POSTGRADUATE INSTITUTE OF SCIENCE
UNIVERSITY OF PERADENIYA

M.Sc. Programme in Pharmaceutical Botany

1. INTRODUCTION

Being an island rich and flourishing in its natural resources, Sri Lanka has ample capacity towards the development of medicine and pharmaceutical industry. Among the natural resources of the country are a wide array of indigenous flora and mineral deposits and these coupled with the inherent traditional knowledge on Ayurveda and herbal medicinal practices which place us a step ahead in present day medicine. However, Sri Lanka is spending around US $ 140 million annually for the import of medicinal drugs alone. Hence, it is obvious that the value of our natural products and knowledge is undermined. In addition, there are multiple shortcomings such as microbial resistance to antibiotics, potential health hazards and occurrence of side effects in most of the widely used synthetic drugs. These emphasize the need for the development of novel, safe, effective and potent drugs where products could play a significant role. This lies in parallel with the 2012 budget which stated that the action will be taken 'to develop manufacturing of pharmaceuticals in Sri Lanka as a Strategic Import Replacement Enterprise by granting tax holidays for investment in the pharmaceuticals production'.

Hence, the M.Sc. programme in Pharmaceutical Botany is focused on training students for the improvement and utilization of our natural products in the pharmaceutical industry, which would virtually be filling a national gap. In this aspect, the M.Sc. programme in Pharmaceutical Botany within its framework will provide the knowledge, training and skills required to cater to the pharmaceutical needs of the country as well as to the entire world. A firm foundation in Botany will give a cutting edge to improve pharmaceutically useful plants and their management (in endeavoring to assure an adequate supply of products for the earth's ever-growing population).

2. COURSE OBJECTIVES

To have students acquire effective knowledge on plant species with pharmaceutical importance, their usage, train them towards development of new commercial pharmaceutical products through innovative research and to introduce both traditional and latest developments in Pharmaceutical Botany with hands on experience.

3. PROGRAMME ELIGIBILITY

The course is intended for those who are involved in or seek career opportunities in pharmaceutical industry, medical practitioners, medicinal plant growers and scholars who are interested in the herbal industry and research. Candidates having a Bachelors' degree in Natural Sciences, Agriculture, Medicine, Dental,

Ayurvedic Medicine, Allied Health Sciences or Veterinary Science from a recognized university or equivalent qualifications are acceptable to the Postgraduate Institute of Science and eligible to enroll in the program. Prospective candidates should possess an adequate proficiency in English language.

4. PROGRAMME FEE

Category	Programme Fee	
	M.Sc. (Course work)	**M.Sc. by (Course work & Research)**
Local candidates	Rs. 130,000/-	Rs. 230,000/-
Foreign candidates	Rs. 260,000/-	Rs. 460,000/-

Students registered for the M.Sc. degree by course work shall pay the Programme fee in full or in two *(1/2 at the registration and the balance at the end of the first semester)* or three *(1/3rd at the registration, another 1/3rd after 4 months from the date of registration and the balance after 8 months from the date of registration)* installments. An additional payment of Rs. 100,000/- (or Rs. 200,000/- form foreign students) should be made at the end of the first year to continue for the M.Sc. degree by course work & research. Other payments including registration fee, medical fee, library subscription, examination fee and deposits (science and library) should be paid according to the procedure stipulated by the PGIS. (N.B. The Programme fees given above may be revised as per recommendation of the Board of Management of the PGIS.)

5. THE PROGRAMME STRUCTURE AND DURATION

This programme consists of three options for completion.

5.1 Masters Degree with Course Work

The M.Sc. degree (Course work) can be obtained by completing course work only (without conducting any research project).

Course work, comprising of theory courses, and laboratory and/or fieldwork, will be conducted over a period of two semesters of 15 weeks each. The total duration of the degree, including examinations, will be about 12 months. Satisfactory completion of a minimum of 30 credits of course work with a GPA of not less than 3.00 is required for the successful completion of the degree (The student who does not satisfy the above criteria but obtains a GPA in the range 2.75 to 2.99 for course work of 25 credits is eligible for the Diploma in Pharmaceutical Botany).

5.2 Masters Degree

In addition to Masters Degree with course work (5.1), the Masters Degree (Research) requires a research project. The duration of the entire programme will be 24 months inclusive of 5.1. Completion of all the requirements of 5.1 with a GPA of not less than 3.00 is a prerequisite for the Masters Degree (Research). The research project for this degree should be conducted on full-time basis, and completed during the second year. The research component is allocated 30 credits, totalling 60 credits for the entire programme. After successful completion of the research project, the student is eligible for the award of the M.Sc. Degree in

Pharmaceutical Botany (The student who does not complete the research project will be awarded the M.Sc. Degree with course work in Pharmaceutical Botany).

5.3 Extension of the programme for M.Phil. or Ph.D.

At the end of the period of the Masters Degree (Research), students who have demonstrated exceptional progress may apply for upgrading the degree status to M.Phil. The student should continue the research project and any additional research work/assignments recommended by the PGIS for another year on full-time basis (30 credits) to qualify for the award of the M.Phil. degree.

At the end of the second year of research, students who have demonstrated exceptional and continuous progress, may apply for upgrading the degree status from M.Phil. to Ph.D. The student should continue the research project and any additional research work/assignments recommended by the PGIS for another year on full-time basis (30 credits) to qualify for the award of the Ph.D. degree.

