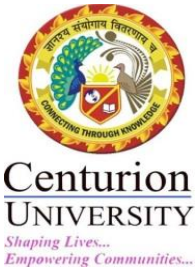

Centurion
UNIVERSITY
Shaping Lives...
Empowering Communities...

B.Sc. (Botany) CBCS syllabus

(Three years programme)

School of Applied Sciences

Centurion University of Technology & Management

2024

CHOICE BASED CREDIT SYSTEM IN B.Sc.(Honours)

Core Courses (CC)

Sl. No.	Code	Subject Name	Type of course	T-P-Pr (Credit)	Credits
1.	**CUTM1455**	Phycology and Microbiology	Theory + Practice+ Project	3-2-1	6
2.	**CUTM1456**	Biomolecules & Cell biology	Theory + Practice+ Project	3-2-1	6
3.	**CUTM1457**	Mycology & Phytopathology	Theory + Practice+ Project	3-2-1	6
4.	**CUTM1458**	Archegoniate	Theory + Practice+ Project	3-2-1	6
5.	**CUTM1459**	Anatomy of Angiosperms	Theory + Practice+ Project	3-2-1	**6**
6.	**CUTM1460**	Economic Botany	Theory + Practice+ Project	3-2-1	6
7.	**CUTM1461**	Basics of Genetics	Theory + Practice+ Project	3-2-1	6
8.	**CUTM1462**	Molecular Biology	Theory + Practice+ Project	3-2-1	**6**
9.	**CUTM1463**	Plant Ecology and Phytogeography	Theory + Practice+ Project	3-2-1	6
10.	**CUTM 1464**	Plant Systematics	Theory + Practice+ Project	3-2-1	6
11.	**CUTM1465**	Reproductive Biology of Angiosperm	Theory + Practice+ Project	3-2-1	6
12.	**CUTM1466**	Plant Physiology	Theory + Practice+ Project	3-2-1	6
13.	**CUTM1467**	Plant Metabolism	Theory + Practice+ Project	3-2-1	6
14.	**CUTM1468**	Plant Biotechnology	Theory + Practice+ Project	3-2-1	6
15.	BSFL1101	English	Theory	2-0-0	2
16.	FCBS0101	Environmental Science	Theory	2-0-0	2
	Total				**84**

CUTM1455 PHYCOLOGY AND MICROBIOLOGY

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Phycology and Microbiology	**CUTM1455**	**Theory + Practice+ Project**	**3-2-1 (6)**	**Nil**

Objectives

- To provide the basic knowledge about viruses, viroid's, Prions, bacteria and algae.
- To explore the living world which is not visible to naked eye.
- To learn about production of vaccines, medicines, disease diagnosis and research.

Course outcome

At the end of the course the student will be able to:

COs	Course outcomes
CO1	Learn about the basics of microbial world and significance of microorganisms.
CO2	Acquire the knowledge on classifications and life cycle of virus.
CO3	Will able to understand the bacterial types, structure and mode of reproduction
CO4	Understand and identify the different types of algae and their importance in day today life.
CO5	Gain laboratory skills such as microscopy, microbial cultures, staining, identification, preservation of microbes and algae for their applications in research and industry.

Course Outcome to Program Outcome Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PS03
CO1	3	2	2	1	1	1	3	1		2	3	2			3	3
CO2	3	1	1	1			1	3		2	1					2
CO3	2	3	2	1			1	3		2	2				2	2
CO4	3	3	3	1		1	2	1		2	1					
CO5	2	3	3	3		2	3	3		3	2	1				

***High-3, Medium-2, Low-1**

Course Outline

Module-I

Introduction to microbial world: Microbial nutrition, growth and metabolism. Economic importance ofviruses with reference to vaccine production, role in research, medicine and diagnostics, as causal organisms of plant diseases.Economic importance of bacteria with reference to their role in agriculture and industry (fermentation and medicine).

Module-II

Viruses: Discovery, physiochemical and biological characteristics; classification (Baltimore), general structurewith special reference to viroids and prions; replication (general account), DNA virus (T-phage), lytic and lysogenic cycle; RNA virus (TMV).

Practice 1. Line drawings/ Photographs of Lytic and Lysogenic Cycle
Practice 2. Electron micrographs/Models of viruses – T-Phage and TMV,

Module-III

Bacteria: Discovery, general characteristics; Types-archaebacteria, eubacteria, wall-less forms (mycoplasma and spheroplasts); Cell structure; Nutritional types; Reproduction-vegetative, asexual and recombination (conjugation, transformation and transduction).

Practice 3. Electron micrographs of bacteria, binary fission, conjugation endospore, root Nodule
Practice 4. Gram staining.
Practice 5. Endospore staining with malachite green (endospores taken from soil bacteria).
Practice 6. Study of Root Nodule bacteria

Module-IV

Algae: General characteristics; Ecology and distribution; range of thallus organization; Cell structure and components; cell wall, pigment system, reserve food (of only groups represented in the syllabus), flagella; methods of reproduction; Classification; criteria, system of Fritsch, and evolutionary classification of Lee (only upto groups); Significant contributions of important phycologists (F.E. Fritsch, G.M. Smith, H.D; Kumar, M.O.P.Iyengar).Role of algae in the environment, agriculture, biotechnology and industry.

Module-V

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

Practice 7. Study of vegetative and reproductive structures of *Nostoc, Vaucheria*

Module-VI

Chlorophyta and Charophyta: General characteristics; Occurrence; Range of thallus organization; Cell structure; Reproduction, Morphology and life-cycles of *Chlamydomonas, Volvox, Oedogonium, Coleochaete, Chara.*

Practice 8. Study of vegetative and reproductive structures of *Chlamydomonas* (electron micrographs), *Volvox,*
Practice 9. Study of vegetative and reproductive structures of *Oedogonium, Coleochaete,*.
Practice 10. Study of vegetative and reproductive structures of *Chara, Vaucheria*(Temporary Slide)

Module-VII

Phaeophyta and Rhodophyta: Characteristics; Occurrence; Range of thallus organization; Cell structure; Reproduction. Morphology and life-cycles of *Ectocarpus, Fucus* and *Polysiphonia.*

Practice 11. Study of vegetative and reproductive structures of *Ectocarpus, Fucus*
Practice 12. Study of vegetative and reproductive structures of *Polysiphonia*,

Text Book:

1. Lee, R.E. (2008). Phycology, Cambridge University Press, Cambridge. 4th edition.
2. Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International.

Reference Book:

1. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West Press, Delhi. 2. Sahoo, D. (2000). Farming the ocean: seaweeds cultivation and utilization. Aravali International, New Delhi.
2. Campbell, N.A., Reece J.B., Urry L.A., Cain M.L., Wasserman S.A. Minorsky P.V., Jackson R.B. (2008). Biology, Pearson Benjamin Cummings, USA. 8th edition.
3. Pelczar, M.J. (2001) Microbiology, 5th edition, Tata McGraw-Hill Co, New Delhi.

CUTM1456 BIOMOLECULES AND CELL BIOLOGY

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Biomolecules and Cell Biology	**CUTM1456**	**Theory + Practice+ Project**	**3-2-1 (6)**	**Nil**

Objectives

- To understand the structure and function of cells. This includes studying the various organelles within a cell, their roles, and how they work together to carry out essential cellular process.
- To explore the different types of biomolecules such as proteins, nucleic acids, lipids, and carbohydrates. This involves understanding their structures, functions, and how they are synthesized and regulated within cells.
- To apply these concepts to various aspects of biology, including genetics, biotechnology, and medicine.

Course outcome

At the end of the course the student will be able to:

Cos	Course outcomes
CO1	Know about the structure and functions of macromolecules (Carbohydrate, Protein, Lipid and Nucleic acid) in eukaryotic cells
CO2	Learn about the enzyme and its mechanism in eukaryotic cell.
CO3	Recognize, classify cell, explain cell theory, evolution and biogenesis of cell wall and plasma membrane.
CO4	Define, describe, classify and explain cytoskeleton, cell organelle and nucleus.
CO5	Explain, illustrate endomembrane system and protein sorting in eukaryotic cell. Learn cell division and cell cycle.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PS03

CO1	2	2	3	3	1		2	2	2	2	3	3	1		2	2
CO2	2	2	1	3			2	2	2	2	1	3			2	2
CO3	3	2	1	3		1	1	3	3	2	1	3		1	1	3
CO4	3	3	2	2			2	2	3	3	2	2			2	2
CO5	3	1	2	2			2	1	3	1	2	2			2	1

***High-3, Medium-2, Low-1**

Course Outline

Module-I

Biomolecules I: Types and significance of chemical bonds; Structure and properties of water; pH and buffers. Carbohydrates:Nomenclature and classification; Monosaccharide, disaccharides, oligosaccharides and polysaccharides.

