DEPARTMENT OF BOTANY

SYLLABUS FOR FOUR YEAR UNDERGRADUATE PROGRAMME (FYUGP)

(FIRST– SIXTH SEMESTER)

Approved by Academic Council vide Resolution no. AC – 03/2024/05 Dated: 04 – 05 – 24

ARYA VIDYAPEETH COLLEGE (AUTONOMOUS)

ARYA NAGAR, GUWAHATI – 16

CONTENT

PREFACE

"Education is not preparation for life; education is life itself." —John Dewey

The aim of imparting education is not only to increase the knowledge but also to create the possibilities for a student to invent and discover. The purpose of this syllabus is to establish minimum basic concepts for each course to meet the needs of all our students. All the elements in this syllabus amalgamate to bring out the best in every student and enable them to be on the path of continuous progress.

The syllabus is framed based on Learning Outcome Based Education (LOCF) - the spirit of NEP, 2020. The programmes offered by the college are :

i. Bachelor Degree in Arts
ii. Bachelor Degree in Science
iii. Bachelor Degree in Commerce

Under the above programme, the following courses are offered by the college:

i. Core Course
ii. Minor Course
iii. Skill Enhancement Course
iv. Interdisciplinary Course
v. Ability Enhancement Course
vi. Value Added Course
vii. Internship

Programme outcome of each programme and Programme Specific Outcomes of each discipline/subject offered by the college is mapped with course learning outcome of each course. Graduate attributes of students obtaining Undergraduate Degree from the college are also incorporated in the syllabus.

The syllabus includes eight semesters where there will be 23 Core Courses, 8 Minor Courses, 2 Value Added Courses, 3 SEC Courses, 3 IDC Courses, 4 AEC courses and internship.. The total credit offered for eight semesters is 160.

The syllabus framed takes into account the different styles of learning – audio, visual and experiential. The syllabus correlates academics to real life situations balancing social and emotional stimulation among the students and imbibe human values. Also the syllabus gives the opportunity for the theoretical knowledge to be pursued ensuring maximum application of it.

Structure of Four Year Undergraduate Course

Semester	Type	Core	Minor	SEC	IDC	AEC	VAC/FC	IN
	Credit	4	4	3	3	2	4(2 + 2)	2
I		CE-1114	MN-1114	SE-1113	ID-1113	AE-1112	VL-1112 (Two Courses)	-
II		CE-2114	MN-2114	SE-2113	ID-2113	AE-2112	VL-2112 (Two Courses)	-
III		CE-3214	MN-3214	SE-3213	ID-3213	AE-3212	-	-
		CE-3224						
IV		CE-4214	MN-4214	-	-	AE-4212	-	IN-4212
		CE-4224						
		CE-4234						
V		CE-5314	MN-5214	-	-	-	-	-
		CE-5324						
		CE-5334						
		CE-5344						
VI		CE-6314	MN-6214	-	-	-	-	-
		CE-6324						
		CE-6334						
		CE-6344						
VII		CE-7414	MN-7314	-	-	-	-	-
		CE-7424						
		CE-7434						
		CE-7444						
VIII		CE-8414	MN-8314	-	-	-	-	-
		CE-8424**						
		CE-8434**						
		CE-8444**						

****Students who secure more than 7.5 CGPA at the end of third year (6th semester) may opt for a research dissertation of 12 credits instead of the three core papers.**

Course code: **First two letters is the abbreviation of course component**
First digit implies semester number
Second digit implies course level
Third digit implies course
Fourth digit implies credit points per course.

Digit	Course Level
1	100 - 199
2	200 - 299
3	300 - 399
4	400 - 499

Semester Wise Credit Distribution

Semester	CREDIT DISTRIBUTION							
	CORE	MINOR	SEC	AEC	IDC	VAC/FC	IN	TOTAL
FIRST	1 x 4	1 x 4	1 x 3	1 x 2	1 x 3	2 x 2	--	20
SECOND	1 x 4	1 x 4	1 x 3	1 x 2	1 x 3	2 x 2	--	20
THIRD	2 x 4	1 x 4	1 x 3	1 x 2	1 x 3	--	--	20
FOURTH	3 x 4	1 x 4	--	1 x 2	--	--	1 x 2	20
FIFTH	4 x 4	1 x 4	--	--	--	--	--	20
SIXTH	4 x 4	1 x 4	--	--	--	--	--	20
SEVENTH	4 x 4	1 x 4	--	--	--	--	--	20
EIGHT	4 x 4	1 x 4	--	--	--	--	--	20

SEC: SKILL ENHANCEMENT COURSE

AEC: ABILITY ENHANCEMENT COURSE

IDC: INTERDISCIPLINARY COURSE

VAC/FC: VALUE ADDED COURSE

IN: INTERNSHIP

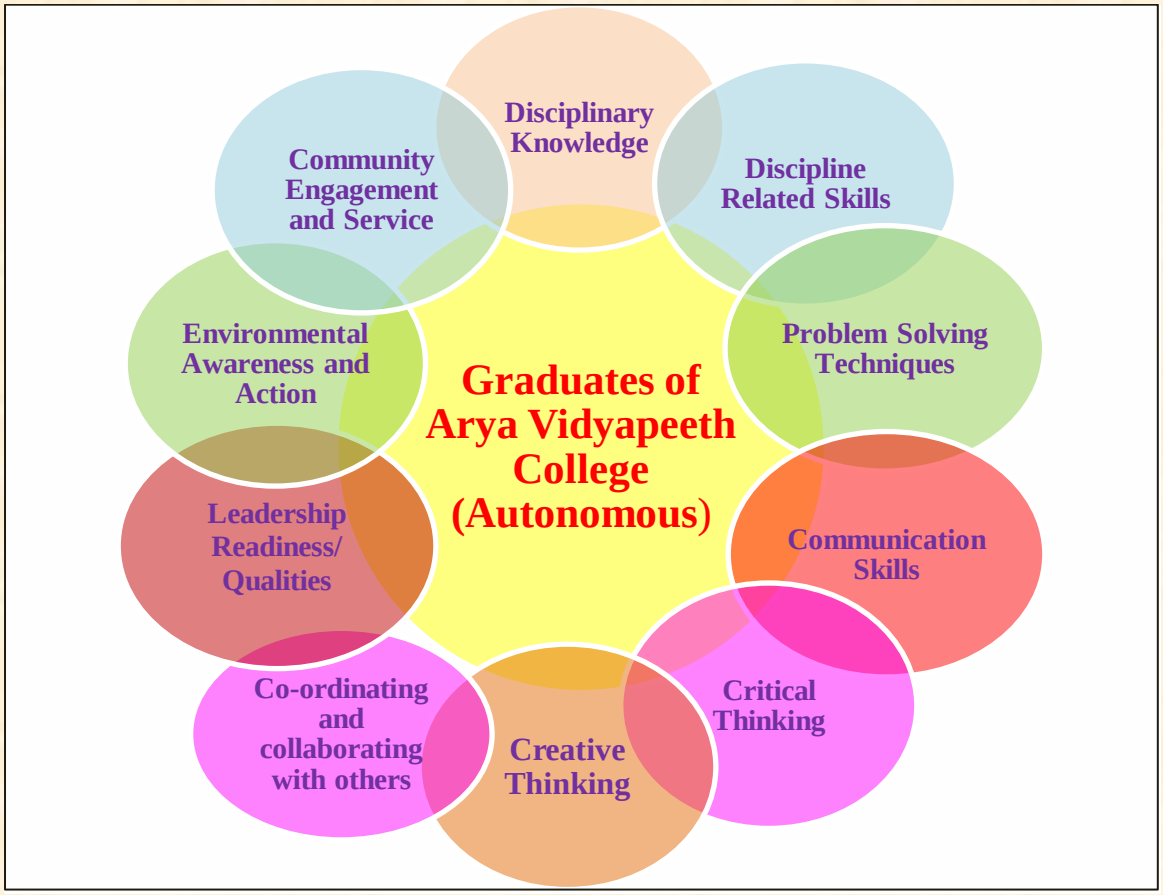
Abbreviation of Course Components:

CE (Core), MN (Minor), SE(Skill Enhancement Course), AE (Ability Enhancement Course), VL (Value added Course), ID (Interdisciplinary Course), IN (Internship)

GRADUATE ATTRIBUTES

Graduate Attributes:

Graduate Attributes are the qualities, skills and understandings that the students should develop during their time with the college. These attributes consequently shape the contribution they are able to make to their profession and society. They are the qualities that also prepare graduates as agents of social good in an unknown future. These attributes sets them apart from those without a degree. The graduate attributes of Arya Vidyapeeth College (Autonomous) are:



Model of Graduate Attributes

1. **Disciplinary knowledge:** Graduates shall acquire comprehensive knowledge and understanding of their subject area, the ability to engage with different traditions of thought, and the ability to apply their knowledge in practice including in multi-disciplinary or multi-professional contexts.
2. **Discipline related skills:** Skills in areas related to specialization in the chosen disciplinary/interdisciplinary/major/minor area(s) of learning in a broad multidisciplinary context. In addition create, select, and apply appropriate modern techniques, resources and IT tools.
3. **Problem solving skills:** A capacity for problem identification, the collection of evidence, synthesis and dispassionate analysis and apply one's learning in real – life situations.

4. **Communication Skills:** Ability to recognize and value communication as the tool for negotiating and creating new understanding, collaborating with others, and furthering their own learning.
5. **Critical thinking:** Graduates acquire the capacity for problem identification, collection of evidence, synthesis and dispassionate analysis. They also acquire the capacity for attentive exchange, informed argument and reasoning.
6. **Creative Thinking:** The graduates acquire an ability to create, perform or think in different and diverse ways about the same objects or scenarios and also the ability to communicate effectively for different purposes and in different contexts. They should also be able to work independently and as part of a team.
7. **Co-ordinating and collaborating with others:** The graduates need to possess the ability to function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings. They should also be able to work productively with others, no matter their culture, perspective or background, and complete joint projects and also to work in partnership.
8. **Leadership readiness/qualities:** The graduates should be able to lead and support others by inspiring them with a clear vision and motivating them to achieve goals. They also need to acquire ability to map out the tasks of a team or an organization and setting directions.
9. **Environmental Awareness and action:** The graduates shall earn the capacity to realize the individual's responsibility in protecting and conserving the environment. They need to gain the capacity to understand the impact of the professional solutions in societal and environmental contexts, and demonstrate the knowledge of need for sustainable development.
10. **Community engagement and service:** The graduates need to develop an understanding of social and civic responsibilities, and of the rights of individuals and groups. The graduates should be able to demonstrate the capability to participate in community-engaged services/ activities for promoting the wellbeing of the society which includes participation in NSS,NCC, adult literacy etc

UNDERGRADUATE PROGRAMME OUTCOME (PO)

BACHELOR DEGREE INSCIENCE: (B.Sc)

1. **SPO-1 Knowledge:** Learners are encouraged to apply the knowledge of mathematics and science fundamentals to various solutions of complex problems. As such, knowledge of the subject is the sole objective of any student learner. A student is exposed to a wide range of topics in various subjects and is given intensive training in each of the courses that have laboratory related work. The learner is encouraged to use various mathematical methods (analytical and numerical) and experimental methods as an application to the acquired concepts and principles that help in studying various branches of sciences. At the end of the program, students are able to gain thorough knowledge in key areas in the subjects offered.
2. **SPO-2 Problem Analyses**: Well equipped with an understanding of the analytical methods involved, they are in a position to interpret and analyze results so obtained from experiments and draw suitable conclusions against their supported data acquired. At the end of the program, students will be able to identify, formulate and analyze scientific problems and reach concrete solutions using various principles of mathematics and sciences.
3. **SPO-3 Designing Solutions**: Having acquired knowledge of subjects, students are trained to think out of the box, design and conduct an experiment or a series of experiments that demonstrate their understanding of the methods and processes involved.
4. **SPO-4 Modern tool usage**: Learners are trained to create, select, and apply appropriate techniques, resources and IT tools in the analysis and synthesis of data within limitations. (Outcome of final year project).
5. **SPO-5 Effective Communication**: Proficiency in speaking, reading, writing and listening in English and one Indian language and find meaning of the world by connecting people, ideas, books, media and technology.
6. **SPO-6 Employability**: This programme enables the learners to perform the jobs in diverse fields such as science, engineering, industries, survey, education, banking, development-planning, business, public service, self business etc. efficiently.They will also be able to appear for competitive examinations
7. **SPO-7 Ethics:** While it is necessary to instil the spirit of competitiveness among students in a world of increasing competition, it is equally vital to develop a strong sense of ethics among learners that will help them develop some positive attitudes and values. This includes appreciation of the various principles and theories that evolved in science, the impact that science has on social,

economical and environmental issues. One of the main objectives of any academic exercise, therefore, should be to produce well-groomed individuals who understand the significance of ethical values and abide by them even in the most pressing circumstances. In this programme, this process is enabled through courses and facilitators who integrate the teaching of ethics in everyday pedagogy. As such, at the end of this programme students will be able to develop, internalise and exercise ethics in their professional as well as personal practices.

8. **SPO-8 Environment and Sustainability**: 'Environmental sustainability' has become the watchword of the 21st century. An increased engagement with environment related concerns is appearing tangibly on global fronts; academics cannot and should not remain quarantined from this massive development. Through classroom discussions and research projects, this programme facilitates active dialogues with factors which influence human-ecology interactions. As such, at the end of this programme students will be able to identify and analyze socio-political, cultural and economic problems which act as deterrents to environmental sustainability and provide creative solutions towards the same.

9. **SPO-9 Soft-Skill Development**: Apart from the attainment of knowledge and hands on skills in practical applicability of the subject, learners need to be equipped with soft-skills and values which will help them function effectively as an individual, and as a member or leader in diverse teams and in multidisciplinary groups. These soft skills include leadership, teamwork, project-management, positive outlook, innovative approaches and effective articulation. Several soft skill programs are organized for learners through various agencies that tie up with the state government. As such, at the end of this programme, students will be able to hone the soft-skills required in positively enhancing their academic, professional and personal pursuits towards self and societal advancement.

10. **SPO-10 Science and Society**: The learners are encouraged to apply logical reasoning based on the knowledge, skills, designing solutions to assess societal, health, safety issues and the responsibilities that go along with the scientific practice. As an extension activity to society, learners are encouraged to take up specific projects such as impact of salinity on fresh water wells in an adopted village, and provide effective solutions.

11. **SPO-11 Life-long learning**: With the pursuit of knowledge for either personal or professional reasons, learners are also encouraged to volunteer and be self motivated that not only enhances society values, active participation and personality development, but also enhances self-sustainability, competiveness and employability. As such, learners will be able to recognize the need for, and have the preparation and ability to engage in independent and life-long learning in every broad context of technological changes.

CORE

LIST OF COURSES:

Semester	Course Name	Course Code
1	Biodiversity (Microbes, Algae, Fungi and Archegoniate)	BT – CE – 1114
2	Plant Ecology and Taxonomy	BT – CE – 2114
3	Applied Mycology and Plant Pathology	BT – CE – 3214
	Biomolecules and Cell Biology	BT – CE – 3224
4	Morphology, Anatomy of Angiosperms and Embryology	BT – CE – 4214
	Advances in Plant Systematics	BT – CE – 4224
	Plant Physiology	BT – CE – 4234
5	Plant Metabolism and Biochemistry	BT – CE – 5314
	Classical Genetics and Plant Breeding	BT – CE – 5324
	Phylogenomic and Paleobotany	BT – CE – 5334
	Application of Plant Ecology and Environment	BT – CE – 5344
6	Advanced Microbiology	BT – CE – 6314
	Molecular Biology and Biotechnology	BT – CE – 6324
	Natural Resources Management	BT – CE – 6334
	Recent Trends in Plant Sciences OR Dissertation	BT – CE – 6344

Programme Specific Outcome of Bachelor of Science – Botany Core (PSO)

PSO No.	Name	Outcome
PSO–1	Importance of plants and their functions (*BTL: Remember, Understanding*)	To develop a conceptual understanding of principles and importance of Botany. Students will be able to understand and explain different specializations of Botany such as systematics, evolution, ecology, developmental biology, physiology, biochemistry, plant interactions with microbes and insects, morphology, anatomy, reproduction, genetics, cell and molecular biology of plants.
PSO–2	Laboratory Skills (*BTL: Application, Evaluate*)	Acquire practical skills in laboratory settings, including microscopy, experimental design, and data analysis. Students are also familiarized with the use of bioinformatics tools and databases and in the application of statistics to biological data. Students will be trained in various analytical techniques of plant biology, use of plants as industrial resources or as support system for human livelihood and will be well versed with the use of transgenic technologies for both basic and applied research in plants.
PSO–3	Development of Research Mindset (*BTL: Create*)	Plan and execute field investigation, collect, analyze and interpret data using appropriate methods including appropriate IT and accurately report the findings of the field investigation. The will be able to identify and analyze various issues prevailing in the societies, like, socio-political, socio-economic, socio-religious, ethnic issues, health issues in bio-cultural context, ethno botanical, ethno medicine, environmental issues, etc.
PSO–4	Applied Botany *(BTL: Apply)*	Demonstrate a thorough understanding of the human past with special emphasis on prehistoric and proto historic phase of the past and documentation of prehistoric implements for collection and preservation in museums.
PSO–5	Critical Thinking and Problem-Solving *(BTL: Analyse)*	Have gained the skill to formulate, analyse and document the outcomes of both biological and socio-cultural aspects of the subject through assignments and project work. Have proficiency in connecting with different communities according to their culture.
PSO–6	Communication Skills *(BTL: Apply)*	Be motivated for further higher studies and research in different sub-disciplines of anthropology.
PSO–7	Ethical and Professional Standards *(BTL: Evaluate)*	Cultivate ethical values and professional standards in scientific research, respecting intellectual property rights and promoting responsible conduct in the field of botany. To understand patterns of heredity and variation among individuals, species and populations and apply principles for improvement of quality and yield.
PSO–8	Closeness with nature *(BTL: Evaluate)*	Students will be eligible in diverse fields in research organization, government services, education sector, human resources, public services, hospitality, industries, corporate sectors, entrepreneur, business, tourism industry, media and Non-Governmental organization.
PSO–9	Continuous Learning *(BTL: Create)*	The primary ethics of the subject is to ensure appreciation of human diversity and it helps to analyze critically the issues that are relevant in contemporary society.

Course Learning Outcome (CLO) – Core

Semester	Course Name & Code	Course Learning Outcome (CLO)	
1	Biodiversity (Microbes, Algae, Fungi and Archegoniate) BT – CE – 1114	CLO - 1	Combination of theoretical and practical components of this course will provide comprehensive information and insight into the fascinating world of microbes and plants.
		CLO - 2	Hand on training will help students learn use of the microscope, mounting, section cutting and staining techniques for the study of plant materials.
		CLO - 3	Making drawing in practical records will enhance understanding morphology and structural details and related functional aspects in diverse plant groups.
		CLO - 4	This paper is both informative and interesting and will enable student to learn about biodiversity not only as plant or nature lover but also for higher academic pursuits, particularly in the field of biological sciences, environment and biodiversity conservation. .
2	Plant Ecology and Taxonomy BT – CE – 2114	CLO - 1	Student would have understanding of various ecological parameters of plant in nature pertaining to influencing ecological factors and their analysis of practical datas on individual, population, community and ecosystem level along with their relationships.
		CLO - 2	Student also would have understanding about basic knowledge of plant taxonomy with the modern taxonomic approaches.
		CLO - 3	Practical knowledge of the course material will develop the skill of identification and classification of plant diversity and characterization of angiospermic families along with their phyto geographical analysis.
3	Applied Mycology and Plant Pathology BT – CE – 3214	CLO - 1	Understanding the practical application of Mycology in Biotechnology and its impact on day today life
		CLO - 2	Proficiently recognize and classify plant diseases caused by various pathogens, including fungi, bacteria, viruses, and nematodes.

3	Applied Mycology and Plant Pathology BT – CE – 3214	CLO - 3	Understanding the biology, lifecycle, and interactions of plant pathogens to develop targeted and sustainable disease control measures.
	Applied Mycology and Plant Pathology BT – CE – 3214	CLO - 4	Apply knowledge to integrate cultural, biological, and chemical approaches for sustainable disease control.
		CLO - 5	Familiarize various diagnostic tools and techniques used in plant pathology for accurate disease assessment and identification
		CLO - 6	Communicate findings effectively, motivating stakeholders and farmers on disease management and its impact on crop productivity.
		CLO - 7	Effectively communicate disease-related information to diverse audiences, emphasizing the importance of disease prevention and management in crop production.
	Biomolecules and Cell Biology BT – CE – 3224	CLO - 1	Students will be able to obtain knowledge of structure, classification, and physicochemical properties of different biomolecules.
		CLO - 2	Students will be able to know about the detailed structure, properties, and functions of a cell and its components.
		CLO - 3	Students will be acquainted with practical knowledge of properties of cell and cell membranes, nucleic acid and microscopy of the plant cell.
		CLO - 4	Students will be able to identify various biomolecules in the laboratory by qualitative tests of biomolecules.
4	Morphology, Anatomy and Embryology of Angiosperms BT – CE – 4214	CLO - 1	After studying the different topic knowledge will be enhanced on Morphology, Anatomy and reproductive biology of angiosperm.
		CLO - 2	Basic and advanced practical knowledge will be acquired in the field of anatomy, morphology and reproductive biology of angiosperm
		CLO - 3	Student will acquire good understanding of the mentioned field of angiosperm
		CLO - 4	Advanced knowledge of pollen morphology will be acquired by the learners(students)
		CLO - 5	Basic theoretical knowledge will help in understanding of the subject matter primarily on advanced morphology, anatomy of angiosperm.
	Advances in Plant Systematics BT – CE – 4224	CLO - 1	Students are expected to gain theoretical knowledge and acquire basic skills on the plant taxonomy with special reference to angiosperms. Upon completion of the course, the students will be able to illustrate the types; merits & demerits of various systems of classification

4	Advances in Plant Systematics BT – CE – 4224	CLO - 2	Students are expected to gain theoretical knowledge and acquire basic skills on the plant taxonomy with special reference to Angiosperms. Upon completion of the course, the students will be able to relate taxonomy and other fields of botany
		CLO - 3	Students are expected to gain theoretical knowledge and acquire basic skills on the plant taxonomy with special reference to Angiosperms. Upon completion of the course, the students will be able to combine classical plant taxonomy with modern molecular phylogeny
		CLO - 4	Students are expected to gain theoretical knowledge and acquire basic skills on the plant taxonomy with special reference to Angiosperms. Upon completion of the course, the students will be able to Integrate concepts of plant evolution and speciation into and understanding of how organisms are classified in a molecular phylogenetic framework.
		CLO - 5	Students are expected to gain theoretical knowledge and acquire basic skills on the plant taxonomy with special reference to Angiosperms. Upon completion of the course, the students will be able to learn the norms of ICBN and Construction of keys.
		CLO - 6	Students are expected to gain theoretical knowledge and acquire basic skills on the plant taxonomy with special reference to Angiosperms. Upon completion of the course, the students will be able to Identify the angiosperms families with specific key characters.
		CLO - 7	Students are expected to gain theoretical knowledge and acquire basic skills on the plant taxonomy with special reference to Angiosperms. Upon completion of the course, the students will be able to Learn various advanced tools to study plant taxonomy.
	Plant Physiology BT – CE – 4234	CLO - 1	Understand the intricate mechanisms of photosynthesis and respiration, including the biochemical processes and their significance in plant energy metabolism.
		CLO - 2	Explore how plants grow, develop, and respond to environmental cues at a physiological level.
		CLO - 3	Study nutrient acquisition, assimilation, and utilization in plants, linking these processes to growth and overall plant health.

