

## Course Outcome: Choice Based Credit System

### B. Sc. Botany (Honours)

Semester	Paper Code	Paper Title	Course Outcome
TDC 1 <sup>st</sup> Semester (Honours)	BOT-HC-1016	Phycology and Microbiology	Upon completing "Phycology and Microbiology" (BOT-HC-1016), students will achieve a comprehensive understanding of microbial life forms and algae. They will grasp the scope of microorganisms in industry and the environment, along with microbial nutrition, growth, and metabolism. Additionally, students will explore the classification and characteristics of viruses, including replication processes, economic significance, and their role in plant diseases. In the realm of bacteria, students will learn about their discovery, general characteristics, various types, cell structure, nutritional modes, and modes of reproduction. They will also appreciate the economic impact of bacteria, particularly in agriculture and the production of alcohol and antibiotics. The course will delve into algae, covering their general characteristics, ecology, thallus organization, cell structure, reproduction, classification, and evolutionary significance. Students will recognize the vital role of algae in the environment, agriculture, biotechnology, industry, and the economic importance of diatoms. The knowledge gained in this course will empower students to comprehend, analyze, and contribute to research and conservation efforts related to microorganisms and algae.
TDC 1 <sup>st</sup> Semester (Honours)	BOT-HC-1026	Biomolecules and Cell Biology	Upon completion of "Biomolecules and Cell Biology," students will gain a profound understanding of essential biochemistry and cell biology concepts. They will comprehend chemical bonds, water properties, pH, and biomolecule classification. Grasp thermodynamics laws, free energy, and ATP's role as an energy currency. Recognize enzyme structures, classifications, active sites, and factors affecting activity. Differentiate prokaryotic and eukaryotic cells, learn about endosymbiotic theory, and understand organelles' structures and functions. Understand cell cycle phases, mitosis, meiosis, and regulatory mechanisms. Practical skills include qualitative tests for biomolecules, cell structure

			studies, protoplasmic streaming observation, cell counting, cytochemical staining, and mitosis/meiosis examination. This course provides a strong foundation for comprehending vital biological processes and performing practical experiments effectively.
TDC 2 <sup>nd</sup> Semester (Honours)	BOT-HC-2016	Mycology and Phytopathology	Upon completing the "Mycology and Phytopathology" course, students will gain a comprehensive understanding of general fungal characteristics, classification, and cell structure. Differentiating major fungal groups, recognizing characteristic features, life cycles, and practical examples of the groups, understanding characteristics and thallus organization, understanding lichen and mycorrhiza occurrences, characteristics, and significance. Exploring fungi's roles in biotechnology, food, pharmaceuticals, agriculture, mycotoxins, and biological control. Gaining knowledge of disease terms, symptoms, etiology, and control strategies. Identifying examples of bacterial, viral, and fungal plant diseases. Practical components will develop hands-on skills in studying fungal specimens, their life stages, and associated diseases, preparing students for careers in research, agriculture, biotechnology, and environmental sciences.
TDC 2 <sup>nd</sup> Semester (Honours)	BOT-HC-2026	Archegoniate	Upon completing the Archegoniate course (BOT-HC-2026), students understand the common features of archegoniates and their role in the transition to terrestrial life, as well as the concept of alternation of generations. Comprehend bryophytes, including their general characteristics, adaptations to land, classification, and diverse thallus structures. Conduct detailed type studies of key bryophytes like Riccia, Marchantia, Anthoceros, Sphagnum, and Polytrichum, focusing on morphology, anatomy, reproduction, and evolutionary trends. Recognize the ecological and economic significance of bryophytes. Gain knowledge of pteridophytes, their general characteristics, classification, and early land plants (Cooksonia and Rhynia). Conduct in-depth type studies of pteridophytes such as Psilotum, Lycopodium, Selaginella, Equisetum, Pteris, and Marsilea, emphasizing classification, morphology, anatomy, reproduction, and important concepts like apogamy, apospory, heterospory, and telome

