Quality Assurance Council

2022

Subject Benchmark Statement

Botany

University Grants Commission – Sri Lanka

SUBJECT BENCHMARK STATEMENT IN BOTANY

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Contents

FOREWORD

Subject Benchmark Statements provide a set of reference points to show how the key features of a programme of study, its intended learning outcomes, and the standards that derive from these intended outcomes, relate to what is deemed appropriate by the subject community.

During the period 2003 - 2013, about 40 Statements were developed by subject committees for programmes offered by the state universities in Sri Lanka, under the guidance of the Quality Assurance & Accreditation Council and the University Grants Commission. Subsequent to adoption of the Sri Lanka Qualifications Framework by the University Grants Commission in 2016, it was decided that these Statements should be revised and updated, particularly to take into account the requirements stipulated in the SLQF 2015, and to incorporate recent developments in each field of study.

Subject Committees were appointed by the UGC for this purpose, drawing on expertise within each subject community both within and outside academia.

The new Subject Benchmarks Statements are meant to provide:

- institutions and academic staff with a framework for articulating the intended learning outcomes of programmes, in the context of SLQF 2015;
- institutions with a minimum standard for the award of a degree in a particular subject area;
- peer reviewers with a reference point for making judgments about the appropriateness of programme outcomes and their achievement;
- students, employers, professional bodies and others with the information about the range of provision in particular subject/discipline areas, the qualities developed in graduates, and the standards that would of graduates;
- the public at large with the information about the nature of higher education awards

1. INTRODUCTION

1.1 About this Subject Benchmark Statement (SBS)

Knowledge-based economies depend on a highly skilled and well-educated workforce and therefore, the intellectual capital produced by Universities and other Higher Education Institutes (HEIs) has become crucial. In response to this growing demand for skilled and knowledgeable graduates, the government of Sri Lanka has taken steps to expand the higher education sector and established new state Universities and other degree awarding entities in different parts of the country. In addition, there is a proliferation of private HEIs which have been granted degree awarding status. With this rapid expansion in the higher education sector, benchmarking of subjects included in study programmes offered by HEIs has become important for maintaining their quality and standards. Hence, the main objective of subject benchmarking is to provide a subject or discipline with greater coherence and exclusive identity by defining knowledge, skills and attitudes that can be expected of a graduate who has followed the relevant subject, upon completion of the study programme.

Subject Benchmark Statements are used for a variety of purposes by relevant stakeholders. However, a benchmark statement is not a syllabus and is not intended to prescribe the time devoted to each component of the curriculum or the order in which the components are to be taught.

Primarily, an SBS describes the nature of the subject, the expected attributes and capabilities of the degree holders and, the expected minimum standards for the award of the degree. Furthermore, SBS provides guidelines for;

- HEIs to develop a framework for study programmes and specify Intended Learning Outcomes (ILOs)
- HEIs on the minimum standards for the award of a degree in the relevant subject area
- peer reviewers a point of reference for making judgments about the appropriateness of academic standards within/ between HEIs in pursuit of internal/ external quality assurance
- professional and statutory bodies with academic and practitioner standards that should be expected of graduates

In addition, benchmarking of academic standards may also provide information for students, employers and other relevant stakeholders about the range of provisions in a particular subject/ discipline, and the attributes and standards of graduates.

The previous SBS for Botany had been formulated in 2004 as an activity of the Quality Assurance (QA) project of the Committee of Vice Chancellors and Directors (CVCD)/ University Grants Commission (UGC) by a team of subject experts. Since then, quality assurance in higher education has grown steadily and become an integral part of academic activities. Accordingly, the UGC has appointed a new committee of experts (Annexure I) to undertake the vital task of revising the existing SBS for Botany to accommodate expansion in the subject and the alignment of study programmes with Sri Lanka Qualifications Framework (SLQF) guidelines. Currently, many Universities offer Botany as a subject in their Bachelor of Science (BSc)/ Bachelor of Science Honours (BScHons) degree programmes. There is also a tendency to offer Plant Biology or Plant Science in place of the subject Botany by some

Universities. This SBS is intended to cover BScHons degree programmes in Botany/ Plant Biology/ Plant Science and BSc or any other degree programme with Botany/ Plant Biology/ Plant Science as a subject. This document may be reviewed and revised in the future to reflect new developments in the subject, the challenges experienced by HEIs and the feedback of academic reviewers.

1.2 Summary of the Changes from the Previous SBS in Botany

The new SBS in Botany has expanded on Section 3, the "nature and extent of the subject", by considering the evolving nature of the discipline. Botany has become more multi-disciplinary in nature with inputs from other areas of sciences and technology which has led some Universities to revise and rename their study programmes in Botany as Plant Biology or Plant Science.

A number of sub-disciplines of Botany, both fundamental and applied, are defined as core areas which are considered essential for proper theoretical and practical understanding of the subject.

In addition, the new SBS has been developed in alignment with the standards specified in the SLQF of 2015, according to which, the degree programmes in Botany or those that include Botany as a subject must be developed at either SLQF Level 5 or 6, while maintaining for each Level the minimum credit requirement of the subject. Furthermore, this SBS provides guidelines to align Teaching, Learning and Assessment methods as well as Performance Standards with Learning Outcomes for each SLQF Level.

1.3 Defining Principles

The study programmes covered by the SBS for Botany should include;

- major concepts, theories, principles and practical aspects related to core fundamental and applied areas of Botany
- an in-depth study of fundamental and applied areas while encouraging interdisciplinary and multidisciplinary approaches
- opportunities for critical analysis and assessment of the subject and its applications
- methods of acquiring, analyzing and interpreting information related to Botany and communicating the information effectively

Any BScHons degree programme in Botany/ Plant Biology/ Plant Science or any other degree programme including Botany as a subject should comprise the following fundamental and applied areas. However, the content may be adapted to suit the nature and objectives of the particular degree programme.