PROGRAMME SUMMARY

Course code	Course Title	Lecture hrs	Practical hrs	Credits
PB 401	Basic chemistry	20	20	--
PB 402/ENS 402	Basic statistics	30	--	--
Semester1 – First Year				
PB 501	General Microbiology	20	20	2
PB 502	Basic Analytical Chemistry	20	20	2
PB 503	Analytical Methods in Pharmaceutical Science	22	16	2
PB 504	Plant Morphology and Systematics	30	30	3
PB 505#	Diversity and Ecology of Sri Lankan Ecosystems	20	20	2
PB 506#	Plant Physiology	20	20	2
Semester II – First Year				
PB 507	Domestication, Cultivation and Conservation of Plants of Pharmaceutical Uses	20	20	2
PB 508	Basic Phytochemistry	25	40	3
PB 509	Socio-cultural Aspects of Herbal Utilization	30	--	2
PB 510	Applied Pharmaceutical Microbiology	15	30	2
PB 511	Specifications, Standardization, Value addition of plants of Pharmaceutical Uses and their Derivatives	30	--	2
PB 512#	Molecular Genetics and Genetic Engineering	35	20	3
PB 513	Marketing Aspects of Herbal Products	30	--	2
PB 514#	Pharmaceutical Biotechnology	15	30	2
PB 515#	Bioinformatics	15	--	1
PB 516	Independent Study	15	--	1
Second Year				
PB 517#	Directed study			2
PB 518#	Research project			30

#Optional courses

6. PROGRAMME CONTENT

Course code	**PB 401**
Course title	Basic Chemistry
Credits	None
Compulsory/optional	Compulsory for those who have not studied chemistry as a major subject area at degree level
Prerequisites	None.
Aims	To impart knowledge and develop basic skills in students on basic chemistry theory and practicals.
Intended learning outcomes	Students who successfully complete this course will be able to, 1 explain basic concepts of chemistry 2 apply basic chemistry knowledge in advanced courses offered in this course 3 able to perform basic chemical analyses such as titrations and gravimetric analyses
Time allocation	Lectures and Tutorials: 20 hrs Practicals: 20 hrs
Content	Modern view of atomic structure; Atomic theory of matter; The quantum mechanical description of the atom; Quantum numbers; Electrons as waves, Wave-particle duality, de Broglie relationship, Wave function; Heisenberg's uncertainty principle; Electron configurations of elements of periodic table and periodic trends in atomic properties; Bonding; Co-ordination chemistry; Stoichiometry; Basics of thermodynamics – zeroth, first and second laws of thermodynamics; Enthalpy, entropy, Gibb's energy; Basic concepts in chemical analysis: titrations, buffers, indicators, solubility equilibria and applications; Gravimetric analyses; Thermodynamics and kinetics of organic reactions; Nomenclature; Separation of mixtures; Basics of Enzymology; Laboratory exercises related to above topics.

Assessment criteria

Continuous assessment	End-semester examination
20%	80%

Recommended Texts:

1. Chang, R. (2002) Chemistry. McGraw-Hill,
2. Cotton, F.A., and Wilkinson, G. (1997). A text book of inorganic chemistry. Wiley Interscience
3. Vogel, A.I. (2004). Qualitative inorganic analysis. Longman Scientific.
4. Vogel, A.I. (2004). Quantitative inorganic analysis. Longman Scientific.

Course code	**PB 402/ ENS 402**
Course title	Basic Statistics
Credits	None
Compulsory/optional	Compulsory
Prerequisites	None

Aims	To develop basic skills in students on biological sampling and designing scientific experiments, train students in quantitative and qualitative analysis of data and train students in using statistical software packages, (MINITAB and SPSS).
Intended learning outcomes	Students who successfully complete this course will be able to, 1. design scientific experiments 2. analyze both qualitative and quantitative data 3. derive valid conclusions and present the outcome 4. use common statistical packages for analyzing data
Time allocation	Lectures and Tutorials: 30 hrs Practicals: 00 hrs
Content	Introduction to basic statistical concepts and methods as applied to biological data; Probability; Descriptive statistics; Hypothesis testing; Analysis of variance; Correlation; Simple linear regression; Basics of experimental designing; Analysis of qualitative data; Frequently used software for statistical analysis: MINITAB and SPSS.

Assessment criteria

Continuous assessment	End-semester examination
20%	80%

Recommended Texts:

1. Clarke, G.M. and Cooke, D. (1995). *A Basic Course in Statistics*. St. Edmundsburry Press Ltd.
2. Hamburg, M. (1974). *Basic Statistics: A Modern Approach*. Harcourt Brace Jovanovich Inc.
3. Priyantha, N. (2012). *Measurements and Errors in Chemical Analysis*. Science Education Unit, University of Peradeniya.

Course code	**PB 501**
Course title	General Microbiology
Credits	02
Compulsory/optional	Compulsory
Prerequisites	None
Aims	To impart knowledge on basics in microbiology, train students in handling microorganisms, culturing and sterilization techniques classify and identify different types of microorganisms and explain the applications of microbiology in different disciplines (plant pathology, industrial, environmental, medical and food microbiology).
Intended learning outcomes	Students who successfully complete this course will be able to, 1. explain basics in microbiology 2. demonstrate skills in classifying and identifying different types of microorganisms, handling and culturing microorganisms and sterilization procedures 3. explain applications of microbiology in different disciplines such as industrial, environmental and food microbiology, plant pathology, or medical microbiology
Time allocation	Lectures and Tutorials: 20 hrs Practicals: 20 hrs
Content	Introduction to Microorganisms; Scope of microbiology (based upon the organisms and applied fields - Exomicrobiology, Food microbiology, Geochemical microbiology, Industrial microbiology and Pathology); Microscopy; Sterile techniques; Culturing of

	microorganisms; Characterization (morphological, physiological, biochemical and serological) and identification; Growth, development and reproduction; Introduction to the application of modern techniques based upon molecular characterization of proteins and nucleic acids; Laboratory exercises related to above topics.

Assessment criteria

Continuous assessment	End-semester examination
20%	80%

Recommended Texts:

1. Madigan, M.T. Martinkor, J.M. and Parker, J. (2002). *Broock Biology of Microorganisms*. Prentice Hall.
2. Stanier, R.Y., Ingrahm, J.L., Wheelis, M.L. and Painter, P.R. (1995). *General Microbiology*. Macmillan Press Ltd.
3. Carpenter, P.L. (1977). *Microbiology*. W.B. Saunders Company.

