

**Program Outcomes (POs)**  
**Program Specific Outcomes (PSO)**  
**Course Outcomes (COs)**



**DEPARTMENT OF BOTANY**

**DOON (P.G.) COLLEGE OF AGRICULTURE SCIENCE AND TECHNOLOGY  
SELAQUI, DEHRADUN, UTTARAKHAND.**

## COURSE OUTCOMES OF M.SC. (BOTANY) PROGRAMME

### First Semester

The students will be able to:

#### SOLS/BOT/C001 Mycology and Microbiology

CO1	Discuss the history and scope of mycology.
CO2	Discuss the general characters and structural organization of Fungi.
CO3	Discuss the phylogeny of fungi and general account of Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina and Deuteromycotina.
CO4	Describe the symptoms and causal organisms of various fungal diseases of plants.
CO5	Discuss the brief history of Microbiology.
CO6	Describe the structure and economic importance of Archaeobacteria and Eubacteria.
CO7	Discuss the characteristics, mode of reproduction and economic importance of viruses.
CO8	Describe the general characteristics and role of phytoplasma in causing plant diseases.
CO9	Discuss the basics of Immunology.

#### SOLS/BOT/C002 Phycology and Bryology

CO1	Learn about the habitats of algae.
CO2	Discuss about the thallus organization, cell structure, and reproduction of algae.
CO3	Explain the criteria and classification of algae.
CO4	Discuss about the phylogeny and interrelationships of algae.
CO5	Discuss about the classification and salient features of Chlorophyta, Charophyta, Xanthophyta, Bacillariophyta, Phaeophyta, Rhodophyta and Cyanophyta
CO6	Describe the life cycles, cytology, sexuality, physiology and biochemistry of algae.
CO7	Discuss about the economic importance of algae.
CO8	Discuss about the morphology, structure reproduction and life history of Bryophytes.
CO9	Discuss the classification and phylogeny of various groups of Bryophytes.
CO10	Discuss the general account of Marchantiales, Jungermanniales, Calobryales, Sphaerocarpaceales and Anthocerotales.
CO11	Explain the features of Sphagnales, Andreales, Funariales and Polytrichales.
CO12	Learn the distribution of bryophytes in the Himalaya and to discuss the ecology and association of bryophytes with other organisms.
CO13	Provide the general account of fossils bryophytes.

#### SOLS/BOT/C003 Pteridology, Gymnosperm and Palaeobotany

CO1	Discuss the history origin, classification, present and past distribution, morphology and life history of Psilophyta.
CO2	Discuss the history origin, classification, present and past distribution, morphology and life history of Lycophyta.
CO3	Discuss the history origin, classification, present and past distribution, morphology and life history of Sphenophyta.

CO4	Discuss the history origin, classification, present and past distribution, morphology and life history of Pterophyta.
CO5	Discuss the classification and distribution of Gymnosperms in India with special reference to Himalaya.
CO 6	Describe the morphology, structure and life history of Pteridospermales.
CO 7	Describe the morphology, structure and life history of Bennettitales.
CO 8	Describe the morphology, structure and life history of Cycadales.
CO 9	Describe the morphology, structure and life history of Pentoxylales and Cordaitales.
CO 10	Describe the morphology, structure and life history of Ginkgoales.
CO 11	Discuss a general account of fossil and living coniferales and taxaes.
CO12	Discuss a general account of Ephedrales, Welwitschiales and Gnetales.
CO13	Describe the economic importance of Gymnosperms.
CO14	Discuss the basics, and types of fossils.
CO15	Provide a general account of Indian Gondwana Sequence.
CO16	Discuss the introductory idea of Continental Drift Hypothesis.

#### **SOLS/BOT/C004 Taxonomy and Diversity of Flowering Plants**

CO1	Discuss about the origin of variations in the population.
CO2	Describe the concept species, taxonomic hierarchy, delimitation of taxa and attribution of rank.
CO3	Learn about the salient features of the International Code of Botanical Nomenclature.
CO4	Discuss about the taxonomic evidences and taxonomic tools.
CO5	Learn about the important systems of angiosperm classification.
CO6	Learn about the uses and importance of Herbarium and Botanical gardens.
CO7	Discuss about the plant exploration in India with special reference to Northwest and Uttarakhand Himalaya.
CO8	Learn the status of flowering plant diversity in Garhwal Himalaya.
CO9	Learn the key features and important plants of various Dicot families.
CO10	Learn the distinguishing features and important plants of various monocot families.

#### **SOLS/BOT/C005 Laboratory Course I**

CO1	Discuss the experimental knowledge of representative genera of various sub-divisions of Fungi.
CO2	Discuss the symptomatology of plant diseases caused by fungal pathogens of various groups.
CO3	Learn about the various instruments routinely required for executing the microbiological studies in the laboratory.
CO4	Learn the techniques and steps required for isolation and studying the rood nodule bacteria <i>Rhizobium</i> .
CO5	Perform isolation and enumeration of microbes from natural samples using Agar Plate technique.
CO6	Discuss the morphological and indentifying features of various algae.

