control and mitigate spread.

Unit 1: Introduction to Plant Diseases **04 Hours**

Definition; History of Plant Pathology, Concept and basic components of disease; Causes and classification of diseases; Disease cycle; Significance of plant diseases.

Unit 2: Plant Disease Diagnosis **06 Hours**

Koch's Postulates; Plant disease symptoms and types (Necrosis, Hypertrophy and Hyperplasia, Hypoplasia); General symptoms of viral, bacterial and fungal plant diseases; Methods of plant disease diagnosis- Histochemical, Serological and PCR techniques.

Unit 3: Plant Disease Epidemiology **05 Hours**

Epidemics and factors affecting the development of epidemics; Epidemic assessment and Disease forecasting; Tools of epidemiology geographic information system (GIS), Global Positioning System (GPS), Geostatistics, Remote sensing.

Unit 4: Plant Diseases **11 hours**

Causal organism, symptoms, disease cycle and management of the plant disease caused by bacteria, virus and fungi: Tobacco Mosaic, Yellow Vein mosaic of Bhendi, Citrus Canker, Angular leaf spot of Cotton, White rust of crucifers, Late & early blight of potato, Rust of wheat, Smut of Cereals.

Unit 5: Management of Plant Diseases **04 Hours**

Concept of integrated disease management (IDM); strategies for IDM- regulatory, cultural, physical, chemical and biological.

Practicals **60 hours**

1. Preparation of Fungal Medium (Potato Dextrose Agar | Czapek Dox), Study of Instruments (Laminar Air flow, Autoclave, Incubator) & sterilization techniques.
2. Isolation pathogen from an infected plant sample.
3. Symptoms of Citrus canker and Angular leaf spot of Cotton through specimens / photograph.
4. Powdery mildew of pea: Symptoms and study of asexual and sexual stage of causal organism (*Erysiphe polygoni*) with the help of temporary tease /section/permanent slides.
5. Symptoms of Tobacco Mosaic Virus and Yellow Vein Mosaic of Bhinde through specimens / photographs.
6. White Rust of Crucifers - Symptoms and study of asexual and sexual stages of *Albugo candida* from tease /section/permanent slides.
7. Late blight of potato. Symptoms
8. Early blight of potato - Symptoms and study of asexual stage of *Alternaria solani* through temporary tease mounts
9. Black stem rust of wheat: Symptoms on both wheat and barberry. Types of spores of *Puccinia gormenis tritici* wheat and barberry by temporary tease/section mount /permanent slides.
10. Symptoms of Loose and covered smuts of barley.

Suggested Readings:

1. Cooke, B.M., Jones, D.G., Kaye, B. (2007) The Epidemiology of Plant Diseases, 2nd ed. Springer.
2. Madden, L.V., Hughes, G. and Bosch, F van den (2017). The Study of Plant Disease Epidemics, APS Publications.
3. Sethi, I.K. and Walia, S.K. (2018). Text book of Fungi and their Allies. (2nd Edition), Medtech Publishers, Delhi.
4. Sharma, P.D. (2014*).* Plant Pathology. Rastogi Publications, Meerut.
5. Singh R.S. (2018*).* Plant Diseases. 10th Edition Medtech, New De

Additional Resources:

1. Agrios G.N. (2005*).* Plant Pathology. 5th Edition, Elsevier.
2. Gupta, V.K. and Sharma, R.C. (2020) Integrated Disease Management and Plant Health, Scientific Publishers, India
3. Kapoor, A.S. and Banyal, D.K. (2012). Plant Disease Epidemiology and Management, AbeBooks.

GENERIC ELECTIVE (BOT-GE-17)

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		
Environmental Monitoring and Ecosystem Restoration BOT-GE-17	4	2	0	2	Class XII pass	**Nil**

Learning Objectives:

- The course will train students on methods for conducting environmental monitoring protocols.
- It will provide experiential learning in conducting quality check experiments on soil, water and air.
- The course will develop understanding on different aspects of ecosystem restoration and processes through monitoring system.

Learning Outcomes:

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

- understand the problem of environmental degradation
- assessment of quantitative and qualitative parameters used in environmental monitoring of air, soil and water.
- understand the strategies and methods for ecosystem restoration, including physico-chemical and biological indicators.
- understand degraded and restored sites through field visits.

Unit 1: Introduction **03 Hours**

Ecosystem degradation, Magnitude/ Scale of degradation (National and Global Scenario); influence of climate change in Ecosystem degradation (extreme and erratic natural events)

Unit 2: Factors of environmental degradation **03 Hours**

Factors responsible for degradation of soil, water, air and loss of biodiversity; natural and anthropogenic-forest fires, landslides, floods, deforestation, overgrazing, soil erosion, mining, landfills, etc.

Unit 3: Ecosystem Restoration **06 Hours**

Definition; UN decade on Ecosystem Restoration; Bradshaw's Concept: Restoration, Rehabilitation and Reclamation (replacement); Role of Sustainable Development Goals (SDGs)., REDD+, Joint Forest Management; Relevance for people, nature and climate.

Unit 4: Environment Monitoring **09 Hours**

Indicators of land degradation: Soil- alkalinity, salinity, organic carbon and soil health; Water- pH, Hardness, BOD, COD and Heavy metals content; Air- PM 10 , PM 2.5 , SO_2 , NOx, ozone), Air Quality Index (AQI); Bioindicators/ Biomonitors (plants, animals and microbes).

Unit 5: Role of Plants and Microbes in Ecosystem Restoration **09 Hours**

Brief account of remediation technologies: bioremediation, phytoremediation (phytoextraction, rhizofiltration, phytovolatilization, phytostabilization etc); Role of associations of Grasses-AMF, Legumes-Rhizobium in restoring degraded land/ mined out areas; Role of macrophytes in wetland restoration; Role of green spaces including parklands and avenue plantations in amelioration of air quality.

Practicals **60 hours**

1. Field visit to degraded ecosystem/ natural ecosystem/restored ecosystem.
2. Analyze the soil and water samples from polluted and unpolluted sites for their pH
3. Analyze carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency by rapid field tests in soil samples from degraded and healthy sites.
4. Determine the organic matter in soil samples by Walkley and Black's rapid titration method.
5. Determine the dissolved oxygen of water samples of polluted and nonpolluted sites by Winkler's method.
6. Determine the BOD and COD content of water samples of polluted and nonpolluted sites.
7. To collect, collate and analyze Air Quality Index (AQI) data, Water Quality data of various locations from DPCC/CPCB website collected from real-time monitoring stations.
8. Study of bioindicators (plant, animal and microbes).