Course code	**PB 502**
Course title	Basic Analytical Chemistry
Credits	02
Compulsory/optional	Compulsory
Prerequisites	None
Aims	To introduce basic principles in analytical chemistry and to develop basic skills in methods of inorganic/organic and quantitative analyses, including gravimetric and volumetric analysis with the use of simple instrumental methods.
Intended learning outcomes	Students who successfully complete this course will be able to, 1. perform laboratory experiments to analyze, purify and characterize biological samples 2. obtain basic skills to follow advanced studies on pharmaceutical studies
Time allocation	Lectures and Tutorials: 20 hrs Practicals: 20 hrs
Content	Basic aspects in analytical chemistry: The concept of significant figures; Measurements and errors in quantitative analysis; Types of errors; Numerical and graphical methods of analysis in chemical analysis; Planning experiments for qualitative and quantitative analysis; Detecting the composition of a sample; Properties of solutions; Ionic equilibrium: Ionization reactions of weak acids, weak bases, salts and buffer solutions; Calculation of pH of the above systems; Titrations involving acid base and complexometric reactions. Solubility equilibrium: Equilibrium of sparingly soluble salts in aqueous medium, effect of experimental conditions on solubility, factors that affect precipitation, calculations involving solubility equilibria; Solvent extraction: Partition coefficient and distribution coefficient, factors affecting partition equilibrium, theory of extraction and methods of extraction substances from natural products. Reaction rates: Review of kinetics of chemical and enzymatic reactions, factors affecting reaction rates and mechanisms. Laboratory component: Experiments on measurements and errors,

	ionic equilibrium, solubility equilibrium, solvent extraction and chemical kinetics, as applied to pharmaceutical aspects; Laboratory exercises related to above topics.

Assessment criteria

Continuous assessment	End-semester examination
25%	75%

Recommended Texts:

1. Skoog, D.A., West, D.A., Holler, D. F. and Crouch, S.R. (1996). *Fundamentals in Analytical Chemistry: An Introduction.* Brooks and Cole, Australia.
2. Priyantha N., (2011). Measurements and Errors in Chemical Analysis, Science Education Unit, University of Peradeniya.

Course code	**PB 503**
Course title	Analytical Methods in Pharmaceutical Science
Credits	02
Compulsory/optional	Compulsory
Prerequisites	None
Aims	To provide a theoretical and hands-on experience on commonly employed analytical techniques used in biological research and pharmaceutical product manufacturing.
Intended learning outcomes	Students who successfully complete this course will be able to, 1. explain theoretical basis for analytical measurements 2. develop understanding and competence of operating conventional and modern analytical instrumentation 3. demonstrate skills on solving bio-analytical problems
Time allocation	Lectures and Tutorials: 22 hrs Practicals: 16 hrs
Content	Importance of quantitative determination of a component in a sample; Sampling techniques, sample preparation, storage and quality assurance; Classical analytical methods: Titrimetry and gravimetry; Overview of instrumental methods used in biological and pharmaceutical research; Spectroscopic techniques (e.g., UV-Vis, atomic absorption, flame emission and mass spectrometry); Separation techniques (solvent extraction, chromatographic techniques such as TLC, column, HPLC, GC and capillary electrophoresis); Electrochemical techniques (e.g., potentiometry, ion-selective electrodes); Biosensors; Molecular biological techniques (DNA and RNA extraction, PCR, RAPD, AFLP and DNA sequencing); immunochemical methods: Enzyme immunoassays (ELISA); Isotopic Methods: Liquid Scintillation Counters; Microscopy: optical, phase, electron and their basic principles; Applications: Quantitative determination of nitrogen (Kjeldahl method), proteins, nucleic acids, sugars, lipids and other elements; applications of radioisotopes in biology.

Assessment criteria

Continuous assessment	End-semester examination
20%	80%

Recommended Texts:

1. Khandpur, R.S. (2006). *Analytical Instruments*. Tata McGraw-Hill New Delhi India.
2. McMohan, G. (2007). *Analytical Instrumentation: A Guide to Laboratory, Portable and Miniaturized Instruments.* John Wiley & Sons, Chichester, England.
3. Currell, G. (2000). *Analytical Instrumentation.* John Wiley and Sons Ltd. Chichester, England.
4. Wilson, K.M. and Walker, J.M. (2010). *Principles and Techniques of Biochemistry and Molecular Biology.* Cambridge University Press, England.

Course Code	**PB 504**
Title	Plant Morphology and Systematics
Credits	03
Compulsory/optional	Compulsory
Prerequisites	None
Aims	To provide an understanding of principles, goals and applications of plant taxonomy in various fields such as medical and pharmaceutical research, explain methods and different approaches to biological classification, plant identification and nomenclature, provide knowledge on the use of plant morphological, anatomical, chemical and molecular characters in plant identification and to expose students to modern techniques of plant collection and herbarium methods.
Intended Learning outcomes	Students who successfully complete this course will be able to, 1. demonstrate a thorough understanding of principles of plant taxonomy 2. possess a knowledge on the philosophical and theoretical concepts of plant taxonomy and historical development of classification systems 3. apply this knowledge in various fields and contributions of systematics to biology 4. identify plants using taxonomical identification keys and related literature 5. produce and use floras and monographs 6. use appropriate methods to solve taxonomic problems, using a range of techniques within systematics including collection management, identification, key construction, and comparative methodologies
Time allocation	Lectures and Tutorials: 30 hrs Practicals: 30 hrs
Content	Aims and uses of plant taxonomy; Historical development of classfication systems: artificial, mechanical, natural and phylogenetic classification systems; Phenetics and cladistics, taxonomic hierarchy; Species concepts and plant nomenclature; Morphology: anatomy, phytochemistry, cytology and molecular data in plant taxonomy; Modern field and herbarium methods; Taxonomic literature: keys, floras, monographs, revisions; Laboratory exercises related to above topics.

Assessment criteria

Continuous assessment	End-semester examination

20%	80%

Recommended Texts:

1. Stace, C.A. (1993). *Plant taxonomy and biosystematics.* Cambridge University Press, U.K.
2. Stuessy, T.F. (2008). *Plant Taxonomy: The Systematic Evaluation of Comparative Data.* Columbia University Press. New York.
3. Simpson, M. G. (2010). *Plant Systematics.* Elsevier-Academic Press.