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

Practice 1. Qualitative tests for carbohydrates, reducing sugars and non-reducing sugars.
Practice 2. Quantitative test for lipid.
Practice 3. Determination of pH in waste water sample.

Module-II

Biomolecules II: Nucleic acids: Structure of nitrogenous bases; Structure and function of nucleotides; Types of nucleic acids; Structure of A, B, Z types of DNA; Types of RNA; Structure of t-RNA.

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

Practice 4. Qualitative tests for Proteins.
Practice 5. Cytochemical staining of: DNA- Feulgen and cell wall in the epidermal peel of onion using Periodic Schiff's (PAS) staining technique.

Module-III

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

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

Module-IV

The cell: Cell as a unit of structure and function; Characteristics of prokaryotic and eukaryotic cells; Origin of eukaryotic cell (Endosymbiotic theory); Cell wall and plasma membrane:Chemistry,

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

Practice 6. Study of plant cell structure with the help of epidermal peel mount of Onion/Rhoeo/Crinum
Practice 7. Demonstration of the phenomenon of protoplasmic streaming in Hydrilla leaf.
Practice 8. Study the phenomenon of plasmolysis and deplasmolysis
Practice 9. Study the effect of organic solvent and temperature on membrane permeability.

Module-V
Nucleus: Structure-nuclear envelope, nuclear pore complex, nuclear lamina, molecular organization of chromatin; nucleolus
Cytoskeleton: Role and structure of microtubules, microfilaments and intermediary filament. Chloroplast, mitochondria and peroxisomes:Structural organization; Function; Semiautonomous nature of mitochondria and chloroplast.

Practice 10. Measurement of cell size by the technique of micrometry.

Module-VI
Endomembrane system: Endoplasmic Reticulum–Structure, targeting and insertion of proteins in the ER,protein folding, processing; Smooth ER and lipid synthesis, export of proteins and lipids; Golgi Apparatus – organization, protein glycosylation, protein sorting and export from Golgi apparatus.

Practice 11. Study of cell and its organelles with the help of electron micrographs.

Module-VII
Cell division: Phases of eukaryotic cell cycle, mitosis and meiosis; Regulation of cell cycle-checkpoints, role of protein kinases

Practice 12. Study different stages of mitosis and meiosis.
Text Books:

1. Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning
2. Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone
3. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H.Freeman
4. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company
5. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition. W.H. Freeman and Company.

Reference Book:

6. Karp, G. (2010). Cell Biology, John Wiley & Sons, U.S.A. 6th edition.
7. Hardin, J., Becker, G., Skliensmith, L.J. (2012). Becker's World of the Cell, Pearson Education Inc. U.S.A. 8th edition.
8. Cooper, G.M. and Hausman, R.E. (2009) The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
9. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009) The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

CUTM 1457 MYCOLOGY AND PHYTOPATHOLOGY

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Mycology and Phytopathology	**CUTM 1457**	**Theory + Practice+ Project**	**3-2-1(6)**	**Nil**

Objectives

- To gain knowledge on fungi, their structure and function, their effect on living world, economic importance of major groups of fungi
- To learn importance of fungi on biotechnology, food industry and in agriculture
- To know the methods of disease management and control

Course outcome

After completion of the course the students will be able to:

Cos	Course outcomes
CO1	Understand the general characters, structure, nutrition, reproduction, the principles on classifications of fungi
CO2	Understand the occurrence, general characters, types, reproduction and life cycles of the major fungal groups including allied fungi
CO3	Gain knowledge on symbiotic associations of fungi and their significance
CO4	Acquire knowledge on importance of fungi on biotechnology, food industry and in agriculture
CO5	Know host-pathogen relationships, disease cycle and environmental relation and control of plant diseases and role of quarantine in disease prevention

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PS03
CO1	3	1	1	1		2	1	1		1	1				2
CO2	3	1	1	1		1	1	1			1				2
CO3	2	1	1	1		2	2	1			2	2	3	2	2
CO4	2	2	3	2		2	3	2		1	2	2	3	3	2
CO5	3	3	2	3			3	2		2	2		2	3	2

***High-3, Medium-2, Low-1**

Course Outline

Module-I

Introduction to true fungi: General characteristics; Affinities with plants and animals; Thallus organization; Cell wall composition; Nutrition; Classification.

Chytridiomycota and Zygomycota: Characteristic features; Ecology and significance; Thallus 9ctomycorrhi; Reproduction; Life cycle with reference to *Synchytrium*, *Rhizopus.*

Practice 1. Introduction to the world of fungi (Unicellular, coenocytic / septate mycelium, ascocarps & basidiocarps).
Practice 2. *Rhizopus*: study of asexual stage from temporary mounts and sexual structures through permanent slides.

Module-II
Ascomycota: General characteristics (asexual and sexual fruiting bodies); Ecology; Life cycle, Heterokaryosis and parasexuality; Life cycle and classification with reference to *Saccharomyces, Aspergillus*, *Penicillium*, *Alternaria*, *Neurospora* and *Peziza.*
Basidiomycota: General characteristics; Ecology; Life cycle and Classification with reference to black stem rust on wheat, *Puccinia* (Physiological Specialization), loose and covered smut (symptoms only), *Agaricus*; Bioluminescence, Fairy Rings and Mushroom Cultivation.

Practice 3. *Aspergillus* and *Penicillium*: study of asexual stage from temporary mounts. Study of Sexual stage from permanent slides/photographs.
Practice 4. *Alternaria:* Specimens/photographs and temporary mounts
Practice 5. *Peziza*: sectioning through ascocarp.
Practice 6. *Puccinia*: Herbarium specimens of Black Stem Rust of Wheat and infected Barberry leaves; sections/mounts of spores on wheat and permanent slides of both the hosts.
Practice 7. *Agaricus*: Specimens of button stage and full grown mushroom; sectioning of gills of Agaricus, fairy ringsand bioluminescent mushrooms to be shown.

Module-III
Allied Fungi: General characteristics; Status of Slime molds, Classification; Occurrence; Types of plasmodia; Types of fruiting bodies.
Oomycota: General characteristics; Ecology; Life cycle and classification with reference to *Phytophthora, Albugo.*

Practice 8. Study of phaneroplasmodium from actual specimens and/or photograph. Study of *Stemonitis* sporangia.
Practice 9. *Albugo:* Study of symptoms of plants infected with *Albugo*; asexual phase study through section/ temporary mounts and sexual structures through permanent slides

Module-IV
Symbiotic associations: Lichen–Occurrence; General characteristics; Growth forms and range of thallus organization; Nature of associations of algal and fungal partners; Reproduction; Mycorrhiza-Ectomycorrhiza, Endomycorrhiza and their significance.

Practice 10. *Lichens:* Study of growth forms of lichens (crustose, foliose and fruticose) on different substrates. Study of thallus and reproductive structures (soredia and apothecium) through permanent slides.
Practice 11. Study of Mycorrhizae: Ectomycorrhizal and endomycorrhiza (Photographs)

Module-V
Applied Mycology: Role of fungi in biotechnology; Application of fungi in food industry (Flavour& texture, Fermentation, Baking, Organic acids, Enzymes, Mycoproteins); Secondary metabolites (Pharmaceutical preparations); Agriculture (Bio-fertilizers); Mycotoxins; Biological control (Mycofungicides, Mycoherbicides, Mycoinsecticides, Myconematicides)

Module-VI

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

Module-VII

Bacterial diseases: Citrus canker and angular leaf spot of cotton. Viral diseases – Tobacco, Mosaic viruses. Fungal diseases – Early blight of potato, Black stem rust of wheat, White rust of crucifers.

Practice 12. Phytopathology: Herbarium specimens of bacterial diseases; Citrus Canker; Angular leaf spot of cotton, Viral diseases: TMV, Vein clearing, Fungal diseases: Early blight of potato, Black stem rust of wheat and White rust of crucifers.