CO7	Discuss the morphological and indentifying features of various algae.
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### **SOLS/BOT/C006 Laboratory Course II**

CO1	Discuss the morphological and indentifying features of representative genera of Pteridophytes.
CO2	Discuss the morphological and indentifying features of representative genera of Gymnosperms.
CO3	Learn the fossil flora using specimens and slides.
CO4	Learn the practical knowledge of identification and description of locally available plants using fresh specimens, herbarium and preserved materials.
CO5	Learn the practical aspects of studying intraspecific variations.
CO6	Learn the practical knowledge of preparing characters keys up to generic level.
CO7	Learn the diversity and distribution of plants thorough field trips.

### **Second Semester**

#### **SOLS/BOT/C007 Plant Development and Reproductive Biology**

CO1	Understand the process of seed germination and seedling growth.
CO2	Understand the organization and differentiation of shoot.
CO3	Discuss the role of cambium in secondary growth of plants.
CO4	Discuss the growth, differentiation and arrangement of leaf on the stem.
CO5	Describe the growth and development of root.
CO6	Learn the developmental process and organization of plant reproductive organs.
CO7	Learn the structure and development of male gametophyte.
CO8	Learn the structure and development of female gametophyte.
CO9	Describe the types and modes of pollination in plants as also the importance of self-incompatibility and double fertilization.
CO10	Discuss the developmental process of seed and fruits.
CO11	Learn the phenomenon of seed dormancy, its reasons and possible ways to breaking it.
CO12	Lean the process of Senescence and concept of Programmed Cell Death (PCD) in plants.

#### **SOLS/BOT/C008 Resource Utilization, IPR and Ethnobotany**

CO1	Discuss the concept, status, utilization and concerns of plant resource utilization.
CO2	Learn about the World Centers of Primary Diversity of domesticated plants.
CO3	Discuss the origin, cultivation, cytotaxonomy and uses of Cereals, Millets, Legumes and sugar and starch yielding plants.
CO4	Describe the origin, cultivation, cytotaxonomy and uses of fiber yielding and medicinal plants.
CO5	Discuss about the firewood, timber, tannins, gum, resins and beverages yielding plants.
CO6	Learn about the IPR and international convention of Biological Diversity.
CO7	Learn the concepts of Ethnobotany and its study tools with special reference to Himalaya.

CO8	Discuss the benefits and adverse consequences of Green Revolution.
CO9	Describe about the ornamental plants and avenue trees.
CO10	Discuss the concepts of biodiversity conservation and its major approaches.
CO11	Describe the importance of Sanctuaries, National Parks and Biosphere Reserves.

### **SOLS/BOT/C009 Cytogenetics and Molecular Biology**

CO1	Discuss the structural organization of plant cell and their various specialized forms.
CO2	Discuss the structure, composition, growth and function of the cell wall.
CO3	Describe the structure and function of plasma membrane.
CO4	Discuss the structure, genome organization and gene expression of Chloroplast and Mitochondria.
CO5	Describe the structural organization and function of nucleus.
CO6	Discuss the structure, and functions of ribosomes in protein synthesis.
CO7	Understand the detail organization Chromatin, packaging of DNA and structural forms of chromosomes.
CO8	Describe the principles of inheritance including exceptions to Mendelian laws.
CO9	Discuss the structural and numerical alterations of chromosomes.
CO10	Describe the genetics of prokaryotic and eukaryotic organisms.
CO11	Discuss the gene structure and expression in prokaryotic and eukaryotic organisms.
CO12	Understand the concept of genetic recombination and genetic mapping.
CO13	Discuss the various aspects of mutation such as types, causes and biological importance
CO14	Understand the concept of C-value paradox and cot curves related to the nuclear DNA content.

### **SOLS/BOT/C010 Plant Breeding and Biostatistics**

CO1	Discuss the definition, historical aspect, genetic basis, and classical and modern tools of plant breeding.
CO2	Discuss the concept of hybridization and its applications in achieving the breeding objectives.
CO3	Describe the physiological and genetic basis of heterosis.
CO4	Describe the concepts and steps of plant breeding to raise resistance against diseases as also to generate new physiological races.
CO5	Discuss the role of mutation in plant breeding.
CO6	Describe the plant breeding work done in India for raising the improved varieties of potato, paddy, wheat and sugarcane.
CO7	Learn the maintenance, registration, production, testing, certification and distribution of seeds.
CO8	Discuss the importance and applications of biostatistics in life sciences.
CO9	Understand the methods of statistical representation of data and the measurement of the central tendencies for the same.
CO10	Understand the process of calculating correlation, regression, curve fitting and ratio of variation of data.

CO11	Discuss the use of probability and binomial trials in life science research.
CO12	Describe the significance of $X^2$ , 't' and 'f' tests in life science research.

