

COURSE CAPSULES

First Semester

AB 5101. Cell Biology (2)

Prokaryotic and eukaryotic cells, Cell fractionation, Ultra structure of cells- Cell Wall. Plasma membrane and endomembrane system, Nucleus, Plastids, Mitochondria, Ribosomes, Golgibodies, Microbodies and other cellular organelles, vacuoles and cytoplasm.

AB 5102. Water relations and Nutrition (2)

Soil-Plant-Air-Water relationship ; Water potential concepts; principles of water movements; cell water relations; roots as absorbing organs - absorption, radial movement of water, ascent of sap ; stomatal physiology ; Essential elements for plant growth - their physiological role. Ion uptake and transport of nutrients. Hydroponics and water culture methods. Phloem transport.

AB 5103 Plant systematic (2)

General definitions, aims and uses of plant taxonomy; Historical development of classification systems; Species concepts and plant nomenclature; Taxonomic data and cyto-taxonomy; Modern field and herbarium methods; Taxonomic literature

AB 5104. Plant Ecosystems (2)

The ecosystem concept in biology and agriculture. Nutrient cycling, energy flow and productivity of natural and man made ecosystems. Floristic, composition, structure and succession of terrestrial and aquatic eco-systems. Soils in Sri Lanka.

AB 5105. Cellular Genetics (2)

Interphase nucleus. Repetitive and unique DNA sequences, Architecture of eukaryotic chromosome, Mitosis and Meiosis, Euploidy and aneuploidy, simple and multiple translocations and inversions, Deviant cytogenetic systems, cytogenetics in plant breeding and evolution., Molecular aspects of cytogenetics, Cytoplasmic inheritance.

AB5106: Exploring the Genomes : Principles and Techniques: (2)

Basic concepts of Genomic exploration, Tools and Techniques of genomic analysis, Genome Mapping, Genome assembly, Transcriptomics, Bridging the Gene-to-Function Knowledge Gap

AB 5107. Microbial Genetics (2)

Bacterial chromosome, episomes and plasmids, mutations, , recombination in bacteria (transformation, conjugation, transduction), viral genetics: SS and DS viruses, DNA and RNA viruses, Life cycle , genomics and recombination of viruses, mutations, transposons, genetics of yeast – 2 μ plasmid, twin hybrid systems, nitrogen-fixing genes, genes responsible for antibiotic resistance, quorum sensing, biofilms

AB 5108 Principles of Plant Breeding (2)

Introduction & challenges of Plant breeding, Goals in plant breeding , Traits considered in plant breeding [qualitative & quantitative] sexual vs asexual reproduction , Characteristic features of self & cross pollinated plants, Emasculation methods & pollination techniques , Male sterility and production of F1 hybrids , Incompatibility systems and its genetic manipulation . Conventional breeding strategies : Self pollinated crops and Cross pollinated crops . Crop improvement of Asexually reproducing crop plants. mutation breeding , protoplast fusion . Wide hybridization , Inter-specific hybridization , Di-haploids . Importance & use of crop genetic resources in plant breeding .

AB 5109. Reproductive Biology (1)

Significance of the knowledge of species' reproductive biology; Flowering and fruiting phenology (stigma receptivity and pollen phenology at individuals and population levels), synchrony of flowering , sex ratio ; Pollination vectors; Histology of reproductive tissues, breeding systems (self and cross), compatibility, apomixis, agamospermy, outcrossing rates; Seed dispersal and regeneration of species; Application of molecular techniques; Application of the knowledge of species reproductive biology on *in situ* and *ex situ* conservation, evolutionary biology and seed collection strategies.

AB 5110 Crop Genetic Resources (1)

Significance of biodiversity, Threats to BD, Values of BD , Importance of PGR, Origin of Agriculture & dynamics of plant speciation, Centers of origin & Centers of diversity , significance of polyploidy in the origin of plant species, gene pool classification, Utilization of PGR in crop improvement - Identifying the potential importance of wild relatives, weedy races , farmer collections. Gene pool classification, Utilization of gene pools in conventional breeding: Case studies of rice, wheat , maize and tomato.

