



# SCHOOL OF LIFE SCIENCES & CHEMICAL TECHNOLOGY

The School of Life Sciences & Chemical Technology (LSCT) has grown steadily in strength and reputation to become a premier provider of life sciences and chemical technology education in Singapore.

The School's niche areas are in fast-evolving fields such as biofuels, aquatic science and technology, skyrise greening, biopharmaceuticals & bioprocess technology, food microbiology and cancer biology. The School also collaborates actively with leading industry partners, as well as renowned local and overseas research and academic institutions.

LSCT students enjoy a broad-based and flexible education through a curriculum that is reviewed regularly to meet the changing needs of the life sciences and chemical industries. They also benefit from the knowledge and guidance of academic staff who are dynamic, dedicated and experienced professionals.

LSCT graduates are well-prepared for a multitude of career paths and are highly valued by industry. Many have excelled in their degree and postgraduate studies at local and overseas universities, and have gone on to make their mark in their chosen fields.

## COURSES OFFERED

The School of Life Sciences & Chemical Technology offers the following courses:

- Diploma in Biomedical Laboratory Technology (BLT)
- Diploma in Biomedical Science (BMS)
- Diploma in Chemical & Biomolecular Engineering (CBE)
- Diploma in Landscape Design & Horticulture (LDH)
- Diploma in Molecular Biotechnology (MBIO)
- Diploma in Pharmacy Science (PHARM)
- Diploma in Veterinary Bioscience (VBS)

## MAJOR ACHIEVEMENTS

Since its establishment, the School has built a track record in research and development in areas

with industrial and commercial potential and has successfully bid for competitive research funding from the National Research Foundation, MOE Innovation Fund, Singapore Totalisator Board and A\*STAR.

The Diploma in Chemical & Biomolecular Engineering was the first polytechnic diploma to receive accreditation from the Institute of Chemical Engineering, United Kingdom.

In collaboration with the National Parks Board, an indoor vertical greening project led to LSCT students and staff developing an innovative portable do-it-yourself Vertical Greenery System. The prototype was displayed at the 2010 Singapore Garden Festival. This technology was licensed to a company for commercialisation.

BLT graduate Penny Tan Yihui, gained admission into the Bachelor of Medicine, Bachelor of Surgery Programme at the University of Leicester in 2006. She was the first polytechnic graduate to be accepted directly into a medical course in the UK. In 2007, BLT graduate Ron Ng Chong Sheng and BIO graduate (the Biotechnology course has since been renamed to Molecular Biotechnology) Soong Junwei made history as the first polytechnic graduates to gain direct acceptance into the Yong Loo Lin School of Medicine. In 2008, BMS graduate Darren Chua Weiquan became the third LSCT graduate to be directly accepted into the MBBS programme of the Yong Loo Lin School of Medicine at the National

University of Singapore. In 2010, BIO graduate, Julian Hong was accepted into Imperial College's medical degree programme after graduating with a first class honours degree from the University of Manchester. Also in 2010, another BIO graduate, Dr. Moses Lok became the third LSCT graduate to have completed a medical degree.

In 2009, Dr Lok Shee-Mei, who graduated from the School with a Diploma in Biotechnology in 1993 joined the Duke-NUS Graduate Medical School. Dr Lok was one of the 10 scientists from five different countries to receive a \$2.2 million NRF Research Fellowship grant to establish their research programmes in Singapore.

In 2011, Molecular Biotechnology graduate, Ms. Leow Yi Ning became the first polytechnic graduate to receive the National Science Scholarship awarded by A\*STAR. Yi Ning will read Neurobiology at the University College in London. Also in 2011, Chemical Engineering graduate Wilson Ang was awarded a prestigious Chevening Scholarship by the British High Commission to undertake undergraduate studies in the UK. Wilson is the founder and president of Environmental Challenge Organisation (ECO) Singapore.

## FACILITIES & STAFF

LSCT academic staff members hold Masters and PhD qualifications and have considerable industrial experience. Their niche areas include aquaculture, horticulture, bioprocess and biopharmaceutical technology, biomedical diagnostics and therapeutics, molecular diagnostics, cancer biology, developmental biology, microbiology, drug discovery, gene delivery and vaccine development, transgenic research, surface chemistry and rheology. For their research activities, they have successfully and continually secured research funding from external bodies. Some of the numerous

research projects carried out by the School have won awards and accolades at national competitions.

Students enjoy a conducive learning environment with well-equipped and up-to-date facilities such as those found at the Biological and Chemical Research Centre, Biopharmaceutical Training Centre, Centre for Aquatic Science and Technology, biotechnology laboratories, chemical engineering laboratories. LSCT also has a design studio, a shadehouse and a greenhouse.

## COLLABORATIONS

LSCT's success in partnering key external organisations in education gives students extensive hands-on training and relevant exposure to the working world.

Biomedical Laboratory Technology (BLT) students take their first year at Ngee Ann Polytechnic before completing the course with a two-year internship programme at the National University Hospital (NUH).

Through the School's collaboration with the National Parks Board, students in the Landscape Design & Horticulture (LDH) course conduct their fieldwork in the vibrant outdoors of the Singapore Botanic Gardens. Clementi Woods Park also serves as a "learning park" where students engage in experiential learning in a real park setting.

Chemical & Biomolecular Engineering (CBE) students undergo a six-week internship conducted by the Chemical Process Training Centre on Jurong Island, where they experience a real work setting and shift work.

In an exclusive partnership with the National University Hospital's (NUH) Department of Pharmacy, Pharmacy Science (PHARM) students receive training and

guidance from practising pharmacists. They are also exposed to activities in a teaching hospital with comprehensive services and state-of-the-art facilities. Students spend their final year at NUH, where relevant modules are taught by clinicians such as doctors and pharmacists. They also work on a project conducted at NUH.

Veterinary Bioscience (VBS) students undergo a four-month internship programme with top local or overseas research institutions, life sciences companies and veterinary clinics. In partnership with Wildlife Reserves Singapore, students will be involved in research and development, training and co-curricular activities.

The School also provides consultancy services and R&D expertise. It has tie-ups with leading names in the industry and academia such as the Temasek Life Sciences Laboratories, Nestle R&D Centre, Johnson & Johnson Pte Ltd, Wyeth Pharmaceutical Pte Ltd, Schering Plough Limited, Genome Institute of Singapore, Institute of Molecular & Cell Biology, National Cancer Centre, the National University of Singapore, the National Parks Board, Jurong Town Corporation, Housing & Development Board and the National Neuroscience Institute.





# DIPLOMA IN BIOMEDICAL LABORATORY TECHNOLOGY (BLT) 3-YEAR COURSE

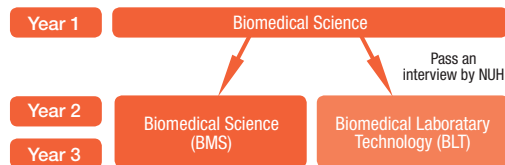
The **Diploma in Biomedical Laboratory Technology (BLT)** is a unique joint programme between Ngee Ann Polytechnic (NP) and the National University Hospital (NUH). Students enjoy undertake two years of intensive, on-the-job training at NUH and institutions under the National Healthcare Group such as Tan Tock Seng Hospital and the polyclinics.

This exclusive arrangement creates many opportunities for students to relate and apply knowledge acquired in classrooms to real-life work and research projects. Students acquire invaluable exposure to the various divisions within NUH's Department of Laboratory Medicine.

Under the supervision of senior clinical laboratory staff and clinicians, students are given the responsibility of analysing patient samples, allowing them to gain firsthand experience in the principles, practices and functions of a clinical laboratory. Research projects are carried out in hospitals, research institutes and at the National University of Singapore.

Students graduate with additional certifications in specialised skills such as phlebotomy (blood collection) and electrocardiogram (ECG) tests. They are also well prepared to sit for international certification tests conducted by the American Society for Clinical Pathologists (ASCP).

## Learning Pathways for BMS: A Unique Option



## ENTRY REQUIREMENTS

To be eligible for consideration, candidates must have the following GCE 'O' Level examination (or equivalent) results:

Subject	'O' Level Grade
English Language*	1-7
Mathematics (Elementary/Additional)	1-6
Science (with Physics, Chemistry or Biology component) or Fundamentals of Electronics	1-6

You must also fulfil the aggregate computation requirements.

\* Candidates with English as a second language (EL2) must have attained a minimum grade of 6.

Students interested in the Diploma in Biomedical Laboratory Technology must not suffer from severe colour appreciation deficiency.

The first year of Biomedical Science and Biomedical Laboratory Technology is common to all students. At the end of the first year, students interested in the Diploma in Biomedical Laboratory Technology will attend an interview conducted by the Department of Laboratory Medicine, National University Hospital. Students not selected for the Diploma in Biomedical Laboratory Technology will remain in the Biomedical Science course.

## CAREER PROSPECTS

Career prospects for graduates of the BLT course are excellent. The unique internship-style of training allows BLT graduates to adapt very quickly to their work environment. BLT graduates are highly valued as medical technologists, and are sought after by medical laboratories, research institutions and by companies and organisations involved in clinical trials.

## ACCREDITATION FOR FURTHER STUDIES

A strong background in clinical chemistry, haematology and clinical microbiology gives BLT graduates a distinct edge when they pursue further studies or medical research.

The National University of Singapore (NUS), Nanyang Technological University (NTU) and the Singapore Management University (SMU) admit BLT graduates into their degree programmes. BLT graduates may apply for degrees in biological science, chemistry, bioengineering, medicine, education, arts, architecture, dentistry, business, psychology and social science.

Graduates can expect up to two years of exemption from BSc programmes from overseas universities. They may receive up to three years of exemption from four year programmes in laboratory medicine or medical technology. Some of these prestigious institutes include:

- University of Leicester (UK)
- Queen Mary University of London (UK)
- University of Newcastle (UK)
- University of Queensland (Australia)
- University of Melbourne (Australia)
- University of Western Australia (Australia)
- University of Adelaide (Australia)
- Monash University (Australia)
- Curtin University of Technology (Australia)
- Queensland University of Technology (Australia)
- Royal Melbourne Institute of Technology (Australia)
- McGill University (Canada)
- Queens University (Ireland)

A number of BLT graduates have been accepted into overseas and local medical degree programmes. Dr Ian Tang graduated with a Bachelor of Medicine and Bachelor of Surgery from the University of Sydney. Jasmine Lee graduated from the NUS' Yong Loo Lin School of Medicine's MBBS programme after entering as a graduate student. In 2005, Penny Tan was admitted into the MBBS degree at Leicester University and in 2007, Ron Ng made history by being one of the first polytechnic graduates to be granted direct entry into the Yong Loo Lin School of Medicine.

## COURSE CURRICULUM

Module Name	Credit Units
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### YEAR 1

#### Level 1.1 (25 hours per week)

Inorganic & Physical Chemistry	7
Microbiology	7
Mathematics	5
Physiology	2
Idea Jumpstart <sup>^</sup>	2
Sports & Wellness <sup>^</sup>	2

#### Level 1.2 (26 hours per week)

Cell Biology	8
Organic Chemistry	7
Information Technology for the Life Sciences	2
Biostatistics	5
Communication & Contemporary Issues <sup>^</sup>	4

### YEAR 2

#### Level 2.1 (29 hours per week)

Clinical Chemistry 1	8
Advanced Topics in Biomedical Science	7
Lab Techniques in Clinical Haematology	7
Lab Techniques in Clinical Microbiology	7

#### Level 2.2 (30 hours per week)

Clinical Haematology 1	8
Clinical Microbiology 1	8
Lab Techniques in Clinical Chemistry 1	7
Lab Techniques in Clinical Chemistry 2	7

### YEAR 3

#### Level 3.1 (28 hours per week)

Clinical Chemistry 2	8
Clinical Haematology 2	8
Clinical Microbiology 2	8
Genomics & Proteomics	2
Bioinformatics	2

Module Name	Credit Units
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#### Level 3.2 (28 hours per week)

Integrative Module	6
Laboratory Endocrinology	5
Laboratory Management	3
Molecular Diagnostics	4
Project	8
Singapore's Perspectives of World Issues	2

#### Notes:

<sup>^</sup> For more details on Interdisciplinary Studies (IS) modules, please log on to [www.np.edu.sg/is/](http://www.np.edu.sg/is/)

#### IS Modules

The School of Interdisciplinary Studies (IS) delivers a broad-based curriculum, which nurtures a new generation of professionals with multidisciplinary skills and an innovative and entrepreneurial spirit to meet the challenges of a knowledge economy. IS offers both prescribed modules and electives to challenge boundaries. Prescribed modules develop students' competencies in core areas such as Communication, Innovation and Enterprise, Culture and Communication, and Personal Mastery and Development, while elective modules provide insights into Arts and Humanities, Business, Design, and Science and Technology.

## COURSE MODULES

### LEVEL 1.1

#### Inorganic & Physical Chemistry

The module surveys the structure of matter, chemical bonding, thermochemistry, chemical equilibria, kinetics, electrochemistry and redox reactions, transition metal chemistry and the chemistry of solutions, including acids, bases and buffers.

#### Microbiology

This module examines microorganisms and techniques in microbiology. Topics include cell structure and function, classification, viruses and fungi, nutrition, growth and regulation, environmental factors affecting growth, microscopy, staining, size measurement,

cell enumeration, media preparation, isolation and cultivation of pure cultures.

### Mathematics

This module provides students with a fundamental analytical knowledge of Mathematics essential for the study of biomedical science.