Suggested Readings:

1. Bagyaraj, D.J. and Jamaluddin (2016) Microbes for Restoration of Degraded Ecosystems, New India Publishing Agency
2. Majumdar R., Kashyap R (2020). Practical Manual of Ecology and Environmental Science, Prestige
3. Ricklefs, R. E., Miller, G. L., (2000). Ecology, 4th edition W.H. Freeman.
4. Sharma, P. D. (2017). Ecology and Environment, 13th Edition. Meerut: Rastogi Publications.
5. Smith, T. M., Smith, R. L. (2012). Elements of Ecology 8th Edition. Pearson.

Additional Resources:

1. Central Pollution Control Board (CPCB) Air and Water: https://cpcb.nic.in/real-time-data/
2. Managing Ecosystems in The Context of Climate Change Mitigation: A review of current knowledge and recommendations to support ecosystem-based mitigation actions that look beyond terrestrial forests https://www.cbd.int/doc/publications/cbd-ts-86-en.pdf
3. National Clean Air Programme (NCAP) 2018. https://moef.gov.in/wp-content/uploads/2019/05/NCAP_Report.pdf
4. Real Time Ambient Air Quality Data (DPCC). https://www.dpccairdata.com/dpccairdata/display/index.php
5. Restoration for People, Nature and Climate, https://wedocs.unep.org/bitstream/handle/20.500.11822/36251/ERPNC.pdf
6. Champion, H. G., and S. K. Seth. A revised classification of forest types of India. Manager Publication, Government of India, Delhi (1968).

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

SEMESTER-V
BSC. (HONS.) BOTANY

DISCIPLINE SPECIFIC CORE COURSE – 13: Molecular Biology of the Cell

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		
Molecular Biology of the Cell – **DSC 13**	**4**	**2**	0	**2**	**Class XII Pass**	**Nil**

Learning Objective:

- To gain comprehensive knowledge about of genetic material, central dogma, genetic code, DNA replication, transcription, modification of transcript, translation and regulation of gene expression.

Learning Outcomes: At the end of this course the student will understand:

6. structure and function of nucleic acids at molecular level.
7. the concept of central dogma and genetic code.
8. molecular details of DNA replication and its types.
9. cellular processes of transcription and translation including modification of transcripts and polypeptides/proteins
10. mechanisms regulating gene expression.

Unit 1: Nucleic acids as carriers of genetic information **02 Hours**
Discovery of nucleic acids, Experiments that established nucleic acids (DNA & RNA) as the carrier of genetic information: Griffith's, Hershey & Chase, Avery, McLeod & McCarty, and Fraenkel-Conrat's experiment.

Unit 2: Structure and organisation of the genetic material **03 Hours**
DNA double helix structure (Chargaff's rule; Watson and Crick model); salient features of DNA double helix. Types of DNA: A, B & Z conformations, denaturation and renaturation (only melting profile- Tm), types of RNA (mRNA, rRNA, tRNA, small RNAs). split genes (Phillip Sharp)

Unit 3: Central Dogma and Genetic Code **04 Hours**
Beadle and Tatum's one gene one enzyme hypothesis; The Central Dogma, Genetic code and its salient features, Experiments for deciphering Genetic code (Experiments by Nirenberg &

Matthaei, and Har Gobind Khorana). Adaptor hypothesis by Crick; Baltimore and Temin's discovery of reverse transcription

Unit 4: Replication of DNA **06 Hours**

Delbruck's Dispersive mechanism model; Bloch and Butler's conservative replication model; Messelson and Stahl's semi-conservative replication model; Mechanism - initiation, elongation and termination; Enzymes and other proteins involved in DNA replication; General principles – bidirectional, semiconservative and semi-discontinuous replication (Replisome), RNA priming (Primase & Primosome); Various modes of DNA replication, including rolling circle, θ (theta) mode of replication, replication of linear dsDNA. Replication of the 5'end of linear chromosome (end-replication problem & Telomerase).

Unit 5: Mechanism of Transcription **05 Hours**

Transcription process in prokaryotes (Initiation, Elongation and Termination); structure and function of RNA polymerase enzyme; concept of promoters and transcription factors; comparison between prokaryotic and eukaryotic transcription; concept of post-transcriptional modifications (introduction to eukaryotic mRNA processing: 5' capping; Splicing and alternative splicing; 3' poly A tailing).

Unit 6: Mechanism of Translation **05 Hours**

Translation in prokaryotes: Initiation, Elongation and Termination; concept of charging of tRNA and role of aminoacyl synthetases; ribosome structure and assembly (prokaryotes and eukaryotes); comparison between prokaryotic and eukaryotic translation; post-translational modifications (phosphorylation, glycosylation).

Unit 7: Gene Regulation **05 Hours**

Gene regulation in prokaryotes: Operon concept; inducible & repressible systems; regulation of lactose metabolism in *E. coli* (inducible system, positive & negative control); regulation of tryptophan synthesis (Repression-De-repression and concept of Attenuation) in *E. coli.* Gene regulation in eukaryotes: concept of gene silencing by DNA methylation and RNA interference.

Practicals **60 hours**

12. Isolation of plasmid and genomic DNA from *E. coli* and quantification using agarose gel electrophoresis
13. Isolation of genomic DNA from plant samples (atleast two different genera / species) using CTAB method and quantification using agarose gel electrophoresis
14. Quantification of unknown DNA by diphenylamine reagent (colorimetry).
15. To estimate the generation time of *Escherichia coli* (prokaryote) and budding yeast (eukaryote) by spectrophotometric measurement and plotting growth curve as an indirect method to study DNA replication

16. To study control of replication in budding yeast with the help of specific inhibitors (beta-lactams:- Clavulanic acid, Ceftazidime, Piperacillin, Ceftriaxone etc) and studying budding frequency.
17. To study control of transcription in *Escherichia coli* with the help of prokaryotic (Rifampicin) and eukaryotic (Actinomycin-D) transcription inhibitors and plotting growth curve
18. To study control of translation in *Escherichia coli* with the help of prokaryotic (Kanamycin / Streptomycin) inhibitors using an IPTG-inducible system.
19. To understand the regulation of lactose (*lac*) operon (positive & negative regulation) and tryptophan (*trp*) operon (Repression and De-repression & Attenuation) through digital resources/data sets.

Suggestive readings:

5. William S. Klug, Michael R. Cummings, Charlotte A. Spencer, Michael A. Palladino, & Darrell Killian (2019). Concepts of Genetics. Pearson; 12th edition.
6. 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.
7. Snustad, D.P. and Simmons, M.J. (2019). Principles of Genetics. John Wiley, 7th edition.
8. Russell, P. J. (2010). iGenetics- A Molecular Approach. Benjamin Cummings, U.S.A. 3rd edition.