4	Plant Physiology BT – CE – 4234	CLO - 4	Analyze plant hormones and their roles in growth, development, and stress responses and evaluate the significance of regulator molecules in controlling life forms.
		CLO - 5	Apply physiological insights to enhance crop yield, quality, and stress tolerance and the principles of plant physiology to solve problems in related fields
		CLO – 6	Enhance critical thinking skills by evaluating and interpreting experimental results and applying theoretical knowledge to solve physiological problems and advancing agricultural practices and sustainability.
5	Plant Metabolism and Biochemistry BT – CE – 5314	CLO - 1	At the end of the course the student will know different types of chemical reactions that run the biological system
		CLO - 2	At the end of the course the student will know the details of carbon assimilation,
		CLO - 3	At the end of the course the student will understand the role of enzymes in regulating metabolic pathways for molecules like carbohydrates, lipids and proteins.
		CLO - 4	At the end of the course the student will understand the coordination of various biochemical reactions with reference to cell requirement and energy (ATP)
		CLO - 5	At the end of the course the student will Establish link between theoretical concepts and experimental evidences.
		CLO - 6	At the end of the course the student will Practically learn advance techniques of analysis which will help in future research activities.
	Classical Genetics and Plant Breeding BT – CE – 5324	CLO - 1	Understanding Mendelian principles, genetic inheritance patterns, and their application in plant breeding.
		CLO - 2	Students also learn about breeding techniques, selection methods, and the genetic basis of desirable traits in plants.
		CLO - 3	Students should gain practical knowledge to apply genetic principles for improving crop plants through selective breeding.
		CLO - 4	Appreciate the historical contributions of key figures in classical genetics, including Mendel, Morgan, and Bateson.
		CLO - 5	Explore the utilization of genetic resources, including wild relatives and germplasm collections, in plant breeding programs.

5	Classical Genetics and Plant Breeding BT – CE – 5324	CLO - 6	Apply breeding principles to develop new cultivars with desired traits, addressing agricultural challenges and contributing to food security and sustainability.
	Phylogenomics and Paleobotany BT – CE – 5334	CLO - 1	By the end of this course, the student shall be able to Able to explain how life evolved through time and reach the present status, with particular emphasis on the evolution of land plants.
		CLO - 2	By the end of this course, the student shall be able to critically analyse and understand the famous saying "Nothing in Biology makes sense except in the light of evolution
		CLO - 3	By the end of this course, the student shall be able to explain about speciation, polyploidy,hybridisation and adaptation.
		CLO - 4	By the end of this course, the student shall be able to understand the genetic background of parasitism, horizontal gene transfer and overall origin and diversification of angiosperms.
		CLO - 5	By the end of this course, the student shall be able to develop the ability to read, understand, analyse, and explain research articles from prestigious journals through the project exercise.
		CLO - 6	By the end of this course, the student shall be able to adapt oneself to the use of computer during this course.
		CLO - 7	Students will be proficient in the molecular techniques used in phylogenomic studies, through both theory and practical sessions, including the use of molecular markers, DNA sequencing technologies, and the construction of phylogenetic trees.
	Application of Plant Ecology and Environment BT – CE – 5344	CLO - 1	Basic and practical knowledge in the field of applied ecology and environment will be enhanced.
		CLO - 2	Learner's will have a good incite in understanding practical and applied aspects of ecology and environment dealt in the areas of the paper.
		CLO - 3	Ecotourism and eco-restoration introduced in the paper will help learner to develop self-sustenance and good understanding in the field of study.
		CLO - 4	Pollution study in the paper will help the learners in understanding current problems and very sensitive issue in sustenance of the environment
		CLO - 5	Total biodiversity issue will be sorted out after learning the various aspect in this field

6	Advanced Microbiology BT – CE – 6314	CLO - 1	Upon successful completion of the course, students will be able to trace the historical development of microbiology and appreciate its role in shaping scientific knowledge.
		CLO - 2	Upon successful completion of the course, students will be able to identify and discuss real-world examples of how microbiology contributes to different scientific and industrial domains.
		CLO - 3	Upon successful completion of the course, students will be able to demonstrate an understanding of the nutritional needs of microorganisms and the metabolic processes that sustain their growth.
		CLO - 4	Upon successful completion of the course, students will be able to comprehend the microbiology of soil, air, and water, recognizing the roles microorganisms play in these environments with a focus on the biological nitrogen fixation process.
		CLO - 5	Upon successful completion of the course, students will be able to differentiate the characteristics of Rickettsiae,Chlamydiae, Actinomycetes, Archaebacteria, and Mycoplasma and the diseases caused by these microorganisms and their impact on human health.
		CLO - 6	Upon successful completion of the course, students will be able to understand the principles and applications of synthetic biology and microbial engineering and application of ethical frameworks to evaluate potential advancements in the field.
		CLO - 7	Upon successful completion of the course, students will be able to foster collaborative learning and communication skills through teamwork, group discussions, seminars, and home assignments.
	Molecular Biology and Biotechnology BT – CE – 6324	CLO - 1	Conduct Molecular Experiments: Execute laboratory experiments using molecular techniques, interpret results, and generate accurate and reliable data.
		CLO - 2	Apply gene cloning and recombinant DNA technology to design and execute experiments aimed at modifying genes for specific purposes.
		CLO - 3	Analyze data from biotechnological experiments, draw conclusions, and present findings effectively, both orally and in writing.
		CLO - 4	Demonstrate problem-solving skills by applying molecular biology and biotechnological knowledge to address real-. world challenges in agriculture, medicine, and industry.

6	Molecular Biology and Biotechnology BT – CE – 6324	CLO - 5	Work collaboratively in a laboratory setting, demonstrating effective communication and teamwork in the execution of experiments and projects.
		CLO - 6	Critically evaluate the ethical, societal, and environmental implications of biotechnological applications, and make informed decisions, based on this understanding
	Natural Resources Management BT – CE – 6334	CLO - 1	Upon successful completion of the course, students will be able to demonstrate an integrated understanding of ecosystem dynamics, recognizing the interconnected relationships among living organisms, their environments, and the services ecosystems provide.
		CLO - 2	Upon successful completion of the course, students will be able to evaluate and apply principles of sustainable resource management, demonstrating the ability to balance human needs with the preservation of ecosystems and biodiversity.
		CLO - 3	Upon successful completion of the course, students will be able to develop the skills to identify, assess, and implement conservation strategies, with a focus on preserving biodiversity, protecting endangered species, and maintaining ecosystem resilience.
		CLO - 4	Upon successful completion of the course, students will be able to analyze environmental policies and governance structures related to natural resource management, and demonstrate the ability to propose, evaluate, and advocate for effective policies that align with sustainability goals.
		CLO - 5	Upon successful completion of the course, students will be able to understand the importance of involving local communities and stakeholders in decision-making processes related to natural resource management. They will demonstrate the ability to foster collaboration, address conflicts, and integrate diverse perspectives for sustainable outcomes.
	Recent Trends in Plant Science BT – CE – 6344	CLO - 1	Gain a comprehensive understanding of recent advancements in botanical sciences, spanning molecular biology, genomics, and bioinformatics, enhancing knowledge of cutting-edge research methodologies and techniques.
		CLO - 2	Explore the interdisciplinary nature of botany, analyzing its connections with ecology, biotechnology, and climate science, fostering a holistic perspective on plant biology and its implications for global challenges.

6	Recent Trends in Plant Science BT – CE – 6344	CLO - 3	Develop critical thinking skills to evaluate and integrate complex scientific information from diverse sources, fostering creativity and innovation in addressing contemporary issues in botany.
		CLO - 4	Acquire proficiency in conducting research, including experimental design, data analysis, and interpretation, enabling contribution to scientific advancements in botany.
		CLO - 5	Enhance communication skills to effectively disseminate research findings and engage in interdisciplinary dialogues, promoting collaboration and knowledge exchange within the scientific community.
		CLO - 6	Recognize and adhere to ethical standards in botanical research and applications, emphasizing integrity, transparency, and responsible conduct in scientific inquiry.
		CLO - 7	Foster a passion for lifelong learning and engagement with current trends and advancements in botany, preparing for future careers in academia, industry, or research institutions.

MAPPING OF PROGRAME OUTCOME (PO) AND COURSE LEARNING OUTCOME (CLO)

Attributes: Co-relation Levels

"1" : Minimum Co-relation
"2" : Moderate Co-relation
"3" : Maximum Co-relation
"-" : No Co-relation

Course Code	CLO	PROGRAMME OUTCOME										
		SPO1	SPO2	SPO3	SPO4	SPO5	SPO6	SPO7	SPO8	SPO9	SPO10	SPO11
BT-CE-1114	CLO - 1	3					2	2			3	3
	CLO - 2	3	3	2	3		3				-	-
	CLO - 3	3	3	2	3		3				-	-
	CLO - 4	3	3	3	3		3				-	-
BT-CE-2114	CLO - 1	-	1	-			3				-	-
	CLO - 2	-	3	1	2		3				2	3
	CLO - 3	-	1	-	1		3				2	3
BT-CE-3214	CLO - 1	-	1	2	-	-	-	-	-	-	-	-
	CLO - 2	1	-	-	-	-	-	-	-	-	-	-
	CLO - 3	-	1	-	-	-	-	-	3	-	-	-
	CLO - 4	-	-	1	-	-	-	-	-	-	-	-
	CLO - 5	-	-	-	1	-	-	-	-	-	-	-
	CLO - 6	-	2	-	-	1	-	-	-	-	-	-
	CLO - 7	-	-	1	-	-	-	-	3	-		
BT-CE-3224	CLO - 1	1	3	2	2	3	3	2	2	3	2	2
	CLO - 2	1	2	2	2	3	3	2	2	3	2	2
	CLO - 3	1	2	1	1	2	2	2	2	3	2	2
	CLO - 4	1	1	1	1	2	2	2	2	3	2	2
BT-CE-4214	CLO - 1	1	-	-	-	-	-	-	-	-	-	-
	CLO - 2	2	-	-	-	-	-	-	-	-	-	-
	CLO - 3	-	1	-	-	-	-	-	-	-	-	-
	CLO - 4	-	3	1	-	-	-	-	-	-	-	-
	CLO - 5	-	1	-	-	-	-	-	-	-	-	-
BT-CE-4224	CLO - 1	1	-	-	-	-	-	-	-	-	-	-
	CLO - 2	1	-	-	-	-	-	-	-	-	-	-
	CLO - 3	-	1	-	-	-	-	-	-	-	-	-
	CLO - 4	-	3	1	-	-	-	-	-	-	-	-
	CLO - 5	-	1	-	-	-	-	-	-	-	-	-
	CLO - 6	-	2	1	-	-	-	-	-	-	-	-
	CLO - 7	-	-	-	1	-	-	-	-	-	-	-
BT-CE-4234	CLO - 1	1	-	-	-	-	-	-	-	-	-	-
	CLO - 2	1	-	-	-	-	-	-	2	-	-	-
	CLO - 3	1	-	-	-	-	-	-	-	-	-	-
	CLO - 4	-	1	2	-	-	-	-	-	-	-	-
	CLO - 5	-	1	-	-	-	-	-	-	2	-	-
	CLO - 6	-	1	2	-	-	-	-	-	-	-	-
BT-CE-5314	CLO - 1	1	-	-	-	-	-	-	-	-	-	-
	CLO - 2	1	-	-	3	-	-	-	2	-	-	-
	CLO - 3	1	-	-	-	-	-	-	-	-	-	-
	CLO - 4	-	2	2	-	-	-	-	-	-	-	-

Course Code	CLO	PROGRAMME OUTCOME										
		SPO1	SPO2	SPO3	SPO4	SPO5	SPO6	SPO7	SPO8	SPO9	SPO10	SPO11
BT-CE-5314	CLO - 5	-	1	-	-	3	-	-	-	2	-	-
	CLO - 6	-	1	2	-	-	-	-	-	-	-	-
BT -CE-5324	CLO - 1	-	1	-	-	-	-	-	-	3	-	-
	CLO - 2	-	-	-	1	-	-	-	-	-	-	-
	CLO - 3	1	-	-	-	-	-	-	-	-	-	-
	CLO - 4	1	-	-	-	-	-	-	-	-	-	-
	CLO - 5	-	-	3	-	-	-	-	-	1	-	-
	CLO - 6	-	-	1	-	-	-	-	-	-	-	-
BT-CE-5334	CLO - 1	2	2		1	2	3	2	3	1		
	CLO - 2		3			2	1	3	2			
	CLO - 3		2			2	1	3	2			
	CLO - 4		2			2	1	3				
	CLO - 5	3		2	3	3	1		2	3	1	3
	CLO - 6			2	3		1			1		3
	CLO - 7	1		2	3		3					3
BT-CE-5344	CLO - 1	-	-	-	2	1	-	-	-	-		
	CLO - 2	1	-	-	-	-	-	-	-	-		
	CLO - 3	-	2	-	-	3	-	-	-	-		
	CLO - 4	1	-	-	-	-	-	-	-	-		
	CLO - 5	-	-	-	3	-	-	-	-	-		
BT-CE-6314	CLO - 1	1	-	-	-	-	-	-	-	-	-	-
	CLO - 2	-	1	-	-	-	-	-	-	-	-	-
	CLO - 3	1	-	-	-	-	-	-	-	-	-	-
	CLO - 4	1	-	-	-	-	-	-	2	-	-	-
	CLO - 5	1	3	-	-	-	-	-	-	-	-	-
	CLO - 6	-	1	-	-	-	-	2	-	-	-	-
	CLO - 7	-	-	-	-	3	-	-	-	-	1	-
BT-CE-6324	CLO - 1	-	-	1	-	-	-	-	-	2	-	-
	CLO - 2	-	-	-	1	-	-	-	-	-	-	-
	CLO - 3	-	-	1	-	-	-	-	-	-	-	-
	CLO - 4	-	2	-	-	-	-	-	-	1	-	-
	CLO - 5	-	-	-	1	-	-	-	-	-	-	-
	CLO - 6	1	-	-	-	-	-	2	-	-	-	-
BT-CE-6334	CLO - 1	1	-	-	-	-	-	-	-	-		
	CLO - 2	-	-	-	-	1	-	-	-	-		
	CLO - 3	-	1	-	-	-	-	3	-	-		
	CLO - 4	-	2	1	-	-	-	-	-	-		
	CLO - 5	-	-	-	-	1	2	-	-	-		
BT-CE-6344	CLO - 1	1	-	2	-	-	-	-	-	-	-	-
	CLO - 2	1	-	-	-	-	-	-	2	-	-	-
	CLO - 3	-	2	-	-	-	-	-	-	1	-	-
	CLO - 4	-	1	2	3	-	-	-	-	-	-	-
	CLO - 5	-	-	-	-	1	-	-	-	-	3	-
	CLO -5	-	-	-	-	-	-	1	-	-	-	-
	CLO -6	-	-	-	-	-	1	-	-	2	3	-

MAPPING OF PROGRAME SPECIFIC OUTCOME (PSO) AND COURSE LEARNING OUTCOME (CLO)

Attributes: Co-relation Levels

"1" : Minimum Co-relation
"2" : Moderate Co-relation
"3" : Maximum Co-relation
"-" : No Co-relation

Course Code	CLO	PROGRAMME SPECIFIC OUTCOME								
		PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	PSO 9
BT-CE-1114	CLO - 1	1					2	2		
	CLO - 2	1	1	2	3		3			
	CLO - 3	3	2	2	3		3			
	CLO - 4	3	2	3	3		1			
BT-CE-2114	CLO - 1	-	1	-			1			
	CLO - 2	-	1	1	2		-			
	CLO - 3	-	1	-	1		3			
BT-CE-3214	CLO - 1	-	-	-	1	-	-	-	-	-
	CLO - 2	1	-	-	-	-	-	-	-	-
	CLO - 3	-	-	3	-	1	-	-	-	-
	CLO - 4	2	-	-	-	1	-	-	-	-
	CLO - 5	-	2	-	-	-	-	-	-	-
	CLO - 6	-	-	-	-	3	1	-	-	-
	CLO - 7	-	-	1	2	-	-	-	-	-
BT-CE-3224	CLO - 1	1	3	2	2	2	2	2	3	1
	CLO - 2	1	3	2	2	2	2	2	3	1
	CLO - 3	1	1	1	1	2	2	2	2	1
	CLO - 4	1	1	1	1	2	2	2	2	1
BT-CE-4214	CLO - 1	2	-	-	-	-	-	-	-	-
	CLO - 2	2	-	-	-	-	-	-	-	-
	CLO - 3	-	-	1	-	-	-	-	-	-
	CLO - 4	-	-	-	-	1	-	-	-	-
	CLO - 5	-	-	-	2	3	-	-	-	-
BT-CE-4224	CLO - 1	1	-	-	-	-	-	-	-	-
	CLO - 2	2	-	-	-	-	-	-	-	-
	CLO - 3	-	-	1	-	-	-	-	-	-
	CLO - 4	-	-	-	-	1	-	-	-	-
	CLO - 5	-	-	-	1	3	-	-	-	-
	CLO - 6	-	-	1	-	-	-	-	-	-
	CLO - 7	-	1	-	-	-	-	-	-	-
BT-CE-4234	CLO - 1	1	-	-	-	3	-	-	-	-
	CLO - 2	-	2	1	-	-	-	-	-	-
	CLO - 3	1	-	-	-	-	-	-	-	-
	CLO - 4	-	-	-	1	-	-	-	-	-
	CLO - 5	-	1	-	-	3	-	-	-	-
	CLO - 6	-	-	-	2	1	-	-	-	-
BT-CE-5314	CLO - 1	1	-	-	-	3	-	-	-	-
	CLO - 2	-	2	2	-	-	-	-	-	-
	CLO - 3	1	-	-	-	-	-	-	-	-
	CLO - 4	-	-	-	2	-	-	-	-	-

Course Code	CLO	PROGRAMME SPECIFIC OUTCOME								
		PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	PSO 9
BT-CE-5314	CLO - 5	-	1	-	-	3	-	-	-	-
	CLO - 6	-	-	-	2	1	-	-	-	-
BT -CE-5324	CLO - 1	-	-	-	2	1	-	-	-	-
	CLO - 2	1	-	-	-	-	-	-	-	-
	CLO - 3	-	1	-	-	3	-	-	-	-
	CLO - 4	1	-	-	-	-	-	-	-	-
	CLO - 5	-	-	-	1	-	-	-	-	-
	CLO - 6			3	1	-	-	-	-	-
BT-CE-5334	CLO - 1	3		1		3	1	1	3	1
	CLO - 2	2		3		3	1	1	3	1
	CLO - 3	2		2	1	3		1	3	1
	CLO - 4	2		3	1	3		1	3	1
	CLO - 5	1	3	3	2	3	3	1	3	2
	CLO - 6		3	2	2	3	3	2	3	2
	CLO - 7	1	3	3	3	3	3	3	3	2
BT-CE-5344	CLO - 1	-	-	-	2	1	-	-	-	-
	CLO - 2	1	-	-	-	-	-	-	-	-
	CLO - 3	-	2	-	-	3	-	-	-	-
	CLO - 4	1	-	-	-	-	-	-	-	-
	CLO - 5	-	-	-	2	-	-	-	-	-
BT-CE-6314	CLO - 1	1	-	-	-	-	-	-	-	-
	CLO - 2	-	-	-	1	2	-	-	-	-
	CLO - 3	1	-	-	-	-	-	-	-	-
	CLO - 4	1	-	-	-	2	-	-	-	-
	CLO - 5	1	-	-	-	-	-	-	-	-
	CLO - 6	-	1	2	-	-	-	-	-	-
	CLO - 7	-	-	-	-	-	1	-	-	-
BT-CE-6324	CLO - 1	-	1	3	-	-	-	-	-	-
	CLO - 2	-	-	1	2	-	-	-	-	-
	CLO - 3	-	-	-	-	1	-	-	-	-
	CLO - 4	-	-	2	1	-	-	-	-	-
	CLO - 5	-	1	2	-	-	-	-	-	-
	CLO - 6	1	-	-	-	-	-	2	-	-
BT-CE-6334	CLO - 1	1	-	-	-	-	-	-	-	-
	CLO - 2	-	-	-	-	1	-	-	-	-
	CLO - 3	-	1	-	-	-	-	3	-	-
	CLO - 4	-	2	1	-	-	-	-	-	-
	CLO - 5	-	-	-	-	1	2	-	-	-
BT-CE-6344	CLO - 1	1	-	-	-	-	-	-	-	-
	CLO - 2	1	-	-	-	2	-	-	-	-
	CLO - 3	-	-	-	-	1	-	-	-	-
	CLO - 4	-	2	1	-	-	-	-	-	-
	CLO - 5	-	-	-	-	-	1	-	-	-
	CLO -5	-	-	-	-	-	-	1	-	-
	CLO -6	-	-	-	-	-	-	-	-	1

COURSE NAME: Biodiversity (Microbes, Algae, Fungi and Archegoniate)
COURSE CODE: BT – CE – 1114
Total Credits: 4 (Theory: 3 + Practical/Tutorial: 1)

THEORY: 3 CREDITS

Total Lectures: 45

COURSE OBJECTIVE:

The course includes modules on basic knowledge of the plant kingdom viz. Microbes, Algae, Fungi and Archegoniatae, with the main objective of giving a sense of mooring to the undergraduates.

Course Learning Outcome:

On completion of this course,

CLO-01: *Combination of theoretical and practical components of this course will provide comprehensive information and insight into the fascinating world of microbes and plants.*

CLO-02: *Hand on training will help students learn use of the microscope, mounting, section cutting and staining techniques for the study of plant materials.*

CLO-03: *Making drawing in practical records will enhance understanding morphology and structural details and related functional aspects in diverse plant groups.*

CLO-04: *This paper is both informative and interesting and will enable student to learn about biodiversity not only as plant or nature lover but also for higher academic pursuits, particularly in the field of biological sciences, environment and biodiversity conservation.*

Unit- I: Microbes (Lectures:9)

Viruses : General Structure, DNA virus (T Phase), Lytic and Lysogenic Cycle, RNA virus (TMV). Economic Importance

Bacteria: General Characteristic and Cell structure, Reproduction – Vegetative, Asexual and Recombination (Conjugation, Transformation and Transduction), Economic importance

Unit- II: Algae (Lectures: 9)

General characteristic, Range of thallus organization and reproduction, Classification of algae (F E Fritsch classification), Morphology and life cycles of Nostoc, Chlamydomonus, Vaucheria, and Polysiphonia, Economic importance of algae.