Fundamental areas	**Applied areas**
Cell Biology	Applied Microbiology
Conservation Biology	Biostatistics and Experimental Design
Ecology	Bioprospecting
Genetics and Evolution	Biotechnology
Microbiology	Computational Biology
Molecular Biology	Environment Science and Sustainable Development
Plant Biochemistry	Forest Management
Plant Diversity	Horticulture
Plant Morphology and Anatomy	Plant Breeding
Plant Physiology	Plant Pathology
Plant Systematics	Weed Biology

The aforementioned areas may constitute the core-curriculum of a study programme in Botany through which subject knowledge and understanding, technical skills, work ethics and professional attitudes would be delivered to produce a graduate who may eventually choose a career in academia, research, teaching, commerce, management or take up any other relevant position in the government or in the private sector (Annexure II).

2. DEGREE PROGRAMMES COVERED BY THE SBS

Bachelor of Science degrees offered by Sri Lankan Universities and other HEIs fall within two SLQF Levels; i.e. Level 5 and Level 6. The qualifications at SLQF Level 5 and Level 6 are the BSc degree and the BScHons degree respectively. This SBS is intended to cover both qualification levels and should be interpreted using both the SBS and the SLQF Level Descriptors for that particular level.

The types of study programmes in Botany or in which Botany is a main subject, and the minimum credit requirement for a degree at SLQF Level 5 and at SLQF Level 6 are as follows;

- BSc study programme with Botany as a subject (SLQF Level 5) should cover a minimum of 24 credits in Botany
- BScHons study programme in Botany (SLQF Level 6) should cover a minimum of 72 credits in Botany
- Any other BScHons study programme with Botany as a major subject (SLQF Level 6) should cover a minimum of 45 credits in Botany

3. NATURE AND EXTENT OF THE SUBJECT

Plants are important components of both terrestrial and aquatic ecosystems. Botany is the study of plants, and the study of plants encompasses nature, variety/ diversity, functions and processes of plants and microorganisms, their interactions with abiotic environment, plants and other organisms and their economic uses.

Botany includes fundamental and applied areas defined in Section 1.3 and associated sub-disciplines in which rapid change and developments are evident. The recent advances in knowledge in Botany have been brought about by rapid development in technologies, particularly in the spheres of molecular biology and computational applications. The new developments have aided better understanding of traditional areas of Botany as well as provided new insights into the functional networks within plant systems. As new knowledge and technologies continue to emerge, there is an increasing necessity to keep abreast of current academic trends and prepare graduates to adapt to lifelong learning.

Botany is essentially a practical and experimental subject. Consequently, appropriate opportunities to participate in laboratory and field projects must be embedded in the curriculum in a manner that enhances the understanding of key concepts and theories of Botany as well as allow students to appreciate real-world applications of plants. Emphasis on an outcome-based Botany curriculum would help to enhance the undergraduates' knowledge, skills/ competencies, attitudes and values. With the advancement from a "knowledge-based economy" to "innovation-driven" economy, infusing research and entrepreneurship in the curriculum should also be emphasized.

The extent recommended to be covered in each fundamental and applied subject areas defined in Section 1.3 is given below.

Fundamental areas

Cell Biology
Cellular organization, Structure and function of cellular membranes and organelles, Transport, receptors and cell signaling, Cytoskeleton, extracellular matrix and cell movements

Conservation Biology
Concepts and foundations, Ethics, values and trends in biodiversity, Threats to biodiversity, Species extinctions, Approaches for biodiversity conservation, Conservation priorities, Strategic species concept, Ecosystem valuation

Ecology
Structure and functions of ecosystems, Ecosystems of the world and Sri Lanka, Qualitative and quantitative Plant Ecology, Population ecology, Community ecology, Vegetation dynamics, Technologies used in plant ecology

Genetics and Evolution
Basic Mendelian and non-Mendelian genetic analysis, Chromosomal basis of inheritance, Molecular basis of inheritance, Sources of variation, Epigenetics, Population genetics, Natural and artificial selection, Short-term and long-term evolutionary processes, Fundamentals of microbial genetics, Applications of genetics to society, Paleobotany

Microbiology
Microbial diversity, Mycology, Bacteriology and Virology, Techniques in microbiology, Microbial metabolism, Microbial ecology and functions, Control of microorganisms

Molecular Biology
Structure, function and interactions of nucleic acids and proteins, Gene and genome organization, Gene expression and regulation, Recombinant DNA technology, Functional genomics, Transgenic plants and biosafety, Techniques in molecular biology

Plant Biochemistry
Biomolecules and their applications, Plant energetics, Enzymes, Plant metabolites, Metabolomics

Plant Diversity
Diversity of algae, fungi and land plants, Identification, classification and evolutionary relationships

Plant Morphology and Anatomy
Morphological diversity and modifications, Plant internal and external structure and organization, Histology, Morphogenesis, Anomalous growth, Wood anatomy and related techniques

Plant Physiology
Plant water relations, Nutrition, Phyto-hormones, Photo-morphogenesis, Plant developmental physiology, Stress physiology, Molecular plant physiology and signal transduction

Plant Systematics
Principles and practices in identification, description, classification and nomenclature including phylogenetic inferences and modern trends, Herbarium techniques

Applied areas

Applied Microbiology
Microbial applications in agriculture for soil and plant health and productivity (biofertilizers, bioherbicides, biopesticides), Environmental applications (water purification, bioremediation, biomining), Industrial applications (brewery, leather, pharmaceutical, food etc.)

