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

B.Sc. (Botany) Syllabus

(Four Years Programme)

School of Applied Sciences

Centurion University of Technology & Management

2025-26

STRUCTURE OF UNDER GRADUATE PROGRAMME

Sl. No.	Board Category of Courses	Minimum Credit Requirement	
		3 Year UG	4 Year UG
01	Major (Core)	60	80
02	Multidisciplinary + Minor	34	42
03	Value added course	07/06	07/06
04	Ability Enhancement Courses (AEC) + Skill Enhancement Courses (SEC)	18	18
05	Summer Internship	02	02
06	Research Project/Domain Project	0	12
	Total	**121/120**	**161/160**

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

Sl. No	Code	Subject Name	Type of course	T-P-Pr (Credit)	Credits	Level
SEMESTER I						
01	**-**	**Value Added**	Theory + Project	**2-0-1**	**3**	**-**
02	CUTM1674	Environmental Science	Theory + Practice+ Project	3-0-1	4	**4.5**
03	CUTM4556	Phycology and Microbiology	Theory + Practice	3-1-0	4	**4.5**
04	CUTM4557	Biomolecules & Cell biology	Theory + Practice	3-1-0	4	**4.5**
05	GE-1@	Inter Disciplinary Subject	Theory + Practice	3-1-0	4	**4.5**
				TOTAL	**19**	
SEMESTER II						
06		Job Readiness	Practice	0-0-2	2	**-**
07	CUTM4558	Mycology & Phytopathology	Theory + Practice	3-1-0	4	**4.5**
08	CUTM4559	Plant Ecology and Phytogeography	Theory + Practice	3-1-0	4	**4.5**
09	GE-2@	Inter Disciplinary Subject	Theory + Practice	3-1-0	4	**4.5**
10		Skill		-	4	**4**
				TOTAL	**18**	
SEMESTER III						
11		Job Readiness	Practice	0-0-2	2	-
12		Value added	Theory + Project	-	3	**-**
13	CUTM4560	Archegoniate	Theory + Practice	3-1-0	4	**5**
14	CUTM4561	Plant Systematics	Theory + Practice	3-1-0	4	**5**
15	CUTM4562	Anatomy of Angiosperms	Theory + Practice	3-1-0	4	**5**
16	GE-3@	Inter Disciplinary Subject	Theory + Practice	3-1-0	4	**5**
				TOTAL	**21**	
SEMESTER IV						
17		Skill			4	-
18		Job Readiness	Practice	0-0-2	2	**-**
19	CUTM4563	Molecular Biology	Theory + Practice	3-1-0	4	**5**
20	CUTM4564	Basics of Genetics	Theory + Practice	3-1-0	4	**5**
21	CUTM4565	Economic Botany	Theory + Practice	3-1-0	4	**5**
22	GE-4@	Inter Disciplinary Subject	Theory + Practice	3-1-0	4	**5**
				TOTAL	**22**	
SEMESTER V						

23	CUTM4566	Plant Physiology	Theory + Practice	3-1-0	4	**5.5**
24	CUTM4567	Plant Metabolism	Theory + Practice	3-1-0	4	**5.5**
25	CUTM4568	Reproductive Biology of Angiosperm	Theory + Practice	3-1-0	4	**5.5**
26	Domain	Multidisciplinary	Theory	-	9	**5.5**
				TOTAL	**21**	
SEMESTER VI						
27	CUTM1439	Plant Biotechnology	Theory + Practice	3-1-0	4	**5.5**
28	CUTM4548	Bioinformatics and Biostatistics	Theory + Practice	3-1-0	4	**5.5**
29	Domain	Multidisciplinary	Practice	-	9	**5.5**
30	Skill	-		-	4	**5**
				TOTAL	**21**	
SEMESTER VII						
31	CUTM4549	Advanced Microbiology	Theory + Practice	3-1-0	4	**6**
32	CUTM4550	Advanced Plant Biochemistry	Theory + Practice	3-1-0	4	**6**
33	CUTM4551	Analytical Techniques in Plant Sciences	Theory + Practice	3-1-0	4	**6**
34	Domain	Multidisciplinary	Project	-	6	
35	-	Internship	-	-	2	
				TOTAL	**20**	
SEMESTER VIII						
36	CUTM4552	Pharmacognosy and Plant Metabolites	Theory + Practice	3-1-0	4	**6**
37	CUTM4569	Plant Breeding	Theory + Practice	3-1-0	4	**6**
38	-	Research Project / Domain Project / 3 No.s Discipline Specific Elective	-	-	12	
				TOTAL	**20**	
				GRAND TOTAL	**162**	

DEPARTMENT OF BOTANY

B.Sc. Botany
Four Years Programme
Course Structure 2025-26

BASKET I - CORE COURSES				
Sl. No.	**Code**	**Subject Name**	**T-P-Pr (Credit)**	**Credits**
1.	CUTM4556	Phycology and Microbiology	3-1-0	**4**
2.	CUTM4557	Biomolecules & Cell biology	3-1-0	**4**
3.	CUTM4558	Mycology & Phytopathology (GE)	3-1-0	**4**
4.	CUTM4559	Plant Ecology and Phytogeography	3-1-0	**4**
5.	CUTM4560	Archegoniate	3-1-0	**4**
6.	CUTM4561	Plant Systematics	3-1-0	**4**
7.	CUTM4562	Anatomy of Angiosperms	3-1-0	**4**
8.	CUTM4563	Molecular Biology	3-1-0	**4**
9.	CUTM4564	Basics of Genetics	3-1-0	**4**
10.	CUTM4565	Economic Botany	3-1-0	**4**
11.	CUTM4566	Plant Physiology	3-1-0	**4**
12.	CUTM4567	Plant Metabolism	3-1-0	**4**
13.	CUTM4568	Reproductive Biology of Angiosperm	3-1-0	**4**
14.	CUTM1439	Plant Biotechnology	3-1-0	**4**
15.	CUTM4548	Bioinformatics and Biostatistics	3-1-0	**4**
16.	CUTM4549	Advanced Microbiology	3-1-0	**4**
17.	CUTM4550	Advanced Plant Biochemistry	3-1-0	**4**
18.	CUTM4551	Analytical Techniques in Plant Sciences	3-1-0	**4**
19.	CUTM4552	Pharmacognosy and Plant Metabolites	3-1-0	**4**
20.	CUTM4569	Plant Breeding	3-1-0	**4**
			Total	**80**

Centurion University

PHYCOLOGY AND MICROBIOLOGY

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Phycology and Microbiology	**CUTM4556**	**Theory + Practice**	**3-1-0 (4)**	**Nil**

Objectives

- To introduce the diverse group of microorganisms and their habitat relationship.
- To learn about production of vaccines, medicines, disease diagnosis and research.
- To have knowledge about the habitats, distribution and diversity of algae.

Course outcome

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

COs	Course outcomes
CO1	**Learn** about the diverse nature and types of microbes
CO2	**Understand** the potential of various microbes, ecological and economic importance of algae and microbes and the approaches to use them for human welfare
CO3	**Identify** different types of bacteria, virus and algal species based on particular identifying characters
CO4	**Categorize** different types of microbes and algae and their importance in daily life
CO5	**Explain** various laboratory skills such as microbial cultures, and staining methods

Course Outcome to Program Outcome Mapping

COs	PO1	PO2	PO3	PO4		PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1		1		3	1		1	2	2	3	2	1
CO2	3	3	2	2		2	1	1	2		2	2	2	3	3	2
CO3	3	3	2	2		2	1	1	1		2	2	3	3	3	2
CO4	3	3	3	3		3	1	2	1		2	3	3	3	3	3
CO5	2	3	3	3		3	1	3	1	1	2	3	3	3	3	3

(High-3, Medium-2, Low-1)

Course Content

Module-I

Microbial world: Microbial nutrition, growth and metabolism;

Viruses: Discovery, nature, physicochemical and biological characteristics; classification (Baltimore), general structure with special reference to viroids and prions; replication (a general account), DNA virus (T-phage), lytic and lysogenic cycle; RNA virus (TMV); Economic importance of viruses with reference to vaccine production, Viral plant diseases: symptoms, effect and control

Module-II

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); Economic importance of bacteria with reference to their role in agriculture and industry (fermentation and medicine).

Module-III

Cyanobacteria: Ecology, occurrence, cell structure, heterocyst, reproduction, economic importance; role in biotechnology. Morphology and life-cycle of *Nostoc;* Economic importance of cyanobacteria.

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 up to groups); Role of algae in the environment, agriculture, biotechnology and industry.

