

## **COURSE MODULES**

### **LEVEL 1.1**

#### **Career & Professional Preparation I**

This module is part of the Education and Career Guidance framework to provide students with the tools and resources necessary for their career and/ or further education. In this first module, students will undergo personal discovery and exploration of industry and career prospects. Students will learn on how they can plan and set achievable goals in preparation for their future. Students will also learn the importance of passion and professionalism, and basic teamwork and interpersonal skills.

#### **Inorganic & Physical Chemistry**

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

#### **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, logarithmic functions, 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.

### **LEVEL 1.2**

#### **Anatomy & Physiology**

This module 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. It also covers the basic skeletal system and anatomy.

#### **Biostatistics**

This module is designed to provide students with basic statistical skills to analyse and interpret simple biological, pre-clinical and clinical data. The basic statistical skills covered are descriptive statistics, data distribution, set sample size, measurement of central tendency, scatter diagram, cluster analysis, and simple linear correlation and regression analysis for linear data. The presentation of data in graphical forms using Microsoft Excel covers selection and preparation of different types of graphs, how to write titles and legends, and interpretation of results and draw conclusions.

#### **Cell Biology & Genetics**

This module explores mammalian cells, tissue and organ systems. Topics include the fundamental chemicals of life, structure and function of cells and organelles, membrane trafficking, cell cycle and division, study of genes, genetic variation and heredity.

#### **Good Laboratory Practice**

Good laboratory practice comprises a set of principles that helps to define and standardise the planning, performance monitoring, recording, reporting, and archiving processes within research institutions and commercial testing laboratories. The module covers standard operating procedures, quality assurance programme, receipt and handling

of samples, monitoring performance of the study, reporting of study results, and retention of records. Compliance to GLP regulations will also be covered.

### 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.

## COURSE CURRICULUM

Module Name	Credit Units
<b>YEAR 1</b>	
<b>Level 1.1 (24.5 hours per week)</b>	
Career & Professional Preparation I	1.5
Inorganic & Physical Chemistry	6
Mathematics	5
Microbiology	6
Innovation Toolkit ^	4
Sports & Wellness ^	2
<b>Level 1.2 (25 hours per week)</b>	
Anatomy and Physiology	4
Biostatistics	3
Cell Biology and Genetics	6
Good Laboratory Practice	2
Organic Chemistry	6
Critical Thinking and Communication ^	4
At the end of their first year, students will select <u>one</u> of two specialisation options: <b>Biomedical Research</b> or <b>Clinical Laboratory Technology</b> .	

### Notes:

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

### IS Modules

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## COURSE MODULES

### BIOMEDICAL RESEARCH SPECIALISATION OPTION

#### LEVEL 2.1

### **Career & Professional Preparation II**

This module is part of the Education and Career Guidance framework to provide students with the tools and resources necessary for their further career and/ or education. In this module, students will explore basic job search strategies, practise the writing of effective resumes and cover letters, and learn interview skills. Students will also learn professional and intercultural communication skills to prepare them for a dynamic and diverse workplace.

### **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.

### **Immunology and Immunological Techniques**

This module introduces the fundamentals of immunology and provides an understanding of how the immune system functions as an integrated defense system against disease. Topics include an overview of the innate and adaptive immunity, humoral and cell mediated immunity, immunisation and vaccination.

Also covered are the applications of immunological techniques in research and clinical diagnostic laboratories.

### **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 institutions, and covers three major areas of protein chemistry, enzymology and metabolism.

### **Medical Microbiology**

This module is a continuation of the first-year microbiology module. The module covers how microorganisms spread and cause disease in humans, properties of the infectious agents, principles of the laboratory diagnosis, and management of infection including the strategies for prevention of infection.

## **LEVEL 2.2**

### **Advanced Organic Chemistry**

This module covers basic organic reaction mechanisms like nucleophilic substitution (SN2 and SN1 mechanisms), elimination (E1 and E2 mechanisms), electrophilic addition and electrophilic aromatic substitution, nucleophilic substitution mechanisms e.g. esterification, reactions of enols and enolates e.g. alkylation, aldol, Claisen reaction. This module will also cover basic strategies in organic synthesis.

### **Analytical & Separation Chemistry**

This module covers various instruments which are used in analytical chemistry/biochemistry with the emphasis on their practical use. Students will study the workings of the UV-Vis, HPLC (including IEX, gel filtration, affinity chromatography), capillary and gel electrophoresis. This module will also cover the interpretation of mass spectrometry as applied to small molecules and proteins; proton and <sup>13</sup>C-NMR, infra-red spectroscopy in the structural elucidation of organic molecules.