Course code	**PB 505**
Course title	Diversity and Ecology of major Sri Lankan Ecosystems
Credits	02
Compulsory/optional	Optional
Prerequisites	None
Aims	To explain the structure and function of ecosystems and plant communities, expose students to the characteristic features of different natural ecosystems of Sri Lanka, describe the biodiversity of major Sri Lankan ecosystems and their sustainability, explain the conservation and restoration of natural habitats of Sri Lanka.
Intended learning outcomes	Students who successfully complete this course will be able to, 1. explain the structure and function of natural ecosystems 2. describe the climate, physiognomic and floristic features of major plant communities /ecosystems of Sri Lanka 3. describe the biodiversity, endemism and threatened plants in different ecosystems of Sri Lanka 4. describe the importance of conserving natural ecosystems of Sri Lanka and explain the importance of rehabilitating degraded ecosystems for the conservation of plants
Time allocation	Lectures and Tutorials: 20 hrs Practicals: 20 hrs
Content	Components of ecosystems; Structure and functions of ecosystems, Plant communities and populations; Plant animal interactions; Climatic, physiognomic and floristic features of major ecosystems of Sri Lanka; Biodiversity, endemism and threatened plant species in different ecosystems of Sri Lanka; Threats in natural ecosystems of Sri Lanka; Conservation and sustainable utilization of biodiversity; Restoration of degraded ecosystems of Sri Lanka. Laboratory exercises, field visits and case studies related to above topics.

Assessment criteria

Continuous assessment	End-semester examination
30%	70%

Recommended Texts:

1. Begon, M. Harper, J.L. and Townsend, C.R. (1996). *Ecology: Individuals, populations and communities.* Blackwell Science Ltd.
2. Crawley, M.J. (1997). *Plant Ecology.* Blackwell Science Ltd.
3. Ashton, P.M.S., Gunatillake, N., *et al*., (1997). A field guide to the common trees and shrubs of Sri Lanka. The wildlife Heritage Trust, Sri Lanka. pp432
4. Suitable journal articles referring to Sri Lankan ecosystems.

Course code	**PB 506**
Course title	Plant Physiology
Credits	02
Compulsory/optional	Optional
Prerequisites	None
Aims	To provide knowledge on fundamentals of functional plant biology as a basis of understanding plant life, expose students to physiological aspects of plant growth and development, and provide exposure to current research trends in the field of Plant physiology.
Intended learning outcomes	Students who successfully complete this course will be able to, 1. recognize the importance of plant physiology in relation to pharmaceutical botany 2. obtain a sufficient knowledge on stress responses and biological interactions that determine the habit and habitat of medicinal plants 3. demonstrate knowledge and experience related to plant physiological aspects 4. report the current research trends in the field of plant physiology
Time allocation	Lectures and Tutorials: 20 hrs Practicals: 20 hrs
Content	Physiology of higher plants with emphasis on biochemical, cell biological and molecular aspects of plants function; Plant and cell architecture; Plant biochemistry and metabolism (photosynthesis, respiration, mineral nutrient assimilation, plant protection and defense compounds, stress physiology); Plant growth and development; Laboratory exercises related to above topics and Case studies.

Assessment criteria

Continuous assessment	End-semester examination
30%	70%

Recommended Texts:

1. Taiz, L. and Zeiger, E. (2002). *Plant Physiology.* The Benjamin Cummings Publishing Company, Inc. California.
2. Öpik, H., Rolfe, S.A., Willis, A.J. (2005). *The Physiology of Flowering Plants.* Cambridge University Press.
3. Lambers, H., Pons, T.L., Chapin, F.S. (2008). *Plant Physiological Ecology.* Springer Science and Business Media, NY, USA.

Course code	**PB 507**
Course title	Domestication, Cultivation and Conservation of Plants of Pharmaceutical Uses
Credits	02
Compulsory/optional	Compulsory
Prerequisites	None
Aims	To impart knowledge on domestication, propagation and cultivation of plants of pharmaceutical aspects, explain ways of improving the quality of plant raw material during cultivation and harvesting, explain sustainable harvesting of plants having pharmaceutical potential found in the wild/in common properties, and to impart

	knowledge in the conservation of plants of pharmaceutical uses.
Intended learning outcomes	Students will be able to, 1. explain domestication, cultivation and conservation of plants of pharmaceutical aspects 2. evaluate agricultural and agronomic needs of medicinal plants 3. demonstrate knowledge on improving the quality of plant raw material during cultivation and harvesting practices 4. apply their knowledge in the conservation of plants of medicinal usage
Time allocation	Lectures and Tutorials: 20 hrs Practicals: 20 hrs
Content	Domestication of plant species; Techniques of plant propagation (Budding, grafting, vegetative propagation); Tissue culture; Introduction to agronomy and cultivation of medicinal plants (growth requirements, weeding, fertilizing & sustainable harvesting); Quality improvement of plant raw material for phyto-medicine production; *In situ* and *Ex-situ* conservation of plants of pharmaceutical aspects; Laboratory exercises and case studies related to above topics.

Assessment criteria

Continuous assessment	End-semester examination
20%	80%

Recommended Texts:

1. Kirtikar, K.R. and Basu, B.D. (1984). *Indian Medicinal Plants.* Goyal Offset Printer, Delhi.
2. Han, S. T. (1998). *Medicinal Plants in the South Pacific.* WHO Regional Publications.

Course code	**PB 508**
Course title	Basic Phytochemistry
Credits	03
Compulsory/optional	Compulsory
Prerequisites	None
Aims	To introduce biochemistry of natural pharmaceuticals, study the pharmaceutical properties of natural substances and preparation of natural products.
Intended learning outcomes	Students who successfully complete this course will be able to, 1. identify and appreciate plants of medicinal value 2. categorically identify substances of pharmaceutical value
Time allocation	Lectures and Tutorials: 25 hrs Practicals: 40 hrs
Content	Introduction to the active ingredients of crude drugs and their classifications; Methods of isolation and identification; Qualitative and quantitative evaluation of alkaloids, glycosides, saponins, flavonoids, coumarins, anthraquinones and tannins carbohydrates, fats and volatile oils; Physical and chemical properties of alkaloids, glycosides, saponins, flavonoids, coumarins, anthraquinones, tannins carbohydrates, fats and volatile oils and their medicinal uses;

	Laboratory exercises related to above topics.

