Four Year Undergraduate Degree Program (FYUGP) Syllabus (Under NEP 2020)

(Effective from 2024 batch onwards)

Department of Botany

Gauhati University -781014

Assam: India

FYUGP new structure

Semester-1			Semester-2		
Type	**Course**	**Credit**	**Type**	**Course**	**Credit**
Major	**Major-1 (Plant and Microbial Diversity)**	**4**	**Major**	**Major-2 (Cell Biology and Biomolecules)**	4
***Minor**	**Minor-1 (Plant and Microbial Diversity)**	4	*Minor	**Minor-2 (Cell Biology and Biomolecules)**	4
SEC	SEC-1 (Major oriented) *	3	SEC	SEC-2 (Major oriented) *	3
AEC	AEC-1 (Languages/Alt. English)	4	AEC	AEC-2 (English Communication)	4
MDC	MDC-1	3	MDC	MDC-2	3
VAC	VAC-1	2	VAC	VAC-2	2
		20			**20**

***Here, the minor paper indicates the minor paper offered by the Department of Botany for the students other than Botany major.**

MAJOR CHANGE to be allowed after 2nd Semester. Changed Major to be started from the Day-1 of Third Semester.

Semester-3			Semester-4		
Type	**Course**	**Credit**	**Type**	**Course**	**Credit**
Major	**Major-3 (Laboratory and Field Techniques in Plant Science**	**4**	**Major**	**Major-5 (Mycology and Phytopathology)**	4
	Major-4 (Plant Physiology)	4		**Major-6 (Morphology and Anatomy of Angiosperms)**	4
*Minor	**Minor-3 (Laboratory and Field Techniques in Plant Science)**	4		**Major-7 (Microbiology)**	4
SEC	SEC-3#	3		**Major-8 (Plant Resources and Economic Botany)**	4
MDC	MDC-3	3	*Minor	**Minor-4 (Plant Resources and Economic Botany)**	4
VAC	VAC-3	2			
		20			**20**

***Here, the minor paper indicates the minor paper offered by the Department of Botany for the students other than Botany major.**

- *Summer Break in Between 4th and 5th Semester: Internship-4 (Credit added to 5th Semester)*
- *Those who miss the Internship in 4th-5th Summer Break, shall do the Internship after the 6thSemester (during 6th Semester Summer Break). In such cases, the 5th Semester result shall not be COMPLETE.*

Semester-5			Semester-6		
Type	**Course**	**Credit**	**Type**	**Course**	**Credit**
Major	**Major-9 (Genetics)**	**4**	**Major**	**Major-12 (Molecular Biology)**	**4**
	Major-10 (Plant Ecology, Phytogeography and Climate Change)	**4**		**Major-13 (Reproductive Biology of Angiosperm)**	**4**
	Major-11 (Plant Systematics)	**4**		**Major-14 (Plant Metabolism and Biochemistry)**	**4**
*Minor	**Minor-5 (Plant Systematics)**	4		**Major-15 (Applied Plant Biology)**	**4**
Internship	Internship	4	*Minor	**Minor-6 (Applied Plant Biology)**	4
		20			**20**

B.Sc. Botany with Honours

Semester-7			Semester-8		
Type	**Course**	**Credit**	**Type**	**Course**	**Credit**
Major	**Major 16- Plant Breeding, Genomics and Bioinformatics**	**4**	**Major**	**Major-20 Molecular Genetics and Cell Signaling**	**4**
	Major-17 Conservation Ecology and Biodiversity Assessment	**4**		**Major-21 Fungal Diversity, Genetics, and Applications**	**4**
	Major 18: Plant diseases, diagnostic and management	**4**		**Major-22 Exploring Cryptogams and Gymnosperms**	**4**
	Major-19 Environmental Microbiology	**4**		**Major-23 Plant Growth and morphogenesis**	**4**
	Research Component (RC-1) Research methodology	**4**			

OR

B.Sc. Botany Honours with Research

Semester-7			Semester-8		
Type	**Course**	**Credit**	**Type**	**Course**	**Credit**
Major	**Major 16- Plant Breeding, Genomics and Bioinformatics**	**4**	**Major**	**Dissertation**	**16**
	Major-17 Conservation Ecology and Biodiversity Assessment	**4**			
	Major 18: Plant diseases, diagnostic and management	**4**			
	Major-19 Environmental Microbiology	**4**			
	Research Component (RC-1) Research methodology	**4**			

***Here, the minor paper indicates the minor paper offered by the Department of Botany for the students other than Botany major.**

*SEC-1 and SEC-2 Should be Major Oriented/to supplement the Major. CCS will prescribe a Bucket of SECs against each Major, so that Hands-on and other Practices/Knowledge

required to be Skilled in Major Subject could be acquired by the students. The Bucket could be drawn from the existing SEC list and also new SECs required may be included. Faculty- wise Buckets should be prescribed, so that number of SECs in a semester could be minimized.

#SEC-3 is Open SEC. Any Skill that the students require to be Skillful in their professional/established life. Students may choose from one from the available Skill Courses in the College for that Semester.

BOTANY

Programme Specific Outcomes (PSOs):

1. Graduates will demonstrate advanced understanding and proficiency in specialized areas of botanical sciences, such as plant taxonomy, plant physiology, plant pathology and microbiology, plant genetics, or plant ecology.
2. Graduates will possess the ability to design and conduct independent research projects in botany, including formulating research questions, designing experiments, collecting, and analyzing data, and drawing scientifically valid conclusions.
3. Graduates will be able to interpret and analyze complex botanical data using statistical and computational methods, and effectively communicate their findings through written reports and oral presentations.
4. Graduates will have acquired proficiency in a wide range of laboratory techniques and methodologies commonly used in botanical research, including microscopy, molecular biology techniques, tissue culture, chromatography, and spectroscopy.
5. Graduates will demonstrate competence in fieldwork methodologies, plant specimen collection, preservation, and identification, and possess taxonomic expertise in the classification and identification of plant species.
6. Graduates will develop strong analytical and critical thinking skills, enabling them to identify and address complex botanical problems, evaluate scientific literature, and propose innovative solutions to real-world challenges in plant sciences.
7. Graduates will be able to communicate botanical concepts and research findings effectively to both specialist and non-specialist audiences through written reports, scientific papers, conference presentations, and outreach activities.

8. Graduates will adhere to ethical principles and professional standards in all aspects of their work, including research integrity, respect for intellectual property rights, and consideration of ethical implications in decision-making.
9. Graduates will collaborate effectively with colleagues from diverse disciplines, integrating botanical knowledge with other scientific fields to address multidisciplinary challenges in environmental science, agriculture, biotechnology, and conservation.
10. Graduates will demonstrate a commitment to lifelong learning and professional development, staying abreast of advancements in botanical sciences, engaging in continuing education, and contributing to the advancement of the field through scholarly activities and professional networking.

Four-year Undergraduate Programme
Subject: Botany
Semester: First
Major 1
Course Name: *Plant and Microbial Diversity*
Course Level: 100-199, and subsequent level as per NEP structure

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	**Origin of life:** Theories of the Origin of Life, Concept of Kingdoms, and Tree of Life	3	4
Unit 2	**Bacteria and Viruses:** Bacteria: General features, cell structure, reproduction, conjugation, transformation, and transduction; introduction to Archaebacteria Viruses: General features, replication, reproduction (Lytic and Lysogenic life cycles), RNA virus (TMV), DNA virus (Cauliflower Mosaic Virus).	8	10
Unit 3	**Algae:** General features, cell structure, range of thallus structure, reproduction, and classification; a brief account on *Nostoc*, *Oedogonium*, and *Chara*	6	10
Unit 4	**Fungi & Lichens:** General features, distribution of fungi and its current status in the living world, reproduction, and classification (Anisworth, 1973); a brief account of *Mucor*, *Ascobolus*, and *Agaricus*; a brief account on lichens: structure, types, and economic importance	7	12
Unit 5	**Bryophytes and Pteridophytes:** Bryophytes: General features, adaptation to land habits, classification, and evolutionary trends; a brief account on *Marchantia* and *Polytrichum* Pteridophytes: General features, classification, reproduction, evolutionary trends (stellar evolution), and affinities; a brief account on *Lycopodium*, *Selaginella*, and *Pteris*	10	12
Unit 6	**Gymnosperms and Angiosperms:** Gymnosperms: General features, classification, reproduction, evolutionary trends, and affinities; a brief account on *Cycas*, and *Gnetum* Angiosperms: General features, Concept of an artificial, natural, and phylogenetic system of	11	12

	classification. Floral parts and inflorescence; Brief accounts on Lamiaceae and Orchidaceae		
PRACTICAL [Credit: 01]			
1. Study of structure of TMV and Bacteriophage (electron micrographs/models). 2. Study of morphology of *Nostoc*, *Oedogonium*, *Chara* (Temporary preparation of slides). 3. Study of *Mucor*, *Ascobolus, Agaricus* (Temporary preparation of slides) 4. Study of vegetative and reproductive parts of *Marchantia* and *Polytrichum* (preparation of slides). 5. Study of *Lycopodium/ Selaginella* (morphology, strobilus, and spores), *Adiantum/ Pteris* (morphology). 6. Study of *Cycas*/ *Pinus* and *Gnetum* (morphology, leaf/ needle, megasporophyll and microsporophyll) 7. Study of leaf venations in dicots and monocots (at least two specimens each) 8. Study of different types of inflorescences and fruits.		30	40

Reading list:

1. Bhatnagar SP, Moitra A (1996) Gymnosperms. New Delhi, Delhi: New Age International (P) Ltd Publishers.
2. Campbell NA, Reece JB (2008) Biology, 8th edition, Pearson Benjamin Cummings, San Francisco.
3. Evert RF, Eichhorn SE (2012) Raven Biology of Plants, 8th edition, New York, NY: W.H. Freeman and Company.
4. Ingrouille M, Eddie B (2006) Plants: Evolution and Diversity. Cambridge University Press.
5. Kumar HD (1999) Introductory Phycology, 2nd edition. Delhi, Delhi: Affiliated East-West. Press Pvt. Ltd.
6. Parihar NS (1991) An Introduction to Embryophyta. Vol. II. Pteridophytes. Prayagraj: U.P.: Central Book Depot.
7. Pelczar MJ (2001) Microbiology, 5th edition. New Delhi, Delhi: Tata McGraw-Hill Co.
8. Puri P (1985) Bryophytes. New Delhi, Delhi, Atma Ram and Sons.
9. Sethi IK, Walia SK (2018) Text book of Fungi and Their Allies. 2nd Edition, Med tech Publishers, Delhi.
10. Singh G (2019) Plant Systematics: An Integrated Approach. 4th edition. CRC Press, Taylor and Francis Group.
11. Singh V, Pandey PC, Jain DK (2001) A Text Book of Botany. Meerut, UP: Rastogi and Co.
12. Tortora GJ, Funke BR, Case CL (2007) Microbiology. San Francisco, U.S.A: Pearson Benjamin Cummings.
13. Vashishta PC, Sinha AK, Kumar A (2010) Pteridophyta. New Delhi, Delhi: S. Chand & Co Ltd.
14. Webster J, Weber R (2007) Introduction to Fungi. Cambridge, Cambridge University Press.

Graduate Attributes

Course Objective:

This paper will explain the origin of life, the diversity of Bacteria, Viruses, Algae, Fungi & Lichen, Bryophytes, Pteridophytes, Gymnosperms, and Angiosperms on the planet, and how they may be related to each other. The emphasis will also be on the hands-on approach and laboratory techniques for identification of the plant and microbial groups using various morphological features.

Course outcomes:

On successful completion of the course, students will have:

1. Knowledge with the concept of different kingdoms and the theories behind how life began.
2. Basic understanding of the characteristics, distribution, classification, reproduction, and current status of various microbial and plant communities.
3. Good understanding of virus, algae, fungus, bryophyte, and pteridophyte cell structures, dicotyledonous and monocotyledonous leaf venation patterns, and inflorescence and fruit features.
4. Knowledge to identify various groups of organisms in the laboratory through morphological analysis.

Theory Credit: 03

Practical Credit: 01

No. of Required Classes: 75 (Theory: 45; Practical: 30)

No. of Contact Classes: 75 (Theory: 45; Practical: 30)

No. of Non-Contact Classes: Nil

Particulars of Course Designer (Name, Institution, email id):

CCS, Department of Botany
Gauhati University, Guwahati-14

Four-year Undergraduate Programme
Subject: Botany
Semester: Second
Major 2
Course Name: *Cell Biology and Biomolecules*
Course Level: 100-199, and subsequent level as per NEP structure

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	**Introduction to cell:** Cell as a unit of structure and function; Characteristics of prokaryotic and eukaryotic cells; Origin of eukaryotic cell (Endosymbiotic theory); Cytoskeleton, Cell division: Phases of eukaryotic cell cycle, mitosis and meiosis; Regulation of cell cycle.	8	12
Unit 2	**Cell wall and plasma membrane:** Chemistry, structure and function of Plant cell wall. Overview of membrane function; fluid mosaic model; Chemical composition of membranes; Membrane transport – Passive, active and facilitated transport.	6	12
Unit 3	**Cell organelles:** Nucleus: Structure-nuclear envelope, Organization of chromatin, Nucleolus, Ribosome, Chloroplast, Mitochondria, Peroxisomes, Endoplasmic Reticulum, Golgi Apparatus, and Lysosomes.	9	8
Unit 4	**Carbohydrates and Lipids:** Carbohydrates: Nomenclature and classification. Lipids: Definition and major classes of storage and structural lipids; Structure, properties and functions of Essential fatty acids.	9	8
Unit 5	**Amino acids and Proteins:** Structure and classification of amino acids; Levels of protein structure (primary, secondary, tertiary, and quarternary); Protein denaturation and biological roles of proteins.	8	10
Unit 6	**Nucleic acids:** Structure of nitrogenous bases; Structure and function of nucleotides; Types of nucleic acids; Structure of A, B, Z types of DNA; Types of RNA.	5	10
PRACTICAL [Credit: 01]			

1. Qualitative tests for carbohydrates, reducing sugars, non-reducing sugars, lipids and proteins. 2. Study of plant cell structure with the help of epidermal peel mount of Onion/ *Rhoeo*/ *Crinum*. 3. Demonstration of the phenomenon of protoplasmic streaming in *Hydrilla* and *Vallisnaria* leaf. 4. Counting the cells per unit volume with the help of haemocytometer. (Yeast/ pollen grains). 5. Cytochemical staining of: DNA- Feulgen and cell wall in the epidermal peel of onion using Periodic Schiff's (PAS) staining technique. 6. Study different stages of mitosis and meiosis.	30	40

Reading list:

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

Graduate Attributes

Course Objective:

This paper will explain biomolecules, the basic building blocks of living organisms, with a focus on their structural organization, molecule properties, biological roles, and functions. The emphasis will be on the relationship between the structure and function of various biomolecules at the chemical level with a biological perspective, as well as a hands-on approach and laboratory techniques.

