ORIENTAL COLLEGE (AUTONOMOUS) TAKYEL, IMPHAL
DEPARTMENT OF BOTANY
TEACHING PLAN

B. Sc. Botany (Honours)

Three years Undergraduate Programme (Six semester course) under CBCS
(Effective from 2020-2021)

Programme Outcomes (POS)

PO No.	Programme Outcomes (Upon completion of B.Sc., Botany Programme, the graduates will be able to)
PO1	Acquire academic competence in the subject of Botany and its subfields and able to apply the acquired knowledge in catering the needs of society, employer and institution.
PO2	Develop analytical, innovative and critical thinking skills and practical skill of traditional and emerging field of Botany and able to handle advance tools and techniques used in study of plant science.
PO3	Carry out activities effectively as an individual and as a team member take active role in team works and give cooperation to other team members. a member of a team or a leader of a group to fulfil the responsibilities related to group activities.
PO4	Gain awareness of decision-making process and develop basic skill of management to become an effective leader.
PO5	Enhance digital literacy to achieve their core competency through use of new technologies in learning process.
PO6	Emerge as responsible citizen of India and be aware of moral and ethical baseline of the country and the world.
PO7	Able to effectively communicate their idea/findings/concepts to audience.
PO8	Able to take logical approach in solving problems.

Programme Specific Outcomes (PSOS)

PSO No.	Programme Specific Outcomes (Upon completion of B.Sc., Botany Programme, the graduates will be able to)
PSO1	Gain basic knowledge of diverse forms of plants consisting of microbes, algae, fungi, bryophytes, pteridophytes, gymnosperms and angiosperms. In addition, students know their ecological significance and economic importance in industry, agriculture and medicines.
PSO2	Develop understanding of how to identify, classify and name plants and evolution of different groups of plants.
PSO3	Understand plant ecology and phytogeography, aware of the current environmental issues such as pollution, climate change, global warming and its associated factor like high ecological footprint.
PSO4	Appreciate biodiversity and various services provided by biodiversity, aware of various approaches to conserve biodiversity and ways to manage bioresources for sustainable development.
PSO5	Understand organization of cell in prokaryotes and eukaryotes and structure and function of cell organelles. Also, students acquire knowledge of major biomolecules such carbohydrate, lipids, proteins and nucleic acids, their roles in cell functioning and inheritance.
PSO6	Understand morphology of different groups of plants and their anatomy, growth in plants and various processes and structures involved in plant reproduction.
PSO7	Learn various metabolic activities of plants in detail, various factors that caused stress to plants and mechanisms to overcome stresses.
PSO8	Develop understanding of structure and functions of genetic materials of plants, storage of the genetic materials and various processes involved in expression of genes into proteins and modifications of RNAs and proteins to attain their desired functions.
PSO9	Develop understanding of laws related to inheritance, interactions of genes and their effects on phenotypes, linkage, mutation and population genetics.
PSO10	Learn various tools and techniques involved in recombination DNA technology and tissue culture. Also, understand the many benefits derived from recombinant DNA technology and tissue culture.
PSO11	Develop practical skills to effectively handle tools employed in analytical techniques in plant science research. Learn to use biostatistics in interpretation of scientific results and utilize bioinformatics to query information of nucleic acids and proteins.
PSO12	Develop skill to perform basic scientific experiments, record data, analyse data and produce results.
PSO13	Aware of ethics in scientific experiments and writing.

Semester I

Paper Code: BOT-HC-1016

Paper Title: Phycology and Microbiology

No. of Hours per week	Credit	Total No. of Hours	Marks
6 (Theory)	4 (Theory)	60	75
4 (Practical)	2 (Practical)	30	25

Course Objectives:

1. Highlight general characteristics of microbes and their classifications.
2. Impart ideas of the economic importance of microbes and its application in the field of agriculture and industry.
3. Discuss on algal classification, economic and ecological importance of algae.
4. Provide practical knowledge on structure of T-Phage and TMV, lytic and lysogenic life cycle, and knowledge on microscopy of bacteria and algae.

Learning Outcomes:

1. Develop understanding on the concept of microbial nutrition.
2. Classify viruses based on their characteristics and structures.
3. Develop critical understanding of plant diseases and their remediation.
4. Examine the general characteristics of bacteria and their cell reproduction/recombination. Increase the awareness and appreciation of human friendly viruses, bacteria, algae and their economic importance.
5. Conduct experiments using skills appropriate to subdivision

Unit 1: Introduction To Microbial World (10 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	History of Microbiology	1	The students are able to understand the history of microbiology.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Scope and relevance of microbes in Industry	1	Develop the understanding of the importance of microbes.		
3.	Scope and relevance of microbes in environment	1	Students are able to understand the utilization of microbes in industries and environment.		
4.	Microbial nutrition	1	Students are able to understand Microbial nutrition.		
5.	Growth and Metabolism (Only an overview) – the Concept of anabolism (Biosynthesis)	1	Students have understanding on the concept of anabolism		
6.	……Contd.	1			
7.	Catabolism (ATP generating pathways) – Respiration	1	Develop understanding of the Catabolism (ATP generating pathways) in microbes		
8.	……..Contd.	1			
9.	Fermentation	1	Students have a clear knowledge about fermentation.		
10.	Major groups of the microbial world	1	Students are able to understand the major groups of the microbial world		

Unit 2: Viruses (7 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Discovery, Physiochemical and biological characteristics of virus	1	Develop the understanding of the basic concept of viruses	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Classification (Baltimore)	1	Students are able to classify		
3.	General structures of virus with special reference to viroids and prions	1	Have clear idea of the structure of viroids and prions		
4.	General account of the replication of virus; lytic and lysogenic cycle	1	Understand replication in virus and the difference between lytic and lysogenic cycle in virus replication		
5.	DNA virus(T-phage), RNA-virus (TMV)	1	Students are able to differentiate RNA and DNA viruses		
6.	Economic importance of viruses with special reference to – vaccine production, role in research, medicine and diagnostics	1	Develop an understanding on the role of viruses in the field of science		
7.	Viruses as causal organisms of plant diseases	1	Students are able to understand the role of virus in plant disease development		

Unit 3: Bacteria (7 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Discovery and general characteristics of bacteria	1	Students can know how the bacteria are discovered and their characteristics	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*

2.	Bacteria types- archaebacteria, eubacteria, actinomycetes.	1	Have knowledge on the types of bacteria	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
3.	*Mycoplasma, Rickettsia Chlamydiae, Sphaeroplasts*	1	Have knowledge on these types of bacteria		
4.	Cell structure, nutrition types	1	Understand about cell structure and types of nutrition in bacteria.		
5.	Reproduction: vegetative, asexual, recombination (conjugation, transformation, transduction)	1	Have a clear idea on the different types of reproduction carried out by bacteria		
6.	…… Contd.	1			
7.	Economic importance of bacteria – role in agriculture, and industry (Alcohol, antibiotics production)	1	Understanding the of bacteria in agriculture and industry.		

Unit 4: Algae (10 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	General characteristics of algae	1	Have knowledge on the characteristics features of algae	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Ecology and distribution of algae	1	Students have knowledge of the role of algae in an ecosystem and the different habitats where they live		
3.	Range of thallus and structure of vegetative body	1	Have the Knowledge of the different forms of thallus found in algae		

4.	Cell structure and components, Cell wall composition, pigment system, flagella and reserve food (only of groups mentioned in the syllabus)	1	Know the structure of algal cells in details. Also have knowledge of the cell wall composition, reserve food, pigments and types of flagella found in different groups of algae	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
5.	Methods of reproduction in Algae	1	Have Knowledge of the different types of reproduction found in algae (vegetative, asexual and sexual).		
6.	Evolutionary significance of *Prochloron*	1	Have the basic concept of the evolution from prokaryotic algae to green chloroplast		
7.	Criteria and Fritsch system of classification.	1	Have idea of Fritsch system of classification of algae and criteria based on which the classification is done		
8.	Evolutionary classification of Lee (only up to groups)	1	Have knowledge of Lee's classification system of algae		
9.	Role of algae in the environment, agriculture, biotechnology and industries	1	Understand the importance of algae in environment, agriculture, biotechnology and industries		
10.	Economic importance of *Diatoms*	1	Understand the importance of *Diatoms*		

Unit 5: Cyanophyta and Xanthophyta (8 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Ecology and occurrence of Cyanophyta and Xanthophyta	1	Students will grasp the knowledge of the role of these groups of algae in ecosystem and the different habitats where they are found	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*

2.	Range of thallus organization	1	Develop understanding of the different forms of thallus found in Cyanophyta and Xanthophyta	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
3.	Cell structure	1	Understand the detailed structure of cell of the algal members belonging to these groups		
4.	Reproduction	1	Have idea of the different methods of reproduction found in these groups of algae		
5.	Morphology and life cycle of *Nostoc*	1	Will be able to know the thallus structure and different stages of life cycle in *Nostoc*		
6.	…….. Contd.	1			
7.	Morphology and life cycle of *Vaucheria*	1	Know thallus structure and different stages of life cycle in *Vaucheria*		
8.	……..Contd.	1			

Unit 6: Chlorophyta, Charophyta and Bacillariophyta (10 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	General characters of Chlorophyta	1	Students have a clear knowledge about General characters of Chlorophyta	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	General characters of Charophyta	1	Students have a clear knowledge about General characters of Charophyta		
3.	General characters of Bacillariophyta	1	Students have a clear knowledge about General characters of Bacillariophyta		

4.	Range of thallus organization in Chlorophyta	1	Understand the different types of thallus in Chlorophyta	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
5.	Range of thallus organization in Charophyta	1	Understand the different types of thallus in Charophyta		
6.	Range of thallus organization in Bacillariophyta	1	Understand the different types of thallus in Bacillariophyta		
7.	Life cycles of *Volvox*	1	Students are able to know about the different life stages of Volvox		
8.	Life cycles of *Oedogonium*	1	Students are able to know about the different life stages of *Oedogonium*		
9.	Life cycles of *Coleochaet*e	1	Students are able to know about the different life stages of *Coleochaete*		
10.	Life cycles of *Chara*	1	Students are able to know about the different life stages of *Chara*		

Unit 7: Phaeophyta and Rhodophyta (8 lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	General characters, occurrence of Phaeophyceae & Rhodophyceae	1	The students will be able to understand the characteristic features and the different habitats where these groups of algae are found	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Range of thallus organization and cell structure Phaeophyceae & Rhodophyceae	1	Have knowledge of different forms of thallus found in these algal groups. And, also know the detailed structure of cells of these algae		
3.	Reproduction Phaeophyceae & Rhodophyceae	1	Have critical understanding of the different methods of reproduction in		

4.	……. contd.	1	*Selaginella* and *Equisetum*	*Lecture/Discussion PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
5.	Morphology and life cycles of *Ectocarpus*	1	Understand morphology and different stages of life cycles of Ectocarpus		
6.	……. contd.	1			
7.	Morphology and life cycles of *Fucus*.	1	Understand morphology and different stages of life cycles of *Fucus*		
8.	……. contd.	1			
9.	Morphology and life cycles of *Polysiphonia.*	1	Understand morphology and different stages of life cycles of *Polysiphonia*		
10.	……. contd.	1			

N.B. The contact hours for tutorial classes will be 15 hours

Course teachers:

1. Padmaja S.
2. L.Degachandra Singh
3. Dr. Y Pramoda Devi
4. N. Nirupama Devi
5. H.Rajesh Sharma
6. Dr. Chipem Vashi

HoD ……

Semester I

Paper Code: BOT-HC-1026

Paper Title: Biomolecules and Cell Biology

No. of Hours per week	Credit	Total No. of Hours	Marks
6 (Theory)	4 (Theory)	60	75
4 (Practical)	2 (Practical)	30	25

Course Objectives:

1. Explain the concepts of biomolecules by highlighting their structures, properties and functions.
2. Provide knowledge about the structure of enzymes and their classification.
3. To discuss about the types of cells, structure of cell wall and plasma membrane, cell organelles and cell-cycle.
4. Impart practical knowledge on properties of cell and cell membrane, DNA staining techniques and microscopy of plant cell.

Course Outcomes:

1. Develop understanding on chemical bonding among molecules.
2. Describe the relationship between the structure and function of biomolecules.
3. Classify the enzymes and explain mechanism of action and structure.
4. Compare the structure and function of cells & explain the development of cells.
5. Identify the concept that explains chemical composition and structure of cell wall and membrane.
6. Explain the structures, function and molecular organization of cell organelles.

Unit 1: Biomolecules (20 lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Types and significance of chemical bonds	1	Students learn the types of chemical bond and their significance	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Classtest/Seminar/ Group Discussion/Q & A Session/Assignment*
2.	Structure and properties of water, P^H and buffers	1	Understand the structure and properties of water, P^H and buffer		
3.	Carbohydrates: Nomenclature and classification	1	Students are able to classify carbohydrates		
4.	Monosaccharides and disaccharides	1	Students will have the idea of monosaccharides, disaccharides and their difference		
5.	Oligosaccharides and polysaccharides	1	Students are able to understand oligosaccharides, polysaccharides and their difference		
6.	Lipids: Definition and major classes of storage and structural lipids	1	Students will learn about lipids and know major classes of storage and structural lipids		
7.	Fatty-acids structure and functions	1	Can understand fatty-acids structure and function		
8.	Essential fatty acids; Triacyl glycerols structure	1	Can understand essential fatty-acids, triacyl glycerol structure		
9.	Functions and properties of triacyl glycerol	1	Understand the functions and properties triacyl glycerol		
10.	Phosphoglycerides	1	Students will learn about Phosphoglycerides		
11.	Proteins: Structure of amino acids	1	Have the knowledge of amino acids structures		
12.	Levels of protein structure – primary and secondary	1	Students learn about the primary and secondary structure of protein		

13.	…… tertiary and quaternary	1	Students learn about the tertiary, quaternary structure of protein	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar/ Group Discussion/Q & A Session/Assignment*
14.	Protein denaturation and biological roles of proteins.	1	Students are able to understand protein denaturation and biological roles of protein		
15.	Nucleic acids: Structure of nitrogenous bases	1	Understand the Nucleic acids-structure of nitrogenous bases		
16.	Structure and function of nucleotides.	1	Clear concept of structure and function of nucleotides		
17.	Types of nucleic acids	1	Understand the different types of nucleic acids		
18.	Structure of A, B, C, D and Z types of DNA	1	Understand the different Structure of A, B, C, D and Z-DNA		
19.	……..contd.	1			
20.	Types of RNA	1	Have the knowledge of amino acids structures		

Unit 2: Bioenergenetics (4 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Laws of thermodynamics	1	The students are able to understand the laws of thermodynamics.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar/ Group Discussion/Q & A Session/Assignment*
2.	Concept of free energy, endergonic and exergonic reactions.	1	Students are able to understand the basic concept of free energy endergonic and exergonic reactions.		
3.	Coupled reactions and redox reactions	1	Students are able to understand the coupled reactions and redox reactions.		
4.	ATP: Structure and its role as energy currency molecule	1	Students are able to understand structure and the roles of ATP.		

Unit 3: Enzymes (6 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Structure of Enzyme: Holoenzyme, apoenzyme, cofactors, coenzyme and prosthetic group	1	Students are able to understand Structure and composition of enzyme	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Classification of enzymes	1	Can classify enzymes		
3.	Features of active site, substrate specificity		Understand the features of the active site of an enzyme		
4.	Mechanism of enzyme action (activation energy, Lock and key hypothesis, Induced-fit theory	1	Students are able to understand the various mechanisms of enzyme action		
5.	Michalis – Menten equation	1	Students develop a clear concept of Michalis-Menton equation		
6.	Enzyme inhibition and factors affecting enzyme activity	1	Have deep knowledge about enzyme inhibition and factors affecting enzyme activity		

Unit 4: The Cell (4 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Cell as a unit of structure and function	1	Students have understanding on the structure and organelles present in the cell	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Function of cell	1	Students have a clear knowledge of the functions of cell		

3.	Characteristics of prokaryotic and eukaryotic cells	1	Students can differentiate prokaryotic and eukaryotic cells	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
4.	Origin of eukaryotic cells (Endosymbiotic theory)	1	Students understand about the origin of eukaryotic cells endosymbiotic theory		

Unit 5: Cell wall and Plasma-membrane (4 lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Chemistry and structure of plant cell wall	1	Students are able to understand the chemical composition and structure of plant cell wall.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Function of plant cell wall	1	Students are cleared about the importance of cell wall.		
3.	Overview of membrane function; Fluid mosaic model, Chemical composition of cell membranes	1	Students have clear idea about the most widely accepted model of cell wall with its chemical composition.		
4.	Membrane transport: Passive, active and facilitated transport, endocytosis and exocytosis	1	Students are able to have an idea about the transport processes in plants as well as endocytosis and exocytosis.		