### **SOLS/BOT/C011 Laboratory Course I**

CO1	Understand the effect of gravity, unilateral light and plant growth regulators on the growth of young seedlings.
CO2	Understand the role of dark and red-farred light on the expansion of cotyledons and epicotylar hook opening in pea.
CO3	Understand the cytohistological zones in the shoot apical meristem through preparing sectioned and double stained slides of various suitable plant species, such as <i>Coleus</i> , <i>Kalanchoe</i> and <i>Nicotiana</i> .
CO4	Understand the leaf arrangement through studying fresh specimens of various types.
CO5	Discuss the differences in the anatomy of C3 and C4 plants by making suitable preparation of leaves of various plants such as <i>Cannabis</i> , <i>Nicotiana</i> , <i>Zea mays</i> and <i>Triticum</i> .
CO6	Study the distribution of stomata and effect of ABA treatment on their closing.
CO7	Learn the experimental knowledge related to the whole root morphology and composition of root apical meristems.
CO8	<ul style="list-style-type: none"> <li>• Understand the experimental steps required for studying the microsprogenesis and gametogenesis in plants.</li> <li>• Learn the experimental knowledge of performing pollen viability as also pollen germination test.</li> <li>• Discuss the experimental steps for pollen storage and studying pollen pistil interaction.</li> <li>• Study the ovule in cleared preparations.</li> <li>• Describe the experimental procedures of studying pollination mechanisms in plants.</li> </ul>
CO9	Learn the resource utilization, IPR and Ethnobotany through carrying out laboratory work, field survey and scientific visits.
CO10	Discuss the experimental procedures for the estimation of carbohydrates, proteins, oils, vitamins, and various other economically and biologically important components of plant products..
CO11	Demonstrate the morphology and microscopic structure of oil yielding tissues.
CO12	Demonstrate the preparation of water extract of vegetable tannins and dyes of various plants.

### **SOLS/BOT/C0012 Laboratory Course II**

CO1	Demonstrate the various stages of mitotic and meiotic cell divisions.
CO2	Demonstrate the two sub-COs of Rubisco performing SDS-PAGE of chlorplastic proteins.
CO3	Isolate DNA and prepare 'cot' curves.
CO4	Perform restriction digestion of plant DNA and its separation using AGE and visualization by staining with EtBr.
CO5	Isolate and quantify RNA using spectrophotometric method.

CO6	Execute southern, northern, western and ELISA.
CO7	Solve problems related to the Mendelian, post-Mendelian ratios, gene interactions, sex linked inheritance and chromosomal mapping.
CO8	Perform the normal practices of plant breeding.
CO9	Identify the Indian varieties of important crops.
CO10	Describe the importance of floral biology of local food, pulse, vegetable and horticulture crops in achieving the breeding objectives.
CO11	Learn the key steps and precautions of collecting germplasm of different crops being grown in the area.
CO12	Demonstrate the use of biometrical techniques in life science studies.
CO13	Perform the goodness of fit and Chi-square test of experimentally collected data.

### Third Semester

#### **SOLS/BOT/C0013 Plant Physiology and Biochemistry**

CO1	Understand the concept of diffusion, osmosis and water potential.
CO2	Understand the concepts of energy flow, chemical potential and structure and function of ATP.
CO3	<ul style="list-style-type: none"> <li>• Understand the structure, composition and functional mechanisms of various biologically important molecules like carbohydrates, amino acids, proteins and lipids.</li> <li>• Understand the fundamentals of enzymology</li> </ul>
CO4	Understand the membrane transport and translocation of water and solutes.
CO5	Understand the fundamentals and advanced aspects of photophysiology and photosynthesis.
CO6	Understand the fundamentals and advanced concepts related to the process of respiration and lipid metabolism.
CO7	Understand the overview, biochemistry and molecular mechanisms of nitrogen fixation and its assimilation in plants.
CO8	Discuss the history and functional mechanisms of plant hormones and sensory photobiology.

#### **SOLS/BOT/C0014 Ecology and Remote Sensing**

CO1	Understand the organization of vegetation.
CO2	Understand the development of vegetation.
CO3	Understand the organization and functioning of ecosystem.
CO4	Understand the biogeochemical cycling of C, N, P and S in terrestrial ecosystem.
CO5	Discuss the concept of ecosystem stability.
CO6	Describe the status, types, and importance of biological diversity in the functioning of ecosystem.
CO7	Discuss about the climate and vegetation pattern of the world.
CO8	Discuss the definition, profile and components of soil types of the world.
CO9	Discuss about the climate change and its consequences in relation to the CO <sub>2</sub> fertilization, global warming, sea level rise and threats of UV radiation.

CO10	Describe the importance of Fire as an ecological factor. Discuss the role of fire in the management of various forest types in special reference to the forests of Uttarakhand.
CO11	Understand the concept of sustainable development and sustainability indicators.
CO12	Understand the fundamentals, and applications of remote sensing in ecological and forestry research.