Course outcomes:

On successful completion of the course, students will be:

1. Able to obtain knowledge of structure, classification, and physicochemical properties of biomolecules and enzymes.
2. Detailed knowledge of the structure, properties, and functions of a cell and its components.
3. Acquainted with practical knowledge of properties of cell and cell membranes, DNA staining techniques, and microscopy of the plant cell.

4. Able to identify various biomolecules in the laboratory by qualitative tests of biomolecules.

Theory Credit: 03

Practical Credit: 01

No. of Required Classes: 75 (Theory: 45; Practical: 30)

No. of Contact Classes: 75 (Theory: 45; Practical: 30)

No. of Non-Contact Classes: Nil

Particulars of Course Designer (Name, Institution, email id):

CCS, Department of Botany
Gauhati University, Guwahati-14

Four-year Undergraduate Programme
Subject: Botany
Semester: Third
Major 3
Course Name: *Laboratory and Field Techniques in Plant Science*
Course Level: 200-299, and subsequent level as per NEP structure

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	**Laboratory safety and good practices:** General laboratory safety: dos and don'ts, lab safety measures, code of conduct in laboratory, safe handling of chemicals, glass apparatus, instruments, electrical appliances; First aid practices (acid spills, burns and other injuries), safety symbols, classes/ grades of chemicals, Laboratory waste management: radioactive, hazardous chemicals and biological wastes.	8	8
Unit 2	**Handling and maintenance of instruments:** Weighing balance, pipettes and micropipettes, magnetic stirrer,autoclave, laminar airflow, pH and conductivity meter (calibration and use), Incubator (static and shaker), Lux meter, hemocytometer, micrometer, spectrophotometer, Agarose gel electrophoresis unit, SDS PAGE unit, centrifuge, distillation unit.	8	12
Unit 3	**Measurements and calculations:** Units of measurements, conversion from one unit to another, Weighing, calculations: scientific notations, powers, logarithm and fractions; measurement of volumes of liquids.	4	8
Unit 4	**Solutions and Buffers:** Preparation of solutions: stock solution, standard solution. Types of solutions: Normal, Molar, Molal, Percentage, ppm, ppb. Dilution and dilution factors, Acids, Bases, adjustment of pH, Buffers - phosphate, Tris- HCl and Citrate buffer.	6	8
Unit 5	**Microscopy and Culture Techniques:** Microscopes: working principles and types (Light and Electron microscopes), sample and slide preparation: fixation, staining, mounting, preservation(for light and electron microscopy). Basic culture media (NA, NB, PDA, MS),	8	12

	selective and differential media, Culture techniques: plating (streak,spread & pour), serial dilution.		
Unit 6	**Biostatistics, computing and field skills:** Data types - primary and secondary, methods of data collection, sample and sampling methods - merits and demerits; technical and biological replicates; Tabulation and presentation of data, Descriptive statistics - Mean, Median, Mode, Variance, Standard Deviation, Standard error, Coefficient of Variation, MS-Word, PowerPoint, Excel, concept on biological databases. Collection, Identification, Preparation and Preservation of Herbarium and Museum specimens.	11	12
PRACTICAL [Credit: 01]			
1. Preparation of solutions- molar, molal, normal, percentage, stock solution and dilution 2. Measurement of pH of solutions using pH meter/ pH strip and preparation of buffers (Phosphate /citrate buffer) 3. Working with instruments - Centrifuge, autoclave, laminar air flow, hot air oven, incubator, light microscope, spectrophotometer/colorimeter, 4. Slide preparation and staining of plant materials. 5. Determination of cell/spore size using micrometer. 6. Preparation of PDA/NA medium for growth and maintenance of fungal/bacterial cultures. 7. Calculation of mean, mode, median, standard deviation using data set. 8. Drawing of tables, graphs and to carry out statistical calculation using Microsoft Excel. 9. Preparation of herbarium specimen: Collection, processing, mounting, and labelling of plant specimen.		30	40

Reading list:

1. Bisen PS (2014) Laboratory Protocols in Applied Life Sciences, 1st Edition. CRC Press.
2. Danniel WW (1987) Biostatistics. New York, NY: John Wiley Sons.
3. Evert RF, Eichhorn SE, Perry JB (2012) Laboratory Topics in Botany. W.H. Freeman and Company.
4. Jones AM, Reed R, Weyers J (2016) Practical Skills in Biology, 6th Edition, Pearson
5. Mann SP (2016) Introductory Statistics, 9th edition. Hoboken NJ, John Wiley and Sons Inc.
6. Mesh MS, Kebede-Westhead E (2012) Essential Laboratory Skills for Biosciences. John Wiley & Sons, Ltd.
7. Mu P, Plummer DT (2001) Introduction to practical biochemistry. Tata McGraw- Hill

Education.
8. Zar ZH (2010) Biostatistical Analysis, 5th Edition, Pearson Prentice Hall, New Jersey, USA.

Graduate Attributes

Course Objective:

This paper will provide basic knowledge and understanding of good laboratory practices, laboratory waste management, understanding hazards and risks to ensure a safe laboratory environment, measurements, units, and common mathematical calculations, sampling and data collection, and instrument operation and maintenance.

Course outcomes:

On successful completion of the course, students will be:

1. Able to learn fundamental skills important for performing laboratory and field experiments.
2. Able to prepare, analysis of data and interpretation of results.

Theory Credit: 03

Practical Credit: 01

No. of Required Classes: 75 (Theory: 45; Practical: 30)

No. of Contact Classes: 75 (Theory: 45; Practical: 30)

No. of Non-Contact Classes: Nil

Particulars of Course Designer (Name, Institution, email id):

CCS, Department of Botany
Gauhati University, Guwahati-14

Four-year Undergraduate Programme
Subject: Botany
Semester: Third
Major 4
Course Name: *Plant Physiology*
Course Level: 300-399, and subsequent level as per NEP structure

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	**Plant-water relations:** Water Potential and its components; Water absorption by roots: aquaporins; Pathway of water movement: symplast, apoplast, transmembrane pathways; Ascent of sap: Mechanisms, cohesion-tension theory, root pressure, guttation; Transpiration: Factors affecting transpiration, anti-transpirants, mechanism of stomatal movement.	5	8
Unit 2	**Mineral nutrition and nutrient uptake:** Criteria for essentiality of mineral elements, macro and micronutrients, nutrient solutions for plant growth experiments, roles of essential elements, mineral deficiency symptoms, chelating agents, Ion antagonism and toxicity. Soil as a nutrient reservoir; Transport of ions across cell membrane: Passive and active absorption, electrochemical gradient, facilitated diffusion, carrier systems, proton ATPase pump and ion flux, uniport, symport, antiport, co-transport.	10	10
Unit 3	**Translocation of organic solutes:** Phloem as the path of organic solute translocation: Experimental evidences, Mechanisms of solute transport, Pressure-Flow Model and Munch's hypothesis, Phloem loading and unloading, Source - sink relationship.	4	8
Unit 4	**Plant growth regulators (PGRs):** Discovery, chemical nature (basic structure), bioassay and physiological roles of Auxins, Gibberellins, Cytokinins, Abscisic acid, Ethylene, Brassinosteroids and Jasmonic acid; Synthetic PGRs; Application of PGRs in agriculture and horticulture.	10	14
Unit 5	**Physiology of flowering and seed dormancy:** Photoperiodism: SDPs and LDPs, flowering	8	12

	stimulus, florigen concept; Vernalization; Photoreceptors: Phytochrome, crytochrome and phototropin; Discovery, chemical nature, mechanism of action, role in photomorphogenesis, low energy responses (LER) and high irradiance responses (HIR); Seed dormancy: Significances, causes of dormancy, mechanisms to break dormancy.		
Unit 6	**Plant stress physiology:** Abiotic and biotic stress: Plants' responses to drought, water logging, salinity, heavy metals, freezing, heat stress and pathogen attack. Oxidative stress: Generation of reactive oxygen species (ROS); Effect of ROS on metabolism; ROS detoxification mechanisms in plants; Stress mitigation strategies (Enzymatic and non-enzymatic).	8	8
PRACTICAL [Credit: 01]			
1. Determination of osmotic potential of plant cell sap by the method of plasmolysis. 2. Determination of water potential of given tissue (e.g., potato tuber) by weight method. 3. Study of the effect of sunlight on the rate of transpiration in excised twig/leaf. 4. Calculation of stomatal index and stomatal frequency from the two surfaces of leaves of mesophyte/ xerophyte. 5. Effect of carbon dioxide concentration on the rate of photosynthesis. 6. To study the effect of different concentrations of IAA on Gram/Pea/Moong root (IAA Bioassay). 7. Determination of seed germination percentage in different physical conditions (Demonstration) 8. To demonstrate water stress by application of PEG/ water withdrawal in germinating seeds /growing plants (Demonstration) 9. Fruit ripening/Rooting from cuttings (Demonstration).		30	40

Reading list:

1. Bajracharya D (1999) Experiments in Plant Physiology-A Laboratory Manual. Narosa Publishing House, New Delhi.
2. Bhatla SC, Lal MA (2018) Plant Physiology, Development and Metabolism. Springer Nature Singapore Pte Ltd.
3. Devlin RM (2017) Outline of Plant Physiology. Medtech: Scientific International Pvt. Ltd.
4. Devlin RM, Witham FH, Blaydes DF (2017) Devlin's Exercises in Plant Physiology. Medtech: Scientific international Pvt. Ltd.

5. Hopkins WG, Huner A (2008) Introduction to Plant Physiology (4th edition). John Wiley and Sons. U.S.A.
6. Kochhar SL, Gujral SK (2021) Plant Physiology: Theory and Applications (2nd edition). Cambridge University Press.
7. Malik CP, Srivastava (2015) Text Book of Plant Physiology. Kalyani Publishers, New Delhi.
8. Salisbury FB, Ross CW (2004) Plant Physiology (4th edition). Cengage Learning India Pvt. Ltd., New Delhi, India.
9. Taiz L, Zeiger E, MØller IM, Murphy A (2015) Plant Physiology and Development (6th edition). Sinauer Associates Inc. USA.

Graduate Attributes

Course Objective:

Students will be able to learn the plant and water relation and thus will be able to elucidate the crucial role of water in diverse physiological functions of plants, by studying this paper. The paper will also highlight the importance of mineral elements in plant physiology and various mechanisms applied to uptake mineral elements by plants. It will provide the basic idea of pathways and mechanisms of translocation of organic solutes synthesised in plant. Furthermore, this paper will explain the role and mechanisms of action of various plant growth regulators as well as physiology of flowering and dormancy of seeds. Additionally, the paper will also focus on the different abiotic and biotic stresses encountered by the plants in their environment as well as various stress mitigation strategies employed by plants to overcome the effects of stress.

Course outcomes:

1. Knowledge on mechanisms of water, minerals, and nutrient absorption of plants
2. Knowledge on roles of plant hormones and mechanism of flowering in plants
3. Practical knowledge on effects of growth regulators on plant parts
4. Practical knowledge on determination of osmotic and water potential

Theory Credit: 03

Practical Credit: 01

No. of Required Classes: 75 (Theory: 45; Practical: 30)

No. of Contact Classes: 75 (Theory: 45; Practical: 30)

No. of Non-Contact Classes: Nil

Particulars of Course Designer (Name, Institution, email id):

CCS, Department of Botany
Gauhati University, Guwahati-14

Four-year Undergraduate Programme
Subject: Botany
Semester: Fourth
Major 5
Course Name: *Mycology and Phytopathology*
Course Level: 200-299, and subsequent level as per NEP structure

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	**Introduction to Fungi:** General characteristics of fungi; hyphal forms; Cell and Cell wall composition; Nutrition; Origin of fungi; Classification of Fungi (Alexopoulos, 1962 & Ainsworth, 1973); General characteristics of Myxomycota and Eumycota; Symbiotic fungi (Lichen & Mycorrhiza): Structural organization and types.	10	10
Unit 2	**Lower Fungi: Mastigomycotina & Zygomycotina:** Characteristic features; Reproduction; Heterothallism; Life cycle with reference to *Synchytrium, Phytophthora* and *Mucor*	6	8
Unit 3	**Higher fungi: Ascomycotina & Basidiomycotina:** Characteristic features; Reproduction; Different fruiting bodies; Life cycle with reference to *Aspergillus, Peziza, Puccinia* and *Agaricus*	6	12
Unit 4	**Fungi Imperfecti: Deuteromycotina:** General characteristics; Thallus organization; Reproduction; Heterokaryosis & Parasexuality; Classification with special reference to *Alternaria* and *Colletotrichum*	5	8
Unit 5	**Phytopathology:** Concept of plant disease; Symptoms of plant diseases; Etiology and disease cycle; Host-pathogens interaction; Control of plant diseases and quarantine; Bacterial diseases - Citrus canker and angular leaf spot of cotton. Viral diseases - Tobacco Mosaic viruses, vein clearing. Fungal diseases - Early blight of potato, Black stem rust of wheat, White rust of crucifers	10	12
Unit 6	**Applied Mycology:** Role of fungi in biotechnology; food industry (Flavour & texture, Fermentation, Organic acids & Enzymes); Pharmaceutical (Secondary metabolites); Agriculture (Biofertilizers & Biological control); Mushroom cultivation; Medical mycology.	8	10

PRACTICAL [Credit: 01]		
1. Study of vegetative and reproductive structures of Mastigomycotina (*Phytophthora*) and Zygomycotina (*Mucor/Rhizopus*) by temporary mounts and through permanent slides. 2. Study of vegetative and reproductive structures of Ascomycotina (*Aspergillus* and *Penicillium*/*Peziza*) and Basidiomyctina (*Agaricus* and *Puccinia*) by temporary mounts and through permanent slides. 3. Study of vegetative and reproductive structures of Deuteromycotina (*Alternaria* and *Colletotrichum/ Fusarium*) by temporary mounts and through permanent slides; Study of thallus and reproductive structures of lichen and mycorrhiza through permanent slides/ photographs. 4. Study of symptoms of locally available plant diseases caused by fungi, bacteria, and virus by preparation of disease album and bottle specimens. 5. Applied mycology: Photographs/report on fungi used in medicine, fungi used as biological control agents, fungi used in industry, fungi causing human infections	30	40

Reading list:

1. Agrios GN (1997) Plant Pathology, 4th edition, Academic Press, U.K.
2. Alexopoulos CJ, Mims CW, Blackwell M (1996) Introductory Mycology, John Wiley & Sons (Asia) Singapore. 4th edition.
3. Gangulee HC, Kar AK. College Botany, Vol. II., New Central Book Agency, Kolkata.
4. Hait G (2022) A Textbook of Plant Pathology: Principles and Diseases. Global Net Publication, India.
5. Hait G, Bhattacharya K, Ghosh AK (2011) Text Book of Botany, Vol. I & II., New Central Book Agency, Kolkata.
6. Mitra JN, Mitra D, Chowdhury S. Studies in Botany. Vol. I., Moulik Library, Kolkata.
7. Pandey BP (2020) Plant Pathology - Pathogen and plant disease. S. Chand and Company Limited, New Delhi, India.
8. Sethi IK, Walia SK (2011) Text book of Fungi and Their Allies, Macmillan Publishers India Ltd.
9. Sharma PD (2011) Plant Pathology, Rastogi Publication, Meerut, India.
10. Webster J, Weber R (2007) Introduction to Fungi, Cambridge University Press, Cambridge. 3rd edition.