Unit 6: Cell organelles (16 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Nucleus: Structure of nuclear envelop, nuclear pore complex, nuclear lamina	1	Have basic idea of the structure of nuclear envelop, nuclear pore complex, nuclear lamina	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	…….. contd.	1			
3.	Molecular organization of chromatin and Nucleolus	1	Have basic concept of the molecular organization of chromatin and nucleolus		
4.	Cytoskeleton: Role and structure of microtubules; microfilaments and intermediary filaments	1	Have knowledge of the role and structure of microtubules; microfilaments and intermediary filaments		
5.	……. contd.	1			
6.	Chloroplast: Structural organization and function	1	Understand the structural organization and function of chloroplast		
7.	Mitochondria: Structural organization, function	1	Understand the structural organization and function of mitochondria		
8.	Semiautonomous nature of chloroplast and mitochondria	1	Semiautonomous nature of chloroplast and mitochondria		
9.	Peroxisomes: Structural organization and function	1	Understand the structure and function of peroxisomes		
10.	Endomembrane system: Endoplasmic reticulum (ER) structure, targeting and insertion of proteins in the ER	1	Have knowledge of the structure of endoplasmic reticulum and targeting and insertion of proteins in the ER		
11.	Protein folding, processing in ER	1	Have basic idea of protein folding, processing in ER		

12.	Smooth ER and lipid synthesis, export of proteins and lipids	1	Understand the structure of smooth ER and also the process of lipid synthesis and export of proteins and lipids	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
13.	Golgi Apparatus organization	1	Understand the structural organization of golgi-apparatus.		
14.	Protein glycosylation from golgi-apparatus	1	Understand the process of protein glycosylation from golgi-apparatus		
15.	Protein sorting and export from golgi-apparatus	1	Understand the process of protein sorting and export from golgi-apparatus		
16.	Lysosomes	1	Understand the structure and function of lysosome.		

Unit 7: Cell Division (6 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Phases of eukaryotic cell cycle	1	Have basic concept of cell cycle and the various events taking place at different stages of cell cycle.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar / Group Discussion/Q & A Session/Assignment*
2.	Mitosis	1	Understand the process of cell division in somatic cell.		
3.	Meiosis	1	Understand the process of cell division in reproductive cell at the time of gamete formation		
4.	……..contd.	1			

5.	Regulation of cell cycle- checkpoints	1	Have the basic concept of the internal control that monitored the cell cycle	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
6.	Role of protein kinase	1	Understand how it regulate the cell cycle		

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HoD ……

Semester-II

Paper Code: BOT-HC-2016

Paper Title: Mycology and Phytopathology

No. of Hours per week	Credit	Total No. of Hours	Marks
6 (Theory)	4 (Theory)	60	75
4 (Practical)	2 (Practical)	30	25

Course Objectives:

1. To provide knowledge of general characteristics, life cycle and classification of fungi.
2. Discuss on the aspects of plant diseases and pathological distribution.
3. To highlight structural analysis of different classes of fungi and their reproductive stages.
4. Impart knowledge on structures of symbiotic associations (Lichens, Mycorrhiza).

Course Outcomes:

1. Identify true fungi and demonstrate the principles and application of plant pathology in the control of plant disease.
2. Demonstrate skills in laboratory, field and glasshouse work related to mycology and plant pathology.
3. Develop an understanding of microbes, fungi and lichens and appreciate their adaptive strategies.
4. Identify the common plant diseases according to geographical locations and device control measures.

Unit 1: Introduction to Fungi (10 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Fungi – Introduction, General characteristics	1	Know what are fungi and the characteristic features of fungi	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test /Seminar/ Group Discussion/Q & A Session/Assignment*
2.	Status of fungi in living system. Nutrition in fungi	1	Have clear idea of the position of fungi in the living world; and also, the different modes of nutrition seen in fungi		
3.	Thallus organization. Modification of thallus	1	Know the different types of thallus found in fungi and their modifications		
4.	Cell and cell wall composition, flagella, septum	1	Understand the cell structure and the different chemical substances found in the cell wall of different groups of fungi. And, also know different types of flagella and septum found in different fungi		
5.	Homothallism and heterothallism	1	Know the sex determination systems in fungi		
6.	History of classification (Hidetta *et al*. 2007)	1	Have understood a higher-level phylogenetic system of classification of fungi		
7.	Classification of fungi (Ainsworth, 1973) up to sub-division with diagnostic characters with example	1	Know about the more natural system of classification of fungi based on morphology, especially of reproductive structure		
8.	Classification of fungi (Webster, 1977) up to sub-division with diagnostic characters with example	1	Understand the classification system of fungi proposed by Webster		
9.	General characteristics of Myxomycota, Oomycota, Zygomycota	1	Have knowledge of the general characteristics of these groups of fungi		

10.	General characteristics of Ascomycota, Basidiomycota and deuteromycota	1	Have knowledge of the general characteristics of these groups of fungi.		

Unit 2: Mastigomycotina: Chytridiomycetes and Oomycetes (6 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Mastigomycotina – Characteristic features	1	Have knowledge of the characteristic features of Mastigomycotina.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test /Seminar/ Group Discussion/Q & A Session/Assignment*
2.	Reproduction in mastigomycotina	1	Know about the vegetative, asexual and sexual methods of reproduction found in Mastigomycotina.		
3.	Life cycle of Synchytrium	1	Understand the vegetative, asexual and sexual cycle of *Synchytrium*		
4.	…… contd.	1			
5.	Life cycle of Phytophthora	1	Understand the vegetative, asexual and sexual cycle of *Ph*ytophthora.		
6.	Life cycle of Albugo	1	Understand the vegetative, asexual and sexual cycle of *Albugo*		

Unit 3: Zygomycotina (2 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Characteristic feature and Reproduction of Zygomycotina	1	Have knowledge of the characteristic feature and the different types of reproduction found in zygomycotina	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar/ Group Discussion/Q & A Session/Assignment*
2.	Life cycle of Rhizopus	1	Understand the vegetative, asexual and sexual cycle of *Rhizophus*.		

5. Basidiomycotina (8 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Basidomycotina: General characteristic	1	Have knowledge of the characteristic features of Basidomycotina	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test /Seminar/ Group Discussion/Q & A Session/Assignment*
2.	Life cycle and classification with reference to black stem rust (Puccinia)	1	Understand the vegetative, asexual and sexual cycle of *Puccinia.*		
3.	……contd (Life cycle and classification with reference to black stem rust (Puccinia)	1			
4.	Loose smut of wheat (symptoms only)	1	Know the causal organisms and symptoms of the diseases		
5.	Cover smut of wheat (symptoms only)	1	Know the causal organisms and symptoms of the diseases		
6.	Agaricus: Bioluminescence	1	Understand what bioluminescence fungi are with some common examples.		
7.	Fairy ring	1	Understand the term fairy ring and it's also how it is form.		
8.	Mushroom cultivation	1	Have knowledge of the different methods and techniques of mushroom cultivation.		

Unit 6: Deuteromycotina: Fungi Imperfecti (5 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Deuteromycotina: General characteristics	1	Have knowledge of the characteristics of Deuteromycotina	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test /Seminar/ Group Discussion/Q & A Session/Assignment*
2.	Thallus organization	1	Know the different form of thallus found in this group of fungi		
3.	Reproduction	1	Have knowledge of the types of reproductions found in Deuteromycotina		

4.	Alternaria	1	Understand the vegetative, asexual and sexual cycle of *Alternaria*.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test /Seminar/ Group Discussion/Q & A Session/Assignment*
5.	Colletotrichum	1	Understand the vegetative, asexual and sexual cycle of *Colletotrichum*.		

Unit 7: Allied Fungi: Myxomycota 3 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Myxomycota : Occurrence, General characteristics, and Status of slime molds	1	Know the ecology, characteristic features and position of slime mold in living world.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test /Seminar Group Discussion/Q & A Session/Assignment*
2.	Classification	1	Knows how the slime molds are classified.		
3.	Types of plasmodia, and types of fruting bodies in myxomycota	1	Know the different types of plasmodia and fruting bodies found in myxomycota.		

Unit 8: Symbiotic Association (3 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Lichens – Occurrence, General characteristics, and range of thallus organization,	1	Know the ecology, characteristics features and different thallus structures and the significance of lichens.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test /Seminar/ Group Discussion/Q & A Session/Assignment*
2.	Internal structure and nature of associations of algal and fungal partners; and Reproduction in lichens	1	Know the structure of the symbiotic associations of algal and fungal partners in lichen thallus and the different types of reproduction found in lichens.		
3.	Mycorrhiza – Ectomycorrhiza, endomycorrhiza, and their significance	1	Understand the symbiotic association between fungi and the roots of higher plants and key role played by mycorrhiza in nutrient cycling, etc.		

Unit 9: Applied Mycology (5 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Role of fungi in biotechnology: Food industries – flavour & texture, Fermentation, Baking,	1	Understand the important uses of fungi in food industries.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test /Seminar/ Group Discussion/Q & A Session/Assignment*
2.	Organic acids, Enzymes, Mucoproteins, Pharmaceuticals (secondary metabolites)	1	Know the uses of fungi in the preparation of mentioned products.		
3.	Agriculture: Biofertilizers, Mycotoxins,	1	Understand the importance of fungi in agriculture.		
4.	Biological control: Myco-fungicides, Mycoherbicides, Mycoinsecticides, Myco-nematocides	1	Understand the role of fungi in controlling disease fungi, herbs, insect-pests and nematodes.		
5.	Medical mycology		Know about infections in human and animals cause by pathogenic fungi.		

Unit 10: Phytopathology (10 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Terms and concepts; General symptoms; and Geographical distribution of diseases.	1	Understand the various terms use in phytopathology; and also, the symptom and distribution of the diseases.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test /Seminar /Group Discussion/Q & A Session/Assignment*
2.	Disease etiology and symptomology	1	Have knowledge about etiology and symptomology.		
3.	Host-Pathogen relationships	1	Understand the complex inter-relationships between host and pathogen.		
4.	Disease and environmental relation	1	Understand the effect of environment on disease cycle.		

5.	Prevention and control of plant disease and role of quarantine	1	Know the methods of prevention and control of plant diseases.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test /Seminar /Group Discussion/Q & A Session/Assignment*
6.	Bacterial diseases – Citrus canker and angular leaf spot of cotton	1	Know the causal organisms and symptoms of the diseases.		
7.	Viral diseases – Tobacco mosaic viruses and vein clearing.	1	Know the causal organisms and symptoms of the diseases.		
8.	Fungal diseases – Early and Late blight of potato	1	Know the causal organisms and symptoms of the diseases.		
9.	Black stem rust of wheat & White rust of Crucifers	1	Know the causal organisms and symptoms of the diseases.		
10.	Blast of rice and Powdery mildew of pea	1	Know the causal organisms and symptoms of the diseases.		

* N.B.The contact hours for tutorial classes will be 15 hours

Course teachers:

1. Padmaja S.
2. N. Nirupama Devi
3. H.Rajesh Sharma
4. Dr. Chipem Vashi

HoD ……

Semester-II

Paper Code: BOT-HC-2026

Paper Title: Archegoniate

No. of Hours per week	Credit	Total No. of Hours	Marks
6 (Theory)	4 (Theory)	60	75
4 (Practical)	2 (Practical)	30	25

Course Objectives:

1. Throw light on the general characteristics and adaptation of Archegoniate (Bryophytes, Pteridophytes and Gymnosperms).
2. Highlight the classification and range of thallus organization.
3. Explain morphology, anatomy ad reproduction of Bryophytes, Pteridophytes and Gymnosperms.
4. Provide practical knowledge on morphology and reproductive structures of Archegoniates.
5. Elaborate on spore morphology analysis and detailed knowledge on male and female reproductive structures in gymnosperms.

Learning Outcomes:

1. Demonstrate an understanding of Archegoniates, Bryophytes, Pteridophytes and Gymnosperms. Develop critical understanding on morphology, anatomy and reproduction of Bryophytes, Pteridophytes and Gymnosperms.
2. Understand plant evolution and their transition to land habitat.
3. Demonstrate proficiency in the experimental techniques and methods of appropriate analysis of Bryophytes, Pteridophytes, Gymnosperms.

Unit 1. Introduction (4 lec)					
Section	***Topic***	***Lec. hrs.***	***Learning outcomes***	***Pedagogy***	***Assessment/Evaluation***
1.	Unifying features of archegoniates	1	Critical understanding on the identifying characteristics of archegoniates	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/ Class test /Seminar/ Group Discussion/ Q&A Session /Assignment*
2.	Transition to land habit	1	Knowledge on the evolution of archegoniates		
3.	Alternation of generations	1	Learn about the life cycles of archegoniates		
4.	……..contd.	1			

Unit 2. Bryophytes (6 Lec)					
Section	***Topic***	***Lec. Hrs.***	***Learning outcome***	***Pedagogy***	***Assessment/ Evaluation***
1.	General characteristics	1	Learn about the common characteristics of bryophytes	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/ Class test /Seminar/ Group Discussion/ Q&A Session /Assignment*
2.	Adaptation to land habits	1	Understand about the adaptations developed for land habit		
3.	Classification	1	Learn how to classify bryophytes		
4.	Range of thallus organisation	1	A clearcut idea on the different thallus organisations of bryophytes.		
5.	……..contd.	1			
6.	Revision	1			

Unit 3. Type Studies-bryophytes (12 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	*Classification*	1	Learn how to classify bryophytes.	*Lecture/Discussion/PPT/Demonstration*	*Quiz/ Class test /Seminar/ Group Discussion/ Q&A Session /Assignment*
2.	Morphology, anatomy and reproduction of *Riccia*	1	Critical knowledge on the morphology, anatomy and reproduction of *Riccia*, *Marchantia, Anthoceros, Sphagnum* and *Polytrichum.*		
3.	Morphology, anatomy and reproduction of *Marchantia*	1			
4.	Morphology, anatomy and reproduction of *Anthoceros*	1			
5.	Morphology, anatomy and reproduction of *Sphagnum*	1			
6.	Morphology, anatomy and reproduction of *Polytrichum*	1			
7.	Reproduction and evolutionary trends in *Riccia*	1	Critical understanding on the reproduction and evolutionary trends found in Riccia, *Marchantia, Anthoceros*, sphagnum and *Polytrichum*		
8.	Reproduction and evolutionary trends in *Marchantia*	1			
9.	Reproduction and evolutionary trends in *Anthoceros*	1			
10.	Reproduction and evolutionary trends in *Sphagnum*	1			
11.	Reproduction and evolutionary trends in *Polytrichum*	1			
12.	Ecological and economic importance of Bryophytes	1	Learn about the importance of bryophytes		

Unit 4. Pteridophytes (6 Lec.)					
Section	***Topic***	***Lec. hrs.***	***Learning outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Genetal characteristics	1	Learn about the characteristics of pteridophytes.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/ Class test/Seminar/ Group Discussion/ Q&A Session /Assignment*
2.	Classification	1	Can classify the pteridophytes.		
3.	Early land plants	1	Learn about the early land plants.		
4.	*Cooksonia*	1	Understand the early land plant *Cooksonia*.		
5.	*Rhynia*	1	Learn about the fossil plant *Rhynia.*		
6.	Differences between *Cooksonia* and *Rhynia*	1	Can compare the two early land plants.		

Unit 5. Type Studies of Pteridophytes (14 Lec.)					
Section	**Topic**	**Lec. hrs.**	**Learning outcome**	**Pedagogy**	**Assessment/Evaluation**
1.	Classification	1	Learn the basic of pteridophyte classification.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/ Class test/Seminar/ Group Discussion/ Q&A Session /Assignment*
2.	Morphology, anatomy and reproduction of Psilotum	1	Complete knowledge about *Psilotum*.		
3.	Morphology, anatomy and reproduction of Lycopodium	1	Complete knowledge about *Lycopodium*.		
4.	Morphology, anatomy and reproduction of Selaginella	1	Complete knowledge about *Selaginella*.		
5.	Morphology, anatomy and reproduction of Equisetum	1	Complete knowledge about *Equisetum*.		
6.	Morphology, anatomy and	1	Complete knowledge about		

	reproduction of Pteris		*Pteris*.		
7.	Morphology, anatomy and reproduction of Marsilea	1	Complete knowledge about *Marsilea*.		
8.	Apogamy and apospory	1	Can evaluate the differences between apogamy and apospory.		
9.	Heterospory	1	Can explain heterospory in pteridophytes.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/ Class test/Seminar/ Group Discussion/ Q&A Session /Assignment*
10.	Seed habit	1	Can elaborate seed habit of pteridophytes		
11.	Telome theory	1	Knowledge on Telome theory.		
12.	Stelar evolution	1	Know what is stelar evolution.		
13.	Ecological importance of Pteridophytes	1	Understand the importance of pteridophytes ecologically.		
14.	Economic importance of pteridophytes	1	Learn the importance of pteridophyte economically.		

Unit 6. Gymnosperms (18 Lec.)					
Section	***Topic***	***Lect. hrs.***	***Learning outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	General characteristics	1	Know how to identify Gymnosperms.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/ Class test/Seminar/ Group Dis-cussion/ Q&A Session /Assignment*
2.	Classification	1	Learn about classification proposed by different workers.		
3.	…… contd.	1			
4.	Morphology of *Cycas*	1	Understand the morphology of *Cycas.*		

5.	Anatomy of *Cycas*		Learn about the internal structure of *Cycas*.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/ Class test /Seminar/ Group Discussion/ Q&A Session /Assignment*
6.	Reproduction in *Cycas*	1	Learn about the phenomenon of reproduction in Cycas		
7.	Morphology of *Pinus*	1	Understand the morphology of *Pinus.*		
8.	Anatomy of *Pinus*	1	Learn about the internal structure of *Pinus.*		
9.	Reproduction in *Pinus*	1	Learn about the phenomenon of reproduction in *Pinu*s		
10.	Morphology of *Ginkgo*	1	Understand the morphology *Ginkgo*		
11.	Anatomy of *Ginkgo*	1	Learn about the internal structure of *Ginkgo*		
12.	Reproduction in *Ginkgo*	1	Learn about the phenomenon of reproduction in *Ginkgo.*		
13.	Morphology of *Gnetum*	1	Understand the morphology and internal anatomy *Gnetum*		
14.	Anatomy of *Gnetum*	1	Learn about the internal structure of *Gnetum*		
15.	Reproduction in *Gnetum*	1	Learn about the phenomenon of reproduction in *Gnetum*		
16.	Ecological importance	1	Can cite the importance of gymnosperms ecologically.		
17.	Economic importance	1	Understands the economic importance of *Gymnosperm*s.		