### **SOLS/BOT/C0015 Laboratory Course I**

CO1	Demonstrate the effect of temperature on the permeability of cytoplasmic membrane.
CO2	Determine the osmotic potential of cell saps of living cells by plasmolytic methods.
CO3	Determine the diffusion pressure deficit of plant cells.
CO4	Set up a Wilmott's bubbler to study the effect of carbon dioxide concentration and light quality on the rate of photosynthesis.
CO5	Extract the photosynthetic pigments from the green leaf, and to study the absorption spectrum of different pigments.
CO6	Separate the photosynthetic pigments from the green leaves using paper chromatography and column chromatography.
CO7	Separate the amino acids by paper chromatography.
CO8	Understand the principles of colorimetry, spectrophotometry and flourimetry.
CO9	Determine the minimum size and number of quadrats to be laid down in the field for the calculating the diversity indices.
CO10	Determine the frequency, density and abundance of species present in a community.
CO11	Calculate relative frequency and relative density of species in a given area.
CO12	Calculate mean basal cover and total basal cover of each species in a given area.
CO13	Compute the relative dominance and IVI of species in a given area.
CO14	Calculate the Alpha, Beta and total diversity of a given area.
CO15	Estimate water holding capacity and percolation percentage of a given soil.
CO16	Find out the bulk density and porosity of different soil types.
CO17	Test the pH and buffering properties of soils.
CO18	Study the types of aerial photos and satellite data products
CO19	Study the orientation of stereo model under mirror stereoscope.

### **SOLS/BOT/E001A Recombinant DNA Technology**

CO1	Understand the fundamentals and scope of rDNA technology in various sectors.
CO2	Understand about the various types of cloning vectors and their use for genomic library construction.
CO3	Discuss the rationale for the design of vectors for the over expression of recombinant proteins.
CO4	Describe the selection of suitable promoter sequences, ribosome binding sites, transcription terminator, fusion protein tags, purification tags, protease cleavage sites and enzymes, etc.



CO5	Learn the key facts of experiments using model systems: <i>E. coli</i> , <i>Yeast</i> , <i>Baculovirus</i> , <i>Agrobacterium tumifaciens</i> .
CO6	Discuss the basic idea of transformation, conjugation and transduction.
CO7	Describe the transformation and identification of recombinants, and transformation of non-bacterial cells.
CO8	Understand the key steps required for obtaining clone of a specific gene.
CO9	Discuss about the process of locating the cloned gene in plasmid and in chromosomes using southern hybridization and chromosome walking techniques.
CO10	<ul style="list-style-type: none"> <li>• Understand the transcript analysis and regulation of the gene expression,</li> <li>• Discuss about the process of identifying and studying the translational product of a cloned gene using HRT and HART techniques.</li> </ul>
CO11	Understand the process and approaches of DNA sequencing methods.
CO12	<ul style="list-style-type: none"> <li>• Understand the concept of whole genome analysis.</li> <li>• Discuss the preparation of ordered cosmid libraries and bacteria artificial chromosome libraries.</li> <li>• Describe the steps and mechanism of PCR &amp; its application.</li> <li>• Discuss about the molecular markers and DNA finger printing technique.</li> <li>• Understand the basic concepts and applications of Bioinformatics.</li> </ul>

#### **SOLS/BOT/E001B Forest Ecology**

CO1	Understand relationship of forests, forestry and man.
CO2	Discuss the essential elements of forest ecology.
CO3	Describe the composition, structure, dynamics, growth and classification of forests and also about the factors affecting forests.
CO4	Discuss the various aspects of Wild Life in relation to Sanctuaries and Biosphere reserves.
CO5	Describe the essential components of forest conservancy and its potential productivity.
CO6	Understand the important aspects of Forest Conservation and Management.
CO7	Understand the issues related with environmental Impact Assessment.

#### **SOLS/BOT/E001C Natural Resource Management in Himalaya**

CO1	Understand the topographic, geomorphic, socio-economic and demographic profile of Uttarakhand Himalaya.
CO2	Understand the natural resources, their classification and consumption pattern emphasizing with sustainability of natural resource.
CO3	Understand the use and sustainable management natural resources.
CO4	Learn the status of natural resources and its sustainable management in Garhwal Himalaya.
CO5	Understand the concept of environment management, environmental protection and fundamental rights, man & environment.
CO6	Discuss about the environment impact assessment, planning and significance.
CO7	Understand the disaster management, classification, concept of landslide and earthquake in Garhwal Himalaya.
CO8	<ul style="list-style-type: none"> <li>• Discuss the global warming and climate change, weather &amp; modification, loss</li> </ul>

	<p>of biodiversity.</p> <ul style="list-style-type: none"> <li>• Describe the indicators of climate change and consequences of climate changes.</li> <li>• Understand the concept of retreating of glaciers.</li> </ul>
CO9	Understand the impact of climate change on natural resources with special reference to Garhwal Himalaya and strategies for mitigation.
CO10	Understand about the water resources, status and conservation in India.
CO11	Discuss about the watershed management techniques.
CO12	<ul style="list-style-type: none"> <li>• Describe the importance of water resources in Uttarakhand (glaciers, lakes and rivers of Uttarakhand),</li> <li>• Discuss the utilization pattern of water resources</li> <li>• Describe about the drainage systems of Ganga, Yamuna and Ramganga.</li> </ul>
CO13	<ul style="list-style-type: none"> <li>• Understand prospects and environmental consequences of development of hydropower projects in Uttarakhand.</li> <li>• Describe about the strategies and policy for water conservation in Uttarakhand.</li> </ul>
CO14	Understand the concept of agroecosystem, farming system, traditional agriculture practices, crop rotation; land use pattern, land-form, land-use change, soil erosion and productivity.
CO15	<ul style="list-style-type: none"> <li>• Understand the effect of climate change on agro-ecosystem.</li> <li>• Understand the challenges of conservation of crop diversity in Garhwal Himalaya.</li> </ul>
CO16	<ul style="list-style-type: none"> <li>• Learn about the traditional seed supply system of mountain farmers,</li> <li>• Understand the diversity and risks to crop genetic resources,</li> <li>• Discuss the key points of agriculture policy.</li> </ul>