Graduate Attributes

Course Objective:

This paper will explain the general characteristics and reproductive procedures of fungi from different groups such as Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina, and Deuteromycotina. The paper will also focus on the basic idea of host-pathogen interaction

during disease development, along with symptomology and the disease cycle of common fungal, bacterial, and viral diseases. Furthermore, the role of fungi in various biotechnological aspects, pharmaceutics, and agriculture will be highlighted.

Course outcomes:

On successful completion of the course, students will have:

1. Knowledge on general features of fungi and their classification
2. Knowledge on different classes of fungi, symbiotic fungi, and their characteristics
3. Knowledge on the application of fungi in different fields
4. Knowledge of plant pathogens and some important plant diseases
5. Practical knowledge on different classes of fungi based on their morphological and reproductive features
6. Practical knowledge on morphology, anatomical features of symbiotic fungi and locally available important plant pathogens.
7. Understanding biotechnological applications of fungi in industry, agriculture, and medicine.

Theory Credit: 03

Practical Credit: 01

No. of Required Classes: 75 (Theory: 45; Practical: 30)

No. of Contact Classes: 75 (Theory: 45; Practical: 30)

No. of Non-Contact Classes: Nil

Particulars of Course Designer (Name, Institution, email id):

CCS, Department of Botany
Gauhati University, Guwahati-14

Four-year Undergraduate Programme
Subject: Botany
Semester: Fourth
Major 6
Course Name: *Morphology and Anatomy of Angiosperms*
Course Level: 200-299, and subsequent level as per NEP structure

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	**Introduction to Plant Morphology and Anatomy:** Morphology of inflorescence, stamens and carpel, fruit; Telome theory, phyllode theory; Role of morphology in plant classification. Plant anatomy: Application in systematics, forensics and pharmacognosy.	6	10
Unit 2	**Tissue and Tissue Systems:** Classification of tissues; Simple and complex tissue, Tissue systems, Pits and plasmodesmata; Wall ingrowths and transfer cells, Types of vascular bundles; Endodermis, exodermis and origin of lateral root. Hydathodes, cavities, lithocysts and laticifers; Ergastic substances.	7	8
Unit 3	**Structure and Development of Plant Body:** Internal organization of plant body: Development of plant body: Polarity, Cytodifferentiation and organogenesis during embryogenic development. Origin and development of leaves; Structure of dicot and monocot stem, root and leaf; Kranz anatomy.	5	8
Unit 4	**Apical meristems:** Concept of organization of shoot apex (Apical cell theory, Histogen theory, Tunica Corpus theory); Organization of root apex (Apical cell theory, Histogen theory, Korper-Kappe theory); Quiescent centre; Root cap.	11	14
Unit 5	**Vascular Cambium and Wood:** Structure, function and seasonal activity of cambium; Secondary growth in stem and root. Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood, tyloses; Dendrochronology. Development and composition of periderm, rhytidome and lenticels.	11	12

Unit 6	**Adaptive and Protective Systems:** Epidermis, cuticle, epicuticular waxes, trichomes (uni- and multicellular, glandular and nonglandular, two examples of each), stomata (classification); Adcrustation and incrustation; Anatomical adaptations of xerophytes and hydrophytes.	5	8
PRACTICAL [Credit: 01]			
1. Study of special types of inflorescences – Cyathium, Hypanthodium, Verticillaster, Hypanthium. 2. Study of special types of fruits- Spurious fruits (*Dillenia*); Aggregate fruits (Custard apple, *Michelia*, Periwinkles, *Polyalthia*); Multiple fruits (Pineapple, Jack fruits). 3. Study of anatomical details through permanent slides/temporary stain mounts / macerations / museum specimens with the help of suitable examples. 4. Apical meristem of root, shoot and vascular cambium (permanent slides/ photographs) 5. Epidermal system: cell types, stomata types; trichomes: non-glandular and glandular. 6. Root anatomy: monocot and dicot 7. Stem: monocot, dicot - primary and secondary growth; periderm; lenticels. 8. Leaf: isobilateral, dorsiventral, C4 leaves (Kranz anatomy). 9. Adaptive Anatomy: xerophytes, hydrophytes. 10. Secretory tissues: cavities, lithocysts and laticifers.		30	40

Reading list:

1. Dickison WC (2000) Integrative Plant Anatomy. Harcourt Academic Press, USA.
2. Evert RF (2006) Esau's Plant Anatomy: Meristems, Cells, and Tissues of the Plant Body: Their Structure, Function and Development. John Wiley and Sons, Inc.
3. Fahn A (1974) Plant Anatomy. Pergmon Press, USA.
4. Mauseth JD (1988). Plant Anatomy. The Benjammin/Cummings Publisher, USA.

Graduate Attributes

Course Objective:

This paper will explain the detailed account on the morphological and anatomical features of Angiosperms.

Course outcomes:

1. Knowledge on morphology of angiosperms and developmental biology of plant body.

2. Knowledge on structural and anatomical organization of tissue system in plants and their classification.
3. Practical knowledge on inflorescences and fruits of angiosperms.
4. Practical knowledge on anatomical features of plant body parts.

Theory Credit: 03

Practical Credit: 01

No. of Required Classes: 75 (Theory: 45; Practical: 30)

No. of Contact Classes: 75 (Theory: 45; Practical: 30)

No. of Non-Contact Classes: Nil

Particulars of Course Designer (Name, Institution, email id):

CCS, Department of Botany
Gauhati University, Guwahati-14

Four-year Undergraduate Programme
Subject: Botany
Semester: Fourth
Major 7
Course Name: *Microbiology*
Course Level: 200-299, and subsequent level as per NEP structure

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	**Introduction to microbial world:** History of development of Microbiology as a subject, Germ theory of diseases, Koch postulates, Major groups of microorganisms, Mode of nutrition and metabolic diversity in microbes, Growth and growth curves, Ecological importance of microorganisms.	6	6
Unit 2	**Viruses:** Characteristics of viruses, viroids and prions; Biomolecules and genetic materials of viruses; Baltimore system of classification; Morphological structure of TMV and Corona viruses; Life cycle and reproduction of bacteriophage; Replication of viral RNA and DNA; Viral diseases of common plants and animals	8	10
Unit 3	**Bacteria:** General characteristics of bacteria, shapes and sizes, ultra-cellular structure, major groups of bacteria with their general characteristics; Actinomycetes, Mycoplasma and Rickettsiae; growth and nutrition, reproduction – binary fission and endospore formation, horizontal gene transfer and genetic recombination in bacteria (conjugation, transformation and transduction). Examples of agriculturally and industrially important bacteria.	8	12
Unit 4	**Environmental Microbiology:** Microorganisms in different habitats: Air, soil and water; Soil microorganisms and their role in soil health; Role of microorganisms in biogeochemical cycles (C, N, P and S); Microorganisms in extreme environments (cold desert, hot water spring, marine water, hydrothermal vent, aquifers)	8	8
Unit 5	**Pathogenic microorganisms and Host Immunity:** Bacterial pathogens causing diseases in plants, animals and humans; fungal pathogens causing diseases in agriculturally important crops; host-pathogen interactions; pathogenesis; disease symptoms; host defence mechanisms; Host	8	12

	immunity - immune responses against pathogens; types of immunity; humoral and cell mediated immunity; hypersensitivity and autoimmunity; concept of Rh antigens.		
Unit 6	**Applied Microbiology:** Application of microorganisms in food industries for food fermentation and SCP production; in agriculture for biofertilizer, biopesticides, biocompost production; in pharmaceuticals for insulin and antibiotics production; in industries for alcohol and organic acid productions; citric acid and acetic acid; in genetic engineering for GMO development and other research purposes; in space and oil exploration and in pollution and waste management.	7	12
PRACTICAL [Credit: 01]			
1. Slide preparation and Gram staining of bacteria (urd bacteria, nodule bacteria) 2. Slide preparation and study of *Nostoc*, *Anabaena*, *Mucor*, *Rhizopus*, *Aspergillus*, *Penicillium*, *Colletotrichum*, *Cladosporium* 3. Pure culture isolation of soil bacteria/fungi through serial dilution plating and subsequent sub-culturing methods, population estimation by CFU and haemocytometer. 4. Measurement of microbial cells/spores with the help of micrometers or inbuilt software in microscopic camera**.** 5. Study on symptoms of plant viral diseases 6. Endospore staining of soil bacteria with malachite green 7. 7. Collection and study of diseases caused by virus, bacteria and fungi in crop plants		30	40

Reading list:

1. Aneja KR, Jain P, Aneza R (2021) A Textbook of Basic and Applied Microbiology. New Age International Publisher.
2. Aneja KR (2022) Experiments in Microbiology, Plant Pathology, Tissue Culture and Microbial Biotechnology. New Age International Publisher
3. Bhattacharya IK, Bhattacharya RN (2017) Fundamentals of Microbiology.
4. Pelczar MJ (2001) Microbiology, 5th edition, Tata McGraw-Hill Co, New Delhi.
5. Sharma PD (2009) Microbiology. latest edition, Rastogi Publication, Meerut.
6. Singh RS (2017) Plant Diseases.
7. Wiley JM, Sherwood LM and Woolverton CJ (2013) Prescott's Microbiology. McGraw Hill International.

Graduate Attributes

Course Objective:

1. To give concise knowledge on basic microbiology
2. To give practical knowledge on handling of microorganisms
3. To inculcate knowledge on usefulness of microorganisms for sustainable development

Course outcomes:

1. Knowledge on microbial diversity and distribution in different habitats
2. Knowledge on ecological and economic importance of microorganisms in our day-to-day life
3. Knowledge on growth, reproduction and life cycles of viruses and microorganisms
4. Knowledge on genetic recombination of bacteria
5. Practical knowledge on microscopy, slide preparation, staining and morphological study of microorganisms
6. Knowledge on pathogenic microorganisms, host-pathogen interaction, and immunity
7. Practical knowledge on isolation and pure culture of bacteria/fungi from soil samples

Theory Credit: 03

Practical Credit: 01

No. of Required Classes: 75 (Theory: 45; Practical: 30)

No. of Contact Classes: 75 (Theory: 45; Practical: 30)

No. of Non-Contact Classes: Nil

Particulars of Course Designer (Name, Institution, email id):

CCS, Department of Botany
Gauhati University, Guwahati-14

Four-year Undergraduate Programme
Subject: Botany
Semester: Fourth
Major 8
Course Name: *Plant Resources and Economic Botany*
Course Level: 200-299, and subsequent level as per NEP structure

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	**Origin of Cultivated Plants:** Centres of Origin, their importance with reference to Vavilov's work. Introductions, domestication, and loss of crop genetic diversity; evolution of new crops/varieties, importance of germplasm diversity and conservation. Classification of plant resources on the basis of their uses.	6	8
Unit 2	**Food and Food Adjuncts:** Cereals and millets: Rice and wheat (origin, morphology, processing, post-harvest management & uses); Brief account of millets and their climatic and nutritional importance. Legumes: Origin, morphology, cultivation, uses and commercial importance of Chick pea, Pigeon pea and fodder legumes. Importance of legumes to man and ecosystem. Spices: Listing of important spices, their family and part used. Economic importance with special reference to Assam. Study of fennel, saffron, clove and black pepper. Beverages: Tea, Coffee (morphology, processing, cultivation, Types & uses).	12	14
Unit 3	**Plants and Plant Products of Industrial Value:** Oils and Fats: General description, classification, extraction, their uses and health implications groundnut, coconut, soybean, and mustard. Essential Oils: General account, extraction methods, comparison with fatty oils & their uses. Non edible oil yielding trees and importance as biofuel. Sugar and starches: Morphology, new varieties and processing of sugarcane, products and by-products of sugarcane industry. Potato: morphology, propagation, post-harvest management, uses of potato and starches.	12	14

	Natural Rubber**:** Para-rubber: tapping, processing and uses. Fibres: Classification based on the origin of fibres; Cotton, Coir and Jute (morphology, extraction and uses).		
Unit 4	**Drug-yielding plants:** Therapeutic and habit-forming drugs with special reference to C*inchona, Digitalis, Aloe vera* and *Cannabis*; Tobacco (Morphology, processing, uses and health hazards).	5	8
Unit 5	**Forest Products:** Forest and forest products. Timber and Non-Timber Forest Products (NTFP), Forest types of Assam and their conservation strategies; Community forestry.	5	8
Unit 6	**Ethnobotany:** Definition, concept and scope; relevance of ethnobotany in the present context; Traditional knowledge and IPR.	5	8
PRACTICAL [Credit: 01]			
1. Cereals: Study of useful parts: Rice/Bean (habit sketch, study of paddy and grain, starch grain, micro-chemical test). 2. Legumes: Bean, (habit, fruit, seed structure, micro-chemical tests). 3. Beverages: Tea (plant specimen, tea leaves). 4. Oils and fats: Coconut and Mustard, Groundnut, 5. Rubber: Specimen, photograph/model of tapping, samples of rubber products. 6. Test for alkaloids: Neem, *Vinca rosea*. 7. Fibre-yielding plants: Cotton (specimen, whole mount of seed to show lint and fuzz; whole mount of fibre and test for cellulose), Jute (specimen, transverse section of stem, test for lignin).		30	40

Reading list:

1. Chrispeels MJ, Sadava DE (1994) Plants, Genes and Agriculture. Jones & Bartlett Publishers.
2. Gonsalves J (2010) Economic Botany and Ethnobotany. Mittal Publications, New Delhi, India.
3. Hill AF (1972) Economic Botany: A Textbook of Useful Plants and Plant Products. Tata McGraw-Hill, New Delhi, India.
4. Jain SK, Mudgal V (1999) A Hand Book of Ethnobotany. Bishen Singh Mahendra Pal Singh, Dehra Dun, India.
5. Kochhar SL (2012) Economic Botany in Tropics, MacMillan & Co. New Delhi, India.