			<p>theory. Understand their ecological and economic relevance. Explore gymnosperms, including their general characteristics, family-level classification, and detailed studies of <i>Cycas</i>, <i>Pinus</i>, <i>Ginkgo</i>, and <i>Gnetum</i>, with a focus on morphology, anatomy, and reproduction. Recognize their ecological and economic importance. Develop practical skills to analyze the morphology of archegoniate plants, prepare slides, and identify key features. Apply theoretical knowledge to real-world scenarios, including the ecological and economic roles of archegoniates. This course provides students with a comprehensive understanding of archegoniates, encompassing bryophytes, pteridophytes, and gymnosperms, enabling them to appreciate these plants' significance in terrestrial ecosystems and human activities.</p>
TDC 3 <sup>rd</sup> Semester (Honours)	BOT-HC-3016	Morphology and Anatomy of Angiosperm	<p>Upon completing the Morphology and Anatomy of Angiosperms course (BOT-HC-3016), students will understand the morphological characteristics of angiosperms, including inflorescence, stamens, carpels, and fruits, and appreciate their role in plant classification, along with concepts like telome theory and phyllode theory. Grasp the scope and practical applications of plant anatomy, including its relevance in systematics, forensics, and pharmacognosy. Gain insight into the internal organization of the plant body, including the three tissue systems and cell types, and understand embryogenic development, polarity, cytodifferentiation, and organogenesis. Comprehend plant tissues, their classification, and specialized features like tracheary elements, sieve elements, pits, plasmodesmata, and various cellular structures. Master concepts related to apical meristems and their evolution theories, as well as the structure of stems, leaves, and roots in dicots and monocots. Develop a comprehensive understanding of vascular cambium, wood, periderm, and protective systems in plants, including their structure, functions, and ecological adaptations. Acquire practical skills for studying various plant structures, from inflorescences and fruits to anatomical details through slides and specimens. This course equips students with in-depth knowledge of angiosperm morphology and anatomy, enabling them to analyze and appreciate the intricate structures</p>

			and functions of plants in both theoretical and practical contexts.
TDC 3 <sup>rd</sup> Semester (Honours)	BOT-HC-3026	Economic Botany	Upon completing the Economic Botany course (BOT-HC-3026), students will understand the origins of cultivated plants, centers of origin, and the importance of crop genetic diversity, as highlighted in Vavilov's work. Comprehend cereals like wheat and rice, including their origins, morphology, processing, and uses, along with a brief overview of millets. Recognize legumes such as chickpea, pigeon pea, and fodder legumes, understanding their origins, morphology, and diverse uses, and appreciating their significance in both human and ecosystem contexts. Familiarize themselves with sources of sugars and starches, such as sugarcane and potatoes, including their morphology, propagation, and uses. Explore the world of spices, with an emphasis on important spices, their families, and economic importance, especially fennel, saffron, clove, and black pepper. Acquire knowledge about beverages, including tea and coffee, their plant morphology, processing methods, and uses. Understand sources of oils and fats, including extraction methods, classifications, uses, and health implications of groundnut, coconut, linseed, soybean, mustard, and coconut. Gain insights into essential oils and their uses. Comprehend natural rubber, specifically Para-rubber, covering tapping methods, processing, and uses. Explore drug-yielding plants, with a focus on therapeutic and habit-forming drugs, including Cinchona, Digitalis, Papaver, Cannabis, and tobacco. Understand their morphology, processing, uses, and health hazards. Gain insights into timber plants, with a general overview and specific reference to teak and pine. Learn about fibers, their classification based on origin, and study cotton, coir, and jute, including their morphology, extraction, and uses. In the practical component, students will develop hands-on skills for identifying and studying economic plants, enabling them to apply their knowledge practically and make informed assessments of these valuable botanical resources.
TDC 3 <sup>rd</sup> Semester (Honours)	BOT-HC-3036	Genetics	Upon completing the Genetics course (BOT-HC-3036), students will acquire a comprehensive understanding of Mendelian genetics, including its historical context and principles of