Text Book:

1.Agrios, G.N. (1997) Plant Pathology, 4th edition, Academic Press, U.K.
2.Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley & Sons (Asia) Singapore. 4th edition.

Reference Book:

1.Webster, J. and Weber, R. (2007). Introduction to Fungi, Cambridge University Press, Cambridge. 3rd edition.
2.Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, Macmillan Publishers India Ltd.
Sharma, P.D. (2011). Plant Pathology, Rastogi Publication, Meerut, India.

CUTM 1458 ARCHEGONIATE

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Archegoniate	**CUTM 1458**	**Theory + Practice+Project**	**3-2-1 (6)**	**Nil**

Objectives

- To gain knowledge on Bryophytes, their structure and function, their evolutionary trend, economic importance of major groups of fungi
- To learn importance of Bryophytes, ecologically and their life cycles.
- To know about reproduction and evolution in Gymnosperm.

Course outcome

At the end of the course the student will be able to:

Cos	Course outcomes
CO1	Understand the evolution, general characters, structure, nutrition, reproduction, classifications of Bryophytes.
CO2	Understand the occurrence, general characters, types, reproduction and life cycles of the Bryophytes.
CO3	Gain knowledge on evolutionary trends in reproductions of major Bryophytes.
CO4	Acquire knowledge on evolution of Pteridophytes, their life cycle and economic importance.
CO5	Know different mode of asexual reproduction in Pteridophytes and also to know about Gymnosperm including their ecological importance.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PS03
CO1	2	1	1					2			1				1	1
CO2	2	1	2					2			1				1	2
CO3	2	1	2					1		3	0				1	1
CO4	1	1	2	2			2	1		2	0			2	1	2
CO5	2	1	1	1			1			2	2			2	1	2

***High-3, Medium-2, Low-1**

Course Outline

Module-I

Introduction: Unifying features of archegoniates; Transition to land habit; Alternation of generations

Bryophytes: General characteristics; Adaptations to land habit; Classification; Range of thallus organization

Type Studies- Bryophytes: Classification (up to family), morphology, anatomy and reproduction of *Riccia, Marchantia, Pellia, Porella*

Practice 1. Study of Morphology of thallus of thallus of ***Riccia***

Practice 2. ***Marchantia***- Morphology of thallus, whole mount of rhizoids & Scales, vertical section of thallus through Gemma cup, whole mount of Gemmae (all temporary slides), Vertical section of Antheridiophore, Archegoniophore, longitudinal section of Sporophyte (all permanent slides)

Practice 3. *Study of the Morphology of thallus of Pellia and Porella*

Module-II

Type Studies- Bryophytes: Classification (up to family), morphology, anatomy and reproduction of, *Anthoceros, Sphagnum and Funaria*.

Practice 4. ***Anthoceros***- Morphology of thallus, dissection of sporophyte (to show stomata, spores, pseudoelaters, columella) (temporary slide), vertical section of thallus.

Practice 5. ***Sphagnum***- Morphology of plant, whole mount of leaf.

Practice 6. ***Funaria***- Morphology, whole mount of leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, longitudinal section of capsule and protonema.

Module-III

Reproduction and evolutionary trends in *Riccia, Marchantia, Anthoceros* and *Funaria* (developmental stages not included). Ecological and economic importance of bryophytes with special reference to *Sphagnum*.

Module-IV

Pteridophytes: General characteristics; Classification; Early land plants (*Cooksonia* and *Rhynia*)

Type Studies- Pteridophytes: Classification (up to family), morphology, anatomy and reproduction of *Psilotum, Selaginella* (Developmental details not to be included)

Practice 7. *Psilotum*- Study of specimen, transverse section of synangium.
Practice 8. *Selaginella*- Morphology, whole mount of leaf with ligule, transverse section of stem, whole mount of strobilus, whole mount of microsporophyll and megasporophyll (temporary slides), longitudinal section of strobilus.

Module-V
Type Studies- Pteridophytes: Classification (up to family), morphology, anatomy and reproduction *Equisetum* and *Pteris* (Developmental details not to be included)

Practice 9. *Equisetum*- Morphology, transverse section of internode, longitudinal section of strobilus, transverse section of strobilus, whole mount of sporangiophore, whole mount of spores (wet and dry) (temporary slide), transverse section of rhizome.
Practice 10. *Pteris*- Morphology, transverse section of rachis, vertical section of sporophyll, wholemount of sporangium, whole mount of spores (temporary slides), transverse section of rhizome, whole mount of prothallus with sex organs and young sporophyte.

Module-VI
Apogamy, and apospory, heterospory and seed habit, telome theory, stellar evolution; Ecological and economic importance.

Module-VII
Gymnosperms: General characteristics, classification (up to family), morphology, anatomy and reproduction of *Cycas, Pinus* and *Gnetum* (Developmental details not to be included); Ecological and economic importance.

Practice 11. *Cycas*- Morphology (coralloid roots, bulbil, leaf), whole mount of microsporophyll, transverse
section of coralloid root, transverse section of rachis, vertical section of leaflet, vertical section of microsporophyll, whole mount of spores (temporary slides), longitudinal section of ovule, transverse section of root (permanent slide).
Practice 12. *Pinus*- Morphology (long and dwarf shoots, whole mount of dwarf shoot, male and female
cones), transverse section of Needle, transverse section of stem, longitudinal section of / transverse section of male cone, whole mount of microsporophyll, whole mount of Microspores (temporary slides), longitudinal section of female cone, tangential longitudinal section & radial longitudinal sections stem (permanent slide).

Text Book:

1. Vashistha, P.C., Sinha, A.K., Kumar, A. (2010). Pteridophyta. S. Chand. Delhi, India.
2. Bhatnagar, S.P. &Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.

Reference Book:

1. Parihar, N.S. (1991). An introduction to Embryophyta: Vol. I. Bryophyta. Central Book Depot. Allahabad.
2. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005). Biology. Tata McGraw Hill, Delhi.

CUTM1459 ANATOMY OF ANGIOSPERMS

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Anatomy of Angiosperms	**CUTM1459**	**Theory + Practice + Project**	**3-2-1 (6)**	**Nil**

Objectives

- To acquaint the internal basic structure and cellular composition of the most evolved group of plants, the angiosperm
- To study of various tissue systems and their development and functions in plants
- To understand the modifications, internal structure & architecture of plants

Course outcome

After completion of the course the students will be able to:

Cos	Course outcomes
CO1	Learn about different types of cells, tissue and tissue system and understand the role of tissues in plant functions along with the applications of plant anatomy
CO2	Understand the concept and theories related to the organization of shoot apex and internal structure of dicot and monocot plants
CO3	Acquire the concept and theories related to root apex organization, origin and internal of root along with the development, arrangement and internal structure of leaves
CO4	Acquire the knowledge on seasonal activity of cambium, and their role in secondary growth in root and stem, anatomical study of wood and types of wood
CO5	Know different adaptive and protective systems exists in plants and able to apply the knowledge for cytotaxonomic identification for product development etc. and can pursue higher studies and can get employment opportunity

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PS03
CO1	3	3	3	3			1	3	0	2	2			1	2	3
CO2	2			1							1					1
CO3	2	1		1							1					1
CO4	2	1	2	1			2	2		1	1			2	1	2
CO5	3	1	3	3			2	2		1	2			2	1	2

***High-3, Medium-2, Low-1**

Course Outline

Module-I

Introduction and scope of Plant Anatomy: Applications in systematics, forensics and pharmacognosy**.**

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

Practice 1. Demonstration of double staining technique and preparation of double staining slides

Practice 2. Distribution of mechanical tissues in Sunflower, *Nyctanthes* stem

Module-II

Development of plant body: Polarity, Cytodifferentiation and organogenesis during embryogenic development.

Tissues: Classification of tissues; Simple and complex tissues (no phylogeny), Pits and plasmodesmata; Wall ingrowths and transfer cells, adcrustation and incrustation, Ergastic substances.

Practice 3. To study secretory tissue system through fresh material or permanent slides Orange rind /Lemon leaf

Module-III

Apical meristems: Evolution of concept of organization of shoot apex (Apical cell theory, Histogen theory, Tunica Corpus theory, continuing meristematic residue, cyto histological zonation); Types of vascular bundles; Structure of dicot and monocot stem.