6. Samba Murty AVSS, Subramanyam NS (1989) A Textbook of Economic Botany. Wiley Eastern Limited, New Delhi.
7. Wickens GE (2001) Economic Botany: Principles & Practices. Kluwer Academic Publishers, The Netherlands.
8. Wickens GE (2006) Economic Botany Principles and Practices, Springer India, New Delhi.

Graduate Attributes

Course Objective:

This paper will provide an understanding of major introduced plant species, concept of centre of origin and their importance, domestication of crops and loss of genetic diversity, evolution of new crops /varieties. This paper will also provide knowledge on germ plasm diversity, importance of ethnobotany and economic importance of various plants.

Course outcomes:

On successful completion of the course, students will:

1. Know the centre of origin, domestication, and loss of genetic diversity
2. Understand the evolution of new crops /varieties
3. Know about the germplasm diversity
4. Understand the economic values of various plant species.
5. Understand the importance of ethnobotany in the present context.

Theory Credit: 03

Practical Credit: 01

No. of Required Classes: 75 (Theory: 45; Practical: 30)

No. of Contact Classes: 75 (Theory: 45; Practical: 30)

No. of Non-Contact Classes: Nil

Particulars of Course Designer (Name, Institution, email id):

CCS, Department of Botany
Gauhati University, Guwahati-14

Four-year Undergraduate Programme
Subject: Botany
Semester: Fifth
Course Name: *Genetics*
Major 9
Course Level: 300-399, and subsequent level as per NEP structure

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	**Mendelian genetics and its extension:** Mendelism: History; Principles of inheritance; Chromosome theory of inheritance; Autosomes and sex chromosomes; Probability and pedigree analysis; Incomplete dominance and codominance; Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Recessive and Dominant traits, Penetrance and Expressivity, Numericals; Polygenic inheritance.	13	14
Unit 2	**Extrachromosomal Inheritance:** Chloroplast mutation: Variegation in Four o'clock plant; Mitochondrial inheritance in yeast; Maternal effects- shell coiling in snail; Infective heredity- Kappa particles in *Paramecium*	4	6
Unit 3	**Linkage, crossing over and chromosome mapping:** Linkage and crossing over - Cytological basis of crossing over; Recombination frequency, two factor and three factor crosses; Interference and coincidence; Numerical based on gene mapping; Sex Linkage.	8	10
Unit 4	**Variation in chromosome number and structure:** Deletion, Duplication, Inversion, Translocation, Position effect, Euploidy and Aneuploidy.	6	8
Unit 5	**Fine structure of gene and Gene mutations:** Classical vs molecular concepts of gene; Ciston, Racon, Muton, rII locus; Types of mutations; Molecular basis of Mutations; Mutagens – physical and chemical (Base analogs, deaminating, alkylating and intercalating agents); Detection of mutations: ClB method. Role of Transposons in mutation. DNA repair mechanisms	10	12
Unit 6	**Unit 6. Population and Evolutionary Genetics:** Allele frequencies, Genotype frequencies, Hardy-Weinberg Law, role of natural selection, mutation, genetic drift. Genetic variation and Speciation.	4	10

PRACTICAL [Credit: 01]		
1. Mendel's laws through seed ratios. 2. Chromosome mapping using point test cross data. 3. Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4). 4. Permanent Slides showing Translocation Ring, Photograph showing Laggards and Inversion Bridge.	30	40

Reading list:

1. Gardner EJ, Simmons MJ, Snustad DP (2015) Principles of Genetics, John Wiley & sons, India. 8th edition.
2. Griffiths AJF, Wessler SR, Carroll SB, Doebley J (2010) Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.
3. Klug WS, Cummings MR, Spencer CA (2012) Concepts of Genetics. Benjamin Cummings, U.S.A. 10th edition.
4. Snustad DP, Simmons MJ (2010) Principles of Genetics, John Wiley & Sons Inc., India. 5thedition.

Graduate Attributes

Course Objective:

To gain knowledge on classical and modern concepts of genetics.

Course outcomes:

1. Knowledge of Mendelian and non- Mendelian inheritance in organisms.
2. Knowledge of gene and chromosomal mutations
3. Knowledge of basic concepts of population and evolutionary genetics
4. Ability to work out problems related to Mendel's experiments, Chromosome mapping and gene interaction

Theory Credit: 03

Practical Credit: 01

No. of Required Classes: 75 (Theory: 45; Practical: 30)

No. of Contact Classes: 75 (Theory: 45; Practical: 30)

No. of Non-Contact Classes: Nil

Particulars of Course Designer (Name, Institution, email id):

CCS, Department of Botany
Gauhati University, Guwahati-14

Four-year Undergraduate Programme
Subject: Botany
Semester: Fifth
Major 10
Course Name: *Plant Ecology, Phytogeography and Climate Change*
Course Level: 300-399, and subsequent level as per NEP structure

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	**Ecology and Ecosystem:** Ecology: Basic concepts, Levels of organization, Inter-relationships between the living world and the environment. Ecosystem: Structure, functions, and types, trophic organisation, food chains and food webs, ecological pyramids, homeostasis.	8	8
Unit 2	**Ecological Factors:** Climatic, Edaphic and Biotic Factors, Factorial interactions, Plant adaptation to environmental factors (light, temperature, wind, and fire); autotrophy, heterotrophy; symbiosis, commensalism, ammensalism, parasitism, parasitoidism. Aquatic ecology- concept.	8	8
Unit 3	**Population ecology:** Population characteristics, Growth curve, Lotka-Volterra model, population regulation, *r* and *k*-selection. Types of ecological speciation, Ecological equivalents.	7	12
Unit 4	**Plant communities:** Plant Community: Basic concept, types, characters (analytical and synthetic), Dynamics: succession – processes, types, models; climax concepts, Habitat and Niche: concept &types.	7	12
Unit 5	**Functional Ecology:** Principles and models of energy flow; Production and productivity; Ecological efficiencies; Ecological energetics; Biogeochemical cycles (C, N and P) and water cycle.	7	10
Unit 6	**Phytogeography and Climate Change:** Principles; Continental drift; Theory of tolerance; Endemism; Brief description of major terrestrial biomes (one each from tropical, temperate & tundra); Phytogeographical division of India; Vegetation types of NE India with special reference to Assam.	8	10

	Climate change: Basic concepts; global warming, causes and consequences (Rise in Sea levels, Glacier melting, Biodiversity Loss), Adaptation, Mitigation, Global and National Efforts, Concept on Sustainable Development, Sustainable Development Goals (SDGs).		
PRACTICAL [Credit: 01]			
1. Determination of minimal quadrat size and number for the study of herbaceous vegetation in the college campus by species area curve method (species to be listed). 2. Quantitative analysis of herbaceous vegetation for density and abundance in the college campus. 3. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law. 4. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter. 5. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid field tests. 6. Determination of dissolved oxygen of water samples from polluted and unpolluted sources. a) Study of morphological adaptations of hydrophytes and xerophytes (four each). b) Study of biotic interactions of the following: Stem parasite, Root parasite, Epiphytes, Predation (Insectivorous plants). 7. Local field visit to nearby areas to familiarise students with various plant communities. 8. Soil respiration study in two agricultural systems to determine the CO_2 evolution.		30	40

Reading list:

1. Ambasht and Ambasht (2002) A text book of Plant Ecology. CBS publisher and Distributors.
2. Bhattacharya K, Ghosh AK, Hait G (2017) A Text Book of Botany. New Central Book Agency (P), Kolkata, India.
3. Bowmen WD, Hacker SD, Cain ML (2018) Ecology, Oxford University Press.
4. Deka U, Dutta T (2022) Plant Ecology and Phytogeography. Asian Humanitities Press, Guwahati, Assam.
5. Kapur P, Govil SR (2000, 2007). Experimental Plant Ecology. CBS Publishers and Distributors, New Delhi (India).
6. Kormondy EJ (1996) Concepts of ecology. PHI Learning Pvt. Ltd., Delhi, India. 4th edition.

7. Misra R (1968, Reprinted in 2019). Ecology Workbook. Scientific Publishers (India), Jodhpur
8. Odum EP (2005) Fundamentals of ecology. Cengage Learning India Pvt. Ltd., New Delhi. 5th edition.
9. Raj M, Deka H (2022) Plant Ecology and Phytogeography. Ashok Book Stall, Guwahati, Assam.
10. Sharma PD (2010) Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.
11. Smith TM, Smith RL (2015) Elements of ecology. Pearson publishers., London. 9th Edition
12. Stiling PD (1996) Ecology: theories and applications (Vol. 4). Upper Saddle River: Prentice Hall.
13. Verma PS, Agarwal VK (2003) Environmental Biology-Principles of Ecology. S Chand & Company Ltd. Ramnagar, New delhi-110055.
14. Wilkinson DM (2007) Fundamental Processes in Ecology: An Earth Systems Approach. Oxford University Press. U.S.A.

Graduate Attributes

Course Objective:

This course will provide an understanding on ecology and ecosystems, biotic and abiotic interactions, ecosystem processes, terrestrial and aquatic environment, population and community interactions, plant distribution and effect of climate change on natural environment. Emphasis will be given on the hands-on approach, field, and laboratory techniques.

Course outcomes:

On successful completion of the course, students will:

1. Understand the concept of ecology, ecosystems, and importance of factors.
2. Understand the population, community, biodiversity, and conservation strategies.
3. Understand the concept of phytogeography, endemism, and floristic distributions.
4. Understand the science of climate change and sustainable development strategies
5. Know the adaptation and mitigation against climate change-induced phenomena.

Theory Credit: 03

Practical Credit: 01

No. of Required Classes: 75 (Theory: 45; Practical: 30)

No. of Contact Classes: 75 (Theory: 45; Practical: 30)

No. of Non-Contact Classes: Nil

Particulars of Course Designer (Name, Institution, email id):

CCS, Department of Botany
Gauhati University, Guwahati-14

Four-year Undergraduate Programme
Subject: Botany
Semester: Fifth
Course Name: *Plant Systematics*
Major 11
Course Level: 300-399, and subsequent level as per NEP structure

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	**Significance of Plant systematics:** Introduction to systematics; Plant identification, Classification, Nomenclature. Evidences from palynology, cytology, phytochemistry and molecular data. Functions and importance of Herbarium and botanical garden; Important herbaria and botanical gardens of the world and India; Virtual herbarium; Categories and taxonomic hierarchy; Concept of taxa (family, genus, species).	8	8
Unit 2	**Botanical nomenclature:** History, Principles and Rules (ICN); Ranks and names; Typification, Author citation, Effective and Valid publication, Rejection of names, Principle of priority and its limitations.	5	8
Unit 3	**Systems of classification:** Major contributions of Theophrastus, Bauhin, Tournefort, Linnaeus, Adanson, de Candolle, Bessey, Hutchinson, Takhtajan and Cronquist; Classification systems of Bentham and Hooker, Engler and Prantl, Takhtajan; Brief account of Angiosperm Phylogeny Group (APG) classification.	9	12
Unit 4	**Numerical taxonomy and cladistics:** OTUs, characters, character weighting and coding; Cluster analysis; Phenograms & Cladograms (definitions and differences).	6	8
Unit 5	**Phylogeny of Angiosperms:** Terms and concepts (primitive and advanced, homology and analogy, parallelism and convergence, monophyly, Paraphyly, polyphyly and clades). Origin and evolution of angiosperms; Co-evolution of angiosperms and animals; Methods of illustrating evolutionary relationship (phylogenetic tree, cladogram).	6	10

Unit 6	**Angiospermic Families:** Detail study of the following families: Magnoliaceae, Fabaceae, Asteraceae, Solanaceae, Acanthaceae, Lamiaceae, Euphorbiaceae, Orchidaceae, Musaceae, Zingiberaceae, Poaceae.	11	14
PRACTICAL [Credit: 01]			
1. Study of vegetative and floral characters of locally available angiospermic plants belonging to the following families (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification): Fabaceae, Solanaceae, Acanthaceae, Lamiaceae, Euphorbiaceae, Musaceae, Orchidaceae. 2. Field visits to familiarise students with vegetation of an area and identification of plant species / Visit to Academic or Research Institutions. 3. Mounting of properly dried and pressed specimens of at least 10 (ten) wild plant species with herbarium labels (to be submitted with the record book).		30	40

Reading list:

1. Jeffrey C (1982) An Introduction to Plant Taxonomy. Cambridge University Press, Cambridge.
2. Judd WS, Campbell CS, Kellogg EA, Stevens PF (2002) Plant Systematics-A Phylogenetic Approach. Sinauer Associates Inc., U.S.A. 2nd edition.
3. Mitra JN (1988) An Introduction to Systematic Botany and Ecology. The World Press Private Ltd. Calcutta.
4. Mondal AK (2009) Advanced Plant Taxonomy. New Central Book Agency (P) Ltd.
5. Naik VN (1984) Taxonomy of Angiosperms. Tata Mc Graw-Hill.
6. Pandey BP (2018) A Textbook of Botany: Angiosperm. S. Chand Publishing, 7361, Ram Nagar, Qutab Road, New Delhi-110055.
7. Simpson MG (2006) Plant Systematics. Elsevier Academic Press.
8. Singh G (2012) Plant Systematics: Theory and Practice. Oxford & IBH Pvt. Ltd., New Delhi. 3rd edition.

Graduate Attributes

Course Objective:

This paper will provide an understanding of knowledge on plant systematics, basic understanding of plant identification, classification systems and plant nomenclature, significance of systematics in different fields/branches of botany, phylogenetic and

evolutionary relationships of angiosperms. The paper will also focus on knowledge about herbaria and botanical gardens in India and abroad and their significant role in plant identification.

Course outcomes:

On successful completion of the course, students will be:

1. Able to obtain knowledge on plant identification and classification systems, plant nomenclature.
2. Detailed knowledge of the phylogenetic and evolutionary relationships of angiosperms.
3. Able to obtain knowledge on various herbaria and botanical gardens in India and abroad, their role in plant systematics.
4. Acquainted with practical knowledge on vegetative and reproductive structures of angiosperms.
5. Acquainted students with practical knowledge on vegetation of an area.