Module-V

Chlorophyta: General characteristics, occurrence, range of thallus organization, cell structure and Reproduction; Morphology and life-cycles of *Chlamydomonas, Volvox, Oedogonium, Coleochaete*

Module-VI

Charophyta: General characteristics, occurrence, range of thallus organization, cell structure and reproduction; Morphology and life-cycles of *Chara,* evolutionary significance

Xanthophyta: General characteristics; Occurrence, morphology and life- cycle of *Vaucheria.*

Module-VII

Phaeophyta: Characteristics; Occurrence, Range of thallus organization, cell structure, reproduction; Morphology and life-cycles of *Ectocarpus* and *Fucus*

Rhodophyta: Characteristics; Occurrence, Range of thallus organization, cell structure, reproduction; Morphology and life-cycles of *Batrachospermum, Polysiphonia.*

Practice

1. Electron micrographs/Models of viruses: TMV
2. Examination of bacteria from bacterial culture by Gram's staining method.
3. Study of Root Nodule bacteria
4. Study of vegetative and reproductive structures of *Nostoc, Vaucheria*
5. Study of vegetative and reproductive structures of *Chlamydomonas*, *Volvox, Oedogonium, Chara, Vaucheria*
6. Study of vegetative and reproductive structures of *Ectocarpus, Fucus, Polysiphonia*,

Text Books:

1. Sanjeev Kumar Vidyarthi (2023). Phycology and Microbiology (Based on CBCS), P.K. Publishers and distributors, Pusta, Kartar Nagar, Delhi
2. Pandey BP (2022). Botany for B.Sc. Students (Archigoniates & Plant Architecture), S. Chand publication, New Delhi
3. Dubey RC, Maheshwari DK (2021) A text book of Microbiology, S. Chand publication, New Delhi
4. Mishra B. K. (2018) Microbiology and Phycology, Kalyani Publishers, New Delhi.
5. Dr. V. Singh, Dr. P.C. Pande , Dr. D.K. Jain, (2017). Microbiology and Phycology, Rastogi Publications; 1st Edition (Reprint): 2017-2018 (1 January 2017); Rastogi Publications Shivaji Road Meerut - 250 002 U.P. India

Reference Books:

1. Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International.
2. P.C. Trivedi, Sonali Pandey, Seema Bhadauria (2010). Text Book of Microbiology, Aavishkar Publishers, Jaipur, (Raj.) India
3. Lee, R.E. (2008). Phycology, Cambridge University Press, Cambridge. 4th edition.
4. Pelczar, M.J. (2001) Microbiology, 5th edition, Tata McGraw-Hill Co, New Delhi.

BIOMOLECULES AND CELL BIOLOGY

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Biomolecules and Cell Biology	**CUTM4557**	**Theory + Practice**	**3-1-0 (4)**	**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.

Course Outcome to Program Outcome Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1			1		1	2	2	3	2	1
CO2	3	3	2	2	2		1	1		1	3	3	3	2	1
CO3	3	3	2	2	1	1	1	1		1	3	2	3	2	1
CO4	3	3	2	2	2	1	1	1		1	3	3	3	2	1
CO5	3	3	3	3	3	1	2	1		2	3	3	3	3	2

(High-3, Medium-2, Low-1)

Course Content

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.

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.

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); Chemistry, structure and function of cell wall. Overview of membrane function; fluid mosaic model; Chemical composition of membranes; Membrane transport – Passive, active and facilitated transport, endocytosis and exocytosis. Chloroplast, mitochondria and peroxisomes: Structural organization; Function; Semiautonomous nature of mitochondria and chloroplast.

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.

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. Lysosome and vacuoles.

Module-VII

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

Practice

1. Qualitative tests for carbohydrates, reducing sugars and non-reducing sugars.
2. Determination of pH in waste water sample.
3. Qualitative tests for Proteins.
4. Study of cell wall in the epidermal peel of onion.
5. Demonstration of the phenomenon of protoplasmic streaming in Hydrilla leaf.
6. 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 Books:

1. Karp, G. (2019). Cell Biology, John Wiley & Sons, U.S.A. 9th edition.
2. Hardin, J., Becker, G., Skliensmith, L.J. (2012). Becker's World of the Cell, Pearson Education Inc. U.S.A. 8th edition.
3. Cooper, G.M. and Hausman, R.E. (2019) The Cell: A Molecular Approach. 8th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.

MYCOLOGY AND PHYTOPATHOLOGY

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Mycology and Phytopathology	**CUTM4558**	**Theory + Practice**	**3-1-0(4)**	**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 characteristics, classification, structure, nutrition, reproduction and life cycles of major fungal groups including allied fungi.
CO2	**Explain** symbiotic associations such as lichens and mycorrhiza, their structure, function, and ecological significance.
CO3	**Describe** the role of fungi in biotechnology, agriculture, food industry, and biological control, including secondary metabolites and mycotoxins.
CO4	**Acquire** knowledge on the basic concepts of phytopathology including plant disease causes, host-parasite interactions, molecular pathogenesis, and defense mechanisms.
CO5	**Identify** symptoms, causal agents, and management strategies of major bacterial, viral, and fungal plant diseases.

Course Outcome to Program Outcome Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	2			1		1	2	3	3	3	2
CO2	3	2	2	2	1			2		2	2	3	3	3	2
CO3	3	3	3	2	3	1	1	2		2	3	3	3	3	3
CO4	3	3	3	3	2	1	1	2	1	2	3	3	3	3	3
CO5	3	3	3	3	2	1	2	2	1	2	3	3	3	3	3

(High-3, Medium-2, Low-1)

Course Content

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 organization; Reproduction; Life cycle with reference to *Synchytrium, Rhizopus.*

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.

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.*

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.

Module-V

Applied Mycology: Role of fungi in biotechnology; Application of fungi in food industry; Secondary metabolites (Pharmaceutical preparations); Agriculture (Bio-fertilizers); Mycotoxins; Biological control (Mycofungicides, Mycoherbicides, Mycoinsecticides, Myconematicides)

Module-VI

Phytopathology: Concepts of plant diseases, modes of infection and dissemination, biotic and abiotic causes of plant diseases; Host parasite interaction, molecular mechanism of

pathogenesis; Defense strategies: mechanism of resistance; elicitors, phyto-alexins, PR proteins, antiviral proteins, SAR, HR and active oxygen radicals.

Module-VII

Plant Diseases: General symptoms, causal organisms, prevention and control of plant diseases; **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, smut of sugarcane.

Practicals

1. *Rhizopus*: study of asexual stage from temporary mounts and sexual structures through permanent slides.
2. *Aspergillus* and *Penicillium*: study of asexual stage from temporary mounts. Study of Sexual stage from permanent slides/photographs.
3. *Peziza*: sectioning through ascocarp.
4. *Puccinia*: Herbarium specimens of Black Stem Rust of Wheat and infected Barberry leaves; sections/mounts of spores on wheat and permanent slides of both the hosts.
5. *Agaricus*: Specimens of button stage and full grown mushroom; sectioning of gills of Agaricus, fairy rings and bioluminescent mushrooms to be shown.
6. *Lichens:* Study of growth forms of lichens (crustose, foliose and fruticose) on different substrates.

Textbooks Books:

1. Kumari, K. (2024). Botany Paper-1 (Mycology and Phytopathology) Book B.Sc.
2. Purohit, S.D., & Kukda, G.K. (2021). Mycology: Microbiology & Plant Pathology.
3. Pandey, B.P. (2025). Mycology and Phytopathology (Botany for B.Sc. Students).

Reference Books:

1. Orlovich, D. (2023). Fundamentals of Mycology and Phytopathology.
2. Manoharachary, C., Tilak, K.V.B.R., Mallaiah, K.V., & Kunwar, I.K. (2021). Mycology, Microbiology and Plant Pathology.
3. Kharte, S. (2023). Advanced Mycology and Plant Pathology.

PLANT ECOLOGY AND PHYTOGEOGRAPHY

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Plant Ecology and Phytogeography	**CUTM4559**	**Theory + Practice**	**3-1-0 (4)**	**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	Understand the basic concepts of ecology, levels of organization, soil formation, composition, and the role of climate in soil development.
CO2	Explain the significance of water in the environment, atmospheric moisture, hydrological cycle, and adaptations of plants to environmental factors like light, temperature, wind, and fire.
CO3	Describe biotic interactions including trophic organization, food chains, food webs, ecological pyramids, and concepts of biomass and standing crop.
CO4	Analyze population ecology, plant communities, ecological amplitude, succession, and climax concepts.
CO5	Explain ecosystem structure, energy flow, production, biogeochemical cycles, phytogeography, and major terrestrial biomes including local vegetation.

Course Outcome to Program Outcome Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	2	1			2		2	2	2	3	2	1
CO2	3	3	2	2	2	1	1	2		3	2	3	3	3	2
CO3	3	3	2	3	2	1	2	2		2	3	3	3	3	2
CO4	3	3	3	3	2	1	2	2	1	2	3	3	3	3	3
CO5	3	3	3	3	3	1	2	2	1	3	3	3	3	3	3

(High-3, Medium-2, Low-1)

Course Content

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.

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.

Module-III

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

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.

Module-V

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

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.

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

1. Determination of organic matter of different soil samples by Walkley& Black rapid titration method.
2. Determination of pH of various soil and water samples (pH meter, universal indicator/Lovibond comparator and pH paper)
3. Determination of dissolved oxygen of water samples from polluted and unpolluted sources.
4. Study of morphological adaptations of hydrophytes and xerophytes
5. Study of biotic interactions of the following: Stem parasite (Cuscuta), Root parasite (Orobanche), Epiphytes, Predation (Insectivorous plants).
6. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus, by species area curve method (species to be listed).

Text Books:

Ecology, Environmental Science and Conservation by J.S. Singh, S.P. Singh, and S.R. Gupta (2017)

1. Perspectives in Environmental Studies by Anubha Kaushik and C.P. Kaushik (2018)
2. 3.Plant Ecology and Phytogeography by Manideep Raj and Hemen Deka (recent edition, ~2020s)

Reference Books:

1. Plant Ecology by Paul A. Keddy (2017, 2nd Edition)
2. Plant Ecology and Phytogeography by N. Arumugam and V. Kumaresan (4th Edition, Saras Publication)
3. Textbook of Environmental Studies for Undergraduate Courses by Erach Bharucha (2018).