Additional Resources:

10. Griffiths, A.J.F., John Doebley J., Peichel, C., Wassarman D.A. (2020). Introduction to Genetic Analysis. W H Freeman & Co; 12th edition
11. Micklos D A., Freyer G.A. (2003) DNA Science: A First Course (2nd Edition), Cold Spring Harbor Laboratory; Greg A., CSHL Press, USA

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

DISCIPLINE SPECIFIC CORE COURSE – 14: Reproductive Biology of Angiosperms

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		
Reproductive Biology of Angiosperms – DSC 14	4	**2**	0	**2**		**Nil**

Learning Objectives:

- To understand the scope of reproductive biology, development and structure of male and female reproductive units of the flower, organization of male and female gametophytes, pre-fertilization, fertilization and post-fertilization events.
- To understand the processes and significance of pollen--pistil interactions, apomixis and polyembryony.
- Significance of seed as a diaspore.

Learning Outcomes:

Upon completion of the course, the students will become familiar with:

- The significance and scope of reproductive biological studies in crop production and conservation. Structure and function of anther and ovule, male and female gametophyte.
- The significance of associations of MGU, FGU and double fertilization; embryo and endosperm development, genomic imprinting.
- Pollination and seed dispersal mechanisms, apomixis and polyembryony as alternate pathways of angiosperm reproduction.
- Experiential learning through field trips, scientific photography, videography and documentary preparation. The students will also learn to write scientific reports and present scientific data.

Unit 1: Introduction **01 Hour**

Introduction about Reproductive biology and its scope; significant contributors to the field; structure of flower.

Unit 2: Anther and Pollen **05 Hours**

Anther wall: Structure and functions, microsporogenesis, microgametogenesis; Pollen wall: Structure and functions, Number Position Character (NPC), pollen viability and storage, Male Germ Unit (MGU) – structure and significance.

Unit 3: Pistil **04 Hours**

General structure and types of pistil and ovules; megasporogenesis (monosporic, bisporic and tetrasporic) and megagametogenesis (details of *Polygonum* type); Organization and ultrastructure of mature embryo sac; cell specification; Female Germ Unit – structure and significance.

Unit 4: Pollination **04 Hours**

Types (Self, cross, geitonogamy, xenogamy), significance; Structure of the stigma and style; Pollen-pistil interactions- capture, adhesion, hydration, pollen tube penetration; Path of pollen tube in the pistil; Role of synergids in pollen tube attraction; Double fertilization; Polytubey block

Unit 5: Self-Incompatibility **04 Hours**

Basic concepts (interspecific, intraspecific, homomorphic, heteromorphic, GSI and SSI); Methods to overcome self-incompatibility (in brief): mixed-pollination, intraovarian and in vitro pollination and fertilization, modification of stigma surface, parasexual hybridization.

Unit 6: Endosperm **02 Hours**

Types (2 examples each), development, structure and functions; Genomic imprinting

Unit 7: Embryo **04 Hours**

General pattern and comparison of development of dicot and monocot embryo (initial apical cell and basal cell polarity, globular embryo with radial polarity, mature embryo); Suspensor: structure and functions; Embryo-endosperm relationship; Nutrition of embryo, haustorial systems: Embryo patterning.

Unit 8: Seed **02 Hours**

Structure and importance of seed as diaspore, as storage organ; germination and seedling formation.

Units 9: Polyembryony and apomixis **02 Hours**

Introduction, types, causes and applications.

Unit 10. Applications of Reproductive biology **02 Hours**

Haploid embryos - concept and significance; crop productivity, conservation

Practicals **60 hours**

- Anther: Wall and its ontogeny, tapetum (amoeboid and glandular), Microspore mother cell, spore tetrads, uninucleate, bicelled and dehisced anther; Temporary stained mounts of T.S. anther to study the organization.

- Pollen: General morphology, psuedomonads, polyads, pollinia (slides/digital resources, fresh material); Ultrastructure of pollen wall (micrograph); Pollen viability: tetrazolium test/FDA; Germination: calculation of percentage germination in different media using hanging drop/sitting method.

- Temporary mounts of pollen grains cleared with 1N HCl/KOH to study germ pores; Ultrastructure of male germ unit (MGU) through micrographs.

- Ovule: Types-anatropous, orthotropous, amphitropous/campylotropous, circinotropous, unitegmic, bitegmic; tenuinucellate and crassinucellate; Special structures: endothelium, obturator, hypostase, caruncle and aril (permanent slides/specimens/digital resources).
  Female gametophyte: developmental sequence of monosporic embryo sac only; Ultrastructure of Female Germ Unit.

- Pollination: Adaptations; bagging experiment; **project on pollination.

- Intra-ovarian pollination; Test tube pollination (through digital resources).

- Endosperm: Dissections of developing seeds for endosperm with free-nuclear haustoria.
- 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.

- Seed dispersal mechanisms (adaptations through live specimens), **project on seed dispersal

** The projects can be on pollination/ seed dispersal or on any other topic based on the syllabus. It can be a write-up with visuals. The students can also make a digital project submission in the form of a documentary of 5-10 min.

Suggested Readings:

- Bhojwani S.S., Bhatnagar S.P. & Dantu P.K. (2015). The Embryology of Angiosperms, 6th Edition. By VIKAS PUBLISHING HOUSE. ISBN: 978-93259-8129-4.
- P. Maheshwari, (2004). An introduction to the embryology of Angiosperms. Tata McGraw-Hill Edition, ISBN: 0-07-099434-X.
- Johri, B.M. (1984). Embryology of Angiosperms. Netherlands: Springer-Verlag. ISBN: 13:978-3-642-69304-5
- Raghavan, V. (2000). Developmental Biology of Flowering plants. Netherlands: Springer. ISBN: 978-1-4612-7054-6.
- Shivanna, K.R. (2003). Pollen Biology and Biotechnology. New Delhi, Delhi: Oxford and IBH Publishing Co. Pvt. Ltd.
- Mangla,Y., Khanduri, P., Gupta, C.K. 2022. Reproductive Biology of Angiosperms: Concepts and Methods.Cambridge University Press ISBN 978-1-009-16040-7.
- Tandon R, Shivanna KR, Koul M Reproductive Ecology of Flowering Plants: Patterns and Processes 1st ed. 2020 Edition ISBN 978-9811542091.Springer Verlag
- Kapoor, R., Kaur, I. Koul M.2016. Plant Reproductive Biology and Conservation IK International Publishing House Ltd. India ISBN: 9789382332909

Additional Resources:

- Shivanna, K.R., Tandon, R. (2020). Reproductive Ecology of Flowering Plants: A Manual. Springer (India) Pvt. Ltd. New Delhi, Heidelberg, New York, Dordrecht, London
- Shivanna, K. R., & Rangaswamy, N. S. (2012). *Pollen biology: a laboratory manual*. Springer Science & Business Media.