### Physiology

This module provides a foundation for the second and third-year modules. It introduces the basic principles of homeostatic mechanisms and the cardiovascular, respiratory, renal, gastrointestinal, neuromuscular, endocrine and reproductive physiological systems that exist in the human body.

## LEVEL 1.2

### Cell Biology

This module explores mammalian cells, tissue and organ systems. Topics include the fundamental chemicals of life, structure and function of cells and organelles, cell division, cytogenetics and DNA replication, transcription and translation.

### Organic Chemistry

This module gives students a strong foundation in basic organic chemistry. Topics include the IUPAC nomenclature, structural formulas, preparations and reactions of the main classes of organic compounds, namely, alkanes, alkenes, alkynes, benzene, alcohols, thiols, ether, aldehydes, ketones, amines, carboxylic acids and derivatives.

### Information Technology for the Life Sciences

This module aims to familiarise students with search engines and scientific databases. It equips students with the IT skills needed to effectively use the vast amount of information on the Internet. Students will learn to use their notebook PCs effectively for mobile computing, as well as how to set up a home wireless network.

### Biostatistics

This module is designed to equip biomedical science students with the necessary statistical techniques to solve biological and chemical problems, as well as to carry out analytical studies in their future work.

## LEVEL 2.1

### Clinical Chemistry 1

Lectures and practical sessions are used in this module to cover topics on the physiology and normal functions of the major organ systems and the homeostatic control of acid-base and electrolytes, as well as the changes that occur as a result of disease. There will be an emphasis on explaining the underlying biochemical disturbances or metabolic derangements in diseased states, and their appropriate evaluation and diagnosis using selective laboratory tests.

### Advanced Topics in Biomedical Science

This module covers basic immunology, medical microbiology, metabolic biochemistry and molecular biology. In immunology, components and functions of the immune system and clinical applications are examined. In medical microbiology, the classification system, diagnostic methods and the various diseases caused by microbes are covered. Metabolic biochemistry introduces fundamental concepts in enzymology and carbohydrate metabolism. Molecular biology introduces students to prokaryotic and eukaryotic molecular biology.

### Laboratory Techniques in Clinical Haematology

This module examines the principles and techniques of laboratory investigations. Specimen collection, handling and processing techniques in blood cell identification and examination will be taught. Students will also be introduced to the various instruments used in clinical laboratories.

### Laboratory Techniques in Clinical Microbiology

This module examines the principles and techniques of laboratory investigations. Specimen collection,

handling and processing techniques in the identification of microorganisms, urine microscopy and examination will be taught. Students will also be introduced to the various instruments used in clinical laboratories.

## LEVEL 2.2

### Clinical Haematology 1

This module covers the theory and principle of antigen-antibody reactions as applied to blood-banking. Emphasis is given to cell-typing, cross-matching, compatibility problems and HLA-typing for organ and bone marrow transplants. Practical aspects such as blood donor recruitment and screening, blood products and their processing, indications for their use and the hazards of blood transfusion are included.

### Clinical Microbiology 1

This module explores the cell structure, chemical composition, growth, nutrition, metabolism, classification, cultivation and epidemiology of microorganisms. The characteristics of medically important bacteria, fungi and viruses will be covered in greater detail, with emphasis on the isolation techniques and methods of identification.

### Laboratory Techniques in Clinical Chemistry 1

This module covers the principles and methods of basic chemical assays, chromatographic techniques and immunoassays. Procedures such as workflow, reagent preparation, sample processing and pre-analytical procedures and issues such as instrumental automation will also be covered.

### Laboratory Techniques in Clinical Chemistry 2

This module covers other techniques not covered in Laboratory Techniques in Clinical Chemistry 1 such as electrophoresis, enzyme assays, osmometry and osmolality, blood gas analysis as well as applications to point-of-care testing. Processing of results such as the use of statistics, reference values, units, decision levels and critical values will be also be taught.

**LEVEL 3.1****Clinical Chemistry 2**

This module is a continuation of Clinical Chemistry 1. Topics covered include diagnostic enzymology, proteins in health and disease, uric acid metabolism, disorders in carbohydrates, lipid and protein metabolism (including inherited disorders), biochemical assessment of malabsorption, nutritional disorders, hypertension and malignancy, therapeutic drug monitoring, and toxicological screening.

**Clinical Haematology 2**

This module is a continuation of Clinical Haematology 1. It examines haematological disorders covering the morphology and function of the blood and bone marrow, as well as the significance of malignant and non-malignant changes occurring in diseased states. Students will learn about the principles, procedures, and interpretation of manual and automated analyses, from general to advanced techniques in clinical haematology and coagulation laboratories.

**Clinical Microbiology 2**

This module is a continuation of Clinical Microbiology 1. The pathophysiology and control of infections affecting organ systems of the human body will be covered. The epidemiology, life cycles and laboratory identification, as well as isolation techniques of clinically important parasites will also be taught. Lectures and practical sessions in basic virology will cover the characteristics, classification, pathogenicity and diagnostic techniques for viruses causing common human diseases.

**Genomics & Proteomics**

This module aims to provide students with a theoretical knowledge of advances in the field of genomics and proteomics. These include the Human Genome Project, an appreciation of high-throughput platforms in genomics and proteomics, and applications in the understanding of, diagnosis and treatment of diseases.

**Bioinformatics**

This module equips students with knowledge of basic bioinformatics, and introduces tools and resources used in molecular bioinformatics. It will offer an overview of biological informatics and the importance of molecular bioinformatics, resources, tools and databases, sequence comparison, database searching, multiple sequences and finding patterns.

**LEVEL 3.2****Integrative Module**

This module integrates the concepts learnt in the earlier modules on Clinical Haematology I & II, Clinical Microbiology I & II, as well as Clinical Chemistry I & II. Students will undertake research and make presentations on assigned topics in these areas to help them to link the three disciplines.

**Laboratory Endocrinology**

This module introduces students to the principles of endocrine testing. The pathophysiology and clinical manifestations of some common endocrine disorders are discussed. Tutorials and practical sessions demonstrate the use of the endocrine laboratory in the diagnosis and interpretation of laboratory results.

**Laboratory Management**

This module covers aspects of basic management, quality control, total quality management and laboratory performance parameters. Emphasis will be placed on various areas of effective laboratory operations. Fundamentals of laboratory information systems, costing, finance and budgeting, laboratory safety, and reference laboratory services will also be taught.

**Molecular Diagnostics**

This module explores basic molecular biology techniques used in the diagnostic laboratory. Topics include the molecular testing of inherited and infectious diseases, haematological disorders, and cancer.

**Project**

This module will enhance students' research skills. Students will be attached to a research laboratory in NUS or a research institute, and carry out a research project, which includes writing a project report and giving a seminar on their research findings.

**Singapore's Perspective of World Issues**

This module will help students to gain a deeper understanding of some global issues and national concerns, and explore how they affect our lives in Singapore.





## DIPLOMA IN BIOMEDICAL SCIENCE (BMS) 3-YEAR COURSE

The **Diploma in Biomedical Science (BMS)** offers students, with a passion for medical sciences, the opportunity to delve into the research and development of human biomedical science, cell & molecular biology and molecular biology of diseases.

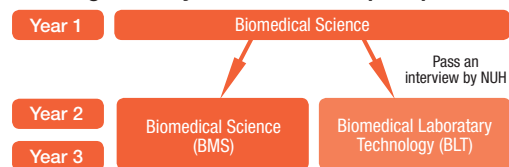
First-year students are given a solid foundation in biological and chemical sciences, mathematics and biostatistics. Second and third-year modules such as Immunology, Medical Microbiology, Medical Biochemistry, Developmental Biology & Genetics, Genomics and Proteomics equip students with the skills and knowledge that are essential in the fast expanding arena of biomedical science. Students are also offered a choice of electives in the third year.

The intensive, hands-on Final Year Research Project is conducted in collaboration with external institutions, and develops students' ability to integrate theoretical knowledge and practical skills. In their final year, students participate in a four-month internship with established biomedical research institutions or companies, either locally or abroad.

Overseas internships have been a standard practice for deserving students since 2000. Students have the opportunity to take up internships with organisations such as Pfizer, Cornell University and the Protein Expression Facility at the University of Queensland.

Local internships with prestigious institutes such as the Institute of Molecular Cell and Biology, National Cancer Centre, National Neuroscience Institute, Genome Institute of Singapore, hospital research laboratories and biomedical companies, also help students secure future employment.

### Learning Pathways for BMS: A Unique Option



### ENTRY REQUIREMENTS

To be eligible for consideration, candidates must have the following GCE 'O' Level examination (or equivalent) results:

Subject	'O' Level Grade
English Language*	1-7
Mathematics (Elementary/Additional)	1-6
Science (with Physics, Chemistry or Biology component) or Fundamentals of Electronics	1-6

You must also fulfil the aggregate computation requirements.

\* Candidates with English as a second language (EL2) must have attained a minimum grade of 6.

Students interested in the Diploma in Biomedical Laboratory Technology must not suffer from severe colour appreciation deficiency.

The first year of Biomedical Science and Biomedical Laboratory Technology is common to all students. At the end of the first year, students interested in the Diploma in Biomedical Laboratory Technology will attend an interview conducted by the Department of Laboratory Medicine, National University Hospital. Students not selected for the Diploma in Biomedical Laboratory Technology will remain in the Biomedical Science course.

### CAREER PROSPECTS

The booming biomedical industry is a key pillar of Singapore's economy. Under the Science & Technology Plan 2010, the biomedical industry will benefit greatly from the allocated budget of \$13.5 billion. The growth in the biomedical industry will drive the demand for trained personnel in this field.

BMS graduates enjoy excellent career prospects as laboratory technologists, research assistants, R&D officers, laboratory analysts or product specialists, before progressing to senior positions in research, biomedical science, healthcare, pharmaceutical and clinical labs, bioinformatics, sales and marketing sectors.

## ACCREDITATION FOR FURTHER STUDIES

BMS graduates are accepted into a wide range of degree programmes offered by the National University of Singapore, Nanyang Technological University and the Singapore Management University. They can take up degrees in biological science, chemistry, bioengineering, medicine, education, arts, architecture, dentistry, business, psychology and social science.

Graduates may be granted advanced standing with established institutions such as:

- Cornell University (US)
- Imperial College (UK)
- University of Leicester (UK)
- University of Manchester (UK)
- University of Queensland (Australia)
- University of Melbourne (Australia)
- University of Edinburgh (Scotland)
- University of Dundee (Scotland)
- McGill University (Canada)

BMS graduates have won many awards and prestigious scholarships. Many have earned first class honours degrees from renowned universities and have gone on to obtain their Masters of Science and PhD from both local and overseas universities.

## COURSE CURRICULUM

Module Name	Credit Units
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### YEAR 1

#### Level 1.1 (25 hours per week)

Inorganic & Physical Chemistry	7
Microbiology	7
Mathematics	5
Physiology	2
Idea Jumpstart <sup>^</sup>	2
Sports & Wellness <sup>^</sup>	2

#### Level 1.2 (26 hours per week)

Cell Biology	8
Organic Chemistry	7
Information Technology for the Life Sciences	2
Biostatistics	5
Communication & Contemporary Issues <sup>^</sup>	4

### YEAR 2

#### Level 2.1 (26.5 hours per week)

Medical Microbiology	6.5
Immunology	6.5
Cell Culture & Tissue Applications	5
Developmental Biology & Genetics	4.5
Interdisciplinary Studies (IS) Module <sup>^</sup>	2
Interdisciplinary Studies (IS) Module <sup>^</sup>	2

#### Level 2.2 (26 hours per week)

Medical Biochemistry	6.5
Instrumentation & Analytical Chemistry	6
Molecular Biology	7.5
Bioinformatics	2
Idea Blueprint <sup>^</sup>	2
Idea Launchpad <sup>^</sup>	2

### YEAR 3

#### Level 3.1 (28 hours per week)

Life Sciences Seminar Series	1.5
Genomics	1.5
Proteomics	8
Project A/B	8
World Issues: A Singapore Perspective <sup>^</sup>	2

Module Name	Credit Units
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Interdisciplinary Studies (IS) Module <sup>^</sup>	2
Electives (Choose 2)	5
Pharmaceutical Science & Clinical Trials	
Molecular Biology of Diseases	
Forensic Science	
<b>Level 3.2 (24 hours per week)</b>	
Project A/B	8
Four-month Internship	16

### Notes:

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### IS Modules

The School of Interdisciplinary Studies (IS) delivers a broad-based curriculum, which nurtures a new generation of professionals with multidisciplinary skills and an innovative and entrepreneurial spirit to meet the challenges of a knowledge economy. IS offers both prescribed modules and electives to challenge boundaries. Prescribed modules develop students' competencies in core areas such as Communication, Innovation and Enterprise, Culture and Communication, and Personal Mastery and Development, while elective modules provide insights into Arts and Humanities, Business, Design, and Science and Technology.

## COURSE MODULES

### LEVEL 1.1

#### Inorganic & Physical Chemistry

The module surveys the structure of matter, chemical bonding, thermochemistry, chemical equilibria, kinetics, electrochemistry and redox reactions, transition metal chemistry, chemistry of solutions, including acids, bases and buffers.

#### Microbiology

This module examines microorganisms and techniques in microbiology. Topics include cell structure and function, classification, bacteria, viruses and fungi,

nutrition, growth and regulation, environmental factors affecting growth, microscopy, staining, size measurement, cell enumeration, media preparation, isolation and cultivation of pure cultures.

#### Mathematics

This module provides students with a fundamental analytical knowledge of Mathematics essential for the study of biomedical science.