Assessment criteria

Continuous assessment	End-semester examination
20%	80%

Recommended Texts:

1. Harbone, J.B. (1984). *Phytochemical Methods.* Chapman and Hall, England.
2. Reid, E. and Wilson, I. (1992). *Bioanalytical approaches for drugs including anti-asthmatics and metabolites.* The Royal Society of Chemistry, England.
3. Skoog, D.A., West, D.M., Holler, D.F. and Crouch, S.R. (1996). *Fundamentals in Analytical Chemistry: An introduction.* Brooks and Cole, Australia.
4. Ross, I.A. (1999). *Medicinal Plants of the World: Chemical constituents, traditional and modern medicinal uses.* Humana Press, USA.

Course code	**PB 509**
Course title	Socio-cultural Aspects of Herbal Utilization
Credits	02
Compulsory/optional	Compulsory
Prerequisites	None
Aim	To introduce the methods and rationale used by traditional systems on herbal pharmaceutical preparations, impart knowledge on interdisciplinary collaboration in research among traditional medicine and other fields and to help plant based drug discovery and development programs in Sri Lanka using ethnobotanical knowledge; To explain the social trends and viewpoints about herbal use, research ethics and intellectual property rights and, to train students to conduct surveys based on questionnaires and clinical trials.
Intended learning outcomes	Students who successfully complete this course will be able to, 1. understand the micro and macro scale development opportunities in the herbal industry 2. identify social and cultural trends and traditions in herbal use 3. identify risk assessment of herbal pharmaceuticals 4. plan and conduct surveys based on questionnaires and clinical trials 5. understand the research ethics and intellectual property rights
Time allocation	Lectures and Tutorials: 30 hrs
Content	Ethnobotany; Traditional wisdom versus modern scientific knowledge; Ethnopharmacological aspects of pharmaceutical preparations; Knowledge-attitude-practice of consumers and health personnel; Strengthening the existing traditional medicine system and herbal pharmaceutical industry in the community; Political and economic relevance of the herbal pharmaceutical industry; Conducting clinical trials related to development of new herbal pharmaceutical products and population-based studies on quality of

	herbal products; Research ethics; Intellectual property rights; Good pharmacovigilance practice of herbal pharmaceutics; Good pharmacoepidemiologic practice of herbal pharmaceutics.

Assessment criteria

Continuous assessment	End-semester examination
20%	80%

Recommended Texts:

1. Anon. (2002). Safety monitoring of medicinal products. The importance of pharmacovigilance. World Health Organization, Geneva.
2. Anon. (2002). Safety of medicines. A guide to detecting and reporting adverse drug reactions. World Health Organization, Geneva.
3. Anon. (1998). Effective communications in pharmacovigilance: The Erice Report. World Health Organization Collaborating Centre for International Drug Monitoring, Uppsala.
4. Jayaweera, D.M.A. (1982). *Medicinal Plants (Indigenous and Exotic) used in Ceylon.* The National Science Council of Sri Lanka, Colombo.
5. Trivedi, P.C. and Sharma, N. (2011). *Text Book of Ethnobotany.* Pointer Publishers. USA.

Course code	**PB 510**
Course title	Applied Pharmaceutical Microbiology
Credits	02
Compulsory/optional	Compulsory
Prerequisites	PB 501
Aims	To impart knowledge on pathogenic microorganisms and their identification; explain the modes of action of antimicrobial agents and mechanisms of resistance to antimicrobial agents; elaborate the methods used to determine bacterial susceptibility or resistance to antibiotics, introduce methods used in the recovery and identification of viruses and to explain the methods to evaluate quality control in microbiology laboratories.
Intended learning outcomes	Students who successfully complete this course will be able to, 1. perform laboratory based culture isolation and identification of pathogenic microorganisms 2. perform biochemical tests used in the identification of bacteria and fungi 3. explain the modes of action of antimicrobial agents, bacterial susceptibility or resistance to antibiotics 4. evaluate quality control of a microbiology laboratory
Time allocation	Lectures and Tutorials: 15 hrs Practicals: 30 hrs
Content	Pathogenic bacteria, fungi, parasites and viruses and their identification; Techniques used in isolating and identifying microorganisms that are pathogenic to man; Biochemical tests used in the identification of bacteria and fungi; Antimicrobial agents and their isolation; Modes of action of antimicrobial agents; Bacterial

	susceptibility or resistance to antibiotics; Susceptibility testing, Hospital epidemiology and quality control in microbiology laboratories, Laboratory exercises based on above topics.

Assessment criteria

Continuous assessment	End-semester examination
20%	80%

Recommended Texts:

1. Glazer, A.N. and Nikado, H. (1995). *Microbial Biotechnology. Fundamentals of Applied Microbiology.* W.H. Freeman and Company, New York, USA.
2. Atlas, R.M. (1995). *Principles of Microbiology.* Mosby.

Course code	**PB 511**
Course title	Specifications, Standardization, Value Addition of Plants of Pharmaceutical Uses and their Derivatives
Credits	02
Compulsory/optional	Compulsory
Prerequisites	None
Aims	To impart knowledge on good manufacturing practices and possible sources of adulteration, explain regulations and quality assurance with emphasis on process validation and sampling techniques, impart knowledge on quarantine aspects of medicinal plants, discuss prospects of local and international market for medicinal plants and technology for product improvement, and explain standardization of herbal products and, ISO Quality and Environmental Management standards for herbal industries.
Intended learning outcomes	Students who successfully complete this course will be able to, 1. be acquainted with the good manufacturing practices 2. claim for adulterations in plants of pharmaceutical uses 3. explain about the quality assurance and quarantine aspects of medicinal plants 4. apply ISO Quality and Environmental Management standards for herbal industries 5. perform research and product development for strategic marketing
Time allocation	Lectures and Tutorials: 30 hrs Practicals: 00 hrs
Content	Herbal drug development and standardization; Cost of herbal production and formulation; Introduction to good manufacturing practice (collection, drying, processing, packing and storage of medicinal plant material); Quality control of medicinal plants and their products and value addition for market profitability; Regulations and quality assurance with emphasis on process scientific validation and sampling techniques; Toxicity and safety aspects; Selected bioactive compounds in herbal pharmaceutical preparations and their therapeutic indications, contradictions and interactions; Sample contamination and adulteration; Use of herbs as nutraceutics and functional food; Loss of medicinal properties during processing and storage; Quarantine aspects of medicinal

	plants; ISO Quality and Environmental Management standards.

