Centurion
UNIVERSITY
Shaping Lives...
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B.Sc. (Botany) CBCS syllabus

(Three years programme)

School of Applied Sciences

Centurion University of Technology & Management

2021

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**

Objective

- The course has been developed to provide the students basic knowledge about viruses, viroids, Prions, bacteria and algae.
- The students will explore the living world which is not visible to naked eye.
- The students will learn about how sub cellular entities like viruses have been used or can be exploited in the production of vaccines and medicines, disease diagnosis and in research.

Course outcome

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Acquire, articulate, retain and apply specialized language and knowledge relevant to microbiology	PO1-3, PO2-3, PO7-3, PO9-2
CO2	Acquire and demonstrate competency in laboratory safety and in routine and specialized microbiological laboratory skills applicable to microbiological research or clinical methods, including accurately reporting observations and analysis	PO1-3, PO2-3, PO7-2, PO9-2

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
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
4. Gram staining.
5.Endospore staining with malachite green (endospores taken from soil bacteria).
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,*
9. Study of vegetative and reproductive structures of *Oedogonium, Coleochaete,.*
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*
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.

CUTM1456BIOMOLECULES AND CELL BIOLOGY

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
BIOMOLECULES & CELL BIOLOGY	**CUTM1456**	**Theory + Practice+ Project**	**3-2-1 (6)**	**Nil**

Objective

- Students will understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles.
- Exploration of different types of biomolecules.

Course outcome

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Know about the structure and functions of macromolecules and the major organelles that occur in eukaryotic cells	PO1-3, PO2-3, PO4-2
CO2	Carry out a range of laboratory exercises, demonstrating the development of practical scientific skills	PO1-3, PO2-3, PO9-2
CO4	Able to investigate protein, carbohydrate and lipid contents in different samples	PO1-3, PO2-3, PO4-3, PO9-2

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.

2. Quantitative test for lipid.

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.

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 andprostheticgroup;Classification of enzymes; Features of active site, substrate specificity, mechanism of action (activation energy, lock and key hypothesis, induced - fit theory), Michaelis– Mentenequation, 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.

7. Demonstration of the phenomenon of protoplasmic streaming in Hydrilla leaf.
8. Study the phenomenon of plasmolysis and deplasmolysis.
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, roleof protein kinases.
Practice: 12. Study different stages of mitosis and meiosis.
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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 1457MYCOLOGY AND PHYTOPATHOLOGY

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

Objective

- Understanding the principles of plant pathology and the application of principles in the control of plant disease.
- To understand of how human as well plant life is highly dependent upon the microbes present in environment.
- Gain knowledge on Fungi, their structure and function, their effect on living world, economic importance etc

Course outcome

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Will have thorough knowledge on the causal agents of plant diseases, symptoms and diagnoses, modes of infection and spread, effects of the environment on disease development	PO1-3, PO2-3, PO4-2, PO9-2
CO2	Identification of diseases on plants, isolation of the causal agents and novel control of plant diseases management with the help of molecular tools to understand these mechanisms and phenomena	PO1-3, PO2-3, PO9-2
CO3	Design the disease management strategies towards disease free crops and produce	PO1-3, PO2-3, PO3-2, PO4-3, PO9-2
CO4	Able to know the methods of disease management and control	PO1-3, PO2-3, PO3-2, PO4-3, PO9-2
CO8	Understand the societal need of disease free crops for human health and safety	PO1-3, PO2-3, PO4-3, PO9-2

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 organisation; 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 stemrust 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: ectomycorrhiza 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**

Objective

- To know the principles of Archegoniate taxonomy.
- To know economic importance of archegoniate.
- Studying the archegoniate phylogeny.

Course outcome

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Learn brief summary of the knowledge or skill the course of archegoniate taxonomy	PO1-3, PO7-2
CO7	Able to know the sustainability ecosystem and knowledge of extant and extinct species of archegoniate	PO1-3, PO7-2

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**	**3-2-1 (6)**	**Nil**

Objective

- Evaluate the importance of various plant tissues in plant development
- Evaluate the stages of plant growth and development
- To understand the conduction path of water and mineral nutrients

Course outcome

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Learn about different types of cells, tissue and tissue system, internal anatomical structures of root, shoot and leaf of representative monocot and dicot angiosperm plants	PO1-3, PO2-3, PO4-2
CO2	Able to know different types cells in plant growth and metabolism and can pursue higher studies and thereby get employment opportunity	PO1-3, PO2-3, PO4-2

Course Outline

Module-I (8Hrs)

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

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
2. Distribution of mechanical tissues in Sunflower, *Nyctanthes*Stem

Module-II (8Hrs)

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 (8Hrs)

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

Module-IV (7Hrs)

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; Rootcap; 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
7. Study of anatomical details primary structure of dicot root through permanent slides/temporary stain mounts
8. Study of anatomical details of isobilateral leaf
9. Study of anatomical details of dorsiventral leaves

Module-V (7Hrs)

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 (7Hrs)

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 (7Hrs)

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
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