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

DISCIPLINE SPECIFIC CORE COURSE – 15: Plant Physiology

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 Physiology – DSC 15	4	2	0	2	Class XII Pass	Nil

Learning objective:

7. To introduce the basic principles of plant structure and function and its application in related fields.

Learning outcomes: On completion of the course the students will be able to:

8. understand the structure and function of plants
9. comprehend and compare various tissue systems in plants and their role
10. realise the importance of water, soil and atmosphere in the life of organisms
11. appreciate the ability of plants to sense the environment and adapt
12. interpret and evaluate the significance of regulator molecules in controlling life forms
13. apply the principles of plant physiology to solve problems in related fields

Unit 1: Plant-water relations **04 Hours**

Water potential and its components, water absorption by roots, water movement via symplast, apoplast and aquaporins, root pressure, guttation, ascent of sap, cohesion-tension theory, transpiration, factors affecting transpiration, anti-transpirants

Unit 2: Mineral nutrition **04 Hours**

Essential and beneficial elements, macro- and micro-elements, criteria for essentiality, roles of essential elements, chelating agents, phytosiderophores, mineral nutrition in hydroponics and aeroponics.

Unit 3: Nutrient uptake **05 Hours**

Transport of ions across cell membrane, passive absorption, simple and facilitated diffusion (carrier and channel proteins), Fick's law, active absorption, proton ATPase pump, electrochemical gradient, ion flux, uniport, co-transport (symport, antiport)

Unit 4: Translocation in the phloem **03 Hours**

Composition of phloem sap, phloem loading and unloading, Pressure-Flow Model, source-sink relationship

Unit 5: Plant growth regulators **08 Hours**

Chemical nature (basic structure, precursor), physiological roles, bioassays and applications of Auxins, Gibberellins, Cytokinins, Abscisic Acid, Ethylene; Other growth regulators - Jasmonic Acid, Brassinosteroids, Nitric Oxide. Mechanism of action of Auxin. Introduction to interactions among plant growth regulators.

Unit 6: Physiology of photo-sensory molecules **03 Hours**

Discovery, chemical nature, mode of action and role of phytochrome, cryptochrome and phototropin in photomorphogenesis

Unit 7: Physiology of flowering **02 Hours**

Concept of florigen, photoperiodism, CO-FT Model of flowering, vernalization.

Unit 8: Seed dormancy **01 hour**

Seed dormancy -causes and methods to induce and/or overcome dormancy

Practicals **60 Hours**

9. Determination of osmotic potential of plant cell sap by plasmolytic method.
10. Determination of water potential of potato tuber cells by weight method.
11. Determination of water potential of potato tuber cells by falling drop method.
12. Study of effect of light on the rate of transpiration in excised leafy twig.
13. Calculation of stomatal index and stomatal frequency from the lower surface of leaves of a mesophyte and a xerophyte.
14. To calculate the area of an open stoma and percentage of leaf area open through stomata in a mesophyte and a xerophyte (lower surface).
15. To study the effect of different concentrations of ABA on stomatal closure.
16. To study the effect of light and dark on seed germination.
17. To study induction of amylase activity in germinating barley grains.
18. To study the effect of ethylene on fruit ripening.
19. To study the effect of auxin on rooting.

Suggested Readings:

6. Hopkins, W. G., Huner, N. P. A. (2009). Introduction to Plant Physiology, 4th edition. New Delhi, Delhi: Wiley India Pvt. Ltd.
7. Taiz, L., Zeiger, E., Moller, I. M., Murphy, A. (2018). Plant Physiology and Development, 6th edition. New York, NY: Oxford University Press, Sinauer Associates.
8. Kochhar, S.L., Gujral, S.K. (2020). Plant Physiology: Theory and Applications. New Delhi, Delhi: Foundation Books, 2nd Edn. Cambridge University Press India Pvt, Ltd.

Additional Resources:

- Bajracharya, D. (1999). Experiments in Plant Physiology: A Laboratory Manual. New Delhi, Delhi: Narosa Publishing House.
- Bhatla, S.C., Lal, M.A. (2018). Plant Physiology, Development and Metabolism. Singapore: Springer Nature, Singapore Pvt. Ltd.

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DISCIPLINE SPECIFIC ELECTIVES (BOT-DSE-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 Pathology **BOT-DSE-05**	4	2	0	2		

Learning Objectives:

- To introduce students with the phytopathology, its concepts and principles\
- To acquaint with various plant diseases, causal organisms and their control

Learning Outcomes: Upon completion of this course, the students will be able to:

- Understand the economic and pathological importance of fungi, bacteria and viruses
- Identify common plant diseases and their control measures

Unit 1: Introduction **03 Hours**

Definition of disease and its components (disease pyramid); Classification of diseases (on the basis of pathogens; geographical distribution; extent of occurrence); History and significance of Phytopathology (with special reference to India); Eminent plant pathologists and their contributions (Anton de Bary; E.J. Butler; Louis Pasteur; PMA Millardet; E.F. Smith; Adolf Mayer; K.C. Mehta, J.F. Dastur ; B.B. Mundkur; R.N. Tandon).

Unit 2: Basic concepts of Plant Pathology **04 Hours**

Definitions (Pathogenesis; Pathogen; symptoms; etiology); Types of pathogens and their Symptoms (Fungus, Oomycetes, Bacteria, Virus, Nematode, Phytoplasma); Koch's Postulates; Disease cycle (Components) - Epidemiology and forecasting of Plant diseases.

Unit 3: Host- -Pathogen relationship **04 Hours**

How pathogens attack plants (brief concept on mode of penetration; post-penetration and colonization). Plant defence mechanisms (Constitutive and induced, structural and biochemical).

Unit 4: Fungal diseases **05 Hours**

Causal Organism, Symptoms, Disease Cycle and control: Powdery mildew of Pea; Ergot of Rye; Apple scab, Early blight of potato, red rot of sugarcane, Black, Yellow and Brown rust of Wheat; Smut of Barley (Loose and Covered Smut).

Unit 5: Oomycete Diseases **02 Hours**

Causal organism, symptoms, disease cycle and control: Late Blight of Potato; White Rust of Crucifers; Downy mildew of Grapes.

Unit 6: Bacterial Diseases **01 Hours**

General symptoms; Disease cycle and Control measures - Citrus canker; Angular leaf spot of Cotton.