18.	Seed habit of the four types of gymnosperms i.e. *Cycas, Pinus, Ginkgo* and gnetum	1	Knowledge on the seed habits of the four *Gymnosperms.*	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/ Class test/Seminar/ Group Discussion/ Q&A Session /Assignment*

N.B. The contact hours for tutorial classes will be 15 hours

Course teacher

1. L.Degachandra Singh
2. Dr. Y Pramoda Devi
3. N. Nirupama Devi

HoD ……

Semester-III

Paper Code: BOT-HC – 3016

Paper Title: Morphology and Anatomy of Angiosperms

No. of Hours per week	Credit	Total No. of Hours	Marks
6 (Theory)	4 (Theory)	60	75
4 (Practical)	2 (Practical)	30	25

Course Objectives:

1. To impart knowledge of the morphological characteristics and its importance in plant classification.
2. To discuss on the application of plant anatomy in other scientific fields.
3. To talk on types of tissues, the tissue systems and organization of plant body.

Course Outcomes:

1. Develop an understanding of concepts and fundamentals of plant morphology and anatomy.
2. Examine the morphological characters of plants and apply in identification and classification. Examine the internal anatomy of plant systems and organs.
3. Develop critical understanding on the evolution of concept of organization of shoot and root apex.
4. Analyse the composition of different parts of plants and their relationships.
5. Evaluate the adaptive and protective systems of plant.

Unit 1. Morphology					
Section	***Topic***	***Lect. Hr.***	***Learning outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Morphology of inflorescence	1	Learn about the different types of inflorescences	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/ Seminar/ Group Discussion/ Q&A Session/Assignment*
2.	Stamens and carpels & fruits	1	Knowledge on the reproductive parts of a flower and the formation and types of fruits		
3.	Telome theory, Phyllode theory	1	Learn about the theories concerning morphology.		
4.	Role of morphology in plant classification	1	Knowledge on Importance of morphology in plant classification.		

Unit 2. Introduction and scope of plant anatomy					
Section	***Topic***	***Lect. Hr.***	***Learning outcome***	***Pedagogy***	***Assessment/Evaluation***
1	Application in systematics	1	Knowledge on the importance of plant anatomy in plant systematics.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/ Seminar/ Group Discussion/ Q&A Session/Assignment*
2	Forensics	1	Knowledge on the importance of plant anatomy in forensics.		
3	Pharmacognosy	1	Knowledge on the importance of plant anatomy in pharmacognosy		
4	……. contd.	1			

Unit 3. Structure and development of plant body					
Section	***Topic***	***Lec. Hrs.***	***Learning outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Internal organization of plant body	1	Students are able to develop an understanding to the internal organization of plant body	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/ Seminar /Group Discussion/ Q&A Session/Assignment*
2.	The three tissue systems	1	Develop critical understanding of the three tissue systems		
3.	Types of cells and tissues	1	Students are able to develop an understanding of the types of cells and tissues		
4.	Development of plant body	1	Understand the development of plant body		
5.	Polarity and cytodifferentiation	1	Understand the concept of organization of shoot and root apex		
6.	Organogenesis during embryogenic development	1	Students are able to understand the terms organogenesis during embryonic development		

Unit 4: Tissue					
Section	***Topic***	***Lect. Hr.***	***Learning outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Simple tissues	1	Understand the types, characteristic features and functions of simple tissues in plants.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/ Seminar /Group Discussion/ Q&A Session/Assignment*
2.	Complex tissues	1	Understand the types, characteristic features and functions of complex tissues in plants		

3.	Cytodifferentiation of tracheary elements	1	Understand the development of tracheary elements from hollow dead cells.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/ Seminar /Group Discussion/ Q&A Session/Assignment*
4.	Cytodifferentiation of sieve elements	1	Understand the development of sieve elements.		
5.	Pits and plasmodesmata	1	Understand the structure and functions of pits and plasmodesmata.		
6.	Wall ingrowths and transfer cells	1	Understand their occurrence, structure, types and functions.		
7.	Adcrustation and incrustation	1	Have a clear knowledge on the adcrustation and incrustation of cell wall		
8.	Ergastic substances	1	Have a clear idea about the non-protoplasmic contents of a cell.		
9.	Hydathodes cavities	1	Understands the structure, types and functions of hydathodes		
10.	Lithocytes	1	Understands the structure and function of lithocytes.		
11.	Laticifers	1	Understands the structure and function of laticifers.		

Unit 5. Apical meristem					
Section	***Topic***	***Lect. Hrs.***	***Learning outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Evolution of concept of organization of shoot apex; Apical cell theories- Histogen theory	1	Students understand how the idea of organization of shoot apex arises and about the mentioned theory and drawbacks.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/ Seminar/ Group Discussion/ Q&A Session/Assignment*

2.	Tunica-Corpus Theory; continuing meristematic theory; cytohistological zonation	1	Critical knowledge on the theories and a brief knowledge on zonation of tissues.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/ Seminar/ Group Discussion/ Q&A Session/Assignment*
3.	Types of vascular bundles	1	Students can analyse the different types of vascular bundles.		
4.	Structure of dicot stems	1	Can identify a dicot stem.		
5.	Structure of monocot stems	1	Can identify a monocot stem.		
6.	Origin, development, arrangement and diversity in the sizes of leaves	1	Thoroughly familiarized with the different sizes of plant leaves.		
7.	Origin, development, arrangement and diversity in the shapes of leaves	1	Thoroughly familiarized with the different shapes of plant leaves.		
8.	Structure of dicot and monocot leaves; Kranz anatomy	1	Can make comparison between dicot and monocot leaves and can explain Kranz anatomy.		
9.	Organisation of root apex	1	Knowledge on the anatomical organization of the root apex.		
10.	Apical cell theory, Kopper Kappe theory	1			
11.	Quiscent centre, Root cap	1	Have a clear idea on the topic concerned.		
12.	Structure of dicot root	1	Knowledge on the anatomical structure of dicot roots.		
13.	Structure of monocot root	1	Knowledge on the anatomical structure of monocot roots.		
14.	Endodermis, exodermis and origin of lateral roots	1	Knowledge on the different layers of cells and origin of lateral roots.		

Unit 6. Vascular cambium and wood					
Section	***Topic***	***Lect. Hr.***	***Learning outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Structure and of cambium	1	Students will learn the structural organization of cambium in secondary growth	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/ Seminar/ Group Discussion/ Q&A Session/Assignment*
2.	Function of cambium	1	Students will learn about the function of cambium		
3.	Seasonal activity of cambium	1	Will learn seasonal activity of cambium and its significance		
4.	Secondary growth in root	1	Students will learn secondary growth in root		
5.	Secondary growth in stem	1	Students will learn secondary growth in stem and how it leads to increase in volume of stem every year		
6.	Axillary oriented elements	1	Students will learn about the axillary oriented elements of xylem		
7.	Radially oriented elements	1	Students will learn about the radially oriented elements of xylem.		
8.	Types of rays and axial parenchyma	1	Students will learn types of rays and axial parenchyma		
9.	Cyclic aspect and reaction wood	1	Students will learn how reaction wood are developed under stress		
10.	Sapwood and hard wood	1	Students will understand Sapwood and hard wood and their functions		

11.	Early and late wood	1	Students will learn that early and late wood are formed at different seasons	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/ Seminar/ Group Discussion/ Q&A Session/Assignment*
12.	Tyloses and dendrochronology	1	Students will learn about tyloses and dendrochronology of wood development		
13.	Development and composition of periderm	1	Students will learn about development of protective features during secondary growth and their composition.		
14.	Development and composition of rhytidoms and lenticels	1	Will understand the development and composition of rhytidoms and lenticels		

Unit 7. Adaptive and Protective systems					
Section	***Topic***	***Lect. Hr.***	***Learning outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Epidermal tissue system	1	Knowledge about the epidermal tissue system	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/ Seminar/ Group Discussion/ Q&A Session/Assignment*
2.	Cuticle, epicuticular waxes	1	Elaborate knowledge on cuticle and epicuticular waxes		
3.	Trichomes-Uni and multicellular with example	1	Knowledge about the different types of trichome		
4.	Glandular and non- glandular with example	1			
5.	Adcrustation and incrustation	1	A clear idea on the adcrustation and incrustation		
6.	Anatomical adaptation of xerophytes	1	Knowledge on the different types		

			of adaptation found in the xerophytes	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/ Seminar/ Group Discussion/ Q&A Session/Assignment*
7.	Anatomical adaptation of hydrophytes	1	Knowledge on the different types of adaptation found in the hydrophytes		

N.B.The contact hours for tutorial classes will be 15 hours

Course teachers:

1. Padmaja S.
2. L.Degachandra Singh
3. Dr. Y Pramoda Devi
4. N. Nirupama Devi
5. H.Rajesh Sharma
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HoD ……

Semester-III

Paper Code: BOT-HC-3026

Paper Title: Economic Botany

No. of Hours per week	Credit	Total No. of Hours	Marks
6 (Theory)	4 (Theory)	60	75
4 (Practical)	2 (Practical)	30	25

Course Objectives:

1. To highlight the detailed background of crops in terms of their origin and changing diversity.
2. To discuss the importance of the crops, methods of propagation and their uses.
3. Provide knowledge on uses of industrially important plants.
4. Impart practical knowledge of economically important plant parts and their products.

Course Outcomes:

1. Understand core concepts of Economic Botany and relate with environment, populations, communities, and ecosystems.
2. Develop critical understanding on the evolution of concept of organization of apex new crops/varieties, importance of germplasm diversity, issues related to access and ownership.
3. Develop a basic knowledge of taxonomic diversity and important families of useful plants.
4. Increase the awareness and appreciation of plants and plant products encountered in everyday life. Appreciate the diversity of plants and the plant products in human use.

Unit 1: origin of Cultivated Plants (6 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Centre of origin	1	Students will have an idea on the origin of cultivated plants.	Lecture/Discussion/ PPT/Demonstration	Quiz/Class test/Seminar/ Group Discussion/Q&A Session/ Assignment
2.	Importance of Centre of Origin with reference to Vavilov's Work	1	Understanding on Vavilovs' work on origin of crops.		
3.	Introduction of Crops; Domestication of crops	1	Idea on the introduction and domestication of cultivated crops.		
4.	Loss of crop genetic diversity	1	Understanding on how genetic diversity is lost and the factors involved.		
5.	Evolution of new crops/ varieties	1	Knowledge on how new crop variety arises.		
6.	Importance of germplasm diversity	1	Knowledge about germplasm diversity and its importance.		

Unit 2: Cereals (6 Lec.)					
Section	**Topic**	**Lec. Hr.**	**Learning Outcome**	**Pedagogy**	**Assessment/Evaluation**
1.	Wheat- Origin and morphology	1	Have knowledge about origin and morphology of wheat,	Lecture/Discussion/ PPT/Demonstration	Quiz/Class test/Seminar /Group Discussion/Q&A Session/ Assignment
2.	Wheat- Processing and uses	1	Understand the processing and uses of wheat,		
3.	Rice- Origin and morphology	1	Have knowledge about the origin and morphology of rice,		
4.	Rice- Processing and uses	1	Understand the processing techniques and uses of rice		
5.	Millet- Origin and morphology	1	Understand the origin and morphology of millet		

6.	Millet- Processing and uses	1	Understand the Processing and uses of millet	Lecture/Discussion/ PPT/Demonstration	Quiz/Class test/Seminar /Group Discussion/Q&A Session/ Assignment

Unit 3: Legume (6 Lec.)					
Section	**Topic**	**Lec. Hr.**	**Learning Outcome**	**Pedagogy**	**Assessment/Evaluation**
1.	Chick- pea-Origin, morphology and uses	1	Have knowledge of Origin, morphology and uses	Lecture/Discussion/ PPT/Demonstration	Quiz/Class test/Seminar /Group Discussion/Q&A Session/ Assignment
2.	Chick- pea- Importance to man and ecosystem	1	Develop deep understanding of its ecological importance		
3.	Pigeon-pea- Origin, morphology and uses	1	Have knowledge of Origin, morphology and uses		
4.	Pigeon-pea-- Importance to man and ecosystem	1	Develop understanding of its ecological importance		
5.	Fodder legume- Origin, morphology and uses	1	Have knowledge of Origin, morphology and uses		
6.	Fodder legume - Importance to man and ecosystem	1	Develop understanding of its ecological importance		

Unit 4. Sources of sugar and starch (4 Lec.)					
Section	***Topic***	***Lec. Hr.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Morphology and processing of sugarcane	1	Have deep knowledge about the processing of sugarcane	Lecture/Discussion/ PPT/Demonstration	Quiz/Class test/Seminar /Group Discussion/Q&A Session/ Assignment
2.	Products and byproducts of sugarcane industry	1	Have knowledge about the different types of byproducts of sugarcane		

3.	Sugarcane plant and uses	1	Understand the uses of sugarcane	Lecture/Discussion/ PPT/Demonstration	Quiz/Class test/Seminar /Group Discussion/Q&A Session/ Assignment
4.	Potato: Morphology, propagation and uses	1	Able to understand the morphology, propagation and uses of potato		

Unit 5. Spices (6 Lec.)					
Section	***Topic***	***Lec. Hr.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Listing of important spices, their family and parts used	1	Know the different types of spices, their family, parts used and uses of these parts	Lecture/Discussion/ PPT/Demonstration	Quiz/Class test/Seminar /Group Discussion/Q&A Session/ Assignment
2.	……. contd.	1			
3.	Economic importance of Fennel	1	Know the families, distribution and uses of fennel plants		
4.	Economic importance of Saffron	1	Know the families, distribution and uses of Saffron		
5.	Economic importance of Clove	1	Know the families, distribution and uses of Clove		
6.	Economic importance of Black-pepper	1	Know the families, distribution and uses of Black-pepper plants		

Unit 6. Beverages					
Section	***Topic***	***Lec. Hr.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Tea- morphology	1	Understand morphology of tea	Lecture/Discussion/ PPT/Demonstration	Quiz/Class test/Seminar /Group Discussion/Q&A Session/ Assignment
2.	Tea- processing and uses	1	Understand the processing and uses of tea		
3.	Coffee-morphology and processing	1	Understand the morphology and processing of coffee	Lecture/Discussion/	Quiz/Class test/Seminar

4.	Uses of coffee	1	Understand the uses and benefits of coffee	PPT/Demonstration	/Group Discussion/Q&A Session/ Assignment

Unit 7. Sources of oils and fats					
Section	**Topic**	**Lec. Hr.**	**Learning Outcome**	**Pedagogy**	**Assessment/Evaluation:**
1.	General description, classification	1	Learn about the sources of oils and their classification	Lecture/Discussion/ PPT/Demonstration	Quiz/Class test/Seminar /Group Discussion/Q&A Session/ Assignment
2.	Extraction and their uses	1	Knowledge on how to extract and use the oils		
3.	Health implications and their uses: Groundnut - Botanical name, family, uses	1	Learn about the health implication of groundnut with its systematic position and uses		
4.	Health implications and their uses: Coconut - Botanical name, family, uses	1	Learn about the health implication of Coconut with its systematic position and uses		
5.	Health implications and their uses: linseed - Botanical name, family, uses	1	Learn about the health implication of Linseed with its systematic position and uses		
6.	Health implications and their uses: Soyabean - Botanical name, family, uses	1	Learn about the health implication of soyabean with its systematic position and uses		
7.	Health implications and their uses: mustard-Botanical name, family, uses	1	Learn about the health implication of Mustard with its systematic position and uses		
8.	Essential oils: General accounts	1	Have a clear idea on the description of essential oils		
9.	Extraction methods	1	Knowledge on how to extract oils	Lecture/Discussion/ PPT/Demonstration	Quiz/Class test/Seminar /Group Discussion/Q&A Session/ Assignment
10.	Comparison with fatty oils and their uses	1	Learn about the difference between oils and fatty oils		

Unit 8. Natural Rubber					
Section	***Topic***	***Lec. Hr.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Para rubber; Tapping	1	Learn what is para rubber and tapping of the latex	Lecture/Discussion/ PPT/Demonstration	Quiz/Class test/Seminar /Group Discussion/Q&A Session/ Assignment
2.	Processing of rubber	1	Knowledge on the processes involved		
3.	Uses of rubber	1	An idea on the uses of rubber		

Unit 9. Drug yielding plants					
Section	***Topic***	***Lec. Hr.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1	Therapeutic and habit -forming drugs	1	Develop understanding of habit-forming drugs	Lecture/Discussion/ PPT/Demonstration	Quiz/Class test/Seminar /Group Discussion/Q&A Session/ Assignment
2	Therapeutic objective of drugs	1	Understand the purpose of using drugs		
3	Cinchona	1	Knowledge of cinchona, its uses, side effects, precautions and history		
4	Digitalis	1	Knowledge of the uses, side effects and precautions		
5	Papaver	1	Knowledge of the uses, benefits, side effects and precautions		
6	Cannabis	1	Knowledge of the benefits, side effects and precautions	Lecture/Discussion/ PPT/Demonstration	Quiz/Class test/Seminar /Group Discussion/Q&A Session/ Assignment
7	Tobacco- Morphology and Processing	1	Knowledge about the plant, its cultivation, processing and grading		

8	Tobacco-Uses and health hazards	1	Increase awareness of the uses and harmful effect to the body		
Unit 10. Timber plants					
Section	*Topic*	*Lec.Hr.*	*Learning Outcome*	*Pedagogy*	*Assessment/Evaluation*
1	General accounts on timber yielding plants	1	A clear knowledge on the plants used for timber	Lecture/Discussion/ PPT/Demonstration	Quiz/Class test/Seminar /Group Discussion/Q&A Session/ Assignment
2	Teak as a timber yielding plant	1	Knowledge on the beneficial values of teak specially for timber		
3	Pine as a timber yielding plant	1	Knowledge on the beneficial values of pine specially for timber		

Unit 11. Fibres					
Section	Topic	Lec. Hr.	Learning Outcome	Pedagogy	Assessment/Evaluation:
1	Classification based on the origin of Fibres: (a) Cotton (b) Coir (c) Jute	1	Knowledge of classification and origin of Cotton, Coir and Jute	Lecture/Discussion/ PPT/Demonstration	Quiz/Class test/Seminar /Group Discussion/Q&A Session/ Assignment
2	Cotton- morphology, extraction and uses	1	Clear knowledge of the fibre yielding cotton		
3	Coir- morphology, extraction and uses	1	Great knowledge about Coir		

4	Jute- morphology, extraction and uses	1	Have knowledge about the morphology, extraction and uses of Jute	Lecture/Discussion/ PPT/Demonstration	Quiz/Class test/Seminar /Group Discussion/Q&A Session/ Assignment

N.B. The contact hours for tutorial classes will be 15 hours

Course teachers:

1. Padmaja S.
2. L.Degachandra Singh
3. Dr. Y Pramoda Devi
4. N. Nirupama Devi
5. H.Rajesh Sharma

HoD ……

Semester-III

Paper Code: BOT-HC-3036

Paper Title: Genetics

No. of Hours per week	Credit	Total No. of Hours	Marks
6 (Theory)	4 (Theory)	60	75
4 (Practical)	2 (Practical)	30	25

Course Objectives:

1. To highlight the principles of inheritance and types of expressions resulting from the interaction of genes.
2. To discuss on how mutation occurs at the genetic level and agents that cause mutation.
3. To give stress on the importance of theories of genetics in relation with genetic variation and speciation.
4. Provide knowledge on Mendelian concepts in genetics; structure, functions and properties of chromosome; chromosomal aberration.
5. Provide practical knowledge on chromosomal mapping and gene interaction studies.