Practice 4. Study of anatomical details of monocot stem through permanent slides/temporary stain mounts

Practice 5. Study of anatomical details of dicot stem through permanent slides/temporary stain mounts

Module-IV

Origin, development, arrangement and diversity in size and shape of leaves; Structure of dicot and monocot leaf, Kranz anatomy. Organization of root apex (Apical cell theory, Histogen theory, Korper-Kappe theory); Quiescent centre; Root cap; Structure of dicot and monocot root; Endodermis, exodermis and origin of lateral root.

Practice 6. Study of anatomical details of monocot root through permanent slides/temporary stain mounts

Practice 7. Study of anatomical details primary structure of dicot root through permanent slides/temporary stain mounts

Practice 8. Study of anatomical details of isobilateral leaf

Practice 9. Study of anatomical details of dorsiventral leaves

Module-V

Vascular Cambium and Wood: Structure, function and seasonal activity of cambium; Secondary growth in root and stem.

Practice 10. Anatomical study of wood in T.S., T.L.S. and R.L.S

Module-VI

Axially and radially oriented elements; Types of rays and axial parenchyma; Cyclic aspects and reaction wood; Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood, tyloses; Dendrochronology; Development and composition of periderm, rhytidome and lenticels.

Module-VII

Adaptive and Protective Systems: Epidermal tissue system, cuticle, epicuticular waxes, trichomes (uni-and multicellular, glandular and non-glandular, two examples of each), stomata (classification); Hydathodes, cavities, lithocysts, laticifers; Anatomical adaptations of xerophytes and hydrophytes.

Practice 11. Study of different types of stomata
Practice 12. Study of anatomical details of hydrophytic leaves

Text Book:

1. Pandey S N, Ajanta Chadha (2009), Plant Anatomy and Embryology, Vikas Publishing House
2. Singh, Pande, Jain,Anatomy of Angiosperm.(2016) Rastogi Publications
3. B. P. Pandey, Plant Anatomy (Revised Edition) S Chand & amp; Co Ltd.

Reference Book:

1. Evert, R.F. (2006), Esau's Plant Anatomy: Meristems, Cells, and Tissues of the Plant Body: Their Structure, Function and Development, .John Wiley and Sons, Inc
2. Eames.A.J. and Macdaniels,L.H (1947), An Introduction to Plant Anatomy, McGrow- Hill,N.Y and London

CUTM1460 ECONOMIC BOTANY

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Economic Botany	**CUTM1460**	**Theory + Practice+ Project**	**3-2-1(6)**	**Nil**

Objectives

- To gain knowledge on Center of Origin and utilization of crop plants.
- To study various categories of economically important plants.
- To understand the morphology, anatomy and chemical constituents of economically important plant.

Course outcome

After completion of the course the students will be able to:

Cos	Course outcomes
CO1	Learn about the Center of Origin and Crop Domestication.
CO2	Understand the general characters, types, of the major cereals and legumes .
CO3	Gain Knowledge on economically important plant of sugar and starches.
CO4	Acquire the knowledge on Spices and Beverages.
CO5	Know different oil, drug yielding plant and fibers and their extraction procedure. Which will be helpful for enterpreurnship in future .

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PS03
CO1	3	3	3	3			3	3		3	2	2	1	3	3	3

CO2	3	3	2	3			3	3		3	2	2	1	2	3	2
CO3	3	3	2	2			2	3		3	3	2	2	2	3	2
CO4	3	3	2	3			2	3		3	3	2	2	2	3	2
CO5	3	3	3	3			3	3		3	3	2	1	1	3	1

***High-3, Medium-2, Low-1**

Course Outline

Module –I

Origin of Cultivated Plants: Concept of Centers of Origin, Their importance with reference to Vavilov's work. Examples of major plant introductions; Crop domestication and evolution of new crops/varieties, importance of germplasmdiversityand a brief outline on recent tools for genetic diversity such as Gene bank including both national and international.

Module-II

Cereals and Legumes: Wheat and Rice (origin, morphology, processing & uses); Brief account of millets.
Origin, morphology and uses of Chick pea, Pigeon pea and fodder legumes.

Practice 1. Habitat sketch of Rice
Practice 2. Qualitative test for presence of starch in Rice and confirmatory test for starch as non reducing sugar

Module-III

Sources of sugars and starches: Morphology and processing of sugarcane, products and by-products of sugar cane industry. Potato – morphology, propagation & uses.

Practice 3. Habitat Sketch of Sugarcane

Module-IV

Spices and Beverages: Listing of important spices, their family and part used; Economic importance with special reference to fennel, turmeric, saffron, clove and black pepper
Tea, Coffee (morphology, processing & uses)

Practice 4. Photograph or Live Specimen of Tea plant and its Leaves.

Module-V

Sources of oils and fats: General description, classification, extraction, their uses and health implications of groundnut, coconut, linseed, soybean, mustard and coconut (Botanical name, family & uses). Essential Oils: General account, extraction methods, comparison with fatty oils & their uses.

Practice 5. Estimation of saponification value of fats and Oils.
Practice 6. Test for the presence of lipid and oil in groundnut seed or oil
Practice 7. Extraction of Essential Oil

Module-VI

Natural Rubber and Drug-yielding plants: Para-rubber: tapping, processing and uses; Therapeutic and habit-forming drugs with special reference to C*inchona*, *Digitalis*, *Papaver*and *Cannabis*; Tobacco (Morphology, processing, uses and health hazards).

Practice 8. Tapping processes in Rubber plant
Practice 9. Habitat sketch of Chincona plant.

Module-VII

Timber plants and Fibers: General account with special reference to teak and pine; Classification based on the origin of fibers; Cotton, Coir and Jute (morphology, extraction and uses).

Practice 10. T.S of *Pinus* Stem
Practice 11. Test for the presence of Lignin in the stem of jute
Practice 12. Test for Presence of Cellulose in Cotton Fibre

Text Book:

1. Kochhar, S.L. (2012). Economic Botany in Tropics, MacMillan & Co. New Delhi, India.
2. Wickens, G.E. (2001). Economic Botany: Principles & Practices. Kluwer Academic Publishers, The Netherlands.

Reference Book:

1. Chrispeels, M.J. and Sadava, D.E. 1994 Plants, Genes and Agriculture.Jones& Bartlett_ Publishers.

CUTM1461 BASICS OF GENETICS

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Basics of Genetics	**CUTM1461**	**Theory + Practice + Projec**	**3-2-1 (6)**	**Nil**

Objectives

- To understand history and principles of Mendelian inheritance, including the laws of segregation and independent assortment.
- To role of natural selection, mutation, and genetic drift in population genetics.
- To analyze different types of gene mutations and understand their molecular basis and role of mutagens.

Course outcome

After completion of the course the students will be able to:

Cos	Course outcomes
CO1	Learn the concept of concept of inheritance and its correlation with the chromosome theory. and understand lethal alleles, pleiotropy, and the distinction between dominant and recessive traits.
CO2	Understand the concepts of interference, coincidence, and numerical gene mapping. and to analyze recombination frequency and apply it to gene mapping.
CO3	Acquire the knowledge on probability and pedigree analysis to solve genetic problems common to the local context.
CO4	Acquire the knowledge and understanding on relationship between genetic variation and speciation and to interpret allele and genotype frequencies using the Hardy-Weinberg Law.

CO5	Know classical and molecular concepts of genes and assess their functional allelism. and able to apply the knowledge on Maintenance of diverse genomes for biodiversity sustainability of and can pursue higher studies to get employability opportunity

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PS03
CO1	2	1	2	1	2		1	3		3	2		2	3	2	3
CO2	3	2	1	2	3		1	3		3	2		2	3	2	3
CO3	3	1	1	2	3		2	3		3	2		2	2	2	3
CO4	2	3	3	3	2		2	1		1	1		1	1	2	3
CO5	3	3	2	2	3	1	3	2		2	1	1	2	3	2	3

***High-3, Medium-2, Low-1**

Course Outline

Module-I

Mendelian genetics and its extension: Mendelism: History; Principles of inheritance; Chromosome theory of inheritance; Autosomes and sex chromosomes; Probability and pedigree analysis

Practice 1. Mendel's laws through seed ratios. Laboratory exercises in probability and chi-square.
Practice 2. Pedigree analysis for dominant and recessive autosomal and sex linked traits.

Module-II

Incomplete dominance and codominance; Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Recessive and Dominant traits, Extrachromosomal Inheritance: Chloroplast mutation: Variegation in Four o'clock plant; Mitochondrial mutations in yeast;Maternal effects-shell coiling in snail; Infective heredity- Kappa particles in Paramecium.