ARCHEGONIATE

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Archegoniate	**CUTM4560**	**Theory + Practice**	**3-1-0(4)**	**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

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

Cos	Course outcomes
CO1	**Understand** the unifying features, adaptations, and classification of archegoniates with emphasis on bryophytes
CO2	**Explain** the morphology, anatomy, reproduction, and evolutionary trends in bryophytes and their ecological and economic significance.
CO3	**Ability** to identify the members of pteridophytes based on morphology, anatomy, and reproduction..
CO4	**Justify** the evolutionary adaptations such as apogamy, apospory, heterospory, seed habit, and telome theory, and assess their significance in plant evolution.
CO5	**Interprete** the morphology, anatomy, classification, and reproduction of gymnosperms and evaluate their ecological and economic significance.

Course Outcome to Program Outcome Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	2	1			1		1	2	2	3	2	1
CO2	3	3	2	2	2	1	1	2		2	2	3	3	3	2
CO3	3	3	2	3	2	1	1	2		2	3	3	3	3	2
CO4	3	3	3	3	2	1	1	2	1	2	3	3	3	3	3
CO5	3	3	3	3	3	1	1	2	1	2	3	3	3	3	3

(High-3, Medium-2, Low-1)

Course Content

Module-I

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

Bryophytes: General characteristics; Adaptations to land habit.

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

Module-II

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

Module-III

Reproduction and evolutionary trends in *Riccia, 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)

Module-V

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

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

1. Study of Morphology and Vertical section of thallus of Riccia
2. *Marchantia*- Morphology of thallus whole mount, vertical section of thallus through Gemma cup

3. *Anthoceros and Sphagnum* - Morphology of thallus, dissection of sporophyte, vertical section of thallus.
4. *Selaginella*- Morphology, whole mount of leaf with ligule, whole mount of strobilus, whole mount of microsporophyll and megasporophyll (temporary slides), longitudinal section of strobilus.
5. *Equisetum and Pteris*- 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.
6. *Cycas* and *Pinus*: T.S root, leaflet and rachis of Cycas, T.S. Needle, stem, L.S. male cone, whole mount of microsporophyll, whole mount of Microspores (temporary slides), L.S. of female cone of Pinus.

Text Books:

1. Vasistha, B. R. (2017) Botany for Degree student, Bryophyta, S. Chand Publication, New Delhi.
2. Singh, V., Pandey, P.C. and Jain, D.K. (2017). Archegoniate, Rastogi Publication, Meerut.
3. Pandey B.P (2020) Botany For Degree Students NEP, S Chand Publication New Delhi.
4. N.S Parihar (2019). Introduction Embryophyta Bryophyta Vol. I.Surjeet Publications.

Reference Books:

1. Acharya, B. S. (2017), Archegoniate, Kalyani Publishers, New Delhi.
2. Vashistha, P.C., Sinha, A.K., Kumar, A. (2010). Pteridophyta. S. Chand. New Delhi,
3. Bhatnagar, S.P. & Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
4. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005). Biology. Tata McGrawHill, Delhi.
5. Rashid. A. An Introduction To Archegoniate Plants (Vikas Publication) New Delhi.

PLANT SYSTEMATICS

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Plant Systematics	**CUTM4561**	**Theory + Practice**	**3-1-0(4)**	**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

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

COs	Course outcomes
CO1	**Know** the principles of plant systematics and the role of palynology, cytology, phytochemistry, and molecular data in plant classification and nomenclature.
CO2	**Understand** the functions and significance of herbarium and botanical gardens, and apply techniques of documentation including floras, monographs, and identification keys.
CO3	**Define** taxonomic hierarchy and species concepts, and differentiate taxonomic categories such as family, genus, and species.
CO4	**Interpret** and apply rules of botanical nomenclature (ICBN/ICN), including binomial system, typification, valid publication, and principle of priority.
CO5	**Compare** major classification systems and analyze the economic importance and systematic position of key angiosperm families using traditional and modern methods including numerical taxonomy and phylogenetics.

Course Outcome to Program Outcome Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	2			1		1	2	3	3	2	2
CO2	3	2	2	3	2	1	1	2		2	2	3	3	3	2
CO3	3	3	2	2	2		1	2		2	3	3	3	3	2
CO4	3	3	2	3	2		1	2	1	2	3	3	3	3	3
CO5	3	3	3	3	3	1	2	2	1	3	3	3	3	3	3

(High-3, Medium-2, Low-1)

Course Content

Module-I

Significance of Plant systematic: Introduction to systematic; Plant Classification, Nomenclature; Evidences from palynology, Cytology, Phytochemistry and Molecular Data.

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.

Module-III

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

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

Module-V

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

Module-VI

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).

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 relationships.

Practice

1. Mounting a properly dried and pressed specimen of wild plant with herbarium label (to be submitted in the record book).
2. Plant classification domain to species level
3. Demonstration of herbarium techniques
4. Study of vegetative and floral characters of the following families: Fabaceae, Asteraceae
5. Study of vegetative and floral characters of the Brassicaceae, Cucurbitaceae, Malvaceae, Rutaceae
6. Study of vegetative and floral characters of families like Poaceae and Cyperaceae

Text Books:

1. Singh, (2012). Plant Systematics: Theory and Practice, Oxford & IBH Pvt. Ltd., New Delhi. 3rd edition.
2. Saxena, H. O. and Brahman, M. The Flora of Orissa, CSIR Publication.
3. Jeffrey, C. (1982). An Introduction to Plant Taxonomy. Cambridge University Press, Cambridge.
4. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. (2002). Plant Systematics Phylogenetic Approach. Sinauer Associates Inc., U.S.A. 2nd edition.
5. Paria, N. D. (2022). Plant Taxonomy & Biodiversity. Santra Publication

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.
3. Singh, Bhavna (2025). Plant Taxonomy: Theory and Practice. Agrotech Press.

ANATOMY OF ANGIOSPERMS

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Anatomy of Angiosperms	**CUTM4562**	**Theory + Practice**	**3-1-0 (4)**	**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:

to understand the internal structure and cellular composition of plant bodies

Cos	Course outcomes
CO1	**Describe** the scope of plant anatomy and classify plant tissues and tissue systems with examples and the applications of plant anatomy
CO2	**Understand** the concept and theories related to plant anatomy and explain meristems, their classification, specialized cell structures (pits, plasmodesmata), and ergastic substances.
CO3	**Identify** the plant parts based on anatomical features
CO4	**Categorize** the plants based on secondary growth, anomalous secondary growth, wood anatomy and **classify** different adaptive and protective systems exists in plants
CO5	**Evaluate** anatomical adaptations in wood and protective systems in different ecological groups (xerophytes, hydrophytes).

Course Outcome to Program Outcome Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	1		1	1		1	2	2	3	2	1
CO2	3	2	2	2	1		1	2		2	2	2	3	2	1
CO3	3	3	2	3	2	1	2	2		2	2	3	3	3	2
CO4	3	3	3	3	2	1	2	2	1	2	3	3	3	3	3
CO5	3	3	3	3	2	1	2	2	1	3	3	3	3	3	3

(High-3, Medium-2, Low-1)

Course Content

Module-I

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

Types of tissues: Classification of tissues: Meristematic tissue types based on position (Apical, intercalary and lateral); Permanent tissue types: (Simple tissue: Parenchyma, Collenchyma, Sclerenchyma); Complex tissue: (Xylem, Phloem)

Tissue system: The three tissue systems (dermal tissue system, the ground tissue system, and the vascular tissue system)

Module-II

Meristems: Classification: Root apical meristem, shoot apical meristem; Pits and plasmodesmata; Wall ingrowths and transfer cells, adcrustation and incrustation, ergastic substances

Module-III

Internal organization of the plant body: Organization of shoot apex (Apical cell theory, Histogen theory, Tunica Corpus theory); Organization of root apex (Apical cell theory, Histogen theory, Korper-Kappe theory), quiescent center concept, root cap, origin of lateral root; Root-shoot transition

Module-IV

Anatomy of root, stem, leaf: Structure of dicot and monocot root; Primary anatomical structure of dicot and monocot stem; Primary anatomical structure of dicot and monocot leaf, Kranz anatomy

Module-V

Secondary growth: Types of vascular bundles; Structure, function of Cambium and seasonal activity of cambium; Secondary growth in root and stem; Anomalous secondary growth in monocots (*Dracaena*), dicots (*Bougainvillea, Nyctanthes*)

Module-VI

Wood anatomy: 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; Periderm (phellem, phellogen and phelloderm), rhytidome, lenticels

Module-VII

Adaptive and Protective Systems: Protective systems in epidermal tissue system: cuticle, epicuticular waxes, trichomes (uni-and multicellular, glandular and non-glandular, two examples of

each), stomata (classification); Hydathodes, lithocysts, laticifers; Anatomical adaptations of xerophytes and hydrophytes

Practice

1. Demonstration of double staining technique and preparation of double staining slides.
2. To study secretory tissue system through fresh material or permanent slides Orange rind /Lemon leaf
3. Study of anatomical details of monocot and dicot stem through permanent slides/temporary stain mounts
4. Study of anatomical details of monocot root and dicot root through permanent slides/temporary stain mounts
5. Study of anatomical details of isobilateral leaf and dorsiventral leaves
6. Study of anatomical details of hydrophytic leaves

Text Books:

1. Rajendra TS (2021). Anatomy of Angiosperm, Academic Aspirations, India
2. Sharma PC. (2028). Anatomy of Angiosperms, Wave Books, India
3. Singh V, Pandey PC, Jain DK (2017). Anatomy of Angiosperms, Rastogi Publication, Meerut.
4. Pandey, B. P. (2017) Plant Anatomy, S. Chand Publication, New Delhi.
5. Mishra, B. K. (2017). Anatomy of Angiosperms, Kalyani Publishers, New Delhi.