AB 5111 Exploration and Characterization of Plant Genetic Resources (2)

Introduction to Exploration & collection of PGR: Types of exploration missions, preparation for the exploration, Collection sources & general guide lines for exploration .Collecting method of seed crops from farmers fields , farmer's stores markets, shops & orchards & kitchen gardens. Sampling methods / sample size, Collecting strategies : vegetatively propagated crop germplasm, wild germplasm of crop plants and fruits & timber crops , germplasm exchange and quarantine requirements.

Characterization : Introduction, seed multiplication, purity maintenance ,isolation distances, preliminary evaluation. Characterization techniques : Morphometric and isozyme analysis/ cytogenetic / biochemical & molecular characterization . Preparation of descriptor lists. Documentation plant genetic resources .

AB 5112. Environmental Physiology I - Microclimate (2)

Introduction to the Quantitative Approach in environmental plant physiology, Plants and radiation, Heat, mass and momentum transfer within and above canopies, Plant and cell water relations, Leaf temperature, energy balance and evapotranspiration, Stomata, Photosynthesis and respiration, Light and plant development, Control of tissue temperature, Effects of wind, altitude, CO₂ and atmospheric pollutants on plant productivity Environmental physiology and yield improvement.

AB 5113. Photosynthesis and Plant Productivity (2)

Significance of photosynthesis in agriculture; early and recent research on photosynthesis. Photosynthetic pigments, radiation energy, and its capture by plants, photosystems and their interactions, CO₂ fixation mechanisms, photorespiration, CO₂ enrichment, environmental and physiological control of photosynthetic productivity in crop plants. Efficiency of photosynthesis in species.

AB 5114. Biosensing (2)

Interaction properties of biological macromolecules, Types of biosensors, biosensor analysis and application, Optical biosensors, Acoustical biosensors, real time biosensor instrumentation, optical system, Kinetic measurements, Practical consideration in biosensing, Application of biosensing.

AB 5115 Assessment of Genetic Diversity (1)

Genetic diversity analysis using morphological, Physiological and molecular data; Measuring variation with-in population, Similarity and dissimilarity measures, Principle Component Analysis (PCA), Cluster analysis, MANOVA , Factor Analysis and Canonical Correlation Analysis.

AB 5116 Plant Biochemistry (2)

Metabolism, free-energy and equilibrium constants, energy charge, enzyme kinetics, reaction types, biological redox molecules. Biosynthesis, biodegradation and distribution of carbohydrates, proteins, lipids and nucleic acids in plants, ;Biochemistry of plant respiration.

AB 5118. Polygenic Inheritance (2)

Genetic & environmental variation; components of means & variances; basic generations; hybrid vigor; heritability; correlations; G x E.

AB 5119 Molecular Biology (1)

The molecular nature of genes, the central dogma, DNA functions; replication, transcription, translation, post-transcriptional modifications, genome and organization in bacteria and higher organisms, chloroplast and mitochondrial DNA.

AB 5120 Theory and Techniques of Plant Gene Manipulation (2)

The central dogma of molecular biology, Structure of plant genes, functions of DNA; replication and gene expression, DNA cloning and transformation, hybridization techniques, construction of genomics and cDNA libraries, PCR and DNA Fingerprinting

AB 5121 Characterization and Evaluation of Plant Genetic Resources (2)

Introduction; Characterization Techniques - Morphometric characterization, Biochemical characterization using isozymes, cytogenetics characterization & Molecular characterization using RAPDs, RFLPs, AFLPs and microsatellites; Genetic diversity analysis using morphological & molecular data; Measuring variation within populations; Similarity and dissimilarity measures, Diversity index, Gene diversity, Genetic diversity among populations, Phylogenetic analysis, genetic distance, Evaluation for biotic and abiotic stress.

AB 5122 Gene Manipulation (2)

Introduction to gene manipulation, cutting and joining DNA molecules, cloning vectors, cloning for gene libraries, cDNA libraries, transformation in *E. coli*, recombinant selection and screening, cloning and transformation strategies in bacteria, plants and animals, analysis of DNA sequences; DNA sequencing and synthesis, labeling and hybridization techniques, polymerase chain reaction and its different applications.