Unit 7: Viral Diseases **01 Hours**

General symptoms; Mode of transmission and Control measures-Tobacco mosaic disease; Vein Clearing of Bhindi

Unit 8: Nematode Diseases **01 Hours**

General symptoms, Disease cycle and Control measures-Root knot disease of Brinjal.

Unit 9: Plant Disease Control **07 Hours**

Plant quarantine and its significance; Methods of disease control: Physical (Heat treatment, drying, radiation and regeneration); Chemical methods (foliar spray; dust, seed treatment; soil treatment; treatment of wounds). Types of fungicides - Inorganic (Bordeaux mixture, Fixed copper; Sulphur, Lime Sulphur); Organic (Dithiocarbamates, quinones); Systemic fungicides and their mode of action (Oxanthin, Strobilurins, Benzimidazole, Pyrimidine). Cultural practices (Host eradication, sanitation, crop rotation, Polythene traps, Mulches) Biological Control (Antibiosis, hyper - parasitism, Hypovirulence, Predation, Induced systemic Resistance).

Unit 8: Plant Disease Control **02 Hours**

Quarantine, Cultural practices, Physical methods, Chemical methods, Biological control (Antibiosis, Hyper-parasitism, Hypovirulence, Predation, Induced Systemic Resistance).

Practicals **60 hours**

4. Study of Late blight of Potato through specimens, temporary mounts (V.S. of leaf showing infection) and permanent slides.
5. Study of Black stem Rust of Wheat: Symptoms on wheat and barberry. Observe uredospores and teleutospores on V.S. wheat leaf/ to study stem spore stages of *Puccinia graminis tritici* with the help of temporary tease/section mount of wheat. Permanent slides of somatic and reproductive phases on both the hosts.
6. Study of smut of barley, symptoms of loose and covered smut and temporary spore mount.
7. Study of Powdery mildew of pea, Symptoms with the help of live or preserved specimens. Study of *Erysiphe* asexual and sexual stages with the help of temporary tease/section mount/ permanent slides.
8. Study of symptoms of Red rot of sugarcane, W.M. of conidia through temporary tease mount.
9. Study symptoms of bacterial diseases: Citrus canker, Angular leaf spot of Cotton.
10. Study symptoms of viral diseases: Tobacco mosaic Disease, Vein clearing of *Abelmoschus esculentus*/*Ageratum* sp.
11. Study of nematode diseases: Root knot disease of Brinjal.
12. Isolation of seed borne mycoflora by moist chamber method technique.
13. Study of biocontrol agents: Nematophagous fungi; *Trichoderma* sp.
14. The students should submit specimens of any two plant diseases studied by them.

Suggested Readings:

7. Agrios, G.N. (2005) *Plant Pathology* 5 th edition: Elsevier Academic Press, Amesterdam.
8. Sharma, P.D. (2014) *Plant Pathology* Rastogi Publications, Meerut, U.P.
9. Singh, R.S. (2018) *Plant Diseases*. 10th Edition Medtech, New Delhi.

Additional Readings:

- Ownley, Bonnie and Trigiano, Robert N. (2017). Plant Pathology: Concepts and Laboratory Exercises, 3rd Edition, CRC Press.

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DISCIPLINE SPECIFIC ELECTIVES (BOT-DSE-06)

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		
Natural Resource Management **BOT-DSE-06**	4	2	0	2	Nil	**Nil**

Learning Objectives:

- Natural Resources are materials from earth which support life and significantly meet the needs of people. The paper aims to describe the different types of natural resources and their management. Students will study about the importance of each natural resource and how and why they are threatened in current times. They will also be taught about sustainably using our resources

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

13. understand the different resources available in nature
14. learn the importance of each resource along with the threats to these resources
15. gain an in-depth understanding of management of these resources and also restoration of natural ecosystems
16. study the importance of sustainable practices
17. gain an insight into various initiatives taken the world over to save our natural resources.
18. understand the concept of clean energy and management of waste

Unit 1: Natural Resources **01 Hours**
Definition, fundamental concepts and types

Unit 2: Sustainable Utilization **04 Hours**
Concept, goals, approaches (economic, ecological, socio-cultural)

Unit 3: Land Resources **06 Hours**
Forests (definition, threats, management); Agricultural practices and their impact; Soil degradation (causes, management and remediation/restoration strategies)

Unit 4: Water Resources **04 Hours**
Freshwater, Marine, Estuarine, Wetlands – Threats and Management

Unit 5: Biological Resources **03 Hours**
Biodiversity – Levels, Significance, Threats, Management

Unit 6: Energy **02 Hours**
Clean energy strategies – Solar, Wind, Hydro, Tidal, Geo-thermal, Bio-energy

Unit 7: Climate Change **04 Hours**
Impact, adaptation and mitigation (Land, Soil, Water, Biodiversity, Air)

Unit 8: Contemporary practices **04 Hours**
EIA, GIS, Energy Audits, Waste Management, Ecosystem Restoration, Carbon footprint

Unit 9: National and International Initiatives **02 Hours**
International Solar Alliance; Ramsar Convention; Basel Convention; Carbon Neutral Goals; Net-zero Coalition; Clean Development Mechanism; CAMPA (Compensatory Afforestation Fund Management and Planning Authority); Carbon Credits; REDD+ project, Renewable Energy Certificates

Practicals **60 hours**

5. Comparison of pH (pH meter) and salinity (Electrical Conductivity) of various soil samples.
6. Comparison of field capacity of various soil samples.
7. Comparison of pH (pH meter) and TDS (TDS meter) of various water samples.
8. Comparison of salinity (titrimetric method) of various water samples.
9. Calculation and comparison of BOD and COD of various water samples from given data.
10. Comparison of species diversity in various communities by Shannon-Wiener Index.
11. Measurement of dominance of woody species by DBH method in the college campus.
12. Project (any one of the following):
    6. Rainwater harvesting (site visit)
    7. Ecological restoration (site visit)
    8. Energy audit
    9. Seed germination and seedling growth in garden and contaminated soils
    10. Composting
    11. Any other
13. Field visit/s to any degraded ecosystem (landfill, polluted water body, invaded forest) or any ongoing restoration project site.

Suggestive readings:

- Vasudevan, N. (2006). Essentials of Environmental Science. New Delhi, India: Narosa Publishing House.
- Singh, J. S., Singh, S.P. and Gupta, S.R. (2006). Ecology, Environment and Resource Conservation. New Delhi, India: Anamaya Publications.

- Rogers, P.P., Jalal, K.F. and Boyd, J.A. (2008). An Introduction to Sustainable Development. New Delhi, India: Prentice Hall of India Private Limited.