Reference Books:

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

MOLECULAR BIOLOGY

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Molecular Biology	**CUTM4563**	**Theory + Practice**	**3-1-0(4)**	**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	**Describe** the historical experiments that established DNA as the genetic material and the structural organization of DNA and RNA.
CO2	**Explain** the structural and functional differences in DNA organization among prokaryotes, eukaryotes, and organelles, and also outline chromatin packaging and heterochromatin types.
CO3	**Apply** knowledge of DNA replication mechanisms, genetic code, and transcriptional regulation to interpret gene expression and inheritance patterns.
CO4	**Analyze** RNA processing events such as splicing, editing, and transport, and their implications in gene expression regulation.
CO5	**Evaluate** the molecular machinery and processes involved in translation and **design** hypothetical experiments to study protein synthesis and post-translational modifications.

Course Outcome to Program Outcome Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2		1						1	2	2	3	2	
CO2	3	2		1				1		1	2	2	3	3	
CO3	3	3	2	2	2		1	1	1	2	3	3	3	3	2
CO4	3	3	2	3	2	1	1	1	1	2	3	3	3	3	2
CO5	3	3	3	3	3	2	2	1	1	3	3	3	3	3	3

(High-3, Medium-2, Low-1)

Course Content

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.

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 genetic material, denaturation and renaturation, cot curves

Module-III

Organization of DNA: Prokaryotes, Viruses, Eukaryotes;

Organelle DNA: Mitochondria and chloroplast DNA

The Nucleosome: Chromatin structure: Euchromatin, Heterochromatin: Constitutive and Facultative heterochromatin.

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.

Module-V

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

Module-VI

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

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 (concept).

Practice

1. Reagent and solution preparation and micro-pipetting exercise
2. Isolation of DNA from leaves
3. Structure of DNA through photographs
4. Study of Rolling circle DNA & Theta model of DNA replication mechanisms through photographs
5. Separation of DNA using Gel electrophoresis.
6. Study of DNA duplication using PCR

Text Books:

1. N. Arumugam (2015), 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. (2017). 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. (original)
3. Molecular Biology of the Gene, 7th Edition Single Issue Magazine – 8 September 2024
4. by Streips (Author).

BASICS OF GENETICS

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Basics of Genetics	**CUTM4564**	**Theory + Practice**	**3-1-0 (4)**	**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 outcomes

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

Cos	Course outcomes
CO1	**Understand** the Mendelian principles and chromosome theory of inheritance; interpret pedigree analysis.
CO2	**Analyze** inheritance patterns beyond Mendelism such as codominance, epistasis, maternal effects, and extra nuclear inheritance, numerical gene mapping..
CO3	**Solve** gene mapping problems using linkage and recombination data.
CO4	**Acquire** the knowledge and understanding on relationship between genetic variation, chromosomal aberrations and gene mutations and speciation and to interpret allele and genotype frequencies using the Hardy-Weinberg Law.
CO5	**Differentiate** classical and molecular gene concepts and explain complementation tests and apply principles of population and evolutionary genetics.

Course Outcome to Program Outcome Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	3	2			1		1	2	3	3	2	2
CO2	3	3	2	2	2			1		1	2	3	3	3	2
CO3	3	3	3	3	3			1		2	3	3	3	3	3
CO4	3	3	3	3	3			2	1	2	3	3	3	3	3
CO5	3	3	3	3	3	1	1	2	1	2	3	3	3	3	3

(High-3, Medium-2, Low-1)

Course Content

Module-I

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

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.

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.

Module-IV

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

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.

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.

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

1. Mendel's laws through seed ratios. Laboratory exercises in probability and chi-square.
2. Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1,9:3:4).

3. Chromosome mapping using point test cross data.
4. Blood Typing: ABO groups & Rh factor.
5. Study of human genetic traits: Widow's peak and Rolling of tongue
6. Study of human genetic traits: Hitchhiker's thumb and attached ear lobe

Text Books:

1. Genetics: A Conceptual Approach (7th Edition, 2021) – Benjamin A. Pierce
2. Genetics: Analysis and Principles (7th Edition, 2021) – Robert J. Brooker
3. Genetics: From Genes to Genomes (6th Edition, 2021) – Leland Hartwell, Michael Goldberg, Janice Fischer, Leroy Hood

Reference Books:

1. Concepts of Genetics (12th Edition, 2021) – William S. Klug, Michael R. Cummings, Charlotte A. Spencer, Michael A. Palladino, Darrell Killian
2. Chromosomes, Genes, and Traits: An Introduction to Genetics (Revised Edition, 2025) – Amanda Simons
3. Textbook of Medical Genetics: A CBME Approach (1st Edition, 2025) – Anjali S. Sabnis

ECONOMIC BOTANY

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Economic Botany	**CUTM4565**	**Theory + Practice**	**3-1-0 (4)**	**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 outcomes

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

Cos	Course outcomes
CO1	**Understand** the origin, domestication, and genetic diversity of cultivated plants with reference to centers of origin and crop evolution.
CO2	**Describe** morphology, processing, and economic significance of major cereals, legumes, and starch sources.

CO3	**Explain** the botanical characteristics, processing, and uses of spices, beverages, oils, and fats along with their economic importance.
CO4	**Analyse** the production, processing, and applications of natural rubber, drug-yielding plants, including their therapeutic and health aspects.
CO5	**Assess** the classification, morphology, extraction methods, and economic importance of timber plants and natural fibers.

Course Outcome to Program Outcome Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	1	1	2	1	2	2	2	3	3	2
CO2	3	3	3	2	2	1	1	2	1	2	2	2	3	3	2
CO3	3	2	2	2	3	1	1	2	1	3	2	2	3	3	2
CO4	3	3	3	2	2	2	1	3	2	3	2	2	3	3	3
CO5	3	3	3	2	3	1	1	2	1	2	2	2	3	3	2

(High-3, Medium-2, Low-1)

Course Content

Module –I

Origin of Cultivated Plants: Concept of Centre's of Origin, their importance with reference to Vavilov's work. Examples of major plant introductions; Crop domestication and loss of genetic diversity; evolution of new crops/varieties, importance of germplasm diversity.

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.

Module-III

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

Module-IV

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

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.

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).

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

1. Habit sketch of Rice plant and Qualitative test for presence of starch in rice
2. Test for protein in leguminous seeds.
3. Test for reducing and non-reducing sugar
4. Test for the presence of lipid and oil in groundnut seed or oil
5. Test for the presence of lignin in the stem of jute
6. Test for presence of cellulose in cotton Fibre

Text Books:

1. Pandey, B. P. (2017) Economic Botany, S. Chand Publication, New Delhi.
2. Kochhar, S.L. (2012). Economic Botany in Tropics, MacMillan & Co. New Delhi, India.

Reference Books:

1. Kochhar, S.L. (2012). Economic Botany in Tropics, MacMillan & Co. New Delhi, India.
2. Samba Murty, A.V.S.S. and Subrahmanyam, N.S. (2011). Text Book of Modern Economic Botany, CBS Publishers and Distributors, New Delhi.
3. Hill, Albert F. Economic Botany, Tata Mc Grow Hill Publishing Company, Ltd. New Delhi.
4. Wickens, G.E. (2001). Economic Botany: Principles & Practices. Kluwer Academic Publishers, The Netherlands.
5. Singh, V., Pandey, P.C. and Jain, D.K. (2017). Economic Botany, Rastogi Publication, Meerut.
6. Baruah, B. (2017). Economic Botany, Kalyani Publishers, New Delhi.

PLANT PHYSIOLOGY

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Plant Physiology	**CUTM4566**	**Theory + Practice**	**3-1-0 (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 outcomes

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 anti-transpirants 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 apply the knowledge on the molecular mechanisms of photoperiodic and vernalization responses and can pursue higher studies and can get employment opportunity

Course Outcome to Program Outcome Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	1	1	2	1	2	2	2	3	3	2
CO2	3	3	3	2	2	1	1	2	1	2	2	2	3	3	2
CO3	3	2	2	2	3	1	1	2	1	3	2	2	2	3	2
CO4	3	3	3	2	2	2	1	3	2	3	2	2	3	3	3
CO5	3	3	3	2	3	1	1	2	1	2	2	2	3	3	2

(High-3, Medium-2, Low-1)

Course Content

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.