Assessment criteria

Continuous assessment	End-semester examination
20%	80%

Recommended Texts:

1. Rajpal, V. (2011). Studies of Botanicals: Testing and Extract of Chemicals of Medicinal Plants. Vol. I, Delhi.
2. Rajpal, V. (2011). Studies of Botanicals: Testing and Extract of chemicals of medicinal plants. Vol. II, Delhi.
3. Rajpal, V. (2008). *Standardization of Botanicals.* Riddhi International, India.
4. Gupta, V.K. (2010). *Medicinal Plants: Phytochemistry, Pharmacology & Therapeutics,* 1st edn. Riddhi International, India.

Course code	**PB 512**
Course title	Molecular Genetics and Genetic Engineering
Credits	03
Compulsory/optional	Optional
Prerequisites	PB 501
Aims	To impart the knowledge in classical and molecular genetics and their interrelationships, capabilities and methods in genetic engineering, introduce principles and concepts in designing genetically modified organisms especially for the production of pharmaceutics and to provide an overview of important examples of biotechnology applications.
Intended learning outcomes	Students who successfully complete this course will be able to, 1. explain the principles of classical and molecular genetics and their interrelationships 2. describe the concepts and techniques in recombinant DNA technology, 3. utilize the molecular information in public databases and 4. explain the uses of biotechnology
Time allocation	Lectures and Tutorials: 35 hrs Practicals: 20 hrs
Content	Classical genetics and the molecular basis of classical genetics; Central dogma; Genomics and proteomics; Recombinant DNA technology; Important applications of biotechnology; Laboratory exercises related to above topics.

Assessment criteria

Continuous assessment	End-semester examination
20%	80%

Recommended Texts:

1. Glick, B.R. , Pasternak, J.J. (1998). *Molecular Biotechnology.* American Society for Microbiology.

2. Lodish, H., Berk, A., Zipursky, S.L., Matsudarira, P., Baltimore, Darnell, J. (1999). *Molecular Cell Biology*. W.H. Freeman and Company.
3. Weaver, R.F. (2005). *Molecular Biology.* McGraw-Hill.

Course code	**PB 513**
Course title	Marketing Aspects of Plants of Pharmaceutical Uses and their Derivatives
Credits	02
Compulsory/optional	Compulsory
Prerequisites	None
Aims	To provide an understanding on management theories, models, and their application in the context of pharmaceutical industry, enhance the skill development of students such as critical thinking and decision making to become an effective manager and strategic planner and expose students to the practical application of theories in the organizational context through case study analysis.
Intended learning outcomes	Students who successfully complete this course will be able to, 1. have a thorough understanding on the principles and practice underpinning marketing, strategic management, and general management in organizations 2. be able to develop effective marketing strategy in the context of pharmaceutical industry 3. be able to develop competencies in strategy formulation, implementation, and evaluation 4. appreciate the role of leadership, communication, and team dynamics in achieving organizational objectives
Time allocation	Lectures and Tutorials: 30 hrs Practicals: 00 hrs
Content	Management: Introduction to Management; Traditional and modern approaches of leadership; Groups and teams; Business communication; Marketing: Introduction to marketing: Scope of marketing, Marketing concepts, Marketing management process; Environmental scanning; consumer behavior; Segmenting, Targeting; and Positioning; Marketing mix; Marketing plan; Application of marketing concepts in pharmaceutical industry; Strategic management: Introduction to strategy; Corporate-level strategy; Business-Unit strategy; Corporate social responsibility and business ethics; Case studies related to pharmaceutical industry.

Assessment criteria

Continuous assessment	End-semester examination
40%	60%

Recommended Texts:

1. Robbins, S. P. and Coutler, M. (2012). *Management*. Pearson Publication, New York.
2. Kotler, P., and Keller, K.L. (2009). *Marketing Management*. Pearson Education Inc.
3. Johnson, G., Scholes, K. and Whittington, R. (2011). *Exploring Strategy: Text and Cases*. Pearson Education Limited, Harlow.

Course code	**PB 514**
Course title	Pharmaceutical Biotechnology
Credits	02
Compulsory/optional	Optional
Prerequisites	PB 512
Aims	The aims of this course are to, introduce principles and concepts in development of biotechnology based drugs and to provide hands-on-experience in experimentation on pharmaceutical biotechnology laboratory.
Intended learning outcomes	Students who successfully complete this course will be able to, 1. equipped with the necessary knowledge, capabilities and methods in pharmaceutical biotechnology and related fields
Time allocation	Lectures and Tutorials: 15 hrs Practicals: 30 hrs
Content	Basic principles; Concepts; Instrumentation and techniques of biotechnology necessary for the development of new biotechnology based drugs and for understanding of effective work in a pharmaceutical research; laboratory setting. Laboratory exercises related to above topics.

Assessment criteria

Continuous assessment	End-semester examination
20%	80%

Recommended Texts:

1. Daan, D.J., Crommelin, J.A., Sindelar, R. D., Meibohm, B. (2008). *Pharmaceutical Biotechnology: Fundamentals and Applications.* Informa Healthcare. USA.
2. Kayser, O. and Miller, R.H. (2006). *Pharmaceutical Biotechnology*. John Wiley & Sons.