#### Physiology

This module provides a foundation for the second- and third-year modules. It introduces the basic principles of homeostatic mechanisms and the cardiovascular, respiratory, renal, gastrointestinal, neuromuscular, endocrine and reproductive physiological systems that exist in the human body.

### LEVEL 1.2

#### Cell Biology

This module explores mammalian cells, tissue and organ systems. Topics include the fundamental chemicals of life, structure and function of cells and organelles, cell division, cytogenetics and DNA replication, transcription and translation.

#### Organic Chemistry

This module gives students a strong foundation in basic organic chemistry. Topics include the IUPAC nomenclature, structural formulas, preparations and reactions of the main classes of organic compounds; namely, alkanes, alkenes, alkynes, benzene, alcohols, thiols, ether, aldehydes, ketones, amines, carboxylic acids and derivatives.

#### Information Technology for the Life Sciences

This module aims to familiarise students with search engines, scientific databases and Excel. It equips students with the IT skills needed to effectively use the vast amount of information on the Internet. Students will learn to use their notebook PCs effectively for mobile computing, as well as how to set up a home wireless network.

#### Biostatistics

This module is designed to equip biomedical science students with the necessary statistical techniques to solve biological and chemical problems, as well as to carry out statistical studies in their future modules and research projects.

### LEVEL 2.1

#### Medical Microbiology

This module is a continuation of the first-year microbiology module. The module covers the identification and applications of basic principles in the utilisation of microorganisms; for example, in medicine and disease infection and control.

#### Immunology

This module introduces the fundamentals of immunology and provides an understanding of how the immune system functions as an integrated defence system against disease. Topics include an overview of the immune system, innate and adaptive immunity, humoral and cell-mediated immunity, immunisation and vaccination, and laboratory immunological techniques. Also covered are the applications of immunology in overcoming assaults on the immune system and the principles of Hybridoma Technology.

#### Cell Culture & Tissue Applications

This module is a detailed study of the techniques and applications of animal cell culture. Topics include the preparation of media, cell viability checks, passaging of inherent cells, cryopreservation, cloning and mycoplasma assays. Tissue engineering and rapid prototyping are also taught.

#### Developmental Biology & Genetics

This module discusses developmental biology and genetics approaches to understanding human embryonic development, and genes that are involved in body plan formation and morphogenesis. Other topics discussed include the pattern of inheritance, mutation, and roles of genes and environmental factors in relation to human health.

### LEVEL 2.2

#### Medical Biochemistry

This module introduces fundamental biochemical concepts and practices. The subject integrates biological and chemical concepts as they relate to biochemistry and biochemical disorders. The module prepares students to work in biochemical industries and research, and covers three major areas of protein chemistry, enzymology and metabolism.

#### Instrumentation & Analytical Chemistry

This module comprises five major sections: viz. protein chemistry, enzymology, metabolism, separation technology and radioactivity. Students will study the workings of various analytical instruments such as gas and high-performance liquid chromatography, mass spectrometry, and atomic absorption spectroscopy, as well as fundamental biochemical concepts and practices with an emphasis on proteins. Topics covered include protein purification and analytical techniques such as UV-spectrophotometry, gel exclusion, ion-exchange and affinity chromatography, filtration, dialysis and centrifugation.

#### Molecular Biology

This module highlights prokaryotic and eukaryotic genetics at the molecular level. Topics include DNA structure and replication, mRNA transcription, protein synthesis, regulation of gene expression, gene mutation and DNA repair mechanisms, and regulation of cell cycle and apoptosis. In the area of recombinant DNA technology and molecular techniques, students will learn about the isolation of genomic and plasmid DNA, polymerase chain reaction, insertion of target DNA into cloning vector, transformation of *E. coli* competent cells, identification of recombinant clones, isolation of total RNA and SDS-PAGE analysis of proteins.

#### Bioinformatics

This module equips students with knowledge of the basic theory of bioinformatics, and introduces tools and resources used in molecular bioinformatics.

**LEVEL 3.1****Life Sciences Seminar Series**

In this module, guest speakers are invited to discuss their current research topics and the latest technology and developments in biomedical science. Students may also attend scientific forums organised by scientific societies and research institutes/universities.

**Genomics**

This module examines the theoretical basis of advances made in the field of genomics. These include transgenic animals, genetically modified foods, cloning in animals, molecular basis of development, human genome project and applications of molecular biology in the diagnosis of diseases and in forensic science.

**Proteomics**

Proteomics concerns the study and analysis of proteins. This module focuses on a number of issues involved in protein purification and analysis.

**Project (Parts A and B)**

Students will work on a project in groups of two or three in an area that is of interest to them, under the supervision of a staff member or an external collaborator. They will start off with lectures on literature searches, basic laboratory safety, project management and statistical analysis of laboratory data, followed by practical work. During the course of their projects, students will acquire an in-depth knowledge and technical expertise that will prepare them for a working environment.

**ELECTIVES****Pharmaceutical Science & Clinical Trials**

This module introduces the concepts required to understand how the biological activities of drugs are derived from their chemical structures and physical chemical properties. Topics covered include the mechanisms involved in the metabolic pathways that a drug could undergo, methods of analysis to

identify and assay drugs, how toxicology studies are conducted, and the rationale of dosage form. The module also equips students with an understanding of the fundamentals of clinical trials.

**Molecular Biology of Diseases**

This module explores the underpinning principles and molecular basis of important diseases such as cancers, neurological disorders, and infectious diseases such as SARS and bird flu.

**Forensic Science**

This module gives an insight into criminal law; an overview of the techniques employed by crime scene investigators and also examines the important aspects of forensic biology, toxicology and analysis. Through case studies, students will get a chance to read the minds of criminals in forensic psychology and crime scene reconstruction.

**LEVEL 3.2****Project (Parts A and B)**

Students will work on a project in groups of two or three in an area that is of interest to them, under the supervision of a staff member or an external collaborator. They will start off with lectures on literature searches, basic laboratory safety, project management and statistical analysis of laboratory data, followed by practical work. During the course of their projects, students will acquire an in-depth knowledge and technical expertise that will prepare them for a working environment.

**Four-month Internship**

Students will undergo a four-month internship, which gives them opportunities to apply the knowledge acquired in classrooms in work situations and research. They will be attached to research institutes and companies in various industries such as biomedical, pharmaceuticals, clinical trials and bioinformatics sectors, either locally or overseas.





## DIPLOMA IN CHEMICAL & BIOMOLECULAR ENGINEERING (CBE) 3-YEAR COURSE

The **Diploma in Chemical & Biomolecular Engineering (CBE)** is designed to meet the growing needs of the petroleum, petrochemical, chemical, pharmaceutical and life sciences industries. Graduates will be empowered to bridge the gaps between these different disciplines.

CBE is the only course in Singapore that integrates biological and chemical sciences with engineering concepts. It encompasses chemical processing, pharmaceuticals, environmental science and engineering as well as life sciences, making it a very versatile course. Students can opt to undertake the pharma & biopharmaceutical specialisation in the final year to capitalise on the vast and rapidly growing biomedical science industry. In addition, students who prefer a research based career can opt for the new research track in their final year.

First-year modules introduce students to concepts from organic, biological, inorganic and physical chemistry, chemical and biochemical engineering, electrotechnology and biomolecular science. Second-year modules offer an in-depth study of biopharmaceutical technology, chemical engineering processes, analytical chemistry, engineering materials, heat and mass transfer processes, and reaction engineering.

In the final year, students can choose either the general chemical engineering track or the pharma & biopharmaceutical specialisation. Both options cover modules on process engineering design, process instrumentation and control as well as unit operations. Hands-on exposure is strongly featured throughout the entire curriculum.

Students will also undertake six weeks of practical training at the Chemical Process Technology Centre in Jurong Island as well as a 16-week internship,

or opt for the research track which gives them an introduction to research followed by 16-week research-based internship, which will be carried out either locally or overseas.

### ENTRY REQUIREMENTS

To be eligible for consideration, candidates must have the following GCE 'O' Level examination (or equivalent) results:

Subject	'O' Level Grade
English Language*	1-7
Mathematics (Elementary/Additional)	1-6
Science (with Physics, Chemistry or Biology component) or Design & Technology or Computer Studies or Fundamentals of Electronics	1-6

You must also fulfil the aggregate computation requirements.

\* Candidates with English as a second language (EL2) must have attained a minimum grade of 6.

### CAREER PROSPECTS

There is increasing demand for multi-disciplined professionals. CBE graduates have the foundation and flexibility to carve various careers in a myriad of industries – from chemical, petrochemical, biochemical, biotechnology and pharmaceutical to food & beverage, electronics, environment and sustainability-related.

CBE graduates enjoy good employment prospects as technologists, technical officers, project supervisors or assistant engineers in a process, design, control, operations or maintenance unit; laboratory technologists, pollution control or plant safety officers in a quality control unit; or as sales engineers.

## ACCREDITATION FOR FURTHER STUDIES

CBE is fully accredited by the Institution of Chemical Engineers (IChemE), UK. CBE graduates can pursue a wide range of degree programmes offered by the Singapore Institute of Technology, National University of Singapore, Nanyang Technological University and the Singapore Management University. In addition to being able to apply for degree course in Chemical Engineering with University of Newcastle right here on Ngee Ann's campus with subsidised fees and advanced standing, Chemical Engineering, Environmental Engineering, Material Sciences, Chemistry and Physics. CBE graduates can also apply to undertake degrees in biological science, bioengineering, education, arts, architecture, dentistry, business, psychology and social science. The following overseas universities offer CBE graduates up to two years' exemption for three- and four-year degree courses respectively:

- University of Adelaide (Australia)
- University of Melbourne (Australia)
- University of Queensland (Australia)
- University of New South Wales (Australia)
- University of Birmingham (UK)
- Loughborough University (UK)
- Newcastle University (UK)

## COURSE CURRICULUM

Module Name	Credit Units
<b>YEAR 1</b>	
<b>Level 1.1 (28 hours per week)</b>	
Engineering Drawing & Computer Applications	3
Engineering Mathematics 1	6
Introduction to Chemical & Biochemical Engineering	3
Organic & Biological Chemistry	8
Electrotechnology	4
Idea Jumpstart^	2
Sports & Wellness^	2
<b>Level 1.2 (26.5 hours per week)</b>	
Biomolecular Science	3.5
Engineering Mathematics 2	6
Inorganic & Physical Chemistry	8
Thermodynamics	5
Communication & Contemporary Issues^	4
<b>YEAR 2</b>	
<b>Level 2.1 (24.5 hours per week)</b>	
Chemical Engineering Laboratory 2.1	3
Engineering Mathematics 3	4
Reaction Engineering	4
Transfer Processes – Fluid Flow	3
Biopharmaceutical Production	5
Analytical Chemistry	3
Idea Blueprint^	2
Interdisciplinary Studies (IS) module^	2
<b>Level 2.2 (25.5 hours per week)</b>	
Analysis of Chemical Engineering Processes	6.5
Chemical Engineering Laboratory 2.2	3
Environmental Technology	4
Transfer Processes – Heat & Mass	4
Occupational Health & Safety	2
Engineering Materials	2
Idea Launchpad^	2
Interdisciplinary Studies (IS) module^	2

Module Name	Credit Units
<b>YEAR 3</b>	
<b>Level 3.1 (28 hours per week)</b>	
Chemical Engineering Laboratories 3.1	3
Process Engineering Design	8
Process Instrumentation & Control	5
Unit Operations	5
Petrochemical Technology	1.5
Industrial Chemical Processes	1.5
World Issues: A Singapore Perspective^	2
Interdisciplinary Studies (IS) module^	2
<b>Pharma &amp; Biopharmaceutical Specialisation</b>	
Pharmaceutical Engineering Laboratories	3
Process Engineering Design	8
Process Instrumentation & Control	5
Unit Operations for Pharmaceutical Processes	5
Biopharmaceutical Quality Control	1.5
Current Good Manufacturing Practice	1.5
World Issues: A Singapore Perspective^	2
Interdisciplinary Studies (IS) module^	2
<b>Level 3.2</b>	
<b>Industry Track</b>	
Chemical Process Training Programme	6
16-week Industrial Internship	16
<b>Research Track</b>	
Introduction to Research	6
16-week Internship by Research	16

### Notes:

^ For more details on Interdisciplinary Studies (IS) modules, please log on to [www.np.edu.sg/is/](http://www.np.edu.sg/is/)

### IS Modules

The School of Interdisciplinary Studies (IS) delivers a broad-based curriculum, which nurtures a new generation of professionals with multidisciplinary skills and an innovative and entrepreneurial spirit to meet the challenges of a knowledge economy. IS offers both prescribed modules and electives to challenge boundaries. Prescribed modules develop students' competencies in core areas such as Communication, Innovation and Enterprise, Culture and Communication, and Personal Mastery and Development, while elective modules provide insights into Arts and Humanities, Business, Design, and Science and Technology.

## COURSE MODULES

### LEVEL 1.1

#### Engineering Drawing & Computer Applications

This practice-oriented module consists of two parts. The first part gives students an appreciation of the scope of computer graphics and computer-aided flow sheets, and provides hands-on practice with CAD in engineering drafting. The second part of the module gives students an appreciation of computer projects modelling.

#### Engineering Mathematics 1

Students will study mathematical subjects relevant to engineering applications. This module provides them with the necessary mathematical skills required in other engineering subjects. Topics include algebra, exponential and logarithmic functions, trigonometry, combination and permutation, plane analytical geometry, binomial expansion, determinants and matrices.