AB 5125 Protein Engineering (1)

Protein structure, function and their relationships, post-translational modifications and their effects, folding and stability, determination of protein interactions, protein structure prediction and modeling, protein dynamics, chimeric protein construction, proteome analysis; 2D gel electrophoresis, chromatography, HPLC, mass spectrophotometry, amino acid sequencing, protein structure determination; X-ray diffraction, NMR spectroscopy, databases for protein structure.

AB 5126 Enzyme Production Technology (2)

Enzyme properties, nomenclature and classification, isoenzymes, enzyme production technology, downstream processing, microorganisms important in industrial enzymes, microbial derived enzymes, commodity enzymes and their production, fine enzymes and their production, genetic engineering and industrial enzyme production

AB 5127 Natural Product Chemistry (2)

Plant analysis for natural products, extraction, separation and identification methods: chemistry and distribution of phenolic compounds, essential oils, other terpenoids, nitrogenous compounds, lipids and plant acids, applications of natural product chemistry in different disciplines of plants.

AB 5154. Valuing Plant Genetic Resources (1)

Concept of valuation; Economics, ethics and values; Loss of biodiversity as an economic process; Rationale for valuing genetic resources; Monetizing the value of PGR - instrumental (direct, indirect, option and quasi option) vs intrinsic values; Valuation techniques for biodiversity; Conservation cost and willingness to pay.

AB 5155. Molecular and Functional Glycobiology (2)

Glycobiology and its biological significance, central dogma of glycobiology, enzymes of glycosylation – the glycosyltransferases, glycoproteins, glycolipids, species – specific glycoprotein glysylation, glycosphingolipids

(GSL), carbohydrate – binding proteins (Lectins), tools for carbohydrate analysis, carbohydrate – based drugs and therapeutic compounds, disease process in which carbohydrates are involved, xenotransplantation, carbohydrate biotechnology.

AB 5195 Practicum 1 Biology (1)

Introduction to principles and practice of biological techniques, centrifugation, spectrophotometry, chromatography, use of radio isotopes, determination of photosynthesis and respiration, determination of and plant water relations, hydroponics and sand cultures, enzyme assays, determination of pigments, Isolation of DNA, Gel electrophoresis.

AB 5196 Practicum in Biotechnology I (1)

Plant DNA extraction, plasmid DNA extraction, RNA extraction from plant tissues, total protein extraction from plant tissues, DNA, protein quantification, Agarose gel electrophoresis for DNA, acrylamide gel electrophoresis for proteins, silver staining of proteins.

Second Semester

AB 5202 Advanced Genetic Analysis: Genes, Genomes and Networks: (2)

The logic of genetic analysis, Mutations, Linking a Phenotypes to DNA Sequences, Identification and screening of mutants, Genome-wide mutant screens, Gene Interactions

AB 5203 Plant Breeding Techniques (2)

Reproductive systems in cultivated plants. Emasculation and pollination techniques, self & cross breeding methods, Incompatibility and male sterility, non-conventional breeding, Mutation Breeding, production of hybrids & pure varieties; traditional knowledge; uses of genetic resources and benefit sharing; breeding strategies of local and regional institutes.

AB 5204 *In vitro* Techniques for Biotechnology (2)

Principles of in vitro culture, Micropropagation, Germplasm establishment in vitro, Multiplication Techniques, Somaclonal variation; In vitro storage and reestablishment in soil, Callus and cell suspensions, Cell culture establishment; maintenance and plant regeneration, Haploid production, Anther/micropore culture. Chromosome elimination, ovule/ovary culture, Protoplast technology, Protoplast isolation, culture, fusion and regeneration of plants and animals.

AB 5205 Stress Physiology (2)

Environment as a stress factor, stress concepts, measuring plant stress, light, temperature, oxygen deficiency, water deficiency, osmotic stress, heavy metals, biotic stress, production of stress tolerant plants, Role of phytohormones and other signaling molecules on plant stress response, Genomic technologies & their applications for environmental research.