Course Outcomes:

1. Possess conceptual understanding of laws of inheritance, genetic basis of loci and alleles and their linkage.
2. Comprehend the effect of chromosomal abnormalities in numerical as well as structural changes leading to genetic disorders.
3. Develop critical understanding of chemical basis of genes and their interactions at population and evolutionary levels.
4. Analyse the effect of mutations on gene functions.

Unit 1: Mendelian Genetics and its Extension (16 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Mendelism: History	1	Understand the inception of genetics and contribution of Mendel.	*Lecture/Discussion/ PPT/ Demonstration*	*Quiz/Class/test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Mendelism-Principles of inheritance	1	Learn law of segregation and law of independent assortment. Able to find out phenotypic and genotypic ratio of monohybrid and dihybrid cross.		
3.	……contd.	1			
4.	……contd.	1			
5.	Chromosome theory of inheritance	1	Learn that chromosome is the carrier of genes.		
6.	Autosomes and sex chromosomes	1	Learn autosomes and sex chromosomes.		
7.	Probability and pedigree analysis	1	Learn to use probability and pedigree analysis in genetics.		
8.	…. contd.	1	,,		
9.	Incomplete dominance	1	Understand that two different alleles have equal effect to a phenotype.		
10.	Co-dominance	1	Understand that two different alleles co-express.		
11.	Multiple alelles	1	Learn that a gene has more than two forms.		
12.	Lethal alleles	1	Understand that lethal allele cause death of the individual possessing the allele.		
13.	Epistasis	1	Understand interaction of different genes to produce phenotype.		

14.	Pleitropy, Recessive and dominant traits	1	Learn that an allele causes more than one phenotype. Understand recessive and dominant traits.	*Lecture/Discussion/ PPT/ Demonstration*	*Quiz/Class/test/Seminar /Group Discussion/Q & A Session/Assignment*
15.	Penetrance and Expressivity	1	Understand penetrance and expressivity.		
16.	Polygenic inheritance	1	Understand polygenic inheritance.		

Unit 2: Extrachromosomal Inheritance (7 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Extra-chromosomal inheritance	1	Understand extra-chromosomal inheritance.	*Lecture/ Discussion/PPT/ Demonstration*	*Quiz/Class/test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Chloroplast inheritance: Variegation in 4 O' clock plant	1	Understand inheritance of variegation in 4 O' clock plant.		
3.	Mitochondrial inheritance in yeast	1	Understand mitochondrial inheritance in yeast.		
4.	Maternal effect	1	Understand the mechanism of maternal effect.		
5.	Shell coiling in snail	1	Understand maternal effect in shell coiling in snail.		
6.	Kappa particles in Paramecium	1	Understand inheritance of Kappa particles in Paramecium.		
7.	……contd.	1			

Unit 3: Linkage, Crossing Over & Chromosome Mapping (12 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Linkage	1	Understand linkage of different genes in a chromosome.	*Lecture/ Discussion/PPT/ Demonstration*	*Quiz/Class/test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Crossing over	1	Understand the process and effect of crossing over.		
3.	Cytological basis of crossing over	1	Understand cytological basis of crossing over.		
4.	Recombination frequency	1	Learn recombination frequency.		
5.	Two factor crosses	1	Understand two factor crosses.		
6.	Three factor crosses	1	Understand three factor crosses.		
7.	Interference	1	Gain knowledge of interference.		
8.	Coincidence	1	Gain knowledge of coincidence.		
9.	Gene mapping	1	Learn to do gene mapping.		
10.	Numericals based on gene mapping	1	Understand numericals based on gene mapping.		
11.	Sex- linkage	1	Understand linkage of genes to sex chromosomes and how sex linkage is different genes linked to autosomes.		
12.	……contd.	1			

Unit 4: Translocation In Phloem (8 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Deletion and duplication	1	Have the basic concept of the genetic effects of the loss or addition of a part of chromosome.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class/test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Translocation	1	Understand the types and genetic effect of the shifting of a part of chromosome		
3.	Inversion	1	Understand about the types and effect of the rotation of a part of chromosome		
4.	Position effect	1	Understand the expression of a gene when its location in a chromosome is changed		
5.	Euploidy	1	Have basic concept of monoploidy, diploidy and polyploidy and their genetic significance		
6.	….. contd.	1			
7.	Aneuploidy	1	Have clear concept of the genetic effect of the loss or addition of one or more chromosome to the complete diploid set of chromosomes		
8.	….. contd.	1			

Unit 5: Gene Mutation (7 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Types of mutation	1	Understand different types of mutations.	*Lecture/ Discussion/PPT/ Demonstration*	*Quiz/Class/test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Molecular basis of mutation	1	Understand four main molecular basis of mutation.		
3.	Mutagens- Physical agents	1	Learn various physical agents, radiations that cause mutation.		
4.	Mutagens- Chemical agents	1	Learn various chemicals that cause mutation.		
5.	Detection of mutations: CIB method	1	Understand CIB as one of the many available methods to detect mutations.		
6.	Role of transposons in mutation	1	Learn the role of transposons in mutation with examples.		
7.	DNA repair mechanism	1	Understand different mechanism of DNA repair.		

Unit 6: Fine Structure of Gene (4 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Classical Vs. molecular concept of gene	1	Learn the differences between classical and molecular concept of gene.	*Lecture/ Discussion/PPT/ Demonstration*	*Quiz/Class/test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Cistron	1	Understand cistron.		
3.	Recon and muton	1	Understand recon as a unit of recombination and muton as mutation.		

4.	Rii locus	1	Understand Rii locus.		
Unit 7: Population and Evolutionary Genetics (6 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/ Evaluation***
1.	Allele frequency and genotype frequency	1	Understand allele and genotype frequency of a particular population.	*Lecture/ Discussion/PPT/ Demonstration*	*Quiz/Class/test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Hardy-Weinberg Law	1	Gain substantial knowledge of Hardy-Weinberg Law.		
3.	Role of natural selection in evolution	1	Know the role of natural selection in evolution.		
4.	Role of mutation in evolution	1	Understand various effects of different types of mutations in evolution.		
5.	Role of genetic drift in evolution	1	Learn how genetic drift causes evolution.		
6.	Genetic variation and speciation.	1	Understand genetic variation in relation to speciation.		

N.B.The contact hours for tutorial classes will be 15 hours

Course teachers:

1. Padmaja S.
2. L.Degachandra Singh
3. N. Nirupama Devi
4. Dr. Chipem Vashi

HoD ……

Semester-IV

Paper Code: BOT-HC-4016

Paper Title: Molecular Biology

No. of Hours per week	Credit	Total No. of Hours	Marks
6 (Theory)	4 (Theory)	60	75
4 (Practical)	2 (Practical)	30	25

Course Objectives:

1. Provide detailed knowledge about the structures and chemical properties of DNA and RNA.
2. Discuss on Central dogma, transcription and protein synthesis.
3. Provide practical acquaintance of isolation and quantification of DNA from plants.
4. Provide knowledge on photographic study of RNA polymerases and RNA modification machinery.

Course Outcomes:

1. Analyse the structures and chemical properties of DNA and RNA through experiments.
2. Differentiate the main types of prokaryotes through their grouping abilities and their characteristic.
3. Evaluate the experiments establishing central dogma and genetic code.
4. Gain an understanding of various steps in transcription, protein synthesis and protein modification.

Unit 1: Nucleic Acids: Carrier of Genetic Information (4 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
8.	Historical perspective	1	Understand history of molecular biology.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Classtest/Seminar/ Group Discussion/Q & A Session /Assignment*
9.	DNA as the carrier of genetic information (Griffith's)	1	Learn Griffith's experiment that demonstrated the principle of transformation in bacteria.		
10.	DNA as the carrier of genetic information (Hershey and Chase; Avery, McLeod and McCarty).	1	Learn how Hershey and Chase shown DNA as genetic material of T2 phage. Understand that Avery, McLeod and McCarty found the transforming principle of bacteria as DNA.		
11.	Fraenkel-Conrat's experiment	1	Understand that RNA is the genetic material of some viruses.		

Unit 2: The structure of DNA and RNA/ Genetic Material (10 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	DNA structure: Meischer to Watson and Crick- historic perspective	1	Gain historical perspective of model of DNA structure.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar / Group Discussion/Q & A Session/Assignment*
2.	DNA structure- Salient features of double helix	1	Understand detail structure of double helix of DNA.		
3.	Denaturation and renaturation of DNA- cot curve	1	Understand denaturation and renaturation of DNA and cot curve.		
4.	Organization of DNA in prokaryote and virus	1	Understand how DNAs are organized differently in prokaryotes and virus.		
5.	Organization of DNA in eukaryote	1	Understand the organization of DNA in eukaryotes.		

6.	Organelle DNA- mitochondria and chloroplast DNA	1	Have idea of DNA found in organelles.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar / Group Discussion/Q & A Session/Assignment*
7.	The nucleosome- chromatin structure	1	Understand the structure and chemical properties of nucleosome.		
8.	Euchromatin and heterochromatin	1	Understand euchromatin and heterochromatin and their differences.		
9.	Constitutive heterochromatin	1	Learn the concept of constitutive heterochromatin and its significance.		
10.	Constitutive heterochromatin	1	Learn the concept of facultative heterochromatin and its significance.		

Unit 3: The Replication of DNA (10 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Chemistry of DNA synthesis (Kornberg's discovery)	1	Understand the chemistry of DNA synthesis	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar / Group Discussion/Q & A /Assignment*
2.	General principles of DNA - replication-bidirectional	1	Understand replication of DNA that progress in two different directions		
3.	General principles of DNA- semiconservative	1	Understand that the newly replicated DNA molecules are made of new and old strands of DNA		
4.	General principles of DNA- semi discontinuous	1	Learn that DNA replication is continuous in one strand and discontinuous in another strand		
5.	RNA priming	1	Learn the mechanism of RNA priming and its significance in initiation of DNA replication		

6.	Various models of DNA replication including rolling circle, theta and in ds DNA	1	Understand various models of DNA replication	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q&A /Assignment*
7.	…. contd.	1			
8.	…. contd.	1			
9.	Enzymes involved in DNA replication	1	Learn about polymerases and other enzymes involved in DNA replication.		
10.	…. contd.	1			

Unit 4: Central Dogma and genetic Code (2 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	The central dogma (Adaptor hypothesis and discovery of mRNA)	1	Have the basic concept of how the genetic information is transferred from DNA to RNA to make functional proteins.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar / Group Discussion/Q & A Session/Assignment*
2.	Genetic code (deciphering and salient features	1	Understand about codons and its features and how to decipher		

Unit 5: Transcription (18 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Transcription in prokaryotes	1	Gain knowledge of the processes involved in transcription in prokaryotes.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar / Group Discussion/Q & A Session/Assignment*
2.	….. contd.	1			
3.	Transcription in eukaryotes	1	Gain knowledge of the processes		

4.	….. contd.	1	involved in transcription in eukaryotes.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar / Group Discussion/Q & A Session/Assignment*
5.	Principles of transcriptional regulation	1	Understand principles of transcriptional regulation.		
6.	Transcription factors in prokaryotes	1	Learn the transcription factors involved of prokaryotes and their role		
7.	Regulation of lactose metabolism in prokaryotes	1	Know about regulation of lactose metabolism in prokaryotes through lac operon.		
8.	…. contd.	1			
9.	Tryptophan synthesis in *E. coli*	1	Know about tryptophan synthesis in *E. coli* through tryptophan operon.		
10.	….. contd.	1			
11.	Transcription factors in eukaryotes	1	Learn the transcription factors involved in eukaryotes and their role.		
12.	Heat shock proteins	1	Gain knowledge of heat shock proteins.		
13.	…. contd.	1			
14.	Steroids	1	Gain knowledge of steroids.		
15.	….. contd.	1			
16.	Peptide hormones	1	Gain knowledge of peptide hormones		
17.	….. contd.	1			
18.	Gene silencing	1	Learn how expression of gene is silenced.		

Unit 6: Processing and Modification of RNA					
Section	*Topic*	*Lec. Hrs.*	*Learning Outcome*	*Pedagogy*	*Assessment/Evaluation*
1.	Split genes- concept of introns and exons	1	Learnt the concept of split genes.	*Lecture/Discussion/ PPT/Demonstration .*	*Quiz/Class test/Seminar /Group Discussion/ Q & A Session/Assignment*
2.	Removal of introns	1	Have knowledge of why and how introns are removed.		
3.	Spliceosome machinery	1	Understand various components of spliceosome.		
4.	Splicing pathway-group I intron splicing	1	Understand the pathway of group I intron splicing.		
5.	Splicing pathway-group II intron splicing, alternative splicing	1	Understand the pathway of group II intron splicing and alternative splicing.		
6.	Eukaryotic mRNA processing (5' cap and poly A tail)	1	Understand that primary transcripts are modified.		
7.	Ribozymes	1	Understand the importance of ribozymes in transcription.		
8.	RNA editing and mRNA transport	1	Know how RNA are edited and mRNA are transported.		

Unit 7: Translation (8 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Ribosome structure and assembly	1	Develop the basic knowledge of the structure and assembly of 80s and 60s ribosomes.	. *Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/ Q & A Session/Assignment*
2.	mRNA; Charging of t RNA	1	Develop the basic knowledge of the role of mRNA and tRNA in translation.		

3.	Aminoacyl tRNA synthetase	1	Understand the role of aminoacyl tRNA synthetase in protein synthesis.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/ Q & A Session/Assignment*
4.	Protein synthesis (various steps involved in it)	1	Understand the mechanism of protein synthesis mainly of initiation, elongation and termination.		
5.	…. .contd.	1			
6.	Fidelity of translation	1	Understand fidelity of translation.		
7.	Inhibition of protein synthesis	1	Understand inhibition of protein synthesis.		
8.	Post- translational modification of proteins.	1	Understand post- translational modification of proteins.		

N.B.The contact hours for tutorial classes will be 15 hours

Course teachers:

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HoD ……

Semester-IV

Paper Code: BOT-HC- 4026

Paper Title: Plant Ecology & Phytogeography

No. of Hours per week	Credit	Total No. of Hours	Marks
6 (Theory)	4 (Theory)	60	75
4 (Practical)	2 (Practical)	30	25

Course Objectives:

1. To discuss in detail about the concepts of ecology and interaction between biotic and abiotic components of the environment.
2. To talk on the origin and formation of soil.
3. To highlight on the importance of abiotic factors and their effects on plants.
4. To provide knowledge about the phytogeographical divisions of India and types of vegetation of NE with special reference to Manipur.
5. Provide practical knowledge of vegetation study and different ecological sites.

Course Outcomes:

1. Understand core concepts of biotic and abiotic.
2. Classify the soils based on physical, chemical and biological components.
3. Analyse the phytogeography or phytogeographical division of India.
4. Evaluate energy sources of ecological system.

5. Assess the adaptation of plants in relation to light, temperature, water, wind and fire.
6. Conduct experiments using skills appropriate to subdivisions.