Unit- III: Fungi (Lectures: 9)

General characteristic, nutrition, reproduction and classification (G.C Ainsworth classification). Life cycles of Rhizopus (Zygomycota), Phytotophthora (Oomycetes) Penicillium, (Ascomycota), Puccinia Agaricus (Basidiomycota), Symbiosis Association – Lichen. General account and significance of Mycorrhiza.

Unit- IV: Introduction to Archegoniate(Lectures: 2)

Unifying features of archegoniates, Transition to land habit, alternation of generation.

Unit- V: Bryophytes (Lectures: 6)

General characteristic, adaptation of land habit, Classification (upto family), Morphology, anatomy and reproduction of *Marchantia, Anthoceros* and *Polytrichum*, Ecology and economic importance of bryophytes with special mention of *Sphagnum.*

Unit- VI: Pteridophytes(Lectures: 5)

General characteristics, classification, Early land plants – *Rhynia* and *Psilotum.* Morphology, anatomy and reproduction of *Selaginella*, and *Pteris.* Heterospory and seed habit, Stellar evolution.

Unit- VII: Gymnosperms (Lectures: 5)

General characteristics, Classification. Morphology, anatomy and reproduction of *Cycas, Pinus and Gnetum,* Ecological and economical importance.

PRACTICAL (Lectures: 30)

1. Model of Virus - T Phage; Lytic and Lysogenic Cycle from Photographs
2. Study of bacterial reproduction – Binary Fission and Conjugation from slides / photographs
3. Gram staining process
4. Study of vegetative and reproductive structure of *Nostoc, Chlamydomonus* and *Polysiphonia*
5. Study of vegetative and reproductive structure of *Penicillium* and *Puccinia*
6. Study of vegetative and reproductive structure of *Marchantia* and *Polytrichum*
7. Study of vegetative and reproductive structure of *Selaginella,*
8. Study of vegetative and reproductive structure of *Cycas and Gnetum.*

RECOMMENDED BOOKS:

1. Pelczar, M. J. (2001) – Microbiology, 5th Edition, Tata McGraw – Hill Co, New Delhi.
2. Sarma, P. D. (2009) – Microbiology, Latest Edition, Rastogi Publication , Meerut.
3. Sahu, D. (2000) – Farming the Ocean : Sea Weeds Cultivation and Utilization. Ara Vali International, New Delhi.
4. Kumar, H. D. (1999) – Introductory Phycology. Affiliated East West Press, Delhi
5. Alexopoulos, C. J.; Mims, C. W.; Blackwell, M. (1996) – Introductory Mycology, J. and Sons, 4th Edition.
6. Vashista, P. C.; Singha, A. K., Kumar, A. (2010) – Pteridophyta, S. Chand, Delhi, India.
7. Parihar, N. S. (1991) – An Introduction to Embryophyta, Vol I – Bryophyta, Central Book Depot. Allahabad.
8. Bhatnagar, S. P.; Moitra, A. (1996) – Gymnosperms, New Age International (P) Ltd, Publishers, New Delhi, India.

COURSE NAME: Plant Ecology and Taxonomy

COURSE CODE: BT – CE – 2114

Total Credits: 4 (Theory: 3 + Practical/Tutorial: 1)

THEORY: 3 Credits

TOTAL LECTURES: 45

COURSE OBJECTIVE:

The main objective of study plant ecology is to examine the relationship of plants with the physical and biotic environment. Plant Taxonomy is the science of discovering, identifying, describing, classifying and naming plants. The main objective of plant taxonomy is to identifycharacteristics of undiscovered species by comparing with known species, to specify characteristics of recently discovered species, to arranged them in respective "taxa" after looking at their similarities and to give them specific names.

Course Learning Outcome:

On completion of this course,

CLO-01: *Student would have understanding of various ecological parameters of plant in nature pertaining to influencing ecological factors and their analysis of practical datas on individual, population, community and ecosystem level along with their relationships.*

CLO-02: *Student also would have understanding about basic knowledge of plant taxonomy with the modern taxonomic approaches.*

CLO-03: *Practical knowledge of the course material will develop the skill of identification and classification of plant diversity and characterization of angiospermic families along with their phyto geographical analysis.*

Unit- I: Ecological Factor (LECTURES: 8)

Soil : Origin, formation, composition, of soil profile., Water : State of water in the environment, precipitation types. Light and Temperature : Variation, optimal and limiting factors; Shelford Law of Tolerance. Adaptation of Hydrophytes and Xerophytes. Biological indicators

Unit-II: Plant Communities (LECTURES: 4)

Characters; Ecotone and Edge Effect; Succession; Processes and Types.

Unit-III: Ecosystem (LECTURES: 8)

Structure; Energy flow trophic organisation; Food chains and Food webs, Ecological Pyramids, Production and Productivity; Bio geochemical Cycle, Carbon, Nitrogen and Phosphorus Cycles

Unit-IV: **Phytogeography (LECTURES: 2)**

Principle of Bio-geographical Zones; Endemism

Unit-V: Introduction to Plant Taxonomy (LECTURES: 2)

Aim and objective of Plant Taxonomy. Identification, Classification and Nomenclature.

Unit-VI: Identification (LECTURES: 4)

Function of Herbarium, Important Herbaria and Botanical Gardens of the world and India; Documentation: Flora, Kyes – Single access and Multi assess.

Unit-VII: Modern Trends of Taxonomy(LECTURES: 5)

Taxonomy in relation to Palynology, Cytology, Phytochemistry and Molecular data

Unit-VIII: Botanical Nomenclature (LECTURES: 4)

Principles and Rules (ICBN): Ranks and Names; Binomial system, Typification, Authorcitation, Valid Publication, Rejection of names, Principle of Priority and its Limitation.

Unit-IX: Taxonomic Classification (LECTURES: 2)

Types of classification; Bentham and Hooker system of classification

Unit - X: Angiospermic families (LECTURES: 6)

Poaceae, Orchidaceae, Magnoliceae, Solanaceae, Lamiaceae and.Asteracae.

PRACTICAL (Lectures: 30)

1. Study of instruments use to measure micro climatic variables –Thermometer, Anemometer, Hygrometer and Luxmeter
2. Study of morphological adaptation of hydrophytes and xerophytes
3. Determination minimal quadrate size for the study of herbaceous vegetation.
4. Study of vegetative and floral characters of Solanaceae, Lamiaceae,Asteraceae and Orchidaceae
5. Collection, processing, drying and preparation of a Herbarium of a wild herbaceous plant species.

RECOMMENDED BOOKS:

1. Kormondy, E. J. (1996) – Concept of Ecology, 4th Edition, Prentice Hall, USA.
2. Sharma, P. D. (2010) – Ecology and Enviornment, 8th Edition, Rastogi Publication, Meerut, India.
3. Singh, G. (2012) – Plant Systematics : Theory and Practice, 3rd Edition, Oxford & IBH Publishing Co Pvt Ltd, New Delhi.
4. Pandey, B. P. (2018) – A Text Book of Botany : Angiosperms, S Chand Publishing, 7361, Ram Nagar, Qutab Road, New Delhi.

COURSE NAME: Applied Mycology and Plant Pathology

COURSE CODE: BT - CE - 3214

Total Credits: 4 (Theory: 3 + Practical/Tutorial: 1)

THEORY

Total Lectures: 45

Course Objectives:

The course objectives are to study of application of mycology in Biotechnology. Recognize and classify plant diseases caused by pathogens like fungi, bacteria and viruses. Understand the lifecycle, behavior, and interactions of pathogens with host plants to design targeted control methods.Enhance crop yield and quality through disease prevention, minimizing economic losses and reducing reliance on chemical interventions. Motivate farmers and stakeholders on disease identification, prevention, and integrated disease management practice.

Course Learning Outcome:

CLO 1 : *Understanding the practical application of Mycology in Biotechnology and its impact on day to day life.*

CLO 2 : *Proficiently recognize and classify plant diseases caused by various pathogens, including fungi, bacteria, viruses, and nematodes.*

CLO 3 : *Understanding the biology, lifecycle, and interactions of plant pathogens to develop targeted and sustainable disease control measures.*

CLO 4 : *Apply knowledge to integrate cultural, biological, and chemical approaches for sustainable disease control.*

CLO 5 : *Familiarize various diagnostic tools and techniques used in plant pathology for accurate disease assessment and identification*

CLO 6 : *Communicate findings effectively, motivating stakeholders and farmers on disease management and its impact on crop productivity.*

CLO 7 : *Effectively communicate disease-related information to diverse audiences, emphasizing the importance of disease prevention and management in crop production.*

Unit 1: Applied Mycology : (Lectures 10)

Role of Fungi in biotechnology; Food industry (Flavour and texture, Fermentation, Baking, Organic Acids, Enzymes, Mycoproteins), Pharmaceutical (Secondary Metabolites and Mycotoxins), Agriculture (Biofertilisers, Mycofungicides, Mycoherbicides, Mycoinsecticides, Myconematocides). Application of Medical Mycology.

Unit 2 : Introduction : (Lectures 04)

Definition of disease and its components (disease pyramid); Classification of diseases; History and significance of Phytopathology.

Unit 3: Basic concepts of Plant Pathology: (Lectures 04)

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

Unit 4: Host-Pathogen relationship: (Lectures 04)

Mode of infection - penetration; post-penetration and colonization). Plant Defense mechanisms (Constitutive and induced, structural and biochemical).

Unit 5: Fungal diseases : (Lectures 08)

Causal Organism, Symptoms, Disease Cycle and control: Powdery mildew of Pea; Ergot of Rye, Late blight of potato, Red rot of sugarcane, Rusts of Wheat.; Smut of Barley.

Unit 6: Bacterial Diseases: (Lectures 02)

General symptoms; Disease cycle and Control measures of Citrus canker.

Unit 7: Viral Diseases : (Lectures 02)

General symptoms; Mode of transmission and Control measures-Tobacco mosaic disease; Citrus excortis.

Unit 8: Nematode Diseases : (Lectures 01)

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

Unit 9: Plant Disease Control: (Lectures 10)

Plant quarantine and its significance; Methods of disease control - Physical, Chemical and biological. Integrated Diseases Management system.

PRACTICAL

Total Lectures: 30

1. Study of late blight of Potato through specimens, temporary mounts (V.S.of leaf showing infection) and permanent slides.
2. Study of Black stem Rust of Wheat: Symptoms on wheat and barberry. Observed spores and teleuto spores on V.S. wheat leaf/ to study stem spore stages of *Pucciniagraministritici* with the help of temporary tease/section mount of wheat. Permanent slides of somatic and reproductive phases on both the hosts.
3. Study of symptom and causal organism (with photograph) - Smut of Barley, Powdery mildew of Pea, Red Rot of Sugarcane, Citrus Canker, Tobacco Mosaic Disease and Citrus excortis.
4. Isolation of pathogens from disease material.
5. Submission specimens of a Plant Diseases Album.

BOOKS RECOMMENDED:

1. Agrios, G.N.(2005) *Plant Pathology* 5th edition: Elsevier Academic Press, Amesterdam.

2. Sharma, P.D.(2014) *Plant Pathology* Rastogi Publications, Meerut, U.P.
3. Singh,R.S. (2018) *Plant Diseases*.10th Edition Medtech, New Delhi.
4. Ownley, Bonnie and Trigiano, Robert N. (2017). Plant Pathology: Concepts and Laboratory Exercises, 3rdEdition, CRC Press.

COURSE NAME: Biomolecules and Cell Biology

COURSE CODE: BT - CE - 3224

Total Credits: 4 (Theory: 3 + Practical/Tutorial: 1)

THEORY

Total Lectures: 45

Course Objective:

The course objectives are to accommodate the widening horizons of the Botany discipline, to reflect about the dynamism of cell biology and biomolecules, to understand the properties, functions and roles of different molecules, to reveal the relationship between the structure and function of various biomolecules at the chemical level and hands-on approach and laboratory techniques by performing different related experiments.

Course Learning Outcome

CLO 1 : *Students will be able to obtain knowledge of structure, classification, and physicochemical properties of different biomolecules.*

CLO 2 : *Students will be able to know about the detailed structure, properties, and functions of a cell and its components.*

CLO 3 : *Students will be acquainted with practical knowledge of properties of cell and cell membranes, nucleic acid and microscopy of the plant cell.*

CLO 4 : *Students will be able to identify various biomolecules in the laboratory by qualitative tests of biomolecules.*

Unit 1 : Introduction to biomolecules (Lectures 03)

Definition of biomolecules, Types of biomolecules, Types of chemical bonds holding cellular biomolecules

Unit 2 : Water (Lectures 03)

Structure and properties

Unit 3 : Carbohydrates (Lectures 03)

Structures, Nomenclature, Classification and function.

Unit 4 : Lipids and Fatty Acid (Lectures 04)

Structure, Classification, Types and functions

Unit 5 : Amino acids and Proteins (Lectures 05)

Structure and functions

Unit 6 : Nucleic Acids (Lectures 06)

Nitrogenous bases, Nucleotides, Types and functions of nucleic acids, Structure of B and Z type of DNA.

Unit 7 : Enzymes (Lectures 04)

Classification, structure and functions

Unit 8 : Introduction to cell (Lectures 06)

Cell as a unit of structure and function; Characteristics of prokaryotic and eukaryotic cells, Cell cycle and Check points, Mitosis and meiosis**.**

Unit 9: Cell wall and plasma membrane (Lectures 05)

Chemistry, Structure and function of Plant cell wall, Cytoskeleton. Membrane structure and functions, Fluid mosaic model

Unit 10 : Cell organelles (Lectures 06)

Nucleus, Ribosome, Chloroplast, Mitochondria, Peroxisomes, Endoplasmic Reticulum, Golgi Apparatus, and Lysosomes.

Practical

Lectures: 30

1. Qualitative tests for carbohydrates, reducing sugars, proteins.
2. Study of plant cell structure with the help of epidermal peel mount of Onion.
3. Demonstration of the phenomenon of protoplasmic streaming in *Hydrilla*.
4. Study different stages of mitosis.
5. Demonstration of meiosis.

RECOMMENDED BOOKS:

1. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H. Freeman and Company.
2. Campbell MK (2012) Biochemistry, 7th Edition. Published by Cengage Learning
3. Campbell PN, Smith AD (2011) Biochemistry Illustrated, 4th Edition, Published by Churchill Livingstone.
4. Cooper GM, Hausman RE (2009) The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
5. Hardin J, Becker G, Skliensmith LJ (2012) Becker's World of the Cell, Pearson Education Inc. U.S.A. 8th Edition.

COURSE NAME: Morphology, Anatomy and Embryologyof Angiosperms

COURSE CODE: BT - CE - 4214

Total Credits: 4 (Theory: 3 + Practical/Tutorial: 1)

THEORY

Total Lectures: 45

Course Objective:

This paper is meant to give adequate knowledge on morphology, anatomy and reproductive biology of Angiosperm . Special stress has been given on basic learning in Advanced Morphology. Anatomical study of plant body of Angiosperm and different theories are dealt with this paper. A thorough knowledge of Reproductive Biology of Angiosperm is being tried to offer in this paper

Course Learning Outcome:

CLO 1: *After studying the different topic knowledge will be enhanced on Morphology, Anatomy and reproductive biology of angiosperm.*

CLO 2: *Basic and advanced practical knowledge will be acquired in the field of anatomy, morphology and reproductive biology of angiosperm*

CLO 3: *Student will acquire good understanding of the mentioned field of angiosperm*

CLO 4: *Advanced knowledge of pollen morphology will be acquired by the learners(students)*

CLO 5: *Basic theoretical knowledge will help in understanding of the subject matter primarily on advanced morphology, anatomy of angiosperm.*

Unit 1 : Introduction to Plant Morphology (Lectures 05)

Morphology of inflorescence, stamen, carpel, telome-theory, Phyllode-theory.

Unit 2 : Applied aspect of Plant Anatomy (Lectures 02)

Anatomy in forensic science, pharmacognosy.

Unit 3 : Tissue, tissue system, vascular cambium and wood (Lectures 10)

Simple and complex tissue, tissue systems; Types of stomata, Hydathode, Lithocytes, Ergastic substances, secondary growth of stem and root, cambium-primary and secondary, periderm.

Unit 4 : Structure and development of plant body (Lectures 06)

Cytodifferentiation, organogenesis in embryonic development dicot and monocot, Kranz anatomy

Unit 5: Apical meristems and adaptive systems (Lectures 06)

Organizational theories of shoot and root apexes, adcrustation, incrustation.Anatomical adaptation of xerophytes and hydrophytes.

Unit 6 : Anther and Pollen Biology (Lectures 06)

Structure and function of anther wall, microsporogenesis, microgametogenesis, Structure of MGU(Male Germ Unit), NPC system.Palynology and its scopes.

Unit 7 : Ovule (Lectures 03)

Types of ovules, megasporogenesis, megagametogenesis.

Unit 8 : Pollination, fertilization, embryo, endosperm and seed (Lectures 07)

Types of pollination and significance, fertilization and double fertilization, types of female gametophytes, types of endosperms, monocot and dicot embryo polyembryony, Apomixes and structure of seed.

Practical

Total Lectures: 30

1. Study of special type of inflorescence, cyathium, hypanthodium, verticillaster
2. Study of types of stomata, trichomes, glandular and non-glandular, raphides, cyslolith.
3. Study of secondary growth in stem and root of dicot and monocot plants.
4. Study of anatomical features of xerophytes and hydrophytes.
5. Pollen morphology by acetolysis method.
6. Types of ovules (from slides or photographs),
7. Types of endosperms (from slides or photographs).
8. Types of embryos(from slides or photographs).

RECOMMENDED BOOKS :

1. A.J Eames, Morphology of angiosperm
2. K.R Sporne – Morphology of angiosperm
3. A.J Eames and L.H Mac Daniels – An introduction to Plant Anatomy
4. A. Fahn – Plant anatomy
5. Arthur J Eames – An Introduction to Plant Anatomy
6. P. Maheshwari – Embryology of Angiosperm
7. SS Bhojwani and SP Bhattnagar – Embryology of Angiosperm
8. K R Shivanna – Pollen biology and biotechnology

COURSE NAME: Advances in Plant Systematics

COURSE CODE: BT - CE - 4224

Total Credits: 4 (Theory: 3 + Practical/Tutorial: 1)

THEORY

Total Lectures: 45

Course Objective:

The course objectives are to understand the various aspects of plant nomenclature and classification. To understand the classical and modern trends of Angiosperm taxonomy. To understand the salient features of angiosperm families with special reference to sexual characters.

Course Learning Outcome:

Students are expected to gain theoretical knowledge and acquire basic skills on the plant taxonomy with special reference to Angiosperms. Upon completion of the course, the students will be able to:

CLO 1: *Illustrate the types; merits & demerits of various systems of classification.*

CLO 2: *Relate taxonomy and other fields of botany.*

CLO 3: *Combine classical plant taxonomy with modern molecular phylogeny.*

CLO 4: *Integrate concepts of plant evolution and speciation into and understanding of how organisms are classified in a molecular phylogenetic framework.*

CLO 5: *Learn the norms of ICBN and Construction of keys.*

CLO 6: *Identify the angiosperms families with specific key characters.*

CLO 7: *Learn various advanced tools to study plant taxonomy.*

Unit I : Introduction : (Lectures – 04)

Components of Systematics: Nomenclature, Identification, Classification; Taxonomy and its phases - Pioneer, Consolidation, Biosystematic and Encyclopaedic; alpha- and omega- taxonomy.

Unit 2 : Nomenclature : (Lectures – 06)

Type method, Publication, Rank of taxa, Rules of priority, Retention and rejection of names, Author Citation, Effective and valid publication, Elementary knowledge of ICN- Principles.

Unit 3 : Systems of Classification : (Lectures – 07)

Broad outline of Bentham & Hooker (1862-1883) and Takhtajan (1997)- systems of classification with merits and demerits. Brief idea of angiosperm phylogeny group (APG IV classification).

Unit 4 : Systematics in Practice : (Lectures – 02)

Herbaria and Botanic Gardens – their role in teaching and research.

Unit 5 : Dichotomous keys : (Lectures – 02)

Indented and Bracketed Keys.

Unit 6 : Brief idea on Phenetics and Cladistics : (Lectures – 02)

Monophyletic, polyphyletic and paraphyletic groups; Plesiomorphy and apomorphy.

Unit 7 : Numerical and Molecular Taxonomy : (Lectures – 03)

Methods and Significance of numerical taxonomy.

Unit 8 : Data sources in Taxonomy : (Lectures – 04)

Supportive evidences from Phytochemistry, Cytology, Palynology and Molecular biology data (Protein and Nucleic acid homology).

Unit 9 : Systematic study of Angiosperm taxa :Monocotyledons (Lectures – 06)

Diagnostic features, systematic position (Bentham & Hooker) and economically important plants (parts used and uses) of the following families - Gramineae (Poaceae), Palmae (Arecaceae), Musaceae, Zingiberaceae, Orchidaceae.

Unit 10 : Systematic study of Angiosperm taxa :Dicotyledons (Lectures – 09)

Diagnostic features, systematic position (Bentham & Hooker) and economically important plants (parts used and uses) of the following families - Magnoliaceae, Leguminosae (subfamilies), Euphorbiaceae, Labiatae (Lamiaceae), Cruciferae (Brassicaceae), Solanaceae, Rubiaceae, Compositae (Asteraceae) Umbelferae (Apiaceae)

Practical:

Total Lectures: 30

1. **Work out of Angiosperms :** Dissection, description, preparation of floral formula and floral diagram, identification up to genus with the help of suitable literature of wild plants and systematic position according to Benthum and Hooker system of classification from the following families: Musaceae, Euphorbiaceae, Labiatae (Lamiaceae), Solanaceae, Rubiaceae, Compositae (Asteraceae).

2. **Spot identification :** (Binomial, Family) of common wild plants from families included in the theoretical syllabus. App based / Artificial Intelligence based plant identification

3. **Field Visit and Report** :

   Field visit to a places of botanical importance, Submission of Herbarium specimens, Field Note Book and Field Report based on vegetation study .