### **Applied Biostatistics**

This module covers advanced statistical skills to analyse and interpret a wide range of biological, pre-clinical and clinical data, and preparation of data for scientific presentation. The statistical skills covered are biological experiment design, hypothesis testing, quantitative data analysis by parametric and non-parametric methods, qualitative data analysis by Chi-square and Fisher tests, and simple correlation & regression analysis for non-linear data. The scientific presentation section covers how to organise data, prepare and incorporate statistical results on graphs and interpretation of results.

### **Molecular Biology**

This module covers the fundamentals of molecular biology. Topics include DNA structure and replication, mRNA transcription, protein synthesis, regulation of gene expression in microorganisms, gene mutation and DNA repair mechanisms. 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 gel electrophoresis. Students will be introduced to basic bioinformatics software for analysis of nucleic acid and protein sequences.

## **ELECTIVES**

Choose any 1

### **Biopharmaceutical Analysis**

This module is designed to equip students with knowledge and molecular techniques that are used to analyse raw materials and biological products. Topics include an overview on biologics production using microbial and mammalian systems, detection of adventitious agents in biological products using quantitative PCR (qPCR), endotoxin and pyrogen testing, bioburden test, and detection of residual host cell proteins using enzyme linked immunosorbent assay (HCP-ELISA). An overview on pharmaceutical law and regulatory landscape will also be covered.

### **Pathology**

This module covers an introduction to pathology, the causes and mechanisms of diseases, characterization and diagnosis of diseases, and treatment and prevention of diseases.

### **Toxicology & Pharmacology**

This module covers the basic principles of pharmacology, pharmacodynamics, pharmacokinetics (absorption, distribution, metabolism, and elimination), the major drug classes and an introduction to toxicology. Students will also be introduced to the various methods in determining drug toxicity and efficacy in vitro drug testing.

## **CLINICAL LABORATORY TECHNOLOGY SPECIALISATION OPTION**

Students undergo a two-year Integrated Clinical Laboratory Training Programme (ICLTP) conducted in collaboration with the National University Hospital. Students will receive additional certification in phlebotomy.

## **LEVEL 2.1**

### **Advanced Topics in Biomedical Science**

This module covers basic immunology, metabolic biochemistry and molecular biology. In immunology, the coverage is on the components and functions of the immune system. Metabolic biochemistry introduces fundamental concepts in enzymology and carbohydrate metabolism. Molecular biology will cover introduction to prokaryotic and eukaryotic molecular biology, gene manipulations and protein expressions.

### **Career & Professional Preparation II**

This module is part of the Education and Career Guidance framework to provide students with the tools and resources necessary for their further career and/ or education. In this module, students will explore basic job search strategies, practice writing of effective resumes and cover letters, and learn interview skills. Students will also learn professional and intercultural communication skills to prepare them for a dynamic and diverse workplace.

### **Laboratory Techniques in Clinical Chemistry**

This module covers the principles of protein separation techniques, immuno-nephelometry, immuno-turbidimetric analysis, chromatographic techniques, therapeutic drug analyses, immunochemical techniques, blood gas analysis and diagnostic procedures for hormonal testing.

### **Laboratory Techniques in Clinical Haematology**

This is an introductory module with emphasis on basic instrumentation and diagnostic procedure performed in Blood Bank and Haematology laboratory. Students will learn about the principles, procedures and interpretation of manual and automated analyzer results.

### **Laboratory Techniques in Clinical Microbiology**

This module aims to demonstrate the daily routines of a microbiology laboratory serving a public hospital. Students should take note of the essential skills such as aseptic techniques, medium preparation, urinalysis, diagnostics methods for parasitology and virology.

## **LEVEL 2.2**

### **Applied Biostatistics**

This module covers advanced statistical skills to analyse and interpret a wide range of biological, pre-clinical and clinical data, and preparation of data for scientific presentation. The statistical skills covered are biological experiment design, hypothesis testing, quantitative data analysis by parametric and non-parametric methods, qualitative data analysis by Chi-square and Fisher tests, and simple correlation & regression analysis for non-linear data. The scientific presentation section covers how to organise data, prepare and incorporate statistical results on graphs and interpretation of results.

### **Clinical Chemistry 1**

This module focuses on basic biochemical pathways such as glucose metabolism and diseases, water and ion metabolism, liver metabolism, plasma proteins as well as their related laboratory tests. Basic pathology and pathogenesis of diseases include cell injury, cell death, inflammation and neoplasia will also be covered.