Unit 1: Introduction (4 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
17.	Basic concept of ecology	1	Understand the concept of ecology.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
18.	Levels of organization	1	Understand the different levels of ecology.		
19.	Inter-relationship between the living world and environment, Components	1	Understand inter-relationship between the living world and environment. Understand the main components of ecosystems.		
20.	Dynamism and homeostasis	1	Understand the need of dynamism and homeostasis in ecosystem		

Unit 2: Soil (8 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Importance, origin and formation of soil	1	Understand the importance of soil and origin of soil. Learn various methods of soil weathering and pedogenesis.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/test/Seminar/Group Discussion/Q & A Session/Assignment*
2.	….. contd.	1			
3.	Compositions of soil -physical, chemical and biological	1	Understand the components of soil and categorization of components.		
4.	….. contd.	1			

5.	Soil profile	1	Learn about soil profile of naturally formed soil.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
6.	….. contd.	1			
7.	Role of climate in soil development	1	Gain knowledge of how climate influences soil development		
8.	….. contd.	1			

Unit 3: Water (4 Lec.)					
Section	*Topic*	*Lec. Hrs.*	*Learning Outcome*	*Pedagogy*	*Assessment/Evaluation*
1.	Importance and states of water in the environment	1	Know the importance of water and different states of water.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Atmospheric moisture; precipitation types (rain, fog, snow, hail, dew)	1	Understand the concept of atmospheric moisture and types of precipitation.		
3.	Hydrological cycle	1	Understand the water cycle.		
4.	Water in soil and water table	1	Learn different types of soil water.		

Unit 4: Adaptations to various Environmental factors (6 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Adaptations to various environmental factors	1	Understand adaptations of plants to various environmental factors.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group*
2.	Adaptation of plants in relation to light	1	Understand various adaptations of plants to light.		

3.	Adaptation of plants in relation to temperature	1	Understand how plants adapt to variation in temperature.		*Discussion/Q & A Session/Assignment*
4.	Adaptation of plants in relation to water	1	Understand how plants adapt to water.		
5.	Adaptation of plants in relation to wind	1	Understand the effect of wind on plants.		
6.	Adaptation of plants in relation to fire	1	Understand adaptation of plants in relation to fire.		

Unit 5: Biotic Interactions (2 Lec)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Trophic organisation, basic source of energy, autotrophy, heterotrophy	1	Understand trophic organisation and source of energy.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Symbiosis, commensalism, parasitism, food chain and webs, ecological pyramids.	1	Understand biotic interactions.		

Unit 6: Population Ecology (4 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Population characteristics	1	Learn population characteristics.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Growth curve and population regulation	1	Understand growth curve and population regulation.		
3.	R and k selection	1	Learn about r and k selection.		
4.	Ecological speciation: Allopatric/sympatric and parapatric speciation	1	Gain knowledge of ecological speciation.		

Unit 7: Plant Communities (8 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Concept of ecological amplitude	1	Understand the concept of ecological amplitude.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Habit and niche	1	Understand the concept of habitat and niche and can differentiate between them.		
3.	Characters-analytical	1	Learn analytical characteristics of communities.		
4.	Characters-synthetic	1	Learn synthetic characteristics of communities.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
5.	Ecotone	1	Understand the concept of ecotone.		
6.	Edge effect	1	Understand the concept of edge effect.		
7.	Succession-process	1	Learn about processes of succession.		
8.	Succession-types, climax concepts	1	Learn about the concept of climax communities and types of succession.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*

Unit 8: Ecosystem (4 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Ecosystem structure and process	1	Learn about the concept of ecosystem structure and process.	*Lecture/Discussion /PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Trophic organization	1	Understand trophic organization.		

3.	Food chain and food web	1	Learn about food chain and food web.		
4.	Ecological pyramid	1	Learn the concept of ecological pyramid		

Unit 9: Functional Aspect of Ecosystem (8 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Principles and models of energy flow	1	Understand principles and models of energy flow in an ecosystem.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	….. contd.	1			
3.	Production and productivity	1	Understand primary and secondary production and productivity of various ecosystems.		
4.	….. contd.	1			
5.	Ecological efficiencies	1	Learn about ecological efficiencies		
6.	Biogeochemical cycle: Cycling of carbon	1	Learn various types of biogeochemical cycle in brief and gain knowledge of cycling of carbon		
7.	Cycling of nitrogen	1	Gain knowledge of cycling of nitrogen	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
8.	Cycling of phosphorus	1	Gain knowledge of cycling of phosphorus		

Unit 9: Phytogeography (12 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Phytogeography	1	Have basic concept of the distribution of plants in different regions of the world	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Principles of Phytogeography	1	Develop the knowledge of the role of environment, routes of migration, etc. in the distribution of plants		
3.	…. continue	1			
4.	Continental Drift Theory	1	Have the basic knowledge of how the different continents are formed.		
5.	…. continue	1			
6.	Theory of Tolerance	1	Have the basic knowledge of how species are able to occupy and adapt to a particular area.		
7.	Endemism	1	Have the basic concept of why some species are restricted to a particular small region only.		
8.	Brief description of major terrestrial biomes – Tropical, Temperate and Tundra	1	Develop the basic knowledge of location and abiotic and biotic characteristics of the biomes		
9.	…continue	1			
10.	Phytogeographical divisions of India	1	Able to analyse the different phytogeographical regions of India.		
11.	…continue	1			

12.	Vegetation of N.E. India with special reference to Manipur	1	Able to analyse the different types of forest found in Manipur.	*Lecture/Discussion/PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*

N.B.The contact hours for tutorial classes will be 15 hours

Course teachers:

1. L.Degachandra Singh
2. Dr. Y Pramoda Devi
3. N. Nirupama Devi
4. H.Rajesh Sharma
5. Dr. Chipem Vashi
6. Dr. R.K.Imosana

HoD……..

Semester-IV

Paper Code: BOT- HC – 4036

Paper Title: Plant Systematics

No. of Hours per week	Credit	Total No. of Hours	Marks
6 (Theory)	4 (Theory)	60	75
4 (Practical)	2 (Practical)	30	25

Course Objectives:

1. Provide knowledge about the plant systematic and the importance of herbaria.
2. Highlight on principles and rules of ICN.
3. Discuss on different systems of plant classification.
4. Explain origin and evolution of angiosperm.
5. To elaborate on the detailed background of angiosperm families.
6. Provide practical knowledge on foliar morphology and taxonomical study of angiosperms.

Course Outcomes:

1. Classify Plant systematics and recognize the importance of herbarium and Virtual herbarium. Evaluate the important herbaria and botanical gardens.
2. Interpret the rules of ICN in botanical nomenclature.
3. Assess terms and concepts related to Phylogenetic Systematics.
4. Generalize the characters of the families according to Bentham & Hooker's system of Classification.

Unit 1: Significance of Plant Systematics (8 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
9.	Introduction to systematics; Plant identification	1	Learn about systematics and plant identification.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class/test/Seminar/ Group Discussion/Q & A Session/Assignment*
10.	Classification and nomenclature	1	Understand classification and nomenclature.		
11.	Evidences from Palynology, cytology, phytochemistry and molecular data	1	Gain knowledge of taxonomic evidences from palynology, cytology, phytochemistry and molecular data.		
12.	Functions and importance of herbarium	1	Know the importance and functions of herbarium in taxonomy.		
13.	Important herbaria and botanical gardens of the world and India	1	Understand some important herbaria and botanical gardens of the world and India.		
14.	Virtual herbarium and E-flora	1	Aware of the advantages and use of virtual herbarium and E-flora.		
15.	Concept of taxa (family, genus and species)	1	Gain knowledge of concept of taxa (family, genus and species).		
16.	Categories and taxonomic hierarchy	1	Understand categories and taxonomic hierarchy.		

Unit 2: Botanical Nomenclature (10 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Principles and rule (ICN)	1	Understand the principles and rule (ICN).	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class/test/Seminar/ Group Discussion/Q & A Session/Assignment*
2.	……continue	1			

3.	Ranks and names	1	Know what are ranks and names in taxonomy.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class/test/Seminar/ Group Discussion/Q & A Session/Assignment*
4.	Typification	1	Learn the process of typification and various type specimens.		
5.	……continue	1			
6.	Author citation	1	Understand author citation.		
7.	Effective and valid publication	1	Gain knowledge of effective and valid publication.		
8.	Rejection of names	1	Understand rejection of names in nomenclature.		
9.	Principle of priority and its limitation	1	Learn principle of priority and its limitation.		
10.	Names of hybrids	1	Understand nomenclature of hybrids.		

Unit 3: Systems of Classification (12 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Major contributions of Theophrastus, Buahin and Tournefort	1	Know major contributions of Theophrastus, Buahin and Tournefort in taxonomy.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class/test/Seminar/ Group Discussion/Q & A Sesison/Assignment*
2.	Contribution of Linnaeus, Adanson, de Candolle and Bessy	1	Learn about the contributions in taxonomy by Linnaeus, Adanson, de Candolle and Bessy.		
3.	Contribution of Hutchinson, Takhtajan and Cronquist in plant classification	1	Learn the contributions of Hutchinson, Takhtajan and Cronquist in plant classification.		
4.	Bentham and Hooker system of classification (up to series)	1	Students learnt to classify based on Bentham and Hooker system of		

5.	continue	1	classification and know that this system of classification is the most common system of classification in India.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class/test/Seminar/ Group Discussion/Q & A Session/Assignment*
6.	continue	1			
7.	Engler and Prantl system of classification (up to series)	1	Learn to classify plants based on Engler and Prantl system.		
8.	……continue	1			
9.	……continue	1			
10.	Brief reference of angiosperm phylogeny group (APG) classification	1	Learn about angiosperm phylogeny group (APG).		
11.	……continue	1			
12.	……continue	1			

Unit 4: Numerical Taxonomy and Cladistics (10 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Introduction to numerical taxonomy	1	Learn what is numerical taxonomy and its differences from taxonomy.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class/test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Characters	1	Understand characters that can be employed in numerical taxonomy.		
3.	Variations	1	Know about variations of characters.		
4.	OTUs	1	Understand the concept of basic unit of numerical taxonomy-OTUs.		
5.	Character weighting and coding	1	Understand character weighting and		

6.	……continue	1	different types of character coding.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class/test/Seminar /Group Discussion/Q & A Session/Assignment*
7.	Cluster analysis	1	Learn the concept of cluster analysis and learn to perform cluster analysis with examples.		
8.	……continue	1			
9.	……continue	1			
10.	Phenograms, cladograms (definition and differences)	1	Phenograms, cladograms (definition and differences).		

Unit 5: Phylogeny of Angiosperms (12 Lec.)					
Section	*Topic*	*Lec. Hrs.*	*Learning Outcome*	*Pedagogy*	*Assessment/Evaluation*
1.	Terms and concepts-primitive and advanced	1	Understand the terms and concepts primitive and advanced in phylogeny.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class/test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Terms and concepts-homology and analogy	1	Understand the terms and concepts homology and analogy in phylogeny.		
3.	Terms and concepts- parallelism and convergence	1	Understand the terms and concepts parallelism and convergence in phylogeny.		
4.	Terms and concepts-paraphyly, polyphyly and clade	1	Understand the terms and concepts paraphyly, polyphyly and clade in phylogeny.		
5.	Origin and evolution of angiosperms	1	Gain knowledge of how angiosperms originated and evolved in time.		
6.	……continue	1			
7.	Co-evolution of angiosperms and animals	1	Gain knowledge of how angiosperms and animals co-evolved.		
8.	……continue	1			
9.	Methods of illustrating evolutionary relationship-phylogenetic tree	1	Learn to illustrate evolutionary relationship with the help of phylogenetic tree.		
10.	……continue	1			

11.	Methods of illustrating evolutionary relationship- cladogram	1	Learn to illustrate evolutionary relationship with the help of cladogram.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class/test/Seminar /Group Discussion/Q & A Session/Assignment*
12.	……continue	1			

Unit 6: Angiospermic families (8 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1	Study of the families- Magnoliaceae, Fabaceae	1	Learn about the distribution, general and distinguishing characters, and economic importance of the families.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class/test/Seminar /Group Discussion/Q & A Session/Assignment*
2	Study of the families-Asteraceae, Solanaceae	1	Learn about the distribution, general and distinguishing characters, and economic importance of the families.		
3	Study of the families- Acanthaceae, Lamiaceae	1	Learn about the distribution, general and distinguishing characters, and economic importance of the families.		
4	Study of the families- Euphorbiacea, Orchidaceae	1	Learn about the distribution, general and distinguishing characters, and economic importance of the families.		
5	Study of the families- Musaceae, Zingiberaceae	1	Learn about the distribution, general and distinguishing characters, and economic importance of the families.		
6	Study of the families-Poaceae, Malvaceae	1	Learn about the distribution, general and distinguishing characters, and economic importance of the families.		
7	Study of the families-Rosaceae, Apiaceae	1	Learn about the distribution, general and distinguishing characters, and		

			economic importance of the families.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class/test/Seminar /Group Discussion/Q & A Session/Assignment*
8	Study of the families- Ranunculaceae, Liliaceae, Brassicaceae	1	Learn about the distribution, general and distinguishing characters, and economic importance of the families.		

N.B. The contact hours for tutorial classes will be 15 hours

Course teachers:

1. Padmaja S.
2. L. Degachandra Singh
3. Dr. Y Pramoda Devi
4. N. Nirupama Devi
5. H. Rajesh Sharma
6. Dr. Chipem Vashi

HoD……

Semester-V

Paper Code: BOT-HC-5016

Paper Title: Reproductive Biology of Angiosperms

No. of Hours per week	Credit	Total No. of Hours	Marks
6 (Theory)	4 (Theory)	60	75
4 (Practical)	2 (Practical)	30	25

Course Objectives:

1. To provide knowledge of detailed morphological and anatomical study of reproductive structures of angiospermic plants.
2. Discuss embryology and embryological abnormalities in angiosperms.
3. To highlight in detail on reproductive structures of angiosperms.
4. To throw light on the types pollination and fertilization.
5. Provide practical knowledge on developmental biology of embryo and endosperms.

Course Outcomes:

1. Understand morphological and anatomical aspects of reproductive structures of angiospermic plants.
2. Explain embryology and embryological abnormalities in angiosperms.
3. Structural documentation of reproductive structures of angiosperms.
4. Apply practical knowledge on developmental biology of embryo and endosperms.

Unit 1: Introduction (4 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1	History of reproductive biology; contributions of G.B. Amici and W. Hofmeister	1	Understand the history of reproductive biology and contribution done by G.B. Amici and W. Hofmeister	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test /Seminar /Group Discussion/Q & A Session/Assignment*
2	Contributions of E. Strasburger and S. G. Nawaschin	1	Learn about the contributions to embryology by E. Strasburger and S. G. Nawaschin.		
3	Contribution of P. Maheshwari, B.M. Joshi and W.A. Jensen	1	Learn about the contributions to embryology by P. Maheshwari, B.M. Joshi and W.A. Jensen		
4	Contribution of Heslop-Harrison and scope of reproductive biology	1	Learn about the contributions to embryology by Heslop-Harrison and various scope of reproductive biology.		

Unit 2: Reproductive Development (6 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Induction of flowering	1	Have basic knowledge of flower induction.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test /Seminar /Group Discussion/Q & A Session/Assignment*
2.	Parts of reproductive organs	1	Understand various parts of reproductive organs of angiosperms.		
3.	Flower as a modified determinate shoot	1	Have clear knowledge of flower as modified determinate shoot.		
4.	Flower development	1	Under flower development.		
5.	Genetic aspect	1	Understand the genetic aspect of reproduction.		

6.	Molecular aspect	1	Understand the molecular aspect of reproduction.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test /Seminar /Group Discussion/Q & A Session/Assignment*

Unit 3: Anther and Pollen Biology (10 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Anther wall- structure and function	1	Understand anther, structure of anther wall and function of each layer of anther wall.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test /Seminar /Group Discussion/Q & A Session/Assignment*
2.	Cellulose deposition and its significance	1	Learn the role of cellulose deposition during microsporogenesis.		
3.	Microsporogenesis	1	Able to describe the steps of microsporogenesis and types of wall formation.		
4.	Micro-gametogenesis	1	Learn different types of microsporogenesis.		
5.	Pollen wall structure	1	Understand pollen wall structure.		
6.	NPC system	1	Learn a system of classification of pollen based on their apertures.		
7.	MGU (Male Germ Unit)	1	Know that two male gametes of a pollen exist as a structural unit.		
8.	Palynology and scope (a brief account); Pollen wall proteins	1	Aware of scope of palynology. Understand that pollen wall proteins contributed to enzymatic activities of pollen.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test /Seminar /Group Discussion/Q & A Session/Assignment*
9.	Pollen viability, storage and germination	1	Understand that pollen longevity varies across species and storage of pollen at optimal conditions is necessary for pollen viability and germination		

10.	Abnormal features- Pseudomonads, polyads, masulae and pollinia	1	Understand that pollens can exist in groups of more than 4 pollens		

Unit 4: Ovule (10 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Structure of ovules	1	Gain knowledge of structure of ovule.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test /Seminar /Group Discussion/Q & A Session/Assignment*
2.	Types of ovules	1	Learn different types of ovules found in angiosperm and their structure.		
3.	Special features- endothelium	1	Understand the structure of endothelium and their role in embryo development.		
4.	Special features- obturator, aril, caruncle and hypostasis	1	Understand obturator, aril, caruncle and hypostasis as special feature of ovules.		
5.	Megasporogenesis- monosporic, bisporic and tetrasporic	1	Understand sequential events in megasporogenesis and its types.		
6.	Megagametogenesis	1	Learn development of female gametophyte.		
7.	Female gametophyte (type)	1	Learn different types of female gametophyte.		
8.	Polygonum type (in details)	1	Learn Polygonum type of embryo sac in detail.		
9.	Organization of mature embryo sac	1	Learn how different cells of embryo sac are organized into egg apparatus, central and antipodals.		
10.	Ultra structure of embryo sac	1	Understand fine structure of the component cells of embryo sac		

Unit 5: Pollination and Fertilization (6 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Pollination types and significance, adaptation	1	Learn pollination and its significance and types.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test /Seminar /Group Discussion/Q & A Session/Assignment*
2.	….. contd.	1			
3.	Structure of stigma and style	1	Understand the structure of stigma and style.		
4.	Path of pollen tube in pistil	1	Learn about path of pollen tube in pistil and stigma.		
21.	Double fertilization	1	Learn double fertilization as two events- syngamy and triple fusion and know the processes in detail.		
22.	….. contd.	1			
Unit 6: Self- incompatibility (6 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1	Basic concept of self-incompatibility: interspecific, intrasepcific	1	Gain clear concept of self-incompatibility and unsuccessful pollination between species and within species.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test /Seminar /Group Discussion/Q & A Session/Assignment*
2	Homomorphic, heteromorphic GSI and SSI	1	Understand various types of self-incompatibility.		
3	Methods to overcome self-incompatibility	1	Learn different methods to overcome self- incompatibility.		
4	Mixed pollination	1	Understand mixed pollination.		