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

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

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

1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. Study of the effect of wind velocity and light on the rate of transpiration in excised twig/leaf.
3. Calculation of stomatal index and stomatal frequency from the two surfaces of leaves of a mesophyte and xerophyte.
4. Calculation of the area of an open stoma and percentage of leaf area open through stomata in a mesophyte and xerophyte (both surfaces)
5. Study of the phenomenon of seed germination (effect of light)
6. Fruit ripening/Rooting from cuttings (Demonstration)

Text Books:

1. Plant Physiology and Development (6th Edition) by Lincoln Taiz, Eduardo Zeiger, Ian M. Møller, and Angus Murphy (2014);
2. A Textbook of Plant Physiology by Dr. A.S. Gontia (2017);
3. Abiotic Stress Signaling in Plants: Functional Genomic Intervention edited by G.K. Pandey, M. Prasad, A. Pandey, and M. Boehmer (2016)

Reference Books:

1. Elucidation of Biotic Stress Signaling in Plants: Functional Genomics Perspective (Volumes 1 & 2) edited by G.K. Pandey (2015);
2. MicroRNAs in Plant Development and Stress Responses edited by S. Sinha and G.K. Pandey (2015);
3. Light and Its Many Wonders by N. Burman, A. Bhatnagar, and J.P. Khurana (2015).

PLANT METABOLISM

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Plant Metabolism	**CUTM4567**	**Theory + Practice**	**3-1-0 (4)**	**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	**Describe** the concept of metabolism, its regulation, and the role of key regulatory enzymes in plant systems.
CO2	**Explain** the mechanisms of carbon assimilation and the significance of various photosynthetic pathways.
CO3	**Analyze** carbohydrate metabolism including glycolysis, TCA cycle, oxidative phosphorylation and their regulation; lipids, and amino acid metabolism, and various pathways involved in energy production and storage.
CO4	**Evaluate** lipid and nitrogen metabolism processes and relate their importance in plant physiology, seed germination, and the role of hormones.
CO5	**Apply** knowledge of ATP synthesis and signal transduction mechanisms to explain energy flow and cellular communication in plants.

Course Outcome to Program Outcome Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	2			1	1	2	2	2	3	2	2
CO2	3	3	2	2	2			1		2	2	2	3	3	2
CO3	3	3	3	3	3			2		2	3	2	3	3	3
CO4	3	3	3	3	2			2		2	2	2	3	3	3
CO5	3	3	3	2	3			2	2	2	3	2	3	3	3

(High-3, Medium-2, Low-1)

Course Content

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

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.

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.

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.

Module-VII

Mechanisms of signal transduction: Receptor-ligand interactions; Second messenger concept, Calcium calmodulin, MAP kinase cascade, GPCR pathway.

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 absorption spectrum of photosynthetic pigments
6. To compare the rate of respiration in different parts of a plant.

Text Books:

1. Hopkins, W.G. and Huner, A. (2019). Introduction to Plant Physiology.John Wiley and Sons. U.S.A. 7th edition.
2. Taiz, L., Zeiger, E., MØler, I.M. and Murphy, A (2018). Plant Physiology and Development.Sinauer Associates Inc. USA. 7th edition.

Reference Books:

1. Harborne, J.B. (1973, 1984, 1998, 2020). Phytochemical Methods.John Wiley & Sons. New York

REPRODUCTIVE BIOLOGY OF ANGIOSPERMS

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Reproductive Biology of Angiosperms	**CUTM4568**	**Theory + Practice**	**3-1-0 (4)**	**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	**Recall** the historical contributions, acquire knowledge on reproductive development and micro gametogenesis
CO2	**Explain** the structure and function of anther, pollen development, male germ unit, ovule and pollen wall.
CO3	**Illustrate** megasporogenesis and megagametogenesis and describe the ultrastructure of female gametophyte.
CO4	**Analyze** the processes of pollination, fertilization, and self-incompatibility mechanisms and discuss methods to overcome incompatibility.
CO5	**Evaluate** the difference between complete and incomplete flowers, embryo and endosperm development, polyembryony, apomixis, and describe seed structure and dispersal mechanisms and able to apply this knowledge for conservation of pollinators and fruit development.

Course Outcome to Program Outcome Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2				1		1	2	2	3	2	2
CO2	3	3	2	2	2			1		2	2	2	3	3	2
CO3	3	3	3	2	2			2		2	2	2	3	3	3
CO4	3	3	3	3	2			2		2	3	2	3	3	3
CO5	3	3	2	3	2			2		2	2	2	3	3	3

(High-3, Medium-2, Low-1)

Course Content

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.

Flower development: genetic and molecular aspects. Anther and pollen biology. Anther wall: Structure and functions.

Module-II

Microgametogenesis; Pollen wall structure, 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.

Module-III

Female gametophyte: Megasporogenesis (monosporic, bisporic and tetrasporic) and megagametogenesis (details of Polygonum type); Organization and ultrastructure of mature embryo sac.

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; Nutrition of embryo; Unusual features; Embryo development; Seed structure, importance and dispersal mechanisms

Module-VII

Embryo-endosperm relationship: Introduction, Classification, Polyembryony and apomixis, Causes and applications

Practice

1. Anther: Wall and its ontogeny; Tapetum (amoeboid and glandular)
2. Study of Spore tetrad, Uninucleate, bicelled and dehisced anther stages through slides/micrographs, male germ unit (MGU) through photographs and schematic representation.
3. Pollen Germination: Calculation of percentage germination in different media using hanging drop method.
4. Ovule: orthotropous, amphitropous/campylotropous, circinotropous, unitegmic, bitegmic
5. Female gametophyte through permanent slides/ photographs: Types, ultrastructure of mature egg apparatus
6. Endosperm: Dissections of developing seeds for endosperm with free-nuclear haustoria

Text Books:

1. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms, Vikas Publishing House. Delhi. 5thedition.
2. Shivanna, K.R. (2003). Pollen Biology and Biotechnology. Oxford and IBH Publishing Co. Pvt. Ltd. Delhi.
3. Singh, V., Pandey, P.C., and Jain, D.K. (2017). Reproductive Biology of Angiosperms, Rastogi Publications, Meerut.
4. Rashid, A. (2022). Reproductive Biology of Angiosperms. IK International Pvt. Ltd.

Reference Books:

1. Raghavan, V. (2000). Developmental Biology of Flowering plants, Springer, Netherlands.
2. Johri, B.M. (1984). Embryology of Angiosperms, Springer-Verlag, Netherlands.
3. Gupta, C.K., Khanduri, P., Mangla, Y. (2022). Reproductive Biology of Angiosperms: Concepts and Laboratory Methods. Cambridge University Press; New edition.

PLANT BIOTECHNOLOGY

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Plant Biotechnology	**CUTM1439**	**Theory + Practice**	**3-1-0 (4)**	**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 outcomes

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

COs	Course outcomes
CO1	**Understand** the historical development, media composition, and fundamental concepts of plant tissue culture including totipotency, organogenesis, embryogenesis, and protoplast techniques.
CO2	**Apply** tissue culture techniques for micropropagation, virus elimination, secondary metabolite production, and germplasm conservation.
CO3	**Describe** recombinant DNA technology including types of restriction endonucleases, cloning vectors, and restriction mapping.
CO4	**Explain** gene cloning techniques, bacterial transformation, PCR-mediated cloning, and screening of genomic/cDNA libraries.
CO5	**Analyze** gene transfer methods, transgenic plant selection, and evaluate applications of biotechnology in crop improvement with improved yield, nutrient content, and resistance to pests or environmental stress, bioremediation, and industrial products.

Course Outcome to Program Outcome Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2				1		1	2	2	3	2	2
CO2	3	3	3	3	2			2		2	3	2	3	3	3
CO3	3	3	2	2	2			1		2	2	2	3	3	2

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

(High-3, Medium-2, Low-1)

Course Content

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;

Module-II

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

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).

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

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).

Module-VI

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

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.

Practice

1. Preparation of MS medium.
2. Demonstration of in vitro sterilization and inoculation methods using leaf explants of Datura, or Brassica.
3. 3: Study of anther, embryo and endosperm culture micro propagation
4. Demonstration of vector construction
5. Isolation of bacterial DNA
6. Study of methods of Agrobacterium-mediated gene transfer through photographs

Text Books:

1. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
2. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms. Vikas Publication House Pvt. Ltd., New Delhi. 5th edition.
3. Shivani Jaggi Guleria (2025). Fundamentals of Plant Biochemistry and Biotechnology. Atlantic Publisher.
4. HS. Chawla (2024). Introduction to Plant Biotechnology OXFORD and IBH Publishers. 4th Edition.

Reference Books:

1. Stewart, C.N. Jr. (2008). Plant Biotechnology & Genetics: Principles, Techniques and Applications.John Wiley & Sons Inc. U.S.A.
2. Sandy B. Primrose (1991). Molecular Biotechnology Blackwell scientific publishers

BIOINFORMATICS AND BIOSTATISTICS

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Bioinformatics and Biostatistics	**CUTM4548**	**Theory + Practice**	**3-1-0 (4)**	**Nil**

Objectives

- To introduce undergraduate botany students to the basic concepts and applications of computational biology and bioinformatics
- To collect the data for processing and analysis of data for inference
- To know the applications of biostatistical methods and interpret the results.