RECOMMENDED BOOKS:

1. Paria, N.D., Plant Taxonomy & Biodiversity, 2022, Santra Publication Pvt. Ltd.
2. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. and Donoghue, M.J. Plant Systematics, A Phylogenetic Approach (4th ed.), 2016, Sinauer Associaties, Inc.
3. Jones, S.B. and Luchsinger, A.E. Plant Systematics (2nd ed.), 1987, McGraw Hill Book Company
4. Singh, G. Plant Systematics: An Integrated Approach (3rd ed.), 2016, CRC Press

5. Sambamurty, A.V.S.S. Taxonomy of Angiosperms, 2005, I.K. International Pvt. Ltd.
6. Sivaranjan, V.V. Principles of Plant Taxonomy (2nd ed.), 1991, Oxford & IBH
7. Subrahmanyam, N.S. Modern Plant Taxonomy, Latest Ed., Vikas Publishing House
8. Naik, V.N. Taxonomy of Angiosperms, Latest Ed., Tata McGraw Hill
9. Stace, C. A Plant Taxonomy & Biosystematics, Latest Ed., Arnold Publishers
10. Mitra, J.N. An Introduction to Systematic Botany & Ecology, Latest Ed., World Press
11. Dutta, S.C. Systematic Botany, Latest Ed., Wiley Eastern. 12. Lawrence, G.H.M. Taxonomy of Vascular Plants Ed., Oxford & IBH.
12. Prain, D. Bengal Plants (Vol I & II), Bishen Singh Mahendra Pal Singh.
13. Jeffrey, C. An Introduction to Plant Systematics, Latest Ed., Allied Publishers Pvt. Ltd.
14. Radford. A.B. Fundamentals of Plant Systematics, Latest Ed., Harper & Row.
15. Simpson, G. Plant Systematics, 2006, 2010, 2019, Springer.
16. Bhattacharya, B. Systematic Botany, 2006, Narosa Publishing House.
17. Heywood, V.H. Plant Taxonomy 1967, Edward Arnold, London.
18. Cronquist, A. The Evolution & Classification of Flowering Plant, 1988 (2nd ed.), New York Bot. Garden Bronx. New York.
19. Cronquist, A. An Integrated System of Classification of Flowering Plants.1981. Bishen Singh Mahendra Pal Singh.
20. Subramanyam, N.S. Laboratory Manual of Plant Taxonomy (2nd ed.) 1999, Vikas Publishing House.
21. Heywood, V.H. Flowering Plants of the World 1978, Oxford University Press.

COURSE NAME: Plant Physiology

COURSE CODE: BT - CE - 4234

Total Credits: 4 (Theory: 3 + Practical/Tutorial: 1)

THEORY

Total Lectures: 45

Course Objective:

The course objectives are to introduce the basic principles of plant structure and function and its application in related fields. Photosynthesis and metabolism: Investigate the processes of photosynthesis, respiration, and metabolism to comprehend energy and nutrient utilization. Analyze plant hormones and their roles in growth, development, and stress responses. Apply physiological insights to enhance crop yield, quality, and stress tolerance. Research and innovation: Conduct experiments to unravel complex plant processes, advancing agricultural practices and sustainability.

Course Learning Outcome:

CLO 1 : *Understand the intricate mechanisms of photosynthesis and respiration, including the biochemical processes and their significance in plant energy metabolism.*

CLO 2 : *Explore how plants grow, develop, and respond to environmental cues at a physiological level.*

CLO 3 : *Study nutrient acquisition, assimilation, and utilization in plants, linking these processes to growth and overall plant health.*

CLO 4 : *Analyze plant hormones and their roles in growth, development, and stress responses and evaluatethesignificanceofregulatormoleculesincontrollinglifeforms*

CLO 5 : *Apply physiological insights to enhance crop yield, quality, and stress tolerance and the principles of plant physiology to solve problems in related fields*

CLO 6 : *Enhance critical thinking skills by evaluating and interpreting experimental results and applying theoretical knowledge to solve physiological problems and advancing agricultural practices and sustainability.*

Unit 1: Plant-water relations (Lectures – 08)

Water potential and its components, water absorption by roots, water movement via symplast, apoplast and aquaporins, root pressure, ascent of sap - cohesion-tension theory, transpiration, Mechanism of stomatal movement, factors affect in gtranspiration, anti-transpirants.

Unit 2: Mineralnutrition (Lectures – 04)

Essential and beneficial elements, macro and micro-elements, criteria for essentiality, mineral deficiency symptoms, role of essential elements, chelatin gagents, Ion antagonism and toxicity. Hydroponics and Aeroponics.

Unit 3: Nutrient uptake (Lectures – 08)

Soil as a nutrient reservoir, Transport of ions across cell membrane, passive absorption, simple and facilitated diffusion (carrier and channel proteins), Fick's law, active absorption,

proton ATPase pump, electro chemical gradient, ion flux, uniport, co-transport (symport, antiport)

Unit 4: Trans-location*in the phloem (Lectures – 08)

Composition of phloem sap, Experimental evidence in support of phloem as the site of sugar translocation, phloem load in gandun loading, Pressure-Flow Model, source-sink relationship.

Unit 5: Plant growth regulators (Lectures – 10)

Chemical nature (basic structure, precursor), physiological roles, bio assays and applications of Auxins, Gibberellins, Cytokinins, Abscisic Acid, Ethylene; Other growth regulators- Jasmonic Acid, Brassino steroids, Nitric Oxide. Mechanism of action of Auxin. Introduction to interactions among plant growth regulators and Plant Extract as growth regulator.

Unit 6: Physiology of photo-sensory molecules (Lectures – 03)

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

Unit7: Physiology of flowering Seed dormancy (Lectures – 04)

Concept of florigen, photoperiodism, CO-FT Model of flowering, vernalization. Causes and methods to induce and/or overcome seed dormancy

Practical:

Total Lectures: 30

1. Determination of osmotic potential of plant cells by plasmolytic method.
2. Determination of water potential of potato tuber cells by weight method.
3. Calculation of stomatal index and stomatal frequency from the lower surface of leaves of amesophyte and axerophyte.
4. To study the effect of different concentrations of ABA onstomatal closure.
5. To study the effect of auxin on rooting.
6. Hydroponics Culture of tomato / spinach / straw berry.

RECOMMENDED BOOKS:

1. Hopkins, W. G., Huner, N. P. A. (2009). Introduction to Plant Physiology, 4th edition. New Delhi, Delhi: Wiley India Pvt. Ltd.
2. Taiz,L.,Zeiger,E.,Moller,I.M.,Murphy,A.(2018).Plant Physiology and Development, 6th edition. New York, NY: Oxford University Press,Sinauer Associates.
3. Kochhar, S.L., Gujral, S.K. (2020). Plant Physiology: Theory and Applications. New Delhi, Delhi: Foundation Books,2ndEdn.Cambridge University Press India Pvt, Ltd.
4. Bajracharya, D. (1999). Experiments in Plant Physiology: A Laboratory Manual. New Delhi, Delhi: Narosa Publishing House.
5. Bhatla,S.C.,Lal, M.A.(2018).Plant Physiology, Development and Metabolism. Singapore: Springer Nature, Singapore Pvt. Ltd

COURSE NAME: Plant Metabolism and Biochemistry

COURSE CODE: BT - CE - 5314

Total Credits: 4 (Theory: 3 + Practical/Tutorial: 1)

THEORY

Total Lectures: 45

Course Objective:

The course objectives are to understand different pathways of metabolism in plant cells. To understand how various metabolic pathways work in a synchronized manner

Course Learning Outcome:

At the end of the course the student will:

CLO 1 : *Know different types of chemical reactions that run the biological system*

CLO 2 : *Know the details of carbon assimilation, oxidation, synthesis of ATP- the energy currency of the cell, nitrogen fixation and lipid metabolism.*

CLO 3 : *Understand the role of enzymes in regulating metabolic pathways for molecules like carbohydrates, lipids and proteins.*

CLO 4 : *Understand the coordination of various biochemical reactions with reference to cell requirement and energy (ATP) economy.*

CLO 5 : *Establish link between theoretical concepts and experimental evidences.*

CLO 6 : *Practically learn advance techniques of analysis which will help in future research activities.*

Unit 1: Concepts in Metabolism (Lectures – 04)

Introduction, anabolic and catabolic pathways, endergonic and exergonic reactions, coupled reactions, redox reactions. ATP: structure, its role as a energy currency molecule.

Unit 2: **Enzymes (Lectures – 03)**

Structure, classification and mechanism of action, Michaelis-Menten equation (no derivation), Hill Spot, Enzyme inhibition (competitive, non-competitive and uncompetitive), allosteric regulation and covalent modulation, factors affecting enzyme activity.

Unit 3: Carbon Assimilation (Lectures – 10)

a) Photochemical reaction; Introduction, Concept of light absorption and action spectra, photosynthetic pigments, their types and functions (including epoxycycle); PSI, PSII; antenna molecules and reaction centres, Q-cycle, LHC, photosynthetic electron transport and photophosphorylation (cyclic and non-cyclic).

b) Thermochemical Reactions (Dark reactions): CO_2 reduction in C_3, C_4 pathways and CAM, photorespiration, factors affecting CO_2 reduction

Unit 4: Carbon Metabolism (Lectures – 04)

Metabolite pool and exchange of metabolites, synthesis and degradation of sucrose and starch.

Unit 5: Carbon Oxidation (Lectures – 06)

Glycolysis, fate of pyruvate- aerobic, anaerobic respiration and fermentation, regulation of glycolysis, oxidative pentose phosphate pathway, oxidative decarboxylation of pyruvate, Krebs cycle and its regulation, amphibolic role of Krebs cycle, mitochondrial electron transport, oxidative phosphorylation, cyanide-resistant respiration

Unit 6: ATP Synthesis (Lectures – 06)

Mechanism of ATP synthesis-substrate level phosphorylation, oxidative and photophosphorylation, chemiosmosis, ATP synthase- structure and functions (Boyers conformational model, Racker's experiment, Jagendorf's experiment; role of uncouplers)

Unit 7: Lipid Metabolism (Lectures – 04)

Triglycerides: synthesis, degradation through alpha and beta - oxidation, glyoxylate cycle, gluconeogenesis and its role in mobilisation of lipids during seed germination

Unit 8: **Nitrogen Metabolism (Lectures – 06)**

Nitrate assimilation (NR and NiR); biological nitrogen fixation inroot nodule heterosis; role of denitrogenate. Nitrogenase enzyme: structure and mechanism of action; Ammonia assimilation: GS-GOGAT, reductive amination and transamination.

Unit 9: Abiotic Stress Physiology in Plants (Lectures – 02)

Introduction to concept of stress, Plant response to Water stress, Temperature stress and Salt stress. ROS, RNS and anti-oxidative defence strategies.

Practical:

Total Lectures: 30

1. Study the effect of pH on the activity of catalase enzyme.
2. Chemical separation of photosynthetic pigments (liquid-liquid partitioning).
3. Amino acid separation by paper chromatography.
4. Estimation of sugar.
5. Determination of TAN in plant materials

RECOMMENDED BOOKS:

1. Nelson, D.L., Cox, M.M. (2017). Lehninger Principle of Biochemistry, 7th edition. New York, NY: W.H. Freeman, Macmillan learning.
2. Taiz, L., Zeiger, E., Moller, I. M. & Murphy, A. 2018. Plant Physiology and Development, International 6thedn, Oxford University Press, Sinauer Associates, New York, USA.
3. Hopkins, W.G., Huner, N. (2008). Introduction of Plant Physiology, 4th edition. New Jearsey, U.S.: John Wiley and sons.
4. Jones, R., Ougham, H., Thomas, H., Waaland, S. (2013). The molecular life of plants. Chichester, England: Wiley-Blackwell.
5. Buchanan, B.B., Gruissem, W. and Jones, R.L. (2015). Biochemistry and Molecular Biology of Plants, 2nd edition. New Jersey, U.S.: Wiley Blackwell.

6. Kochhar, S.L. & Gujral, S.K. 2020. Plant Physiology: Theory and Applications, 2nd Edition. Cambridge University Press, UK.
7. Bhatla, S.C., Lal, M.A. (2018). Plant Physiology, Development and Metabolism. Singapore: Springer.

COURSE NAME: Classical Genetics and Plant Breeding

COURSE CODE: BT - CE - 5324

Total Credits: 4 (Theory: 3 + Practical/Tutorial: 1)

THEORY

Total Lectures: 45

Course Objective :

1. *Understand the basic principles of classical genetics, including Mendelian inheritance, chromosome theory, and genetic variation.*
2. *Genetic Analysis Skills: Develop proficiency in genetic analysis techniques, such as Punnett squares, pedigree analysis, and genetic crosses.*
3. *Application in Research: Apply classical genetic principles to analyze and interpret inheritance patterns in various organisms, facilitating further research in genetics and related fields.*
4. *Breeding Objectives: Understand the goals and objectives of plant breeding, including improving yield, quality, resistance to biotic and abiotic stresses, and adaptation to specific environments.*
5. *Breeding Methods: Learn breeding methods such as hybridization, selection, and hybrid vigor to develop improved plant varieties.*

Course Learning Outcome :

CLO 1 : *Understanding Mendelian principles, genetic inheritance patterns, and their application in plant breeding.*

CLO 2 : *Students also learn about breeding techniques, selection methods, and the genetic basis of desirable traits in plants.*

CLO 3 : *Additionally, the course may cover the principles of population genetics and how they relate to plant breeding strategies. Finally students should gain practical knowledge to apply genetic principles for improving crop plants through selective breeding.*

CLO 4 : *Historical Context: Appreciate the historical contributions of key figures in classical genetics, including Mendel, Morgan, and Bateson.*

CLO 5 : *Explore the utilization of genetic resources, including wild relatives and germplasm collections, in plant breeding programs.*

CLO 6 : *Apply breeding principles to develop new cultivars with desired traits, addressing agricultural challenges and contributing to food security and sustainability.*

Unit 1 : Introduction to Genetics (Lecture 08)

Historical Perspective on Genetics, Mendelian principles, Monohybrid and dihybrid cross, Non-Mendelian Inheritance, (Multiple alleles, polygenic inheritance, epistasis), Extensions of Mendelian Genetics, (Co dominance and incomplete dominance) Chromosomal theory of inheritance.

Unit 2 : Molecular Basis of Inheritance (Lectures 04)

DNA structure and replication, Gene expression and regulation, Genetic mutations, point mutations, nonsense codon, tautomeric and frame shifts mutations.

Unit 3 : Population Genetics (Lectures 06)

Hardy-Weinberg equilibrium, factors effecting in equilibrium, Genetic drift and gene flow, Evolution theory and Natural selection, modern synthetic selection.

Unit 4 : Classical Plant Breeding (Lectures 06)

Basics of plant breeding, Breeding objectives and strategies, Hybridization techniques, artificial fertilization.

Unit 5 : Quantitative and Molecular Genetics (Lectures 04)

Quantitative trait inheritance, Marker-assisted selection, Genomic selection

Unit 6 : Breeding for Disease Resistance (Lectures 04)

Plant-pathogen interactions, Resistance breeding approaches, Biotechnological interventions

Unit 7 : Breeding for Abiotic Stress Tolerance (Lectures 04)

Understanding abiotic stress factors, Breeding for stress tolerance, Molecular approaches in stress breeding

Unit 8 : Seed Science and Technology (Lectures 04)

Seed development and maturation, Seed quality and testing, Seed enhancement techniques

Unit 9 : Ethical and Regulatory Aspects (Lectures 05)

Ethical considerations in plant breeding, Intellectual property rights, Plant varieties and GI, Regulatory frameworks for Geneon Editing and Transgenic.

Practical :

Total Lectures: 30

1. Mendelian Inheritance: Perform experiments to understand Mendelian inheritance patterns using model organisms like pea plant.
2. Genetic Crosses: Conduct genetic crosses to analyze inheritance of traits, including monohybrid and dihybrid crosses, to study segregation and independent assortment.
3. Chromosome Mapping: Use recombination data to construct genetic maps and understand the linkage and recombination of genes on chromosomes.
4. Germplasm Evaluation: Study diverse germplasm collections to identify genetic variability and potential sources of novel traits for breeding programs.
5. Emasculation.

RECOMMENDED BOOKS:

1. Lewines, Gene XI.
2. T. A Brown, Genome.
3. Alberts *et al*, Molecular Biology of the Cell.
4. J D Watson, Molecular biology of the Gene.

5. Primrose and Twyman, Principles of Gene Manipulation and Genomics.
6. Reinhard Renneberg, Biotechnology for Beginners.

COURSE NAME: Phylogenomics and Paleobotany

COURSE CODE: BT - CE - 5334

Total Credits: 4 (Theory: 3 + Practical/Tutorial: 1)

THEORY

Total Lectures: 45

Course Objective:

1. *A course on the experimental and comparative analysis of evolutionary processes, speciation, and phylogenetic patterns in plants.*
2. *The course aims to provide students with a deep understanding of the evolution of plants, integrating principles of phylogenomics, speciation and insights from palaeobotany.*
3. *Through a combination of theoretical knowledge and practical applications, students will gain an appreciation for the diversity of plant life and the evolutionary processes that have shaped it over geological time scales.*

Course Learning Outcome:

By the end of this course, the student shall be able to:

CLO 1: *Able to explain how life evolved through time and reach the present status, with particular emphasis on the evolution of land plants.*

CLO 2: *Critically analyse and understand the famous saying "Nothing in Biology makes sense except in the light of evolution".*

CLO 3: *Able to explain about speciation, polyploidy, hybridisation and adaptation.*

CLO 4: *Understand the genetic background of parasitism, horizontal gene transfer and overall origin and diversification of angiosperms.*

CLO 5: *Develop the ability to read, understand, analyse, and explain research articles from prestigious journals through the project exercise.*

CLO 6: *Able to adapt oneself to the use of computer during this course.*

CLO 7: *Students will be proficient in the molecular techniques used in phylogenomic studies, through both theory and practical sessions, including the use of molecular markers, DNA sequencing technologies, and the construction of phylogenetic trees.*

Unit 1. Palaeobotany (Lectures: 06)

Definition of Palaeobotany; Fossils- Importance, Types of Fossil Plants, Types of Fossils, Fossilisation process, Different types of rocks; Gondwana; Geological time scale with biological events.

Unit 2. Origin of Life (Lectures: 05)

Evidences of organic evolution; Mechanism of evolution-Variation, Adaptation, Heredity etc.; Elementary knowledge of theories related to evolution of life- Pre-Darwinian, Lamarck's, Darwin's, Pangenesis, Weismann's, De Vries', Modern synthetic theory.

Unit 3. Population and Evolutionary Genetics (Lectures: 05)

Population genetics, Hardy-Weinberg Law; Genetic drift, Gene pool, Allele frequencies, Chromosomal variation and Mutation, Speciation.

Unit 4. Phylogeny of Angiosperms (Lectures: 12)

Terms and concepts (primitive and advanced, homology and analogy, parallelism and convergence, monophyly, paraphyly, polyphyly and clades). Origin & evolution of angiosperms; co- evolution of angiosperms and animals; Morphological vs Molecular Phylogeny, Methods of illustrating evolutionary relationship-phylogenetic tree, cladogram, rooted vs unrooted tree, distance approach (UPGMA, NJ) and character state approach (Parsimony, Maximum Likelihood, Bayesian).

Unit 5. Phylogenomics (Lectures: 06)

Introduction to Phylogenomics, Definition, Scope, Applications of phylogenomics in understanding the tree of life (including plants); Chloroplast phylogenomics of different plant groups; Phylogenomics and plant adaptations; Perspectives on co-evolution of pollinators; adaptation to parasitism in plants; horizontal gene transfer.

Unit 6. Plant Adaptations and Diversification (Lectures: 05)

Evolution of plant adaptations to different environments; Evolutionary trends in plant reproductive strategies; Plant-animal interactions and coevolution; Impact of plant evolution on terrestrial ecosystems; Evolutionary response to climate change.

Unit 7. Molecular techniques in plant evolution (Lectures: 06)

Molecular clock hypothesis and its application; Role of genetic regulation in plant evolution; DNA sequencing techniques, Next Generation Sequencing, Single Nucleotide Polymorphism, Microsatellites or SSRs, Nucleotide and Chloroplast sequencing for concept of conserved sequences, Ancient DNA from herbarium, Environmental DNA (e-DNA).

Practical

Total Lectures: 30

1. Identification and study of different plant fossils.
2. Construction of two phylogenetic trees using sequence data from NCBI
3. Case study / Assignment in Phylogenomics and presentation of these data (Discuss any recent research papers published in world's topmost prestigious journals)– Case study topics can be allotted on the first day but the last 3 practical slots to be used for their presentations: individual seminars if number of students is less; else group discussions / group presentation (3 lecture hour equivalents)

RECOMMENDED BOOKS:

1. Niklas, K. J., & Kutschera, U. (2012). The Evolutionary Biology of Plants. University Of Chicago Press.
2. Taylor, T. N., Taylor, E. L., & Krings, M. (2009). Paleobotany: The Biology and Evolution of Fossil Plants. Academic Press.
3. Soltis, D. E., & Soltis, P. S. (2018). The Rise of Angiosperms: A Genomic View. Advances in Botanical Research, 85, 1–36.

4. Jiao, Y., & Huang, J. (2016). Phylogenomic Analysis of the Triticeae. Current Genomics, 17(2), 185–198.
5. Dutta, A.C., & Dutta, T.C. (1995). Botany for Degree Students. Sixth Edition, Oxford University Press.
6. Bromham, L. (2015). An Introduction to Molecular Evolution and Phylogenetics. Second Edition, Oxford University Press.
7. Lemey, P., Salemi, M. & Vandamme, A-M, eds. (2009). The Phylogenetic Handbook: A Practical Approach to Phylogenetic Analysis and Hypothesis Testing. Second Edition, Cambridge: Cambridge University Press.
8. Weising, K., Nybom, H., Pfenninger, M., Wolff, K., & Kahl, G. (2005). DNA Fingerprinting in Plants: Principles, Methods, and Applications, Second Edition, CRC Press.

COURSE NAME: Application of Plant Ecology and Environment

COURSE CODE: BT - CE - 5344

Total Credits: 4 (Theory: 3 + Practical/Tutorial: 1)

THEORY

Total Lectures: 45

Course Objective:

1. *This paper shall try to give an insight into practical and theoretical knowledge of Applied Ecology and environment.*
2. *This paper deals with mathematical application on biodiversity.*
3. *Unit on ecotourism and Eco restoration will help in understanding in the field of above area and its practical utility and restoration of environmental study*
4. *Forestation and pollution study will help the learners to develop some practical knowledge to mitigate and develop solution to the current menace confronting the environment*

Course Learning Outcome:

CLO 1: *Basic and practical knowledge in the field of applied ecology and environment will be enhanced.*

CLO 2: *Learner's will have a good incite in understanding practical and applied aspects of ecology and environment dealt in the areas of the paper.*

CLO 3: *Ecotourism and eco-restoration introduced in the paper will help learner to develop self-sustainance and good understanding in the field of study.*

CLO 4: *Pollution study in the paper will help the learners in understanding current problems and very sensitive issue in sustainance of the environment.*

CLO 5: *Total biodiversity issue will be sorted out after learning the various aspect in this field*

Unit 1. Forestry (Lectures: 05)

Definition, forest types, global deforestation, threats to and loss of biodiversity, extinction crisis, causes of extinction, habitat loss, bio-invasion, invasive species, exotic species, afforestation, re-forestation, mass-extinction

Unit 2. Biodiversity and measurement (Lectures: 10)

Definition, magnitude, level of diversity, species diversity, tree diversity in tropical forest, measurement of genetic diversity, agro-biodiversity, measurement of biodiversity, species-richness evenness frequency, density, I.V.I(importance value index), diversity indices, Shannon Simpson indices, fisher's indices, biodiversity conservation, threats, global biodiversity

Unit 3. Environmental pollution (Lectures: 12)

Definition, environmental pollution and pollutants, types of pollution, air, water, soil and noise pollution, causes, effects, control, bio-magnification, particulate matters (PM),

photochemical smog, PAN tropospheric ozone, radioactive pollutants, heavy metals pollution, eutrophication, indoor air pollutants, solid waste management, liquid waste management

Unit 4. Ecological application (Lectures: 06)

Organic farming, sustainable development, ecological sustainability, bio-pesticides, bio-fertilizers, integrated pest management, biological monitoring of the environment - indicator species, ecosystem services, exobiology, types of life supporting systems, ecology of space travel

Unit 5. Ecotourism (Lectures: 09)

Definition, historical background, identification of potential sites for ecotourism, conventional and mass-tourism, nature-based tourism, role of parks and gardens in ecotourism, community involvement in ecotourism, development and management. Role of photographs and electronic media in ecotourism, environmental impact, trends, and future of ecotourism, recreation, conservation and economic development.