Theory Credit: 03

Practical Credit: 01

No. of Required Classes: 75 (Theory: 45; Practical: 30)

No. of Contact Classes: 75 (Theory: 45; Practical: 30)

No. of Non-Contact Classes: Nil

Particulars of Course Designer (Name, Institution, email id):

CCS, Department of Botany
Gauhati University, Guwahati-14

Four-year Undergraduate Programme
Subject: Botany
Semester: Sixth
Major 12
Course Name: *Molecular Biology*
Course Level: 300-399, and subsequent level as per NEP structure

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	**Nucleic acids: Carriers of genetic information:** Historical perspective; DNA as the carrier of genetic information (Griffith's, Hershey & Chase, Avery, McLeod & McCarty, Fraenkel-Conrat's experiment.	3	4
Unit 2	**The Structures of DNA and RNA / Genetic Material:** DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure, Salient features of double helix, denaturation and renaturation, cot curves; Organization of DNA- Prokaryotes, Viruses, Eukaryotes. Organelle DNA - mitochondria and chloroplast DNA. The Nucleosome Chromatin structure- Euchromatin, Heterochromatin- Constitutive and Facultative heterochromatin.	8	12
Unit 3	**The replication of DNA, Central dogma and genetic code:** Chemistry of DNA synthesis (Kornberg's discovery); General principles – bidirectional, semi- conservative and semi discontinuous replication, RNA priming; Various models of DNA replication, including rolling circle, θ (theta) mode of replication, replication of linear ds-DNA; Enzymes involved in DNA replication. Key experiments establishing-The Central Dogma (Adaptor hypothesis and discovery of mRNA template), Genetic code (deciphering & salient features)	10	12
Unit 4	**Transcription:** Transcription in prokaryotes and eukaryotes. Principles of transcriptional regulation; Prokaryotes: Regulation of lactose metabolism and tryptophan synthesis in *E. coli*. Eukaryotes: transcription factors, heat shock proteins, steroids and peptide hormones; Gene silencing.	10	12
Unit 5	**Processing and modification of RNA:** Split genes-concept of introns and exons, removal of introns,	7	10

	spliceosome machinery, splicing pathways, group I and group II intron splicing, alternative splicing eukaryotic mRNA processing (5' cap, 3' poly A tail); Ribozymes; RNA editing and mRNA transport.		
Unit 6	**Translation:** Ribosome structure and assembly, mRNA; Charging of tRNA, aminoacyl tRNA synthetases; Various steps in protein synthesis, proteins involved in initiation, elongation and termination of polypeptides; Fidelity of translation; Inhibitors of protein synthesis; Post-translational modifications of proteins.	7	10
PRACTICAL [Credit: 01]			
1. DNA isolation from any plant material. 2. DNA estimation by diphenylamine reagent/UV Spectrophotometry (Demonstration). 3. Study of DNA replication mechanisms through photographs (Rolling circle, Theta replication and semi-discontinuous replication). 4. Study of structures of prokaryotic RNA polymerase and eukaryotic RNA polymerase II through photographs. 5. Study of the following through photographs: Assembly of Spliceosome machinery; Splicing mechanism in group I & group II introns; Ribozyme and Alternative splicing.		30	40

Reading list:

1. Griffiths AJF, Wessler SR, Carroll SB, Doebley J (2010) Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.
2. Klug WS, Cummings MR, Spencer CA (2009) Concepts of Genetics. Benjamin Cummings. U.S.A. 9th edition.
3. Russell PJ (2010) iGenetics - A Molecular Approach. Benjamin Cummings, U.S.A. 3rd edition.
4. Snustad DP, Simmons MJ (2010) Principles of Genetics. John Wiley and Sons Inc., U.S.A. 5th edition.
5. Watson JD, Baker TA, Bell SP, Gann A, Levine M, Losick R (2007) Molecular Biology of the Gene, Pearson Benjamin Cummings, CSHL Press, New York, U.S.A. 6th edition.

Graduate Attributes

Course Objective:

To have detailed knowledge of DNA, RNA and central dogma of molecular biology

Course outcomes:

1. Knowledge of structure, organization, and replication mechanism of DNA

2. Detailed knowledge of central dogma, mechanism of transcription and processing of different types of RNA
3. Knowledge of genetic code, molecular mechanisms associated with various steps in protein synthesis and post translational modifications
4. Ability to isolate genomic DNA from plant samples

Theory Credit: 03

Practical Credit: 01

No. of Required Classes: 75 (Theory: 45; Practical: 30)

No. of Contact Classes: 75 (Theory: 45; Practical: 30)

No. of Non-Contact Classes: Nil

Particulars of Course Designer (Name, Institution, email id):

CCS, Department of Botany
Gauhati University, Guwahati-14

Four-year Undergraduate Programme
Subject: Botany
Semester: Sixth
Major 13
Course Name: *Reproductive Biology of Angiosperm*
Course Level: 300-399, and subsequent level as per NEP structure

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	**Introduction to reproductive biology of Angiosperms:** History (contributions of G.B. Amici, W. Hofmeister, E. Strasburger, S.G. Nawaschin, P. Maheshwari, B.M. Johri, W.A. Jensen, J. Heslop-Harrison) and scope.	4	4
Unit 2	**Reproductive development:** Induction of flowering; flower as a modified determinate shoot. Flower development: genetic and molecular aspects.	4	6
Unit 3	**Anther and pollen biology:** Anther wall: Structure and functions, microsporogenesis, callose deposition and its significance. Micro-gametogenesis; Pollen wall structure, MGU (male germ unit) structure; Palynology and scope (a brief account); NPC system; Pollen wall proteins; Pollen viability, storage and germination; Abnormal features: Pseudomonads, polyads, massulae, pollinia.	10	14
Unit 4	**Ovule:** Structure; Types; Special structures– endothelium, obturator, aril, caruncle and hypostase; Female gametophyte- megasporogenesis (monosporic, bisporic and tetrasporic) and megagametogenesis (details of *Polygonum* type); Organization and ultrastructure of mature embryo sac.	6	10
Unit 5	**Pollination and fertilization:** Pollination types and significance; adaptations; structure of stigma and style; path of pollen tube in pistil; double fertilization. Basic concept of Self incompatibility (interspecific, intraspecific, homomorphic, heteromorphic, GSI and SSI); Methods to overcome self- incompatibility: mixed pollination, bud pollination, stub pollination; Intra-ovarian and *in vitro* pollination; Modification of stigma surface,	12	12

	parasexual hybridization; Cybrids, *in vitro* fertilization.		
Unit 6	**Embryo, Endosperm and Seed:** Structure and types; General pattern of development of dicot and monocot embryo and endosperm; Suspensor: structure and functions; Embryo-endosperm relationship; Nutrition of embryo; Unusual features; Embryo development in *Paeonia*. Seed structure, importance, and dispersal mechanisms. Polyembryony and apomixis: Introduction; Classification; Causes and applications.	9	14
PRACTICAL [Credit: 01]			
1. **Anther:** Wall and its ontogeny; Tapetum (amoeboid and glandular); MMC, spore tetrads, uninucleate, bi-celled and dehisced anther stages through slides/micrographs, male germ unit (MGU) through photographs and schematic representation. 2. **Pollen grains:** Fresh and acetolyzed showing ornamentation and aperture, psuedomonads, polyads, pollinia (slides/photographs, fresh material), ultrastructure of pollen wall(micrograph); Pollen viability: Tetrazolium test for germination: Calculation of percentage germination in different media using hanging drop method. 3. **Ovule:** Types-anatropous, orthotropous, amphitropous/ campylotropous, circinotropous, unitegmic, bitegmic; Tenuinucellate and crassinucellate; Special structures: Endothelium, obturator, hypostase, caruncle and aril (permanent slides/specimens/photographs). 4. **Female gametophyte through permanent slides/ photographs:** Types, ultrastructure of mature egg apparatus. 5. Intra-ovarian pollination; Test tube pollination through photographs. 6. **Endosperm:** Dissections of developing seeds for endosperm with free-nuclear haustoria. 7. **Embryogenesis:** Study of development of dicot embryo through permanent slides; dissection of developing seeds for embryos at various developmental stages.	30	40

Reading list:

1. Bhattacharya M, Bhattacharya. (2012). A Textbook of Palynology: Basic and Applied. New Central Book Agency (P) Ltd. Guwahati.
2. Bhojwani SS, Bhatnagar SP (2011) The Embryology of Angiosperms, Vikas Publishing House. Delhi. 5th edition.
3. Johri BM (1984) Embryology of Angiosperms, Springer-Verlag, Netherlands.
4. Raghavan V (2000) Developmental Biology of Flowering plants, Springer, Netherlands.
5. Shivanna KR (2003) Pollen Biology and Biotechnology. Oxford and IBH Publishing Co. Pvt. Ltd. Delhi.

Graduate Attributes

Course Objective:

This paper will explain the detailed accounts on reproductive and developmental characteristics of Angiosperm.

Course outcomes:

1. Knowledge on detailed morphological and reproductive structures of angiosperm.
2. Knowledge on embryology and embryological abnormalities in angiosperms.
3. Practical knowledge on developmental biology of embryo and endosperms.

Theory Credit: 03

Practical Credit: 01

No. of Required Classes: 75 (Theory: 45; Practical: 30)

No. of Contact Classes: 75 (Theory: 45; Practical: 30)

No. of Non-Contact Classes: Nil

Particulars of Course Designer (Name, Institution, email id):

CCS, Department of Botany
Gauhati University, Guwahati-14

Four-year Undergraduate Programme
Subject: Botany
Semester: Sixth
Major 14
Course Name: *Plant Metabolism and Biochemistry*
Course Level: 300-399, and subsequent level as per NEP structure

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	**Concepts of metabolism:** Introduction, anabolic and catabolic pathways, regulation of metabolism, role of regulatory enzymes; classification, nomenclature, and importance of enzyme; Concept of coenzyme, apoenzyme and prosthetic group; Enzyme inhibition (allosteric, covalent modulation); Isozymes.	6	8
Unit 2	**Carbon assimilation:** Role of photosynthetic pigments (chlorophylls and accessory pigments), antenna molecules and reaction centers, photochemical reactions, photosynthetic electron transport, PSI, PSII, Q-cycle, CO_2 reduction: C3, C4-pathways, Crassulacean acid metabolism; Photorespiration.	8	12
Unit 3	**Carbon oxidation and ATP Synthesis:** Glycolysis and its regulation, oxidative decarboxylation of pyruvate, TCA cycle and regulation, amphibolic role, anaplerotic reactions, mitochondrial electron transport, oxidative phosphorylation, cyanide-resistant respiration, pentose phosphate pathway; Factors affecting respiration; ATP synthesis: substrate level phosphorylation, chemiosmotic mechanism, ATP synthase, Boyer's conformational model, Racker's experiment, Jagendorf's experiment, role of uncouplers.	10	12
Unit 4	**Carbohydrate, Lipid and Nitrogen metabolism:** Synthesis and catabolism of sucrose, starch and cellulose, Synthesis and breakdown of triglycerides, β-oxidation, glyoxylate cycle, gluconeogenesis and its role in mobilisation of lipids during seed germination, α-oxidation. Nitrogen assimilation: biological nitrogen fixation (examples of legumes and non-legumes), biochemistry of nitrogen fixation, ammonia assimilation and transamination.	12	14

Unit 5	**Mechanisms of Signal Transduction:** Receptor-ligand interactions, Second messenger concept, Calcium-calmodulin, MAP kinase cascade, two-component system.	5	8
Unit 6	**Secondary Metabolites:** Shikimate Pathway: Role in biosynthesis of secondary metabolites; Biosynthesis and physiological roles of terpenes, phenols and nitrogenous compounds.	4	6
PRACTICAL [Credit: 01]			
1. Chemical separation of photosynthetic pigments by solvent method/paper chromatography 2. Estimation of sugar content by DNSA method 3. Determination of titratable acid number (TAN) in plant materials 4. Quantification of chlorophyll a, b and total chlorophyll and determination of chlorophyll a/b ratio 5. Estimation of phenol/tannin/flavonoid by colorimetric method 6. Estimation of protein in plant sample by Lowry's method/Biuret method 7. Separation of amino acids by paper chromatography 8. Demonstration of Thin layer chromatography (TLC)/Column chromatography 9. To compare the rate of respiration by Ganong's respirometer in different parts of plant (Demonstration)		30	40

Reading list:

1. Cox MM, Nelson DL (2017) Principles of Biochemistry (7th Edition). WH Freeman & Co., Newyork.
2. Goodwin TW, Mercer EI (2005) Introduction to Plant Biochemistry. CBS Publishers and Distributors Pvt. Ltd., New Delhi.
3. Jain J L, Jain S, Jain N (2016) Fundamentals of Biochemistry (7th edition). S Chand & Co. PVT. Ltd., New Delhi, India;
4. Palmer T, Bonner P (2008) Enzymes: Biochemistry, Biotechnology, Clinical Chemistry. East West Press Pvt. Ltd., New Delhi;
5. Plummer D (2017) An Introduction to Practical Biochemistry (3rd edition). McGraw Hill Education, New Delhi, India
6. Sadasivam A, Manickam S (2022) Biochemical Methods (4th edition). New Age International Pvt. Ltd.
7. Satyanarayana U, Chakrapani U (2021) Biochemistry (6th edition). Elsevier;
8. Voet D, Voet JG, Pratt CW (2018) Principles of Biochemistry (5th edition). J Wiley & Sons, Singapore Pte. Ltd.

Graduate Attributes

Course Objective:

Students will be acquainted with the elaborate concept of plant metabolism and biochemical pathways, by studying this paper. The paper will highlight the carbon assimilation pathways as well as carbon oxidation and ATP synthesis mechanisms in plant body. It will provide the detailed idea of pathways and mechanisms of carbohydrate, lipid, and nitrogen metabolism in plants. Furthermore, this paper will explain the various aspects and cascades of signal transduction mechanism. Additionally, the paper will also focus on the biosynthesis and physiological roles of secondary metabolites in plants.

Course outcomes:

1. Knowledge in basic understanding of plant metabolism and their regulation
2. Knowledge in concepts of carbon assimilation, oxidation, ATP synthesis
3. Knowledge in basic concepts of carbohydrate, Lipid and Nitrogen metabolism
4. Knowledge in basic concepts of signal transduction
5. Practical knowledge in separation of pigments, estimation of sugars, rate of respiration.
6. Ability to perform experiments on chromatographic techniques, spectrophotometric analysis.