#### Introduction to Chemical & Biochemical Engineering

Students are introduced to basic chemical engineering concepts and applications, for example, units and dimensions, material balance calculations, reaction stoichiometry, reaction engineering, flow-sheeting and fluid mechanics. Upon completion of this module, they will be able to undertake basic chemical engineering calculations.

#### Organic & Biological Chemistry

This practical-oriented module is designed to give students an introduction to organic and biological chemistry. Students will be introduced to the chemistry of hydrocarbons, alcohols, amines, carboxylic acids and their derivatives. The structure, function and chemical reactions of carbohydrates, lipids, proteins, nucleic acids, enzymes and coenzymes are also covered.

#### Electrotechnology

Students will explore the basics of electrical engineering principles. Topics include the study of direct and

alternative current circuits that consist of resistors, capacitors and inductors. Phasor diagrams and complex numbers are used in AC-circuit analysis. The basic three phase AC system is also covered.

### LEVEL 1.2

#### Biomolecular Science

This module introduces students to cell biology, microorganisms and techniques in microbiology. Students will learn about cell structure, cell membrane, microbial growth and nutrition, cellular transport mechanisms, DNA replication, transcription and translation, mycology, virology and aseptic techniques.

#### Engineering Mathematics 2

A continuation of the Engineering Mathematics 1 module, topics in this module include complex numbers, statistical techniques, differentiation, integration, further integration techniques and numerical methods for evaluating definite integrals. Emphasis is placed on their applications in solving engineering-related problems. A mathematical software package is also used to solve these problems.

#### Inorganic & Physical Chemistry

This module covers the principles of physical chemistry as well as the reactions and properties of inorganic compounds. Students will study the structure of matter, chemical bonding, chemical calculations, electrochemistry and redox reaction, chemical equilibria, ionic equilibria, chemical kinetics, thermochemistry, transition metal chemistry and chemistry of solutions, including acids and bases.

#### Thermodynamics

Students will study the fundamental concepts of thermodynamics and fluid mechanics. Topics include the first and second laws of thermodynamics, properties of liquids and vapours, non-flow processes and steady flow processes with steam and perfect gases. The concepts of pressure, pressure head, and pressure measurement will also be discussed.

### LEVEL 2.1

#### Chemical Engineering Laboratory 2.1

This module integrates the practical aspects of Reaction Engineering and Transfer Processes – Fluid Flow modules.

#### Engineering Mathematics 3

Building upon the materials covered in the earlier two modules on Engineering Mathematics, this module provides students with an adequate knowledge of mathematics to solve problems encountered in their future work. Topics include vector algebra, first and second order differential equations and their applications, Laplace transform technique and its applications, and Regression Analysis. Students will also use a mathematical software package to solve these problems.

#### Reaction Engineering

Students will focus on reactor design principles. Topics include reactor kinetics, analysis of batch reactors, continuous stirred tank reactors and plug flow reactors. It also covers topics in material balance calculations as well as aspects of the design, construction and operation of chemical and biological reactors. Examples from the petrochemical, chemical, environmental and biotechnology industries are used to reinforce lecture materials.

#### Transfer Processes – Fluid Flow

Students are introduced to fluid dynamics in this module. Topics include energies of liquids in motion, flow in pipes, general principles of pumps and system characteristics compressors, and flow measurement.

#### Biopharmaceutical Production

This module provides students with a working knowledge of all aspects of the manufacturing of biologics products. This module will cover various aspects of upstream and downstream manufacturing including media and buffer batching, cell banking, microbial and animal cell culture, bioreactor technology

cell harvesting, chromatography, and fill and finish processes.

#### Analytical Chemistry

This module teaches students some common separation and characterisation instruments and instrumental techniques used in the laboratory, as well as provide hands-on opportunity for them. These techniques include UV-visible spectrophotometry (UV-Vis), gas liquid chromatography (GLC), high performance liquid chromatography (HPLC) and Atomic Absorption Spectroscopy (AAS).

### LEVEL 2.2

#### Analysis of Chemical Engineering Processes

In this module, students will study the fundamental principles of flow diagram analysis, including both mass and energy balances, and the use of a process flowsheeting package.

#### Chemical Engineering Laboratory 2.2

This module integrates the practical aspects of Environmental Technology and Transfer Processes – Heat and Mass modules.

#### Environmental Technology

This module introduces students to environmental problems and their impact. Students will study the various methods, applications and equipment in solving and preventing environmental problems, specifically in the areas of air and water pollution, and the management of industrial wastes.

#### Transfer Processes – Heat & Mass

This module explores the mechanisms of heat transfer (conduction, convection and radiation), and introduces the importance of heat exchangers in chemical engineering processes. The fundamentals of mass transfer are also covered, giving a deeper understanding of key chemical engineering processes such as evaporation and condensation, distillation, and other extraction and separation techniques.

#### Occupational Health & Safety

This module gives students an understanding of biological, chemical and physical hazards, ergonomics, radiation, and management of dangerous and toxic goods. It also includes an overview of occupational health and safety legislation as part of a basic knowledge of industrial safety.

#### Engineering Materials

In this module, students will study the properties of materials commonly used in industries and gain an understanding of the basic requirements to carry out the proper selection of materials. Topics include the classification of materials, properties of materials, metals, alloy and polymeric materials, corrosion and degradation of materials.

### LEVEL 3.1

#### Chemical Engineering Laboratories 3.1

This module integrates the practical aspects of Level 3.1 modules of Unit Operations, and Process Instrumentation & Control.

#### Process Engineering Design

Students will deal with process flow sheets, piping and instrumentation diagrams, process and mechanical design of equipment, cost and evaluation of projects, materials of construction, safety and loss prevention. A practical design project is used to reinforce theory.

#### Process Instrumentation & Control

This module gives students a broad introduction to the principles and applications of instruments in process industries such as instrumentation for temperature, flow, level and pressure measurements. Other topics include the fundamental concepts of feedback control, system dynamics and stability, PID control modes, controller tuning, multivariable control strategies, control valve sizing, and an introduction to digital control techniques and computer control of chemical processes.

#### Unit Operations

This module focuses on solvent extraction, crystallisation, drying, evaporation, distillation, digestion, absorption, adsorption and material handling as applied to unit operations in various sectors such as the petroleum, petrochemical, chemical and pharmaceutical industries.

#### Petrochemical Technology

In this module, students are introduced to the petrochemical industry. Topics include an overview of the industry and its importance to Singapore and the region, its key products, raw materials, intermediate and product flows, economics of petrochemical processing and key petrochemical processes.

#### Industrial Chemical Processes

In this module, students will have the opportunity to apply their knowledge of basic chemical engineering principles such as material balance calculations, heat and mass transfer principles, reaction engineering and fluid mechanics for large-scale chemical synthesis. Topics include production of synthetic fibres, plastics, resins, rubbers, oils and fats, paints and related products, dyes, drugs and pharmaceuticals. It also highlights the importance of the processes in local and regional contexts.

### PHARMA & BIOPHARMACEUTICAL SPECIALISATION

#### Pharmaceutical Engineering Laboratories

This module integrates the practical aspects of Level 3.1 modules of Unit Operations, and Process Instrumentation & Control.

#### Process Engineering Design

Students will deal with process flow sheets, piping and instrumentation diagrams, process and mechanical design of equipment, cost and evaluation of projects, materials of construction, safety and loss prevention. A practical design project is used to reinforce theory.

### Process Instrumentation & Control

This module gives students a broad introduction to the principles and applications of instruments in process industries such as instrumentation for temperature, flow, level and pressure measurements. Other topics include the fundamental concepts of feedback control, system dynamics and stability, PID control modes, controller tuning, multivariable control strategies, control valve sizing, and an introduction to digital control techniques and computer control of chemical processes.

### Unit Operations for Pharmaceutical Processes

This module covers topics such as solvent extraction, crystallisation, drying, evaporation, distillation, digestion, absorption, adsorption and material handling as applied to unit operations in various sectors such as the petroleum, petrochemical, chemical and pharmaceutical industries.

### Biopharmaceutical Quality Control

This module will introduce the functions of a quality control entity in a pharmaceutical and biopharmaceutical manufacturing facility, as well as the various raw material, in-process, product and stability testing methodologies and specifications.

### Current Good Manufacturing Practice

Students will cover the US Food and Drug Administration's current Good Manufacturing Practice (GMP) regulations for pharmaceutical and related products. Various aspects, such as attributes of materials, labelling, materials in process, finished pharmaceuticals, manufacturing validation, quality control, personnel and facilities are covered.

## LEVEL 3.2

### INDUSTRY TRACK

#### Six-week Chemical Process Training Programme

In this module, students will undergo a 6-week internship with the Chemical Process Training Centre on Jurong Island, where they will undergo training involving

the operations of a live plant. They will be introduced to various aspects of plant operations such as start-up, shutdown, maintenance, emergency and safety operations, and will have the opportunity to experience shift work.

#### 16 weeks Industrial Internship

Students will do an 18-week internship and project which will give them opportunities to apply the knowledge acquired in classrooms to real-world work situations. They will be attached to research institutes and companies in various industries such as the petroleum, petrochemicals, chemicals and pharmaceuticals sectors.

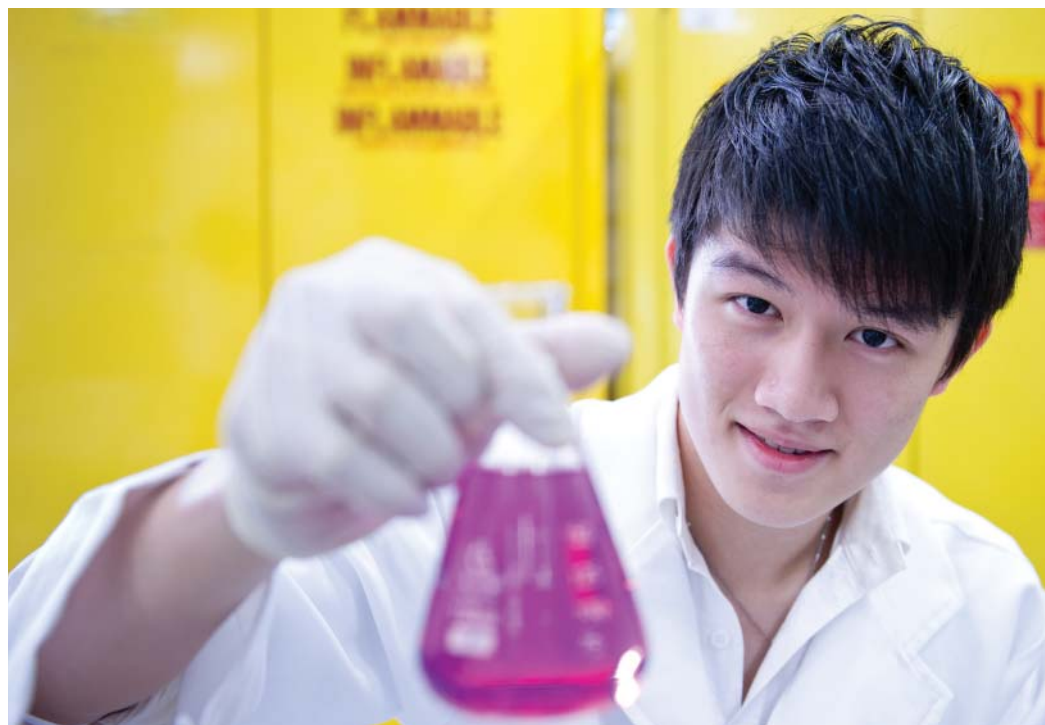
### RESEARCH TRACK

#### Introduction to Research

The module enables students to be equipped with basic research skills. The module includes lectures on literature searches, basic laboratory safety, project management and statistical analysis of laboratory data, followed by practical work.

#### 16 weeks Internship by Research

Students will undertake a scientific research project as a continuation of the introduction module. The projects will be carried out in-house or at external research institutions, which include overseas institutions and last for 4 months.





# DIPLOMA IN LANDSCAPE DESIGN & HORTICULTURE (LDH) 3-YEAR COURSE

A unique hybrid of landscape design, plant science and horticulture, the **Diploma in Landscape Design & Horticulture (LDH)** is the only course of its kind in Singapore offered at a tertiary level.

The course is jointly conducted by Ngee Ann Polytechnic (NP) and the National Parks Board (NParks). A major part of the course includes hands-on practical training, field visits and outdoor lessons at the Singapore Botanic Gardens and other parks. With Clementi Woods Park as a “Learning Park” serving as an outdoor classroom, students can engage in experiential learning in a real park setting.

Students will develop a strong understanding of plant taxonomy, plant anatomy, plant biochemistry and physiology, plant pathology, plant genetics and soil science. They will learn how to apply this basic knowledge in modules covering turf management, plant nutrition, hydroponics, horticultural engineering, park and leisure management and nursery management. They will thus learn how plants are affected by their environment and how they influence both the natural and human environment. This knowledge of plant science is integrated with extensive training in the principles and practices of landscape design. Key modules cover topics in digital graphics, computer aided drafting, softscape design, and landscape design.

LDH students also undertake projects with government bodies and private companies to develop innovative designs that are attractive, easily maintained and co-exist with Singapore’s natural heritage and urban environment. LDH graduates are well-equipped with the expertise to create thriving landscapes to suit different environmental conditions, urban lifestyles and green spaces.