Practice 3. Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1,9:3:4).

Module-III

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

Practice 4. Chromosome mapping using point test cross data.

Module-IV

Variation in chromosome number and structure: Deletion, Duplication, Inversion, Translocation, Euploidy and Aneuploidy.

Practice 5. Study of aneuploidy: Down's, Klinefelter's and Turner's syndromes.

Practice 6. Photographs/Permanent slides showing Translocation ring, Laggards and Inversion bridge.

Module-V
Gene mutations: Types of mutations; Molecular basis of Mutations; Mutagens – physical and chemical (Base analogs, deaminating, alkylating and intercalating agents); Detection of mutations: ClB method. Role of Transposons in mutation. DNA repair mechanisms.

Practice 7. Blood Typing: ABO groups & Rh factor.

Module-VI
Fine structure of gene: Classical vs molecular concepts of gene; Cis-Trans complementation test for functional allelism; Structure of Phage T4, rII Locus.

Practice 8. Study of human genetic traits: Sickle cell anemia.
Practice 9. Study of human genetic traits: Xeroderma Pigmentosum.
Practice 10. Study of human genetic traits: Albinism, Red-green Colour blindness.

Module-VII
Population and Evolutionary Genetics: Allele frequencies, Genotype frequencies, Hardy-Weinberg Law, role of natural selection, mutation, genetic drift. Genetic variation and Speciation.
Practice 11. Study of human genetic traits: Widow's peak and Rolling of tongue
Practice 12. Study of human genetic traits: Hitchhiker's thumb and attached ear lobe

Text Book

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (1991). Principles of Genetics, John Wiley & sons, India. 8th edition.
2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics, John Wiley & Sons Inc., India. 5th edition.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings, U.S.A. 9th edition.

Reference Book

1. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.

CUTM1462 MOLECULAR BIOLOGY

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Molecular Biology	**CUTM1462**	**Theory + Practice + Project**	**3-2-1(6)**	**Nil**

Objectives

- To know about the structure and types of genetic materials
- To learn the molecular mechanisms of DNA replication and repair etc.
- To understand the mechanisms of protein synthesis

Course outcome
After completion of the course the students will be able to:

Cos	Course outcomes
CO1	Acquire the knowledge about the genetic materials, their types and structure
CO2	Know about the organization of DNA in prokaryotes and eukaryotes and DNA replication mechanism
CO3	Acquire the knowledge on genetic code, transcription process in prokaryotes and eukaryotes and principles of transcriptional regulation
CO4	Know about processing and modification of RNA and mRNA transport mechanisms
CO5	Acquire the knowledge on basic tools and techniques for isolation of DNA, mechanisms of protein synthesis and post-translational modifications of proteins

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PO13**	**PSO1**	**PSO2**	**PS03**
CO1	3	2	1	1				3		1	1		1	1	3	3
CO2	3	2	1	1	1		1	3		3	2		2	3	3	3
CO3	3	3	2	3		2	3	1		3	1		2	3	3	3
CO4	3	3	3	3	3		3	1	1	1	1		3	3	3	3
CO5	3	3	3	3	3	2	3	1	1	2	2		3	3	3	3

***High-3, Medium-2, Low-1**

Course Outline

Module-I

Nucleic acids: Carriers of genetic information: Historical perspective; DNA as the carrier of genetic information (Griffith's, Hershey &Chase, Avery, McLeod & McCarty, Fraenkel-Conrat's experiment.

Practice 1. Safety guide lines and regulations in Laboratory of molecular biology
Practice 2. Reagent and solution preparation and micro-pipetting exercise

Module-II

The Structures of DNA and RNA / Genetic Material: DNA Structure Watson and Crick model of DNA, Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation, cot curves

Practice 3. Isolation of DNA from leaves
Practice 4. Isolation of DNA from ripe banana
Practice 5. DNA estimation by diphenylamine reagent
Practice 6. DNA estimation by UV Spectrophotometry
Practice 7. DNA estimation by Witham et. al. (1971) method

Module-III

Organization of DNA: Prokaryotes, Viruses, Eukaryotes;

Organelle DNA: Mitochondria and chloroplast DNA
The Nucleosome: Chromatin structure: Euchromatin, Heterochromatin: Constitutive and Facultative heterochromatin; RNA Structure

Practice 8. Structure of DNA through photographs

Module-IV
The replication of DNA: Chemistry of DNA synthesis (Kornberg's discovery); General principles: bidirectional, semi conservative and semi discontinuous replication, RNA priming; Various models of DNA replication, including rolling circle, θ (theta) mode of replication, replication of linear ds-DNA, replication of the 5'end of linear chromosome; Enzymes involved in DNA replication.
Central dogma and genetic code: The Central Dogma (Adaptor hypothesis and discovery of mRNA template); Genetic code: Deciphering and salient features of genetic code

Practice 9. Study of Rolling circle DNA replication mechanisms through photographs
Practice 10. Study of Theta model of DNA replication mechanisms through photographs
Practice 11. Study of semi-discontinuous DNA replication mechanisms through photographs

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

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

Practice 12. Study of splicing mechanism in group I & group II introns

Module-VII
Translation: Ribosome structure and assembly, mRNA; Charging of tRNA, aminoacyl tRNA synthetases
Various steps in protein synthesis: Proteins involved in initiation, elongation and termination of polypeptides; Inhibitors of protein synthesis; Post-translational modifications of proteins.

Text Book:
1. N. Arumugam (2012), Molecular Biology, Saras Publication
2. Verma P.S. Agarwal V.K. (2010), Molecular Biology, S.Chand& Co

Reference Books:
1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (1991). Principles of Genetics, John Wiley & sons, India. 8th edition.
2. 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.

CUTM2402 PLANT ECOLOGY AND PHYTOGEOGRAPHY

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Plant Ecology and Phytogeography	**CUTM2402**	**Theory + Practice + Project**	**3-2-1 (6)**	**Nil**

Objectives

- To know about the structure and the factors of Ecosystem.
- To learn the different types of interactions existing in the ecosystem.
- To understand the dynamics of population ecology and a brief knowledge on phytogeography.

Course outcome

After completion of the course the students will be able to:

Cos	Course outcomes
CO1	Acquire the knowledge about the level of organization in the ecosystem and its dynamics.
CO2	Know about the organization of DNA in prokaryotes and eukaryotes and DNA replication mechanism
CO3	Acquire the knowledge on Hydrological cycles, States of Water and its different parameters.
CO4	Know about population ecology and tropical organization in ecosystem.
CO5	Acquire the knowledge on interactions in ecosystem, functional aspects of ecosystem and phytogeography.

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PO13**	**PSO1**	**PSO2**	**PS03**
CO1	2	1	2	1			1	3		3	3		1	2	3	3
CO2	2	1	2	1			1	2		3	3		1	2	2	3
CO3	2	2	1	2			3	3		3	2		2	2	3	2
CO4	3	2	1	1		1	2	3		3	2		1	2	3	2
CO5	2	2	2	2		1	3	1		3	2		1	2	3	3

***High-3, Medium-2, Low-1**

Course Outline

Module-I

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

Soil: Importance; Origin; Formation; Composition; Physical; Chemical and Biological components; Soil Profile; Role of climate in soil development.

Practice 1. Determination of organic matter of different soil samples by Walkley& Black rapid titration method.

Practice 2. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid field tests.

Module-II

Water: Importance: States of water in the environment; Atmospheric moisture; Precipitation types (rain, fog, snow, hail, dew); Hydrological Cycle; Water in soil; Water table.
Light, temperature, wind and fire: Variations; adaptations of plants to their variation.

Practice 3. Determination of pH of various soil and water samples (pH meter, universal indicator/Lovibond comparator and pH paper)
Practice 4. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, Anemometer, Psychrometer/ Hygrometer, Rain gauge and Lux meter.

Module-III

Biotic interactions: Trophic organization, basic source of energy, Autotrophy, Heterotrophy; Symbiosis, Commensalism, Parasitism; Food chains and webs; Ecological pyramids; Biomass, Standing crop.

Practice 5. Comparison of bulk density, porosity and rate of infiltration of water in soils of three habitats.
Practice 6. Determination of dissolved oxygen of water samples from polluted and unpolluted sources.