CUTM1460ECONOMIC BOTANY

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

Objective

- Investigate utilization of crop plants.
- Study of origin, distribution, botanical description, brief idea of cultivation and economic uses of cereals, pulses, beverages, natural fibers and medicinal plants
- Gain knowledge about the taxonomic diversity of important families of useful plants
- Is able to map and recognize geographical, historical and cultural contributions of economically important plants
- Understanding of the roles of potentially important plant and plant products to the development of human culture

Course outcome

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Understand core concepts of Economic Botany and relate with environment, populations, communities, and ecosystems	PO1-3, PO2-3, PO4-2, PO8-2, PO9-1
CO2	Able to get idea of cultivation and economic uses of cereals, pulses, beverages, natural fibers and medicinal plants and evolution of new crops/varieties and importance of germ plasma diversity	PO1-3, PO2-3, PO4-2, PO8-2, PO9-3
CO8	Increase the awareness and appreciation of plants & plant products encountered in everyday life	PO1-3, PO8-2, PO9-3

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
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.

6.Test for the presence of lipid and oil in groundnut seed or oil

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.

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

11.Test for the presence of Lignin in the stem of jute

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 + Project**	**3-2-1 (6)**	**Nil**

Objective

- The basic principles of inheritance at the molecular, cellular and organism levels.
- Describe the mechanisms governing Mendelian inheritance, gene interactions, and gene expression.
- Apply principles of genetics to real-world problems in biology.

Course outcome

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Acquired knowledge on genetics and inheritance of the characters	PO1-3, PO3-2, PO4-2, PO9-1
CO2	Apply quantitative problem and solving skills to genetics problems and issues	PO1-3, PO2-3, PO4-2, PO8-2
CO7	Maintenance of diverse genomes for biodiversity sustainability of and can pursue higher studies to get employability opportunity	PO1-3, PO2-3, PO4-3, PO7-2

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**

Objective

- Molecular biology deals with nucleic acids and proteins and how these molecules interact within the cell to promote proper growth, division, and development
- This course will emphasize the molecular mechanisms of DNA replication, repair, protein synthesis etc.

Course outcome

COs	Course outcomes	Mapping COs with POs (High-3,

		Medium-2, Low-1)
CO1	Gain an understanding of chemical nature of biological macromolecules and molecular processes that occur in and between cells	PO1-3, PO3-2, PO4-2
CO2	Learn skills required to effectively do scientific research	PO1-3, PO2-3, PO4-2, PO5-1
CO4	Can investigate protein and nucleic acid in the samples and can pursue higher studies to get employability opportunity	PO1-3, PO2-3, PO4-3, PO5-2
CO5	Acquire the computational skill in relation with Protein and nucleic acid data base	PO1-3, PO2-3, PO4-3, PO5-3

Course Outline

Module-I (7Hrs)

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
2. Reagent and solution preparation and micro-pipetting exercise

Module-II (7Hrs)
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
4. Isolation of DNA from ripe banana
5. DNA estimation by diphenylamine reagent
6. DNA estimation by UV Spectrophotometry
7. DNA estimation by Witham et. al.(1971) method

Module-III (8Hrs)
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 (9Hrs)

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
10. Study of Theta model of DNA replication mechanisms through photographs
11. Study of semi-discontinuous DNA replication mechanisms through photographs

Module-V (7Hrs)

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 (7Hrs)

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 (7Hrs)

Translation: Ribosome structure and assembly, mRNA; Charging of tRNA, aminoacyltRNAsynthetases; **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.

CUTM2402PLANT 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**

Objective

- Be able to understand the ecological context in which a particular species may have evolved, or a specific ecological process takes place

Course outcome

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Gain an understanding the major factors influencing the geographic distribution of species	PO1-3, PO3-1, PO7-1
CO2	Learn skills required for effective scientific research in industry or academia research	PO1-2, PO2-3, PO4-3, PO3-1, PO7-2
CO4	Have increased capacity to think critically; ability to design and execute an experiment; confidence and ability in communicating ideas	PO1-2, PO2-3, PO4-3, PO3-1, PO7-2
CO7	Be able to understand the ecological context in which a particular species may have evolved, or a specific ecological process takes place	PO1-2, PO2-3, PO4-3, PO3-1, PO7-3

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.

BSBO2403 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**

Objective

- 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

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
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	PO1-3, PO2-3, PO6-1, PO7-1, PO8-2, PO9-3
CO2	Learn skills required for effective identification of order, family, genus and species. Students will understand the process of plant	PO1-3, PO2-3, PO7-3, PO8-2, PO9-2
CO6	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	PO1-2, PO2-1, PO6-3, PO7-3, PO8-2, PO9-3

	opportunity	

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
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
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
9. Cytotaxonomical analysis of Some important families like Euphorbiaceae, Poaceae
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.
12. Study on evolution of few plants

Text Book

- Singh, (2012). *Plant Systematics:* Theory and Practice Oxford & IBH Pvt. Ltd., New Delhi. 3rdedition.
- Jeffrey, C. (1982). An Introduction to *Plant Taxonomy.*Cambridge University Press, Cambridge.
- 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 Book

- Maheshwari, J.K. (1963). *Flora* of Delhi. CSIR, New Delhi.
- 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**

Objective

- 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 observe some of the variation in different parts of sample fruits, and relate these modifications to changes in function.