Biostatistics and Experimental Design
Organization and presentation of data, Application of statistical analyses for biological data, Statistical inferences, Experimental design and data analysis, Data analysis soft-ware

Bioprospecting
Biodiversity prospecting, Biochemical resources from plants and fungi, Natural products as drugs and pharmaceuticals, Pharmacognosy, Ethnobotany, Bioprospecting agreements, Biopiracy and legal implications

Biotechnology
Tissue culture technology, Plant and microbial biotechnology and applications, Environmental biotechnology, Biotechnology industry

Computational Biology
Databases and tools, Analysis of molecular data using bioinformatics, Mathematical modeling, Biological and numerical data analysis, interpretation and manipulation using algorithms

Environment Science and Sustainable Development
Human interactions with environment and over exploitation, Ecological foot print, Sustainable management of natural resources, Environmental challenges including climate change, Mitigation and management of environmental issues, Cleaner production and green technology

Forest Management
Local and global demand for forest products, Forest landscape management, Forests and forest policy of Sri Lanka, Forest mensuration, Basics of silviculture systems and practices, Sustainable forest management

Horticulture
Horticultural crops, Floriculture, Nursery management, Protected-environment cultivation, Organic farming, Plant propagation, Commercial horticulture, Post-harvest technology

Plant Breeding
Germplasm resources and crop evolution, Quantitative inheritance, genetic variation and heritability, Conventional and molecular plant breeding methods, Plant variety protection

Plant Pathology
Concepts of plant disease, Causative agents, Stages and significance of pathogenesis and the infection cycle, Pathogenicity determinants, Plant defense against pathogens, Disease epidemiology, Disease diagnosis, assessment and management, Post-harvest Pathology

Weed Biology
Characteristics and identification of weeds, important weeds in Sri Lanka, Effects of weeds on crop production, Allelopathy, Weed management, Impacts of weeds on environment

4. AIMS AND OBJECTIVES OF THE SUBJECT

The main aims of a study programme in or including Botany as a major component are to;

- impart knowledge in principles of Botany
- develop proficiency in experimental techniques related to Botany
- inculcate in students, the ability to apply the knowledge and skills they have acquired to solve a range of theoretical and practical problems related to Botany
- stimulate students intellectually and guide them to appreciate Botany as a subject
- develop communication skills for effective dissemination of scientific findings
- develop a range of transferable skills that would assist graduates in their future employment/ self-employment
- train students to demonstrate intellectual autonomy through independence of thought and openness to ideas
- inculcate leadership skills and team spirit
- guide students to appreciate the need for personal, professional and academic integrity and have an awareness of codes of ethics appropriate to Botany

5. SUBJECT SPECIFIC LEARNING OUTCOMES IN CORE AREAS

The learning outcomes set out below are applicable for individual study programmes in Botany/ Plant Biology/ Plant Science, in which the objective is to produce *either*

a) graduates with more general broad-based theoretical knowledge and practical skills in the subject at SLQF Level 5 along with necessary skills and attitudes, who will be able to use the qualification to progress towards diverse career paths, *or*

b) graduates with specific in-depth theoretical knowledge and practical skills in the subject at SLQF Level 6 along with necessary skills and attitudes, who will be specialists equipped to undertake further academic training and research or subject-related employment. They will also be able to adapt to non-subject related careers.

5.1 Knowledge

5.1.1 Subject/ Theoretical Knowledge

Subject/ theoretical knowledge provided by a BScHons degree programme in Botany/ Plant Biology/ Plant Science or a BSc degree programme that has Botany/ Plant Biology/ Plant Science as a main subject should include a broadly-based core comprising different disciplines of the main subject area. However, the range of specific topics of the core subjects covered by individual study programmes may vary according to the emphasis of the particular study programme.

Upon successful completion of the study programme, the learning outcomes on theoretical knowledge expected in a person graduating at SLQF Levels 5 and 6 are as follows:

A graduate at SLQF Level 5 should be able to;

- demonstrate knowledge and understanding of key concepts and principles in Botany, particularly in core areas given in Section 1.3
- demonstrate awareness of the current knowledge and development of the subject
- recognize current issues of wider concern to society, including environmental impacts and sustainability, issues related to Genetically Modified Organisms (GMOs)/ GM foods, bio-piracy and Intellectual Property Rights (IPR)
- collect, analyze and interpret information related to the subject

A graduate at SLQF Level 6 should be able to;

- demonstrate advanced knowledge and understanding of key concepts and principles in Botany, particularly in core areas given in Section 1.3
- demonstrate enhanced awareness of the current knowledge and development of the subject and identify gaps in knowledge
- evaluate current issues of wider concern to society, including environmental impacts and sustainability, issues related to GMOs /GM foods, bio-piracy and IPR
- collect, critically analyze and interpret information related to the subject and apply the knowledge in problem solving

5.1.2 Practical Knowledge and Application

There is a range of practical skills that a Botany/ Plant Biology/ Pant Science graduate should acquire during the programme of study which will help him/ her to design, plan and conduct laboratory or field-based experiments and report on investigations.

The learning outcomes in practical knowledge and application expected in a person graduating at SLQF Levels 5 and 6 are as follows:

A graduate at SLQF Level 5 should be able to;

- apply practical skills related to Botany, particularly in core areas identified in Section 1.3 and listed in Annexure III
- design experiments, investigations, surveys and other means to test hypotheses
- collect, record and analyze quantitative and qualitative data using appropriate statistical methods and computer-based data analysis packages to arrive at valid conclusions
- employ safe laboratory and field practices

A graduate at SLQF Level 6 should be able to;

- apply practical skills related to Botany efficiently and effectively, particularly in core areas identified in Section 1.3 and listed in Annexure III
- design experiments, investigations, surveys and other means to test hypotheses
- collect, record and analyze quantitative and qualitative data using appropriate statistical methods and computer-based data analysis packages, appreciating issues of sample selection, accuracy, precision and making sound judgments or propose solutions
- apply digital/ *in silico* approaches to practical work (data mining, modeling and interpretation/ prediction)
- demonstrate competence in independent research
- employ safe laboratory and field practices

5.2 Skills

A Botany/ Plant Biology/ Plant Science graduate should have acquired several soft skills during the study programme in order to succeed in education, the workplace and in life.