Module-IV

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

Practice 7. Study of morphological adaptations of hydrophytes and xerophytes
Practice 8. Study of biotic interactions of the following: Stem parasite (Cuscuta), Root parasite (Orobanche), Epiphytes, Predation (Insectivorous plants).

Module-V

Ecosystems: Structure; Processes; Trophic organisation; Food chains and Food webs; Ecological pyramids.

Practice 9. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus, by species area curve method (species to be listed).
Practice 10. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus, by species area curve method (species to be listed)

Module-VI

Functional aspects of ecosystem: Principles and models of energy flow; Production and productivity; Ecological efficiencies; Biogeochemical cycles; Cycling of Carbon, Nitrogen and Phosphorus.

Practice 11. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus, by species area curve method (Species to be listed).

Module-VII

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

Practice 12. Field visit with 15 familiarize students to different ecological sites.

Text Book:

1. Odum, E.P. (2005). Fundamentals of ecology. Cengage Learning India Pvt. Ltd., New Delhi. 5th edition.
2. Singh, J.S., Singh, S.P., Gupta, S. (2006). Ecology Environment and Resource Conservation. Anamaya Publications, New Delhi, India.
3. Sharma, P.D. (2010). Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.

Reference Book:

1. Wilkinson, D.M. (2007). Fundamental Processes in Ecology: An Earth Systems Approach. Oxford University Press. U.S.A.
2. Kormondy, E.J. (1996). Concepts of ecology. PHI Learning Pvt. Ltd., Delhi, India. 4th edition.

CUTM 1464 PLANT SYSTEMATICS

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Plant Systematics	**CUTM 1464**	**Theory + Practice + Project**	**3-2-1 (6)**	**Nil**

Objectives

- The major features and evolutionary origins of vascular plants
- Identification of plants using dichotomous keys
- The major features and evolutionary origins of vascular plants
- Collect, preserve and identify herbarium specimens in a phylogenetic context

Course outcome
After completion of the course the students will be able to:

COs	Course outcomes
CO1	Develop understanding of major patterns in the evolution of seed plants and plant diversity including the basic understanding of the principles of phylogenetic systematics
CO2	Know the concept of plant taxa, ICBN and evolutionary history of plants
CO3	Gain knowledge about various systematic classification and APG
CO4	Learn skills required for effective identification of order, family, genus and species. Students will understand the process of plant
CO5	Have increased capacity to think critically; ability to design and execute an experiment; confidence and ability in communicating ideas for plant identification leading to pursue higher studies to get employability

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PS03
CO1	2	2	2	2		2	3	2		1	2	1	1	1	2	1

CO2	3	2	3	2		2	2	3		2	2	2	1	2	2	1
CO3	3	1	2	3		2	3	3		1	3	1	2	2	2	3
CO4	3	2	2	2		1	2	3		3	3	2	2	1	2	3
CO5	3	2	1	1		1	2	2		3	3	2	2	2	1	3

***High-3, Medium-2, Low-1**

Course Outline

Module-I
Significance of Plant systematic: Introduction to systematic; Plant Classification, Nomenclature; Evidences from palynology, Cytology, Phytochemistry and molecular data.

Practice 1. Identification of phytochemical present in plants

Module-II
Field inventory: Functions and importance of Herbarium; Botanical gardens of the world and India; Virtual herbarium; Documentation: Flora, E-flora; Monographs, Journals; Keys: Single access and Multi-access.

Practice 2. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book).

Module-III
Taxonomic hierarchy: Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concept, taxonomic, biological, evolutionary

Practice 3. Plant classification domain to species level

Module-IV
Botanical nomenclature: Principles and rules of (ICBN), Ranks and names; principle of priority, binomial system; type method, author citation, valid-publication, rejection of names; Ranks and names; Typification
Practice 4. Demonstration of herbarium techniques
Practice 5. Demonstration of virtual herbarium

Module-V
Systems of classification: Major contributions of Theophrastus, Linnaeus, Adanson, de Candolle, Bessey, Hutchinson, Engler and Prantles, Takhtajan and Cronquist; Types ofclassification: Artificial; Natural and Phylogenetic; Angiosperm Phylogeny Group (APG I, II, III) classification.

Practice 6. To understand how classification systems work

Module-VI
Classification system
Systematic study and economic importance of the following families: Fabaceae, Euphobiaceae, Cucurbitaceae, Malvaceae, Rutaceae, Annonaceae, Brassicaceae, Ranunculaceae&Poaceae.

Numerical taxonomy: Characters; Variations; OTUs, character weighting and coding; Phenograms, cladograms (definitions and differences).

Practice 7. Study of vegetative and floral characters of the following families (Description, ovary, floral diagram/s, floral formula/e and systematic position according to Bentham& Hooker's system of classification): Ranunculaceae, Brassicaceae

Practice 8. Study of vegetative and floral characters of the following families (Description, ovary, floral diagram/s, floral formula/e and systematic position according to Bentham& Hooker's system of classification): Myrtaceae, Umbelliferae

Practice 9. Cytotaxonomical analysis of Some important families like Euphorbiaceae, Poaceae

Practice 10. Study of vegetative and floral characters of the following families Fabaceae, Asteraceae

Module-VII

Phylogeny of Angiosperms Terms and concepts, primitive and advanced, homology and analogy, parallelism and convergence, monophyly, Paraphyly, polyphyly and clades. Origin and evolution of angiosperms; Co-evolution of angiosperms and animals; Methods of illustrating evolutionary relationship.

Practice 11. Interaction and co-evolution of flowering plants and animals.

Practice 12. Study on evolution of few plants

Text Books:

1. Singh, (2012). *Plant Systematics:* Theory and Practice Oxford & IBH Pvt. Ltd., New Delhi. 3rdedition.
2. Jeffrey, C. (1982). An Introduction to *Plant Taxonomy.*Cambridge University Press, Cambridge.
3. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. (2002). Plant Systematics-A Phylogenetic Approach. Sinauer Associates Inc., U.S.A. 2nd edition.

Reference Books:

1. Maheshwari, J.K. (1963). *Flora* of Delhi. CSIR, New Delhi.
2. Radford, A.E. (1986). Fundamentals of *Plant Systematics*. Harper and Row, New York.

CUTM 1465 REPRODUCTIVE BIOLOGY OF ANGIOSPERMS

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Reproductive Biology of Angiosperms	**CUTM 1465**	**Theory + Practice+ Project**	**3-2-1 (6)**	**Nil**

Objectives

- To study the development of the different parts of the flower, and how these regions further develop to form the fruit with its seeds.
- To know about structure and function of reproductive organs and their significance in plant reproduction.
- To learn about Pollination, Fertilization, Embryogenesis, Embryo-endosperm relationship etc.

Course outcome

After completion of the course the students will be able to:

COs	Course outcomes
CO1	Acquire knowledge on reproductive development and microgametogenesis

CO2	Learn about the differentiate reproductive organs at Morphological, Anatomical, Physiological and Biochemical level.
CO3	Explain the process, locations, and significance of angiosperm gametogenesis and fertilization, including double fertilization
CO4	Understand the anther structure, pollen development, pollination, ovule, embryo sac development.
CO5	Learn skills required for identification of complete and incomplete flowers, also student would be able to apply this knowledge for conservation of pollinators and fruit development.

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PO13**	**PSO1**	**PSO2**	**PS03**
CO1	3	2	2	1			1			1				1	1	2
CO2	3	3	1	2			2	1		2	1		1	2	2	2
CO3	3	3	2	2			3	2		2	1		2	2	2	2
CO4	3	3	2	3		2	3	2		2	1		2	3	3	3
CO5	3	3	2	3		1	3	2		3	2		3	3	3	3

***High-3, Medium-2, Low-1**

Course Outline

Module-I

Introduction History: (contributions of G.B. Amici, W. Hof Strasburger, S.G. Nawaschin, P. Maheshwari, B.M. Johri, W.A. Jenen, J. Heslop-Harrison) .

Reproductive Development: Induction of flowering; flower as a modified determinate shoot.

Flowerdevelopment: genetic and molecular aspects. Anther and pollen biology Anther wall: Structure and functions, microsporogenesis, callose deposition and its significance.

Practice 1. Anther: Wall and its ontogeny; Tapetum (amoeboid and glandular); MMC,

Practice 2. Study of Spore tetrad, Uninucleate, bicelled and dehisced anther stages through slides/micrographs, male germ unit (MGU) through photographs and schematic representation.