## ENTRY REQUIREMENTS

To be eligible for consideration, candidates must have the following GCE ‘O’ Level examination (or equivalent) results:

Subject	‘O’ Level Grade
English Language*	1-7
Mathematics (Elementary/Additional)	1-7
Science (with Physics, Chemistry or Biology component) or Design & Technology or Fundamentals of Electronics	1-6
Any one other subject	1-6

You must have also sat for a Science or Art / Higher Art or Design & Technology or Food & Nutrition or a relevant OSIE / Applied Subject and fulfil the aggregate computation requirements.

\* Candidates with English as a second language (EL2) must have attained a minimum grade of 6.

## CAREER PROSPECTS

With the anticipated growth of the horticultural and landscaping industries, LDH graduates will find ready employment as horticulturists, technologists, nursery supervisors, landscape project executives, landscape designers, park officers, or golf course maintenance officers in the varied horticulture, landscape, facilities management, and leisure and recreation industries.

## ACCREDITATION FOR FURTHER STUDIES

LDH graduates can enjoy up to two years of exemption in relevant degree courses in horticulture, plant science, agriculture, biological science, botany, environmental science, landscape architecture, architecture, turf management and business management offered by local and overseas universities such as the National University of Singapore, Nanyang Technological University, the Singapore Management University, Lincoln University, University of Melbourne, University of New South Wales, University of Queensland, Murdoch University and University of Georgia.

## COURSE CURRICULUM

Module Name	Credit Units
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### YEAR 1

#### Level 1.1 (24.5 hours per week)

Chemistry	4.5
Plant Anatomy & Morphology	5
Taxonomy & Plant Identification	5
IT Applications	2
Digital Graphics Applications	3
Landscape Studio 1	1
Idea Jumpstart <sup>^</sup>	2
Sports & Wellness <sup>^</sup>	2

#### Level 1.2 (24.5 hours per week)

Environmental Science	2.5
Plant Nutrition & Hydroponics	5
Landscape Studio 1 – Design Fundamentals	4
Graphics & Communication 1	2
Soil Science	3
Floristry & Interiorscapes	3
Landscape Studio 2 and 3	2
Communication & Contemporary Issues <sup>^</sup>	4

### YEAR 2

#### Level 2.1 (24 hours per week)

Plant Biochemistry & Physiology	6
Plant Pathology & Entomology	5
Planting & Maintenance	3
Computer Aided Drafting	3
Landscape Construction Principles	1.5
Softscape Design Principles	1.5
Landscape Studio 4	1
Interdisciplinary Studies (IS) module <sup>^</sup>	2
Interdisciplinary Studies (IS) module <sup>^</sup>	2

#### Level 2.2 (24.5 hours per week)

Genetics & Plant Breeding	6
Propagation & Nursery Management	5
Arboriculture	2.5
Landscape Studio 2 – Design Process	4
Graphics & Communication 2	2
Landscape Studio 5	1
Idea Blueprint <sup>^</sup>	2
Idea Launchpad <sup>^</sup>	2

## Module Name

## Credit Units

### YEAR 3

#### Level 3.1 (22 hours per week)

Landscape Studio 3 – Independent Projects	5
Leisure & Park Management	2.5
Project Management	2.5
Turf Management	3
Horticultural Engineering	2.5
Landscape Studio 6 and 7	2
Plant Identification 2	2
World Issues: A Singapore Perspective <sup>^</sup>	2
Interdisciplinary Studies (IS) module <sup>^</sup>	2

#### Electives

Plant Tissue Culture Project	3
	3

#### Level 3.2

Internship	24
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#### Notes:

<sup>^</sup> For more details on Interdisciplinary Studies (IS) modules, please log on to [www.np.edu.sg/is/](http://www.np.edu.sg/is/)

#### IS Modules

The School of Interdisciplinary Studies (IS) delivers a broad-based curriculum, which nurtures a new generation of professionals with multidisciplinary skills and an innovative and entrepreneurial spirit to meet the challenges of a knowledge economy. IS offers both prescribed modules and electives to challenge boundaries. Prescribed modules develop students' competencies in core areas such as Communication, Innovation and Enterprise, Culture and Communication, and Personal Mastery and Development, while elective modules provide insights into Arts and Humanities, Business, Design, and Science and Technology.

## COURSE MODULES

### LEVEL 1.1

#### Chemistry

In this module, students will study the basic concepts of chemistry, including the nature, properties, and transformations of matter; stoichiometry and equilibria of chemical reactions; acids and bases; redox reactions; and the fundamentals of organic chemistry.

#### Plant Anatomy & Morphology

This module explores the structural and functional features of plant cells, types of cells and tissues, anatomy and morphology of roots, stems and leaves, and the anatomical development of seeds. Other topics include differences between monocots and dicots, flower structure and plant reproductive cycle.

#### Taxonomy & Plant Identification

This module surveys the principles of plant taxonomy, the relationship among plants, and the classification and biology of algae, fungi, bryophytes, gymnosperms and angiosperms. Other topics include the identification, use, origin and cultural requirements of trees, shrubs, vines and ground covers used for horticultural practices. The emphasis is on common landscape plants used in Singapore.

#### IT Applications

This module equips students with skills in producing electronic spreadsheets and multimedia slide presentations. Other topics include database management, electronic publishing, Internet and Web page design. Hands-on practical sessions provide students with a working knowledge of application software packages to assist them in data analysis and information management.

#### Digital Graphics Applications

This module trains students to produce digital graphics using the latest version of industry-standard graphic application software. Topics include an introduction to

digital imaging, drawing in Illustrator and image editing in Photoshop. Students will gain practical knowledge during lab sessions to create graphics objects for desktop publications, landscape portfolios, website development and other media production.

### Landscaping Workskills 1

This module is designed to give students practical knowledge of the tools commonly used in the horticulture industry. The emphasis is on the proper use, safety, maintenance and storage of tools.

## LEVEL 1.2

### Environmental Science

This module covers components of the physical and biological environment, ecology and populations, concepts of biomass, ecosystems, successions, biodiversity, environmental pollution and energy conservation. Human impact on the environment will be emphasised.

### Plant Nutrition & Hydroponics

This module covers plants, nutrients and the environment, from cultural practices to crop production. Topics include controlled environment, assimilation of minerals, soilless culture techniques, types of hydroponics systems, plant growth and establishment in hydroponics systems, and the maintenance of hydroponics systems.

### Landscape Studio 1 – Design Fundamentals

This module introduces the design fundamentals of space creation and visualisation, two- and three-dimensional designs and their application to simple designs. Students are given an overview of professional concerns and responsibilities to use land in an efficient and attractive manner.

### Graphics & Communication 1

This module focuses on landscape design communication using different types of media. Freehand representation is used in design conceptualisation that

emphasises the development of landscape design representation techniques.

### Soil Science

This module covers the fundamentals of soil science, soil chemical processes, physical-chemical properties and ion exchange. Students will study the causes of soil acidity, alkalinity and salinity, and surface solution relationships. Other topics include reactions between soils, fertilisers, pesticides or heavy metals as well as techniques for the study of interactions between microorganisms and their natural environment.

### Floristry & Interiorscapes

In this module, students will come to appreciate the finer points of basic flower designs and the proper handling of fresh flowers and foliage, as well as the use of potted plants and hydroculture plants in interiorscapes.

### Landscaping Workskills 2 and 3

This module is designed to give students practical knowledge of planting different types of plants, including their aftercare to ensure their recovery, growth and development.

## LEVEL 2.1

### Plant Biochemistry & Physiology

This module examines the molecular basis of living processes in plants, metabolism of carbohydrates, plant growth regulators, and environmental and plant stress physiology. Topics include comparative physiological and biochemical processes during growth, maturation, ripening and senescence in fruits, vegetables and flowers in relation to changes to quality and storage life.

### Plant Pathology & Entomology

This module explores various plant pathogens and diseases as well as their classification and morphology. Topics covered include the biology of bacteria, fungi, nematodes and viruses attacking economic crops; etiology and the control of plant bacterial diseases; the

biology of insect pests of horticultural plants; and the application of an integrated pest management system.

### Planting & Maintenance

This module trains students in the preparation of planting and maintenance schedules, planting management and maintenance projects. Students will demonstrate their competence in planting new areas and maintaining existing areas of planting. Types of media used and the use of fertilisers, pesticides and mulching are also covered.

### Computer-Aided Drafting

This module helps students to develop an understanding of the communication of design with the use of technical drawings. The module will expose students to landscape construction drawings and detailing for hard and soft landscape design documentation by using AutoCAD as a computer aided drafting tool. Students will also learn to use other complementary IT tools such as file compression (zip files), publishing CAD files on websites, and basic 3D principles.

### Landscape Construction Principles

In this module, students will be introduced to landscape architectural construction, materials and implementation, as well as detailing as an extension of design and a means of ensuring design intent.

### Softscape Design Principles

This module surveys planting design and documentation for different scales of landscape. Topics include the recognition of the visual and ecological characteristics of plants used in landscape design, and the basic principles of planting design.

### Landscaping Workskills 4

This module is designed to give students practical knowledge of how to prune different types of plants.

## LEVEL 2.2

### Genetics & Plant Breeding

This module explores the organisation and expression of nuclear and plastid genomes of plants. Topics include the transcriptional regulation and structure of plant genes, gene regulation during plant development and techniques in molecular plant biology for plant research, genetics and breeding of tropical fruit and nut crops, and the classification, culture, cytogenetics and breeding of orchids (orchidology).

### Propagation & Nursery Management

This module focuses on plant propagation using seeds and various plant parts, and nursery management. Topics include asexual/vegetative propagation techniques, arboricultural management, nursery facility planning and work organisation, irrigation systems, nursery operations management, management practices in production of commercial nurseries and environmental control systems.

### Arboriculture

This module outlines the aims and objectives of an urban forest, leading to an understanding of the value of non-commodity trees in our society. It addresses the theoretical and practical aspects of arboriculture in a city setting with emphasis on the selection, establishment, and maintenance of trees. Basic field machinery and safety precautions are also included.

### Landscape Studio 2 – Design Process

This module introduces landscape design from around the world, including historic landscapes and gardens, urban plazas and pedestrian areas, as well as parks and infrastructure. Topics include the arrangement of buildings, circulation, and other landscape design elements, as well as the development of landscape design processes as applied to small-scale projects.

### Graphics & Communication 2

In this module, students will study advanced presentation techniques to develop their skills in

visualisation and representation using freehand and perspective drawings.

### Landscaping Workskills 5

This module is designed to give students' practical knowledge of types of fertilizers, and their application to promote growth and development in different types of plants.

## LEVEL 3.1

### Landscape Studio 3 – Independent Projects

In this module, students will undertake individual projects that involve the entire landscape design process, addressing various aspects of landscape design taught in the first and second year.

### Leisure & Park Management

This module examines the philosophy, history, psychology, science and development in leisure and park management. It will also cover the principles, practices and economics of such management and some contemporary issues on recreation and leisure. Site visits will enable students to integrate theory with practice.

### Project Management

This module covers concepts of project management within the horticulture industry, work planning, cost analysis and risk management. Other topics include construction management, cost estimates and measurements, horticultural contract specifications, work supervision and schedules. Students will use project management software and benefit from case studies.

### Turf Management

This module highlights a selection of grasses for various types of turf, preparation and turf establishment, subsoil drainage and irrigation, turf maintenance machinery, as well as pests and diseases. Students can also look forward to field trips and site visits.

### Horticultural Engineering

This practical module introduces students to structural materials, horticultural machinery and tools, and irrigation management. The module combines design knowledge and technical training in the various light construction works most often used in hardscape implementation.

### Landscaping Workskills 6 and 7

This module is designed to give students practical knowledge of pesticides commonly used in the horticulture industry. The emphasis is on the correct use, safety and storage of pesticides.

### Plant Identification 2

In this module, students will focus on an additional 100 plants commonly used in the horticulture and landscaping industry in Singapore.

## ELECTIVES

### Project

Students will undertake group developmental projects in an area involving horticulture or landscaping.

### Plant Tissue Culture

Students will learn to apply aseptic techniques in the propagation of tropical plants. The use of plant tissue culture in the study of other areas of plant science will also be discussed.

## LEVEL 3.2

### Internship

In this six-month programme, students will be attached to private companies and government bodies. Students will be exposed to the rigours of the industry in a real-time environment, and will receive valuable on-the-job training in areas of landscape implementation, cut-flower retail, nursery management, turf management and horticulture maintenance.



# DIPLOMA IN MOLECULAR BIOTECHNOLOGY (MBIO) 3-YEAR COURSE

The **Diploma in Molecular Biotechnology (MBIO)** provides students with a sound scientific foundation in modern biological sciences leading to careers and further studies in a diverse range of areas such as research, biopharmaceutical manufacturing, chemistry, medicine, pharmacy, engineering, aquaculture, marine biology, and plant science.

This foundation is built on core disciplines such as chemistry, biochemistry, microbiology, cell culture, genomics, proteomics and bioinformatics.

In line with recent developments in life sciences, the course curriculum provides intensive training in the area of molecular biosciences.

In the second and third years, students can select modules from electives and choose a specialisation option. The Entrepreneurship option addresses issues on product development and marketing, and intellectual property management in the biotechnology and biopharmaceutical industry. The option in Biopharmaceuticals focuses on discovery, development and manufacturing of biopharmaceuticals. In the Forensic Medicine option, besides learning about drug discovery and development, students will learn how science is used to solve crimes.

MBIO is the most established life science programme in Singapore, and students will gain invaluable experience from a large pool of existing industrial collaborations. Final-year students have the opportunity to take on research projects while undertaking their internship at the R&D laboratories of local universities, research institutes and life science companies. Dr Teo Hsiang Ling, who received the Philip Yeo Award, credited her success to the practical training that she received while studying for her Biotechnology diploma at Ngee Ann Polytechnic.