### **Clinical Haematology 1**

This module covers the theory and principle of morphologic alterations in blood cells, various blood cell disorders, pediatrics hematology and 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.

### **Clinical Microbiology 1**

This module aims to provide students with more in- depth microbiological knowledge. Students will also learn about tuberculosis diagnostic tests and non- culture based investigations such as serology. In terms of theoretical knowledge, students are expected to be familiar with pathogen laboratory characteristics and identification, as well as relating specific pathogens to clinically important diseases.

## COURSE CURRICULUM

Module Name	Credit Units
<b>YEAR 2</b>	
<b>BIOMEDICAL RESEARCH SPECIALISATION OPTION</b>	
<b>Level 2.1 (27 hours per week)</b>	
Career & Professional Preparation II	2
Cell Culture & Tissue Applications	5
Immunology & Immunological Techniques	6
Medical Biochemistry	6
Medical Microbiology	6
Interdisciplinary Studies (IS) elective ^	2
<b>Level 2.2 (25 hours per week)</b>	
Advanced Organic Chemistry	4
Analytical & Separation Chemistry	6
Applied Biostatistics	4
Molecular Biology	6
Elective (Choose 1):	
• Biopharmaceutical Analysis	4
• Pathology	4
• Toxicology and Pharmacology	4
<b>CLINICAL LABORATORY TECHNOLOGY SPECIALISATION OPTION</b>	
<b>Level 2.1 (27 hours per week)</b>	
Advanced Topics in Biomedical Science	4
Career & Professional Preparation II	2
Laboratory Techniques in Clinical Chemistry	7
Laboratory Techniques in Clinical Haematology	7
Laboratory Techniques in Clinical Microbiology	7
<b>Level 2.2 (25 hours per week)</b>	
Applied Biostatistics	4
Clinical Chemistry 1	7
Clinical Haematology 1	7
Clinical Microbiology 1	7

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## **COURSE MODULES**

### **BIOMEDICAL RESEARCH SPECIALISATION OPTION**

#### **LEVEL 3.1**

##### **Bioinformatics**

This module equips students with essential bioinformatics computational skills. Topics include an overview of biological informatics, microarray, protein structure prediction and structural databases, finding conserved motifs and patterns in protein using online databases, and applications of software tools and resources in gene expression data analysis.

##### **Capstone Project**

Students will complete a final year research project under the guidance of an academic staff or industry mentor. The Capstone Project can cover any of the key areas in life science research including Molecular Biosciences, Industrial Biotechnology, Food Technology, Aquatic Science & Technology, Environmental Technology and Urban Horticulture and Greenscape.

Students will be able to integrate and apply the knowledge and skills learned from the course. They will be involved in report writing as well as presenting the outcomes of the project in poster and oral presentations. The Capstone Project will further strengthen their writing and communication skills as well as analytical and problem solving skills, thus preparing them for the industry or further studies.

##### **Drug Discovery & Clinical Trials**

This module will introduce students to the drug discovery processes, the relationship between activity and functional group chemistry, chemistry of drugs and drug systems. The module also covers the role, composition and authority of Institutional Review Board (IRB), the phases of clinical trials, informed consent, ethical issues in clinical trials, and compliance to regulations.

##### **Genomics & Proteomics**

This module provides an insight into the fields of proteomics and genomics. Students will study the functions of genes and their interaction within a genome, the human genome project, genetically modified organisms and gene therapy, protein expression with emphasis on the structure and functions of proteins and methods of purification and analyses of proteins and applications of proteomics.

##### **Nutrition & Dietetic Science**

This module provides students with a basic understanding of nutritional and dietetic concepts, including the role of micro and macronutrients in the diet and their effects on health. Principles of clinical nutrition and dietary requirements for special medical conditions and at different life stages will also be covered. Students will also learn to evaluate the evidence behind the use of common nutraceuticals and functional foods for health benefits as well as the regulations associated with the sales and marketing of such therapies.

##### **Pharmaceutical Analysis**

This module is designed to introduce students to the chemical analysis of raw materials and final pharmaceutical products. It also covers the sample preparation and separation techniques as well as analytical methods. Topics include chemical analysis on active pharmaceutical ingredients (APIs), detection of heavy metals, stability test, purity test, sample preparation using various extraction methods, limit test, and test for extractables and leachables.

##### **Translational Medicine**

This module builds on the previous modules taken in the first and second year of the Biomedical Science course. Upon completion of this module, students will be able to appreciate the difference between basic and clinical research and apply the knowledge learnt in conducting translation research.