Additional resource:

10. https://moef.gov.in/en/division/forest-divisions-2/campa/compensatory-afforestation-fund-management-and-planning-authority-campa/
11. https://www.un.org/en/climatechange/net-zero-coalition
12. https://www.recregistryindia.nic.in/
13. https://static.investindia.gov.in/National%20Policy%20on%20Biofuels.pdf
14. https://cri.nccf.in/
15. https://www.investindia.gov.in/team-india-blogs/carbon-financing-india
16. https://www.un-redd.org/
17. Ecosystem Restoration for People, Nature and Climate https://wedocs.unep.org/bitstream/handle/20.500.11822/36251/ERPNC.pdf
18. Managing Ecosystems In The Context Of Climate Change Mitigation: A review of current knowledge and recommendations to support ecosystem-based mitigation actions that look beyond terrestrial forests https://www.cbd.int/doc/publications/cbd-ts-86-en.pdf
19. Jordan III, W. R., Gilpin, M. E., Aber, J. D. (1987). Restoration Ecology: a synthetic approach to ecological research. Cambridge, Great Britain: Cambridge University Press.

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. Programmes with Botany as Major 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	Nil	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 O_2 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.

COURSES OFFERED BY DEPARTMENT OF BOTANY

Category III:

B.Sc. programme in Applied Life Sciences with Agrochemicals and Pest Management Botany (H) Courses for Undergraduate Programme of study with Botany as a Single Core Discipline

DISCIPLINE SPECIFIC CORE COURSE (DSC 05)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the core course			Eligibility criteria	Pre-requisite of the course (If any)
		Lecture	Tutorial	Practical/ Practice		
Plant Physiology and Metabolism ALS BOT DSC 05	4	2	0	2	Appeared in semester IV	NIL

Learning Objectives:

The learning objectives of this course are as follows:

- to understand the fundamental concepts of plant physiology and metabolism.
- to identify the role of water, minerals, hormones, and light in plant growth and development.
- to understand the basic biochemical mechanisms and mineral nutrition of plants.
- to identify the criteria for the essentiality of elements.
- to understand the role of hormones in plant growth and development.
- to examine the commercial applications of growth regulators.
- to understand the physiology of flowering and senescence.
- to understand the mechanisms of photosynthesis and respiration.
- to examine the biological nitrogen fixation in plants.

Learning Outcomes:

By studying this course, students will be able to:

6. comprehend the physiological processes that occur in plants, including the role of water, minerals, hormones, and light in plant growth and development.
7. acquaint the basic biochemical mechanisms of plants, including photosynthesis, respiration, nitrogen metabolism, and chemical regulation of growth and development.
8. comprehend the process of biological nitrogen fixation, reproductive physiology and senescence of plants.
9. develop practical skills in plant physiology and metabolism.

Unit 1: Plant-water relations **(3 Hours)**

Water potential and its components, pathway of water movement, ascent of sap, transpiration and its significance, factors affecting transpiration, root pressure and guttation.

Unit 2: Mineral Nutrition **(3 Hours)**

Essential elements, Macro- and micronutrients, Criteria for essentiality of elements, Methods of studying mineral requirement (Hydroponics, Aeroponics)

Unit 3: Translocation in Phloem **(3 Hours)**

Composition of phloem sap, girdling experiments, Pressure Flow Model, phloem loading and unloading.

Unit 3: Chemical Regulation of Growth and Development **(3 Hours)**

Role of hormones in plant growth and development, Commercial applications of growth regulators, Growth retardant and its usefulness

Unit 4: Reproductive Physiology and Senescence **(3 Hours)**

Photo-periodism and flowering response, Photo-perception and critical photoperiod, Phyto-chrome and its role in flowering, Vernalization and senescence.

Unit 5: Photosynthesis **(7 Hours)**

Historical contributions of Blackman, Emerson, and Hill, Photosynthetic pigments (chlorophyll-a and b, xanthophyll, carotene), Photosystem I and II, reaction center, antenna molecules, Electron transport and mechanism of ATP synthesis, C3 pathway, C4 and CAM plants (in brief, no pathways), Photorespiration.

Unit 6: Respiration **(5 Hours)**

Glycolysis, Anaerobic respiration, TCA cycle, Oxidative phosphorylation, Glyoxylate cycle, RQ

Unit 7: Nitrogen Metabolism **(3 Hours)**

Biological nitrogen fixation - nodulation in detail, Nitrate and ammonia assimilation.

PRACTICAL **(60 Hours)**

2. To determine the osmotic potential of plant cell sap by plasmolytic method.
3. Calculate stomatal index and stomatal frequency of a mesophyte and a xerophyte.
4. Study Hill's reaction.
5. To study the effect of the environmental factor light on transpiration by excised twig.
6. Study the effect of light intensity on O_2 evolution in photosynthesis.

7. Compare the rate of respiration in any two parts of a plant.
8. To study the activity of catalase and the effect of pH and heavy metals.
9. Demonstrate the effect of auxin on rooting.
10. Demonstration of Bolting.
11. Demonstration of root respiration.
12. Demonstration of suction due to transpiration
13. A field visit to Hydroponics and Aeroponics facilities.

Essential/ Recommended readings:

6. Hopkins, W. G., Huner, N. P. A. (2009) *Introduction to Plant Physiology*, 4th edition. New Delhi, Delhi: Wiley India Pvt. Ltd
7. Taiz, L., Zeiger, E., Moller, I. M., Murphy, A. (2018) *Plant Physiology and Development* International 6th edition. New York, NY: Oxford University Press, Sinauer Associates.
8. Kochhar, S.L., Kaur, S. and Gujral, S.K. (2020) *Plant Physiology: Theory and Applications*. New Delhi, Delhi: Foundation Books, imprint of Cambridge University Press India Pvt, Ltd.

Suggestive readings:

6. Bajracharya, D. (1999) *Experiments in Plant Physiology: A Laboratory Manual.* New Delhi, Delhi: Narosa Publishing House.
7. Bhatla S.C. and Lal, M.A. (2018) *Plant Physiology, Development and Metabolism*, Springer.
8. Salisbury F.B. and Ross C.W. (1992) Plant Physiology, 4th edition, Wadsworth Publishing Company, California.

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DISCIPLINE SPECIFIC ELECTIVE COURSE (DSC 05)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title& Code	Credits	Credit distribution of the core course			Eligibility criteria	Pre-requisite of the course (If any)
		Lecture	Tutorial	Practical/ Practice		
Developmental Biology of Plants ALS BOT DSE 03	**4**	**2**	**0**	**2**	**Appeared in semester IV**	**NIL**

Learning Objectives:

The learning objectives of this course are follows:

12. to acquaint the students with internal basic structure and cellular composition of the plant body.
13. to correlate structure with important functions of different plant parts.
14. to study of various tissue systems and their development and functions in plants
15. to have knowledge of the flowering and fruiting, reproduction process, role of pollinators, ovule and seed development.