Course code	**PB 515**
Course title	Bioinformatics
Credits	01
Compulsory/Optional	Optional
Prerequisites	PB 504, PB 512
Aims	The aims of this course are to, provide students with a theoretical and practical knowledge in computational molecular biology and to retrieve, analyze and interpret nucleic acid and protein sequence data from publicly available databases such as GenBank.
Intended learning outcomes	At the end of successful completion of the course, students will be able to, 1. Explain theoretical aspects of bioinformatics 2. Retrieve and analyze sequence data 3. Interpret the biological implications with respect to particular research questions 4. Appreciate bioinformatics as an essential tool in biological research
Time allocation	Lectures and Tutorials: 10 hrs Practicals: 10 hrs
Content	Introduction to bioinformatics, sequence data bases, sequence alignments, phylogenetic alignments, protein structure analysis, case studies using bioinformatic tools; Laboratory exercises based

	on above topics.

Assessment criteria

Continuous assessment	End-semester examination
20%	80%

Recommended Texts:

1. Durbin, R., Eddy, S., Krogh, A. and Mitchinson, G. (1998). *Biological Sequence Analysis: Probabilistic models of proteins and nucleic acids.* Cambridge University Press.
2. Lesk, A.M. (2004). *Introduction to Bioinformatics.* Oxford University Press.

Course code	**PB 516**
Course title	Independent Study
Credits	01
Compulsory/optional	Compulsory
Prerequisites	None
Aims	To train students to obtain specific literature and prepare a bibliography, to collate information, to write an abstract under a chosen topic using collated information, to guide them in writing research reports, with due references and findings and to train students to make scientific presentations using power point slides.
Intended learning outcomes	Students who successfully complete this course will be able to, 1. to gather scientific information from a variety of sources (available, both from local libraries and from the internet) 2. learn to organize salient information systematically on a scientific report with appropriate quoting and listing of references 3. gain experience in preparing and making an oral presentation in a professional scientific format as a Power Point presentation
Time allocation	Lectures and Tutorials: 15 hrs Practicals: 00 hrs
Content	Distinguish different literative sources and ways of accessing them, methods of quoting and listing references, different components of a research paper/ review paper, avoiding plagiarism, organization of information into an abstract and the use of Power Point. Thereafter, the students will be assigned a supervisor for consultation, while working independently.

Assessment criteria

Continuous assessment	End-semester examination
20%	80%

Recommended Texts:

1. Gustavii, B. (2008). *How to Write and Illustrate a Scientific Paper*. Cambridge University Press, Cambridge.
2. Wu, J. (2011). Improving the writing of research papers. *Landscape Ecology* **26**, 1345-1349.

Course code	**PB 517**
Course title	Directed Study
Credits	01
Compulsory/optional	Compulsory if following the program: MSc by course work
Prerequisites	None
Aims	To train students in collecting and evaluating scientific literature, handling and presenting scientific data and scientific writing
Intended learning outcomes	The student will be 1. Able to Collect scientific literature related to a given topic 2. Present scientific data in reports and during power point presentations 3. Show a thorough knowledge in the subject area
Time allocation	2 months
Content	The students will work independently on a chosen topic under the guidance provided by an assigned supervisor/s and produce a dissertation.

Assessment criteria

Dissertation	Presentation
60%	40%

Course code	**PB 518**
Course title	Research Project
Credits	30
Compulsory/optional	Compulsory if following the program: MSc by research
Prerequisites	None
Aims	To train students the protocol of scientific method: collecting and evaluating scientific literature, generate hypothesis, planning and conducting of scientific research, analysing, handling and presenting scientific data and scientific writing
Intended learning outcomes	Students will be 1. Able to collect scientific literature related to a given topic 2. Able to generate hypothesis, Plan and conduct scientific experiments, collect and analyse results and make inferences based on the results 3. competent enough in presenting scientific data in reports and during power point presentations 4. Show a proficiency in knowledge in the subject area
Time allocation	One year
Content	The students will conduct sufficient amount of laboratory/field work on a chosen topic under the guidance provided by an assigned supervisor/s and produce a thesis.

Assessment criteria

Thesis	Presentation
90%	10%

7. PROGRAMME EVALUATION

Evaluation Scheme

For all courses a minimum of 80% attendance is compulsory. The evaluation of each course shall be based on three components: within course (quizzes, tutorials etc.) and end of course examinations.

Grade Points and Grade Point Average (GPA)

The Grade Point Average (GPA) will be computed using the grades assigned for core and optional courses, taken for credit.

The Grade Point Average (GPA) will be computed using the formula:

$$GPA = \frac{\Sigma c_i g_i}{\Sigma c_i}$$

where c_i = number of credit units for the ith course, and

g_i = grade point for the ith course

Make-up Examinations

'Make-up' examinations may be given only to students who fail to sit a particular examination due to medical or other valid reasons acceptable to the PGIS.

Repeat Courses

If a student fails (less than a 'C' grade) a course or wishes to improve his/her previous grade in a course, he/she shall repeat the course at the next available opportunity. The maximum grade, he/she could obtain at a repeat examination is B. Candidates are allowed to repeat a course only on two subsequent occasions. However, if there's no possibility of offering the course in the near future, on the recommendation of the relevant Board of Study, special examinations may be substituted.

Evaluation of Research Project

Research project will be evaluated on the basis of a written report (M.Sc. project report) and oral presentation (see section 6.0 of the PGIS hand book for the format of the project report).

8. TEACHING PANEL

The teaching panel consists of resource personnel form various institutes to provide sound theoretical understanding and an adequate exposure to the industrial and market aspects of herbal use.