The learning outcomes with respect to important transferable skills expected of a person graduating at SLQF Levels 5 and 6 are as follows:

5.2.1 Communication

A graduate at SLQF Level 5 and SLQF Level 6 should be able to;

- organize and interpret data through graphical and other scientifically acceptable means
- present information, ideas and concepts accurately, efficiently and effectively employing appropriate scientific language
- present scientific findings effectively to specialized, non-specialized and non-scientific audiences
- use accurate referencing to avoid plagiarism
- use Information Technology (IT) platforms and social media to communicate information to a wide audience effectively

5.2.2 Team Work and Leadership

A graduate at SLQF Level 5 and SLQF Level 6 should be able to;

- exercise team responsibility and leadership and participate effectively in a team
- show positive intent, take initiative and contribute constructively to group discussions
- set realistic targets, identify individual and collective goals and responsibilities
- consider, appreciate and respect the views of others
- plan, allocate and evaluate the work of self, individuals and teams

5.2.3 Creativity and Problem Solving

A graduate at SLQF Level 5 should be able to;

- develop arguments and make appropriate judgments
- analyze and use information creatively and imaginatively to solve problems
- reason independently and solve problems
- demonstrate creativity through innovation

A graduate at SLQF Level 6 should be able to;

- construct and sustain arguments and make appropriate judgments/ conclusions
- analyze and use information creatively and imaginatively to solve problems
- reason independently and solve problems
- demonstrate creativity through innovation

5.2.4 Managerial Skills and Entrepreneurship

A graduate at SLQF Level 5 should be able to;

- take initiative, assume personal responsibility and demonstrate accountability
- organize, direct and coordinate activities
- introduce innovative approaches and develop entrepreneurship
- demonstrate self-motivation
- take professional risks and challenges as appropriate

A graduate at SLQF Level 6 should be able to;

- take initiative, assume personal responsibility and demonstrate accountability
- organize, direct and coordinate activities
- use research outcomes to introduce innovative approaches and develop entrepreneurship
- demonstrate self-motivation
- take professional risks and challenges as appropriate

5.2.5 Information Usage and Management

A graduate at SLQF Level 5 and SLQF Level 6 should be able to;

- demonstrate competence in the retrieval, use and handling of printed and electronic information
- use internet responsibly as a source of information
- demonstrate competence in using data processing and relevant data analysis software
- demonstrate legitimate, ethical, effective and safe use of digital and social media

5.2.6 Networking and Social Skills

A graduate at SLQF Level 5 and SLQF Level 6 should be able to;

- interact with people and organizations
- act efficiently without unnecessary conflict

5.2.7 Adaptability and Flexibility

A graduate at SLQF Level 5 and SLQF Level 6 should be able to;

- develop appropriate strategies to adapt to changing and challenging situations
- develop an adaptable and flexible approach to study and work
- reach quick and sensible decisions in complex and unpredictable contexts

5.3 Attitudes

After completing a study programme in Botany/ Plant Biology/ Plant Science, a graduate should have developed attitudes that would make him/ her motivated to work hard and appreciate contribution by others. He/ she should have also developed values such as honesty and academic integrity, professionalism and punctuality.

The learning outcomes with respect to appropriate attitudes expected of a person graduating at SLQF Levels 5 and 6 are as follows:

5.3.1 Attitudes, Values and Professionalism

A graduate at SLQF Level 5 and SLQF Level 6 should be able to;

- understand the importance of academic integrity
- exercise initiative, personal responsibility and accountability in tasks performed
- recognize the need for ethical standards and professional codes of conduct
- demonstrate positive attitudes and social responsibility
- assess the ethical consequences of human activities in order to optimize community and environmental sustainability

5.3.2 Vision for Life

A graduate at SLQF Level 5 and SLQF Level 6 should be able to;

- identify and work towards targets in personal, academic and career development
- acquire new competencies to assume responsibilities with confidence

5.3.3 Updating Self and Lifelong Learning

A graduate at SLQF Level 5 and SLQF Level 6 should be able to;

- engage in further learning and training
- develop necessary generic skills for independent and lifelong learning
- demonstrate the ability to acquire new competencies required for career progression

6. TEACHING, LEARNING AND ASSESSMENT PROCESS

6.1 Teaching and Learning

The objective of an effective teaching and learning process should be to produce graduates who are competent in a range of appropriate knowledge, skills, attitudes and mindset. A combination of teaching and learning methods should be designed to achieve these graduate attributes and ILOs in each course unit. Furthermore, the process should ensure active and deep learning and encourage students to engage in self and lifelong learning. Teaching and learning methods should be designed for the progressive transition from teacher-centered (dependent learning) to a learner-centered (independent/ self-directed learning) system where the students become increasingly responsible for their own learning.

BScHons degree programmes in Botany/ Plant Biology/ Plant Science should incorporate a research project of a minimum of 06 credits in the final year leading to a dissertation. The research project is expected to provide experience in the scientific approach, including the practice and evaluation of hypothesis-driven research. The research project should also include a literature survey, laboratory work/ field work/ computer-based work, data collection, data analysis and interpretation. Consideration of safety and ethical aspects should also be emphasized.

6.2 Assessments

Assessment methods are integral to teaching and learning process and should be designed to assess the ILOs. For each course unit, appropriate assessment methods should be envisioned to evaluate the level of achievement of
the ILOs. Assessments can be formative as well as summative. Both continuous and final assessments/ examinations in suitable proportions should be considered for the final grading. Assessment should be managed to promote deep rather than surface learning, based on real-life problems with potential employer involvement and with effective feedback.

6.3 Recommended Teaching, Learning and Assessment Methods

Teaching, learning and assessment methods should be aligned with ILOs of the study programme. Assessment options appropriate for a broad range of teaching and learning methods that cover core areas of Knowledge, Skills, Attitudes and Mind-set (KSAM) are summarized separately for SLQF Level 5 and Level 6 in the tables below. The list is not intended to be prescriptive or exhaustive. A balanced selection of the teaching and learning techniques can be used with a variety of assessment strategies to measure KSAM.