#### **SOLS/BOT/E001D Palynology and Pollination Biology**

CO1	<ul style="list-style-type: none"> <li>• Understand the general concepts of palynology and</li> <li>• Discuss the process of microsporogenesis, formation of microspore tetrads and polarity of spores and pollen grains.</li> </ul>
CO2	Discuss the structure and development of pollen wall development.
CO3	Describe the morphological features of Spore-pollen.
CO4	Describe the various aspects of Palynotaxonomy.
CO5	Discuss the importance of Aeropalynology with reference to allergy.
CO6	Discuss the concepts, scope and future perspectives of Melissopalynology.
CO7	Describe the idea of palaeopalynological remains and significance of palaeopalynology.
CO8	Discuss the forensic applications of palynology.
CO9	Understand the various aspects of pollination biology.
CO10	Describe the roles of palynology in plant breeding and biotechnology.

#### **SOLS/BOT/E001E Any Other Elective Course Offered by Other Departments**


**SOLS/BOT/E001F Algal Biotechnology**

CO1	<ul style="list-style-type: none"><li>• Understand the methods of mass cultivation of algae.</li><li>• Understand the importance of photobioreactors in mass cultivation of algal biomass.</li></ul>
CO2	<ul style="list-style-type: none"><li>• Understand the factors responsible for the formation of algal blooms.</li><li>• Discuss the harmful effects of algal blooms.</li></ul>
CO3	Discuss the commercial prospective of <i>Spirulina</i> , <i>Chlorella</i> , <i>Dunaliella</i> , <i>Porphyra</i> and other seaweeds, and hydrogen production by algae.
CO4	Understand the physiological, biochemical and molecular adaptation of thermophilic and psychrophilic algae and their commercial potential.
CO5	Describe the use of high-rate algal ponds for the treatment of wastewaters and for the production of useful biomass and energy; immobilized, self-immobilized and inactivated algal biomass for metal and nutrient removal.
CO6	Understand the diversity and importance of cyanobacteria in Paddy field.
CO7	<ul style="list-style-type: none"><li>• Discuss the influence of climate change on high latitude algae.</li><li>• Describe the role of algae in carbon sequestration and generating feedstock for the production of biofuel.</li></ul>
CO8	<ul style="list-style-type: none"><li>• Describe the characteristic, development and industrial applications of phototrophic biofilms and mats.</li><li>• Discuss the importance of periphytic algal community to aquatic systems.</li></ul>

**SOLS/BOT/E002A Plant Health Management**

CO1	Describe the basic procedure of diagnosis of plant diseases.
CO2	Discuss the concepts of seed pathology.
CO3	Discuss the important diseases of Nursery.
CO4	Discuss the important diseases of plantation.
CO5	Discuss the important diseases of cash crops.
CO6	Describe the various types of mycorrhizal associations and their role in forestry.
CO7	Describe the diseases of cereals and millets.
CO8	Describe the diseases of vegetables and fruit trees.

**SOLS/BOT/E002B Diversity and Cultivation of Mushrooms**

CO1	Understand the general characteristics and life history of mushrooms.
CO2	Understand the biodiversity of mushrooms.
CO3	Understand the status of mushroom research in India.
CO4	Understand the features of edible and poisonous mushrooms.
CO5	Understand the features and systematics of Agaricales.
CO6	Understand the features and systematics of Aphylophorales.
CO7	Understand the features and systematic of Gasteromycetes.
CO8	Understand the process of DNA isolation, amplification and ITS.
CO9	Understand the computer application in Mushroom Science.
CO10	Understand the ecology of mushrooms.
CO11	Understand the features and importance of mycorrhiza.
CO12	Understand the process of cultivation of edible and medicinal mushrooms.

**SOLS/BOT/E002C Applied Plant Anatomy**

CO1	Understand the types, working and utility of different types of microscopes.
CO2	Understand the important knowledge of wood structure.
CO3	Understand the process of wood formation.
CO4	Understand the physical features of wood.
CO5	Understand the gross features of wood.
CO6	Understand the ultra structure of wood.
CO7	Understand the natural defects of wood.
CO8	Understand the wood structure in relation properties and uses.
CO9	Understand the criteria and methods of assessment of wood quality in plantation grown timber viz. <i>Eucalyptus</i> , and Poplar for pulp and timber.