## ENTRY REQUIREMENTS

To be eligible for consideration, candidates must have the following GCE 'O' Level examination (or equivalent) results:

Subject	'O' Level Grade
English Language*	1-7
Mathematics (Elementary/Additional)	1-6
Science (with Physics, Chemistry or Biology component) or Fundamentals of Electronics	1-6

You must also fulfil the aggregate computation requirements.

\* Candidates with English as a second language (EL2) must have attained a minimum grade of 6.

## CAREER PROSPECTS

MBIO graduates have been successful in a broad range of career paths. They can look forward to rewarding careers in research and development with world renowned local institutions such as the Temasek Life Sciences Laboratory, Genome Institute of Singapore, Institute of Molecular and Cell Biology, National Cancer Centre, National Neuroscience Institute and the National University of Singapore.

MBIO graduates are highly sought after by the biotechnology, biomedical, food and agrotechnology, environmental technology, and pharmaceutical and healthcare industries. The applied nature of the curriculum provides an edge to graduates pursuing careers in the rapidly developing biopharmaceutical industry in Singapore. A number of our graduates have already received EDB-sponsored overseas training in biopharmaceutical manufacturing.

Dr Eyleen Goh, who graduated in 1994, received an A\*STAR PhD scholarship and is now an assistant professor at Duke NUS Graduate Medical School.

### ACCREDITATION FOR FURTHER STUDIES

MBIO graduates can pursue a wide range of degree programmes offered by the National University of Singapore, Nanyang Technological University and Singapore Management University. They can take up degrees in biological science, chemistry, chemical engineering, bioengineering, education, arts, architecture, dentistry or business.

In 2007, Soong Junwei was one of two LSCT graduates who were the first polytechnic grads to be accepted directly into the MBBS degree programme offered by the Yong Loo Lin School of Medicine at the National University of Singapore. To date, at least eight LSCT graduates have entered medical schools in Singapore and overseas.

The MBIO Diploma is internationally recognised, with graduates receiving one or two years of exemptions from three and four-year degree courses respectively. Overseas universities which accept MBIO graduates include:

- University of Melbourne (Australia)
- University of Queensland (Australia)
- Australian National University (Australia)
- Imperial College (UK)
- University of Manchester (UK)
- Glasgow University (Scotland)
- Edinburgh University (Scotland)
- Dundee University (Scotland)
- McGill University (Canada)
- University of Toronto (Canada)
- University of Michigan (USA)
- University of California Davis (USA)
- Cornell University (USA)

## COURSE CURRICULUM

Module Name	Credit Units
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### YEAR 1

#### Level 1.1 (25 hours per week)

Mathematics	5
Microbiology	7
Inorganic & Physical Chemistry	7
Physiology	2
Idea Jumpstart <sup>^</sup>	2
Sports & Wellness <sup>^</sup>	2

#### Level 1.2 (26 hours per week)

Organic Chemistry	7
Cell Biology	8
Information Technology for the Life Sciences	2
Biostatistics	5
Communication & Contemporary Issues <sup>^</sup>	4

### YEAR 2

#### Level 2.1 (27 hours per week)

Applied Microbiology	6.5
Immunology	6.5
Cell Culture & Bioprocess Engineering	5
Interdisciplinary Studies (IS) Module <sup>^</sup>	2
Interdisciplinary Studies (IS) Module <sup>^</sup>	2

#### Electives

Agrotechnology & Plant Tissue Culture	5
Aquaculture	5

#### Level 2.2 (26 hours per week)

Biochemistry	6.5
Instrumentation & Analytical Chemistry	6
Molecular Biology	7.5
Bioinformatics	2
Idea Blueprint <sup>^</sup>	2
Idea Launchpad <sup>^</sup>	2

### YEAR 3

#### Level 3.1 (28 hours per week)

Life Sciences Seminar Series	1.5
Genomics	1.5
Proteomics	8
Project A/B	8

Module Name	Credit Units
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World Issues: A Singapore Perspective <sup>^</sup>	2
Interdisciplinary Studies (IS) Module <sup>^</sup>	2

#### Entrepreneurship Option

Biotech Innovations & Business Ventures	3
Bioscience Sales & Marketing	2

#### Biopharmaceutical Option

Drug Discovery and Development	2.5
Biomufacturing Practices	2.5

#### Forensic Medicine Option

Drug Discovery and Development	2.5
Forensic Science	2.5

#### Level 3.2 (24 hours per week)

Four-month Internship	16
Project A/B	8

#### Notes:

<sup>^</sup> For more details on Interdisciplinary Studies (IS) modules, please log on to [www.np.edu.sg/is/](http://www.np.edu.sg/is/)

#### IS Modules

The School of Interdisciplinary Studies (IS) delivers a broad-based curriculum, which nurtures a new generation of professionals with multidisciplinary skills and an innovative and entrepreneurial spirit to meet the challenges of a knowledge economy. IS offers both prescribed modules and electives to challenge boundaries. Prescribed modules develop students' competencies in core areas such as Communication, Innovation and Enterprise, Culture and Communication, and Personal Mastery and Development, while elective modules provide insights into Arts and Humanities, Business, Design, and Science and Technology.

## COURSE MODULES

### LEVEL 1.1

#### Mathematics

This module provides students with a fundamental and analytical knowledge of Mathematics essential for the study of life sciences. The module is designed to equip students with the necessary mathematical techniques to solve biological and chemical problems, as well as to

carry out analytical studies in their future work. Topics include analytical geometry, integration, differentiation and differential equations.

### Microbiology

This module introduces a basic understanding of microorganisms and techniques in microbiology. Topics include cell structure and function, classification, viruses and fungi, nutrition, growth and regulation, environmental factors affecting growth, microscopy, staining, size measurement, cell enumeration, media preparation, isolation and cultivation of pure cultures.

### Inorganic & Physical Chemistry

The module covers the structure of matter, chemical bonding, thermochemistry, chemical equilibria, kinetics, electrochemistry and redox reactions, transition metal chemistry, chemistry of solutions, including acids, bases and buffers.

### Physiology

This module provides a foundation for the second and third-year modules. It equips students with an understanding of the basic principles of homeostatic mechanisms and the cardiovascular, respiratory, renal, gastrointestinal, neuromuscular, endocrine and reproductive physiological systems that exist in the human body.

## LEVEL 1.2

### Organic Chemistry

In this module, students are introduced to the chemistry of hydrocarbons, alcohols, amines, aldehydes, ketones, carboxylic acids and their derivatives. The properties and chemical reactivity of these compounds in relation to the application of chemistry in life sciences will also be discussed.

### Cell Biology

This module explores mammalian cells, tissue and organ systems. Topics include the fundamental chemicals of life, structure and function of cells and organelles, cell division, cytogenetics and DNA replication, transcription and translation.

### Information Technology for the Life Sciences

This module aims to familiarise students with search engines and scientific databases. It equips students with the IT skills needed to effectively use the vast amount of information on the Internet. Students will learn to use their notebook PCs effectively for mobile computing, as well as to set up a home wireless network.

### Biostatistics

This module is designed to provide both a theoretical and an application-based foundation in statistical techniques. Topics include probability, descriptive analysis, sampling, regression analysis and analysis of variance. The use of computers and statistical software to solve problems will be emphasised.

## LEVEL 2.1

### Applied Microbiology

This module is a continuation of the basic microbiology module. The module covers topics in microbial growth and control, medical bacteriology, environmental microbiology, food microbiology and industrial microbiology.

### Immunology

This module introduces the fundamentals of immunology and provides an understanding of how the immune system functions as an integrated defence system. Topics include an overview of the immune system, innate and adaptive immunity, humoral and cell-mediated immunity, immunisation and vaccination, and laboratory immunological techniques. Applications of immunology in overcoming assaults on the immune system and the principles of Hybridoma Technology are also covered.

### Cell Culture & Bioprocess Engineering

This module equips students with strong aseptic techniques and an understanding of the application of cell cultures in bioprocess engineering. Topics include types of sterilisation methods, preparation of media, maintenance of cell cultures, understanding of microbial fermentation and downstream processing technology. Students will also acquire practical and theoretical knowledge of developing fermentation processes and manufacturing biological products.

## ELECTIVES

### Agrotechnology & Plant Tissue Culture

This module focuses on the modern technology relevant to intensive operations of commercial plant-related activities. It covers applied aspects of plant science, seed technology, protected cultivation, crop nutrition, soilless culture, integrated pest management, crop protection, post-harvest technology and agribusiness. Greenhouse laboratory-based practical work forms an integral part of the module. For plant cell culture, topics include the culturing of cells and tissues, micropropagation, protoplast culture and gene transfer.

### Aquaculture

The applied aspects of biotechnology in the aquaculture of finfish and shellfish are introduced. Topics include fish spawning, larval and nursery management, assessment of growth, fish nutrition, diagnosis and treatment of common fish diseases, aspects of water quality management and analysis, and an introduction to fish farm management.

## LEVEL 2.2

### Biochemistry

This module introduces fundamental and applied concepts in biochemistry. Topics covered include protein chemistry, enzymology, the metabolism of carbohydrates, lipids and proteins. Topics covered during laboratory classes will include spectrophotometric assays, determination of kinetic parameters of enzymatic reactions, thin layer chromatography, dialysis, size exclusion chromatography and polyacrylamide electrophoresis.

### Instrumentation & Analytical Chemistry

In this module, students learn about the workings of various analytical instruments such as gas liquid chromatography, high-performance and low-pressure liquid chromatography, mass spectrometry, and atomic absorption spectroscopy.

### Molecular Biology

This module highlights prokaryotic and eukaryotic genetics at the molecular level. Topics include protein synthesis, regulation of gene expression in microorganisms, gene mutation, DNA repair

mechanisms, and applications of gene manipulations in microorganisms. Also covered are generation and isolation of target DNA fragment, insertion of target DNA into vectors, transformation of *E. coli* competent cells, identification of recombinant clones, protein expression of target DNA, and the concept of how cells undergo apoptosis or become tumorous. Laboratory classes will provide students with skills in DNA extraction, cloning, DNA fingerprinting, PCR analysis, Southern blot analysis, Western blot analysis, and Protein expression and purification.

#### Bioinformatics

This module equips students with knowledge of the basic theory of bioinformatics and introduces tools and resources used in molecular bioinformatics.

#### LEVEL 3.1

##### Life Sciences Seminar Series

In this module, guest speakers are invited to discuss their current research topics and the latest technology and developments in the areas covered under the Advances in Genomics module. Students may also attend scientific forums organised by scientific societies and research institutes/universities.

#### Genomics

This module examines the theoretical basis of advances made in the field of genomics. These include transgenic animals, genetically modified foods, cloning in animals, molecular basis of development, human genome project, and applications of molecular biology in the diagnosis of diseases and in forensic science.

#### Proteomics

Proteomics concerns the study and analysis of proteins. This module focuses on protein detection, purification and identification, and application of proteomics. Protein purification includes extraction of proteins from different sources, and use of different types of chromatography and electrophoresis. Protein identification covers mass spectrometry, identification through peptide mass fingerprinting and peptide sequence, and use of appropriate software.

#### Project A/B

Students will work on a project in groups of two or

three in an area that is of interest to them, under the supervision of a staff member. They will start off with lectures on literature searches, basic laboratory safety, project management and statistical analysis of laboratory data, followed by practical work. During the course of their projects, students will acquire an in-depth knowledge and technical expertise that will prepare them for a working environment.

#### ENTREPRENEURSHIP OPTION

##### Biotech Innovations & Business Ventures

This module introduces biotech innovations and business ventures concepts with the aim of harnessing entrepreneurial skills and developing creativity and innovation in students. The module will introduce the principles involved in identifying life science products with commercialisation potential, and developing and commercialising the product. Practical aspects of the business cycle will be covered, including the protection of inventions, intellectual property management, formulation of a business plan, project evaluation, clinical trials, funding and business ventures, and financial and risk management.

##### Bioscience Sales & Marketing

The sales and marketing of scientific products is a multibillion dollar industry. This module provides an understanding of the sales and marketing functions in an organisation. The knowledge will prepare graduate to work in the sales and marketing of scientific products.

#### BIOPHARMACEUTICAL OPTION

##### Drug Discovery & Development

This module gives students a good understanding of the major approaches to drug discovery, application of molecular biology techniques to identifying lead compounds, methods for determining the pharmacological properties of compounds, regulatory requirements for drugs, and clinical evaluation of new drugs.

##### Biomanufacturing Practices

The module focuses on practices applied in the manufacturing of biological agents such as vaccines, biologic drugs and antibodies. Topics include an overview of biomanufacturing process operations,

quality assurance systems. Current Good Manufacturing Practices and quality control practices in the biopharmaceutical and pharmaceutical sectors.

#### FORENSIC MEDICINE OPTION

##### Drug Discovery & Development

This module gives students a good understanding of the major approaches to drug discovery, application of molecular biology techniques to identifying lead compounds, methods for determining the pharmacological properties of compounds, regulatory requirements for drugs, and clinical evaluation of new drugs.

##### Forensic Science

This module gives an insight into criminal law; an overview of the techniques employed by crime scene investigators and also examines the important aspects of forensic biology, toxicology and analysis. Through case studies, students will get a chance to read the minds of criminals in forensic psychology and crime scene reconstruction.