6.3.1 Teaching, Learning and Assessment Methods for SLQF Level 5

Category of Learning (KSAM)	Recommended Teaching and Learning Methods	Recommended Assessment Methods
Knowledge:		
Subject/ Theoretical Knowledge	• Interactive lectures with audio-visual aids and power point presentations • Activity-based learning • Blended learning • Independent learning • Small group activities	• Closed and open book examinations (structured and essay questions) • Quizzes (MCQ, true-false, matching items) • Assignment reports
Practical Knowledge and Application	• Laboratory sessions • Computer-based learning/ Use of virtual platforms • Field classes/ excursions • Team-based learning • Group projects • Mini projects • Assignments	• Practical assessments • Laboratory reports • Field work reports • Project reports • Assignment reports • Oral presentations • Videos
Skills:		
Communication	• Student presentations/ Seminars • Scientific writing • Interactive discussions • Workshops • Debates • Dramas • Role play	• Oral presentations • Written reports • *Viva voce* examinations
Team Work and Leadership	• Small group learning • Group projects • Problem-based learning • Work-based learning/ Industrial training	• Oral presentations • Written reports • Work experience reports/ Log books
Creativity and Problem Solving	• Mini projects • Group projects • Assignments • Problem-based learning	• Oral presentations • Written reports

Category of Learning (KSAM)	**Recommended Teaching and Learning Methods**	**Recommended Assessment Methods**
Managerial Skills and Entrepreneurship	• Group projects • Small group learning • Problem-based learning • Industrial training/ Workplace-based learning • Development of portfolios • Business plan	• Oral presentations • Written reports • Work experience reports/ Log books • Business proposals • Portfolios
Information Usage and Management	• Assignments • Projects • Case studies	• Assignment reports • Project reports • Review reports
Networking and Social Skills	• Student presentations • Debates • Community based activities	• Oral presentations • Activity reports
Attitudes, Values, Professionalism and Vision for Life: Adaptability and Flexibility	• Group projects • Problem-based learning • Development of portfolios • Industrial training	• Oral presentations • Portfolios
Attitudes, Values and Professionalism	• Group projects • Problem-based learning • Development of portfolios • Industrial training • Role play	• Oral presentations • Work experience reports • Portfolios
Vision for Life	• Development of portfolios • Motivational talks • Career planning workshops • Career fairs	• Portfolios • Oral presentations • Written reports • Interviews
Mind-set and Paradigm: Updating Self and Lifelong Learning	• Development of portfolios • Reflective practice • Self-learning	• Portfolios • Written reports • Oral presentations

6.3.2 Teaching, Learning and Assessment Methods for SLQF Level 6

Category of learning (KSAM)	Recommended Teaching and Learning Methods	Recommended Assessment Methods
Knowledge:		
Subject/ Theoretical Knowledge	• Interactive lectures with audio-visual aids and power point presentations • Activity-based learning • Team-based learning • Blended learning • Computer-based learning • Independent learning • Guest lectures	• Closed and open book examinations (structured and essay questions) • Assignment reports • Quizzes (MCQ, true-false, matching items)
Practical Knowledge and Application	• Laboratory sessions • Computer-based learning • Field classes/ excursions • Team-based learning • Group projects • Mini projects • Laboratory-based research • Field-based research • Computer--based research • Use of virtual platforms, software, databases	• Practical assessments • Laboratory reports • Field work reports • Project reports • Assignment reports • Dissertations/ thesis • Videos
Skills:		
Communication	• Student presentations • Seminars • Scientific writing • Interactive discussions • Workshops • Debates • Dramas • Role play • Peer and collaborative learning	• Oral presentations • Written reports • Project proposals • Dissertations/ thesis • Abstracts • Reviews • *Viva voce* examinations
Team Work and Leadership	• Small group learning • Group projects • Problem-based learning • Work-based learning/ Industrial training	• Oral presentations • Written reports • Work experience reports/ Log books

Category of learning (KSAM)	**Recommended Teaching and Learning Methods**	**Recommended Assessment Methods**
Creativity and Problem Solving	• Mini projects • Group projects • Research projects • Assignments • Problem-based learning • Case studies • Data analysis and interpretation • Critical analysis • Research communication	• Oral presentations • Written reports • Dissertations/ theses • *Viva-voce* examinations • Critical reviews
Managerial Skills and Entrepreneurship	• Group projects • Small group learning • Problem-based learning • Industrial training/ Work based learning • Simulated training • Prototype development • Development of portfolios • Business plan	• Oral presentation • *Viva-voce* examinations • Work experience reports / Log books • Business proposals
Information Usage and Management	• Assignments • Student Presentations • Projects • Case studies • Data analysis and interpretation • Critical analysis	• Essays • Assignment reports • Term papers • Computer-based assessments • Project reports • Reviews
Networking and Social Skills	• Student presentations • Role play • Debates • Dramas • Peer and collaborative learning • Group projects • Community-based activities • Business networking platforms	• Oral presentations • Poster presentation • Activity reports • Videos
Attitudes, Values, Professionalism and Vision for Life: Adaptability and Flexibility	• Group projects • Problem-based learning • Industrial training/ work-based training	• Oral presentations • *Viva voce* examinations

Category of learning (KSAM)	**Recommended Teaching and Learning Methods**	**Recommended Assessment Methods**
Attitudes, Values and Professionalism	• Group projects • Seminars • Problem-based learning • Development of portfolios • Industrial training/ work-based training	• Seminars • *Viva voce* examinations • Presentations • Work experience reports • Portfolios
Vision for Life	• Development of portfolios • Discussions • Motivational talks • Career planning workshops • Career fairs	• Portfolios • Oral presentations • Written reports • Interviews
Mind-set and Paradigm: Updating Self and Lifelong Learning	• Development of portfolios • Reflective practice • Self-learning	• Portfolios • Reports • Oral presentations

7. PERFORMANCE STANDARDS

In this section, standards of attainment are expressed as statements of learning outcomes. These describe the standard achieved by a student on completion of a BSc degree (SLQF Level 5) with Botany as a subject or BScHons degree (SLQF Level 6) with Botany as the major subject or BSc Joint Major degree with Botany as one of the two subjects. The outcomes are demonstrable through appropriate assessment strategies, which are designed to measure student achievement of standards. The performance standards are described in terms intended to give a rough scale of competence, such as 'threshold', 'good' and 'excellent'.