Learning Outcomes:

By studying this course, students will be able to:

11. gain knowledge of various cells and tissues, meristem, epidermal and vascular tissue system in plants.
12. get an insight of various aspects of growth, development of the tissues and differentiation of various plant organs.
13. gain the knowledge of basic structure and organization of plant parts in angiosperms and its correlation with morphology and functions.
14. get acquainted with pollen development and pollination, ovule development and fertilization, endosperm development and its importance.

Unit 1: Meristematic and permanent tissue: (4 Hours)

Meristems and derivatives- structural organization of shoot and root apices; permanent tissue: simple and complex tissues.

Unit 2: Dermal System (2 Hours)

Epidermis, stomata, trichomes and glands

Unit 3: Organs (4 Hours)

Structure of dicot and monocot root, stem and leaf

Unit 4: Secondary Growth (4 Hours)

Vascular cambium – structure and function, Secondary growth in root and stem, periderm.

Unit 5: Anther (4 Hours)

Structure and development, microsporogenesis, Pollen Development, structure of pollen and pollen wall (Basic Concepts).

Unit 6: Ovules (4 Hours)

Structure and types, megasporogenesis and mega gametogenesis, mature embryo sac.

Unit 7: Pollination and Fertilization (4 Hours)

Pollination mechanisms and adaptations; double fertilization; sexual incompatibility- basic concepts

Unit 8: Endosperm and Embryo (3 Hours)

Types and function of endosperm, embryogenesis, dicot and monocot embryo

Unit 9: Seed development (1 Hours)

Basic concepts of seed development

PRACTICAL (60 Hours)

1. Study of root and shoot apex through permanent slides and photographs.
2. Tissues (parenchyma, collenchyma, sclerenchyma and their types); Macerated xylary elements, Phloem (Permanent slides/ Photographs/ Digital resources)

3. To cut transverse section of stem: Monocot: *Zea mays*; Dicot: *Helianthus*; Study of secondary growth in *Helianthus* stem.
4. To cut transverse section of root: Monocot: *Zea mays*; Dicot: *Cicer*; Study of secondary growth in *Helianthus* .
5. Study of the structure of Dicot and Monocot leaf.
6. Study of anther structure (young and mature).
7. Calculation of percentage of germinated pollen in a given medium through hanging drop/sitting drop method.
8. Types of ovules: anatropous, orthotropous, circinotropous, amphitropous/ campylotropous.
9. Female gametophyte: Mature embryo sac (photographs). Ultrastructure of mature egg apparatus cells through electron micrographs.
10. Dissection of embryo and endosperm from developing seeds.

Essential/ Recommended readings:

1. Bhojwani, S.S., Bhatnagar, S.P. (2011). *Embryology of Angiosperms*, 5th edition. New Delhi, Delhi: Vikas Publication House Pvt. Ltd.
2. Mauseth, J.D. (1988). *Plant Anatomy*. San Francisco, California: The Benjamin/Cummings Publisher.
3. Franklin, E. R. (2006). *Esau's Plant Anatomy: Meristems, Cells, And Tissues of the Plant Body: Their Structure, Function, and Development.* New Jersey, U.S.: John Wiley & Sons, Inc., Hoboken.
4. Shivanna, K.R. (2003). *Pollen Biology and Biotechnology.* Delhi, Delhi: Oxford and IBH Publishing Co. Pvt. Ltd.

Suggestive readings:

1. Raghavan, V. (2000). *Developmental Biology of Flowering plants*. Netherlands, Europe: Springer.
2. Johri, B.M. (1984). *Embryology of Angiosperms.* Netherlands, Europe: Springer-Verlag.
3. Bhojwani S.S., Dantu P.K. and Bhatnagar, S.P. (2015) The Embryology of Angiosperms, 6th edition. Vikas Publication House Pvt. Ltd. New Delhi.
4. Tayal, M.S. (2021). Plant Anatomy, 4th Edition. Meerut, U.P.: Rastogi publications.
5. Crang, R., Lyons-Sobaski, S., and Wise, R., (2018) Plant Anatomy: A Concept-Based Approach to the Structure of Seed Plants, 1st Edition, Springer Nature Switzerland AG.

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

GENERIC ELECTIVE (BOT-GE-18)

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		
Genetic Engineering Technologies & Applications BOT-GE-18	4	2	0	2	Nil	**Nil**

Learning Objectives:

- To illustrate the use of modern techniques for the manipulation and analysis of DNA sequences
9. To understand the applications of recombinant DNA technology for the generation of commercial biotechnological products of diverse usage.
10. To gain knowledge about biosafety and ethical concerns associated with recombinant DNA technology.
11. To train students in strategizing research topics employing genetic engineering techniques.

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

- understand methods and techniques involved in manipulation and analysis of nucleic acids, gene cloning and creation of genetically modified organisms (GMOs).
- understand the commercial application of rDNA technology in research, agriculture and human health
- comprehend biosafety and ethical issues associated with rDNA technology

Unit 1: Introduction **01 Hours**

Introduction to rDNA technology and gene cloning.

Unit 2: Enzymes and Vectors in genetic engineering **07 Hours**

Restriction endonucleases, exonucleases, polymerases, RNAses, kinases, ligases; Plasmids (pBR322, pUC18, pUC19); Lambda based vectors and derivatives (Insertion vectors, replacement vectors, cosmids, phagemids); Artificial Chromosomes (YACs, BACs); Bacterial transformation, strategies for selection and screening (α complementation, antibiotic resistance); Plant Transformation vectors (Ti plasmid), Protein Expression Vectors for use in *E. coli*; introduction to marker and reporter genes (GUS, GFP).

Unit 2: Gene transfer methods **04 Hours**

Agrobacterium mediated transformation, Electroporation, Microinjection, Particle Bombardment, PEG mediated

Unit 3: DNA libraries construction and screening **04 Hours**

Procedures for construction of genomic and cDNA libraries, screening methods for locating the desired gene (Replica plating, Complementation screening, heterologous gene probe-based hybridizations)

Unit 4: PCR, nucleic acid hybridization and DNA sequencing **08 Hours**

PCR technique and its applications, RT-PCR, qPCR, Hybridization based assays (Southern and Northern blotting), Sanger's di-deoxy chain termination method of sequencing – gel-based electrophoresis (semi-automated) and capillary-based gel electrophoresis (automated sequencing).