Course outcomes

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

COs	Course outcomes
CO1	**Understand** the fundamentals of bioinformatics and acquire knowledge on primary and secondary data collection and Basic concepts of algorithms
CO2	**Explain** the basic concepts of Computational Biology and its significance in biological data analysis
CO3	**Describe** various biological databases and know the use of radioisotopes for analysis of biological samples.
CO4	**Apply** concepts of mathematical and statistical theory underlying the application of biostatistical methods; use and interpret results from specialized computer software, and statistical analysis of research data
CO5	**Perform** basic statistical analysis including data collection, measures of central tendency, and hypothesis testing and analyze complex data sets by multivariate analysis

Course Outcome to Program Outcome Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	2				1		1	2	2	3	2	1
CO2	3	3	2	2				1		2	3	2	3	2	2
CO3	3	3	2	2				1		2	3	2	3	2	2
CO4	3	3	3	3				2		2	3	3	3	3	2
CO5	3	3	3	3	2			2		3	3	3	3	3	3

(High-3, Medium-2, Low-1)

Course Content

Module I

Introduction to Bioinformatics and Computational Biology: What is Bioinformatics? Role and importance in Botany and Life Sciences in Bioinformatics, Basic concepts of algorithms (without programming) in bioinformatics, Applications in taxonomy, ecology, plant evolution, molecular biology

Module II

Basics of Sequence and Sequence Alignment: Biological sequences: DNA, RNA, and Proteins, Concepts of Sequence Alignment: Local and Global, Pairwise vs Multiple alignment, Overview of BLAST and its biological applications

Module III

Biological Databases: Importance of databases in biology, Types of biological data: Genomic DNA, cDNA, mRNA, ESTs, Database classifications: Primary, Secondary, Functional, Composite (Examples: GenBank, UniProt, PubMed, Ensembl, PDB)

Module IV

Scoring and Visualization in Sequence Analysis: Concept of scoring matrices (PAM and BLOSUM – basics only), Gaps and penalties in alignments, Introduction to phylogenetic trees and their importance in plant evolution

Module V

Basics of Sequence Alignment: Local and Global alignment recap, Introduction to tree construction methods, Interpretation of evolutionary trees, Introduction to MEGA software for basic phylogeny

Module-VI

Collection of Data Primary and Secondary: Statistical methods: basic principles; uses of statistics; Types and methods of data collection procedures: merits and demerits; Classification: tabulation and presentation of data, sampling methods.

Module-VII

Measures of central tendency: Mean, median, mode, geometric mean, merits and demerits. variance, standard deviation, mean deviation, standard error, Coefficient of variation, and confidence interval. Statistical inference hypothesis: simple hypothesis: Student 't' test - chi square test; Multiple comparison: The Turkey’s test

Practice

1. Sequence retrieval from NCBI and analysis using BLAST
2. Exploring Gen Bank, UniProt, and PubMed databases
3. Basic sequence alignment using online tools (NCBI BLAST, EMBL-EBI)
4. Construction of phylogenetic tree using MEGA software
5. Calculation of mean, standard deviation, and standard error
6. Chi-square test of field samples to test distribution pattern (binomial and Poisson distribution), Two-factor ANOVA and test of hypothesis.

Text Books:

1. Introduction to bioinformatics by Teresa K. Attwood, David J. Parry-Smith, 1999, Pearson Education.
2. Arthur M.Lesk, Introduction to Bioinformatics, Oxford University Press, New Delhi, 2003.
3. D.Higgins and W.Taylor (Eds), Bioinformatics-Sequence, Structure and data banks, Oxford University Press, New Delhi, 2000.
4. Banerjee K. Pranab (Revised Ed) Introduction to Biostatistics. S Chand Publication New Delhi
5. Statistical Analysis of epidemiological data, Selvin, S., 1991.New York University Press.
6. Bast, Felix. (2023). Biostatistics and Mathematical Biology. Pearson Education (10 July 2023); Pearson Education.

Reference Books:

1. Bioinformatics: Sequence and Genome Analysis by Mount D., 2004, Cold Spring Harbor Laboratory, Press, New York.
2. Biological Sequence Analysis: Probabilistic models of protein and Nucleicacids by Durbinet al., 2007, Cambridge University Press.
3. Biostatistical Analysis, Jar, J.H., 2006, 4th Ed, Pearson Education Inc.
4. Stastical Procedure for Agricultural Research, Gomez, K.A., and Gomez, A. A., 1984, Wiley.
5. Statistical Analysis of epidemiological data, Selvin, S., 1991. New York University Press.

Advanced Microbiology

Subject Name	Code	Type of course	T-P-Pr(Credit)
Advanced Microbiology	**CUTM4549**	Theory + practice	3-1-0(04)

Course objectives

- To know various Culture media and their applications and also understand various physical and chemical means of sterilization.
- To perform routine culture handling tasks safely and effectively
- To know the various physical and chemical growth requirements of microbes and get equipped with various methods of microbes culture techniques and their role in various industry

Course outcomes

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

COs	Course outcomes
CO1	**Understand** the basic concepts of microbiology, classification, structure, nutrition, and reproduction of common microbes, genetic diversity of microbes.
CO2	**Explain** microbial culture methods and growth kinetics, life cycle, their transmission, including physiological aspects and metabolism.
CO3	**Describe** applications of microbes in agriculture, cosmetics, and pharmaceutical industries, growth kinetics, and different metabolic process (photosynthesis, respiratory metabolism of microbes.
CO4	**Categorize** important diseases caused by bacteria, protozoa and virus, emergence of multiple-drug resistance strains, interpretation of molecular markers.
CO5	**Adopt** the methods of food preservation, microbiological legal standards of selected food and milk products, bioreactors, and genome mapping

Course Outcome to Program Outcome Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	2				1		1	2	2	3	2	1
CO2	3	3	2	3				1		2	3	2	3	3	2
CO3	3	3	3	3				2		2	3	2	3	3	3
CO4	3	3	3	3	2			2		3	3	3	3	3	3
CO5	3	3	3	3	2			2		3	3	3	3	3	3

(High-3, Medium-2, Low-1)

Course Content

Module I

Classification of Bacteria: Introduction to micro-organisms, Classification of bacteria (Phylogenetic system of classification, Bergey's manual), metabolic groups of bacteria.

Structure of Bacteria: Ultra structure of bacterial cell and cell wall. Nutrition of bacteria: modes of nutrition, nutritional types, growth characteristics, reproduction and genetic recombination: binary fission, resting structure, conjugation, transformation and transduction; mechanism of antibacterial action.

Module II

Classification of Virus: Classification of viruses; Structural and genetic diversity of viruses

Virus: Structure, plant and animal viruses, nature and transmission, lytic and lysogenic cycle, genome organization (TMV, CMV, CAMV and Gemini viruses), isolation and purification, detection, identification and economic importance; bacteriophages, viroids, prions, viruses in cancer

Module III

Microbial culture methods: Culture media (types, Different culturing Technique), Isolation, purification, growth, maintenance and preservation of microbes, axenic and synchronous culture, batch and continuous culture

Module IV

Microbial Physiology and Metabolism: Growth Kinetics, Growth cycle, Logistic growth equation, Measurement and growth monitoring in culture, Factor affecting growth; Photosynthetic pigments, Paths of carbon and electron in bacterial photosynthesis; Fermentation, Respiratory metabolism, Embden-Meyerhoff pathway, Entner-Doudroff pathway, Pasteur Effect.

Module V

Applications of microbes in agriculture and industry: Agriculturally important microorganisms, Bio fertilizers, bio pesticides, mycorrhizae, industry (alcoholic beverages, citric acid, penicillin production), environment (pollution indicator and control), and genetic engineering

Food Microbiology: Microbial toxins produced in food items, Probiotics and prebiotics; Methods of food preservation, Microbiological legal standards of selected food and milk products

Module VI

Medical Microbiology: Host pathogen interactions, important plant diseases caused by bacteria, protozoa, virus; Antibiotics: Definition, phenomenon of antibiotics, and mode of action, biochemical mechanisms of resistance development, multiple-drug resistance

Module VII

Microbial genetics: Genetic regulation: Operon concept (Lac, Trp operon), Genetic mapping: Genome mapping of E. *coli*, Molecular markers in genome analysis.

Bioprocess technology and Engineering: Fermenter design and growth processes, types of bioreactors

Practice

1. Working principles and operations of basic equipment of microbiological laboratory.
2. Microbial culture media preparation and sterilization techniques.
3. Isolation of bacteria by different culture methods (Streak, pour and spread plate method).
4. Preparation of bacterial smear and different staining methods (Gram's staining, Acid-fast staining).
5. Preparation of antibiotic disc and antibiotic sensitivity test.
6. Detection of microorganisms in air, soil and water by standard plate count method.

Text Books:

1. Dubey R C. (2023). A Textbook of Microbiology. 5th Edition, S Chand & Company.
2. Singh, R.P. Microbiology. 2020-2021 edition
3. Dubey R. C. Maheswari, D. K. (2022). A Textbook of Microbiology. 5th Edition. S. Chand and Company.
4. Dubey R. C. Maheswari D. K. (2023). Practice Microbiology. S. Chand.

Reference Books:

1. Pelczar, Michale J. Jr., Chan E.C.S., Krieg Noel R. (2023). Microbiology, 5th Ed, Affiliated East-West Press Private Limited, G-1/16, Ansari Road, New Delhi 110002
2. Prescott, L. M., Harley, J. P. and Klen, D. A. (1999). Microbiology, 7thEd., McGraw-Hill, New York.
3. Agrios, G. N. (2005). Plant Pathology,5th Ed, Elsevier Academic press,USA

ADVANCED BIOCHEMISTRY

Subject name	Code	Type of course	T-P-Pr (Credit)
Advanced Biochemistry	**CUTM4550**	Theory+ practice	3-1-0 (04)

Objectives

- To understand the structure and function of key biomolecules (carbohydrates, proteins, lipids, and nucleic acids) and their roles in plant biochemical processes.
- To explore the principles and applications of enzymology and molecular signal transduction in plants, including enzyme kinetics, regulation, and plant hormone signaling.
- To apply biochemical knowledge to real-world problems in agriculture, industry, and environmental sustainability through the study of secondary metabolites, enzyme technologies, and applied plant biochemistry.