Unit 6. Eco-restoration (Lectures: 03)

Definition, restoration of wasteland, forests, soil fertility, ground water, restoration of ecology in urban and industrial center, indicators of restoration and reclamation

Practical

Total Lectures: 30

1. Instrumentation: pH meter, B.O.D incubator, titrimetry, spectophatometry, chromatography, gravimetry, photographs/instrument
2. Determination of soil types, texture, pH, nitrogen, potassium, phosphorus and organic matters
3. Dissolved oxygen measurement by Winkler's method
4. Determination of frequency, density and abundance of local area
5. Analysis of importance value index (I.V.I) with phytographs
6. Field visits to different areas to identify ecological degradation, industrial establishment to know more about pollution devices and management

RECOMMENDED BOOKS:

1. E.P. Odum- Fundamental of ecology
2. P.D. Sharma- Ecology and Environment
3. R.S. Ambhast- Plant ecology
4. Willard, Merritt and Dean- Instrumental Analysis
5. Jom Bockins- Environmental Chemistry
6. Lauret Hodges- Environmental Pollution
7. Brady- The nature of properties of soil
8. M.N. Rao and A.K. Datta- Waste water treatment

9. H.C. Parkins- Air pollution
10. C.S. Rao- Environmental science and engineering
11. Martha Honey- Ecotourism and sustainable development, Island press, Washington DC
12. B.K Tiwari, Surendra Singh- Eco-restoration of degraded Hills

COURSE NAME: Advanced Microbiology

COURSE CODE: BT - CE - 6314

Total Credits: 4 (Theory: 3 + Practical/Tutorial: 1)

THEORY

Total Lectures: 45

Course Objective:

1. *To understand the historical development of microbiology and its significance in scientific discovery.*
2. *Explore the scope of microbiology and its applications in various fields.*
3. *To comprehend the nutritional requirements and metabolic processes of microorganisms.*
4. *To understand the microbiology of soil, air, and water, and their roles in biogeochemical cycles; the mechanism and significance of biological nitrogen fixation.*
5. *To gain insight into the modern concept of bacterial cell structure and function.*
6. *To understand the principles of bioremediation and waste treatment using microorganisms.*
7. *To understand the principles and applications of synthetic biology and microbial engineering and also explore ethical considerations related to synthetic biology.*

Course Learning Outcome:

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

CLO 1 : *Trace the historical development of microbiology and appreciate its role in shaping scientific knowledge.*

CLO 2 : *Identify and discuss real-world examples of how microbiology contributes to different scientific and industrial domains.*

CLO 3 : *Demonstrate an understanding of the nutritional needs of microorganisms and the metabolic processes that sustain their growth.*

CLO 4 : *Comprehend the microbiology of soil, air, and water, recognizing the roles microorganisms play in these environments with a focus on the biological nitrogen fixation process.*

CLO 5 : *Differentiate the characteristics of Rickettsiae, Chlamydiae, Actinomycetes, Archaebacteria, and Mycoplasma and the diseases caused by these microorganisms and their impact on human health.*

CLO 6 : *Understand the principles and applications of synthetic biology and microbial engineering and application of ethical frameworks to evaluate potential advancements in the field.*

CLO 7: *Foster collaborative learning and communication skills through teamwork, group discussions, seminars, and home assignments.*

Unit 1 : Introduction (Lectures 06)

History and development, scope of Microbiology, introduction to microbial world, microbial taxonomy and its modern trends.

Unit 2: Microbial Metabolism (Lectures 10)

Microbial nutrition, growth and metabolism, microbiology of soil, air and water, role of microorganisms in biogeochemical cycles (N, C, S cycles) in nature, biological nitrogen fixation

Unit 3: Structure and Growth of Microbes (Lectures 08)

Modern concept of Bacterial cell, Reproduction and Growth of Bacteria- genetic recombination; General account of Rickettsiae, Chlamydeae and diseases caused by them. Distinguishing features of Actinomycetes, Archaebacteria and Mycoplasma

Unit 4: Industrial Microbiology (Lectures 10)

Microorganisms in food and beverage production, Bioremediation and waste treatment; Medical Microbiology: Pathogenesis of microbial infections, Antimicrobial resistance; Microbial Control

Unit 5: Immunology (Lectures 05)

Concept of immunology, types of immunity, cell mediated and humoral immunity, primary and secondary immune responses, antigen and antibody structure and classes, vaccine.

Unit 6: Application aspects of Microbiology (Lectures 06)

Synthetic Biology and Microbial Engineering: Engineering microorganisms for various applications; Ethical considerations in synthetic biology**;** Recent Advances in Microbiology Research

Practical

Total Lectures: 30

1. Culturing and monitoring microbial growth using different culture.
2. Isolation and identification of microorganisms from environmental samples.
3. Analysis of microbial diversity in soil, air, and water samples.
4. Microscopic examination of bacterial cell structures.
5. Visualization of bacterial morphology using advanced microscopy techniques.
6. Hands-on experience in the production of microbial products (e.g., fermentation of food and beverages).

RECOMMENDED BOOKS:

1. Dubey, R.C & D.K. Maheswari: A Text Book of Microbiology.
2. Kaushik, P.: Microbiology.
3. Kumar, H.D. & S. Kumar: Modern Concept of Microbiology.
4. Pelczar, Chan and King: Microbiology
5. Purohit, S.S.: Microbiology.
6. Rangaswami, R. & C.K.J. Panikar: Text Book of Microbiology.
7. Sharma, P.D.: Microbiology and Pathology.
8. Singh, U.S. & K. Kapoor: Introductory Microbiology.

9. Trivedi, P.C. Pandey, S. & Seema Hadauria: Text Book of Microbiology.
10. Banerjee, A.K. & N. Banerjee: Fundamentals of Microbiology and Immunology.

COURSE NAME: Molecular Biology and Biotechnology

COURSE CODE: BT - CE - 6324

Total Credits: 4 (Theory: 3 + Practical/Tutorial: 1)

THEORY

Total Lectures: 45

Course Objective:

1. *To provide students with a comprehensive understanding of the principles and concepts underlying biotechnology, including molecular biology, genetics, and biochemistry, forming the foundation for advanced studies and research in the field.*
2. *To develop practical skills in biotechnological techniques, such as DNA manipulation, protein purification, cell culture, and genetic engineering, through hands-on laboratory exercises and experiments.*
3. *To familiarize students with the diverse applications of biotechnology in various sectors, including agriculture, pharmaceuticals, healthcare, and environmental science, enabling them to appreciate the real-world impact and potential of biotechnological advancements.*
4. *To cultivate awareness of ethical issues, safety protocols, and regulatory frameworks governing biotechnological research and applications, fostering responsible conduct and decision-making in the field.*
5. *To encourage interdisciplinary learning by integrating concepts from biology, chemistry, physics, and engineering into the study of biotechnology, preparing students to address complex scientific challenges through collaborative and innovative approaches.*
6. *To enhance critical thinking skills by challenging students to analyze and solve biotechnological problems, fostering creativity, adaptability, and resilience in tackling scientific inquiries and technological developments.*

Course Learning Outcome:

CLO 1: *Conduct Molecular Experiments: Execute laboratory experiments using molecular techniques, interpret results, and generate accurate and reliable data.*

CLO 2: *Apply Genetic Engineering Techniques: Apply gene cloning and recombinant DNA technology to design and execute experiments aimed at modifying genes for specific purposes.*

CLO 3: *Analyze Biotechnological Data: Analyze data from biotechnological experiments, draw conclusions, and present findings effectively, both orally and in writing.*

CLO 4: *Solve Biotechnological, Problems: Demonstrate problem-solving skills by applying molecular biology and biotechnological knowledge to address real-. world challenges in agriculture, medicine, and industry.*

CLO 5: *Collaborate in a Laboratory Setting: Work collaboratively in a laboratory setting, demonstrating effective communication and teamwork in the execution of experiments and projects.*

CLO 6: *Critically Evaluate Biotechnological Applications: Critically evaluate the ethical, societal, and environmental implications of biotechnological lapplications, and make informed decisions, based on this understanding*

UNIT 1: Introduction to Molecular Biology (Lectures 06)

Overview of Molecular Biology- Concept of chromosome and chromatin, structure of nucleosome, chronology of historical mile stones, Synthesis and Processing ofDNA, Concept of intron splicing.

UNIT 2 : Genetic Information flow (Lectures 06)

Central Dogma, RNA Processing, Unidirectional flow Transcription and translation, Reverse transcription and the basis of gene hunting, genetic code (three letter codon), codon bias, protein synthesis, regulation of gene expression - prokaryots and eukaryots, Epigenetics

UNIT 3 : Molecular Techniques (Lectures 04)

Gel Electrophoresis, SDS PAGE – 1 D, 2 D electrophoresis and Agarose Gel Electrophoresis, Polymerase Chain Reaction (PCR), DNA sequencing, Molecular Cloning

UNIT 4 : Recombinant DNA Technology (Lectures 08)

Gene Cloning, DNA Libraries, Expression Vectors, Prokaryotic (pUC 18 and pUC19, pBR322, Ti plasmid, BAC); Lambda phage, M13 phagemid, Cosmid; Eukaryotic Vectors (YAC). Preparation of expression cassettes, Site-Directed Mutagenesis, Gene knock outs and gene editing.

UNIT 5: Biotechnological Applications (Lectures 05)

Genetic Engineering, Genetically Modified Organisms (GMOs), Living modified organisms, Agricultural Biotechnology, Medical Biotechnology.

UNIT 6: Proteomics and Functional Genomics (Lectures 05)

Protein Structure and Function, Proteomics Techniques, Functional Genomics Approaches

UNIT 7: Industrial Biotechnology (Lectures 05)

Fermentation Processes, Enzyme Technology, Bioprocessing

Unit 8 : Plant Tissue Culture (Lectures 08)

Composition of media; Nutrient and hormone requirements; Totipotency; Organogenesis; Embryogenesis (somatic and zygotic); Protoplast isolation, culture and fusion; Tissue culture applications (micropropagation, androgenesis, virus elimination, secondary metabolite production, haploids, triploids and hybrids; Cryopreservation; Germplasm Conservation).

Unit 9 : Ethical and Social Issues in Biotechnology (Lectures 03)

Ethical Considerations in Genetic Engineering, Environmental and Societal Impacts, Bio safety Regulations and Guidelines.

Practical

Total Lectures: 30

1. Isolation of genomic DNA
2. Amplification by PCR method and visualization of gel doc,
3. Use of restriction enzymes RFLP.

4. Handling of biological data base from proteomic and genomic data.

RECOMMENDED BOOKS:

1. Lewines, Gene XI.
2. T. A Brown,Genome.
3. Alberts *et al*, Molecular Biology of the Cell.
4. JD Watson, Molecular biology of the Gene.
5. Primrose and Twyman, Principles of Gene Manipulation and Genomics.
6. Reinhard Renneberg, Biotechnology for Beginners.

.

COURSE NAME: Natural Resources Management

CODE: BT - CE - 6334

Total Credits: 4 (Theory: 3 + Practical/Tutorial: 1)

THEORY

Total Lectures: 45

Course Objective:

1. *To understand and classify different types of waste, including solid, liquid, and hazardous waste, and understand the characteristics that define each category.*
2. *To explore and evaluate strategies for waste minimization, including source reduction, reuse, and recycling.*
3. *To understand the principles and processes of recycling different types of materials, and assess the environmental and economic benefits of recycling initiatives.*
4. *To develop the ability to design and implement comprehensive waste management plans for different settings, considering the local context, available infrastructure, and waste generation patterns.*
5. *To understand the importance of waste audits and monitoring in the planning and evaluation of waste management programs.*
6. *To explore the potential of converting waste into energy and other valuable resources, emphasizing sustainability and environmental benefits.*
7. *Recognize the importance of biodiversity and the role it plays in ecosystem stability. Identify and assess threats to biodiversity and explore strategies for conservation.*
8. *To understand the legal and regulatory frameworks governing waste management at local, national, and international levels.*
9. *Demonstrate the ability to navigate and comply with regulations, and recognize the role of policies in promoting sustainable waste management practices.*

Course Learning Outcome:

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

CLO 1: *Demonstrate an integrated understanding of ecosystem dynamics, recognizing the interconnected relationships among living organisms, their environments, and the services ecosystems provide.*

CLO 2: *Evaluate and apply principles of sustainable resource management, demonstrating the ability to balance human needs with the preservation of ecosystems and biodiversity.*

CLO 3: *Develop the skills to identify, assess, and implement conservation strategies, with a focus on preserving biodiversity, protecting endangered species, and maintaining ecosystem resilience.*

CLO 4: *Analyze environmental policies and governance structures related to natural resource management, and demonstrate the ability to propose, evaluate, and advocate for effective policies that align with sustainability goals.*

CLO 5: *Understand the importance of involving local communities and stakeholders in decision-making processes related to natural resource management. They will demonstrate the ability to foster collaboration, address conflicts, and integrate diverse perspectives for sustainable outcomes.*

Unit 1: Introduction to Natural Resource Management (Lectures 10)

Introduction to Natural Resources, types, and classification of natural resources, importance and role of natural resources in bio economy; Ecology and Ecosystems, Ecosystem structure and function, Human impact on the environment, Environmental issues and challenges, Spatial distribution of natural resources, Environmental Economics, Principles of environmental economics, Valuation of natural resources.

Unit 2: Sustainable Resource Management (Lectures 07)

Concepts and principles of sustainable development, Sustainable development goals (SDGs), Biodiversity conservation, Threats to biodiversity and conservation strategies, Natural Resource Policy and Law, Legal frameworks for resource management.

Unit 3: Soil Resource Management (Lectures 07)

Land Utilization (agricultural, pastoral, horticultural, silvicultural); Soil degradation and management. Land Use Planning, Principles of land use planning, Integrated land management, Environmental Impact Assessment (EIA), EIA process and methodologies.

Unit 4: Water Resource Management (Lectures 05)

Aquatic ecosystems and their dynamics, Water quality and pollution, Water Resource Policy and Governance, Laws and regulations related to water resources, Water Conservation and Management, Water harvesting and conservation techniques, Hydrology and Watershed Management, hydrological cycle.

Unit 5: Forest Resource Management (Lectures 12)

Introduction to Forestry, Forest ecosystems and their components, Importance of forests for biodiversity and climate, Forest Conservation and Policy, Forest laws and regulations, Community-based Forest management, Wildlife Management, Conservation of wildlife and their habitats, Human-wildlife conflict resolution, Forest Inventory and Remote Sensing, Techniques for forest inventory.

Unit 6: Contemporary practices in resource management (Lectures 04)

SIA, GPS, GIS and remote sensing applications in resource mapping,Participatory Resource Appraisal, Ecological Footprint with emphasis on carbon footprint, Resource Accounting; Waste management.

Practical:

Total Lectures: 30

1. GIS and Remote Sensing applications,

2. Creation a map of India embedding the geo location of Gir Forest, Nilgiri, Rani-Garbhanga Reserve Forest, Jim Corbett NP using vector and raster data (Q-GIS).
3. Identification of threats and mitigation strategies the threats at the Ramser site near Guwahati
4. Water Quality Analysis techniques, Sampling and testing of local water sources
5. Collection of data on forest cover of specific area.
6. Measurement of dominance of woody species by DBH (diameter at breast height) method.
7. Calculation and analysis of ecological footprint.

RECOMMENDED BOOKS:

1. Vasudevan, N. (2006). Essentials of Environmental Science. Narosa Publishing House, New Delhi.
2. Dwivedi, O.P. India's Environmental Policies, Programmes and Stewardship
3. Chopra K. R. Development and Environmental Policy in India: The Last few decades.
4. Singh, J. S., Singh, S.P. and Gupta, S. (2006). Ecology, Environment and Resource Conservation. Anamaya Publications, New Delhi.
5. Rogers, P.P., Jalal, K.F. and Boyd, J.A. (2008). An Introduction to Sustainable Development. Prentice Hall of India Private Limited, New Delhi.

COURSE NAME: Recent Trends in Plant Science

COURSE CODE: BT - CE - 6344

Total Credits: 4 (Theory: 3 + Practical/Tutorial: 1)

THEORY

Total Lectures: 45

Course Objective:

1. *Explore emerging research areas: Investigate recent advancements in botanical sciences, including molecular biology, genomics, and bioinformatics, to understand cutting-edge research trends.*
2. *Analyze interdisciplinary connections: Examine the intersection of botany with other disciplines like ecology, biotechnology, and climate science to explore holistic approaches to plant study.*
3. *Foster innovation: Encourage critical thinking and creativity to address contemporary challenges in plant biology, such as climate change, food security, and sustainable agriculture, through novel research methodologies and solutions*

Course Learning Outcome :

CLO 1 : *In-depth Understanding: Gain a comprehensive understanding of recent advancements in botanical sciences, spanning molecular biology, genomics, and bioinformatics, enhancing knowledge of cutting-edge research methodologies and techniques.*

CLO 2 : *Interdisciplinary Connections: Explore the interdisciplinary nature of botany, analyzing its connections with ecology, biotechnology, and climate science, fostering a holistic perspective on plant biology and its implications for global challenges.*

CLO 3 : *Critical Thinking Skills: Develop critical thinking skills to evaluate and integrate complex scientific information from diverse sources, fostering creativity and innovation in addressing contemporary issues in botany.*

CLO 4 : *Research Proficiency: Acquire proficiency in conducting research, including experimental design, data analysis, and interpretation, enabling contribution to scientific advancements in botany.*

CLO 5 : *Communication Abilities: Enhance communication skills to effectively disseminate research findings and engage in interdisciplinary dialogues, promoting collaboration and knowledge exchange within the scientific community.*

CLO 6 : *Ethical Awareness: Recognize and adhere to ethical standards in botanical research and applications, emphasizing integrity, transparency, and responsible conduct in scientific inquiry.*

CLO 7 : *Professional Development: Foster a passion for lifelong learning and engagement with current trends and advancements in botany, preparing for future careers in academia, industry, or research institutions.*

Unit 1 : Role of Plants and Microbes in Ecosystem Restoration (Lectures 07)

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

Unit 2 : National and International Initiatives of Natural Resources (Lectures 04)

Natural resource management as National (BDA) and international policies (CBD), International Solar Alliance; Ramsar Convention; Basel Convention; Carbon Neutral Goals; Netzero Coalition; Clean Development Mechanism; CAMPA (Compensatory Afforestation Fund Management and Planning Authority); Carbon Credits; REDD+ project, Renewable Energy Certificate.Convention Biological Diversity (CBT) and Biodiversity (BD) Act

Unit 3: Spectrophotometry (Lectures 04)

Principles and applications of UV, Visible and IR spectrophotometry.

Unit 4 : Techniques for detection and analysis of nucleic acids and proteins (Lectures 09)

PCR – design of PCR primers, enzymes used for PCR, cloning of PCR products; DNA polymorphism and its applications (RFLP, AFLP, SSR, SNPs); RNA isolation and analysis, cDNA synthesis and qRT-PCR; Extraction of proteins, PAGE (Native and denaturing); Blotting and hybridization techniques: Southern (Radioactive and Non-radioactive), Northern and Western; DNA sequencing – Sanger's dideoxy sequencing; ELISA

Unit 5: Climate change and Forest (Lectures 08)

Carbon Sequestration, Climate change institution and governance; IPCC, UNF, CCC – Conference of Partis (COP); Kyoto Protocol- Emission Trading, Join implementations, Global warming and its effect in Coral Ecosystem; Mycorrhizae in forest ecosystem restoration.

Unit 6: Biostatistics (Lectures 07)

Statistics, data, population, samples, parameters; Representation of Data: Tabular, Graphical; Measures of central tendency: Arithmetic mean, mode, median; Measures of dispersion: Range, mean deviation, variation, standard deviation; Chi-square test for goodness of fit.

Unit 7: Computational Biology (Lectures 06)

Computer assisted drug design - concept, methods and practical approaches. Diagrammatic, graphical and tabular representations of data; measures of central tendency, dispersion, skewness and kurtosis. Basic concepts of hypothesis testing, two kinds of error, level significance, p value, t- Test.

Practical:

Total Lectures: 30

1. Project (any one of the following): a. Rainwater harvesting (site visit) b. Ecological restoration (site visit) c. Energy audit d. Seed germination and seedling growth in garden and contaminated soils e. Composting f. Any other g. Field visit/s to any degraded ecosystem (landfill, polluted water body, invaded forest) or any ongoing restoration project site.
2. Isolation of chloroplasts by differential centrifugation.

3. Gene identification by using GenBank (NCBI), Sequence alignment and construction of phylogenetic tree by using tools (BLAST, MEGA, Bioedit).

RECOMMENDED BOOKS:

1. K.V. Krishnamurthy, Recent Trends in Botany.
2. Indian Council of Agricultural Research (ICAR), Advances in Botany Research in India.
3. Matthias Lang and Adelino da Silva, Trends in Botany.
4. Frontiers Media SA, Frontiers in Plant Science.