Unit 5: Applications of rDNA technology **06 Hours**

Applications in basic research (identify, map, clone, and sequence genes and to determine their functions); applications in agriculture (biotic and abiotic stress tolerant transgenic plants, improved Nitrogen fixation, and plant growth); applications in human health (Disease diagnosis (heritable diseases and acquired infectious diseases) and therapeutics (production of recombinant vaccines, protein therapies: production of Insulin, Interferons, and human growth hormone). Human genome project and sequencing of plant genomes by taking *Arabidopsis* genome as an example. Safety and Ethical Issues related to rDNA research.

Practicals **60 hours**

- Isolation of genomic/plasmid DNA from bacteria.
- Quantification of extracted DNA by DPA (Diphenylamine) method.
- Restriction digestion and AGE (Agarose gel electrophoresis) of DNA.
- Restricting Mapping of linear and circular DNA.
- Study of direct and indirect gene transfer methods by photographs: Electroporation, Microinjection and Particle Bombardment, Ti-plasmid mediated gene transfer.
- Demonstration of techniques by photographs: PCR, RT-PCR, qPCR, Southern and Northern blotting and hybridization.
- Study of applications of rDNA technology by photographs: recombinant insulin, interferon and human growth hormone, Bt Cotton, Golden rice, and Flavr Savr tomato.
- Demonstration of working of equipments used in rDNA technology: Thermocycler, Laminar air flow cabinet, Autoclave, Incubator shaker, Refrigerated centrifuge.

Suggested Readings:

11. M. R. Green, J. Sambrook. Molecular Cloning: A Laboratory Manual (Cold Spring Harbor, ed. 4, 2012).
12. M. Wink. An Introduction to Molecular Biotechnology: Molecular Fundamentals, Methods and Applications in Modern Biotechnology (Wiley, ed. 2, 2011).
13. Glick, B.R., & Patten C. (2022). Molecular Biotechnology: Principles and Applications. 6th edn. Washington, U.S.: ASM Press.

14. Snustad, D.P.,Simmons, M.J. (2019). Principles of Genetics, 7th edition. Chichester, England: John Wiley and Sons.
15. Brown, T. A. 2020. Gene Cloning & DNA Analysis: An Introduction. 8th edn. UK: Wiley Blackwell.
16. Primrose, S. B., Twyman, R. (2009). Principles of gene manipulation and genomics. Wiley. com.
17. Howe, C. J. (2007). Gene cloning and manipulation. Cambridge University Press.

Additional Resources:

3. M. M. Burell. (1993) Enzymes of Molecular Biology, Humana Press.
4. H.M. Eun. (1996) Enzymology: Primer for Recombinant DNA Technology, Academic Press.
5. S. B. Primrose, R. Twyman. (2006) Principles of Gene Manipulation and Genomics (Wiley-Blackwell, ed. 7).

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

GENERIC ELECTIVE (BOT-GE-19)

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		
Fundamentals of Molecular Biology **BOT-GE-19**	4	2	0	2	Nil	**Nil**

Learning Objectives:

5. To gain the knowledge of structure and functions of DNA and RNA

Learning Outcomes:

Students would have understanding of

9. understanding of nucleic acid, organization of DNA in prokaryotes and Eukaryotes, DNA replication mechanism, genetic code and transcription process.
10. Processing and modification of RNA and translation process, function and regulation of expression.

Unit 1: Nucleic Acids as genetic material **02 Hours**

Discovery of Nuclein by Fredrich Miescher; Experiments by Griffith, Hershey and Chase, Avery, McLeod and McCarty and Fraenkel Conrat.

Unit 2: Structure of Nucleic acids- the blueprint of Life **04 Hours**

Building blocks of nucleic acid: Ribose sugar, Purine, Pyrimidine, phosphate; Watson and Crick's model of DNA, DNA types (A,B,Z type), Comparison of RNA structure and types (tRNA, mRNA and rRNA); nucleosome- chromatin structure; Euchromatin and heterochromatin.

Unit 4: Central Dogma of Life **04 Hours**

Concept of Central dogma; Salient features of genetic code, deciphering the genetic code (Contribution of Nirenberg, Matthei and Ochoa, H.G. Khorana).

Unit 3: Replication **05 Hours**

Semi-conservative mode of DNA replication; replication of linear and circular DNA (Theta and Rolling circle model); mechanism and role of key enzymes in replication; role of telomerase enzyme in eukaryotic DNA replication; reverse transcription.

Unit 5: Transcription **05 Hours**

Comparative account of transcription in Prokaryotes and eukaryotes; post-transcriptional processing of pre-mRNA in eukaryotes (3', 5' end modifications and general mechanism of splicing involving spliceosomes).

Unit 6: Translation **05 Hours**

Comparative account of prokaryotic and eukaryotic ribosome structure and translation; inhibitors of protein synthesis (antibiotics).

Unit 7: Gene regulation **05 Hours**

Gene regulation in Prokaryotes- Operon concept: inducible and repressible operon; regulation of lactose (lac) and tryptophan (trp) in *Escherichia coli*; attenuation regulation.

Practicals **60 hours**

6. DNA isolation from cauliflower head by spooling method.
7. Study experiments establishing nucleic acid as genetic material: Griffith's, Avery et al, Hershey & Chase's and Fraenkel Conrat's experiments (through photographs)
8. Study DNA packaging (photographs/paper models).
9. Study modes of DNA replication: Meselson and Stahl's experiment, Rolling circle and Theta model of replication and semi-discontinuous, semi conservative replication (photographs).
10. Study structure of tRNA, prokaryotic RNA polymerase and eukaryotic RNA polymerase II (photographs/paper models).
11. Study RNA modification: Assembly of Spliceosome machinery, Splicing mechanism in group I & group II introns (photographs/paper models).
12. Study gene regulation mechanism in prokaryotes: lactose (lac) operon and tryptophan (trp) operon (photographs).
13. Finding the Tm of different DNA samples from the photographs of DNA melting profile provided. Problem solving for calculating the GC content.

Suggested Readings:

- Cooper, G.M., Hausman, R.E. (2009). The Cell: A Molecular Approach, 5th edition. Washington, D.C.: ASM Press & Sunderland, Sinauer Associates, MA.
- Karp, G. (2010). Cell Biology, 6th edition. New Jersey, U.S.A.: John Wiley & Sons
- Snustad, D.P., Simmons, M.J. (2012). Principles of Genetics, 6th Edition. New Delhi, Delhi: John Wiley & Sons
- Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics, 10th edition. San Francisco, California: Benjamin Cummings

Additional Resources:

6. Hardin, J. and Lodolce, J.P. (2021). Becker's World of the cell, 10th edition, Pearson

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