Module-II

Microgametogenesis; Pollen wallstructure, MGU (male germ unit) structure, NPC system; Palynology and scope (a brief account);

Pollen wall proteins; Pollen viability, storage and germination;

Abnormal features: Pseudomonads, polyads, massulae, pollinia.Ovule Structure; Types; Special structures–endothelium, obturator, aril, caruncle.

Practice 3. Ultrastructure of pollen wall (micrograph);

Practice 4: Pollen Germination: Calculation of percentage germination in different media using hanging drop method.

Practice 5: Pollen grains: Fresh and acetolyzed showing ornamentation and aperture, psuedomonads, polyads, pollinia (slides/photographs, fresh material),
Practice 6: Pollen viability, Tetrazolium test.

Module-III
Female gametophyte: Megasporogenesis (monosporic, bisporic and tetrasporic) and megagametogenesis (details of Polygonumtype); Organization and ultrastructure of mature embryo sac.

Practice 7. Ovule: orthotropous, amphitropous/campylotropous, circinotropous, unitegmic, bitegmic;
Practice 8. Tenuinucellate and crassinucellate; Special structures: Endothelium, obturator, hypostase, caruncle and aril (permanent slides/specimens/photographs).
Practice 9. Female gametophyte through permanent slides/ photographs: Types, ultrastructure of mature egg apparatus.
Practice 10. Intra-ovarian pollination; Test tube pollination through photographs.

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

Module-V
Self-incompatibility Basic Concepts (interspecific, intraspecific, homomorphic, heteromorphic, GSI and SSI); Methods to overcome self- incompatibility: mixed pollination, bud pollination, stub pollination; Intra-ovarian and in vitro pollination; Modification of stigma surface, parasexual hybridization; Cybrids, in vitro fertilization.

Module-VI
Embryo, Endosperm and Seed Structure and types; General pattern of development of dicot and monocot embryo and endosperm; Suspensor: structure and functions.

Practice 11. 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
Practice 12. Endosperm: Dissections of developing seeds for endosperm with free-nuclear haustoria.

Module-VII
Embryo-endosperm relationship; Nutrition of embryo; Unusual features; Embryo development in Paeonia.Seed structure, importance and dispersal mechanisms, Polyembryony and apomixisIntroduction; Classification; Causes and applications.

Text Book:
1.Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryologyof Angiosperms, Vikas Publishing House. Delhi. 5thedition.
2.Shivanna, K.R. (2003). Pollen Biology and Biotechnology.Oxford and IBH Publishing Co. Pvt. Ltd. Delhi

Reference Book:
1.Raghavan, V. (2000). Developmental Biology of Flowering plants, Springer, Netherlands.
2.Johri, B.M. l (1984). Embryology of Angosperms, Springer-Verlag, Netherlands.

CUTM 1466 PLANT PHYSIOLOGY

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Plant Physiology	**CUTM1466**	**Theory + Practice+ Project**	**3-2-1 (6)**	**Nil**

Objectives

• To understand concept of water potential and its components.
• To understand the role of ATP and carrier systems in nutrient absorption and analyze the concept of source-sink relationship in nutrient transport.
• To analyze the effects of plant growth regulators on plant growth and development and to identify and differentiate between abiotic stresses, including drought, salinity, cold, and heat.

Course outcome

After completion of the course the students will be able to:

Cos	Course outcomes
CO1	Learn the concept of water potential and its components and relate it to water movement in plants and understand root pressure, guttation, and their implications in plant water balance.
CO2	Understand the Cohesion-Tension Theory and its role in water transport within plants and to evaluate the use of antitranspirants and their applications in plant water conservation.
CO3	Acquire the role of soil as a nutrient source and the mechanisms of ion transport across membranes.
CO4	Acquire the knowledge of impact of biotic stressors on plant health and growth and to understand the mechanisms of plant adaptation to stress conditions.
CO5	Know photoperiodism, florigen concept, vernalization, and seed dormancy in relation to flowering and able to apply the knowledge on the molecular mechanisms underlying photoperiodic and vernalization responses. etc. and can pursue higher studies and can get employment opportunity

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PO13**	**PSO1**	**PSO2**	**PS03**
CO1	2	2	2	2		2	2	2	1	2	1	1	2	2	1	2
CO2	2	2	3	2		3	2	2	2	3	1	1	2	2	1	2
CO3	2	3	3	3		3	2	2	2	3	2	1	2	1	1	3
CO4	2	1	3	1	2	2	3	2		2	2	2		1	2	3
CO5	3	3	3	3		3	3	3	2	2	2	2	2	1	3	3

***High-3, Medium-2, Low-1**

Course Outline

Module-I

Plant-water relations: Water Potential and its components, water absorption by roots, aquaporins, pathway of water movement,symplast, apoplast, transmembrane pathways, root pressure, guttation.

Practice 1. Determination of osmotic potential of plant cell sap by plasmolytic method.
Practice 2. Determination of water potential of given tissue (potato tuber) by weight method

Module-II

Ascent of sap: Cohesion-tension Theory; Transpiration and factors affecting transpiration, antitranspirants, mechanism of stomatal movement.
Minerals: Mineral nutrition; Macro and micronutrient; Essential and beneficial elements, methods of study and use of nutrient solutions; criteria for essentiality, mineral deficiency symptoms and their solution, roles of essential elements, chelating agents

Practice 3. Study of the effect of wind velocity and light on the rate of transpiration in excised twig/leaf.
Practice 4. Calculation of stomatal index and stomatal frequency from the two surfaces of leaves of a mesophyte and xerophyte.
Practice 5. To calculate the area of an open stoma and percentage of leaf area open through stomata in a mesophyteand xerophyte (both surfaces)
Practice 6. To demonstrate suction due to transpiration

Module-III

Nutrient Uptake: Soil as a nutrient reservoir, transport of ions across cell membrane, passive absorption, electrochemical gradient, facilitated diffusion, active absorption, role of ATP, carrier systems

Module-IV

Translocation in The Phloem: Experimental evidence in support of phloem as the site of sugar translocation, Pressure–Flow Model; Phloem loading and unloading, Source–sink relationship

Module-V

Plant Growth Regulator: Discovery, chemical nature (basicstructure), bioassay and physiological role of Auxin, Gibberellins, Cytokinin, Abscisic acid, Ethylene, Brassino steroids and Jasmonic acid

Practice 7. To study different concentration on Avenacoleoptile elongation (IAA Bioassay).
Practice 8. Bolting experiment/Avenacoleptile bioassay (demonstration)

Module-VI

Stress Physiology: Abiotic stress on plant; drought, salinity, cold, heat, submergence etc. Biotic stress on plant

Module-VII

Physiology of Flowering: Photoperiodism, flowering stimulus, florigen concept, vernalization, seed dormancy. Phytochrome, Crytochromes and Phototropins: Discovery, chemical nature, role in photo morphogenesis, low energy responses (LER) and high irradiance responses (HIR),mode of action.

Practice 9. To study the phenomenon of seed germination (effect of light)
Practice 10. To study the induction of amylase activity in germinating barley grains.
Practice 11. Fruit ripening/Rooting from cuttings (Demonstration)

Text & Reference Books:

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

CUTM 1467 PLANT METABOLISM

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Plant Metabolism	**CUTM 1467**	**Theory + Practice+ Project**	**3-2-1 (6)**	**Nil**

Objectives

- To gain knowledge on the relationship between photosynthesis and respiration in plants.
- To know the significance of plant mass gain and loss to larger-scale ecosystem processes, such as the global carbon cycle.
- To explore the sources and sinks involved in the acquisition and utilization of carbon in plant systems.

Course outcome

After completion of the course the students will be able to:

Cos	Course outcomes
CO1	Grasp the intricate details of photosynthesis. Learn about the structure and function of chloroplasts, the role of pigments, and the various steps of photosynthetic electron transport.
CO2	Explore cellular respiration, which is how plants release energy stored in carbohydrates and also learn how plants balance energy production with other metabolic processes.
CO3	Gain a deep understanding of the biochemical processes that occur within plant cells. This includes the metabolism of carbohydrates, lipids, and amino acids, as well as the various pathways involved in energy production and storage.
CO4	Understand how plant metabolism regulation is essential and also learn about the control mechanisms that govern metabolic pathways, including allosteric regulation, feedback inhibition, and the role of hormones.
CO5	Learn about the mechanism of signaling transduction in plant.