#### LEVEL 3.2

##### Four-month Internship

Students will undertake a four-month internship and project, giving them opportunities to relate and apply the knowledge acquired in classrooms to work situations and in research. They will be attached to research institutes and companies in various industries such as the pharmaceuticals, healthcare, food, agrotechnology and bioinformatics sectors. Students will also have the opportunity to go on overseas internships.

##### Project A/B

Students will work on a project in groups of two or three in an area that is of interest to them, under the supervision of a staff member. They will start off with lectures on literature searches, basic laboratory safety, project management and statistical analysis of laboratory data, followed by practical work. During the course of their projects, students will acquire an in-depth knowledge and technical expertise that will prepare them for a working environment.



# DIPLOMA IN PHARMACY SCIENCE (PHARM) 3-YEAR COURSE

In an exclusive partnership with the Department of Pharmacy of the National University Hospital (NUH), the **Diploma in Pharmacy Science (PHARM)** enables students to receive training and guidance from practising pharmacists, and exposure to activities in a teaching hospital with comprehensive services and state-of-the-art facilities.

Unlike other pharmacy-related courses that are skewed towards drug manufacturing, Ngee Ann Polytechnic students will have the benefit of broad-based training in a range of disciplines from medicinal chemistry, clinical biochemistry and pharmaceuticals, to drug discovery and clinical trials.

Students spend their final year at NUH, where relevant modules are taught by clinicians such as senior pharmacists and clinicians. They also work on a project conducted at NUH, and have the opportunity to choose elective modules like Complementary Medicine & Traditional Chinese Medicine or Nutraceuticals & Functional Foods.

## ENTRY REQUIREMENTS

To be eligible for consideration, candidates must have the following GCE 'O' Level examination (or equivalent) results:

Subject	'O' Level Grade
English Language*	1-7
Mathematics (Elementary/Additional)	1-6
Science (with Physics, Chemistry or Biology component) or Fundamentals of Electronics	1-6

You must also fulfil the aggregate computation requirements.

\* Candidates with English as a second language (EL2) must have attained a minimum grade of 6.

Candidates with colour appreciation deficiency should not apply for the course.

## CAREER PROSPECTS

The numerous government initiatives encouraging the growth of the pharmaceutical and biomedical industries, as well as the increasing need for healthcare services in Singapore, ensure good employment opportunities for our graduates.

PHARM graduates have a broad-based education in the chemical, biomedical and pharmaceutical sciences. In addition, they acquire relevant and specialised practical skills in the healthcare setting at NUH. PHARM graduates are well-equipped to work in a wide variety of jobs such as pharmaceutical and biomedical manufacturing, research and clinical trials, sales and marketing, and pharmacy practice in retail and hospital pharmacies.

## ACCREDITATION FOR FURTHER STUDIES

The strong foundation that PHARM students have in pharmacy practice and the pharmaceutical sciences give them a head-start when applying for courses in the pharmaceutical, pharmacy, biomedical sciences and other healthcare-related courses in universities around the world.

Well-known overseas universities such as the following will grant one to two years' exemption for three and four year degree courses:

- University of Queensland (Australia)
- University of Melbourne (Australia)
- Monash University (Australia)
- Royal Melbourne Institute of Technology (Australia)
- Massey University (New Zealand)
- University of Dundee (Scotland)

PHARM graduates can pursue a wide range of degree programmes offered by the National University of Singapore, Nanyang Technological University and the Singapore Management University. In addition to being able to apply for degree courses in Pharmacy, Chemistry and Biological Science, PHARM graduates can also apply to undertake degrees in a wide range of disciplines, including bioengineering, education, arts, architecture, dentistry, business, psychology and social sciences.

COURSE CURRICULUM	
Module Name	Credit Units
<b>YEAR 1</b>	
<b>Level 1.1 (25 hours per week)</b>	
Introduction to Pharmacy	7
Organic & Biological Chemistry	7
Cell & Molecular Biology	7
Idea Jumpstart <sup>^</sup>	2
Sports & Wellness <sup>^</sup>	2
<b>Level 1.2 (25 hours per week)</b>	
Anatomy & Physiology	7
Inorganic & Physical Chemistry	7
Information Technology for the Life Sciences	2
Mathematics & Statistics	5
Communication & Contemporary Issues <sup>^</sup>	4
<b>YEAR 2</b>	
<b>Level 2.1 (25 hours per week)</b>	
Microbiology & Infectious Diseases	6
Pharmacology	5
Clinical Biochemistry	4
Pharmaceutics	6
Interdisciplinary Studies (IS) Module <sup>^</sup>	2
Interdisciplinary Studies (IS) Module <sup>^</sup>	2
<b>Level 2.2 (25 hours per week)</b>	
Clinical Immunology	4.5
Pathology	3
Pharmaceutical Legislation & cGMP	3
Medicinal Chemistry & Drug Discovery	4.5

Module Name	Credit Units
Pharmaceutical Analysis	6
Idea Blueprint <sup>^</sup>	2
Idea Launchpad <sup>^</sup>	2
<b>YEAR 3</b>	
<b>Level 3.1 (32 hours per week)</b>	
Clinical Pharmacy	8
Pharmacotherapeutics	9
Clinical Trials Management	4
Research Project A	7
World Issues: A Singapore Perspective <sup>^</sup>	2
Interdisciplinary Studies (IS) Module <sup>^</sup>	2
<b>Level 3.2 (32 hours per week)</b>	
Pharmacy Practice	8
Pharmacy Management & Logistics	8
Aseptic Dispensing & Compounding	5
Research Project B	7
<b>Electives</b>	
Complementary Medicine & Traditional Chinese Medicine (TCM)	4
Nutraceuticals & Functional Foods	4
<b>Notes:</b>	
Levels 1 and 2 will be conducted at Ngee Ann Polytechnic. Level 3 will be conducted at NUH. Students will be at NUH four days a week (9am- 5pm). They will return to Ngee Ann Polytechnic one day of the week to undertake the IS /Elective modules. Research Projects A and B will be conducted at NUH.	
<sup>^</sup> For more details on Interdisciplinary Studies (IS) modules, please log on to <a href="http://www.np.edu.sg/is/">www.np.edu.sg/is/</a>	
<b>IS Modules</b>	
The School of Interdisciplinary Studies (IS) delivers a broad-based curriculum, which nurtures a new generation of professionals with multidisciplinary skills and an innovative and entrepreneurial spirit to meet the challenges of a knowledge economy. IS offers both prescribed modules and electives to challenge boundaries. Prescribed modules develop students' competencies in core areas such as Communication, Innovation and Enterprise, Culture and Communication, and Personal Mastery and Development, while elective modules provide insights into Arts and Humanities, Business, Design, and Science and Technology.	

## COURSE MODULES

### LEVEL 1.1

#### Introduction to Pharmacy

This module introduces students to pharmaceuticals and the roles, responsibilities, job scope and future of pharmacists and pharmacy technicians. It provides a foundation for subsequent modules in the course. Introductory topics in pharmacology, pharmaceutical science and pharmaceuticals will be covered, and students will learn to perform pharmaceutical calculations to determine dosages.

#### Organic & Biological Chemistry

In this module, students are introduced to the chemistry of hydrocarbons, alcohols, amines, aldehydes, ketones, carboxylic acids and their derivatives. The structures, functions and chemical reactions of biological molecules, including carbohydrates, lipids and proteins and their derivatives are also covered.

#### Cell & Molecular Biology

This module explores mammalian cells, tissue and organ systems, and prokaryotic and eukaryotic genetics at the molecular level. Topics include the fundamental chemicals of life, structure and the function of cells and organelles, cell division, cytogenetics, DNA structure, replication, transcription, and translation, protein synthesis, gene mutation, cell communication, mitosis and meiosis, genetics and hereditary, apoptosis and cancer.

### LEVEL 1.2

#### Anatomy & Physiology

This module introduces the anatomy and functions of the human body. It equips students with an understanding of the anatomy and physiology of the cardiovascular, respiratory, renal, gastrointestinal, neuromuscular, skeletal, endocrine and reproductive systems.

### Inorganic & Physical Chemistry

The module covers the structure of matter, chemical bonding, thermochemistry, chemical equilibria, kinetics, electrochemistry and redox reactions, transition metal chemistry, and chemistry of solutions, including acids, bases and buffers, polarity and solubility.

### Information Technology for the Life Sciences

In this hands-on module, students will be introduced to the field of IT. It will equip them with a working knowledge of basic computer system, spreadsheets, business presentations and database management system.

### Mathematics & Statistics

This module provides students with a fundamental analytical knowledge of Mathematics and Statistics essential for working in the pharmaceutical industry. Topics include a review of basic algebra, differentiation and integration. The module will also cover error analysis, probability, distribution, hypothesis testing, sampling, and application of computers and software in statistical analysis.

## LEVEL 2.1

### Microbiology & Infectious Diseases

This module studies medical microbiology, microbial pathogenesis and antimicrobial therapy. The module covers fundamental information regarding microorganisms, specifically pathogenic bacteria, fungi and viruses. Topics include mechanism of disease production, antibiotic resistance, emerging pathogens, contamination, sterilisation and disinfection, infection control, methods of treatment and prevention of disease.

### Pharmacology

This module covers the basic principles of pharmacology, the mechanism of drug action, dose response relation, adverse reaction, pharmacokinetics (absorption, distribution, metabolism, elimination) and major drug classes.

### Clinical Biochemistry

This module expands on the basic biochemical concepts taught in earlier modules and allows students to better understand the biochemical processes in the human body systems. The application of core biochemistry knowledge to the diagnosis and treatment of diseases in clinical practice is covered.

### Pharmaceutics

This module focuses on the design and formulation of two-phase pharmaceutical products, including suspensions, emulsions and solid pharmaceutical products, and how they relate to absorption and drug delivery routes. Topics include drug formulations, preparation and dispensing of pharmaceuticals, introduction to biopharmaceutics, pharmacokinetics, bioavailability, specialised dosage forms, prodrugs, liposomes, targeted drug delivery, drug stability of various formulations and shelf life.

## LEVEL 2.2

### Clinical Immunology

This module introduces students to the fundamentals of immunology. The module will provide an understanding of how the immune system functions. Topics include an overview of the immune system, innate and adaptive immunity, humoral and cell-mediated immunity, immunisation, vaccination, laboratory immunological techniques, diseases of the immune system and antibody-based therapies.

### Pathology

This module helps students to understand the causes and mechanisms of disease. Students will learn about disease processes affecting common organ systems. The mechanisms of disease, natural history and progression and implications for treatment and prevention will be discussed.

### Pharmacy Legislation & cGMP

This module surveys the various legislations such as the Medicines Act and the Sale of Drugs Act, with

emphasis on their applications in the various industries. Guidelines on the control of Traditional Chinese Medicines, cosmetics and health supplements, as well as Good Pharmacy Practice, Good Distribution Practice and the Code of Marketing will also be discussed. The second part of this module aims to equip students with an understanding of current Good Manufacturing Practice regulations for pharmaceuticals.

### Medicinal Chemistry & Drug Discovery

The first part of this module highlights the drug discovery process and how compounds are identified and developed into drugs. The second part of the module introduces students to the chemistry of drugs and drug systems, with particular emphasis on heterocyclic chemistry and the major drug classes. They will also learn about the relationship between activity and functional group chemistry, and drug design.

### Pharmaceutical Analysis

This module studies modern analytical techniques that are used for the detection, identification and quantitative determination of drugs and related substances. Techniques for the evaluation of analytical data and validation of analytical methods will be discussed.

## LEVEL 3.1

### Clinical Pharmacy

This module introduces the rational selection and the use and effects of drugs on individual patients and patient groups. Students will learn the application of quantitative clinical data in the optimisation of drug therapy, as well as pertinent clinical therapeutic material that enables them to optimise patient therapies in a wide range of disorders.

### Pharmacotherapeutics

This module highlights the use of drugs in the treatment of diseases as well as the biochemical and physiologic effects of drugs and their mechanisms of action. Students will learn how drugs are evaluated, the mechanism by which drugs act, and their side effects.

### Clinical Trials Management

This module equips students with an understanding of the fundamentals of clinical research and clinical trial management. Students will learn the different phases of clinical trials, types of study designs used and different elements of the clinical trial protocol. Good clinical practice, ethics, regulatory compliance, clinical trial implementation, data management, quality management and financial management will also be discussed.

### Research Project A

In this module, students will undertake a research project at NUH related to topics covered in the course.

## LEVEL 3.2

### Pharmacy Practice

This module equips students with effective communication skills for interacting with patients, caregivers and other health professionals. Topics include how to respond to patients, crisis intervention, dealing with people from culturally diverse backgrounds, dealing with grief and loss, and patient education. Good pharmacy practice relating to the dispensing and reformulation of commercial pharmaceutical products will also be discussed, as well as the Code of Ethics, and the impact of legal and ethical issues on drug management.

### Pharmacy Management & Logistics

This module focuses on business aspects of the operation of hospital and retail pharmacies. Topics include procurement, logistics and inventory management, business automation, marketing and principles of finance pertaining to the operations of a pharmacy.

### Aseptic Dispensing & Compounding

This module provides students with the basic skills used in the pharmacy compounding laboratory. This includes an understanding of the techniques, calculations, facilities and quality control and assurance

in aseptic dispensing. Students will learn to prepare total parenteral and enteral nutrition, IV admixtures and cytotoxic drug preparation, and will be given hands-on experience in compounding different types of extemporaneous preparations.

### Research Project B

In this module, students will undertake a research project at NUH related to topics covered in their course.