**SOLS/BOT/E002D Ecosystem Analysis, GIS and Remote Sensing**

CO1	Understand the fundamentals of aerial photography.
CO2	Understand the fundamentals of phtogrammetry.
CO3	Understand the fundamentals and principles of aerial photo-interpretation.
CO4	Understand the concepts of remote sensing.
CO5	Understand the principles and basic concepts of various types of scanning and imaging.
CO6	Understand the basic concepts of image interpretation and role of remote sensing in ecological research.
CO7	Understand the fundamentals of digital image processing.
CO8	Understand the image classification.
CO9	Understand the microwave sensing.
CO10	Understand the basics of computer hardware and software.
CO11	Understand the basics of Geographic Information System.
CO12	Understand the basics of Global Positioning system.

**SOLS/BOT/E002E Any Other elective offered by other department**


**SOLS/BOT/E002F Stress Biology and Molecular Genetics of Cyanobacteria**

CO1	Understand the fundamentals of stress environment and cyanobacteria growing in such environments.
CO2	<ul style="list-style-type: none"> <li>• Understand the effects of various abiotic factors on the growth of cyanobacteria.</li> <li>• Understand the functioning of cell organelles and of various biomolecules like proteins, nucleic acids, lipids in relation to the presence of abiotic stressors.</li> </ul>
CO3	<ul style="list-style-type: none"> <li>• Understand the physiological and molecular mechanisms of adaptations to biotic and abiotic stresses,</li> <li>• Understand the roles of various biomolecules such as carbohydrates, proteins, nucleic acids, lipids and pigments in the management of stresses, stress responses and signal transduction.</li> </ul>

CO4	<ul style="list-style-type: none"> <li>Describe the genome organization of model cyanobacteria <i>Synechocystis</i> sp. PCC 6803 and <i>Anabaena</i> sp. PCC 7120.</li> <li>Discuss the use of bioinformatics in studying molecular biology of cyanobacteria.</li> </ul>
CO5	Understand the concepts and steps of raising Genetically Modified Cyanobacteria.
CO6	Discuss the importance of cyanobacteria in human welfare.

### **SOLS/BOT/E003 Laboratory Course II**

**(Based on elective papers)**

#### **E001A**

CO1	Carry out the isolation of DNA and plasmid.
CO2	Carry out the restriction digestion of vector and DNA.
CO3	Carry out the ligation of DNA extract and Vector.
CO4	Carry out the transformation and selection of recombinant clones.

#### **E001B**

CO1	Undertake the studies on stand analysis, dominance, diversity and similarity coefficient.
CO2	Carry out the studies on gradient analysis.
CO3	Identify different forest types of the locale.
CO4	Calculate the Pateron week Index of any natural forest stand.
CO5	Study the ordination and continuum of different forest stands.
CO6	Study the interspecific association in forest stands using plot less technique.
CO7	Calculate analytical and synthetic characters of different forest stands.
CO8	Prepare profile diagram of forest stands using single plot method.

#### **E001C**

CO1	Carry out field surveys to study various types of natural resources in Uttarakhand Himalaya.
CO2	Study on the pressures impinging on the natural resources.
CO3	Record observations on the environment impact assessment of hydroelectric power project in Uttarakhand Himalaya.
CO4	Carry out research on Natural disasters and on frequent forest fires in Himalayas.
CO5	Learn from the visits of National Parks, Wild life Sancturries and Biosphere reserves.

#### **E001D**

CO1	Execute the experiments related to the morphological studies of pollen of some pteridophytes, gymnosperms and angiosperms.
CO2	Extract pollen grains from honey samples and to study the frequency of different morpho-types.
CO3	Study in vivo and in vitro germination of pollen grains.
CO4	Study morphological and anatomical features of stigma and style.
CO5	Study the growth of pollen tube through stigma and style.
CO6	Study of allergy producing pollen morpho-types.

**E001F**

CO1	Learn collection of algal samples from the various habitats
CO2	Learn procedures of isolation and purification of algal strains from the collected samples.
CO3	Learn the procedures for studying the growth behavior of alga strains in batch culture.
CO4	Learn the technique of outdoor culturing of algal samples for the production of biomass.
CO5	Learn the concept of bioreactors in optimizing the growth of algal strains comprising promising potential for the production algal biofuel and value added materials.
CO6	Perform the basic experiments related to the removal of nutrients, heavy metals and dyes from the wastewaters.

**E002A**

CO1	Perform the isolation and inoculation of mycorrhiza.
CO2	Study the seed borne pathogen.
CO3	Isolate some important plant pathogen.
CO4	Learn the procedure of using equipments related to the plant health management.
CO5	Learn the basics of establishing plant pathogen clinic for the advice of local farmers.

**E002B**

CO1	Carry out collection, preservation and identification of wild mushrooms.
CO2	Prepare field notes and executing chemical spot tests, photography and spore printing.
CO3	Learn section cutting and other tools related with studying anatomical features of mushrooms.
CO4	Learn the tissue culture techniques of mushrooms.
CO5	Learn the procedure of cultivation of <i>Agaricus</i> , <i>Calocybe</i> , <i>Flammulina</i> , <i>Ganoderma</i> , <i>Lentinus</i> and <i>Volvariella</i> .
CO6	Learn about the molecular tools of mushroom taxonomy.