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PO13**	**PSO1**	**PSO2**	**PS03**
CO1	2	2	2	3	1	2	2	2	1	2	1	2	2	2	2	3
CO2	3	2	3	3	1	3	2	2	2	2	1	2	2	2	2	3
CO3	3	2	3	3	1	2	3	3	2	2	2	2	3	2	2	3

CO4	2	3	2	3	2	3	3	2	2	3	3	3	3	3	2	3
CO5	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3	3

***High-3, Medium-2, Low-1**

Course Outline

Module-I

Concept of metabolism: Introduction, Anabolic and Catabolic pathways, Regulation of metabolism, Role of regulatory enzymes (allosteric, covalent modulation and Isozymes)

Module-II

Carbon assimilation: Historical background photosynthetic pigments, Role of photosynthetic pigments (chlorophylls and accessory pigments), antenna molecules and reaction centres, Photochemical reactions, photosynthetic electron transport, PSI, PSII, Q cycle, CO_2 reduction, Photorespiration, C_4 pathways; Crassulacean acid metabolism; Factors affecting CO_2 reduction

Practice 1. Chemical separation of photosynthetic pigments.
Practice 2. Experimental demonstration of Hill's reaction.
Practice 3. To study the effect of light intensity on the rate of photosynthesis.
Practice 4. Effect of carbon dioxide on the rate of photosynthesis.
Practice 5. Demonstration of fluorescence by isolated chlorophyll pigments.
Practice 6. Demonstration of absorption spectrum of photosynthetic pigments

Module-III

Carbohydrate metabolism: Synthesis and catabolism of sucrose and starch. Carbon Oxidation, Glycolysis: Fate of pyruvate, Regulation of glycolysis, Oxidative pentose phosphate pathway, Oxidative Decarboxylation of Pyruvate, Regulation of PDH, NADH shuttle; TCA cycle, Amphibolic role, Anaplerotic Reactions, Regulation of the Cycle, Mitochondrial Electron Transport, Oxidative Phosphorylation, Cyanide-Resistant Respiration, Factors affecting respiration.
Practice 7. To compare the rate of respiration in different parts of a plant.
Practice 8. To compare the rate of respiration in different germinating seed.

Module-IV

ATP-Synthesis: Mechanism of ATP synthesis, Substrate level phosphorylation, Chemiosmotic mechanism (oxidative and photophosphorylation), ATP synthase, Boyers conformational model, Role of uncouplers

Module-V

Lipid metabolism: Synthesis and breakdown of triglycerides, β-oxidation, glyoxylate cycle, gluconeogenesis and its role in mobilization of lipids during seed germination, α oxidation.

Practice 9. To study the activity of lipases in germinating oilseeds
Practice 10. Demonstration of mobilization of lipids during germination.

Module-VI

Nitrogen metabolism: Nitrate assimilation, Biological nitrogen fixation (examples of legumes and non-legumes); Physiology and biochemistry of nitrogen fixation; Ammonia assimilation and transamination.

Practice 11. To demonstrate activity of nitrate reductase in germinating leaves of gram, pea, mung
Practice 12. To demonstrate activity of nitrate reductase in germinating leaves of rice, wheat

Module-VII
Mechanisms of signal transduction: Receptor-ligand interactions; Second messenger concept, Calcium calmodulin, MAP kinase cascade

Text Books:

1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology.John Wiley and Sons. U.S.A. 4thedition.
2. Taiz, L., Zeiger, E., MØler, I.M. and Murphy, A (2015). Plant Physiology and Development.Sinauer Associates Inc. USA. 6thedition.

Reference Book:

3. Harborne, J.B. (1973). Phytochemical Methods.John Wiley & Sons. New York

CUTM1468 PLANT BIOTECHNOLOGY

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Plant Biotechnology	**CUTM1468**	**Theory + Practice+ Project**	**3-2-1 (6)**	**Nil**

Objectives

- To understand the basic laboratory skills, handling of explant tissue, media formulations, tissue culture methods, establishing the culture and its application in plants
- To illustrate creative use of modern tools and techniques for manipulation and analysis of genomic sequences
- To learn to different techniques to transfer a gene efficiently and stably into another cell or organism to alter its phenotype

Course outcome

At the end of the course the student will be able to:

COs	Course outcomes
CO1	Learn the basic concept of micro-propagation and plant tissue culture technique
CO2	Gain knowledge to manipulate and combine DNA from different sources, creating modified organisms with desired traits.
CO3	Gain knowledge on gene cloning, vector construction and gene transfer
CO4	Explore various techniques on genetic engineering for innovations in agriculture, disease treatment, and the production of valuable proteins
CO5	Understand the technology to develop crops with improved yield, nutrient content, and resistance to pests or environmental stress.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PS03
CO1	2	2	2	1	1	2	2	1	2	1	2	1	3	2	2	2
CO2	2	3	2	2	2	3	2	2	2	1	2	1	3	2	2	2
CO3	3	3	2	3	2	3	2	2	3	2	2	2	3	2	2	2
CO4	3	3	2	3	2	3	2	3	3	2	3	2	3	2	2	2
CO5	3	2	2	3	2	3	3	3	3	2	3	3	3	3	2	2

***High-3, Medium-2, Low-1**

Course Outline

Module-I

Plant Tissue Culture Historical perspective; Composition of media; Nutrient and hormone requirements (role of vitamins and hormones); Totipotency; Organogenesis; Embryogenesis (somatic and zygotic); **Protoplast** isolation, culture and fusion;

Practice 1. Preparation of MS medium.
Practice 2. Demonstration of in vitro sterilization and inoculation methods using leaf explants of tobacco, Datura, Brassica etc.
Practice 3. Demonstration of in vitro sterilization and inoculation methods using nodal explants of Tobacco, Datura, Brassica etc.
Practice 4. Isolation of protoplasts.

Module-II

Tissue culture applications (micropropagation, and regenesis, virus elimination, secondary metabolite production, haploids, triploids and hybrids; Cryopreservation, Germplasm Conservation)

Practice5: Study of anther, embryo and endosperm culture micro propagation, micropropagation, somatic embryogenesis & artificial seeds through photographs

Module-III

Recombinant DNA technology Restriction Endonucleases (History, Types I-IV, biological role and application) Restriction Mapping (Linear and Circular); Cloning **Vectors:** Prokaryotic (pUC 18 and pUC19, pBR322, Ti plasmid, BAC) Lambda phage, M13 phagemid, Cosmid, Shuttle vector; Eukaryotic Vectors (YAC).

Practice 6. Restriction digestion and gel electrophoresis of plasmid DNA.
Practice 7. Construction of restriction map of circular and linear DNA from the data provided

Module-IV

Gene Cloning Recombinant DNA, Bacterial Transformation and selection of recombinant clones, PCR-mediated gene cloning; Gene Construct; construction of genomic and cDNA libraries, screening

DNA libraries to obtain gene of interest by genetic selection; complementation, colony hybridization; PCR

Practice 8. Isolation of plasmid DNA.

Module-V

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

Practice 9. Study of methods of Agrobacterium-mediated gene transfer through photographs
Practice 10. Study of methods of gene transfer through photographs: direct gene transfers by electroporation, microinjection, and microprojectile bombardment.

Module-VI

Applications of Biotechnology Pest resistant (Bt-cotton); herbicide resistant plants (Round Up Ready soybean); Transgenic crops with improved quality traits (FlavrSavr tomato, Golden rice); Improved horticultural varieties (Moondust carnations)

Practice 11. Study of steps of genetic engineering for production of Bt cotton, Golden rice through photographs
Practice 12. Study of steps of genetic engineering for production of Flavr Savr tomato through photographs

Module-VII

Role of transgenic: Role in bioremediation (Superbug); edible vaccines; Industrial enzymes (Aspergillase, Protease, Lipase); Genetically Engineered Products–Human Growth Hormone; Humulin; Biosafety concerns.

Text Books:

1. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam.The Netherlands.
2. Glick, B.R., Pasternak, J.J. (2003). MolecularBiotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
3. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms.Vikas Publication House Pvt. Ltd., NewDelhi. 5thedition.
4. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons, U.K. 5thedition.

Reference Book:

1. Stewart, C.N. Jr. (2008). Plant Biotechnology & Genetics: Principles, Techniques and Applications.John Wiley & Sons Inc. U.S.A