Course outcome

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

Cos	Course outcomes
CO1	**Know** about the structural and functional properties of biomolecules and their roles in plant cells.
CO2	**Explain** enzyme kinetics, inhibition, and regulation mechanisms in the context of plant metabolism
CO3	**Demonstrate** the use of enzyme technology (e.g., purification, immobilization, reactors) for industrial or agricultural applications
CO4	**Analyze** molecular signaling pathways and biochemical responses of plants under stress conditions such as drought or salinity
CO5	**Design** biotechnological strategies using enzymes, biosensors, or plant metabolites for sustainable agriculture and industrial processes.

Course Outcome to Program Outcome Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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	0	2	3	2

(High-3, Medium-2, Low-1)

Course Content

Module 1

Biomolecules: Structure and Function; **Carbohydrates:** Complex polysaccharides (starch, cellulose, hemicellulose), glycoproteins; Proteins: Structure-function relationship, plant enzymes; Lipids: Phospholipids, glycolipids, sterols in membranes; Nucleic Acids: DNA/RNA types, replication in plant cells

Module II

Enzymology: Enzyme classification, coenzymes, isoenzymes; Kinetics (Michaelis-Menten, Lineweaver-Burk); Enzyme inhibition and regulation; Allosteric enzymes and feedback inhibition; Role of enzymes in plant metabolism

Module III

Enzyme Technology: Enzyme Purification, Assay, Large Scale production of Enzyme; Enzyme Immobilization (kinetics), enzyme reactor; Biotransformation, Nobel Enzyme

Module IV

Molecular Biochemistry and Signal Transduction: Hormonal signaling (auxin, gibberellin, abscisic acid, ethylene); Signal transduction pathways (receptor kinases, second messengers like Ca^{2+}, IP3); Redox signaling and ROS in plants; Protein phosphorylation/dephosphorylation

Module V

Secondary Metabolites and Phytochemistry: Phytochemicals and secondary metabolites: alkaloids, flavonoids, terpenes; Role of Secondary Metabolites in plant defense, pollination, allelopathy; Importance in pharmaceuticals, nutrition, and agriculture

Module VI

Applied Aspects of Plant Biochemistry: Biochemical basis of plant stress responses (drought, salinity, temperature, pathogens); Applications of Plant Biochemistry in Agriculture (Biofertilizers, biopesticides, GMO); Use in disease diagnosis, bioremediation; Role of biosensors and plant-based biofuels in sustainable agricultural practices

Module VII

Industrial Biochemistry and Enzyme Applications: Industrial applications of enzymes in sectors such as food, agriculture, and healthcare, Detergents, leather, textiles; Biochemical assessment of crops for proteins, vitamins, antioxidants; Bio-Fortification and nutraceuticals; Microbial

polysaccharides: Dextrans, Xanthan gum, Polyhydroxyalkanoates (PHAs) and Polyhydroxybutyrate (PHB)

Practice

1. Quantitative estimation of Carbohydrates/Nucleic Acid
2. Quantitative estimation of proteins (Biuret, Lowry, BCA and Bradford methods)
3. Effects of pH, Temperature, and Substrate Concentration on enzyme activity
4. Estimation of urease activity in plant sample
5. Extraction of Phytochemicals from Plants
6. Bio-diesel production from Biomass and its Characterization
7. Preparation of neem extract biopesticide and testing its effect on leaf-eating insects

Text Books:

1. David L. Nelson, Michael M. Cox. Lehninger Principles of Biochemistry, W.H. Freeman, 8th Edition (2021)
2. Jeremy M. Berg, John L. Tymoczko, Lubert Stryer. Biochemistry, W.H. Freeman, 9th Edition (2019)
3. Hans-Walter Heldt, Birgit Piechulla, Plant Biochemistry, Elsevier, 5th Edition (2021)
4. Satyanarayana, U. and Chakrapani, U, Biochemistry, Elsevier, 6th Edition (2021)

Reference Books:

1. Bob B. Buchanan, Wilhelm Gruissem, Russell L. Jone, Biochemistry & Molecular Biology of Plants, Wiley Blackwell, 2015
2. Michael Wink, Secondary Metabolites in Plant Defense Mechanisms, Springer, 2010
3. Julio Polaina, Andrew P. MacCabe, Industrial Enzymes: Structure, Function and Applications, Springer, 2007
4. Trevor Palmer, Philip L. Bonner - Enzymes_ Biochemistry, Biotechnology, Clinical Chemistry-Woodhead Publishing, 2007

ANALYTICAL TECHNIQUES IN PLANT SCIENCES

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Analytical Techniques in Plant Sciences	**CUTM4551**	**Theory + Practice**	**3-1-0 (4)**	**Nil**

Objectives

- To learn the principles and operations of microscopes of various complexity and their application in biological studies.
- To learn the techniques of centrifugation for separation of biological samples.
- To learn the methods of radioisotopes measurement in and their importance in study of biological materials and processes.

Course outcomes

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

COs	Course outcomes
CO1	Proper understanding of the microscopy and knowledge to analyze plant samples using electron microscopy and flow Cytometer.
CO2	Separation of biomolecules and cell organelle and appropriate application of the knowledge of centrifugation for the same.
CO3	Basic knowledge on the use of radioisotopes for analysis of biological samples.
CO4	Extraction and qualitative and quantitative analysis of extracts as well as the assay mixtures using spectrophotometer.
CO5	Skillful application of chromatographic techniques for separation of amino acids, pigments and biomolecules.

Course Outcome to Program Outcome Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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**	**0**	**2**	**3**	**2**

(High-3, Medium-2, Low-1)

Course Content

Module-I

Imaging and related techniques: Principles of microscopy; Light microscopy; Fluorescence microscopy; Flow cytometry (FACS); Transmission and Scanning electron microscopy – sample preparation for electron microscopy, cryofixation, negative staining, shadow casting, freeze fracture, freeze etching.

Module-II

Cell fractionation: Centrifugation: Differential and density gradient centrifugation,
Sucrose density gradient, CsCl2 gradient, analytical centrifugation, ultracentrifugation. Radioisotopes: Use in biological research, auto-radiography, pulse chase experiment.

Module-III

Spectroscopy: Principles, Components and working mechanism of UV-Visible and Infra-Red spectroscopy, Fluorescence spectroscopy, Chlorophyll a fluorescence, Flame photometer, Bomb Calorimeter and Atomic Absorption Spectrophotometer.

Module-IV

Chromatography: Principle of chromatography, paper chromatography, column chromatography, TLC, HPLC, Ion-exchange chromatography, Molecular sieve chromatography, Affinity chromatography.

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

Practice

1. Study of different microscopic techniques observation through simple and compound microscope
2. Study of PCR using demonstration.
3. To separate pigments by paper chromatography.
4. To separate phytochemicals by thin layer chromatography.
5. Qualitative analysis of total Carbohydrates, Proteins & Lipids.
6. Demonstration of SEM/ Electrophoresis/ Chromatography.
7. Measuring OD using spectroscopy.
8. Beer Lombard’s law and its validation

Text Books:

1. Patil, C. S. (2017). Advanced Analytical Techniques, ABE Books, New Delhi.
2. Pandey BP (2023). Botany for B.Sc. Students Semester I, NEP 2020; S. Chand publication, New Delhi

Reference Books:

1. Aneja, K. R. (2014). Laboratory manual of microbiology and biotechnology, Medtech, New Delhi
2. Ausubel, F., Brent, R., Kingston, R. E., Moore, D.D., Seidman, J.G., Smith, J.A., Struhl, K. (1995). Short Protocols in Molecular Biology. John Wiley & Sons. 3rd edition.
3. Plummer, D.T. (1996). An Introduction to Practical Biochemistry. Tata McGraw-Hill Publishing Co. Ltd. New Delhi. 3rd edition.
4. Ruzin, S.E. (1999). Plant Micro technique and Microscopy, Oxford University Press, New York. U.S.A.
5. Pandey, B.P. (2023). Botany for B.Sc. Students Semester I: NEP 2020, S. Chand Publishing.

PHARMACOGNOSY AND PLANT METABOLITES

Subject Name	Code	Type of course	T-P-Pr (Credit)
Pharmacognosy and Plant Metabolites	**CUTM4552**	Theory + Practice	**(3-1-0)** (04)

Course objectives

- To understand the principles and applications of various microscopy techniques including electron microscopy and flow cytometry.
- To learn the methods and significance of cell fractionation and centrifugation techniques in biological research.
- To comprehend the basic principles and applications of spectroscopy techniques used in biological studies.
- To gain knowledge of chromatography techniques for separation and analysis of biomolecules.
- To develop understanding of advanced methods for protein and nucleic acid characterization including electrophoresis, mass spectrometry, and X-ray crystallography.