5	Bud pollination	1	Understand bud pollination.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test /Seminar /Group Discussion/Q & A Session/Assignment*
6	Stub pollination	1	Understand stub pollination		
7	Intra ovarian and in-vitro pollination	1	Understand intra ovarian and in-vitro pollination.		
8	Modification of stigma surface	1	Learn stigma surface modification for its function.		
9	Parasexual, hybridization	1	Learn parasexual and hybridization.		
10	Cybrids and in vitro fertilization	1	Learn about fusion of cytoplasm and in vitro fertilization.		

Unit 7: Embryo, Endosperm and Seed (6 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Structure and types; General pattern of development of dicot embryo	1	Understand the structure, types and general pattern of development of dicot embryo.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Structure and types; General pattern of development of monocot embryo	1	Understand the structure, types and general pattern of development of monocot embryo.		
3.	Suspensor: structure and functions	1	Learn about the structure and functions of suspensor.		
4.	Embryo-endosperm relationship	1	Learn the concept of embryo-endosperm relationship.		
5.	Nutrition of embryo	1	Understand nutrition of embryo.		
6.	Unusual features of embryo	1	Learn some unusual features of embryo.		
7.	Embryo development in Paeonia	1	Learn in detail of the embryo development in Paeonia.		
8.	Seed structure, importance and dispersal mechanism	1	Learn about seed structure, importance and dispersal mechanism.		

Unit 8: Polyembryony and apomixis (6 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Introduction; classification of polyembryony	1	Learn about polyembryony and its classification.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test /Seminar /Group Discussion/Q & A Session/Assignment*

2.	Causes of polyembryony	1	Know some causes of polyembryony.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test /Seminar /Group Discussion/Q & A Session/Assignment*
3.	Application of polyembryony	1	Know some application of polyembryony.		
4.	Introduction; classification of apomixis	1	Learn about apomixis and its classification.		
5.	Causes of apomixis	1	Learn what causes apomixis.		
6.	Application of apomixis	1	Learn how to use apomixis.		

N.B. The contact hours for tutorial classes will be 15 hours

Course teachers:

1. Padmaja S.
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3. Dr. Chipem Vashi

HoD ……

Semester-V

Paper Code: BOT-HC-5026

Paper Title: Plant Physiology

No. of Hours per week	Credits	Total No. of Hours	Marks
6 (Theory)	4 (Theory)	60	75
4 (Practical)	2 (Practical)	30	25

Course Objectives:

1. Provide knowledge of mechanisms of water, minerals and nutrient absorption of plants. Explain the roles of plant hormones and mechanism of flowering in plants.
2. To highlight on determination of osmotic and water potential.
3. To illuminate on photoperiodism and the factors that induce flowering.
4. Provide practical knowledge on effects of growth regulators on plant parts.

Course Outcomes:

1. Understand Water relation of plants with respect to various physiological processes.
2. Explain chemical properties and deficiency symptoms in plants.
3. Classify aerobic and anaerobic respiration.
4. Explain the significance of Photosynthesis and respiration.
5. Assess dormancy and germination in plan.

Unit 1: Plant Water Relations (10 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Types of solution; Water Potential and its components	1	Have knowledge of different types of solutions. Also understand the term water potential and also its role in absorption of water.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Water absorption by roots	1	Understand how water move from the soil into the xylem of root and the mechanisms involved in the process.		
3.	Aquaporins	1	Understand the types, structure and function of plant aquaporins.		
4.	Pathway of water movement – symplast, apoplast and transmembrane pathways	1	Understand how water moves from one cell to another cortical cells in the process of absorption of water.		
5.	Root pressure	1	Know the term root pressure, how it is created and its role in the absorption of water.		
6.	Guttation	1	Know the term, how and where it occurs and its significance.		
7.	Ascent of sap – cohesion-tension theory	1	Understand the theory, mechanism of movement of water through xylem in the upward direction, evidences in support of theory and the objections.		
8.	Transpiration	1	Understand the term, its types, mechanism and the significance.		
9.	Factors affecting transpiration	1	Understand how different external and internal factors affect transpiration.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
10.	Anti-transpirants	1	Understand how they affect transpiration.		

Unit 2: Mineral Nutrition (8 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
12.	Essential and beneficial elements; macro- and micro-nutrients, criteria for essentiality of elements	1	Have knowledge of these elements and the criteria for the essentiality of these elements.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
13.	Methods of study and use of nutrients solution	1	Understand the methods and the use of nutrients in nutrients solution.		
14.	Mineral deficiency symptoms in plants	1	Know the deficiency symptoms of essential elements in plants.		
15.	…. contd.	1			
16.	Role of essential elements in plants	1	Know the specific functions of essential elements in plants.		
17.	……contd.	1			
18.	Chelating agents	1	Have knowledge about the chemical compounds which react with metal ions to form a stable water-soluble complex.		
19.	Ion antagonism & toxicity	1	Know about the combine effect of two nutrients rather than the individual response.		

Unit 3: Nutrient Uptake (8 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
13.	Soil as a nutrient reservoir	1	Understand the importance of soil in plants.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
14.	Transport of ions across cell membrane	1	Have clear knowledge about the transport system taking place in plants.		
15.	Passive absorption	1	Have clear knowledge about the passive absorption in plants.		
16.	Electrochemical gradient	1	Have knowledge about the topic.		
17.	Fascicular diffusion	1	Understand about the role of fascicular diffusion in plants.		
18.	Active absorption; Role of ATP	1	Understand about active absorption and role of ATP.		
19.	Carrier system	1	Know about the carrier system.		
20.	Proton ATPase pump and influx – uniport, co-transport, symplast, antiport	1	Understand about the concerned topics.		

Unit 4: Translocation In Phloem (8 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Introduction phloem translocation	1	Develop a basic knowledge on phloem.		
2.	Experimental evidences in support of phloem as the site of sugar translocation	1	Develop critical understanding on the different works of different researchers.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
3.	……contd.	1			
4.	Pressure – Flow model		Could analyze the model concerned.		
5.	……contd.	1			
6.	Phloem loading	1	Understand the mechanism involved in the transfer of sugar from mesophyll cells (source) to sieve tubes.		
7.	Phloem unloading	1	Understand the mechanism involved in the transfer of sugar from sieve tubes elements to roots or other storage cells.		
8.	Sources-sink relationship	1	Understand the relationship between the site of production and site of utilization.		

Unit 5: Plant Growth Regulators (14 Lec.)					
Section	*Topic*	*Lec. Hrs.*	*Learning Outcome*	*Pedagogy*	*Assessment/Evaluation*
1.	Discovery of Plant growth regulators	1	Know the discovery of major plant growth regulators began with Charles Darwin and his son Francis Darwin.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Chemical nature (basic structure) of plant growth regulators	1	Know that they can be of diverse chemical composition such as gases (ethylene), terpenes (gibberellic acid) or carotenoid derivatives (ABA).		
3.	…contd.	1			
4.	Bioassay of plant growth regulator	1	Have knowledge of the specific test which determine the biological activity of a particular hormone by showing its measurable or detectable effect on specific part.		
5.	Physiological role of auxin	1	Know its role in cell elongation, apical dominance parthenocarpy, flowering etc.		
6.	….. cont'd	1			
7.	Physiological role of gibberellins	1	Know its role in stem and leaf growth, bolting, flowering see d germination, sex determination etc.		
8.	……cont'd	1			
9.	Physiological role of cytokinin	1	Know its role in cell division, cell		

10.	……cont'd	1	elongation, seed dormancy, senescence, etc.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
11.	Physiological role of abscisic	1	Know its role in bud dormancy, seed dormancy, parthenocarpy, etc.		
12.	Physiological role of ethylene	1	Know its role in fruit ripening, breaking dormancy, root initiation, etc.		
13.	Brassinosteroids	1	Have idea of its role in regulating division, elongation and differentiation of numerous cell types throughout the plant life cycle.		
14.	Jasmonic acid	1	Have idea of its in physiological and responses.		

Unit 6: Physiology of Flowering (6 Lec.)					
Section	*Topic*	*Lec. Hrs.*	*Learning Outcome*	*Pedagogy*	*Assessment/Evaluation*
1.	Photoperiodism	1	Know about the developmental responses of plants to the relative lengths of light and dark period.	*Lecture/Discussion/ PPT/Demonstration*	Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment
2.	Flowering stimulus	1	Have a basic concept of it, where it is produced and translocate in the plant body.		
3.	Florigen concept	1	Know who proposed the florigen concept and also know the metabolism of florigen.		

4.	Vernalization	1	Know the process of flowering in plants.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
5.	Seed dormancy	1	Know what seed dormancy is, its causes and methods of breaking dormancy.		
6.	…….. contd.	1			

Unit 7: Phytochrome, cytochromes and phototropins (6 Lec.)					
Section	*Topic*	*Lec. Hrs.*	*Learning Outcome*	*Pedagogy*	*Assessment/Evaluation*
1.	Discovery of phytochrome, cytochromes and phototropins	1	Have knowledge of the discovery of phytochrome, cytochromes and phototropins	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Chemical nature of phytochrome, cytochromes and phototropins	1	Know the chemical nature of phytochrome, cytochromes and phototropins		
3.	Role in photomorphogenesis	1	Have clear idea on the relationship between the		

			plants and phyto-hormones		
4.	Low energy response	1	Knowledge on Low energy response	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
5.	High energy response	1	Knowledge on Low energy response		
6.	Mode of action	1	How the hormones act in the activities of the plant is understood.		

N.B. The contact hours for tutorial classes will be 15 hours

Course teachers:

1. Dr. Y Pramoda Devi
2. N. Nirupama Devi
3. H.Rajesh Sharma

HoD ……

Semester-V

Paper Code: BOT-HE-5016

Discipline Specific Elective Course
Paper Title: Natural Resource Management

No. of Hours per week	Credit	Total No. of Hours	Marks
6 (Theory)	4 (Theory)	60	75
4 (Practical)	2 (Practical)	30	25

Course Objectives:

1. Provide comprehensive knowledge regarding different types of natural resources and their ecological, economical and socio-cultural values.
2. Highlight the backgrounds of land, water and forest resources.
3. Discuss on resource degradation, importance of their judicious use and management for sustainability.
4. Discuss on 'biodiversity' - its importance, management and Bio-prospecting.

Course Outcomes:

1. Understand the concept of different natural resources and their utilization.
2. Critically analyse the sustainable utilization land, water, forest and energy resources.
3. Evaluate the management strategies of different natural resources.
4. Reflect upon the different national and international efforts in resource management and their conservation.

Unit 1: Natural resources (2 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Introduction – Natural resources	1	Understand about natural resources.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Definition and types	1	Understand different types of natural resources and the basis of their classification.		

Unit 2: Sustainable utilization (8 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Concept of sustainable utilization	1	Have concept of sustainable utilization of natural resources.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Economic approaches of sustainable utilization	1	Have knowledge on economic approach of sustainable resources		
3.	…. .contd.	1			
4.	Ecological approaches of sustainable utilization	1	Have knowledge on ecological approach of sustainable resources		
5.	……contd.	1			
6.	Socio-cultural approaches of sustainable utilization	1	Have knowledge on socio-cultural approach of sustainable resources		
7.	…….. contd.	1			
8.	Revision class	1			

Unit 3: Land (8 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Introduction – Land	1	Know the characteristics features of land.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Utilization of land in agricultural	1	Have the knowledge of the different types of land used in agriculture.		
3.	…. contd.	1			
4.	Utilization of land in pastoral	1	Know about the pastoral lands use in grazing.		
5.	Utilization of land in horticultural	1	Have the knowledge of different types of land suitable for horticulture.		
6.	Utilization of land in silvicultural	1	Have the knowledge of different types of land suitable for silviculture.		
7.	Soil degradation	1	Have the knowledge of the process of soil degradation.		
8.	Soil management	1	Know about the techniques of soil management.		

Unit 4: Water (8 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Introduction – Fresh water	1	Understand what fresh water is and also its chemical and physical properties.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Fresh water – rivers, lakes	1	Know about the properties of the		

3.	Ground water, aquifers & Watershed	1	fresh water found in these sources.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
4.	Marine & Estuarine	1	Know about the properties of the marine and eastaurine water.		
5.	Wetlands	1	Have the knowledge about the wetlands.		
6.	Threats	1	Have knowledge of the different threats that leads to water crisis.		
7.	Management strategies	1	Have knowledge of the different techniques of water management strategies.		
8.	…..contd.	1			

Unit 5: Biological Resources (10 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Biodiversity – definition and types	1	Know biodiversity and its type.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Significance of biodiversity	1	Learn the significance of biodiversity to ecosystem and human.		
3.	Threats faced by biodiversity	1	Learn various threats faced by plants.		
4.	Management strategies	1	Learn management strategies of biodiversity.		
5.	Bioprospecting	1	Learn how to extract benefits from biodiversity.		
6.	Intellectual Property Right (IPR)	1	Learn IPR with reference to biodiversity.		
7.	……contd.	1			

8.	Convention of biological Biodiversity (CBD)	1	Learn about CBD, its goal and operation.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
9.	National Biodersity Action Plan (NBAP)	1	Learn about NBAP taken up by India under the CBD		
10.	……contd.	1			

Unit 6: Forest (6 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Definition of forest, Forest cover	1	Comprehensive knowledge knowledge on the topic.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Significance of forest (with special reference to India)	1	Understand the knowledge of forest.		
3.	Major forest products of India	1	Understand the various products of Indian forest.		
4.	Minor forest products of India	1			
5.	Depletion of forest	1	Have knowledge on forest depletion factors, etc.		
6.	Management of forest	1	Know about the management strategies of forest.		

Unit 7: Energy (6 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Energy – Introduction, as a natural resource.	1	Know about energy.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Types of energy	1	Have knowledge on different types of energy.		

3.	Sources of energy	1	Know about the different sources of energy.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
4.	Renewable source of energy	1	Know about the renewable energy sources.		
5.	Non-renewal source of energy	1	Know about the non-renewal energy sources.		
6.	Difference between renewal and non-renewal source of energy	1	Understand the difference between renewal and non-renewable source of energy.		

Unit 8: Contemporary practice in resource management (8 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Environmental Impact Assessment (EIA)	1	Students learn that for big projects before being executed heeds CIA to protect environment.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	GIS	1	Learn GIS and its uses in modern science.		
3.	Participatory Resource Appraisal	1	Students learn Participatory resource Appraisal		
4.	Ecological Footprint with emphasis on carbon footprint	1	Learn ecological footprint and carbon footprint and how we can predict awareness of the earth.		
5.	……contd.				
6.	Resource Accounting	1	Students learn about resource accounting.		
7.	Waste management	1	Students learn about waste management.		
8.	…. contd.				

Unit 9: National & International efforts in resources management and conservation (4 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	National level – Joint Forest management	1	Imparted the knowledge on the importance of the participation of local people in forest management	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	National Forest Act, 1972	1	Have knowledge about the rules and regulations of Forest Act, 1972		
3.	Indian Biodiversity board	1	Have knowledge on the role of the Indian Biodiversity Board in identifying and conservation of species		
4.	Convention on International Trade on Endangered Species	1	Have idea about the international efforts to curb the illegal trades of rare and endangered species		

N.B. The contact hours for tutorial classes will be 15 hours

Course teachers:

1. Dr. Y Pramoda Devi
2. N. Nirupama Devi
3. Dr. Chipem Vashi
4. Dr.R.K.Imosana

HoD ……

Semester-V

Paper Code: BOT-HE-5026

Discipline Specific Elective Course

Paper Title: Horticultural Practices and Post-Harvest Technology

No. of Hours per week	Credit	Total No. of Hours	Marks
6 (Theory)	4 (Theory)	60	75
4 (Practical)	2 (Practical)	30	25

Course Objectives:

1. Provide knowledge of Horticultural science and its importance in employment generation and socio-economic development.
2. Highlight on classification of horticultural crops, identification of potential horticultural crops – their cultivation, production, management and commercialization.
3. Discuss in detail on post-harvest technology, disease management, and germplasm management for horticulture.
4. Impart field knowledge of gardening, nurseries, standing crops of horticultural importance.

Course Outcomes:

1. Understand the concept of different types of horticultural crops, their conservation and management.
2. Examine the various branches of horticulture, fruit and vegetable crops, floriculture, medicinal and aromatic plants.
3. Critically evaluate different cultivation practices and disease management.
4. Reflect upon different Landscaping practices and garden design.
5. Understand the concept of different types of horticultural practices for value addition.
6. Visualize the post-harvest problems likely to be confronted.

7. Know the tricks of the trade and how to increase the longevity of the produce.

Unit 1: Introduction (4 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Horticulture – its scope, branches and importance	1	Know what is horticulture, its scope, different branches and its importance	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Role of horticulture in rural economy and employment generation	1	Know the importance of horticulture in the economic development and employment generation in rural areas.		
3.	Importance of horticulture in food and nutritional security	1	Know the role of horticulture in eradication of hunger through meeting the food requirements and other necessities.		
4.	Urban horticulture and ecotourism	1	Understand the relationship between crop plants and the urban environment, and also ecotourism and its importance.		