			<p>inheritance. They will be proficient in applying the chromosome theory of inheritance, probability, and pedigree analysis. Students will grasp concepts like incomplete dominance, codominance, multiple alleles, lethal alleles, epistasis, pleiotropy, recessive and dominant traits, penetrance, expressivity, and polygenic inheritance. Comprehend extrachromosomal inheritance, illustrated by examples like chloroplast inheritance, mitochondrial inheritance, and maternal effects.</p> <p>Master the concepts of linkage, crossing over, and chromosome mapping, enabling them to calculate recombination frequencies and conduct genetic mapping experiments. Explore variations in chromosome number and structure, including deletion, duplication, inversion, translocation, and their implications. Understand gene mutations, their types, molecular basis, and the role of mutagens, with an emphasis on practical mutation detection techniques and DNA repair mechanisms. Differentiate between classical and molecular gene concepts, including relevant terminology. Develop a grasp of population and evolutionary genetics, including the Hardy-Weinberg Law, factors influencing genetic variation, and their implications for speciation. In the practical component, students will gain hands-on experience in meiosis, Mendelian genetics, chromosome mapping, gene interaction, and the study of chromosomal aberrations, enhancing their ability to apply genetic principles in practical settings.</p>
TDC 4 <sup>th</sup> Semester (Honours)	BOT-HC-4016	Molecular Biology	<p>Upon completing the Molecular Biology course (BOT-HC-4016), students will understand the historical context of nucleic acids as genetic information carriers, including seminal experiments like Griffith's transformation and Hershey &amp; Chase's viral replication study. Comprehend the structures of DNA and RNA, tracing the historical journey from Miescher to Watson and Crick. Learn about the salient features of the DNA double helix, denaturation, and renaturation. Explore DNA organization in various biological entities, including prokaryotes, viruses, eukaryotes, and organelles like mitochondria and chloroplasts. Understand chromatin structure, encompassing euchromatin and heterochromatin. Master the intricacies of DNA replication, covering the chemistry of DNA</p>

			<p>synthesis, bidirectional, semi-conservative, and semi-discontinuous replication, RNA priming, and key enzymes involved. Grasp the central dogma of molecular biology and genetic code deciphering experiments. Explore transcription in prokaryotes and eukaryotes, with a focus on transcriptional regulation and practical examples. Understand gene silencing mechanisms. Comprehend RNA processing, modification, and transport, including intron-exon concepts, spliceosome machinery, alternative splicing, and mRNA processing. Master translation, including ribosome structure, tRNA charging, protein synthesis steps, fidelity, inhibitors, and post-translational modifications. In practical sessions, students will gain hands-on experience in DNA isolation, estimation, and visual understanding of replication, RNA polymerase structures, spliceosome assembly, splicing mechanisms, and ribozyme functions, enhancing their molecular biology research skills.</p>
TDC 4 <sup>th</sup> Semester (Honours)	BOT-HC-4026	Plant Ecology and Phytogeography	<p>Upon completing the Plant Ecology and Phytogeography course (BOT-HC-4026), students will develop a strong foundation in fundamental ecology concepts, understanding the interplay between organisms and their environment. Acquire comprehensive knowledge of soil, including its formation, composition, and the role of climate in shaping it. Comprehend the importance of water in various forms, from atmospheric moisture to precipitation and the hydrological cycle. Explore how plants adapt to environmental factors like light, temperature, wind, and fire. Understand biotic interactions, including trophic relationships, symbiosis, and ecological pyramids. Master population ecology, including growth dynamics and regulatory mechanisms. Gain insights into plant communities, eco-tones, and succession dynamics. Grasp ecosystem structure, function, and energy flow, along with biogeochemical cycles. Learn about phytogeography principles, continental drift, and vegetation types, with a focus on Northeast India. Develop practical skills in environmental measurement, soil and water analysis, plant adaptation assessment, and vegetation analysis through hands-on activities and field visits.</p>

TDC 4 <sup>th</sup> Semester (Honours)	BOT-HC-4036	Plant Systematics	<p>Upon completing the Plant Systematics course (BOT-HC-4036), students will recognize the significance of plant systematics in plant identification, classification, and nomenclature. Understand the principles and rules of botanical nomenclature, including ranks, author citation, typification, and the principle of priority. Explore the historical development of systems of classification, from Theophrastus to modern contributions like the APG classification. Gain proficiency in numerical taxonomy and cladistics, including character weighting, coding, and the construction of phenograms and cladograms. Comprehend the terms and concepts related to angiosperm phylogeny, such as monophyly, paraphyly, and polyphyly, and learn to illustrate evolutionary relationships using phylogenetic trees and cladograms. Develop in-depth knowledge of selected angiospermic families, including their vegetative and floral characteristics, floral diagrams, and systematic positions. Acquire practical skills in plant specimen preparation, including mounting dried and pressed plant specimens with herbarium labels. Enhance their fieldwork capabilities through visits to natural habitats and academic or research institutions, gaining practical experience in plant identification and vegetation assessment.</p>
TDC 5 <sup>th</sup> Semester (Honours)	BOT-HC-5016	Reproductive Biology of Angiosperms	<p>Upon completing the Reproductive Biology of Angiosperms course (BOT-HC-5016), students will gain an understanding of the historical contributions of scientists in reproductive biology. Explore the development of reproductive structures in plants, from flower induction to genetic and molecular aspects. Learn about anther and pollen biology, including microsporogenesis, pollen wall structure, viability, and abnormalities. Comprehend the structure and types of ovules, including special structures and the development of female gametophytes. Understand pollination types, stigma and style structure, pollen tube growth, and double fertilization. Explore self-incompatibility and methods to overcome it, including in vitro pollination. Study embryo, endosperm, and seed development, including types of embryos and seed dispersal. Gain knowledge about polyembryony and apomixis. Practical skills will include studying anther development, pollen morphology, ovule types,</p>