MINOR

Programme Specific Outcome of Bachelor of Science – Botany Minor

PSO No.	Name	Outcome
PSO–1	Importance of plants and their functions (*BTL: Remember, Understanding*)	To develop a conceptual understanding of principles and importance of Botany. Students will be able to understand and explain different specializations of Botany such as systematics, evolution, ecology, developmental biology, physiology, biochemistry, plant interactions with microbes and insects, morphology, anatomy, reproduction, genetics, cell and molecular biology of plants.
PSO–2	Laboratory Skills (*BTL: Application, Evaluate*)	Acquire practical skills in laboratory settings, including microscopy, experimental design, and data analysis. Students are also familiarized with the use of bioinformatics tools and databases and in the application of statistics to biological data. Students will be trained in various analytical techniques of plant biology, use of plants as industrial resources or as support system for human livelihood and will be well versed with the use of transgenic technologies for both basic and applied research in plants.
PSO–3	Development of Research Mindset (*BTL: Create*)	Plan and execute field investigation, collect, analyze and interpret data using appropriate methods including appropriate IT and accurately report the findings of the field investigation. The will be able to identify and analyze various issues prevailing in the societies, like, socio-political, socio-economic, socio-religious, ethnic issues, health issues in bio-cultural context, ethno botanical, ethno medicine, environmental issues, etc.
PSO–4	Applied Botany *(BTL: Apply)*	Demonstrate a thorough understanding of the human past with special emphasis on prehistoric and proto historic phase of the past and documentation of prehistoric implements for collection and preservation in museums.
PSO–5	Communication Skills *(BTL: Apply)*	Be motivated for further higher studies and research in different sub-disciplines of anthropology.
PSO–6	Closeness with nature *(BTL: Evaluate)*	Students will be eligible in diverse fields in research organization, government services, education sector, human resources, public services, hospitality, industries, corporate sectors, entrepreneur, business, tourism industry, media and Non-Governmental organization.
PSO–7	Continuous Learning *(BTL: Create)*	The primary ethics of the subject is to ensure appreciation of human diversity and it helps to analyze critically the issues that are relevant in contemporary society.

LIST OF COURSES:

Semester	Course Name	Course Code
1	Biodiversity (Microbes, Algae, Fungi and Archegoniate)	BT – MN – 1114
2	Plant Ecology and Taxonomy	BT – MN – 2114
3	Biomolecules and Cell Biology	BT – MN – 3214
4	Plant Physiology and Metabolism	BT – MN – 4214
5	Plant Anatomy, Embryology and Economic Botany	BT – MN – 5214
6	Plant Breeding and Biotechnology	BT – MN – 6214

Course Learning Outcome (CLO)

Semester	Course Name & Code	Course Learning Outcome (CLO)	
1	Biodiversity (Microbes, Algae, Fungi and Archegoniate) BT – MN – 1114	CLO - 01	Combination of theoretical and practical components of this course will provide comprehensive information and insight into the fascinating world of microbes and plants.
		CLO - 02	Hand on training will help students learn use of the microscope, mounting, section cutting and staining techniques for the study of plant materials.
		CLO - 03	Making drawing in practical records will enhance understanding morphology and structural details and related functional aspects in diverse plant groups.
		CLO - 04	This paper is both informative and interesting and will enable student to learn about biodiversity not only as plant or nature lover but also for higher academic pursuits, particularly in the field of biological sciences, environment and biodiversity conservation. .
2	Plant Ecology and Taxonomy BT – MN – 2114	CLO - 01	Student would have understanding of various ecological parameters of plant in nature pertaining to influencing ecological factors and their analysis of practical datas on individual, population, community and ecosystem level along with their relationships.
		CLO - 02	Student also would have understanding about basic knowledge of plant taxonomy with the modern taxonomic approaches.
		CLO - 03	Practical knowledge of the course material will develop the skill of identification and classification of plant diversity and characterization of angiospermic families along with their phyto geographical analysis.
3	Biomolecules and Cell Biology BT – MN – 3214	CLO - 01	Students will be able to obtain knowledge of structure, classification, and physicochemical properties of different biomolecules.
		CLO - 02	Students will be able to know about the detail structure, properties, and functions of a cell and its components.
		CLO - 03	Students will be acquainted with practical knowledge of properties of cell and cell membranes, Nucleic acid, and microscopy of the plant cell.
		CLO - 04	Students will be able to identify various biomolecules in the laboratory by qualitative tests of biomolecules.

4	Plant Physiology and Metabolism BT – MN – 4214	CLO - 01	At the end of the course the student will understand the fundamental concepts of plant physiology and metabolism and know the role of water, hormones, and light in plant growth and development.
		CLO - 02	At the end of the course the student will understand the role of mineral in plants growth and their deficiency symptoms.
		CLO - 03	At the end of the course the student will understand the conduction of substances within the plant body- cell to cell conduction as well as movement through the entire plant body.
		CLO - 04	At the end of the course the student will know in detail the conduction of the absorption and conduction of water in plant body and understand the role of hormones in plant growth and development.
		CLO - 05	At the end of the course the student will know the application of hormones in growth, morphogenesis, flowering, germination and senescence of plant and also examine the commercial applications of growth regulators.
		CLO - 06	At the end of the course the student will know the basic mechanisms of carbon utilization (photosynthesis, respiration) and nitrogen utilization (nitrate and ammonia assimilation) in plants.
		CLO - 07	At the end of the course the student will understand the response of plants to different stress condition and develop practical skills in plant physiology and metabolism
5	Plant Anatomy, Embryology and Economic Botany BT – MN – 5214	CLO - 01	Students are expected to gain theoretical knowledge and acquire basic skills on the plant anatomy, embryology with special reference to Angiosperms. Students are also expected to gain theoretical knowledge to explore the basic utilitarian aspects of plants. Upon completion of the course, the students will be able to illustrate the structure, types, organization of various cells, tissues and organs of plant body.
		CLO - 02	Students are expected to gain theoretical knowledge and acquire basic skills on the plant anatomy, embryology with special reference to Angiosperms. Students are also expected to gain theoretical knowledge to explore the basic utilitarian aspects of plants. Upon completion of the course, the students will be able to relate plant anatomy and embryology of angiosperms with other fields of botany.
		CLO - 03	Students are expected to gain theoretical knowledge and acquire basic skills on the plant anatomy, embryology with special reference to Angiosperms. Students are also expected to gain theoretical knowledge to explore the basic utilitarian aspects of plants. Upon completion of

			the course, the students will be able to Combine classical utilitarian aspects of plant with modern molecular organization of plants.
5	Plant Anatomy, Embryology and Economic Botany BT – MN – 5214	CLO - 04	Students are expected to gain theoretical knowledge and acquire basic skills on the plant anatomy, embryology with special reference to Angiosperms. Students are also expected to gain theoretical knowledge to explore the basic utilitarian aspects of plants. Upon completion of the course, the students will be able to Learn various advanced tools to study plant anatomy and embryology.
6	Plant Breeding and Biotechnology BT – MN – 6214	CLO - 01	After completing this course, students will be able to understand fundamental concepts of centers of origin of crop plants and explain diversity, acclimatization, plant introduction, and domestication.
		CLO - 02	After completing this course, students will be able to gain knowledge on plant tissue culture and the basic molecular techniques used in biotechnology.
		CLO - 03	After completing this course, students will be able to Differentiate between types of molecular markers (RAPD, AFLP, SSR, SNP) and apply molecular markers in marker-assisted selection (MAS) for crop improvement.
		CLO - 04	After completing this course, students will be able to Identify major biotechnology institutes and companies in India. They will be able to explain applications of DNA recombinant technology in agriculture and medicine.
		CLO - 05	After completing this course, students will be able to apply plant tissue culture techniques by understanding the composition of media and nutrient requirements in plant tissue culture.
		CLO - 06	After completing this course, students will be able to understand recombinant DNA technology and the role of restriction enzymes. Identify and describe various cloning vectors and gene cloning techniques.
		CLO - 07	After completing this course, students will be able to discuss applications of biotechnology in agriculture, such as pest-resistant and herbicide-resistant plants; Explain the role of transgenics in bioremediation and the production of safer and cheaper medicines; and evaluate biosafety concerns associated with genetically engineered products.
		CLO - 08	After completing this course, students will be able to gain hands-on experience in the preparation of MS medium, in vitro sterilization, and inoculation methods.

Mapping of Programe Outcome (PO) and Course Learning Outcome (CLO):

Attributes: Co-relation Levels

"1" : Minimum Co-relation
"2" : Moderate Co-relation
"3" : Maximum Co-relation
"-" : No Co-relation

Course Code	CLO	Programme Outcome (SPO)										
		SPO - 1	SPO - 2	SPO - 3	SPO - 4	SPO - 5	SPO - 6	SPO - 7	SPO - 8	SPO - 9	SPO - 10	SPO -11
BT-MN-1114	CLO - 1	1	2	1	1	2	2	2	2	3	2	2
	CLO - 2	1	1	1	1	2	2	2	2	3	2	2
	CLO - 3	1	-	2	-	-	-	-	-	-	-	-
	CLO - 4	1	-	-	-	-	-	-	2	-	-	-
BT-MN-2114	CLO - 1	3	3	2	1		3				2	3
	CLO - 2	3	3	3	2		3				2	3
	CLO - 3	3	3	2	1		3				2	3
BT-MN-3214	CLO - 1	1	3	2	2	3	3	2	2	3	2	2
	CLO - 2	1	2	2	2	3	3	2	2	3	2	2
	CLO - 3	1	2	1	1	2	2	2	2	3	2	2
	CLO - 4	1	1	1	1	2	2	2	2	3	2	2
BT-MN-4214	CLO - 1	1	-	2	-	-	-	-	-	-	-	-
	CLO - 2	1	-	-	-	-	-	-	2	-	-	-
	CLO - 3	-	2	-	-	-	-	-	-		-	-
	CLO - 4	-	1	2	3	-	-	-	-	-	-	-
	CLO - 5	-	-	-	-	1	-	-	-	-	3	-
	CLO - 6	-	-	-	-	-	-		-	-	-	-
	CLO - 7	-	-	-	-	-	1	-	-	2	3	-
BT-MN-5214	CLO - 1	1	-	-	-	-	-	-	-	-	-	-
	CLO - 2	1	-	-	-	-	-	-	-	-	-	-
	CLO - 3	-	2	3	-	-	-	-	-	-	-	-
	CLO - 4	-	-	-	1	-	-	-	-	-	-	-
BT-MN-6214	CLO - 1	3	1	1		1	1	2	1			1
	CLO - 2	3	1	1		1	1	2	1			1
	CLO - 3	3	1	1		1	1	2	1			1
	CLO - 4	1	1	1	2	1	2	2	1		1	1
	CLO - 5	1	1	1	2	1	2	2	3	2	1	1
	CLO - 6	1	1	2	3	1	2	2	3	2	3	1
	CLO - 7	1	1	2	3	1	3	3	3	2	3	1
	CLO - 8	1	1	2	3	1	2	2	3	3	3	1

Mapping of Programe Specific Outcome (PSO) and Course Learning Outcome (CLO)

Attributes: Co-relation Levels

"1" : Minimum Co-relation
"2" : Moderate Co-relation
"3" : Maximum Co-relation
"-" : No Co-relation

Course code	CLO	Programme Specific Outcome						
		PSO - 1	PSO - 2	PSO - 3	PSO - 4	PSO - 5	PSO - 6	PSO - 7
BT-MN-1114	CLO - 1	1	2	1	1	2	2	2
	CLO - 2	1	1	1	1	2	2	2
	CLO - 3	1	-	2	-	-	-	-
	CLO - 4	1	-	-	-	-	-	-
BT-MN-2114	CLO - 1	3	3	2	1		3	
	CLO - 2	3	3	3	2		3	
	CLO - 3	3	3	2	1		3	
BT-MN-3214	CLO - 1	1	3	2	2	2	3	1
	CLO - 2	1	3	2	2	2	3	1
	CLO - 3	1	1	1	1	2	2	1
	CLO - 4	1	1	1	1	2	2	1
BT-MN-4214	CLO - 1	1	-	-	-	-	-	-
	CLO - 2	1	-	-	-	-	-	-
	CLO - 3	-	-	-	-	-	-	-
	CLO - 4	-	2	1	-	-	-	-
	CLO - 5	-	-	-	-	1	-	-
	CLO - 6	-	-	-	-	-	-	-
	CLO - 7	-	-	-	-	-	-	1
BT-MN-5214	CLO - 1	1	-	-	-	-	-	-
	CLO - 2	1	-	3	-	-	-	-
	CLO - 3	-	-	-	1	-	-	-
	CLO - 4	-	1	-	-	-	-	-
BT-MN-6214	CLO - 1	3		1	1	1	1	1
	CLO - 2	3		1	1	1	1	1
	CLO - 3	3		1	1	1	1	1
	CLO - 4	3		1	1	1	1	1
	CLO - 5	3		1	1	1	1	1
	CLO - 6	3		1	2	2		1
	CLO - 7	3	3	2	2	2		2
	CLO - 8	2	3	3	3	2		2

COURSE NAME: Biodiversity (Microbes, Algae, Fungi and Archegoniate)
COURSE CODE: BT – MN – 1114
Total Credits: 4 (Theory: 3 + Practical/Tutorial: 1)

THEORY: 3 CREDITS

Total Lectures: 45

COURSE OBJECTIVE:

The course includes modules on basic knowledge of the plant kingdom viz. Microbes, Algae, Fungi and Archegoniatae, with the main objective of giving a sense of mooring to the undergraduates.

Course Learning Outcome:

On completion of this course,

CLO-01: *Combination of theoretical and practical components of this course will provide comprehensive information and insight into the fascinating world of microbes and plants.*

CLO-02: *Hand on training will help students learn use of the microscope, mounting, section cutting and staining techniques for the study of plant materials.*

CLO-03: *Making drawing in practical records will enhance understanding morphology and structural details and related functional aspects in diverse plant groups.*

CLO-04: *This paper is both informative and interesting and will enable student to learn about biodiversity not only as plant or nature lover but also for higher academic pursuits, particularly in the field of biological sciences, environment and biodiversity conservation.*

Unit- I: Microbes (Lectures:9)

Viruses : General Structure, DNA virus (T Phase), Lytic and Lysogenic Cycle, RNA virus (TMV). Economic Importance

Bacteria: General Characteristic and Cell structure, Reproduction – Vegetative, Asexual and Recombination (Conjugation, Transformation and Transduction), Economic importance

Unit- II: Algae (Lectures: 9)

General characteristic, Range of thallus organization and reproduction, Classification of algae (F E Fritsch classification), Morphology and life cycles of Nostoc, Chlamydomonus, Vaucheria, and Polysiphonia, Economic importance of algae.

Unit- III: Fungi (Lectures: 9)

General characteristic, nutrition, reproduction and classification (G.C Ainsworth classification). Life cycles of Rhizopus (Zygomycota), Phytotophthora (Oomycetes) Penicillium, (Ascomycota), Puccinia Agaricus (Basidiomycota), Symbiosis Association – Lichen. General account and significance of Mycorrhiza.

Unit- IV: Introduction to Archegoniate(Lectures: 2)

Unifying features of archegoniates, Transition to land habit, alternation of generation.

Unit- V: Bryophytes (Lectures: 6)

General characteristic, adaptation of land habit, Classification (upto family), Morphology, anatomy and reproduction of *Marchantia, Anthoceros* and *Polytrichum*, Ecology and economic importance of bryophytes with special mention of *Sphagnum.*

Unit- VI: Pteridophytes(Lectures: 5)

General characteristics, classification, Early land plants – *Rhynia* and *Psilotum.* Morphology, anatomy and reproduction of *Selaginella*, and *Pteris.* Heterospory and seed habit, Stellar evolution.

Unit- VII: Gymnosperms (Lectures: 5)

General characteristics, Classification. Morphology, anatomy and reproduction of *Cycas, Pinus and Gnetum*, Ecological and economical importance.

Practical:

Total Lectures: 30

1. Model of Virus - T Phage; Lytic and Lysogenic Cycle from Photographs
2. Study of bacterial reproduction – Binary Fission and Conjugation from slides /photographs
3. Gram staining process
4. Study of vegetative and reproductive structure of *Nostoc, Chlamydomonus* and *Polysiphonia*
5. Study of vegetative and reproductive structure of *Penicillium* and *Puccinia*
6. Study of vegetative and reproductive structure of *Marchantia* and *Polytrichum*
7. Study of vegetative and reproductive structure of *Selaginella*,
8. Study of vegetative and reproductive structure of *Cycas and Gnetum.*

RECOMMENDED BOOKS:

1. Pelczar, M. J. (2001) – Microbiology, 5th Edition, Tata McGraw – Hill Co, New Delhi.
2. Sarma, P. D. (2009) – Microbiology, Latest Edition, Rastogi Publication , Meerut.
3. Sahu, D. (2000) – Farming the Ocean : Sea Weeds Cultivation and Utilization. Ara Vali International, New Delhi.
4. Kumar, H. D. (1999) – Introductory Phycology. Affiliated East West Press, Delhi
5. Alexopoulos, C. J.; Mims, C. W.; Blackwell, M. (1996) – Introductory Mycology, J. and Sons, 4th Edition.
6. Vashista, P. C.; Singha, A. K., Kumar, A. (2010) – Pteridophyta, S. Chand, Delhi, India.
7. Parihar, N. S. (1991) – An Introduction to Embryophyta, Vol I – Bryophyta, Central Book Depot. Allahabad.
8. Bhatnagar, S. P.; Moitra, A. (1996) – Gymnosperms, New Age International (P) Ltd.

COURSE NAME: Plant Ecology and Taxonomy

COURSE CODE: BT – MN – 2114

Total Credits: 4 (Theory: 3 + Practical/Tutorial: 1)

THEORY: 3 Credits

TOTAL LECTURES: 45

COURSE OBJECTIVE:

The main objective of study plant ecology is to examine the relationship of plants with the physical and biotic environment. Plant Taxonomy is the science of discovering, identifying, describing, classifying and naming plants. The main objective of plant taxonomy is to identifycharacteristics of undiscovered species by comparing with known species, to specify characteristics of recently discovered species, to arranged them in respective "taxa" after looking at their similarities and to give them specific names.

Course Learning Outcome:

On completion of this course,

CLO-01: *Student would have understanding of various ecological parameters of plant in nature pertaining to influencing ecological factors and their analysis of practical datas on individual, population, community and ecosystem level along with their relationships.*

CLO-02: *Student also would have understanding about basic knowledge of plant taxonomy with the modern taxonomic approaches.*

CLO-03: *Practical knowledge of the course material will develop the skill of identification and classification of plant diversity and characterization of angiospermic families along with their phyto geographical analysis.*

Unit- I: Ecological Factor (LECTURES: 8)

Soil : Origin, formation, composition, of soil profile., Water : State of water in the environment, precipitation types. Light and Temperature : Variation, optimal and limiting factors; Shelford Law of Tolerance. Adaptation of Hydrophytes and Xerophytes. Biological indicators

Unit-II: Plant Communities (LECTURES: 4)

Characters; Ecotone and Edge Effect; Succession; Processes and Types.

Unit-III: Ecosystem (LECTURES: 8)

Structure; Energy flow trophic organisation; Food chains and Food webs, Ecological Pyramids, Production and Productivity; Bio geochemical Cycle, Carbon, Nitrogen and Phosphorus Cycles

Unit-IV: **Phytogeography (LECTURES: 2)**

Principle of Bio-geographical Zones; Endemism

Unit-V: Introduction to Plant Taxonomy (LECTURES: 2)

Aim and objective of Plant Taxonomy. Identification, Classification and Nomenclature.

Unit-VI: Identification (LECTURES: 4)

Function of Herbarium, Important Herbaria and Botanical Gardens of the world and India; Documentation: Flora, Kyes – Single access and Multi assess.

Unit-VII: Modern Trends of Taxonomy(LECTURES: 5)

Taxonomy in relation to Palynology, Cytology, Phytochemistry and Molecular data

Unit-VIII: Botanical Nomenclature (LECTURES: 4)

Principles and Rules (ICBN): Ranks and Names; Binomial system, Typification, Authorcitation, Valid Publication, Rejection of names, Principle of Priority and its Limitation.

Unit-IX: Taxonomic Classification (LECTURES: 2)

Types of classification; Bentham and Hooker system of classification

Unit - X: Angiospermic families (LECTURES: 6)

Poaceae, Orchidaceae, Magnoliceae, Solanaceae, Lamiaceae and.Asteracae.

Practical:

Total Lectures: 30

1. Study of instruments use to measure micro climatic variables –Thermometer,Anemometer, Hygrometer and Luxmeter
2. Study of morphological adaptation of hydrophytes and xerophytes
3. Determination minimal quadrate size for the study of herbaceous vegetation.
4. Study of vegetative and floral characters of Solanaceae, Lamiaceae,Asteraceae and Orchidaceae
5. Collection, processing, drying and preparation of a Herbarium of a wildherbaceous plant species.

RECOMMENDED BOOKS:

1. Kormondy, E. J. (1996) – Concept of Ecology, 4th Edition, Prentice Hall, USA.
2. Sharma, P. D. (2010) – Ecology and Enviornment, 8th Edition, Rastogi Publication, Meerut, India.
3. Singh, G. (2012) – Plant Systematics : Theory and Practice, 3rd Edition, Oxford & IBH Publishing Co Pvt Ltd, New Delhi.
4. Pandey, B. P. (2018) – A Text Book of Botany : Angiosperms, S Chand Publishing,

COURSE NAME: Biomolecules and Cell Biology

COURSE CODE: BT - MN - 3214

Total Credits: 4 (Theory: 3 + Practical/Tutorial: 1)

THEORY

Total Lectures: 45

Course Objectives:

1. To accommodate the widening horizons of the Botany discipline
2. To reflect about the dynamism of cell biology and biomolecules.
3. To understand the properties, functions and roles of different molecules.
4. To reveal the relationship between the structure and function of various biomolecules at the chemical level.
5. Hands-on approach and laboratory techniques by performing different related experiments.

Course Learning Outcome:

CLO 1: *Students will be able to obtain knowledge of structure, classification, and properties of physicochemical different biomolecules.*

CLO 2 : *Students will be able to know about the detail structure, properties, and functions of a cell and its components.*

CLO 3 : *Students will be acquainted with practical knowledge of properties of cell and cell membranes, Nucleic acid, and microscopy of the plant cell.*

CLO 4 : *Students will be able to identify various biomolecules in the laboratory by qualitative tests of biomolecules.*

Unit 1 : Introduction to biomolecules (Lectures 03)

Definition of biomolecules, Types of biomolecules, Types of chemical bonds holding cellular biomolecules

Unit 2 : Water (Lectures 03)

Structure and properties

Unit 3 : Carbohydrates (Lectures 03)

Structure and classification.

Unit 4 : Lipids and Fatty Acid (Lectures 04)

Classification, Types and functions

Unit 5 : Amino acids and Protein (Lectures 05)

Structure and functions

Unit 6 : Nucleic Acids: (Lectures 06)

Nitrogenous bases, Nucleotides, Types and functions of nucleic acids, Structure of B type of DNA

Unit 7 : Enzymes (Lectures 04)

Classification, structure and functions

Unit 8 : Introduction to cell (Lectures 06)

Cell as a unit of structure and function; Characteristics of prokaryotic and eukaryotic cells, Cell cycle, Mitosis and meiosis**.**

Unit 9 : Cell wall and plasma membrane (Lectures 05)

Chemistry, Structure and function of Plant cell wall, Cytoskeleton, Membrane structure and functions, Fluid mosaic model

Unit 10 : Cell organelles (Lectures 06)

Nucleus, Ribosome, Chloroplast, Mitochondria, Peroxisomes, Endoplasmic Reticulum, Golgi Apparatus, and Lysosomes.