The standards indicated as 'threshold', 'good' and 'excellent' are defined as;

- Threshold standard – the minimum level of attainment required for a BSc/ BScHons degree; graduates at this level will demonstrate an acceptable level of ability and skills
- Good standard – the level of attainment required for BSc/ BScHons degree graduates; such graduates will demonstrate definite competence and skills
- Excellent standard – graduates achieving this standard upon completion of BSc/ BScHons degree will have a range of competencies and skills at a highly enhanced level

7.1 Performance standards of BSc degree programme – SLQF Level 5

On completing a BSc degree with Botany as a subject, graduates will have achieved the required standards in core subject-based theoretical and practical knowledge and skills as well as transferable skills, attitudes, and values.

7.1.1 Subject/ Theoretical Knowledge

Graduates should be able to understand the concepts, theory and practice in Botany and appreciate the role of Botany in its contexts.

Threshold	**Good**	**Excellent**
Recall knowledge based on the directly taught course	Recall knowledge based on the directly taught course with some evidence of wider enquiry	Recall knowledge based well beyond the directly taught course
Demonstrate a fair knowledge of theories, paradigms, concepts, and principles in Botany	Demonstrate substantial knowledge of theories, paradigms, concepts, and principles in Botany	Demonstrate a thorough, in depth knowledge of theories, paradigms, concepts and principles in Botany
Collate, summarize and analyze information related to Botany	Analyze, synthesize, summarize and evaluate information related to Botany	Seek out, analyze, synthesize, summarize, and critically evaluate information related to Botany

7.1.2 Practical Knowledge and Application

Graduates should demonstrate skills in practical applications of Botany and utilize the expertise for resolving real life problems.

Threshold	Good	Excellent
Apply a range of methods and technologies to solve practical problems with guidance and supervision	Select and apply a range of appropriate methods/ strategies and technologies to solve practical problems with guidance	Select and apply a range of well-planned strategies and technologies to solve challenging problems with minimum guidance and supervision
Describe and record data in the field and laboratory	Describe and record data in the field and laboratory with accuracy	Describe and record data in the field and laboratory with precision and accuracy
Interpret practical results with guidance	Interpret practical results in a logical manner with minimum guidance	Interpret practical results independently with logic and perception
Use appropriate laboratory and field equipment safely	Use appropriate laboratory and field equipment competently and safely	Use appropriate laboratory and field equipment highly competently and safely

7.1.3 Creativity and Problem Solving

Graduates should have the ability to explore ideas and alternative ways to overcome the shortcomings or barriers in achieving the desired objectives.

Threshold	Good	Excellent
Contribute to discussions in problem solving based on existing concepts	Contribute actively in discussions in problem solving and analyze problems based on existing concepts	Contribute actively and effectively in discussions in problem solving and analysis based on existing concepts and reason critically by conceptualization
Find information and use appropriate principles and methods to define and analyze problems to generate solutions	Find information and use appropriate principles and methods to define both routine and unfamiliar problems and analyze them	Find information and use appropriate principles and methods to define, analyze and solve problems, and assess the success of the plan
Reason logically and write creatively	Reason logically and write creatively and critically	Reason logically and write critically and analytically with confidence

7.2 Performance standards of BScHons degree programme – SLQF Level 6

Upon graduating with a BScHons degree in Botany, graduates should have reached elevated standards under the following categories:

7.2.1 Subject/ Theoretical Knowledge

Graduates should acquire a deeper understanding of reasoning, theories and concepts in Botany and acquire ability of analyzing associated practices.

Threshold	Good	Excellent
Integrate lines of evidence from a limited range of sources to support findings and hypotheses	Integrate lines of evidence from a range of sources to formulate and test hypotheses	Show a well-developed ability to integrate lines of evidence from a wide range of sources to formulate and test hypotheses
Demonstrate a fair ability to analyze issues from a range of multidisciplinary and interdisciplinary perspectives	Demonstrate ability to analyze issues from a range of multidisciplinary and interdisciplinary perspectives and to draw on appropriate concepts and values in arriving at a conclusion	Demonstrate ability to analyze issues from a wide range of multidisciplinary and interdisciplinary perspectives and to draw on appropriate concepts and values in arriving at a critical assessment and/or conclusion

7.2.2 Practical Knowledge and Application

Graduates should possess an in-depth knowledge of the processes of scientific enquiry expressed through practical capability to develop a more reflective, declarative knowledge of the nature of Botany.

Threshold	Good	Excellent
Plan and conduct an independent practical assignment or research with significant guidance	Plan and conduct a practical assignment or research with some guidance	Plan and conduct a practical assignment or research independently with minimum guidance
Relate investigations and outcomes to prior work and reference it appropriately	Relate investigations and outcomes more comprehensively to prior work and reference it appropriately	Analyze and relate investigations and outcomes to prior work with emphasis on recent research developments and reference it appropriately
Present research findings clearly and adequately	Present research findings effectively and appropriately	Present research findings perceptively and effectively in a number of formats

7.2.3 Creativity and Problem Solving

Graduates should be able to contest knowledge and practice, critically consider ideas, texts and research and think reflectively and reflexively.

Threshold	Good	Excellent
Sustain subject based ideas and make appropriate conclusions	Develop and defend subject based ideas using existing facts and theories	Develop and defend new subject based ideas and opinions using existing as well as new theories
Demonstrate a fair level of intellectual autonomy through independence of thought and openness to ideas	Demonstrate a substantial level of intellectual autonomy through independence of thought and openness to ideas	Demonstrate a high level of intellectual autonomy through independence of thought and critical analyses
Seek solutions, taking advantage of developments in research, technology and innovations	Creatively seek solutions, taking advantage of developments in research, technology and innovations	Creatively seek solutions and conceptualize, taking advantage of developments in research, technology and innovations

7.3 Performance standards common to both BSc degree programme (SLQF Level 5) and BScHons degree programme (SLQF Level 6)

BSc and BScHons graduates should have acquired the following skills and attitudes equably and the standards that should be achieved cannot be discerned between the two groups as these attributes are essential for successful integration into society and the 'world of work' as well as for career and self-advancement.