## ELECTIVES

### Complementary Medicine & Traditional Chinese Medicine (TCM)

This module describes how philosophies of alternative medicines and therapies are used to complement those of conventional medicine. The mechanism of

action, dosage forms and pharmacological aspects of selected complementary medicines and traditional Chinese medicines will be covered, including the responsibilities associated with the sale and marketing of complementary medicines.

### Nutraceuticals & Functional Foods

This module deals with therapeutic options marketed for use without a prescription. Students will learn about the properties, mechanisms of action, philosophical differences, principles of therapy, regulations, potency issues, and interactions related to nutraceuticals and functional foods, as well as the responsibilities associated with the sale and marketing of such therapies.





## DIPLOMA IN VETERINARY BIOSCIENCE (VBS) 3-YEAR COURSE

The **Diploma in Veterinary Bioscience (VBS)** is a unique course that combines the strengths of both bioscience and veterinary science disciplines. This course prepares students for a wide array of interesting careers.

In the biomedical science sector, animal models enable researchers to study human diseases more effectively. They are critical for the development of new medicines and therapeutics. Students will be trained to properly care for, handle and manage laboratory animals.

With the growth of pet ownership, there is an increasing need for animal care. VBS graduates may assist veterinarians in medical examinations and treatments, vaccinations, and surgical procedures.

Students will learn about the maintenance, health and well-being of laboratory animals as well as about how veterinary immunology and pharmacology are important in the clinical diagnosis and treatment of animal diseases. This course also covers the essential elements of a life science programme and provides an excellent pathway for students to enter a career in biomedical research.

In their final year, students will undergo a four-month internship either locally or overseas. They will be attached to research laboratories, veterinary clinics or animal theme parks (such as the Singapore Zoo and Jurong Bird Park). Students will also carry out a final year research project.

### ENTRY REQUIREMENTS

To be eligible for consideration, candidates must have the following GCE 'O' Level examination (or equivalent) results:

Subject	'O' Level Grade
English Language*	1-7
Mathematics (Elementary/Additional)	1-6
Science (with Physics, Chemistry or Biology component) or Fundamentals of Electronics	1-6

You must also fulfil the aggregate computation requirements.

\* Candidates with English as a second language (EL2) must have attained a minimum grade of 6.

### CAREER PROSPECTS

With the growing importance of translational medicine in the biomedical sector, increasing pet ownership and the continued development of animal theme parks, VBS graduates can find employment in a wide range of jobs. VBS graduates can work as research assistants in research institutions and university laboratories, or work as veterinary bioscientists in animal research facilities and pre-clinical trial centres. VBS graduates can also be employed as veterinary assistants in veterinary clinics and animal hospitals.

VBS graduates can also work in animal welfare organisations (such as the SPCA), animal theme parks (such as the Singapore Zoo, Jurong Bird Park, Night Safari, and UnderWater World), and equine establishments (such as the Singapore Polo Club). Other employers include animal-related businesses (such as pet shops, pet hotels and pet supply companies) as well as government agencies (such as the Agri-food and Veterinary Authority).

## ACCREDITATION FOR FURTHER STUDIES

VBS graduates can be accepted into biological science and biomedical science degrees offered by both local and overseas universities if they wish to pursue careers in the life sciences and do research.

They can also become veterinarians by enrolling into Veterinary Medicine programmes offered by universities in Australia, New Zealand, UK, Canada and the USA. Murdoch University (Australia) currently offers VBS graduates (who have attained a GPA of at least 3.8) a one year exemption into their Bachelor of Veterinary Medicine & Surgery programme.

## COURSE CURRICULUM

Module Name	Credit Units
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### YEAR 1

#### Level 1.1 (27.5 hours per week)

Veterinary Microbiology	7
Inorganic & Physical Chemistry	7
Animal Anatomy & Physiology	6
Animal Nutrition	3.5
Idea Jumpstart <sup>^</sup>	2
Sports & Wellness <sup>^</sup>	2

#### Level 1.2 (27.5 hours per week)

Cell Biology	7
Organic & Biological Chemistry	7
Animal Welfare, Behaviour & Handling	4.5
Wildlife Conservation & Biodiversity	1
Biostatistics	4
Communication & Contemporary Issues <sup>^</sup>	4

### YEAR 2

#### Level 2.1 (25 hours per week)

Veterinary Immunology	6.5
Cell Culture & Tissue Applications	5
Aquaculture & Fish Diseases	5
Veterinary Pharmacology & Toxicology	4.5
Interdisciplinary Studies (IS) Module <sup>^</sup>	2
Interdisciplinary Studies (IS) Module <sup>^</sup>	2

Module Name	Credit Units
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#### Level 2.2 (26 hours per week)

Molecular Biology	6.5
Bioinformatics	2
Animal Diseases & Pathology	6.5
Clinical Diagnostics, Surgical & Veterinary Practices	4.5
Animal Developmental Biology & Genetics	2.5
Idea Blueprint <sup>^</sup>	2
Idea Launchpad <sup>^</sup>	2

### YEAR 3

#### Level 3.1 (25.5 hours per week)

Genomics	1.5
Proteomics	6
Animal Husbandry & Breeding	3.5
Preclinical & Clinical Trials	2.5
Project A/B	8
World Issues: A Singapore Perspective <sup>^</sup>	2
Interdisciplinary Studies (IS) Module <sup>^</sup>	2

#### Level 3.2 (24 hours per week)

Project A/B	8
Internship Programme (4 months)	16

### Notes:

<sup>^</sup> For more details on Interdisciplinary Studies (IS) modules, please log on to [www.np.edu.sg/is/](http://www.np.edu.sg/is/)

### IS Modules

The School of Interdisciplinary Studies (IS) delivers a broad-based curriculum, which nurtures a new generation of professionals with multidisciplinary skills and an innovative and entrepreneurial spirit to meet the challenges of a knowledge economy. IS offers both prescribed modules and electives to challenge boundaries. Prescribed modules develop students' competencies in core areas such as Communication, Innovation and Enterprise, Culture and Communication, and Personal Mastery and Development, while elective modules provide insights into Arts and Humanities, Business, Design, and Science and Technology.

## COURSE MODULES

### LEVEL 1.1

#### Veterinary Microbiology

This module provides students with a basic understanding of microorganisms and techniques in veterinary microbiology. Topics include cell structure and function, classification, viruses and fungi, nutrition, growth and regulation, environmental factors affecting growth, microscopy, staining, size measurement, cell enumeration, media preparation, isolation and cultivation of pure cultures.

#### Inorganic & Physical Chemistry

This module introduces students to aspects of inorganic and physical chemistry. Topics covered comprise the structure of matter, chemical bonding, thermochemistry, chemical equilibria, kinetics, electrochemistry, redox reactions, transition metal chemistry, and chemistry of solutions including acids, bases and buffers.

#### Animal Anatomy & Physiology

This module introduces the anatomy and functions of the animal body. It equips students with an understanding of the anatomy and physiology of the integumentary, musculoskeletal, respiratory, cardiovascular, gastrointestinal, urinary, reproductive, nervous and endocrine systems.

#### Animal Nutrition

This module focuses on animal nutrition and its importance for the growth and well being of laboratory, domesticated and farm animals. The module will provide knowledge on the feed milling processes and the evaluation methods used for the measuring of nutrients in feed rations. The use of raw ingredients in the formulation of commercial feed and the regulatory procedures involved to ensure safe production of animal feed will also be discussed.

**LEVEL 1.2****Cell Biology**

This module explores mammalian cells, tissue and organ systems, and prokaryotic and eukaryotic genetics at the molecular level. Topics include the fundamental chemicals of life, structure and the function of cells and organelles, DNA structure, replication, transcription and translation, protein synthesis, gene mutation, cell communication, cell division (mitosis and meiosis), genetics and hereditary, apoptosis and cancer.

**Organic & Biological Chemistry**

This module gives students a strong foundation in basic organic chemistry. Topics include the IUPAC nomenclature, structural formulas, preparations and reactions of the main classes of organic compounds namely alkanes, alkenes, alkynes, benzene, alcohols, thiols, ether, aldehydes, ketones, amines, carboxylic acids and derivatives.

**Animal Welfare, Behaviour & Handling**

In this module, students will learn about the proper care and handling of domestic animals, including the responsible care and use of laboratory animals for research purposes. This module also covers the fundamental principles underlying animal behaviour and the basic principles of animal welfare.

**Wildlife Conservation & Biodiversity**

This module covers aspects of biodiversity conservation, and discusses how biodiversity is generated and maintained. It will also address issues such as how we can manage and restore habitats and develop strategies for the conservation of species threatened with extinction.

**Biostatistics**

This module is designed to provide both a theoretical and an application based foundation in statistical techniques. Topics include descriptive analysis, probability, sampling, regression analysis and hypothesis testing. Microsoft Excel will be introduced as a tool to solve statistical problems.

**LEVEL 2.1****Veterinary Immunology**

This module introduces students to the fundamentals of immunology and provides an understanding of how the immune system functions as an integrated defence system against disease. Topics include an overview of the immune system of vertebrates, innate and adaptive immunity, humoral and cell-mediated immunity, immunisation, vaccination, laboratory immunological techniques, diseases of the immune system and antibody-based therapies.

**Cell Culture & Tissue Applications**

This module is a detailed study of the techniques used in the culturing of cells and tissues. Topics include the preparation of media, cell viability checks, passaging of inherent cells, cryopreservation, cloning and mycoplasma assays. Applications of animal cell culture, tissue engineering and rapid prototyping are also covered.

**Aquaculture & Fish Diseases**

This module covers fish spawning, larval and nursery management, assessment of growth, fish nutrition, and the diagnosis and treatment of common fish diseases. Aspects of water quality analysis and fish farm management will also be introduced.

**Veterinary Pharmacology & Toxicology**

This module covers the basic principles of veterinary pharmacology, pharmacodynamics, pharmacokinetics (absorption, distribution, metabolism, elimination), the major drug classes and an introduction to toxicology.

**LEVEL 2.2****Molecular Biology**

This module highlights prokaryotic and eukaryotic genetics at the molecular level. Topics include DNA structure and replication, mRNA transcription, protein synthesis, regulation of gene expression, gene mutation and DNA repair mechanisms and regulation of cell cycle and apoptosis. In the area of recombinant DNA

technology and molecular techniques, students will learn about the isolation of genomic and plasmid DNA, polymerase chain reaction, insertion of target DNA into cloning vector, transformation of *E. coli* competent cells, identification of recombinant clones, isolation of total RNA and SDS-PAGE analysis of proteins.

**Bioinformatics**

This module equips students with the knowledge of the basic theory of bioinformatics, and introduces tools and resources used in molecular bioinformatics.

**Animal Diseases & Pathology**

This module will train students in the skills necessary for the investigation, prevention and control of animal diseases. The module will cover common veterinary bacterial, fungal, viral and parasitic diseases and their agents. The study of pathogenic mechanisms and the morphological aspects of disease will also be covered. Emphasis will be given to common diseases affecting small laboratory animals.

**Clinical Diagnostics, Surgical & Veterinary Practices**

This module covers introductory clinical diagnostics and basic surgical techniques. Students will be taught how to handle clinical samples, prepare and examine skin scrapings, fecal samples, bacteriological and urine samples, and carry out elementary haematology analysis. They will also learn to perform histological sections and stain tissues for diagnostic purposes. Students will be introduced to the peri-operative preparation of an animal for surgery, monitoring of an animal during surgery, and surgical instrumentation. Management of a veterinary practice will also be briefly covered.

**Animal Developmental Biology & Genetics**

This module discusses developmental biology and genetics approaches to understanding animal embryonic development, and genes that are involved in body plan formation and morphogenesis. Other topics discussed include the pattern of inheritance, mutation, and roles of genes and environmental factors in relation to animal health.

### LEVEL 3.1

#### Genomics

This module examines the advances made in the field of genomics. These include transgenic animals, cloning in animals, molecular basis of development, human and animal genome projects, and applications of molecular biology in the diagnosis of diseases.

#### Proteomics

Proteomics concerns the study and analysis of proteins. This module focuses on protein detection, purification and identification, and application of proteomics. Protein purification includes extraction of proteins from different sources, and use of different types of chromatography and electrophoresis. Protein identification covers mass spectrometry, identification through peptide mass fingerprinting and peptide sequence, and use of appropriate software.

#### Animal Husbandry & Breeding

This module covers the essentials of farming practice, particularly the breeding and raising of livestock. The impact of genetics on breeding and the selection of desirable heritable traits will be discussed. Techniques which are used to improve herd genetics, such as artificial insemination and embryo transfer, will also be discussed.

#### Preclinical & Clinical Trials

This module equips students with an understanding on use of cell culture and animals in preclinical trials and the fundamentals of clinical research and clinical trial management. The use of biostatistics and the biostatistics software in the analyses of pre-clinical and clinical trials data will also be emphasised.

### LEVEL 3.2

#### Internship (4 months)

Students will undergo a four-month internship programme and project, giving them opportunities to relate and apply the knowledge acquired in classrooms

to work situations and in research. They will be attached to research institutes and companies in various industries such as the biomedical, pharmaceuticals, clinical trials, bioinformatics sectors, animal shelters, pet shops, vet clinics and veterinary regulatory bodies.

#### Final Year Research Project (A/B)

In Project A, students will work on a project in groups of two in an area that is of interest to them, under the supervision of a staff member. They will start off

with lectures on literature searches, basic laboratory safety, project management and statistical analysis of data, followed by practical work. In the course of their projects, students will acquire an in-depth knowledge and technical expertise that will prepare them for a working environment. In Project B, students will continue their work on their project. They will submit a final year report and present their project through posters and oral presentations.