Theory Credit: 03

Practical Credit: 01

No. of Required Classes: 75 (Theory: 45; Practical: 30)

No. of Contact Classes: 75 (Theory: 45; Practical: 30)

No. of Non-Contact Classes: Nil

Particulars of Course Designer (Name, Institution, email id):

CCS, Department of Botany
Gauhati University, Guwahati-14

Four-year Undergraduate Programme
Subject: Botany
Semester: Sixth
Major 15
Course Name: *Applied Plant Biology*
Course Level: 300-399, and subsequent level as per NEP structure

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	**Plant Tissue Culture:** Historical perspective; Composition of media; Nutrient and hormone requirements (role of vitamins and hormones); Totipotency; Organogenesis; Embryogenesis (somatic and zygotic); Protoplast isolation, culture and fusion.	8	10
Unit 2	**Application of tissue culture:** Micropropagation, androgenesis, virus elimination, secondary metabolite production, haploids, triploids and hybrids; Cryopreservation; Germplasm conservation.	4	6
Unit 3	**Recombinant DNA technology:** Restriction Endonucleases (History, Types I-IV, biological role and application); Restriction Mapping (Linear and Circular); Cloning Vectors: Prokaryotic (pUC 18 and pUC19, pBR322, Ti plasmid, BAC); Lambda phage, M13 phagemid, Cosmid, Shuttle vector; Eukaryotic Vectors (YAC).	8	10
Unit 4	**Gene Cloning:** Recombinant DNA, Bacterial Transformation and selection of recombinant clones, PCR- mediated gene cloning; Gene Construct; construction of genomic and cDNA libraries, screening DNA libraries to obtain gene of interest by genetic selection; complementation, colony hybridization; PCR	9	12
Unit 5	**Methods of gene transfer:** *Agrobacterium*-mediated, Direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment; Selection of transgenics - selectable marker and reporter genes (Luciferase, GUS, GFP).	6	10
Unit 6	**Applications of genetic engineering:** Pest resistant (Bt-cotton); herbicide resistant plants (Round Up Ready soybean); Transgenic crops with improved quality traits (FlavrSavr tomato, Golden rice);	10	12

	Improved horticultural varieties (Moondust carnations); Role of transgenics in bioremediation (Superbug).		
PRACTICAL [Credit: 01]			
1. (a) Preparation of MS medium. (b) Demonstration of *in vitro* sterilization and inoculation methods using leaf and nodal explants of any plant species. 2. Study of anther, embryo and endosperm culture, micropropagation, somatic embryogenesis & artificial seeds through photographs. 3. Isolation of protoplasts. 4. Construction of restriction map of circular and linear DNA from the data provided. 5. Study of methods of gene transfer through photographs: Agrobacterium-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment. 6. Study of steps of genetic engineering for production of Bt cotton, Golden rice, FlavrSavr tomato through photographs. 7. Isolation of plasmid DNA. 8. Restriction digestion and gel electrophoresis of plasmid DNA.		30	40

Reading list:

1. Bhojwani SS, Bhatnagar SP (2011) The Embryology of Angiosperms. Vikas Publication House Pvt. Ltd., New Delhi. 5th edition.
2. Bhojwani SS, Razdan MK (1996) Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
3. Ganguli P (2001) Intellectual Property Rights: Unleashing the Knowledge Economy. New Delhi: Tata McGraw-Hill Pub.
4. Glick BR, Pasternak JJ (2003) Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
5. Kuhse H (2010) Bioethics: An Anthology. Malden, MA: Blackwell.
6. Snustad DP, Simmons MJ (2010) Principles of Genetics. John Wiley and Sons, U.K.
7. Stewart CNJr (2008) Plant Biotechnology & Genetics: Principles, Techniques and Applications. John Wiley & Sons Inc. U.S.A.

Graduate Attributes

Course Objective:

To gain knowledge on plant tissue culture, recombinant DNA technology and applications of genetic engineering techniques.

Course outcomes:

1. Knowledge of various methods of Plant tissue culture and their application
2. Knowledge of gene cloning, recombinant DNA technology and various methods of gene transfer in plants
3. Knowledge of the application of genetic engineering techniques for agriculture.
4. Ability to demonstrate tissue culture technique; isolate plasmid DNA and to carry out DNA manipulation using restriction enzymes

Theory Credit: 03

Practical Credit: 01

No. of Required Classes: 75 (Theory: 45; Practical: 30)

No. of Contact Classes: 75 (Theory: 45; Practical: 30)

No. of Non-Contact Classes: Nil

Particulars of Course Designer (Name, Institution, email id):

CCS, Department of Botany
Gauhati University, Guwahati-14

Four-year Undergraduate Programme
Subject: Botany
Semester: Seventh
Major 16
Course Name: *Plant Breeding, Genomics and Bioinformatics*
Course Level: 400-499, and subsequent level as per NEP structure

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no	**Unit content**	**No. of classes**	**Marks**
Unit 1	Principles of plant breeding, hybridization and selection; concepts in improvement of major crop species; polyploidy inheritance, self-incompatibility.	6	8
Unit 2	QTL mapping using molecular marker, population statistics; heritability, Hardy-Weinberg law of equilibrium, Novel plant breeding tools (TALEN's, CRISPR-Cas9, Base editing).	7	10
Unit 3	Chromosome variation in higher plants; haploid production system, breeding application of haploids; aneuploidy, trisomic, tetrasomic, nullisomic and their significance in genetic studies; parthenogenesis and apogamy, action of physical and chemical mutagens; mutation in crop improvement.	8	10
Unit 4	Intellectual Property Rights -- Intellectual property rights (IPR); Patents, trade secrets, copyright, trademarks; Geographical Indicators (GI); Registration, subject matter and ownership of IPRs. Plant genetic resources; GATT & TRIPPS; Patenting of biological material; Plant breeders rights (PBRs) and farmers rights.	8	10
Unit 5	Genomics: Organization of nuclear and organellar genomes, Sequencing Genomes, Comparative genomics, Functional genomics	6	10
Unit 6	Bioinformatics: Introduction to bioinformatics, biological databases, data mining and retrieval, scope and application of bioinformatics, nucleic acid and protein sequence analysis, sequence alignment, local and global alignment, database search for homologous sequences-BLAST and	10	12

	FASTA, protein structure analysis, Ramachandran plot, computer-aided drug discovery.		
PRACTICAL [Credit: 01]			
1. Principle, techniques and procedure of emasculation. 2. Sequence (protein/DNA) downloading from databases, alignment and homologous sequence search 3. Sequence BLAST, annotation and gene prediction with the help of bioinformatical tools. 4. Protein modelling, structure prediction and Ramachandran plot analysis 5. Chromosome analysis, study of chromosome behaviour in mitosis and meiosis, chromosome anomalies in plant cells. 6. Comparative genomics of bacteria		30	40

Reading list:

1. Acquaah, G. (2012). Principles of Plant Genetics & Breeding. 2nd edition. Hoboken, NJ, Wiley.
2. Allard, R.W. (1999). Principles of Plant Breeding. John Wiley, New York.
3. Singh, B.D. (2022). Plant Breeding: Principles and Methods, 12th edition. New Delhi, Delhi: Kalyani Publishers.
4. Frey, K. J. (1982). Plant Breeding II. Kalyani Publishers, New Delhi.
5. Chopra, V.L. (2023). Plant Breeding: Theory and Practice 2nd Restructured Edition, New India Publishing Agency, New Delhi.
6. Poehlman J. M. and Sleper D. A. (1995). Breeding Field Crops, 4th Ed. Panima Publishing Corporation, New Delhi.
7. Welsh, J. R. (1981). Fundamentals of Plant Genetics and Breeding. John Wiley and Sons, New York.
8. Ahuja, V.K. (2007) Laws related to IPR. LexisNexis, India.
9. Snustad DP, Simmons MJ (2010) Principles of Genetics, John Wiley & Sons Inc., India. 5thedition
10. Pierce BA (2016) Genetics-A conceptual approach, W.H. Freeman and Co. USA, Sixth edition.
11. Primerose SB and Twyman RM (2014), Principles of Gene manipulation and genomics. Wiley Blackwell. Seventh Edition.

Graduate Attributes

Course Objective:

This course will give an insight on various plant breeding approaches for crop improvement and related IPR related issues. It will provide a basic understanding on various tools available genomics and bioinformatics.

Course outcomes:

On successful completion of the course, students will be able to:

1. Explain the principles of plant breeding, hybridization, and selection, as well as the concepts in the improvement of major crop species, polyploidy inheritance, self-incompatibility, and the Hardy-Weinberg law of equilibrium.
2. Apply novel plant breeding tools such as TALEN's, CRISPR-Cas9, and base editing in practical scenarios to improve crop species.
3. Analyze chromosome variations in higher plants, including haploid production systems and the breeding application of haploids, as well as the significance of aneuploidy, trisomic, tetrasomic, and nullisomic conditions in genetic studies.
4. Evaluate the significance of intellectual property rights in plant breeding and assess the use of bioinformatics tools in genomics and functional genomics.
5. Design and conduct practical experiments in plant breeding and bioinformatics, including emasculation techniques, sequence analysis, gene prediction, protein modeling, chromosome analysis, and comparative genomics of bacteria.

Theory Credit: 03
Practical Credit: 01
No. of Required Classes: 75 (Theory: 45; Practical: 30)
No. of Contact Classes: 75 (Theory: 45; Practical: 30)
No. of Non-Contact Classes: Nil

Particulars of Course Designer (Name, Institution, email id):

CCS, Department of Botany
Gauhati University, Guwahati-14

Four-year Undergraduate Programme

Subject: Botany

Semester: Seventh

Major-17

Course Name: *Conservation Ecology and Biodiversity Assessment*

Course Level: 400-499, and subsequent level as per NEP structure

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit No	**Unit Content**	**No. of classes**	**Marks**
Unit 1	**Conservation Ecology**- Concept, principles, postulates and ethics, genetic variation and its loss, variation in natural populations, Species and habitat conservation- prioritizing species and habitat, protected area networks; major approaches to their management, Indian case studies on conservation/management strategy.	8	10
Unit 2	**Conservation strategies**- In-situ, Ex-situ and hybrid approaches, conservation: facilities, the establishment of new populations, captive breeding, reintroduction, advantages and disadvantages, Metapopulation- concept, types, and conservation importance	7	8
Unit 3	**Biodiversity:** Concept, levels, types and Importance, Methods for biodiversity monitoring, Indicators for biodiversity, megadiversity zones and hot spots; hottest hot spots, mega diversity countries, centres of plant diversity and endemism biodiversity and ecosystem services	6	8
Unit 4	**Threats to biodiversity:** Causes of biodiversity loss, species extinction, vulnerability of species to extinction, IUCN threat categories, Red data book; Biodiversity Act and biodiversity action plan; IPRs, national and international programs for biodiversity conservation, wildlife values and eco-tourism, wildlife distribution in India, problem in wildlife protection, role of WWF, WCU, CITES, TRAFFIC.	10	12
Unit 5	**Biodiversity Assessment:** Concept and Importance, methodology of assessment and analysis of different species groups, monitoring of different species groups; importance of documentation and use of information technology in biodiversity study, sustainable use of biodiversity; biodiversity loss and its consequences.	7	10

Unit 6	**Protected Area Network:** Concept, History, Indian Scenario: Biospheres, National Parks and Wildlife Sanctuaries, Wildlife conservation projects, Conservation population, design and management of protected areas; problems of protected areas in India, connectivity and corridors; population biology of endangered species. Population viability analysis, Wildlife conservation in NE India- Case Studies	7	12
PRACTICAL [Credit: 01]			
1. Ecological data analysis in Microsoft Excel: Data entering in Excel worksheet; Statistical interpretation in Excel; Data analysis tool, Pak: Basic graphical tools; T-test; Chi-Square test for independence of attributes; Spearman's rank correlation test. 2. Introduction to MS-Access: Creation of databases, tool bars, menu bars, opening of a data bar, entry format, entry of data, saving and formatting of data, queries of data, sorting of data and others. 3. Demonstration of biodiversity assessment methods in the University campus; 4. Qualitative and Quantitative analysis of vegetation. 5. Field visit to the forest nearby or protected area to study the biodiversity and understand the conservation strategies employing the protected area.		30	40

Reading list:

1. Anna A. Sher, Richard B. Primack · (2019) an Introduction to Conservation Biology. Oxford University Press
2. Anne E. Magurran, Brian J. McGill (2011) Biological Diversity: Frontiers in Measurement and Assessment. Oxford University Press.
3. Fred Van Dyke, Rachel L. Lamb (2020). Conservation Biology: Foundations, Concepts, Applications. Springer International Publishing 6
4. Jase Fitzgerald (2017). Biodiversity: An Introduction. Larsen and Keller Education.
5. Kelsey Malone (2020) Ecology: Evolution, Biodiversity and Conservation CALLISTO REFERENCE.
6. Krishnamurthy KV (2018) an Advanced Textbook on Biodiversity – Principles and Practice, Oxford and IBH Publishing, New Delhi.
7. Lisa Idzikowski (2019). Biodiversity and Conservation. Greenhaven Publishing LLC
8. Malcolm L. Hunter, Jr., James P. Gibbs, Viorel D. Popescu. (2021). Fundamentals of Conservation biology (4th edition). Wiley
9. Michael O'Neal Campbell. 2021. Critical Research Techniques in Animal and Habitat Ecology. Nova Science Publishers.
10. Peter Stiling (2015). Ecology: Global Insights & Investigations 2nd Edition. McGraw-Hill international edition Reference books

11. PetrosGanatsas (2021). Forest Biodiversity, Conservation and Sustainability. Mdpi AG
12. Singh JS, Singh SP and Gupta SR (2014) Ecology, Environmental Science and Conservation. 4th Edition. S. Chand & Company Pvt. Ltd.

Graduate Attributes

Course Objective:

This course will provide an understanding on importance of conservation ecology, status of the planet's biological diversity, value of biodiversity and drivers of its loss, basic concepts and scientific principles of conservation and global patterns in biodiversity, practical issues and challenges with wildlife conservation.

Course outcomes:

On successful completion of the course, students will:

1. Understand the concept and importance of biodiversity
2. Understand biodiversity changes and factors associated with the changes
3. Understand the biodiversity assessment methods
4. Understand the ecological, social, and economic impacts of biodiversity loss, and
5. Learn the management principles and tools that are used to conserve diversity at various levels.

Particulars of Course Designer (Name, Institution, email id):

CCS, Department of Botany
Gauhati University, Guwahati-14

Four-year Undergraduate Programme

Subject: Botany

Semester: Seventh

Major 18

Course Name: ***Plant diseases, diagnostic and management***

Course Level: 400-499, and subsequent level as per NEP structure

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	Introduction to Plant Diseases: Koch's postulate and germ theory of diseases, biotic and abiotic causes of plant diseases, symptoms and signs of plant diseases caused by fungi, bacteria, virus, and nematode.	6	6
Unit 2	Dissemination of plant pathogens; disease cycle; physiological changes due to disease in plants; Genetics of plant diseases	8	10
Unit 3	Diagnosis of Plant Diseases: Visual identification of common plant diseases, Laboratory techniques (microscopy, culturing, and serological tests); molecular methods (PCR, DNA sequencing, and ELISA)	8	12
Unit 4	Epidemiology of plant diseases; Disease mapping, forecasting and surveillance techniques	8	8
Unit 5	Concept of plant disease control; Cultural, Chemical, and biological control of plant diseases; Integrated pest management (IPM); Management of soil borne plant pathogens; Management of seed borne pathogens	8	12
Unit 6	Resistant gene identification and development of disease resistant plant (Traditional and biotechnological approach), GMO (bt-cotton, bt-brinjal, bt-chickpea)	7	12
PRACTICAL [Credit: 01]			
8. Study of plant disease symptoms and their causal organisms 9. Isolation and identification of pathogen from diseased plant materials 10. Isolation of soil borne fungal pathogens and their control 11. Proving of Koch's postulate at least one disease		30	40

Reading list:

1. Agrios, G. N. (2005). Plant pathology (5th ed.). Academic Press.
2. Lucas, J. A. (2015). Plant pathology and plant pathogens (4th ed.). Wiley-Blackwell.