7.3.1 Communication Skills

Graduates should possess effective communication skills that are necessary to inform, persuade and motivate relevant audiences.

Threshold	Good	Excellent
Communicate to a variety of audiences in written, graphical, and verbal forms	Communicate effectively to a variety of audiences in written, graphical, and verbal forms	Communicate effectively to engage a variety of audiences in written, graphical, and verbal forms
Communicate clearly using context dependent language and appropriate references	Communicate clearly and effectively using context dependent language and appropriate references	Communicate clearly, logically, and effectively using context dependent language and appropriate references
Use a range of Information and Communication Technology (ICT) /virtual platforms to communicate and present information	Use a range of ICT/ virtual platforms to communicate and present information effectively	Use a range of ICT/ virtual platforms to communicate and present information effectively and with confidence and conviction

7.3.2 Teamwork and Leadership Skills

Graduates should possess teamwork and leadership skills crucial to motivate and utilize the individual strengths of team members.

Threshold	Good	Excellent
Demonstrate leadership, positive intent and work collaboratively and responsibly to achieve a common goal	Demonstrate leadership, positive intent and work collaboratively, responsibly and constructively to achieve a common goal	Demonstrate leadership, positive intent and work responsibly, collaboratively and constructively, to influence and motivate others to achieve a common goal
Recognize and respect the views of others and show empathy	Contribute effectively to teamwork while respecting the views of others and showing empathy	Contribute effectively and enthusiastically to coordinate the smooth functioning of a team by recognizing and respecting the views of others and showing empathy
Evaluate own performance	Evaluate performance as an individual and a team member	Evaluate performance as an individual and a team member, and learn for the future

7.3.3 Managerial and Entrepreneurship Skills

Graduates should demonstrate the capacity for independent work and innovative thinking as well as a possessing a business sense.

Threshold	Good	Excellent
Assume personal responsibility	Take initiatives and risks and assume personal responsibility	Take initiatives and risks, assume personal responsibility, and demonstrate accountability
Manage tasks individually and as a team	Assign and manage individual and team tasks effectively	Assign, prioritize and manage individual and team tasks effectively and efficiently
Show self-discipline and persistence	Show self-discipline, persistence and willingness to work hard	Show a high level of self-discipline, tenacity and willingness to work hard
Demonstrate self-motivation to reach goals	Demonstrate self-motivation and the ability to motivate others to achieve goals	Demonstrate a high level of self-motivation and, capacity to assemble and motivate a team to achieve goals
Introduce subject based innovations as an entrepreneurial venture	Develop subject based innovations as a successful entrepreneurial venture	Introduce and develop multi-disciplinary innovations and research outcomes as an entrepreneurial venture

7.3.4 Information Usage and Management

Graduates should be aware of sources of information, the means of retrieval and the effective use of available information.

Threshold	Good	Excellent
Use digital and printed material for communication and information retrieval	Use digital and printed material critically for communication and information retrieval	Use digital and printed sources critically and imaginatively for communication and information retrieval
Handle retrieved information effectively, using appropriate techniques, software and applications	Handle retrieved information effectively and responsibly using appropriate techniques, software and applications	Handle retrieved information effectively, confidently and competently, using appropriate techniques, custom interfaces, software, and applications
Display skills in synthesis of retrieved information	Display skills in synthesis and evaluation of retrieved information in a balanced manner	Display skills in evaluating, synthesizing and interpreting information in a balanced manner
Have an awareness of effective and safe use of digital media	Demonstrate the effective and safe use of digital media	Develop effective and safe use of digital media

7.3.5 Networking and Social Skills

Graduates should possess effective networking and social skills that are necessary to develop a broad scope for personal and professional development as well as for successful social engagement.

Threshold	Good	Excellent
Build a network of social and professional contacts for sharing ideas, information and experiences	Build and maintain a network of social and professional contacts for sharing ideas, information and experiences	Build and maintain a network of continuously expanding social and professional contacts for sharing ideas, information, and experiences
Demonstrate the ability to interact and communicate with individuals and organizations with empathy and respect	Demonstrate the ability to interact and communicate with individuals and organizations with empathy, respect and understanding	Demonstrate the ability to interact and communicate with individuals and organizations with respect, empathy, understanding and open-mindedness
Possess sufficient emotional intelligence for relationship management	Possess sufficient emotional intelligence for relationship management and to avoid unnecessary conflict	Possess sufficient emotional intelligence for relationship management and for conflict resolution

7.3.6 Adaptability and Flexibility

Graduates should possess mental and emotional capacity to adapt to changing and challenging situations.

Threshold	Good	Excellent
Demonstrate an adaptable and flexible approach to study and work	Demonstrate a responsible, adaptable and flexible approach to study and work	Manage a responsible, adaptable and flexible approach to study and work within a variety of situations
Possess the ability to work with different individuals or groups	Possess the ability to work effectively with different individuals or groups	Possess the ability to work effectively and efficiently with different individuals or groups
Acknowledge shortcomings of self and be ready to improve for the better	Acknowledge shortcomings of self and be ready and willing to improve for the better	Acknowledge shortcomings of self and be responsible for self-improvement

7.3.7 Attitudes, Values, and Professionalism

Graduates should be able to learn and work autonomously and ethically to develop the appropriate attitudes, values, and professionalism

Threshold	Good	Excellent
Work with self-discipline	Work autonomously with self-discipline	Work autonomously with self-discipline and self-insight
Recognize the need for personal, professional and academic integrity and have an awareness of appropriate codes of ethics	Recognize the need for personal, professional and academic integrity and have an awareness of the means of practicing appropriate codes of ethics	Recognize and understand the need for personal, professional, and academic integrity and disseminate the knowledge of means of practicing appropriate codes of ethics
Show social responsibility, an appreciation of equity, equality and social justice	Show social responsibility, an appreciation of equity, equality and social justice and a personal and professional sense of responsibility to create a sustainable future	Show social responsibility and actively engage in ensuring equity, equality, and social justice to create a sustainable future

7.3.8 Vision for Life, Updating Self and Lifelong Learning

Graduates should recognize a role for themselves in creating a sustainable future and be able to consider the social, cultural, environmental, and economic consequences of national and international issues. They also should be lifelong learners, show resilience, proactivity and an ability to make principled decisions in academic and professional spheres.