Practical:

Total Lectures: 30

1. Qualitative tests for carbohydrates, reducing sugars, proteins.
2. Study of plant cell structure with the help of epidermal peel mount of Onion.
3. Demonstration of the phenomenon of protoplasmic streaming in *Hydrilla* .
4. Study different stages of mitosis.

RECOMMENDED BOOKS:

1. Berg J M, Tymoczko JL and Stryer L (2011) Biochemistry, W.H. Freeman and Company.
2. Campbell MK (2012) Biochemistry, 7th Edition. Published by Cengage Learning
3. Campbell PN, Smith AD (2011) Biochemistry Illustrated, 4th Edition, Published by Churchill Livingstone.
4. Cooper GM, Hausman RE (2009) The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
5. Hardin J, Becker G, Skliensmith LJ (2012) Becker's World of the Cell, Pearson Education Inc. U.S.A. 8th Edition.
6. Karp G (2010) Cell Biology, John Wiley & Sons, U.S.A. 6th Edition.
7. Nelson DL, Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition, W.H. Freeman and Company.

COURSE NAME: Plant Physiology and Metabolism

COURSE CODE: BT - MN - 4214

Total Credits: 4 (Theory: 3 + Practical/Tutorial: 1)

THEORY

Total Lectures: 45

Course Objectives:

The learning objectives of this course are as follows:

1. *Comprehend the physiological processes that occur in plants, including the role of water, minerals, hormones, and light in plant growth and development.*
2. *Acquaint the basic biochemical mechanisms of plants, including photosynthesis, respiration, nitrogen metabolism, and chemical regulation of growth and development*
3. *Develop skill of practical analysis of plant physiological processes.*

Course Learning Outcome:

At the end of the course the student will:

CLO 1: *Understand the fundamental concepts of plant physiology and metabolism and know the role of water, hormones, and light in plant growth and development.*

CLO 2: *Understand the role of mineral in plants growth and their deficiency symptoms.*

CLO 3: *Understand the conduction of substances within the plant body- cell to cell conduction as well as movement through the entire plant body.*

CLO 4: *Know in detail the conduction of the absorption and conduction of water in plant body and understand the role of hormones in plant growth and development.*

CLO 5: *Know the application of hormones in growth, morphogenesis, flowering, germination and senescence of plant and examine the commercial applications of growth regulators.*

CLO 6: *Know the basic mechanisms of carbon utilization (photosynthesis, respiration) and nitrogen utilization (nitrate and ammonia assimilation) in plants.*

CLO 7: *Understand the response of plants to different stress condition and develop practical skills in plant physiology and metabolism*

Unit 1: Plant-water relations (Lectures 07)

Water potential and its components, pathway of water movement-symplast, apoplast and aquaporins, root pressure, guttation, ascent of sap-cohesion tension theory, transpiration and its significance, factors affecting transpiration, anti-transparent. Mechanism of stomatal movement.

Unit 2: Mineral Nutrition (Lectures 04)

Essential and beneficial elements, macro- and micro-elements, criteria for essentiality, roles of essential elements and their deficiency symptoms, chelating agents.

Unit 3: Nutrient uptake (Lectures 05)

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

Unit 4: Translocation in Phloem (Lectures 04)

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

Unit 5: Plant growth regulators (**Lectures** 0**5)**

Role of hormones in plant growth and development. Chemical nature (chemical formula and precursor), physiological roles and applications of Auxins, Gibberellins, Cytokinins, Abscisic Acid, Ethylene; Other growth regulators - Jasmonic Acid, Brassinosteroids, Nitric Oxide. Commercial applications of growth regulators, Growth retardant and its usefulness

Unit 6 : **Enzymes (Lectures 04)**

Structure and properties; Mechanism of enzyme action and enzyme inhibition

Unit 7: Photosynthesis (Lectures 07)

Historical contributions of Blackman, Emerson, and Hill, Photosynthetic pigments (chlorophyll-a and b, xanthophyll, carotene), Photosystem I and II, reaction center, antenna molecules, Electron transport and mechanism of ATP synthesis (Chemiosmotic mechanism), C3 pathway, C4 and CAM plants (in brief), Photorespiration.

Unit 8: Respiration (Lectures 04)

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

Unit 9: Nitrogen Metabolism (Lectures 01)

Biological nitrogen fixation: Definition and types, Role of nitrogenase enzyme, Nitrate and ammonia assimilation (basic concept).

Unit 10: Seed dormancy (**Lectures 02)**

Types; Causes and Methods of breaking seed dormancy

Unit 11: **Physiology of Senescence and Ageing** (**Lectures 02)**

Senescence and Ageing

Practical

Total Lectures: 30

1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. Determination of water potential of potato tuber cells by weight method.
3. Calculation of stomatal index and stomatal frequency from the two surfaces of leaves of a mesophyte and xerophyte.
4. To study the effect of different concentrations of ABA on stomatal closure.
5. Effect of carbon dioxide concentration on the rate of photosynthesis.

RECOMMENDED BOOKS:

1. Nelson, D.L., Cox, M.M. (2017). Lehninger Principle of Biochemistry, 7th edition. NewYork, NY: W.H. Freeman, Macmillan learning.
2. Taiz, L., Zeiger, E., Moller, I. M. & Murphy, A. 2018. Plant Physiology and Development, International 6thedn, Oxford University Press, Sinauer Associates, New York, USA.
3. Hopkins, W.G., Huner, N. (2008). Introduction of Plant Physiology, 4th edition. New Jearsey, U.S.: John Wiley and sons.
4. Jones, R., Ougham, H., Thomas, H., Waaland, S. (2013). The molecular life of plants. Chichester, England: Wiley-BlackwelBuchanan, B.B., Gruissem, W. and Jones, R.L. (2015). Biochemistry and Molecular Biology of Plants, 2nd edition. New Jearsey, U.S.: Wiley Blackwell.
5. Kochhar, S.L. & Gujral, S.K. 2020. Plant Physiology: Theory and Applications, 2nd Edition. Cambridge University Press, UK.
6. Bhatla, S.C., Lal, M.A. (2018). Plant Physiology, Development and Metabolism. Singapore: Springer.

COURSE NAME: Plant Anatomy, Embryology and Economic Botany

COURSE CODE: BT - MN - 5214

Total Credits: 4 (Theory: 3 + Practical/Tutorial: 1)

THEORY

Total Lectures: 45

Course Objectives:

To enable the students:

1. *To understand the various aspects of plant anatomy Embryology and Economic Botany.*
2. *To understand the application of plant anatomical knowledge and angiospermic plants in utilitarian aspects of resource management.*
3. *To understand the salient features of plant anatomy and embryology of angiosperms with special reference to plant taxonomy.*

Course Learning Outcome:

Students are expected to gain theoretical knowledge and acquire basic skills on the plant anatomy, embryology with special reference to Angiosperms. Students are also expected to gain theoretical knowledge to explore the basic utilitarian aspects of plants. Upon completion of the course, the students will be able to:

CLO 1: *Illustrate the structure, types, organization of various cells, tissues and organs of plant body.*

CLO 2: *Relate plant anatomy and embryology of angiosperms with other fields of botany.*

CLO 3: *Combine classical utilitarian aspects of plant with modern molecular organization of plants.*

CLO 4: *Learn various advanced tools to study plant anatomy and embryology.*

Unit I : Introduction and Organization of Plant Body (Lectures – 03)

Organization of plant body - Types of Cells, Tissues and Tissue systems.

Unit 2 : Apical Meristems (Lectures – 04)

Organizational theories of Shoot and Root Apex. Primary structure stem, root and leaves of dicot and monocot.

Unit 3 : Vascular Cambium and Wood (Lectures – 05)

Structure, Function and seasonal activity of Cambium. Secondary Growth in Stem and root of dicot and monocot. Dendrochronology.

Unit 4 : Adaptive and Protective Systems (Lectures – 03)

Hairs and Trichomes. Anatomical Adaptation of Xerophytes and Hydrophytes.

Unit 5 : Reproductive Development (Lectures – 12)

Introduction and Interdisciplinary approaches of Embryology and its application. Genetic and molecular aspect of flower development. Structure and Significance of Anther and Anther wall. Microsporogenesis and Microgametogenesis. Pollen Wall Structure and NPC System. Structure

and Types of ovules. Megasporogenesis and Megagametogenesis (*Polygonum* type). Organization and Structure of Embryo sac; Pollination – Type Adaption and significance.

Unit 6: Fertilization, Embryo and Seeds (Lectures – 03)

Double fertilization. General pattern of development of dicot and monocot embryo and endosperm. Seed – Structure, Type and dispersal mechanisms.

Unit 7 : Origin and Cultivation of Commercially Importance Plants (Lectures -15)

Centres of Origin with reference to Vavilov's work. Evaluation of new crops. Importance of germplasm diversity in food security. Morphology, processing and uses of Rice, Wheat, Sugarcane. Clove, Black Pepper, Tea, Coffee, Jute and Cotton.

Practical

Total Lectures: 30

1. **Work out of Experiment :**
   i. Dissection, description, preparation of temporary / permanent slides of primary cells, root and stem apexes, secondary growth of dicot and monocot stems, adaptations of hydrophyte and xerophyte.
   ii. Study and preparation of temporary slides or from permanent slides of anther, ovules and endosperms.
   iii. Study of morphology, useful part and active ingredients of rice, wheat, sugar cane, clove, black pepper, tea, coffee, jut and cotton.
2. **Spot identification** : Plant specimens (fresh specimens, permanent slides or photographs) of Anatomy, Embryology and Economic Botany included in the theory syllabus.

RECOMMENDED BOOKS:

1. Pandey, B. P. Plant Anatomy, S Chand.
2. Sinha, S. K. A Text Book of Plant Anatomy, Bames and Noble
3. Ragland, A and Arumugam, N. Fundamentals of Plant Anatomy and Microtechniques, Saras Publication
4. Lersten, N. R. Flowering Plant Embryology, Blackwell Publishing.
5. Shukla, R. N. Embryology Concept and Application, Goodreads.
6. Rane, G. M. Plant Embryology, Prashant Publications.
7. Rathor, J. S. Textbook of Economic Botany, Indian Books and Periodicals.
8. Pandey, B. P. Economic Botany, S Chand.
9. Sarma, O. P. Economic Botany (Plants and Human Welfare), Progati Edition.

COURSE NAME: Plant Breeding and Biotechnology

COURSE CODE: BT - MN - 6214

Total Credits: 4 (Theory: 3 + Practical/Tutorial: 1)

THEORY

Total Lectures: 45

Course Objective:

1. *To provide students with a comprehensive understanding of advanced principles and techniques in plant breeding and biotechnology.*
2. *Students will explore the genetic basis of plant breeding methods, the application of molecular markers, and the integration of biotechnological tools in crop improvement.*
3. *Practical sessions will reinforce theoretical knowledge through hands-on experience with essential laboratory techniques in plant tissue culture, recombinant DNA technology, and molecular biology.*

Course Learning Outcome :

After completing this course, students will be able to:

CLO 1: *Understand fundamental concepts of centers of origin of crop plants and explain diversity, acclimatization, plant introduction, and domestication.*

CLO 2: *Gain knowledge on plant tissue culture and the basic molecular techniques used in biotechnology.*

CLO 3: *Differentiate between types of molecular markers (RAPD, AFLP, SSR, SNP) and apply molecular markers in marker-assisted selection (MAS) for crop improvement.*

CLO 4: *Identify major biotechnology institutes and companies in India. They will be able to explain applications of DNA recombinant technology in agriculture and medicine.*

CLO 5: *Apply plant tissue culture techniques by understanding the composition of media and nutrient requirements in plant tissue culture.*

CLO 6: *Understand recombinant DNA technology and the role of restriction enzymes. Identify and describe various cloning vectors and gene cloning techniques.*

CLO 7: *Discuss applications of biotechnology in agriculture, such as pest-resistant and herbicide-resistant plants; Explain the role of transgenics in bioremediation and the production of safer and cheaper medicines; and evaluate biosafety concerns associated with genetically engineered products.*

CLO 8: *Gain hands-on experience in the preparation of MS medium, in vitro sterilization, and inoculation methods.*

Unit 1. Introduction to plant breeding (Lectures 03)

Objectives of plant breeding; Centre of origin of crop plants and diversity, acclimatization, plant introduction and domestication of crops.

Unit 2. Principles and breeding methods I (Lectures 05)

Selection - mass selection, pure line selection and clonal selection, genetic basis of selection methods; Hybridization - Procedure of hybridization, back & test cross method, inter generic, inter specific, inter varietal hybridization with examples; Hybrid Vigor.

Unit 3. Principles and breeding methods II (Lectures 06)

Heterosis; Inbreeding depression (genetic basis); Mutation breeding methods and achievements in India; Breeding for biotic and abiotic resistance; Male sterility; Polyploidy and its significance in evolution of new species.

Unit 4. Molecular markers in plant breeding (Lectures 05)

Types of molecular markers (RAPD, AFLP, SSR, SNP); Marker-assisted selection (MAS) in plant breeding; Applications of molecular markers in crop improvement.

Unit 5. Basic Biotechnology (Lectures 03)

Scope and branches of Biotechnology, Major Biotechnology institutes and companies in India, applications of DNA recombinant technology in agriculture and medicines, transgenic plants.

Unit 6. Plant Tissue Culture (Lectures 08)

Composition of media; Nutrient and hormone requirements; Totipotency; Organogenesis; Embryogenesis (somatic and zygotic); Protoplast isolation, culture and fusion; Tissue culture applications (micropropagation, androgenesis, virus elimination, secondary metabolite production, haploids, triploids and hybrids; Cryopreservation; Germplasm Conservation).

Unit 7. Recombinant DNA Technology (Lectures 06)

Recombinant DNA technology, restriction enzymes (Types I-IV), Cloning Vectors: Prokaryotic (pUC 18 and pUC19, pBR322, Ti plasmid, BAC); Lambda phage, M13 phagemid, Cosmid; Eukaryotic Vectors (YAC)., DNA libraries, Gene cloning and PCR.

Unit 8. Applications of Biotechnology (Lectures 09)

Pest resistant (Bt-cotton); herbicide resistant plants (RoundUp Ready soybean); Transgenic crops with improved quality traits (Flavr Savr tomato, Golden rice); Role of transgenics in bioremediation (Superbug); Safer and cheaper medicines by Biotechnology (e.g. insulin, tPA, and Blood clotting factor); edible vaccines; Genetically Engineered Products– Human Growth Hormone; Humulin; Biosafety concerns.

Practical

Total Lectures: 30

1. Preparation of MS medium.
2. Demonstration of *in vitro* sterilization and inoculation methods using leaf.
3. Study of anther, embryo and endosperm culture, micropropagation, somatic embryogenesis & artificial seeds through photographs.
4. Study of Emasculation in plants.
5. Study of genetic engineering techniques (photographs): FISH, DNA Fingerprinting, Gene gun, Ti plasmid, Bt cotton, Golden rice, Savrflavr tomato.

6. Study of molecular techniques: PCR, Blotting techniques, AGE and PAGE.

RECOMMENDED BOOKS:

1. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
2. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
3. Stewart, C.N. Jr. (2008). Plant Biotechnology & Genetics: Principles, Techniques and Applications. John Wiley & Sons Inc. U.S.A.
4. Chaudhury, R. C. (1989). Introduction to Plant Breeding, Oxford and IBH publishing PVT. LTD
5. Gupta,P. K (2009), Biotechnology and Genomics, Rastogi Publications.
6. Singh, B. D. (2016) Plant Breding: Principles and Methods. Kalyani Publishers.

SKILL ENHANCEMENT COURSE (SEC)

Programme Specific Outcome of Bachelor of Science – Botany (Skill Enhancement Course)

PSO No.	Name	Outcome
PSO–1	Importance of plants and their functions (*BTL: Remember, Understanding*)	To develop a conceptual understanding of principles and importance of Botany. Students will be able to understand and explain different specializations of Botany such as systematics, evolution, ecology, developmental biology, physiology, biochemistry, plant interactions with microbes and insects, morphology, anatomy, reproduction, genetics, cell and molecular biology of plants.
PSO–2	Laboratory Skills (*BTL: Application, Evaluate*)	Acquire practical skills in laboratory settings, including microscopy, experimental design, and data analysis. Students are also familiarized with the use of bioinformatics tools and databases and in the application of statistics to biological data. Students will be trained in various analytical techniques of plant biology, use of plants as industrial resources or as support system for human livelihood and will be well versed with the use of transgenic technologies for both basic and applied research in plants.
PSO–3	Communication Skills *(BTL: Apply)*	Be motivated for further higher studies and research in different sub-disciplines of anthropology.
PSO–4	Closeness with nature *(BTL: Evaluate)*	Students will be eligible in diverse fields in research organization, government services, education sector, human resources, public services, hospitality, industries, corporate sectors, entrepreneur, business, tourism industry, media and Non-Governmental organization.
PSO–5	Continuous Learning *(BTL: Create)*	The primary ethics of the subject is to ensure appreciation of human diversity and it helps to analyze critically the issues that are relevant in contemporary society.

Basic Syllabus Structure of SEC

Semester	Course Name	Course code
1	Gardening	BT – SE – 1113
2	Floriculture and Interior Decoration with Indoor Plants	BT – SE – 2113
3	Value added Horticultural Product and Nursery Development	BT – SE – 3213

Course Learning Outcome - Skill Enhancement Course (SEC)

Semester	Course Name & Code	Course Learning Outcome (CLO)	
1	Gardening BT-SE-1113	CLO - 01	After completing the course students will get service career opportunities which include such jobs as floral designers, groundskeepers, landscape designers, architects and horticultural therapists.
		CLO - 02	Professional qualification combined with an inclination towards gardening and such other activities produces efficient floriculturists as well as horticulturists and landscaping professionals..
2	Floriculture and Interior Decoration with Indoor Plants BT-SE-2113	CLO - 01	A course work on floriculture and interior decoration with indoor plants would equip the participants to join the floriculture field as farm/estate managers, plantation experts, supervisors and project coordinators etc.
		CLO - 02	It would qualify the candidates to join in the marketing of floriculture products and develop technique of interior decoration with indoor plants for different ventures is emerging as a potential segment of this course.
		CLO - 03	Besides research and teaching are some other avenues of employment in the field.
3	Value added Horticultural Product and Nursery Development BT-SE-3213	CLO - 01	Product Diversification: Students will gain expertise in producing a range of value-added horticultural products such as jams, juices, and dried fruits, enhancing their ability to meet diverse consumer demands and capitalize on market opportunities.
		CLO - 02	Nursery Management Proficiency: Through hands-on training, students will develop skills in nursery development, plant propagation, and management practices, enabling them to establish and maintain successful horticultural nurseries.
		CLO - 03	Entrepreneurial Skills: Students will acquire entrepreneurial acumen, including market analysis, business planning, and marketing strategies, empowering them to establish and manage profitable horticultural ventures.
		CLO - 04	Sustainable Practices: Understanding sustainable horticultural practices, students will be able to integrate principles of environmental stewardship and resource conservation into their production and management processes.
		CLO - 05	Industry Collaboration: Through industry partnerships and practical experiences, students will cultivate professional networks and collaboration opportunities, enhancing their readiness for employment or entrepreneurship in the horticultural sector

Mapping of Course Learning Outcome and Programme Outcome

Course Code	CLO	PROGRAMME OUTCOME										
		SPO-1	SPO-2	SPO-3	SPO-4	SPO-5	SPO-6	SPO-7	SPO-8	SPO-9	SPO-10	SPO-11
BT-SE-1113	CLO 1	3	1	2	3	-	3	-	-	-	2	3
	CLO 2	-	-	1	3	-	3	-	-	-	2	3
BT-SE-2113	CLO 1	-	2	-	3	-	3	-	-	-	2	3
	CLO 2	3	1	2	3	-	3	-	-	-	2	3
	CLO 3	-	2	-	3	-	3	-	-	-	2	3
BT-SE-3213	CLO 1	-	-	-	-	-	2	-	-	1	-	-
	CLO 2	-	-	-	-	-	-	-	-	1	-	3
	CLO 3	-	-	-	-	-	-	-	-	1	-	-
	CLO 4	-	-	-	-	-	-	-	1	-	-	2
	CLO 5	-	-	-	-	-	-	2	-	-	1	-

Mapping of Course Learning Outcome and Programme Specific Outcome

Course code	CLO	Programme Specific Outcome (PSO)				
		PSO – 1	PSO - 2	PSO - 3	PSO - 4	PSO - 5
BT-SE-1113	CLO 1	3	2	3	3	3
	CLO 2	3	2	2	1	3
BT-SE-2113	CLO 1	3	1	-	3	3
	CLO 2	-	-	-	1	-
	CLO 3	-	-	2	1	-
BT-SE-3213	CLO 1	-	-	-	1	-
	CLO 2	-	-	2	1	-
	CLO 3	-	1	-	-	-
	CLO 4	-	1	-	-	2
	CLO 5	-	-	-	1	-

COURSE NAME: Gardening

COURSE CODE: BT – SE – 1113

Total Credits: 3 (Theory: 2 + Project/Practical/Tutorial: 1)

THEORY: 2 Credits

TOTAL LECTURES: 30

Course Objective:

A course work on gardening would equip the students to join the horticultural field as farm / estate management, plantation experts, supervisors and project coordinators etc. Besides research and teaching aspects, it would qualify the students to join as consultant of projects, landscape architect etc with proper training. One can also work as entrepreneur and offer employment to others.

Course Learning Outcome:

CLO – 01 : *After completing the course students will get service career opportunities which include such jobs as floral designers, groundskeepers, landscape designers, architects and horticultural therapists.*

CLO – 02 : *After completing the course students will acquire professional qualification combined with an inclination towards gardening and such other activities produces efficient floriculturists as well as horticulturists and landscaping professionals.*

Unit I: Introduction (Lectures 6)

Definition of Gardening, History, Types, Features and Component of gardening.

Unit II: Technique of Gardening (Lectures 5)

Planning and Layout for different types of gardens.

Unit III: Preparation of Propagules (Lectures 6)

Sowing, raising of seeds and seedlings; Types and Process of vegetative propagations.

Unit IV: Management of Garden: (Lectures: 9)

Gardening operations: Soil laying, Manuring, Watering, Management of pests and diseases and Harvesting

Unit V: Prospect of Gardening (Lectures 4)

Future prospects and values of gardening

Practical/Project:

Total Lectures: 30

Project / Field work based on the syllabus of theory course.

RECOMMENDED BOOKS:

1. Bose, T. K. and Mukherjee, D. (1972) – Gardening in India, Oxford and IBH Publishing Co., New Delhi.

2. Edmond Musser and Andres – Fundamentals of Horticulture, McGraw Hill Book Co.,New Delhi.
3. Johnson, H. Principles of Gardening : The Practice of the Gardener's Art.