3. Schumann, G. L., & D'Arcy, C. J. (2010). Essential plant pathology. American Phytopathological Society Press.
4. Maloy, O. C., & Murray, T. D. (Eds.). (1993). Encyclopedia of plant pathology (Vol. 1-2). Wiley-Interscience.
5. Madden, L. V., Hughes, G., & van den Bosch, F. (2007). The study of plant disease epidemics. American Phytopathological Society Press.
6. Hammond, B. G., & Lemaux, P. G. (2008). Genetically modified crops: Promises, perceptions, and realities. Advances in Agronomy, 98, 1-41.
7. Staskawicz, B. J., & Jones, J. D. (2000). Molecular plant pathology since 2000. Molecular Plant Pathology, 1(1), 9-20.

Graduate Attributes

Course Objective:

This paper will focus on the comprehensive understanding of plant diseases, their diagnosis, and effective management strategies.

Course outcomes:

On completion of the course, students will-

8. Comprehend the fundamental concepts of plant diseases, including Koch's postulates, the germ theory of diseases, and the distinction between biotic and abiotic causes of plant diseases.
9. Analyze the dissemination of plant pathogens, understand the disease cycle, and evaluate the physiological changes induced by diseases in plants, with a focus on the genetic aspects of plant pathogens.
10. Apply various diagnostic techniques for plant diseases, including visual identification, laboratory methods such as microscopy and culturing, and advanced molecular methods like PCR, DNA sequencing, and ELISA.
11. Evaluate the epidemiology of plant diseases, including disease mapping, forecasting, and surveillance techniques, to understand the spread and control of plant pathogens in different environments.
12. Propose and assess various methods for plant disease control, including cultural, chemical, and biological approaches, as well as integrated pest management strategies tailored to manage soil-borne and seed-borne plant pathogens, while also considering the identification and development of disease-resistant plants, including biotechnological approaches such as GMOs.

Theory Credit: 03
Practical Credit: 01
No. of Required Classes: 75 (Theory: 45; Practical: 30)
No. of Contact Classes: 75 (Theory: 45; Practical: 30)
No. of Non-Contact Classes: Nil

Particulars of Course Designer (Name, Institution, email id):

CCS, Department of Botany
Gauhati University, Guwahati-14

Four-year Undergraduate Programme
Subject: Botany
Semester: Seventh
Major-19
Course Name: *Environmental Microbiology*
Course Level: 400-499, and subsequent level as per NEP structure

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	Microbiology of soil, water and air (common soil microflora, microbes in soil health improvement, common water microflora, microbial water quality analysis, common air microflora)	6	6
Unit 2	Culture-dependent microbial study (Growth media, culture techniques, CFU count and enumeration, characterization of isolates and species identification)	8	10
Unit 3	Culture-independent microbial study (direct microscopic methods, meta-genomics, transcriptomics, proteomics and metabolomics)	8	12
Unit 4	Microbial interactions (symbiosis, antagonism, parasitism, commensalism, amensalism, cooperation, quorum and anti-quorum sensing)	8	8
Unit 5	Biogeochemical cycling (Role of microbes in biogeochemical cycling, carbon cycle, nitrogen cycle, sulfur cycle, phosphorus cycle)	8	12
Unit 6	Scope of microbiology in environmental engineering (reclamation of degraded soil, purification of polluted water, biodegradable waste management)	7	12
PRACTICAL [Credit: 01]			
1. Enumeration and identification of common soil microbes 2. Enumeration and identification of common water microbes 3. Use of differential media/specific media to identify a particular group of microbes 4. Catalase/Phosphatase test for bacteria 5. MPN test for water quality 6. Methylene blue reductase test for milk quality		30	40

Reading list:

1. Sylvia DM, Fuhrmann JJ, Hartel PG, Zuberer DA (2005) Principles and Applications of Soil Microbiology, Pearson, USA.
2. Pepper IL, Gerba CP, Gentry TJ (2014) Environmental Microbiology, Academic Press, USA.
3. Atlas RM (2010) Handbook of Microbiological Media, CRC Press, USA.
4. Madigan MT, Martinko JM, Bender K, Buckley D, Stahl D (2018) Brock Biology of Microorganisms, Pearson, USA.
5. Riesenfeld CS, Schloss PD, Handelsman J (2004) Metagenomics: Genomic Analysis of Microbial Communities, Kluwer Academic Publishers, USA.
6. Hugenholtz P, Tyson GW (2008) Metagenomics, Springer, USA.
7. Falkowski PG, Fenchel T, Delong EF (2008) The Microbial Engines That Drive Earth's Biogeochemical Cycles, Science, USA.
8. Fuqua C, Greenberg EP (2002) Signaling in Bacteria: New Insights into Microbial Ecology and Evolution, ASM Press, USA.
9. Schlesinger WH, Bernhardt ES (2013) Biogeochemistry: An Analysis of Global Change, Academic Press, USA.
10. Paul EA (2014) Soil Microbiology, Ecology, and Biochemistry, Academic Press, USA.
11. Bitton G (2011) Wastewater Microbiology, Wiley-Blackwell, USA.
12. Thakur IS (2006) Environmental Biotechnology: Basic Concepts and Applications, I.K. International Publishing House, India.
13. Cappuccino JG, Welsh CT (2016) Microbiology: A Laboratory Manual, Pearson, USA.
14. Benson HJ (2012) Microbiological Applications: Laboratory Manual in General Microbiology, McGraw-Hill, USA.

Graduate Attributes

Course Objective:

The objective of this course is to provide a comprehensive understanding of environmental microbiology, emphasizing microbial communities in soil, water, and air, and their roles in soil health, water purification, and biogeochemical cycles. Students will learn both culture-dependent and culture-independent techniques for studying microbes, including growth media preparation, CFU counting, and advanced genomic methods. The course covers microbial interactions and their ecological significance, and includes practical skills in microbial enumeration, identification, and biochemical testing. It also highlights the application of microbiology in environmental engineering, preparing students for advanced studies or careers in the field.

Course outcomes:

On completion of the course, students will be able to-

1. List common soil microbes and explain their role in the nitrogen cycle.
2. Understand the concept of symbiosis and provide examples of how this interaction benefits soil health.
3. Perform CFU counting and use meta-genomics data to analyze microbial diversity in a soil sample.

4. Analyze results from the methylene blue reductase test to determine milk quality and identify the presence of specific microbial contaminants.
5. Evaluate different microbial bioremediation strategies for purifying polluted water and recommend the most effective method based on scientific evidence.

Theory Credit: 03
Practical Credit: 01
No. of Required Classes: 75 (Theory: 45; Practical: 30)
No. of Contact Classes: 75 (Theory: 45; Practical: 30)
No. of Non-Contact Classes: Nil

Particulars of Course Designer (Name, Institution, email id):

CCS, Department of Botany
Gauhati University, Guwahati-14

Four-year Undergraduate Programme
Subject: Botany
Semester: Seventh
Research component-(RC-1)
Course Name: *Research Methodology*
Course Level: 400-499, and subsequent level as per NEP structure

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	Research methodology: Research concept, Identification of research gap, Understanding the scientific question(s), Novelty of research in support of existing literatures, setting hypothesis and objectives, writing research proposal/synopsis.	6	6
Unit 2	Experimental designs: Formulation of research problem, sampling technique, methods selection, experimental set up, data generation/acquiring, Coding/decoding and reproducibility of data.	8	10
Unit 3	Statistical analysis and data representation: SD, SE, Correlation and Regression, Test of significance, ANOVA, DMRT, data validation, biological significance of data, impact of small sampling size in data analysis, utility of computer/software (MS office, excel, power point, graphics, sigma plot, SPSS etc.) in data analysis and presentation	8	12
Unit 4	Scientific writings: Forms of scientific writing i.e. research articles, notes, reports, review, monograph, dissertation/thesis, popular article, etc. Components of research article, Writing strategy for a research article. Research ethics and Plagiarism	8	8
Unit 5	Field Techniques: Collection and preservation techniques of specimens (Algae, Fungi, Higher Plants), Instrumentation and safety measures in laboratory and field, sampling methods/strategy, Principle and application of GIS, GPS, Remote sensing Unit	8	12
Unit 6	Basic knowledge on analytical (Principle and application of UV-Vis, IR, FTIR and NMR Spectroscopy), Basic knowledge on separation techniques (Principal and application of Chromatography techniques, Gel filtration, Ion exchange, GC, HPLC), Centrifugation, Microscopy (Principle and application of Phase	7	12

	contrast, DIC, Fluorescence, Confocal, SEM, TEM) and molecular techniques.		
PRACTICAL [Credit: 01]			
1. A local field visits for collection and preservation of specimens like algae, fungi, and higher plants. 2. To perform statistical analysis using the software tool like Excel. 3. To work out standard deviation (SD), standard error (SE), correlation and regression, and test of significance. 4. Demonstrations on HPLC and gel filtration. 5. Detection of plagiarism using any plagiarism detection tool.		30	40

Suggested Readings:

1. Kumar R (2014) Research Methodology: A Step-by-Step Guide for Beginners. Sage Publications, UK.
2. Booth WC, Colomb GG, Williams JM (2016) The Craft of Research. University of Chicago Press, US.
3. Quinn GP, Keough MJ (2002) Experimental Design and Data Analysis for Biologists. Cambridge University Press, UK.
4. Montgomery DC (2019) Design and Analysis of Experiments. Wiley, United States.
5. Box GEP, Hunter JS, Hunter WG (2005) Statistics for Experimenters: Design, Innovation, and Discovery. Wiley-Interscience, US.
6. Zar JH (2010) Biostatistical Analysis. Pearson, US.
7. Schimel J (2012) Writing Science: How to Write Papers That Get Cited and Proposals That Get Funded. Oxford University Press, US.
8. Hofmann AH (2019) Scientific Writing and Communication: Papers, Proposals, and Presentations. Oxford University Press, US.
9. Brower JE, Zar JH, von Ende CN (1998) Field and Laboratory Methods for General Ecology. McGraw-Hill, US.
10. Wegmann M, Leutner B, Dech S (2016) Remote Sensing and GIS for Ecologists: Using Open Source Software. Pelagic Publishing, UK.
11. Skoog DA, Holler FJ, Crouch SR (2017) Principles of Instrumental Analysis. Cengage Learning, US.
12. Upadhyay A, Upadhyay K, Nath N (2014) Biophysical Chemistry: Principles and Techniques. Himalaya Publishing House, India.
13. Kirkup L (2002) Data Analysis with Excel®: An Introduction for Physical Scientists. Cambridge University Press, UK.
14. Leech NL, Barrett KC, Morgan GA (2011) SPSS for Intermediate Statistics: Use and Interpretation. Routledge, US.

Graduate Attributes

Course Objective:

The course aims to equip students with a comprehensive understanding of research methodology, covering key aspects such as identifying research gaps, formulating hypotheses, and designing reproducible experiments. Students will learn statistical analysis and data representation using software tools like MS Office, SPSS, and SigmaPlot. Additionally, they will receive training in scientific writing and ethical considerations, as well as field techniques including specimen collection and safety protocols. Basic knowledge of analytical techniques such as spectroscopy and microscopy will also be provided to support research endeavors.

Course outcomes:

On successful completion of the course, students will be able to:

1. Comprehend fundamental research concepts, critically analyze literature to identify gaps, and articulate scientific questions, setting clear hypotheses and objectives within the context of existing studies.
2. Apply experimental design principles to formulate research problems, select sampling techniques, design experimental setups, and ensure reproducibility through proper data coding and decoding.
3. Apply statistical methods and use software tools for data analysis and presentation, understanding the impact of sample size on data validity.
4. Create diverse forms of scientific writing, understand research article components, develop writing strategies, and evaluate ethical considerations and plagiarism.
5. Understand and implement collection and preservation techniques for various specimens (Algae, Fungi, Higher Plants), apply GIS, GPS, and remote sensing, and become proficient in various analytical techniques and microscopy methods while adhering to safety measures.

Theory Credit: 03
Practical Credit: 01
No. of Required Classes: 75 (Theory: 45; Practical: 30)
No. of Contact Classes: 75 (Theory: 45; Practical: 30)
No. of Non-Contact Classes: Nil

Particulars of Course Designer (Name, Institution, email id):

CCS, Department of Botany
Gauhati University, Guwahati-14

Four-year Undergraduate Programme
Subject: Botany
Semester: Eighth
Major-20
Course Name: *Molecular Genetics and Cell Signaling*
Course Level: 400-499, and subsequent level as per NEP structure

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no	**Unit content**	**No. of classes**	**Marks**
Unit 1	Structure and processing of messenger RNA, transfer RNA, ribosomal RNA, small interfering RNAs and micro RNAs, regulation through RNA processing and decay, alternative splicing	6	8
Unit 2	Transcription, RNA polymerases, initiation, elongation and termination; eukaryotic promoters, enhancers, transcription factors, processing of mRNA for translation. Operon concept in prokaryotes, Mutation and DNA repair	8	12
Unit 3	Molecular genetic techniques, Electrophoresis, restriction digestion, ligation, DNA probes and hybridization, DNA cloning, Cloning and expression vectors, genomic and cDNA library, PCR amplification, Plant and bacterial transformation, DNA sequencing. Genetic manipulation in plants	10	10
Unit 4	Applications of molecular genetic techniques: Developing transgenic plants, Genome editing in plants using CRISPR/Cas9 system, Gene silencing using RNAi, Gene therapy	7	10
Unit 5	Cell Signaling I: Cell signaling: Hormones and their receptors, cell surface receptor, signaling through G protein coupled receptors, Ion channel linked receptors, Enzyme linked receptors	6	8
Unit 6	Cell signaling II: Signal transduction pathways, second messengers, regulation of signaling pathways, bacterial chemotaxis and quorum sensing.	8	12
PRACTICAL [Credit: 01]			
1. Isolation of genomic DNA from plant materials, purification, estimation, separation with gel electrophoresis and documentation		30	40

2. RNA isolation and cDNA synthesis 3. PCR reaction and gel electrophoresis 4. Restriction digestion and mapping 5. Transformation of plasmids in bacteria 6. Plasmid isolation 7. Differential gene expression study using semi quantitative PCR or qPCR		

Reading list:

1. Gardner EJ, Simmons MJ, Snustad DP (2015) Principles of Genetics, John Wiley & sons, India. 8th edition.
2. Klug WS, Cummings MR, Spencer CA (2012) Concepts of Genetics. Benjamin Cummings, U.S.A. 10th edition.
3. Snustad DP, Simmons MJ (2010) Principles of Genetics, John Wiley & Sons Inc., India. 5thedition.
4. Pierce BA (2016) Genetics-A conceptual approach, W.H. Freeman and Co. USA, Sixth edition
5. Cooper GM, Hausman RE (2009) The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
6. Hardin J, Becker G, Skliensmith LJ (2012) Becker's World of the Cell, Pearson EducationInc. U.S.A. 8th Edition.
7. Karp G (2010) Cell Biology, John Wiley & Sons, U.S.A. 6th Edition.
8. Primerose SB and Twyman RM (2014), Principles of Gene manipulation and genomics. Wiley Blackwell. Seventh Edition.
9. Watson JD, Baker TA, Bell SP, Gann A, Levine M, Losick R (2007) Molecular Biology of the Gene, Pearson Benjamin Cummings, CSHL Press, New York, U.S.A. 6th edition.