AB 5207. Environmental Physiology II - Root Environment (2)

Physiology of roots from germination to senescence, Source-sink conditions affecting root growth and development, Rooting and root physiology in well aerated soils, Biochemistry of roots under waterlogged conditions, Root physiology in swamps and mangroves, Effects of temperature on root growth and functioning, Hormones, plant growth regulators and roots, Saline conditions and root reactions, Industrial waste effects on root physiology, Rhizosphere and biochemistry of roots, Soil less agriculture - hydroponics, Aquaculture, tissue culture and the root system, Root physiology in different potting media.

AB 5208. Plant Physiology Techniques (2)

Use of centrifugation, Spectrophotometry, Chromatography and radio isotopes, Determination of photosynthesis, Respiration, Plant water relations and nitrogen fixation. Plant tissue culture and hydroponics.

AB 5209 Nutritional Quality Improvement of Food Crops (1)

Nutritional quality parameters, Factors affecting nutritional quality of foods, Genetic basis of nutritional quality parameters, Pre and post harvest practices for quality improvement, Breeding for quality improvement, Transgenic approaches in quality improvement, Present perspectives and future trends

AB 5210 Statistical Genomics in Biotechnology (2)

Introduction to statistical genomics, DNA markers as the landmarks of the genome, Structure of genomes and mapping, QTL, QTN, eQTL and QTP as the jewels of genomes, Association mapping, Haplotype analysis and molecular breeding, Case studies, Interpreting gel data, Interpreting high throughput genomic data, Genome mapping, Quantitative genetics and genomics, QTL analysis and its practical applications in Biotechnology.

AB 5211. Methods in Plant Genetic Resources Conservation (2)

Introduction; Fundamentals on plant genetic resources conservation; Strategies of plant genetic resources conservation; Choice of conservation strategies; Species vs habitat or ecosystem based conservation; *In situ* conservation (natural, exploited and enriched habitats); *Ex situ* conservation (seed storage, field conservation, in vitro conservation, DNA libraries, gene banks, botanical gardens and herbariums, on farm conservation); Design and management of genebank facilities; Institutions involved in plant genetic conservation

AB 5213 Plant Growth and Development (1)

Biology of growth and development; Embryonic and post embryonic development, Seed germination, Organ development; flowering, Internal and external factors on development; Phytohormones and Light and temperature, Biological rhythms, Plant movements, Photomorphogenesis, Photoperiodism,

AB 5214 Biotechnology in Crop Improvement (1)

Development of molecular markers, Marker-assisted breeding, Plant genetic engineering, *Agrobacterium* mediated transformation and monocot transformation, Prospects for improving the efficiency of transformation, screening and improving transgenic plants, cisgenesis Tissue culture in advanced breeding, doubled haploid populations, functional and comparative genomics in plant improvement Impact of plant genomics and molecular breeding on Cereals, vegetables and fruit crops, root and tuber crops, other crops.

AB 5215. Population Genetics (2)

Hardy-Weinberg equilibrium and its assumptions. Multiple alleles. Race and species formation. Changes in gene frequency. Mutation, drift, migration, selection, meiotic drive and mating behavior. Self-pollinated and Cross-pollinated populations. Inbreeding depression.

AB 5216. Genetic Designs (2)

Basic generations, BIPs, diallel genetic designs and data analysis; use of 'Microsim' software package for analysis of simulated data

AB5217 Breeding strategies of Economic crops (2)

Visit to Research stations and Institutes to understand the breeding procedures of the following crops: Rice , Plantation, field, vegetable , spice and Fruit crops. Scientists from various Research Institutes will be identified [up to 3 – 4 scientists] to deliver breeding methodologies of relevant crops. Assessment will be based on the report submitted by the candidate after each field visit and also end term and oral examination conducted at the end of the semester .

AB 5218 Character Inheritance Mechanisms (1)

Major genes and poly genes, sources of variation, genetic basis of quantitative variation, components of means of basic generations and predictions, association and dispersion of genes, components of variances, heritability, hybrid vigor/heterosis

AB 5220 Marine Biotechnology (1)

Marine biology: organisms, diversity, environmental adaptations, biochemical production by different marine organisms and their activities, drugs and other pharmaceutical products from marine organisms, waste management and bi-product utilization, new techniques of culturing sea weeds and other marine organisms, genetic tagging of marine organisms, sex changing of fish, use of marine organisms for detection of environmental contaminants, anti-fouling techniques, environmental protection, transgenic marine organisms, quality and safety of sea foods.