			female gametophyte structure, embryo development, pollen viability, and germination. Students will also learn pollination techniques and seed dissection.
TDC 5 <sup>th</sup> Semester (Honours)	BOT-HC-5026	Plant Physiology	Upon completing the Plant Physiology course (BOT-HC-5026), students will understand plant-water relations, including water potential components, absorption, and transpiration mechanisms, and analyze factors affecting transpiration. Gain knowledge of mineral nutrition, essential and beneficial elements, nutrient deficiency symptoms, and ion uptake mechanisms. Explore sugar translocation in the phloem, the Pressure-Flow Model, phloem loading/unloading, and source-sink relationships. Learn about plant growth regulators (auxins, gibberellins, cytokinins, abscisic acid, ethylene, brassinosteroids, jasmonic acid), their chemical nature, bioassay methods, and roles. Understand flowering physiology, including photoperiodism, florigen, vernalization, and seed dormancy. Gain insights into photoreceptors (phytochrome, cryptochromes, phototropins) and their roles in photomorphogenesis. Practical skills include determining osmotic potential, water potential, studying transpiration, calculating stomatal indices, conducting IAA bioassays, and demonstrating physiological processes like transpiration and fruit ripening/rooting.
TDC 5 <sup>th</sup> Semester (Honours)	BOT-HE-5016	Natural Resource Management	Completing the Natural Resource Management course (BOT-HE-5016) will equip students with a comprehensive understanding of resource conservation and sustainable utilization. They will learn about various natural resources, including land, water, biological resources, forests, and energy sources. The course emphasizes the concept of sustainable resource management, considering economic, ecological, and socio-cultural approaches. Students will explore land utilization practices like agriculture, pastoralism, horticulture, and silviculture, along with strategies to combat soil degradation. They will delve into water resources, covering freshwater, marine, estuarine, and wetland ecosystems, and study threats and management strategies. The course includes topics on biodiversity, bioprospecting, intellectual property rights, and conservation efforts. Forest conservation, energy resource classification, and contemporary management practices like

			Environmental Impact Assessment, GIS, and Ecological Footprint analysis are also part of the curriculum. Students will gain insights into national and international resource conservation initiatives. Practical sessions involve waste estimation, forest cover analysis, ecological footprint calculation, and GPS/GIS utilization for mapping. This knowledge prepares students for roles in environmental conservation and sustainable resource management.
TDC 5 <sup>th</sup> Semester (Honours)	BOT-HE-5026	Horticultural Practices and Post-Harvest Technology	The Horticultural Practices and Post-Harvest Technology course (BOT-HE-5026) is designed to provide students with a comprehensive understanding of horticulture. This six-credit course consists of both theoretical and practical components. In the theoretical part, students are introduced to the concept of horticulture and its significance in rural economies, employment generation, and food security. They learn about various types of ornamental plants, fruit and vegetable crops, and their production, management, and marketing. The course covers essential horticultural techniques such as fertilization, weed control, irrigation methods, and propagation. Landscaping and garden design are explored, along with floriculture, post-harvest technology, disease control, and integrated pest management. Students also gain insights into germplasm conservation, micropropagation, and intellectual property rights in horticulture. The practical component includes field visits to gardens, crop sites, nurseries, and horticultural fields, providing hands-on experience. Upon completing this course, students will be well-equipped to pursue careers in horticulture, landscaping, and post-harvest management, contributing to sustainable food production and urban beautification.
TDC 6 <sup>th</sup> Semester (Honours)	BOT-HC-6016	Plant Metabolism	Upon completing the Plant Metabolism course (BOT-HC-6016), students will develop a strong foundation in metabolic concepts, including anabolic and catabolic pathways, enzyme regulation, and coenzyme functions. Acquire in-depth knowledge of carbon assimilation processes, including photosynthetic pigments, electron transport, and various photosynthetic pathways, enabling them to understand how plants convert light energy into chemical energy. Comprehend carbohydrate metabolism, focusing on the synthesis and breakdown of sucrose and