Course outcome

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

COs	Course outcomes
CO1	**Acquire** the knowledge about the commercial medicinal and aromatic plants, cultivation, conservation, yield and cost benefit analysis and marketing strategies
CO2	**Understand** the techniques of extraction, isolation of phytoconstituents from selected medicinal plants.
CO3	**Identify** the important therapeutic classes of compounds
CO4	**Analyse** different phytocompounds through phytochemical analysis of selected medicinal plants.
CO5	**Estimate** about the importance of crude drugs and quality control methods for authenticity of crude drugs

Course Outcome to Program Outcome Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	1			2	2		3	2	2	3	3	3
CO2	3	3	3	3	1	2	3	3		3	2	3	3	3	3
CO3	3	3	3	3	1	1	3	3		3	3	3	3	3	3
CO4	2	3	3	3	1	1	3	3		2	3	3	3	3	3
CO5	3	3	3	3	1	2	3	3		3	3	3	3	3	3

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

Course content

Module I

Concept note on commercial medicinal and aromatic plants (MAPs); Collection, cultivation and trade of MAPs; Relationship between conservation sites and richness of MAPs; Commercial MAPs of India; Promoting medicinal plants cultivation as a tool for biodiversity conservation. Yield assessment and cost- benefit analysis; Role of National Medicinal Plant Board (NMPB) in Promotion of MAPs; Marketing of Medicinal Plants: Challenges and Strategies.

Module II

Methods of extraction, isolation and characterization of natural products; Various separation techniques used for isolation of natural products; Biosynthetic pathways; Primary metabolites, their examples; Secondary metabolites, various classes of secondary metabolites (e.g. Alkaloids, glycosides, tannins, lignans, saponins, lipids, flavonoids, coumarins etc.).

Module III

Important therapeutic classes: Anti-diabetics, hepatoprotectives, immunomodulators, nutraceuticals, natural products for gynaecological disorders, anti-cancer, anti-viral (mainly anti-HIV), adaptogens etc.

Module IV

Phytochemistry of Neem: General chemical class and identification tests, specific tests for markers, special reference to alkaloids (nimbin, nimbolide etc.);

Photochemistry of Brahmi: General chemical class and identification tests, specific tests for markers, special reference to bitters (bacosides)

Phytochemistry of Turmeric: General chemical class and identification tests, specific tests for markers, special reference to phenols (curcuminoids);

Phytochemistry of *Withania somnifera*: General chemical class and identification tests, specific tests for markers, special reference to steroids (withanolides).

Module V

Phytochemistry of *Andrographis paniculata*: General chemical class and identification tests, specific tests for markers, special reference to bitters (andrographolides);

Phytochemistry of Ginger: General chemical class and identification tests, specific tests for markers, special reference to phenols (gingerols);

Phytochemistry of Garlic: General chemical class and identification tests, specific tests for markers, special reference to phenols (allicin);

Phytochemistry of *Terminalia arjuna*: General chemical class and identification tests, specific tests for markers, special reference to triterpenes (arjunolic acid)

Module VI

Introduction: Definition, history, scope of Pharmacognosy in indigenous system of medicine

Sources of drugs: Biological, marine, mineral and modern techniques like plant tissue cultures as sources of drugs; Classification of drugs and natural origin: Alphabetical, morphological, taxonomical, chemical and pharmacological classification of drugs; Demand and supply of crude drugs and their regulations with reference to trade and biodiversity

Module VII

Quality control and drug evaluation: Adulteration; Significance of Pharmacopoeia standards; Detection of adulteration by organoleptic, macroscopic and microscopic methods for detection of adulteration.

Practical

1. Preparation of extracts of Herbs by successive solvent extraction method to record the percentage yield.
2. Detection of Phytoconstituents such as i) Alkaloids, ii) Steroids, Triterpenoids and their glylosides and Saponins iii) Flavonoids and their glycosides iv) Anthracene Glycosides v) Coumarins vi) Tannins.
3. Antimicrobial activity of some selected medicinal plants and antibiotics.
4. Isolation and Purification of the following natural products: (a) Piperine from Black Pepper, (b)Caffeine from Tea Powder, (c) Eugenol from Clove oil.
5. Extraction and estimation of volatile oils by Clevenger's method (Hydro distillation method).
6. TLC figure print profiles of the following medicinal plants with special emphasis on their marker compounds: (a) *Withania somnifera*, (b) *Bacopa monnieri*, (c) *Curcuma longa*.

Reference Books:

1. Biren Shah and A.K. Seth. (2020). Textbook of Pharmacognosy and Phytochemistry. CBS Publishers and Distributors Pvt. Ltd; 2nd edition
2. Jarald, Edwin E. and Edwin Jarald Sheeja (2018). Textbook of Pharmacognosy and Phytochemistry. CBS Publisher.
3. William C. E (2009). Trease and Evans Pharmacognosy.

Practical Books:

1. Raphael Ikan (2013). Natural Products: A laboratory guide, Academic Press.
2. C.K. Kokate (2019). Pharmacognosy. Nirali Prakashan Publisher
3. Vinod Rangari (2019). Pharmacognosy and Phytochemistry. Career Publications; 4th edition
4. Krishnaswamy N. R. (2021). Chemistry of Natural Products: A Laboratory Handbook.Universities Press (India) Private Limited.

PLANT BREEDING

Subject Name	Code	Type of course	T-P-Pr (Credit)	Prerequisite
Plant Breeding	**CUTM4569**	**Theory + Practice**	**3-1-0 (4)**	**Nil**

Objectives

- To understand the history, scope, and objectives of plant breeding and germplasm conservation.
- To describe and distinguish between various breeding methods used for sexually and asexually propagated crops.
- To apply conventional and molecular breeding techniques to improve crop varieties.
- To analyse and implement special breeding approaches such as mutation breeding, polyploidy, MAS and selection techniques for cultivar development.
- To understand the legal, participatory, and regulatory frameworks involved in cultivar release and farmer's rights.

Course outcomes

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

COs	Course outcomes
CO1	Recall the history, scope, and objectives of plant breeding and list methods of germplasm conservation.
CO2	Explain breeding methods and mechanisms like self-incompatibility and male sterility.
CO3	Apply breeding methods such as mass selection, pedigree, and backcross for crop improvement.
CO4	Analyze special breeding strategies like mutation breeding, MAS, polyploidy, and ideotype breeding.
CO5	Evaluate hybridization and F1 seed development techniques and their impact on crop performance and able to design and create a basic plant breeding program including cultivar development and testing strategies.

Course Outcome to Program Outcome Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2		1				1		1	2	1	3	2	1
CO2	3	3	2	2	1			1	1	1	2	2	3	3	1
CO3	3	3	3	2	3	1	1	2	1	2	3	3	3	3	2
CO4	2	3	3	3	3	1	1	2	1	3	3	3	3	3	2
CO5	3	3	3	3	3	2	2	2	2	3	3	3	3	3	3

(High-3, Medium-2, Low-1)

Course Content

Module 1

Fundamentals of Plant Breeding: History, objectives, and scope of plant breeding; Centers of origin and various methods of germplasm conservation (seed banks, plant banks, and DNA banks), processes of germplasm evaluation and distribution.

Module II

Breeding methods: Breeding methods in asexually/ clonally propagated crops, clonal selection; Incompatibility systems (self-incompatibility types and mechanisms); male sterility (genetic, cytoplasmic, and cytoplasmic-genetic), their roles in enhancing breeding efficiency in crop plants.

Module III

Breeding techniques: Conventional breeding methods for self, cross-pollinated crop plants: Mass, pure line, pedigree, and bulk selection; Backcross method for trait transfer, quantitative trait transfer, and modifications for cross-pollinated crops; Heterosis and hybrid vigour.

Module IV

Special breeding techniques: Mutation breeding, breeding for abiotic and biotic stresses; Concept of plant ideotype and its role in crop improvement, concept of MAS, concept of polyploidy and wide hybridization, doubled haploidy.

Module V

Hybridization techniques: Interspecific and distant hybridization, emasculation, bagging, tagging, pollination, and harvesting and storing of the F1 seeds and selfing for developing improved crop varieties;

Module VI

Tools in plant breeding: Cytogenetic tools in plant breeding, Genetic crossing; Molecular markers: RAPD, ISSR, SSR, SNPs, Marker Assisted selection: Foreground and background selection; Marker assisted pyramiding.

Module VII

Cultivar development: Testing, release and notification, maintenance breeding; Participatory Plant Breeding, Plant breeders' rights and regulations for plant variety protection and farmer's rights.

Practice

1. To study the floral biology in selected self and cross pollinated species.
2. Demonstration of Selfing and crossing hybridization techniques in selected plant species.
3. Demonstration of selection methods in segregating populations and evaluation of breeding material.
4. To amplify the supplied DNA sample by using random amplified polymorphic DNA(RAPD) and inter simple sequence repeat (ISSR) markers.
5. To amplify the supplied DNA sample using SSR markers
6. To determine the analysis of variance (ANOVA) of two variants.

Text Books:

1. H.K. Chaudhary, Plant Breeding: Classical to Modern"**(**2019)
2. C. Neal Stewart Jr. Plant Biotechnology and Genetics: Principles, Techniques, and Applications (2016)
3. B.D. Singh. Plant Breeding: Principles and Methods (2015).

Reference Books:

1. George Acquaah, "Principles of Plant Genetics and Breeding". Wiley Blackwell.
2. George A. 2012. Principles of Plant Genetics and Breeding. John Wiley & Sons.