AB 5222. Gene Expression and Developmental Genetics (2)

Gene expression and control of gene expression of prokaryotes and eukaryotes; operons, transcriptional regulation through regulatory elements and proteins, DNA binding domains, DNA methylation, chromatin remodeling, gene regulation through signal transduction, post transcriptional regulations, translational and post-translational regulatory mechanisms, cell cycle and growth regulation, cell death and apoptosis, oncogenes, developmental genetics, homeotic genes and plant development, regulation of plant growth and scope for manipulation, current perspectives.

AB 5223 Cereal Biotechnology (1)

Cereal genomics; genome structure, comparative genetics among cereals, GM cereals, current perspectives, quality characters of cereal grains and correlations of them with cereal end products, inheritance of major quality characters; physical, chemical (starch, protein), physico-chemical and other quality characters, analyzing quality characters; amylose content, swelling power, gelatinization temperature, alkali spreading score, SDS-PAGE for proteins, breeding for product quality improvement and diversification in rice, wheat and other cereals.

AB 5224 Secondary Metabolite Production (1)

Plant secondary metabolites and their occurrence, biosynthetic pathways, regulatory factors of secondary metabolite production, application of transgenic plants to secondary metabolite production, medicinal plants and screening for new compounds, pharmacological evaluation of new compounds.

AB 5225 Biological Nitrogen Fixation (1)

Nitrogen fixation in perspective, N-fixing organisms, biochemistry of nitrogen fixation, nitrogenase enzyme, nitrogen fixation and metabolism, new diazotrophs, agricultural and industrial applications of biological nitrogen fixation, current trends in nitrogen fixation research.

AB 5227 Cellular Immunology (1)

Immune response, immunoglobulins, monoclonal antibodies, polyclonal antibodies, histocompatibility, antigen-antibody reactions, cell-mediated immunity and humoral immunity, complement, hypersensitivity, immunological defects, immunoassays.

AB 5228 Molecular Breeding and DNA Fingerprinting (2)

Recap of classical breeding methods and their limitations, MAS for major genes and polygenes, linkage drag and linkage analysis, gene pyramiding, novel breeding methods, DNA fingerprinting methods, mapping populations, assessing genetic distance, Nei methods, current trends of transgenics.

AB 5229 Genetically Modified Organisms, Food, Feed and Processed Products and Biosafety (1)

Convention on Biological Diversity- CBD and its relation to biotechnology, status of Genetically Modified Organisms (GMO), Food, Feed and Processed Products (;FFPs), advantages, risks and concerns, Cartagena Protocol, risk assessment and management, biosafety policy, detection of GMO and FPP, legislations.

AB 5230 Plant Variety Protection, Intellectual Property Rights and Policy Issues (1)

Patents, plant variety protection, farmers' rights, relevant legislations, Intellectual Property Rights, national policies, international policies, international agreements (WTO etc.), bilateral agreements, plant quarantine.

AB 5232 Variety Testing for Adaptability (1)

History of variety development in Sri Lanka, present status of variety development, role of public and private sector in variety development, early testing of varieties, national coordinated varietal test, variety adaptability test, , hybrid variety testing, DUST test, over view of statistical methods in variety testing and variety release procedures.

AB 5233 Nanotechnology in Agriculture (1)

Introduction to nanotechnology, nanoagrochemicals, nanoemulsions and nano plant growth regulators, synthetic biology, nano genetic manipulation of agricultural crops, nanoarrays, nanosensors for precision farming, health risks of nanomaterials, nanomaterials in foods, food packaging, food coatings, nutritional supplements, fertilizers, pesticides and seed treatments, nanomaterials and ecological risks.

AB 5235 Scientific Communication in Biology (1)

Research proposals, components of a research proposal, criteria for developing effective research proposals, preparation of research articles; research papers, extended abstracts and abstracts, poster presentations, submission and communications with publishers.

AB 5236 Production of Transgenics (1)

Historical background, uses of transgenic organisms, procedure for transgenesis, advantages of transgenesis over traditional breeding for animals and plants, procedure for transgenesis, genetic transformation of medicinal plants for pharmaceuticals, designing symbionts for control of plant diseases, transgenic insects, problem of transgenic insect fitness, transgenic fish.