			<p>starch, essential for understanding energy storage and utilization in plants. Explore carbon oxidation pathways, such as glycolysis and the TCA cycle, and grasp their regulation and roles in energy production. Gain insights into ATP synthesis mechanisms, emphasizing chemiosmotic processes and the role of ATP in cellular energy transfer. Understand lipid metabolism, including triglyceride synthesis and breakdown, essential for comprehending energy reserves and utilization. Study nitrogen metabolism, covering nitrate assimilation, biological nitrogen fixation, and ammonia assimilation, critical for plant growth and development. Learn about signal transduction mechanisms, providing insights into how plants respond to external cues and regulate metabolic processes. In practical sessions, students will perform experiments related to photosynthetic pigment analysis, sugar and protein estimation, and chromatography techniques to reinforce theoretical knowledge and develop laboratory skills.</p>
TDC 6 <sup>th</sup> Semester (Honours)	BOT-HC-6026	Plant Biotechnology	<p>Upon completing the Plant Biotechnology course (BOT-HC-6026), students will to develop a deep understanding of plant tissue culture techniques, including nutrient and hormone requirements, totipotency, organogenesis, and applications like micropropagation, virus elimination, and germplasm conservation. Learn about crucial aspects such as restriction endonucleases, cloning vectors, and gene cloning techniques, enabling them to manipulate DNA for various purposes. Explore methods of gene transfer like Agrobacterium-mediated transformation, electroporation, microinjection, and microprojectile bombardment, along with their applications. Understand how biotechnology transforms agriculture, including genetically engineered pest-resistant and herbicide-resistant crops, improved horticultural varieties, and the production of vital products like human growth hormone and insulin. Gain insights into the ethical and safety considerations associated with biotechnology. Through practical sessions, students will gain hands-on experience in plant tissue culture, genetic engineering, and molecular biology techniques. This knowledge and practical exposure will prepare them for careers in biotechnology, research, and agriculture,</p>

			where they can contribute to advancements in crop improvement and biotechnological innovations.
TDC 6 <sup>th</sup> Semester (Honours)	BOT-HE-6016	Industrial and Environmental Microbiology	<p>The course "Industrial and Environmental Microbiology" (BOT-HE-6016) is a comprehensive six-credit program encompassing theory and practical components. In the theoretical section, students explore the diverse applications of microorganisms in industry and the environment. They delve into bioreactors, fermentation processes, and various types of fermentations, including solid-state and liquid-state. The course covers bioreactor components and types, from laboratory-scale to production-scale fermenters. Students also gain practical exposure by visiting educational institutes or industries with industrial-scale fermenters. Microbial production of industrial products is a core focus, including microorganisms involved, fermentation conditions, downstream processing, and applications. Hands-on experience is provided in microbial fermentations for enzyme, organic acid, alcohol, and antibiotic production. The course also covers industrial enzymes, enzyme immobilization, and their applications.</p> <p>The role of microbes in maintaining environmental quality is explored, especially in water and wastewater treatment. Additionally, the course addresses microbial impacts on agriculture and soil remediation, including biological fixation and bioremediation.</p> <p>In the practical component, students learn essential microbiological techniques such as sterilization, media preparation, and pure culture methods. This course equips students with knowledge and skills to apply microbiology principles in industrial processes and environmental management.</p>
TDC 6 <sup>th</sup> Semester (Honours)	BOT-HE-6036	Project work/Dissertation	The "Project Work/Dissertation" course (BOT-HE-6036) is a vital component of the academic curriculum, providing students with a platform to conduct independent research in the field of botany. During this course, students select a specific research topic within botany, review relevant literature, design and execute experiments or data collection, analyze findings, and document their research in a comprehensive report. The key objectives include fostering

			<p>research skills, critical thinking, and problem-solving abilities in students. They learn to apply theoretical knowledge to practical scenarios and contribute to the advancement of botanical science. Presentation and communication skills are honed as students often present their findings to peers or faculty. Ultimately, this course empowers students to engage in original research, make meaningful contributions to the field, and prepare for future careers in academia, research institutions, or industries related to botany and environmental science. Successful completion of a dissertation demonstrates a student's proficiency in scientific research and is a significant component of their academic evaluation.</p>
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