Threshold	**Good**	**Excellent**
Identify targets for personal, career and academic development	Identify and work towards targets for personal, career and academic development	Identify and work ambitiously towards targets for personal, career and academic development
Acquire new competencies in order to assume responsibilities	Acquire new competencies in order to assume responsibilities and career progression	Acquire new competencies in order to assume responsibilities and career progression under challenging situations
Accept some responsibility for own learning	Accept responsibility for own learning	Assume responsibility for own learning
Engage in continuous pursuit of knowledge	Engage in continuous and voluntary pursuit of knowledge	Engage in continuous, voluntary, and self-motivated pursuit of knowledge for personal and professional progress
Achieve self-awareness	Achieve self-awareness through some metacognitive strategies	Achieve higher self-awareness through metacognitive strategies

Annexure I: Members of the Subject Committee on Botany

1. Prof. Tara Silva (Chair), University of Colombo
2. Prof. Nelum Deshappriya (Co-chair), University of Sri Jayewardenepura
3. Prof. Pushpa Abeysinghe, University of Ruhuna
4. Prof. Saman Abeysinghe, University of Ruhuna
5. Prof. Gehan Jayasuriya, University of Peradeniya
6. Prof. Sumedha Madawala, University of Peradeniya
7. Prof. Anoma Perera, University of Peradeniya
8. Prof. Priyanganie Senanayake, University of Kelaniya
9. Prof. Sandun Senarath, University of Sri Jayewardenepura
10. Prof. Shamala Tirimanne, University of Colombo
11. Prof. Kolitha Wijesekara, Uva-Wellassa University
12. Prof. Deepthi Yakandawala, University of Peradeniya
13. Ms. Chathuri Edirisinghe, MAS Holdings (Pvt) Ltd.
14. Ms. Isha Wijeyeratnam, Eco-Serene Biotech (Pvt) Ltd.

Annexure II: Careers Relevant for Botany/ Plant Biology/ Plant Science Graduates

The following is a list of typical Botany-related career options in Sri Lanka for graduates in Botany/ Plant Biology/ Plant Science.

- State Universities (Academic and administrative positions)
- Private Universities/HEIs (Academic and administrative positions)
- Research Institutes (Research Officers/ Administrative Officers)
- Department of Agriculture (Research Officers/ Administrative Officers)
- National Plant Quarantine Service (Scientific Officers)
- Department of Export Agriculture (Research Officers/ Administrative Officers)
- Department of National Botanic Gardens (Curators/ Assistant Directors)
- Department of Wild Life Conservation (Wildlife Officers)
- Forest Department (Divisional Forest Officers)
- Department of National Museums (Assistant Directors)
- Government Agencies such as National Science Foundation (NSF), National Research Council (NRC), Sri Lanka Council for Agricultural Research Policy (SLCARP), Industrial Technology Institute (ITI), Central Environment Authority (CEA) (Scientific Officers)
- Secondary Schools (Teachers)
- Non-Governmental Organizations such as International Union for Conservation of Nature (IUCN), Sri Lanka Wild Life Trust
- Biotechnology companies (S&T Managers/ Research Officers)
- Floriculture companies (S&T Managers/ Research Officers)
- Agrochemical companies (S&T Managers/ Research Officers)
- Herbal products and Pharmaceutical companies (S&T Managers/ Research Officers)
- As Entrepreneurs

Furthermore, a Botany graduate can also sit for examinations for the Sri Lanka Scientific Service, Sri Lanka Administrative Service (SLAS), Sri Lanka Foreign Service, and Banking Services and gain employment in relevant state or private sector institutions.

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Annexure III: Core Practical Skills Expected in Botany/ Plant Biology/ Plant Science Graduates

SLQF Level 5:

- Basic microscopy
- Characterization and identification related to Microbiology and Plant Diversity
- Herbarium/ preservation techniques related to Plant Systematics
- Media preparation and aseptic culture techniques related to Microbiology
- Floral dissection, hand sectioning and staining related to Plant Morphology and Anatomy
- Chromatography, spectrophotometry etc. related to Plant Physiology and Biochemistry
- DNA isolation, Polymerase Chain Reaction, gel electrophoresis related to Molecular Biology
- Vegetation Sampling and Analysis related to Ecology
- Identification of signs, symptoms and causative agents of disease related to Plant Pathology
- Micro-propagation and regeneration techniques related to Plant Tissue Culture
- Data analytical skills related to Biostatistics

SLQF Level 6:

- Basic and advanced microscopy
- Characterization and identification related to Microbiology and Plant Diversity
- Herbarium/ preservation techniques related to Plant Systematics
- Media preparation and aseptic culture techniques related to Microbiology
- Floral dissection, hand and microtome sectioning and staining related to Plant Morphology and Anatomy
- Chromatography, spectrophotometry etc. related to Plant Physiology and Biochemistry
- DNA isolation, cloning, Polymerase Chain Reaction, gel electrophoresis and genetic transformation techniques related to Molecular Biology
- Micro-propagation and regeneration techniques related to Plant Tissue Culture
- Specialized *in vitro* culture techniques related to Plant Breeding
- Vegetation sampling, analysis and mapping related to Ecology
- Disease diagnosis and management related to Plant Pathology
- Computational skills related to Bioinformatics
- Data analytical skills related to Biostatistics