AB 5251 Bioindustry (1)

Fermentation technology, Organic acid fermentation, Vitamins, Antibiotics, Animal feeds, Secondary metabolites. Biomass utilization, , Biopolymers, biofertilizer waste as renewable force of energy, Petroplants, Bioreactors, Molecular diagnosis (1) ELISA / IFA, MAB, PAB, antigen and antibodies, Microbial synthesis of pharmaceuticals and gene therapy.

AB 5252 Bioinformatics (2)

Organizing and managing biological data, web based information - access search and retrieval of biological information and literature. analyses of biological data and interpretation. mathematical basis and algorithms in analytical tools. sequence analysis, structure and alignment of nucleic acids and proteins using data banks- NCBI, EMBL, swiss-prot. software in bioinformatics, phylogenetic analysis.

AB 5253 Utilization of Plant Genetic Resources in Crop Improvement (1)

Relevance of PGR in crop improvement, identifying the potential importance of wild relatives, weedy races, land races farmer collection etc. for crop improvement. Utilization their gene pools in conventional breeding, protoplast fusion and molecular breeding to transfer specific genes. Case studies - utilizing PGR to improve rice wheat, maize, tomato etc. Visits to breeding stations.

AB 5254 Environmental Physiology III - Stress Physiology (2)

Definition of stress, Environmental stress factors, Drought stress, Temperature stress, Salinity stress, Impact of disease induced stress, Thigmomorphogenesis/ effect of mechanical perturbations under growth of plants, Ionic stress, Air pollution, The role of plant stress research in future agriculture productivity.

AB 5256 Environmental Physiology IV - Simulation of Plant Growth (3)

Presentation of problems and available data, Presentation of available models, Process-models and their parameterisation, Maintenance respiration, Growth respiration, Morphological development, assimilate partitioning and remobilization, Leaf and root development, Transpiration and water uptake, Soil water balance.

Practical: Students should work with a problem and prepare a report on obtained results.

AB 5258 Documentation and Information Management of Plant Genetic Resources (2)

Ex situ and in situ documentation systems. PGR information processing and Data recording - using Descriptors, dealing with heterogeneous data and data exchange. Manual documentation systems. Ethnobotanical and botanical information. Geographical information systems. Use of gene bank software (GMS, PCGRIN, MGIS, CGRD, SINGER). Data security.

AB 5295 Practicum 2 - Crop Improvement (1)

- i) **Classical breeding techniques** – Practice in hand Pollination - Rice, chilli , brinjal & tomatoes , Testing for pollen viability, Inheritance studies , Quantitative character studies
- ii) **Molecular breeding** - Laboratory safety, Plant DNA Extraction, DNA Quantification, Agarose Gel Electrophoresis & Visualization , PCR – DNA Finger Printing [RAPD or SSR]

Double Haploid Plant Production [RRDI - Batalagoda , Embryo Culture - CRI

AB 5296 Practicum in Biotechnology II (1)

Restriction digestion of plasmid DNA and electrophoresis, cloning and transformation, Randomly Amplified Polymorphic DNA (RAPD) analysis and electrophoresis, data interpretation, DIG labeling, blotting techniques.

AB 5298 Directed Study (5)

Each student is required to conduct and complete a research project on topic falling within the disciplines of Plant Biology, Breeding and Conservation or Molecular Biology and Biotechnology. The students are expected to present a pre-proposal at the commencement of the project. Each student has to present a seminar on the research conducted and submitting a project report for the final evaluation of the research project. The selection and planning of the project should commence during the second academic semester. This research project will be supervised by an academic staff member of the PGIA and also an external supervisor in case the student is from a research institute or conducting the project outside the university. This course will be offered during every semester as decided by the Board of Study.

AB 5299 Seminar (1)

Students will be provided with the knowledge and skills required to make a scientific presentation. They will be guided to prepare for the presentation; selection of topics, preparation of presentations, visual aids etc. At the end of the course students should make a scientific presentation and they will be evaluated based on the presentation made. This course will be offered during every semester as decided by the Board of Study.