**E002C**

CO1	Learn about the different types of microscopy, working and their utility.
CO2	Distinguish between juvenile and mature wood as also learn about the maceration techniques.
CO3	Learn the procedures of section cutting and sample preparation of different types of soft and hard wood.
CO4	Learn the techniques related to the study of ultra structure of woods.
CO5	Study the physical features visible on the cross section of log.
CO6	Study the gross features visible on the longitudinal surface of wood.

**E002D**

CO1	Carry out stereo test and to study different types of aerial photos.
CO2	Determine of scale, height and slope.
CO3	Do the interpretation of aerial photos and satellite data.
CO4	Study the multispectral data and image processing systems.
CO5	Carry out digital classification and enhancement of satellite data.
CO6	Learn the key steps of using Geographical Information System and designing of GIS database.

#### **E002F**

CO1	Perform the experiments related to the subject content mentioned under E002F.
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### **Fourth Semester**

#### **C016 Conservation Biology**

CO1	Discuss the basic concepts and history of conservation biology.
CO2	Describe the origin and evolution of organism; genetic plasticity and the invasion of unoccupied ecological niches.
CO3	Understand the global and regional patterns of biodiversity.
CO4	Describe the uses of biodiversity.
CO5	Understand the threats to biodiversity.
CO6	Discuss about the Global environmental problems: Global warming, ozone depletion, desertification.
CO7	Understand the concept of species extinction, endangered species, Red and Green Data Books.
CO8	Discuss about the Environmental Impact Assessment (EIA).
CO9	Discuss about the concepts and principles of conservation of biological diversity.
CO10	Describe principles and methodology of the survey and monitoring of biological resources.
CO11	Discuss the conservation of energy resources in relation to non renewable fossil fuel resources and biodiversity based renewable energy resources.
CO12	Describe the specific concepts of conservation of biological resources.
CO13	Discuss about the international efforts for conserving biodiversity of Indian region.
CO14	Discuss the basic concepts and strategies ecosystem restoration.
CO15	Discuss the legal acts of Biodiversity, such as National Forest Policy 1929, Wildlife (Protection) act 1975, Forest (Conservation) Act 1980, Environment (Protection) Act 1986, Fisheries Act 1987, Wildlife (Protection) Amendment Act 1991, Biodiversity Act 2003, etc.

#### **C017 Biotechnology and Genetic Engineering of Plants and Microbes**

CO1	Discuss the basic concepts, principles and scope of Biotechnology.
CO2	Discuss the general introduction, history, scope and concept of plant cell and tissue culture.
CO3	Understand the fundamental aspects of organogenesis and adventive

	embryogenesis.
CO4	Understand the concepts, key features and limitations of somatic hybridization technique.
CO5	Describe the applications of plant tissue culture.
CO6	Discuss the fundamentals of Recombinant DNA technology.
CO7	Understand the process and mechanism of Genetic engineering of plants.
CO8	Understand the process of microbial genetic manipulation and applications of industrial and fermentation microbiology.
CO9	Understand the concepts and principles of Genomics and proteomics.

### **C018 Laboratory Course I**

CO1	Study the pattern of regional biodiversity.
CO2	Study the Hot spots and key stone species.
CO3	Carry out the survey of biological resources.
CO4	Study of habitat loss with respect to plant species.
CO5	Collect information visiting national parks, sanctuaries and biosphere reserves of Uttarakhand.
CO6	Collect information visiting ecosystem restoration sites in mined areas in Uttarakhand Himalayas.
CO7	Study the growth characteristics of <i>E. coli</i> using plating and turbidimetric methods.
CO8	Carry out isolation of plasmid of <i>E. coli</i> by alkaline lysis method and its quantification spectrophotometrically.
CO9	Carry out restriction digestion of plasmid and estimation of the size of different DNA fragments.
CO10	Carry out cloning of a DNA fragment in a plasmid vector.
CO11	Understand the procedure of DNA sequencing of Sanger's dideoxy method.
CO12	Understand the procedure of protoplast fusion employing PEG.
CO13	Understand the process of organogenesis and somatic embryogenesis using appropriate explants and preparation of artificial seed.
CO14	Understand the steps of co-cultivation of the plant material (e.g. leaf discs) with <i>Agrobacterium</i> and studying GUS activity histo-chemically.

### **E004 Dissertation**

CO1	Develop awareness and interest towards research.
CO2	Develop scientific temperament.
CO3	Understand the fundamentals of research methodology.
CO4	Develop skills for the writing of thesis and scientific papers.

### **Elective Papers in lieu of Dissertation**

#### **E005A Propagation Techniques**

CO1	Discuss about the environmental factors affecting Propagation and post propagation process.
CO2	Discuss the seed-based Propagation process.



CO3	Understand the process of vegetative Propagation.
CO4	Understand the biology of various methods of vegetative propagation.
CO5	Understand the grafting process.
CO6	Learn the techniques of Budding and microbudding.
CO7	Understand the layering and its natural modifications.
CO8	Understand the fundamentals of Micropropagation.