Graduate Attributes

Course Objective:

This paper will provide knowledge of molecular genetics, and various techniques available for molecular genetics study. It will also provide in depth understanding of cell signaling and signal transduction pathways.

Course outcomes:

On successful completion of the course, students will be able to:

1. Identify and describe the different types of RNA (mRNA, tRNA, rRNA, siRNAs, miRNAs) and their roles in gene expression and regulation.
2. Explain the mechanisms of transcription, RNA processing, and the operon concept in prokaryotes, including the roles of RNA polymerases, promoters, enhancers, and transcription factors.
3. Apply molecular genetic techniques such as electrophoresis, restriction digestion, ligation, PCR amplification, and DNA cloning to manipulate and analyze genetic material.

4. Analyze the results of genetic manipulation experiments, such as plant and bacterial transformation, gene silencing using RNAi, and genome editing using CRISPR/Cas9, to assess the effectiveness of these techniques.
5. Evaluate the role and impact of various cell signaling pathways, including hormone-receptor interactions and second messenger systems, in regulating cellular processes and responses.

Theory Credit: 03
Practical Credit: 01
No. of Required Classes: 75 (Theory: 45; Practical: 30)
No. of Contact Classes: 75 (Theory: 45; Practical: 30)
No. of Non-Contact Classes: Nil

Particulars of Course Designer (Name, Institution, email id):
CCS, Department of Botany
Gauhati University, Guwahati-14

Four-year Undergraduate Programme

Subject: Botany

Semester: Eighth

Major-21

Course Name: *Fungal Diversity, Genetics, and Applications*

Course Level: 400-499, and subsequent level as per NEP structure

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	Introduction to fungal diversity; Global fungal diversity and Biogeography; Understanding Cryptic fungi; Methods for estimation of fungal diversity and conservation	6	10
Unit 2	Diversity of Soil Fungi; Diversity of Phytopathogenic fungi; Mushroom diversity; Diversity of endophytic fungi and their functional roles	6	6
Unit 3	Molecular genetic analysis of fungi; Extra chromosomal and transposable genetic elements in fungi; Cell cycle control points in yeast	9	10
Unit 4	Mating-Type switching in Yeasts; Extra-chromosomal inheritance in fungi; Sex hormones in fungi; Retroposon and retrotransposon in fungi	9	14
Unit 5	Fungal secondary metabolites (Polyketides, Terpenes, and Indole alkaloids); Heat shock protein in filamentous fungi	5	8
Unit 6	Biotechnological application of fungi in food, industries, medicines, and agriculture; Myconanotechnology; Mycoremediation and mycofumigation; Mycoses (Types, diagnosis, and treatments)	10	12
PRACTICAL [Credit: 01]			
11. Isolation and enumeration of soil fungi 12. Study of phytopathogenic fungi from diseased samples 13. Molecular identification of fungal specimen 14. Fungal tissue- culture; cultivation of edible mushroom 15. Isolation and determination of secondary metabolites from fungi		30	40

Reading list:

5. Introduction to Fungi. John Webster and Roland W. S. Weber
6. Introduction to Mycology. C. J. Alexopoulos, C. W. Mims and M. Blackwell.
7. Fungi Nutrition & Physiology. Michael O. Garraway and Robert C. Evans.
8. Physiology of Fungi. Lilian E. Hawker

9. The Mycota; Vol: III: Biochemistry and Molecular Biology. K. Esser and P. A. Lemke.
10. The Mycota; Vol: VII: Systematics and Evolution (Part A). K. Esser and P. A. Lemke.

Graduate Attributes

Course Objective:

This paper will explain the detailed account on the diversity, genetics, and applications of Fungi.

Course outcomes:

On completion of the course, students will-

5. Demonstrate an understanding of the diversity of fungi, their global distribution, and the methods used for estimating and conserving fungal diversity.
6. Analyze the roles of different types of fungi in various ecosystems, including soil, plants, and their applications in agriculture and medicine.
7. Apply molecular genetic techniques to analyze fungal genomes, understand the mechanisms of genetic inheritance, and explore the molecular basis of fungal traits and behaviors.
8. Evaluate the significance of genetic elements, such as mating-type switching and retrotransposons, in fungal evolution and adaptation to different environments.
9. Design and propose biotechnological applications of fungi in food production, industrial processes, medicine, and environmental remediation, considering the principles of mycology and practical feasibility.

Theory Credit: 03
Practical Credit: 01
No. of Required Classes: 75 (Theory: 45; Practical: 30)
No. of Contact Classes: 75 (Theory: 45; Practical: 30)
No. of Non-Contact Classes: Nil

Particulars of Course Designer (Name, Institution, email id):

CCS, Department of Botany
Gauhati University, Guwahati-14

Four-year Undergraduate Programme

Subject: Botany

Semester: Eight

Major-22

Course Name: *Exploring Cryptogams and Gymnosperms*

Course Level: 400-499, and subsequent level as per NEP structure

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	**Algae**: Recent trends in the classification, pigmentation, phylogeny and interrelationships among different groups, patterns of life cycle and post fertilization stages in Chlorophyta, Xanthophyta, Phaeophyta and Rhodophyta	6	10
Unit 2	Ecological importance in different habitats, Algal indicators, Algal blooms, Eutrophication, Productivity in fresh water and marine environment, symbiotic association, Algal culture.		
Unit 3	**Bryophytes**: Origin, evolution, classification, diversity and distribution in North East India, Economic importance. Morphological, anatomical and reproductive diversity, Morphogenesis, Evolution of gametophytes and sporophytes; Bryophytes as pollution indicator and monitoring.	6	10
Unit 4	**Pteridophyta**: Origin and evolution of Pteridophytes; Telome concept; heterospory and origin of seed habit; classification of vascular cryptogams. Morphological, anatomical and reproductive diversity, soral evolution in ferns.	8	15
Unit 5	**Palaeobotany:** Geological time scale, fossilization process, techniques in studying fossils.	2	10
Unit 6	**Gymnosperms**: Classification and salient features of major taxa; characteristics, affinities and relationships of Ginkgoales, Coniferales, Taxales and Gnetales.	8	15
PRACTICAL [Credit: 01]			
1. Study of some important genera of Algae with respect to their morphology, anatomy and reproductive structures. Algal culture technique. 2. Study of some important genera of Bryophytes available in NE India with respect to their morphology, anatomy and reproductive structures. 3. Study of some important fossil and living members of major groups of Pteridophytes. 4. Study of morphological, anatomical and reproductive features of gymnosperms available in the region.		30	40

Reading list:

1. Bhatnagar SP, Moitra A (1996) Gymnosperms. New Delhi, Delhi: New Age International (P) Ltd Publishers.
2. Kumar HD (1999) Introductory Phycology, 2nd edition. Delhi, Delhi: Affiliated East-West. Press Pvt. Ltd.
3. Puri P (1985) Bryophytes. New Delhi, Delhi, Atma Ram and Sons.
4. Singh V, Pandey PC, Jain DK (2001) A Text Book of Botany. Meerut, UP: Rastogi and Co.
5. Vashishta PC, Sinha AK, Kumar A (2010) Pteridophyta. New Delhi, Delhi: S. Chand & Co Ltd.
6. Parihar NS (1991) An IntroductiontoEmbryophyta.Vol. II.Pteridophytes. Prayagraj: U.P.: Central Book Depot.
7. Singh S. R. (2006). A Text Book of Bryphota. Campus Book International. New Delhi.
8. Chopra RN and Kumar P K. (1989) Biology of Bryophytes. New York, Wiley.
9. Singh V, Pandey PC, Jain DK (2001) A Text Book of Botany. Meerut, UP: Rastogiand Co.
10. Vashishta PC, Sinha AK, Kumar A (2010) Pteridophyta. New Delhi, Delhi: S. Chand & Co Ltd.

Graduate Attributes

Course Objective: This course will provide an understanding on the origin and evolutionary history of Algae, Bryophytes, Pteridophytes, and Gymnosperms. Understand the structural adaptations and reproductive strategies unique to each group with their importance to economic and ecological prospective.

Course outcomes:

On successful completion of the course, students will have:

1. Knowledge on Classification of algae based on recent trends.
2. Evaluate ecological roles and importance of these groups.
3. Analyze the evolutionary history and diversity of Algae, Bryophytes, Pteridophytes and Gymnosperms.
4. Synthesize knowledge of morphology and reproduction to understand evolutionary adaptations in Cryptograms.
5. Interpret the classification and characteristics of gymnosperm taxa to infer evolutionary relationships

Theory Credit: 03
Practical Credit: 01
No. of Required Classes: 75 (Theory: 45; Practical: 30)
No. of Contact Classes: 75 (Theory: 45; Practical: 30)
No. of Non-Contact Classes: Nil

Particulars of Course Designer (Name, Institution, email id):

CCS, Department of Botany
Gauhati University, Guwahati-14

Four-year Undergraduate Programme
Subject: Botany
Semester: Eight
Major-23
Course Name: *Plant Growth and morphogenesis*
Course Level: 400-499, and subsequent level as per NEP structure

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	**Photomorphogenesis:** Photochemical and biochemical properties of phytochromes, cryptochromes and phototropins; phytochrome biosynthesis, cellular localization, roles; Mechanism of action of photomorphogenetic receptors.	8	12
Unit 2	**Plant developments:** Plant developments: Biochemical changes during development of seeds; Plant movement: tropic and nastic movements.	6	8
Unit 3	**Post-harvest physiology:** Ripening of fruit and its regulation, post-harvest management; Fruit and vegetable preservation: chemical and non-chemical preservation techniques, nutritional changes during preservation.	7	8
Unit 4	**Plant Growth Regulators:** A brief idea about discovery, role and possible mechanism of action of Triacontanol, Salicylic acid, and Polyamines. A brief idea about role of plant growth retardants- CCC, Maleic hydrazide, Trizoles and TIBA.	8	10
Unit 5	**Senescence and Programmed Cell Death (PCD):** Biochemical changes during senescence of leaves and petals and regulation of senescence. PCD: Biochemical changes in cellular level, regulation of PCD, caspases and metacaspases.	8	10
Unit 6	**Applied Plant physiology:** Foliar nutrition: Conditions, factors affecting efficiency of Foliar nutrition; Advantages, and disadvantages. Chelators and soil conditioners. Phytoremediation: History, Mechanisms and types, Advantages, and disadvantages. Role of tissue culture, and mutants in plant physiological studies.	8	12
	PRACTICAL [Credit: 01]		
1. Study of changes in starch / protein content during seed development. 2. Study of lipid accumulation during development of oil seeds. 3. Demonstration of hormonal regulation of leaf and petal senescence. 4. To study the effect of different PGRs on seedling growth.		30	40

Suggested Readings:

1. Bajracharya D (1999) Experiments in Plant Physiology-A Laboratory Manual. Narosa Publishing House, New Delhi.
2. Bhatla SC, Lal MA (2018) Plant Physiology, Development and Metabolism. Springer Nature Singapore Pte Ltd.
3. Devlin RM (2017) Outline of Plant Physiology. Medtech: Scientific International Pvt. Ltd.
4. Devlin RM, Witham FH, Blaydes DF (2017) Devlin's Exercises in Plant Physiology. Medtech: Scientific international Pvt. Ltd.
5. Hopkins WG, Huner A (2008) Introduction to Plant Physiology (4th edition). John Wiley and Sons. U.S.A.
6. Kochhar SL, Gujral SK (2021) Plant Physiology: Theory and Applications (2nd edition). Cambridge University Press.
7. Malik CP, Srivastava (2015) Text Book of Plant Physiology. Kalyani Publishers, New Delhi.
8. Salisbury FB, Ross CW (2004) Plant Physiology (4th edition). Cengage Learning India Pvt. Ltd., New Delhi, India.
9. Taiz L, Zeiger E, MØller IM, Murphy A (2015) Plant Physiology and Development (6th edition). Sinauer Associates Inc. USA.

Graduate Attributes

Course Objective:

The course objective is to enable students to demonstrate a comprehensive understanding of plant photomorphogenesis, including the photochemical and biochemical properties of phytochromes, cryptochromes, and phototropins, as well as the mechanisms of action and roles of these photomorphogenetic receptors in plant development. Additionally, students will gain insights into biochemical changes during seed development, plant movement mechanisms, and post-harvest physiology with a focus on fruit ripening, preservation techniques, and nutritional changes. Furthermore, the course aims to familiarize students with plant growth regulators such as Triacontanol, Salicylic acid, Polyamines, and growth retardants like CCC, Maleic hydrazide, Trizoles, and TIBA, elucidating their roles and possible mechanisms of action. Finally, students will explore senescence, program med cell death (PCD), and applied plant physiology topics including foliar nutrition, chelators and soil conditioners, phytoremediation mechanisms and applications, as well as the role of tissue culture and mutants in advancing plant physiological studies.

Course outcomes:

On successful completion of the course, students will be able to:

1. Apply knowledge of the mechanism of action of photomorphogenesis receptors in plant responses to light.
2. Apply knowledge of tropic and nastic movements in plants and their adaptive roles.
3. Evaluate the advantages and disadvantages of chemical and non-chemical preservation techniques on nutritional changes in fruits and vegetables.
4. Evaluate the advantages and disadvantages of chemical and non-chemical preservation techniques on nutritional changes in fruits and vegetables.

Theory Credit: 03
Practical Credit: 01
No. of Required Classes: 75 (Theory: 45; Practical: 30)
No. of Contact Classes: 75 (Theory: 45; Practical: 30)
No. of Non-Contact Classes: Nil

Particulars of Course Designer (Name, Institution, email id):

CCS, Department of Botany
Gauhati University, Guwahati-14