Unit 2: Ornamental Plants (4 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Ornamental plants, types and classification of ornamental plants	1	Know what ornamental plants are, their importance, types and classification.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Identification and salient features of – Rose, Marigold, Gladiolus, Carnation, Orchids, Poppies	1	Understand the characteristic features and ornamental value of these plants.		

3.	Gerberas, Tuberose, Sages, Cacti, Succulents, Opuntia, Agave and Spurges	1		*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
4.	Identification and salient features of – Indian laburnum, Gulmohar, Jacaranda, Lagerstroemia	1	Understand the characteristic features and ornamental value of these plants.		
5.	Identification and salient features of – Fishtail, Areca palm, Semul, Coral tree	1	Understand the characteristic features and ornamental value of these plants.		

Unit 3: Fruit and vegetable crops (4 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Production of fruits and vegetables, origin and distribution	1	Understand the concept of the different practices of fruit and vegetable production, and also their origin and distribution.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Description of plants and their economic products	1	Know the important characteristics and economic importance of some fruit and vegetable crops.		
3.	Management and marketing of vegetables and fruit crops	1	Have knowledge about the management and marketing of vegetable and fruit crops.		
4.	Identification of some fruits and vegetables varieties (Citrus, Banana, Mango, Chilies and Cucurbits)	1	Know the salient features of these crop plants.		

Unit 4: Horticultural techniques (8 Lec.)					
Section	*Topic*	*Lec. Hrs.*	*Learning Outcome*	*Pedagogy*	*Assessment/Evaluation*
1.	Application of – manure, fertilizers.	1	Know the methods of applying manure and fertilizers in the field.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Application of – nutrients, PGRs and bio-fertilizers	1	Know the methods of applying nutrients and PGRs to the plants.		
3.	Weed control, Bio-pesticides	1	Know the technique of controlling weed and use of bio-pesticides.		
4.	Irrigation method – drip irrigation, surface irrigation, furrow and border irrigation	1	Know the different methods of irrigation practice in India in horticulture crops.		
5.	Hydroponics	1	Understand about hydroponics farming and its advantages disadvantages.		
6.	Propagation methods – asexual (grafting, cutting, layering, budding)	1	Know how to perform grafting, cutting, layering, budding.		
7.	Propagation methods – sexual (seed propagation)	1	Have knowledge of propagation through seeds, its advantages disadvantages.		
8.	Scope and limitations	1	Understand the scope and limitations of different methods of propagation.		

Unit 5: Landscaping and Gardening Design (6 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Introduction – Landscaping and gardening	1	Know the importance of landscaping in gardening.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Planning and layout (park and avenues)	1	Know the importance of planning and layout in setting up of park and avenue		

3.	Gardening traditions – Ancient Indian and European gardens.	1	Have idea on their style and designs.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
4.	Mughal and Japanese Gardens	1	Have idea on their style and designs.		
5.	Urban forestry, policies and practices	1	Know what urban forestry is, its advantages, policies and practices.		
6.	Revision	1			

Unit 6: Floriculture (6 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Introduction – Floriculture	1	Able to understand about floriculture and its economic importance.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Cut flowers	1	Have the knowledge about the process of making cut flower.		
3.	Bonsai	1	Have the knowledge about the process of making bonsai.		
4.	Commerce (market demand and supply)	1	Able to grasp the idea of the commercial value.		
5.	…….. contd.	1			
6.	Importance of flower shows and exhibitions	1	Understand the importance of flower shows and exhibition in promoting floriculture		

Unit 7: Post-harvest Technology (10 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Introduction – post-harvest technology	1	Students will be able to understand the importance of post-harvest technology in improving the quality of products.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Importance of post-harvesting technology in horticultural crops	1	Students will be able to understand the importance of post-harvest technology in improving the quality of horticultural crops		
3.	Evaluation of quality traits	1	Be able to understand the importance of quality traits required		
4.	Harvesting and handling of fruits, vegetables and flowers	1	Be able to understand the scientific process and conditions required for harvesting and handling of fruits, vegetables and flowers		
5.	…….. contd.	1			
6.	Principles, methods of preservation and processing	2	Students be well thorough about the methods and principles of preservation and processing		
7.	……. contd.	1			
8.	Methods of minimizing loses during storage and transportation	1	Students will be able to understand the methods of minimizing losses during storage and transportation		
9.	Food irradiation – advantage and disadvantage	1	Students be well thorough about the Food irradiation – advantage and disadvantage		
10.	Food safety	1	Be able to understand the importance of food safety.		

Unit 8: Disease Control and Management (8 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Introduction – Plant disease control and management	1	Know about plant diseases, control and management technique.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Field and post-harvest disease	1	Have knowledge about field and post-harvest diseases.		
3.	Identification of deficiency symptoms	1	Can identify the deficiency diseases.		
4.	Remedial measures and nutritional management practices	1	Know about the remedial measures and nutritional management techniques.		
5.	Crop sanitation & Quarantine practices	1	Know about sanitation and quarantine practices.		
6.	IPM strategies (genetic, biological and chemical methods for pest control)	1	Have the knowledge of the IPM strategies.		
7.	Identification of common diseases	1	Can identify some common diseases of crop plants.		
8.	Pest of ornamentals, fruits and vegetable crops	1	Know the common pest of these crop plants and their control measures.		

Unit 9: Horticultural crops: Conservation and Management (10 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Horticultural crops – documentation and conservation of germplasm	1	Students will be able to document various locally available horticultural crops and understand the importance of conservation of germplasm.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*

2.	Role of micropropagation and tissue culture technique	1	Students will be able to grasp the idea and importance of micro-propagation and tissue culture.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
3.	…….. contd.	1			
4.	Varieties and cultivars of various horticultural crops	1	Students will be well familiar about the varieties and cultivars of horticultural crops.		
5.	IPR issues	1	Students will be able to grasp the idea and importance of IPR and its issues.		
6.	…….. contd.	1			
7.	National, international and professional societies	1	Students will have the comprehensive idea about the National, international and professional societies.		
8.	…….. contd.	1			
9.	Sources of information on horticulture	1	Students will be able to access the various sources of information on horticulture.		

N.B. The contact hours for tutorial classes will be 15 hours

Course teachers:

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3. H.Rajesh Sharma
4. Dr. R.K. Imosana

HoD ……

Semester-VI

Paper Code: BOT-HC-6016

Paper Title: Plant Metabolism

No. of Hours per week	Credit	Total No. of Hours	Marks
6 (Theory)	4 (Theory)	60	75
4 (Practical)	2 (Practical)	30	25

Course Objectives:

1. To provide knowledge of photosynthesis and nutrient metabolism.
2. Discuss on C4-pathway and Crassulacean acid metabolism.
3. Throw light on Glycolysis, ATP-synthesis and Lipid metabolism.
4. Provide practical knowledge on different types of chromatographic techniques.
5. Estimation of TAN, sugar and protein contents in plant sample.

Course Outcomes:

1. Differentiate anabolic and catabolic pathways of metabolism.
2. Recognize the importance of Carbon assimilation in photorespiration.
3. Explain the ATP-Synthesis.
4. Interpret the Biological nitrogen fixation in metabolism.

Unit 1: Concept of Metabolism (8 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Introduction to Metabolic reactions	1	The students have a thorough knowledge of metabolic reactions.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test Seminar /Group Discussion/Q & A Session/Assignment*
2.	Anabolic and catabolic reactions	1	Understand anabolic and catabolic reactions.		
3.	Introduction to Enzymes	1	The students have a thorough knowledge of enzymes.		
4.	Classification of enzymes and nomenclature	1	Students will be able to know how enzymes are classified and how they are named.		
5.	Importance of enzymes	1	Students will know the importance of enzymes in different fields.		
6.	Concept of co- enzymes, apoenzymes and prosthetic groups	1	Will know the different parts of enzymes.		
7.	Enzyme inhibition	1	The students have a thorough knowledge of enzyme inhibition.		
8.	Enzyme inhibition	1			

Unit 2: Carbon Assimilation (12 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Historical background of photosynthesis	1	Understand the history of photosynthesis.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test Seminar /Group Discussion/Q & A Session/Assignment*
2.	Photosynthetic pigments, role of photosynthetic pigments (chlorophyll and accessory pigments)	1	Have clear knowledge of different photosynthetic pigments and how they help in photosynthesis.		

3.	Antenna molecules and reaction centre	1	Have basic concept of antenna molecules and reaction centre		
4.	Photochemical reaction	1	Understand how light energy is converted chemical energy.		
5.	PS-1 and PS-11	1	Have basic knowledge of light absorbing system of photosynthesis.		
6.	Photosynthetic electron transport	1	Understand how ATP and NADPH are produced in light reaction of photosynthesis.		
7.	CO_2 reduction	1	Understand how CO_2 and H_2O are converted into carbohydrate in dark reaction of photosynthesis.		
8.	Photorespiration	1	Understand the process of photorespiration, its advantages and disadvantages.		
9.	C_4 pathway	1	Understand the process of C_4 pathway and different plants having the pathway.		
10.	Crassulacean acid metabolism	1	Understand the process of Crassulacean acid pathway and different plants having the pathway.		
11.	Factors affecting CO_2 reduction	1	Have the knowledge of different factors which affect photosynthesis.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test Seminar /Group Discussion/Q & A Session/Assignment*
12.	Factors affecting CO_2 reduction	1	Have the knowledge of different factors which affect photosynthesis.		

Unit 3: Carbohydrate Metabolism (2 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Synthesis and catabolism of	1	Students will understand how	*Lecture/Discussion/*	*Quiz/Class test Seminar*

	sucrose and starch		sucrose and starch are synthesised and also their breakdown processes.	*PPT/Demonstration*	*/Group Discussion/Q & A Session/Assignment*
2.	Synthesis and catabolism of Sucrose and Starch	1			

Unit 4: Carbon Oxidation (10 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Glycolysis	1	Students will have the knowledge of different steps of glycolysis.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test Seminar /Group Discussion/Q & A Session/Assignment*
2.	Fate of pyruvate	1	Will understand after the formation of pyruvate how it can enter different routes.		
3.	Regulation of Glycolysis	1	Will gain a clear idea of regulation of glycolysis.		
4.	Oxidative pentose phosphate pathway	1	Will introduce different steps of oxidative pentose phosphate pathway.		
5.	Oxidative decarboxylation of pyruvate, NAD and NADH shuttle system	1	Students will have the knowledge of different shuttle systems of NAD and NADH.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test Seminar /Group Discussion/Q & A Session/Assignment*
6.	TCA cycle	1	Have the knowledge of the different steps of tri-carboxylic acid cycle.		
7.	Amphibolic and anaplerotic reactions	1	Will have a clear idea of amphibolic and anaplerotic reactions.		
8.	Mitochondrial electron transport	1	Students are able to understand electron transport systems that happened in inner mitochondrial membrane.		
9.	Oxidative phosphorylation and cyanide resistant respiration	1	Have a clear idea of oxidative phosphorylation and cyanide		

			resistant respiration.		
10.	Factors affecting respiration	1	Students are able to know different factors affecting respiration.		

Unit 5: ATP-Synthesis (8 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Mechanism of ATP synthesis	1	Students will gain the knowledge of ATP synthesis.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test Seminar /Group Discussion/Q & A Session/Assignment*
2.	Substrate level Phosphorylation	1	Students will gain the knowledge of substrate level phosphorylation.		
3.	Chemiosmotic Mecha-nism (oxidative phos-phorylation)	1	Knowledge on ATP synthesis during oxidative phosphorylation		
4.	ATP synthsis	1	Knowledge on the enzymes involved.		
5.	Boyer,s conformatio-nal model	1	Knowledge on this enzyme model put by Boyer.		
6.	Racker;s experiment	1	Knowledge about the experiment by Racker.		
7.	Jagendrof’’s experiment	1	Knowledge about the experiment by Jagendrof.		
8.	Role of uncouplers	1	Idea on uncouplers and their role in ATP synthesis.		

Unit 6: Lipid Metabolism (8 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Introduction and synthesis of lipids	1	Light on the synthesis of lipids.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test Seminar /Group Discussion/Q & A Session/Assignment*
2.	Breakdown of triglycerides	1	Knowledge on the different steps of triglyceride breakdown.		
3.	…….. contd.	1			
4.	B- oxidation	1	Knowledge on B- oxidation.		
5.	Glyoxylate cycle	1	Knowledge on glyoxylate cycle.		
6.	Gluconeogenesis	1	Knowledge on glucogenesis.		
7.	Role of gluconeogenesis in mobilization of lipid during germination	1	An elaborate knowledge on gluconeogenesis.		
8.	α-Oxidation	1	Clear idea on the topic α-oxidation.		

Unit 7: Nitrogen Metabolism (8 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Nitrate assimilation	1	Understand how inorganic N_2 compounds are used by the plant.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test Seminar /Group Discussion/Q & A Session/Assignment*
2.	Biological Nitrogen fixation	1	Understand how atmospheric nitrogen is incorporated into the tissue of certain plants with the help of bacteria.		
3.	……. contd.	1			
4.	Physiology of nitrogen fixation	1	Understand the process of conversion of nitrogen gas into		

			nitrate and nitrite.		
5.	Biochemistry of nitrogen fixation	1	Understand the process of deposition of nitrogen gas into soil.		
6.	…….contd.	1			
7.	Ammonia assimilation	1	Understand the process of conversion of ammonia to organic nitrogen.		
8.	Transamination	1	Understand the process of forming a new amino acid by removing the amino groups to a keto-acid.		

Unit 8: Mechanism of Signal Transduction (4 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Introduction to signal transduction	1	Will get the basic idea of signal transduction.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test Seminar /Group Discussion/Q & A Session/Assignment*
2.	Receptor-ligand interactions, second messenger concept	1	Understand the receptor-ligand interactions, second messenger concept.		
3.	Calcium calmodulin	1	Will get the knowledge of different sensors.		
4.	MAP Kinase -cascade	1			

N.B.The contact hours for tutorial classes will be 15 hours

Course teachers:

1. Dr. Y Pramoda Devi
2. N. Nirupama Devi
3. H.Rajesh Sharma

HoD ……

Semester-VI

Paper Code: BOT-HC-6026

Paper Title: Plant Biotechnology

No. of Hours per week	Credit	Total No. of Hours	Marks
6 (Theory)	4 (Theory)	60	75
4 (Practical)	2 (Practical)	30	25

Course Objectives:

1. To provide knowledge of plant tissue culture technique.
2. Discuss the importance of recombinant DNA technology.
3. Throw light on Gene transfer and applications of biotechnology.
4. Provide knowledge on practical utility of isolation of plasmid DNA, its digestion and separation of fragments through gel electrophoresis.
5. Preparation of media for tissue culture techniques and photographic study of plant tissue culture.

Course Outcomes:

1. Understand the applications of tissue culture techniques, construction of recombinant DNA and transformation into hosts, construction of DNA libraries.
2. Explain on the development of transgenic plants for agricultural or industrial use.
3. Prepare media for tissue culture techniques and photographic study of plant tissue culture.

Unit 1: Plant Tissue Culture (16 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Historical perspective of plant tissue culture	1	Students have the knowledge of history of plant tissue culture.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Composition of media,	1	Have knowledge of the composition of different culture media media used in plant tissue culture.		
3.	Nutrient and hormone requirement (role of vitamins and hormones)	1	Have knowledge of the role of vitamins and hormone in plant tissue culture.		
4.	……..contd.	1			
5.	Totipotency	1	Have the concept of totipotency and its type in plant tissue culture.		
6.	Organogenesis	1	Have basic concept of the idea of culture from organ.		
7.	Embryogenesis (somatic and zygotic)	1	Have basic concept of the idea of culture from embryo.		
8.	Protoplast isolation, culture and fusion	1	Have idea of culture from protoplast isolation, culture and fusion.		
9.	……cond.	1			
10.	Tissue culture: applications, micropropagation	1	Have knowledge of tissue culture applications and micro-propagation.		
11.	Androgenesis,	1	Understand androgenesis.		
12.	Virus elimination,		Have knowledge of different methods of viral elimination in		

			plant tissue culture.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
13.	Secondary metabolites production,	1	Understand how secondary metabolites are produce in plants.		
14.	Haploid, triploids and hybrids	1	Have the idea of haploid, triploids and hybrids culture.		
15.	Cryopreservation	1	Understand the term, technique of cryopreservation and purpose of cryopreservation.		
16.	Germplasm conservation	1	Understand the term germplasm conservation, its types and methods.		

Unit 2: Recombinant DNA Technology (12 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	History of Restriction endonuclease	1	Students will get the past events about the discovery of Restriction endonuclease.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Restriction endonuclease types I-IV	1	Students should acknowledge the different types of Restriction endonuclease.		
3.	Biological role of Restriction endonuclease	1	Students get the knowledge of biological role of Restriction endonuclease.		
4.	Application of Restriction endonuclease	1	Students get the knowledge of application of Restriction endonuclease.		
5.	Restriction mapping (Linear)	1	Students can get a clear knowledge about linear mapping.		
6.	Restriction mapping (circular)	1	Students can get a clear knowledge		

			about circular mapping.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
7.	Cloning vectors: Prokaryotic – pUC18, pUC19 and pBR322	1	Get a clear idea about cloning vectors – pUC18, pUC19 and pBR322.		
8.	Cloning vectors: Prokaryotic (Ti plasmid, BAC)	1	Have knowledge about cloning vectors – Ti plasmid, BAC.		
9.	Lambda phage, M13 phagemid	1	Have knowledge about Lambda phage, M13 phagemid.		
10.	Cosmid vector	1	Have knowledge about Cosmid vector.		
11.	Shuttle vector	1	Have knowledge about shuttle vector.		
12.	Eukaryotic vectors (YAC)	1	Have knowledge about Eukaryotic vectors.		

