

Four-year Undergraduate Programme
Subject: Botany
Semester: Sixth
Course Name: *Reproductive Biology of Angiosperm*
Existing Base Syllabus: UG CBCS Syllabus
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. Microgametogenesis; 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 <i>Polygonum</i> 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	12	12

	pollination, stub pollination; Intra-ovarian and <i>in vitro</i> pollination; Modification of stigma surface, parasexual hybridization; Cybrids, <i>in vitro</i> 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 <i>Paeonia</i> . Seed structure, importance, and dispersal mechanisms. Polyembryony and apomixis: Introduction; Classification; Causes and applications.	9	14
PRACTICAL [Credit: 01]			
	Anther: Wall and its ontogeny; Tapetum (amoeboid and glandular); MMC, spore tetrads, uninucleate, bi-celled and dehiscent anther stages through slides/micrographs, male germ unit (MGU) through photographs and schematic representation. Pollen grains: Fresh and acetolyzed showing ornamentation and aperture, pseudomonads, 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. Ovule: Types-anatropous, orthotropous, amphitropous/campylotropous, circinotropous, unitegmatic, bitegmatic; Tenuinucellate and crassinucellate; Special structures: Endothelium, obturator, hypostase, caruncle and aril (permanent slides/specimens/photographs). Female gametophyte through permanent slides/photographs: Types, ultrastructure of mature egg apparatus. - Intra-ovarian pollination; Test tube pollination through photographs. Endosperm: Dissections of developing seeds for endosperm with free-nuclear haustoria. 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.

Learning outcome:

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):

Prof. Bhaben Tanti

Head, Department of Botany,

Gauhati University

Email id: btanti@gauhati.ac.in

Four-year Undergraduate Programme
Subject: Botany
Semester: Sixth
Course Name: *Plant Physiology*
Existing Base Syllabus: UG CBCS Syllabus
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, Absciscic 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 stimulus, florigen concept; Vernalization; Photoreceptors: Phytochrome, cryptochrome 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.	8	12
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.

Learning outcome:

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):

Prof. Bhoben Tanti
 Head, Department of Botany,
 Gauhati University
 Email id: btanti@gauhati.ac.in

Four-year Undergraduate Programme
Subject: Botany
Semester: Sixth
Course Name: *Plant Metabolism and Biochemistry*
Existing Base Syllabus: UG CBCS Syllabus
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: C ₃ , C ₄ -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	12	14

	fixation, ammonia assimilation and transamination.		
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.

Learning outcome:

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)

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

Prof. Bhaben Tanti

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Gauhati University

Email id: btanti@gauhati.ac.in

Four-year Undergraduate Programme
Subject: Botany
Semester: Sixth
Course Name: *Applied Plant Biology*
Existing Base Syllabus: UG CBCS Syllabus
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: <i>Agrobacterium</i> -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); Improved horticultural varieties (Moondust carnations); Role of transgenics in bioremediation (Superbug).	10	12
PRACTICAL [Credit: 01]			
(a) Preparation of MS medium. (b) Demonstration of <i>in vitro</i> sterilization and inoculation methods using leaf and nodal explants of any plant species. - Study of anther, embryo and endosperm culture, micropropagation, somatic embryogenesis & artificial seeds through photographs. - Isolation of protoplasts. - Construction of restriction map of circular and linear DNA from the data provided. - Study of methods of gene transfer through photographs: Agrobacterium-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment. - Study of steps of genetic engineering for production of Bt cotton, Golden rice, FlavrSavr tomato through photographs. - Isolation of plasmid DNA. - Restriction digestion and gel electrophoresis of plasmid DNA.		30	40

Reading list:

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

Learning outcome:

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):

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