Prof. A. Wickramasinghe, Dept. of Chemistry, Faculty of Science, Univ. of Peradeniya
B.Sc. (Perad.), M.Phil. (Perad.), Ph.D. (Muenster, Germany)
Field of specialization – Organic Chemistry

Prof. H. M. D. N. Priyantha, Dept. of Chemistry, Faculty of Science, Univ. of Peradeniya
B.Sc. (Perad.), Ph.D. (Hawaii, USA)
Field of specialization – Inorganic Chemistry

Prof. B. M. R. Bandara, Dept. of Chemistry, Faculty of Science, Univ. of Peradeniya
B.Sc. (Perad.), Ph.D. (ANU, Australia)
Field of specialization – Organic Chemistry

Dr P. K. Perera, Institute of Indigenous Medicine, Univ. of Colombo
B.A.M.S. (Colombo), M.Sc. (SJP), Ph.D. (China)
Field of specialization – Ethno Botany and Ayurvedic Medicine

Dr J. M. Dahanayake, Institute of Indigenous Medicine, Univ. of Colombo
B.A.M.S. (Colombo), M.Phil. (Colombo)
Field of specialization – Ethno Botany and Ayurvedic Medicine

Prof. V. Thevanesam, Dept. of Microbiology, Faculty of Medicine, Univ. of Peradeniya
MBBS (Cey.), MD, MRCP, MRC Path
Field of specialization – Medical Microbiology

Dr D. B. M. Wickamarathne, Dept. of Pharmacy, Faculty of Allied Health Sciences, Univ. of Peradeniya
B.Sc. (Perad.), Ph.D. (Perad.)
Field of specialization – Allied Health Sciences and Biochemistry

Dr M. Alfred, Dept. of Management Studies, Faculty of Arts, Univ. of Peradeniya
B.Sc. (Perad.), M.Phil. (Perad.), Ph.D. (JNU)
Field of specialization – Economics and Management

Prof. S. A. Kulasooriya, Institute of Fundamental Studies, Hantana, Kandy.
B.Sc. (Cey.), Ph.D. (London, UK)
Field of specialization – Microbiology

Prof. N. K. B. Adikaram, Dept. of Botany, Faculty of Science, Univ. of Peradeniya
B.Sc. (Colombo), Ph.D. (Belfast, UK)
Field of specialization – Plant Pathology

Dr A. M. Karunaratne, Dept. of Botany, Faculty of Science, Univ. of Peradeniya
B.Sc. (Perad.), M.S. (Nebraska, USA), Ph.D.. (Perad.)
Field of specialization – Food and Nutrition

Dr G. A. D. Perera, Dept. of Botany, Faculty of Science, Univ. of Peradeniya
B.Sc. (Perad.), M.Sc. (Oxon), D.Phil. (Oxon, UK)
Field of specialization – Ecology

Dr H. M. S. P. M. Weerasinghe, Dept. of Botany, Faculty of Science, Univ. of Peradeniya
B.Sc. (Perad.), M.Phil. (Cambridge, UK), Ph.D. (Cambridge, UK)
Field of specialization – Ecophysiology

Prof. D. M. D. Yakandawala, Dept. of Botany, Faculty of Science, Univ. of Peradeniya
B.Sc. (Perad.), Ph.D. (Reading, UK)
Field of specialization – Plant Systematics

Dr W. A. M. Daundasekara, Dept. of Botany, Faculty of Science, Univ. of Peradeniya
B.Sc. (Perad.), Ph.D. (Cranfield, UK)
Field of specialization – Postharvest Technology and Pathology

Dr J. W. Damunupola, Dept. of Botany, Faculty of Science, Univ. of Peradeniya
B.Sc. (Perad.), Ph.D. (Queensland, Australia)

Field of specialization – Horticulture

Dr A. M. T. A. Gunaratne, Dept. of Botany, Faculty of Science, Univ. of Peradeniya
B.Sc. (Perad.), Ph.D. (Aberdeen, UK)
Field of specialization – Ecology

Ms H. A. C. K. Ariyarathne, Dept. of Botany, Faculty of Science, Univ. of Peradeniya
B.Sc. (Perad.), M.Phil. (Perad.)
Field of specialization – Molecular Genetics and Plant Breeding

Dr S. C. K. Rubasinghe, Dept. of Botany, Faculty of Science, Univ. of Peradeniya
B.Sc. (Perad.), M.Phil. (Perad.), Ph.D. (Edinburgh, UK)
Field of specialization – Bryology and Plant Systematics

Dr C. L. Abayasekara, Dept. of Botany, Faculty of Science, Univ. of Peradeniya
B.Sc. (Perad.), Ph.D. (Perad.)
Field of specialization – Microbiology

Dr G. A. N. Suranjith, Dept. of Botany, Faculty of Science, Univ. of Peradeniya
B.Sc. (Perad.), Ph.D. (Kentuky, USA)
Field of specialization – Seed Biology and Food Science

Dr S. D. S. S. Sooriyapathirana, Dept. of Molecular Biology and Biotechnology, Faculty of Science, Uni. of Peradeniya
B.Sc. (Perad.), M.Phil. (Perad.), Ph.D. (Michigan State, USA)
Field of specialization – Molecular Biology and Biotechnology

Mr. N. Agilan, Dept. of Management Studies, Faculty of Arts, Univ. of Peradeniya
BBA (Jaffna), MBA (UK), MBS (Ireland)
Field of specialization – Economics and Management

Dr K. M. G. G. Jayasuriya, Dept. of Botany, Faculty of Science, Univ. of Peradeniya
B.Sc. (Perad.), Ph.D. (Kentuky, USA)
Field of specialization – Seed Biology

Dr R. G. S. C. Rajapakse, Dept. of Molecular Biology and Biotechnology, Faculty of Science, Univ. of Peradeniya
B.Sc. (Perad.), M.Phil. (Perad.), Ph.D. (Japan)
Field of specialization – Molecular Biology and Biochemistry

Dr F. Noordeen, Dept. of Microbiology, Faculty of Medicine, Univ. of Peradeniya
BVSc (SL), MPhil (SL), Diag Med Virol (UK), Ph.D. (Australia)
Field of specialization – Medical Microbiology and Parasitology

Dr P. Samaraweera, Dept. of Molecular Biology and Biotechnology, Faculty of Science, Univ. of Peradeniya
B.Sc. (Perad.), Ph.D. (Arizona, USA)
Field of specialization – Biochemistry and Molecular Biology

Dr M. Ganehenage, Dept. of Chemistry, Faculty of Science, Univ. of Peradeniya
B.Sc. (Perad.), Ph.D. (USA)
Field of specialization – Inorganic Chemistry