Course outcome

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Differentiate among annual, biennial, and perennial plants	PO1-3, PO2-3, PO6-1, PO7-1, PO8-2, PO9-3
CO2	Learn skills required for identification of complete and incomplete flowers, and between monoecious and dioecious plants	PO1-3, PO2-3, PO7-3, PO8-2, PO9-2
CO6	Explain the process, locations, and significance of angiosperm gametogenesis and fertilization, including double fertilization	PO1-2, PO2-1, PO6-3, PO7-3, PO8-2, PO9-3

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. 1 (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**	**3-2-1 (6)**	**Nil**

Objective

- Describe how physiological processes scale up from the functioning of complex structures such as stems, roots and leaves to whole plants and plant communities
- Our objective is to provide training in scientific and transferable skills through modular lecture courses, research projects, written work, seminars and supervisions.

Course outcome

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Learn the knowledge on metabolism, physiology and structure of plants together with a better understanding of regulation of growth and development and influence of environment	PO1-3, PO2-3, PO4-1, PO8-1
CO2	Laboratory skills to estimate different physiological processes in plants	PO1-3, PO2-3, PO3-2, PO4-3
CO4	Integrate and analyze the data and concepts from current scientific literature	PO1-2, PO2-3, PO3-2, PO4-3

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.
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.
4. Calculation of stomatal index and stomatal frequency from the two surfaces of leaves of a mesophyte and xerophyte.
5. To calculate the area of an open stoma and percentage of leaf area open through stomata in a mesophyteand xerophyte (both surfaces).
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).
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)
10. To study the induction of amylase activity in germinating barley grains.
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.NarosaPublishing 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**

Objective

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

Course outcome

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Understanding the kingdoms of biomolecules, metabolites and pathways that are the prerequisites and consequences of physiological phenomenon for further manipulations	PO1-3, PO2-3, PO3-2, PO4-1
CO2	Laboratory skills on integrative approach for biological experiments	PO1-3, PO2-3, PO3-2, PO4-3
CO3	Have a comprehensive understanding on designing the experimental work and current understanding in the field between various plant metabolic processes to analyze the data and concepts from current scientific literature	PO1-2, PO2-3, PO3-3, PO4-3

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.
2.Experimental demonstration of Hill's reaction.
3.To study the effect of light intensity on the rate of photosynthesis.
4.Effect of carbon dioxide on the rate of photosynthesis.
5.Demonstration of fluorescence by isolated chlorophyll pigments.
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.
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
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
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,Calciumcalmodulin,
MAP kinase cascade

Text Book:

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**

Objective

- The objective of the course is to give students new knowledge by handling of classical and modern plant biotechnology processes
- Understanding of biotechnological processes has also applicative value in pharmaceutical and food industry, in agriculture and in ecology..

Course outcome

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Develop fundamental knowledge in Plant Molecular Biotechnology and its application in laboratory and industry settings	PO1-3, PO2-3, PO3-2, PO4-3, PO7-2
CO2	Laboratory skills on integrative approach for biotechnological experiments specifically on basic, techniques in micro-propagation	PO1-3, PO2-3, PO3-3, PO4-3, PO7-2
CO3	Design of experiments for complex scientific problems towards conservation of plant species	PO1-2, PO2-3, PO3-3, PO4-3, PO7-3
CO7	Experimental skills to conserve plants for sustainability	PO1-2, PO2-3, PO3-3, PO4-3, PO7-3

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;

Practice1: Preparation of MS medium.
Practice2: Demonstration of in vitro sterilization and inoculation methods using leaf explants of tobacco, Datura, Brassica etc.
Practice3: Demonstration of in vitro sterilization and inoculation methods using nodal explants of tobacco, Datura, Brassica etc.
Practice4: 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).
Practice6: Study of anther, embryo and endosperm culture micro propagation, micropropagation, Restriction digestion and gel electrophoresis of plasmid DNA.
Practice7: Study of anther, embryo and endosperm culture micro propagation, micropropagation, 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
Practice8: Study of anther, embryo and endosperm culture micro propagation, micropropagation, 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).
Practice9: Study of anther, embryo and endosperm culture micro propagation, micropropagation, Study of methods of Agrobacterium-mediated gene transfer through photographs
Practice10: Study of anther, embryo and endosperm culture micro propagation, micropropagation, Study of methods of gene transfer through photographs: direct gene transfer 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)
Practice11: Study of anther, embryo and endosperm culture micro propagation, micropropagation, Study of steps of genetic engineering for production of Bt cotton, Golden rice through photographs.
Practice12: Study of anther, embryo and endosperm culture micro propagation, micropropagation, Study of steps of genetic engineering for production of FlavrSavr 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 Book:

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