Unit 3: Gene Cloning (10 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Recombinant DNA	1	Students are able to understand the various laboratory techniques to manipulate DNA.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Bacterial Transformation	1	Students are able to understand the genetic alternation of a cell.		
3.	Selection of recombinant clones	1	Have deep knowledge of recombinant selection process….		
4.	PCR mediated gene cloning	1	Students are able to understand the numerous approaches of PCR to gene cloning.		
5.	Gene construct	1	Have a clear knowledge of the		

			various functional units of gene of interest.		
6.	Construction of genomic and cDNA libraries	1	Students have a clear knowledge of the construction of DNA libraries.		
7.	Screening DNA libraries to obtain gene of interest by genetic selection	1	Understand the process involved screening DNA libraries.		
8.	Complementation	1	Students are able to the process of complementation and its importance.		
9.	Colony hybridization	1	Understand the methods for colony hybridization.		
10.	PCR	1	Have basic idea of PCR technique.		

Unit 4: Methods of Gene Transfer (8 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Agrobacterium –mediated gene transfer	1	Students are able to the process of Agrobacterium –mediated gene transfer	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Direct gene transfer by Electroporation,	1	Students are able to know t gene transfer techniques through electroporation.		
3.	Direct gene transfer by microinjection	1	Students are able to know t gene transfer techniques through microinjection.		

4.	Direct gene transfer by microprojectile	1	Students are able to know t gene transfer techniques through microprojectile.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*\
5.	Direct gene transfer by	1	Students are able to know t gene transfer techniques through bombardment.		
6.	Selection of transgenic- Selectable markers	1	Have knowledge of selectable markers.		
7.	Selection of transgenic-Reporter genes (Luciferase, GUS, GFP)	1	Have knowledge of Reporter genes (Luciferase, GUS GFP)		
8.	……. contd.	1			

Unit 5: Application of Biotechnology (14 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Application of Biotechnology	1	Students are able to understand the various technologies for the application of Biotechnology.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/ Seminar /Group Discussion/Q & A Session/Assignment*
2.	Pest resistant: Bt- cotton	1	Have knowledge about Bt-cotton.		
3.	Herbicide resistant plants (RoundUp Ready soybean)	1	Have a clear concept about herbicide resistant plants.		
4.	Transgenic crops	1	Have idea about transgenic crops.		
5.	Transgenic crops with improved quality traits (Flavr Savr tomato and Golden rice)	1	Have a deep understanding of transgenic plants Flavr Savr tomato and golden rice.		
6.	Improved horticultural varieties (Moondust carnations)	1	Students have understanding about improved horticultural varieties.		
7.	Role of transgenics in bioremediation (Superbug)	1	Students have a clear concern about the role of transgenics in bioremediation; Superbug.		
8.	Edible vaccines	1	Have knowledge about edible vaccines.		
9.	Industrial enzyme: Aspergillase	1	Have a clear idea about industrial enzyme: Aspergillase.		
10.	Protease	1	Have a clear idea about industrial enzyme: Protease.		
11.	Lipase	1	Have a clear idea about industrial enzyme: Lipase.		
12.	Genetically engineered products	1	Students are able to understand the concept of genetically engineered products.	*Lecture/Discussion/*	*Quiz/Class test/Seminar*

13.	Human growth hormone: Humulin	1	Have a clear idea about Humulin.	*PPT/Demonstration*	*/Group Discussion/Q & A Session/Assignment*
14.	Biosafety concerns about biotechnology	1	Students have a deep understanding of Biosafety.		.

N.B.The contact hours for tutorial classes will be 15 hours

Course teachers:

1. Padmaja S.
2. L.Degachandra Singh
3. Dr. Chipem Vashi

HoD ……

Semester-VI

Paper Code: BOT-HE-6016

Discipline Specific Elective Course
Paper Title: Industrial and Environmental Microbiology

No. of Hours per week	Credit	Total No. of Hours	Marks
6 (Theory)	4 (Theory)	60	75
4 (Practical)	2 (Practical)	30	25

Course Objectives:

1. Highlight the roles of microbes in industries and environment.
2. Provide basic knowledge of different kinds of bioreactors and fermentation processes. Impart knowledge of production processes of some microbial products in industries through site visits.
3. Discuss on the applications of enzymes in industries.
4. Discuss in detail on the diversity and distribution of microbes in air, water and soil.
5. Highlight on water microbiology and water analysis methods.
6. Discuss the usefulness of microbes in agriculture and bioremediation of contaminated soils.
7. Provide practical experiences on basic microbiological techniques and handlings.

Course Outcomes:

1. Understand the concept and role of microbes in industry and environment.
2. Critically analyse the types of bioreactors and the fermentation process.
3. Evaluate the role of microorganisms in industry and microbes in agriculture.
4. Reflect upon different Landscaping practices and garden design.
5. Develop skills on the remediation process of contaminated soils.

Unit 1: Imaging and Related Technique (15 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Introduction to Microscopy	1	Introductory knowledge of microscopy	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Principles of light microscopy	1	Understand the principles of light microscopy		
3.	Principles of Fluorescence Microscopy	1	Understand the principles of fluorescence microscopy		
4.	Principles of Confocal microscopy	1	Understand the principles of confocal microscopy		
5.	Use of fluorochromes: Flow cytometry (FACS)	1	Knowledge of (FACS)		
6.	Application of Fluorescence Microscopy	1	Can understand the application of Fluorescence Microscopy		
7.	Chromosome banding	1	Understand the term, different banding technique and its importance		
8.	FISH	1	Have basic concept of the technique and its importance		
9.	Chromosome painting	1	Understand its principle, strategic and scope.		
10.	Transmission electron microscopy	1	Know the technique of transmission and scanning electron microscopy		
11.	Scanning electron microscopy	1	Have idea of scanning electron microscopy technique		
12.	Sample preparation for electron microscopy, cryofixation, negative staining	1	Understand the technique of sample preparation for electron microscopy, cryofixation, negative staining		
13.	……. . contd.	1			
14.	Shadow casting, freeze fracture, and freeze etching	1	Knowledge of shadow casting, freeze fracture, and freeze etching		
15.	Importance of microscopy	1	Understand the importance of microscopy		

Unit 2: Cell Fractionation (8 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Introduction: Cell fractionation	1	Introductory knowledge of cell fractionation.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Centrifugation: Differential and density gradient centrifugation	1	Understand different types of Centrifugation		
3.	….continued	1			
4.	Sucrose density gradient	1	Idea of sucrose density gradient		
5.	$CsCl_2$ gradient	1	Idea of $CsCl_2$ gradient		
6.	Analytical centrifugation	1	Knowledge of analytical centrifugation		
7.	Ultracentrifugation	1	Understand ultracentrifugation		
8.	Marker enzymes	1	Understand the functions of marker enzymes		

Unit 3: Radioisotopes (4 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Introduction: Radioisotopes	1	Introductory idea of. Radio isotopes	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Use in biological research	1	Use of radioisotopes in biological research		
3.	Auto-radiography	1	Idea of auto-radiography		
4.	Pulse chase experiment	1	Have idea of pulse chase experiment		
Unit 4: Spectrophotometry (4 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Introduction, types of Spectrophotometers	1	Students are able to have a clear concept of spectrophotometry	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q &*

2.	Principles of spectrophotometry	1	Students will know how spectrophotometer works		*A Session/Assignment*
3.	Principles of spectrophotometry(continued)	1	Students are able to handle and operate a spectrophotometer		
4.	Application of spectrometry in biological research	1	Students have an idea about the application of spectrometry in biological research		

Unit 5: Chromatography (8 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Principle, Types of chromatography	1	Students are able to have an idea on how chromatography functions and different types of chromatography which can be employed.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Paper chromatography	1	Students can perform paper chromatography and its uses are clearly understood by them.		
3.	Column chromatography	1	Students will be able to perform column chromatography and understand its uses		
4.	TLC, GLC	1	Will get the knowledge of TLC, GLC.		
5.	HPLC	1	Will get the knowledge HPLC.		
6.	Ion Exchange chromatography	1	Will get the knowledge of ion Exchange chromatography.		
7.	Molecular sieve chromatography	1	Will get the knowledge of molecular sieve chromatography.		
8.	Affinity chromatography	1	Will get the knowledge of affinity chromatography		

Unit 6: Characterization of Proteins and Nucleic Acid (6 Lec.)					
Section	*Topic*	*Lec. Hrs.*	*Learning Outcome*	*Pedagogy*	*Assessment/Evaluation*
1.	Mass spectrometry	1	Students get a clear idea about Mass spectrometry.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	X-ray diffraction	1	Students get a clear idea about X-ray Diffraction.		
3.	X-ray crystallography	1	Students get a clear idea about X-ray crystallography.		
4.	Characterization of proteins and nucleic acids; Electrophoresis, AGE, PAGE, SDS-PAGE	1	Students will get the knowledge of various methods employed in the characterization of proteins and nucleic acids.		
5.	Characterization of proteins and nucleic acids; Electrophoresis, AGE, PAGE, SDS-PAGE (contd.)	1			
6.	Characterization of proteins and nucleic acids; Electrophoresis, AGE, PAGE, SDS-PAGE (contd.)	1			

Unit 7: Biostatistics (15 Lec.)					
Section	*Topic*	*Lec. Hrs.*	*Learning Outcome*	*Pedagogy*	*Assessment/Evaluation*
1.	Introduction to biostatistics	1	Have a clear knowledge about the branch biostatistics.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Primary and secondary data	1	Understand what are Primary and secondary data.		

3.	Samples and Parameters	1	Understand what is Sample and Parameter	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
4.	Presentation of data; Tabular and Graphical	1	Able to present data in tabular and graphical forms.		
5.	Presentation of data; Tabular and Graphical	1			
6.	Measures of central tendency; Mean	1	Students are able to calculate mean.		
7.	Measures of central tendency; Median	1	Students are able to calculate median.		
8.	Measures of central tendency; Mode	1	Students are able to calculate mode.		
9.	Measures of dispersion; Range	1	Students are able to determine Range.		
10.	Measures of dispersion; Mean deviation	1	Students are able to calculate mean deviation.		
11.	Measures of dispersion; Standard deviation	1	Students are able to calculate Standard deviation.		
12.	Testing of Hypothesis	1	Will get a clear idea about testing of hypothesis.		

13.	Chi square test for Goodness of fit	1	Students are able to calculate Chi square value to test the Goodness of fit.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
14.	Chi square test for Goodness of fit(continued)	1			
15.	Application of biostatistics	1	Students will get the knowledge of application of biostatistics in different fields.		

N.B.The contact hours for tutorial classes will be 15 hours

Course teachers:

1. Padmaja S.
2. L.Degachandra Singh
3. H.Rajesh Sharma

HoD ……

Semester-VI

Paper Code: BOT-HE-6026

Discipline Specific Elective Course
Paper Title: Analytical Techniques in Plant Sciences

No. of Hours per week	Credit	Total No. of Hours	Marks
6 (Theory)	4 (Theory)	60	75
4 (Practical)	2 (Practical)	30	25

Course Objectives:

1. Provide knowledge on microscopy and imaging in plant science.
2. Highlight principles and application of centrifuge, spectroscopy and chromatography in biology.
3. Impart basic knowledge of biostatistics including measures of central tendency and dispersions, statistical data analysis and representations.
4. Enabling students imbibe practical knowledge on microscopy, chromatography, centrifugation and spectroscopy.

Course Outcomes:

1. Explain the principles of Light microscopy, Compound microscopy, Fluorescence microscopy and Confocal microscopy.
2. Develop conceptual understanding of cell fractionation.
3. Classify different types of chromatography techniques.
4. Apply suitable strategies in data collections and disseminating research findings.

Unit 1: Imaging and Related Technique (15 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Introduction to Microscopy	1	Introductory knowledge of microscopy	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Principles of light microscopy	1	Understand the principles of light microscopy		
3.	Principles of Fluorescence Microscopy	1	Understand the principles of fluorescence microscopy		
4.	Principles of Confocal microscopy	1	Understand the principles of confocal microscopy		
5.	Use of fluorochromes: Flow cytometry (FACS)	1	Knowledge of (FACS)		
6.	Application of Fluorescence Microscopy	1	Can understand the application of Fluorescence Microscopy		
7.	Chromosome banding	1	Understand the term, different banding technique and its importance		
8.	FISH	1	Have basic concept of the technique and its importance		
9.	Chromosome painting	1	Understand its principle, strategic and scope		
10.	Transmission electron microscopy	1	Know the technique of transmission and scanning electron microscopy		
11.	Scanning electron microscopy	1	Have idea of scanning electron microscopy technique		
12.	Sample preparation for electron microscopy, cryofixation, negative staining	1	Understand the technique of sample preparation for electron microscopy, cryofixation, negative staining		
13.	……. contd.	1			

14.	Shadow casting, freeze fracture, and freeze etching	1	Knowledge of shadow casting, freeze fracture, and freeze etching	*Lecture/Discussion/PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
15.	Importance of microscopy	1	Understand the importance of microscopy		

Unit 2: Cell Fractionation (8 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Introduction: Cell fractionation	1	Introductory knowledge of cell fractionation	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Centrifugation: Differential and density gradient centrifugation	1	Understand different types of Centrifugation		
3.	….. contd.	1			
4.	Sucrose density gradient	1	Idea of sucrose density gradient		
5.	$CsCl_2$ gradient	1	Idea of $CsCl_2$ gradient		
6.	Analytical centrifugation	1	Knowledge of analytical centrifugation		
7.	Ultracentrifugation	1	Understand ultracentrifugation		
8.	Marker enzymes	1	Understand the functions of marker enzymes		

Unit 3: Radioisotopes (4 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Introduction: Radioisotopes	1	Introductory idea of. Radio isotopes	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Use in biological research	1	Use of radioisotopes in biological research		

3.	Auto-radiography	1	Idea of auto-radiography	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
4.	Pulse chase experiment	1	Have idea of pulse chase experiment		

Unit 4: Spectrophotometry (4 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Introduction, types of Spectrophotometers	1	Students are able to have a clear concept of spectrophotometry.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Principles of spectrophotometry	1	Students will know how spectrophotometer works.		
3.	Principles of spectrophotometry(continued)	1	Students are able to handle and operate a spectrophotometer.		
4.	Application of spectrometry in biological research	1	Students have an idea about the application of spectrometry in biological research.		

Unit 5: Chromatography (8 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Principle, Types of chromatography	1	Students are able to have an idea on how chromatography functions and different types of chromatography which can be employed.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Paper chromatography	1	Students can perform paper chromatography and its uses are clearly understood by them		

3.	Column chromatography	1	Students can perform column chromatography and its uses are clearly understood by them	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
4.	TLC, GLC	1	Will get the knowledge of TLC, GLC		
5.	HPLC	1	Will get the knowledge HPLC		
6.	Ion Exchange chromatography	1	Will get the knowledge of ion Exchange chromatography		
7.	Molecular sieve chromatography	1	Will get the knowledge of molecular sieve chromatography		
8.	Affinity chromatography	1	Will get the knowledge of affinity chromatography		

Unit 6: Characterization of Proteins and Nucleic Acid (6 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Mass spectrometry	1	Students get a clear idea about Mass spectrometry	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	X-ray diffraction	1	Students get a clear idea about X-ray Diffraction		
3.	X-ray crystallography	1	Students get a clear idea about X-ray crystallography		
4.	Characterization of proteins and nucleic acids; Electrophoresis, AGE, PAGE, SDS-PAGE	1	Students will get the knowledge of various methods employed in the characterization of proteins and nucleic acids		
5.	Characterization of proteins and nucleic acids; Electrophoresis, AGE, PAGE, SDS-PAGE (contd.)	1			
6.	Characterization of proteins and nucleic acids; Electrophoresis, AGE, PAGE, SDS-PAGE (contd.)	1			

Unit 7: Biostatistics (15 Lec.)					
Section	***Topic***	***Lec. Hrs.***	***Learning Outcome***	***Pedagogy***	***Assessment/Evaluation***
1.	Introduction to biostatistics	1	Have a clear knowledge about the branch biostatistics.	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*
2.	Primary and secondary data	1	Understand what are Primary and secondary data.		
3.	Samples and Parameters	1	Understand what is Sample and Parameter		
4.	Presentation of data; Tabular and Graphical	1	Able to present data in tabular and graphical forms.		
5.	Presentation of data; Tabular and Graphical	1			
6.	Measures of central tendency; Mean	1	Students are able to calculate mean.		
7.	Measures of central tendency; Median	1	Students are able to calculate median		
8.	Measures of central tendency; Mode	1	Students are able to calculate mode		
9.	Measures of dispersion; Range	1	Students are able to determine Range.		
10.	Measures of dispersion; Mean deviation	1	Students are able to calculate mean deviation		
11.	Measures of dispersion; Standard deviation	1	Students are able to calculate Standard deviation		
12.	Testing of Hypothesis	1	Will get a clear idea about testing of hypothesis		
13.	Chi square test for Goodness of fit	1	Students are able to calculate Chi square value to test the Goodness of fit		
14.	Chi square test for Goodness of fit(continued)	1			

15.	Application of biostatistics	1	Students will get the knowledge of application of biostatistics in different fields	*Lecture/Discussion/ PPT/Demonstration*	*Quiz/Class test/Seminar /Group Discussion/Q & A Session/Assignment*

N.B.The contact hours for tutorial classes will be 15 hours

Course teachers:

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2. N. Nirupama Devi
3. Dr. Chipem Vashi
4. Dr.R.K.Imosana

HoD ……