### **E005B Environment Management With Reference to Western Himalaya**

CO1	Understand the topographic, geomorphic, socio-economic and demographic profile of Uttarakhand Himalaya.
CO2	Understand the classification, utilization and consumption pattern of natural resources.
CO3	Discuss about the management, policy and strategies for appropriate and sustainable natural resource management.
CO4	Understand the status of natural resources and its sustainable management in Garhwal Himalaya.
CO5	Discuss the concept of environment management, environmental protection and fundamental rights of man in relation to the environment.
CO6	Describe the environment impact assessment, planning and significance.
CO7	Understand the essentials of disaster management, classification, concept of landslide and earthquake in Garhwal Himalaya.
CO8	Understand the threats associated with Global warming and climate change as also about the various steps that need to taken as possible control measures to minimize the consequences.
CO9	Discuss about the impact of climate change on natural resources with special reference to Garhwal Himalaya and strategies for mitigation.
CO10	Understand about the water resources, status and their conservation strategies in India.
CO11	Understand the concept of watershed management techniques.
CO12	Discuss about the utilization pattern; drainage systems of Ganga, Yamuna and Ramganga.
CO13	<ul style="list-style-type: none"> <li>• Describe the environment and prospects of hydropower development,</li> <li>• Discuss about the Hydro-electric projects and their effects on natural resource management in Uttarakhand.</li> <li>• Discuss the strategies and policy for water conservation in Uttarakhand.</li> </ul>
CO14	<ul style="list-style-type: none"> <li>• Discuss about the following:</li> <li>• Agroecosystem and farming system,</li> <li>• Traditional agriculture practices and crop rotation;</li> <li>• Land use pattern, Land-form and land-use change,</li> <li>• Soil erosion: problems and curative measures.</li> </ul>
CO15	<ul style="list-style-type: none"> <li>• Discuss the effect of climate change on agro-ecosystem;</li> <li>• Describe the conservation of crop diversity in Garhwal Himalaya and challenges of managing agro-biodiversity in Garhwal Himalaya.</li> </ul>
CO16	<ul style="list-style-type: none"> <li>• Discuss the traditional seed supply system of mountain farmers,</li> <li>• Describe the diversity and risks to crop genetic resources and</li> </ul>

	<ul style="list-style-type: none"> <li>• Discuss about the agriculture policy</li> </ul>
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### **E005C Bioinformatics and Biological Data Base**

CO1	Understand the basic concepts and principles of bioinformatics.
CO2	Understand the importance and uses of various databases.
CO3	<ul style="list-style-type: none"> <li>• Understand the data retrieval with Entrez, DBGET/Link DB and SRS,</li> <li>• Carry out the sequences similarity searches, amino acid substitution matrices, databases searches with FASTA and BLAST,</li> <li>• Learn about the multiple sequences alignment and family relationships,</li> <li>• Discuss about the protein families and pattern databases.</li> </ul>
CO4	<ul style="list-style-type: none"> <li>• Understand the principles of genome annotation,</li> <li>• Discuss the annotation tools and resources,</li> <li>• Discuss about the conceptual models of protein structure and functioning.</li> </ul>
CO5	<ul style="list-style-type: none"> <li>• Understand the Microarray data analysis, tools and resources,</li> <li>• Know about the sequences sampling and SAGE,</li> <li>• Discuss about the 2D-PAGE gels and its uses,</li> <li>• Understand the principles and applications protein mass spectrometry, protein interaction informatics and higher-order models.</li> </ul>
CO6	Understand the fundamentals of Phylogenetics, cladistics and ontology and building phylogenetic trees.
CO7	Discuss about the chemoinformatic and pharmainformatics.

### **E005D Seed Pathology**

CO1	Understand the basics of seed pathology.
CO2	Discuss about the kinds of seed borne pathogens.
CO3	Discuss the types of damage caused by the seed borne fungi to seeds and crops.
CO4	Discuss the nature of seed infection.
CO5	Discuss about the longevity of seed borne pathogens.
CO6	Discuss the epiphytology of seed borne diseases, monocyclic and polycyclic diseases.
CO7	Understand the methodology of detection of seed borne pathogens.
CO8	Study the seed borne diseases of certain specific crops, cereals, millets, pulses, oil crops, fibre crops, and vegetable and timber crops.
CO9	Understand basic concepts of management of seed borne pathogens.

### **Laboratory Course II**

CO1	Perform the various experiments related to any two elective papers (E005A to E005D)
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### **Programme Specific Outcomes of M.Sc. Botany Programme**

The students will be able to:

PSO1	Understand the basics and advanced aspects of cryptogamic botany.
PSO2	Understand the basics and advanced aspects of taxonomy and diversity of flowering plants.
PSO3	Understand the various aspects of developmental and reproductive biology.
PSO 4	Understand the basics of resource utilization, IPR and ethnobotany.
PSO 5	Understand basics and advanced aspects of cytogenetics and molecular biology.
PSO6	Understand the basics and importance of plant breeding and biostatistics.
PSO7	Understand fundamentals and updated knowledge of Plant Physiology and Biochemistry.
PSO8	Understand the basics and the advanced aspects of ecology and remote sensing.
PSO9	Understand the advanced knowledge of conservation biology.
PSO10	Understand the concepts Biotechnology and Genetic Engineering.
PSO11	Understand the concepts and fundamentals of various applied fields of Botany.
PSO12	Enhance their knowledge about the essentials for excelling in plant science research.