COURSE NAME: Floriculture and Interior Decoration with Indoor Plants

COURSE CODE: BT-SE-2113

Total Credits: 3 (Theory: 2 + Practical/Tutorial: 1)

THEORY

Total Lectures: 30

Course Objectives:

There has been a great improvement of the quality of life, leading to a well balanced demand and supply of flowers. As a result, floriculture has blossomed into a viable business segment. So the main objective is in promotion of the floriculture trade leading to development of nursery, seed and bulb production, micro propagation of flowering plants like orchids, silviculture and extraction of essential oils. Thus it would involve with cultivation of ornamental flowers and crops from the time of planting to the time of harvesting.

Course Learning Outcome:

CLO – 01: *A course work on floriculture and interior decoration with indoor plants would equip the participants to join the floriculture field as farm/estate managers, plantation experts, supervisors and project coordinators etc.*

CLO – 02: *It would qualify the candidates to join in the marketing of floriculture products and develop technique of interior decoration with indoor plants for different ventures is emerging as a potential segment of this course.*

CLO – 03: *Besides research and teaching are some other avenues of employment in the field.*

Unit I: Introduction (LECTURES 5)

Definition of Floriculture, History, Importance and scope of floriculture.

Unit II: Management (LECTURES 4)

Nursery Management and routine garden operations and Green House

Unit III: Types and Technique (LECTURES 10)

Principle, Features and Management of Interior Decorations; Landscaping gardening of Public Places, Highways and Educational Institutions.

Unit IV: Ornamental Plants (LECTURES 5)

Different types of ornamental plants and their utilization, Indoor Plants, Potted Plants, Hydroponics and Bonsai

Unit IV: Commercial Floriculture (LECTURES 6)

Production and Packaging of flowers; Methods and impotence of Flower arrangement.Market potentialities of floriculture.

PRACTICAL/PROJECT:

Total Lectures: 30

Project / Field work based on the syllabus of theory course

RECOMMENDED BOOKS:

1. Randhowa, G. S. and Mukhopadhyay, A. (1986) – Floriculture in India, Allied Publishers.
2. Balaji, S. Kulkarni (2016) – Floriculture and Land scapping, Agro India Publication.
3. Roy, A. Larson (1992) - Introduction to Floriculture, 2nd Edition, Academic Press.

COURSE NAME: Value added Horticultural Product and Nursery Development

COURSE CODE: BT-SE-3213

Total Credits: 3 (Theory: 2 + Practical/Tutorial: 1)

THEORY

Total Lectures: 30

Course Objectives:

The course objectives are as follows:

1. *Diversified Product Portfolio: Introduce students to various value-added horticultural products like jams, juices, and essential oils, broadening their understanding of horticultural entrepreneurship.*
2. *Nursery Development Skills: Equip students with skills in nursery management, propagation techniques, and plant breeding to foster sustainable horticultural practices and support industry growth.*
3. *Market Analysis: Provide insights into market trends, consumer preferences, and marketing strategies for horticultural products, enabling students to develop viable business plans and enhance market competitiveness*

Course Learning Outcome:

CLO 1: *Product Diversification: Students will gain expertise in producing a range of value-added horticultural products such as jams, juices, and dried fruits, enhancing their ability to meet diverse consumer demands and capitalize on market opportunities.*

CLO 2: *Nursery Management Proficiency: Through hands-on training, students will develop skills in nursery development, plant propagation, and management practices, enabling them to establish and maintain successful horticultural nurseries.*

CLO 3: *Entrepreneurial Skills: Students will acquire entrepreneurial acumen, including market analysis, business planning, and marketing strategies, empowering them to establish and manage profitable horticultural ventures.*

CLO 4: *Sustainable Practices: Understanding sustainable horticultural practices, students will be able to integrate principles of environmental stewardship and resource conservation into their production and management processes.*

CLO 5: *Industry Collaboration: Through industry partnerships and practical experiences, students will cultivate professional networks and collaboration opportunities, enhancing their readiness for employment or entrepreneurship in the horticultural sector.*

Unit 1: Introduction to Value-Added Horticultural Products (Lectures 02)

Overview of value-added products in horticulture.Importance and market potential of value-added products.

Unit 2: Product Development Techniques (Lectures 05)

Processing methods for value addition such as preservation (Class I and Class I), fermentation, extraction. Quality control measures and standards for product development.Specific Product Lines.

Unit 3: Exploration of various value-added products and Marketing (Lectures 13)

Production of various value-added such as jams, jellies, pickles, sauces, and beverages. Market research methodologies to identify consumer preferences and trends. Analysis of market opportunities and challenges for horticultural products. Business Planning and Entrepreneurship: Basics of business planning, including feasibility studies and financial projections. Entrepreneurial skills development, including marketing, branding, and distribution strategies.

Unit 4: Nursery Infrastructure Planning and Layout Design (Lectures 06)

Techniques for plant propagation, including seed sowing, grafting, and cutting propagation. Nursery management practices, including irrigation, pest control, and disease management.

Unit 5: Genetics for Nursery Development (Lectures 02)

Selection criteria for superior cultivars and varieties.

Unit 6 : Fundamentals of Plant Breeding (Lectures 02)

Sustainable Practices and Environmental Management.

Practical

Total Lectures : 30

1. Industry Visits and Guest Lectures:
    i. Field trips to horticultural enterprises and processing facilities.
    ii. Guest lectures by industry experts to provide insights into current trends and best practices.
2. Practical Training and Project Work:
    i. Hands-on training sessions in product development, nursery management, and business planning.
    ii. Project work or internships to apply theoretical knowledge in real-world settings and gain practical experience.
    iii. Hands-on training in product formulation, packaging, and labeling.

RECOMMENDED BOOKS:

1. Indian Council of Agricultural Research (ICAR), Handbook of Horticulture.
2. S.S. Sindhu and R.K. Pathak,Propagation of Horticultural Crops.
3. R.K. Pathak and S.S. Sindhu,Nursery Management for Horticultural Crops
4. Richard N. Arteca,Introduction to Horticulture.
5. Michael A. Dirr and Charles W, The Reference Manual of Woody Plant Propagation.
6. Christopher Lloyd,The Well-Tempered Garden.
7. Bruce Macdonald,Practical Woody Plant Propagation for Nursery Growers.
8. George Acquaah, Horticulture: Principles and Practices

INTER-DISCIPLINARY COURSE (IDC)

Programme Specific Outcome of Bachelor of Science – Botany (IDC)

PSO No.	Name	Outcome
PSO–1	Importance of plants and their functions (*BTL: Remember, Understanding*)	To develop a conceptual understanding of principles and importance of Botany. Students will be able to understand and explain different specializations of Botany such as systematics, evolution, ecology, developmental biology, physiology, biochemistry, plant interactions with microbes and insects, morphology, anatomy, reproduction, genetics, cell and molecular biology of plants.
PSO–2	Communication Skills *(BTL: Apply)*	Be motivated for further higher studies and research in different sub-disciplines of anthropology.
PSO–3	Closeness with nature *(BTL: Evaluate)*	Students will be eligible in diverse fields in research organization, government services, education sector, human resources, public services, hospitality, industries, corporate sectors, entrepreneur, business, tourism industry, media and Non-Governmental organization.
PSO–4	Continuous Learning *(BTL: Create)*	The primary ethics of the subject is to ensure appreciation of human diversity and it helps to analyze critically the issues that are relevant in contemporary society.

Basic Syllabus Structure of IDC

Semester	Course Name	Course Code
1	Plant Biodiversity	BT-ID-1113
2	Plants and Human Welfare	BT-ID-2113
3	Nursery and Gardening	BT-ID-3213

Course Learning Outcome (CLO)

Semester	Course Name & Code	Course Learning Outcome (CLO)	
1	Plant Biodiversity BT-ID-1113	CLO - 01	After completing the course, the student will learn about biodiversity not only as plant or nature lover but also for higher academic pursuits, particularly in the field of biological sciences, environment and biodiversity conservation.
2	Plants and Human Welfare BT-ID-2113	CLO - 01	This paper will enable student to learn about importance of plants and human welfare.
		CLO - 02	They will also learn about microbes, different types of forest and forest products.
		CLO - 03	They will also gain knowledge about mushroom technology together with knowledge of medicinal plants.
3	Nursery and Gardening BT-ID-3213	CLO - 01	Students will demonstrate proficiency in establishing and managing horticultural nurseries, including site selection, layout planning, infrastructure development, and inventory management.
		CLO - 02	They will acquire knowledge of nursery business operations, including financial management, marketing strategies, and customer relations, preparing them for entrepreneurship or employment in the nursery industry
		CLO - 03	Through practical training, students will master various plant propagation techniques, including seeding, grafting, cutting propagation, and tissue culture, enabling them to produce a diverse range of healthy and vigorous plant stock. They will understand the principles of seed germination, root development, and plant growth, allowing them to propagate plants efficiently and sustainably..
		CLO - 04	Students will develop practical gardening skills, including soil preparation, planting techniques, watering practices, fertilization methods, and integrated pest management strategies.
		CLO - 05	They will learn to design and maintain ornamental gardens, vegetable plots, and landscape features, enhancing their ability to create aesthetically pleasing and environmentally sustainable outdoor spaces.
		CLO - 06	They will gain knowledge of plant nutrition, disease identification, and pest control measures, enabling them to maintain plant health and vitality in nursery and garden settings. They will learn to diagnose common plant problems and implement appropriate remedies, promoting the long-term health and productivity of plants under their care.
		CLO - 07	They will develop an understanding of sustainable gardening practices, including water conservation, organic gardening methods, and habitat creation for wildlife. They will appreciate the ecological benefits of gardening, such as biodiversity conservation, soil erosion control, and carbon sequestration, fostering a sense of environmental stewardship

Mapping of Course Learning Outcome (CLO) and Programme Outcome (PO)

Course Code	CLO	Programme Outcome (PO)										
		SPO - 1	SPO - 2	SPO - 3	SPO - 4	SPO - 5	SPO - 6	SPO - 7	SPO - 8	SPO - 9	SPO - 10	SPO - 11
BT-ID-1113	CLO - 1	-	-	1	-	-	-	-	-	-	-	-
BT-ID-2113	CLO - 1	-	-	-	-	-	1	-	-	-	-	-
	CLO - 2	-	-	-	1	2	-	-	-	-	-	-
	CLO - 3	3	3	3	3	-	3	-	-	-	3	3
BT-ID-3213	CLO - 1	-	-	1	-	-	-	-	-	-	-	-
	CLO - 2	-	-	-	-	-	1	-	-	-	-	-
	CLO - 3	-	-	-	1	2	-	-	-	-	-	-
	CLO - 4	-	-	-	2	-	-	-	-	1	-	-
	CLO - 5	-	-	1	2	-	-	-	3	-	-	-
	CLO - 6	1	2	-	-	-	-	-	-	-	-	-
	CLO - 7	1	-	-	-	-	-	-	2	-	-	3

Mapping of Course Learning Outcome (CLO) and Programme Specific Outcome (PSO)

Course Code	CLO	Programme Specific Outcome (PSO)			
		PSO – 1	PSO - 2	PSO - 3	PSO - 4
BT-ID-1113	CLO - 1	1	2	-	3
BT-ID-2113	CLO - 1	-	-	-	1
	CLO - 2	-	1	2	-
	CLO - 3	3	2	2	1
BT-ID-3213	CLO - 1	1	2	-	3
	CLO - 2	-	-	-	1
	CLO - 3	-	1	2	-
	CLO - 4	-	1	-	-
	CLO - 5	-	1	-	-
	CLO - 6	1	-	-	-
	CLO - 7	-	-	-	1

COURSE NAME : Plant Biodiversity

COURSE CODE : BT – ID – 1113

TOTAL CREDITS : 3 (Theory: 3)

THEORY

Total Lectures - 45

Course Objective:

This course will provide comprehensive information and insight into the fascinating world of biodiversity. A proper orientation for the students that would make them own up responsibility for conservation of our exploited and threatened biological natural resources.

Course Learning Outcome:

CLO – 01: *After completing the course, the student will learn about biodiversity not only as plant or nature lover but also for higher academic pursuits, particularly in the field of biological sciences, environment and biodiversity conservation.*

Unit-I: Introduction of Biodiversity (Lectures: 6)

Definition, history, objectives, type and interdisciplinary approaches of Plant Biodiversity.

Unit-II: Function of Biodiversity (Lectures: 6)

Human and Societal need – food and nutrition security, energy, medicine and pharmaceutical development and fresh air and water

Unit-III: Challenges for Biodiversity (Lectures: 13)

Climate change, Pollution - air, water and land, destruction of habitat, invasive of exotic species, over exploitation of natural environment. Afforestation

Unit-IV: Sustainable development and Conservation of Biodiversity (Lectures: 13)

Concept, threats and principle of sustainable development. Causes of unsustainability. Social forestry, Ex-situ and In-situ conservation, deforestation, traditional approaches of plant conservation.

Unit-V: National and International legal aspects of Biodiversity (Lectures: 7)

History, framework of laws policies and projects of biodiversity conservation in regional, national and international basis. Importance of National Green Tribunal (NGT)

RECOMMENDED BOOKS:

1. Krishnamurty, K. V. (2018) – An Advanced textbook on biodiversity : Principles and Practice, Oxford & IBH Publishing Co. Pvt Ltd, New Delhi.
2. Hosetty, B. B. and Rama krishan, S. (2016) – Biodiversity : Concept and Conservation, Aavishkar Publishers, Distributors, Jaipur , India
3. Das, B. K. and Banerzee, A. (Edited) (2014) – biodiversity Conservation in India, Concept Publishing Company Pvt. Ltd.

COURSE NAME : Plants and Human Welfare

COURSE CODE : BT – ID – 2113

TOTAL CREDITS : 3 (Theory: 3)

THEORY

Total Lectures - 45

Course Objective:

This course will provide comprehensive information and insight into the importance of Plants and Human Welfare. It would give the students exposure on how such concepts like herbal technologies that are present and maintained in traditional knowledge systems and how they helps in human welfare

Course Learning Outcome :

CLO – 01: *This paper will enable student to learn about importance of plants and human welfare.*

CLO – 02: *The students will also learn about microbes, different types of forest and forest products.*

CLO – 03: *The students will also gain knowledge about mushroom technology together with knowledge of medicinal plants.*

Unit- I: Microbes and industrial importance (LECTURES: 10)

Introduction, Microbes (Bacteria and Yeast) in diary technology, medicine, bakery, brewery industries.

Unit-II: Forest and Forest Products (LECTURES: 5)

Type of forest, timber, paper, essential oils and other natural products yielding plants.

Unit-III: Mushroom – Technology, Production and Marketing (LECTURES: 9)

Introduction and economic importance, spawn culture, cultivation of mushroom, and harvesting, storage of mushrooms and processing

Unit-IV: Practical utilizations of crop and medicinal plants (LECTURES: 13)

Harvesting and post harvesting processes of different agricultural crops. . Extraction processes of alkaloids, flavonoids for medicine manufacturing.

Unit-V: Ethno-botany and Traditional Indigenous Knowledge (LECTURES: 8)

Definition, aim, objectives and Interdisciplinary approaches of ethnobotany, importance of traditional knowledge, IPR relating traditional knowledge.

RECOMMENDED BOOKS:

1. Pelczar, M. J. (2001) – Microbiology, 5th Edition, Tata McGraw – Hill Co, NewDelhi.
2. Verma, V. (2019) - Text Book of Economic Botany.
3. Alam, A (2021) – A Text Book of Economic Botany and Ethnobotany, I. K. International Publishing House Pvt. Ltd.
4. Agarwal, A., Sharma, Y. P. and Jangra, E. (2021) – A Text Book on Mushroom
5. Cultivation : Theory and Practice, Newrays Publishing House

COURSE NAME : Nursery and Gardening

COURSE CODE : BT – ID – 3213

TOTAL CREDITS : 3 (Theory: 3)

THEORY

Total Lectures - 45

Course Objective :

1. *Nursery Establishment: Develop skills in setting up and managing a horticultural nursery, including site selection, infrastructure development, and inventory management.*
2. *Plant Propagation Techniques: Learn various propagation methods such as seeding, grafting, and cutting propagation to produce healthy and high-quality plants.*
3. *Gardening Basics: Understand principles of gardening, including soil preparation, planting, watering, fertilizing, and pest management, to create and maintain attractive and healthy garden spaces.*

Course Learning Outcome:

CLO 1: *Students will demonstrate proficiency in establishing and managing horticultural nurseries, including site selection, layout planning, infrastructure development, and inventory management.*

CLO 2: *They will acquire knowledge of nursery business operations, including financial management, marketing strategies, and customer relations, preparing them for entrepreneurship or employment in the nursery industry.*

CLO 3: *Through practical training, students will master various plant propagation techniques, including seeding, grafting, cutting propagation, and tissue culture, enabling them to produce a diverse range of healthy and vigorous plant stock. They will understand the principles of seed germination, root development, and plant growth, allowing them to propagate plants efficiently and sustainably.*

CLO 4: *Students will develop practical gardening skills, including soil preparation, planting techniques, watering practices, fertilization methods, and integrated pest management strategies.*

CLO 5: *They will learn to design and maintain ornamental gardens, vegetable plots, and landscape features, enhancing their ability to create aesthetically pleasing and environmentally sustainable outdoor spaces.*

CLO 6: *Students will gain knowledge of plant nutrition, disease identification, and pest control measures, enabling them to maintain plant health and vitality in nursery and garden settings. They will learn to diagnose common plant problems and implement appropriate remedies, promoting the long-term health and productivity of plants under their care.*

CLO 7: *Students will develop an understanding of sustainable gardening practices, including water conservation, organic gardening methods, and habitat creation for wildlife. They will appreciate the ecological benefits of gardening, such as biodiversity conservation, soil erosion control, and carbon sequestration, fostering a sense of environmental stewardship and responsibility.*

Unit 1: Introduction to Horticulture (Lectures 02)

Introduction to the scope and significance of nursery management and gardening in horticultural sciences.

Unit 2: Nursery Establishment and Management (Lectures 06)

Site selection criteria for nursery establishment, including soil type, topography, and climate considerations. Planning and layout design of nursery infrastructure, including greenhouse construction, shade structures, and irrigation systems. Inventory management techniques for plant stock, including record-keeping, labeling, and inventory control.

Unit 3: Plant Propagation Techniques (Lectures 06)

Principles and methods of seed propagation, including seed dormancy, germination, and seedling production.Techniques for vegetative propagation, such as grafting, budding, cutting propagation, and tissue culture.

Unit 4: Development, Planning and Management of Nursery (Lectures 10)

Selection of plant species for nursery production, considering market demand, climatic suitability, and economic feasibility. Nursery production schedules and planning for seasonal and perennial crops, including propagation cycles and production timelines. Nursery crop management practices, including fertilization, irrigation, pest and disease management, and weed control.Soil preparation techniques for gardening, including soil testing, amendment, and improvement strategies.Planting techniques for ornamental and vegetable gardens, including spacing, depth, and planting arrangements. Watering practices and irrigation methods for efficient water management in gardens.

Unit 5: Gardening (Lectures 06)

Principles of garden design, including layout, focal points, balance, and harmony in landscape composition. Landscape planning considerations, including site analysis, functional zoning, and aesthetic elements.

Unit 6: Integrated Pest Management (IPM) in Horticulture (Lectures 04)

Concepts of environmental sustainability in horticultural practices, including water conservation, soil health, and biodiversity conservation. Sustainable gardening practices, including organic gardening methods, composting, and mulching for soil fertility and health. Role of horticulture in environmental conservation and ecosystem services, including carbon sequestration, habitat creation, and urban greening initiatives.

Unit 7: Professional Skills and Career Development (Lectures 06)

Development of professional skills, including communication, teamwork, problem-solving, and leadership skills in horticultural contexts.Career opportunities in nursery management, garden design, landscape architecture, horticultural therapy, and sustainable agriculture.

Unit 8: Ethical and Legal Considerations in Horticulture (Lectures 05)

Ethical considerations in horticultural practices, including plant conservation, biodiversity preservation, and ethical sourcing of plant material. Legal regulations and standards governing nursery and garden operations, including plant quarantine laws, pesticide regulations, and intellectual property rights. Awareness of ethical and legal responsibilities in horticultural professions, including adherence to industry standards, codes of conduct, and professional ethics.

RECOMMENDED BOOKS:

1. Dr. N. Armstrong, Indian Gardening and Planting.
2. C.P. Khare, Indian Medicinal Plants: An Illustrated Dictionary
3. Pradip Krishen, The Gardener's Guide to Indian Plants

4. Michael A. Dirr, Manual of Woody Landscape Plants: Their Identification, Characteristics, Culture, Propagation and Uses
5. Christopher Lloyd, The Well-Tempered Garden
6. Eliot Coleman, The New Organic Grower: A Master's Manual of Tools and Techniques for the Home and Market Gardener.

Certificate Course
On
Mushroom Production Technology
Credits: 3
Total Lectures: 45

Course Objective :

1. *Enabling students to identify edible and poisonous mushrooms.*
2. *Hands on training for preparation of mushroom production at home on small scale basis.*
3. *Providing exposure to students to experts mainly Counsel on Mushroom Farming.*
4. *Provide an edge to students to self employment and income generation*

Unit 1 : Introduction (Lectures – 4)

Introduction to Mushroom, historical perspective, scope, taxonomical aspects and its significance – regionally, nationally and internationally. Different types of commercial mushroom production – Button mushroom, Paddy straw mushroom and Oyster mushroom. Post harvest management of commercial mushroom.

Unit 2 : Morphology of mushroom (Lectures – 4)

Vegetative, anatomical and reproductive characters of Button mushroom (*Agaricus bispora),* Paddy straw mushroom (*Volvariella volvea*) and Oyster mushroom (*Pleurotus suiorcaju*). Differentiation of edible and poisonous mushroom.

Unit 3 : Economic Importance of mushroom (Lectures – 3)

Nutritional profile of different type of mushrooms, Health benefits, medicinal and therapeutic values and antitumor effect of mushroom**.**Market potentiality of mushroom in local, regional and national aspects.

Unit 4 : Principles and Techniques of mushroom Production (Lectures – 4)

Structure and Construction of various mushroom production houses. Prepreparation stage – Collection, Storage, Cutting and Sterilization techniques of straw; Collection and Storage of Spawn. Composition technology and preparation of beds. Spawn seeding and making mushroom begs. Conditions for spawn germinate. Cultivation process of Paddy straw mushroom and Oyster mushroom. Various challenges and problems of mushroom cultivation: Management strategies for mushroom diseases, pest and nematode incidence.

Harvesting and Post Harvesting Technique - Preservation technique special refences to freezing, dry freezing and dry packaging.

Unit 5 : Practical Aspect for Mushroom Production (Lectures – 15)

i. Morphological and anatomical studies of various mushroom specimens.

ii. Study of various sterilization technique, mushroom house preparation, straw collection and cutting, mushroom beg preparation, various harvesting techniques.

iii. Training / Workshop and Intuitional Visit / Field Visit.