#### **LEVEL 3.2**

#### **4-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 and bioinformatics sectors. Students will also have the opportunity to go on overseas internships.

#### **Capstone Project**

Students will complete a final year research project under the guidance of an academic staff or industry mentor. The Capstone Project can cover any of the key areas in life science research including Molecular Biosciences, Industrial Biotechnology, Food Technology, Aquatic Science & Technology, Environmental Technology and Urban Horticulture and Greenscape.

Students will be able to integrate and apply the knowledge and skills learned from the course. They will be involved in report writing as well as presenting the outcomes of the project in poster and oral presentations. The Capstone Project will further strengthen their writing and communication skills as well as analytical and problem solving skills, thus preparing them for the industry or further studies.

### **CLINICAL LABORATORY TECHNOLOGY SPECIALISATION OPTION**

#### **LEVEL 3.1**

##### **Bioinformatics**

This module equips students with essential bioinformatics computational skills. Topics include an overview of biological informatics, microarray, protein structure prediction and structural databases, finding conserved motifs and patterns in protein using online databases, and applications of software tools and resources in gene expression data analysis

##### **Integrative Module**

This module will cover the basic phlebotomy course focusing on the techniques, and theories of phlebotomy as well as the basic skills to interact with the patients. Besides, polyclinic attachment is also covered under this module.

##### **Laboratory Endocrinology**

This module introduces the physiology and pathogenesis of endocrine disorders, as well as laboratory testing related to endocrine disorders. This provides important background and understanding to use of laboratory tests in diagnosis, monitoring and prognosticating endocrine diseases.

##### **Laboratory Management**

This module covers an overview of important aspects of laboratory management, including costing, material management, project management, infectious disease management, information technology and the laboratory, quality management and laboratory laws and accreditation.

##### **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. Related laboratory tests are covered.

#### **LEVEL 3.2**

##### **Capstone Project**

Students will complete a final year research project under the guidance of an academic staff or industry mentor. The Capstone Project can cover any of the key areas in life science research including Molecular Biosciences, Industrial

Biotechnology, Food Technology, Aquatic Science & Technology, Environmental Technology and Urban Horticulture and Greenscape.

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### Clinical Chemistry 2

This module covers advanced topics in clinical chemistry such as acid base physiology and disorders, lipid metabolism, calcium regulation, organ system review and diseases (gastrointestinal tract, cardiac markers, infectious disease testing, and autoimmune diseases).

### Clinical Haematology 2

This module covers the normal and pathophysiology of bone marrow, haematological malignancies such as leukemias, lymphoma, myeloproliferative disorders and non-malignancies disorders such as anemia, myelodysplasia, coagulation disorders. Advanced haematological investigation using Flow Cytometry and conventional methods as well as Fluorescence In-situ Hybridisation (FISH) cytogenetics will also be covered.

### Clinical Microbiology 2

This module focuses on less frequently encountered infectious diseases which are associated with significant morbidity and mortality. Students will learn more about processing blood culture and cerebrospinal fluid specimens, susceptibility testing methods, non-culture based diagnostic tests, infections associated with bacteria, fungi, viruses and parasites along with an introduction to the antibiotic classes.

### 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.

## COURSE CURRICULUM

Module Name	Credit Units
<b>YEAR 3</b>	
<b>BIOMEDICAL RESEARCH SPECIALISATION OPTION</b>	
<b>Level 3.1 (24 hours per week)</b>	
Bioinformatics	2
Capstone Project	8
Genomics & Proteomics	6
Interdisciplinary Studies (IS) elective ^	2
World Issues: A Singapore Perspective ^	2
Electives (Choose 1):	
• Drug Discovery & Clinical Trials	4
• Nutrition & Dietetic Science	4
• Pharmaceutical Analysis	4
• Translational Medicine	4
<b>Level 3.2 (24 hours per week)</b>	
4-Month Internship	16
Capstone Project	8

## CLINICAL LABORATORY TECHNOLOGY SPECIALISATION OPTION

### Level 3.1 (18 hours per week)

Bioinformatics	2
Integrative Module	6
Molecular Diagnostics	4
Laboratory Endocrinology	3
Laboratory Management	3

### Level 3.2 (33 hours per week)

Capstone Project	8
Clinical Chemistry 2	7
Clinical Haematology 2	7
Clinical Microbiology 2	7
Genomics and Proteomics	2
World Issues: A Singapore Perspective ^	2

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