

# Faculty of Science

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- 4.2.2.4 [Master of Science in Financial Engineering \(Full-Time, Part-Time or Distance Learning\)](#)
- 4.2.2.5 [Master of Science in Mathematics \(Full-Time or Part-Time\)](#)
- 4.2.2.6 [Master of Science in Pharmaceutical Sciences and Technology \(Part-Time\)](#)
- 4.2.2.7 [Master of Science in Physics \(Full-Time or Part-Time\)](#)
- 4.2.2.8 [Master of Science in Quantitative Finance \(Full-Time or Part-Time\)](#)
- 4.2.2.9 [Master of Science in Statistics \(Full-Time or Part-Time\)](#)
- 4.2.2.10 [Joint Masters of Science in Industrial Chemistry \(NUS & TUM\) \(Full-Time\)](#)
- 4.2.2.11 [Masters of Science in Science Communication \(Full-Time or Part-Time\)](#)
- 4.2.2.12 [Doctor of Pharmacy \(PharmD\) \(Full-Time or Part-Time\)](#)

## 1 Faculty's Commitment

The Faculty of Science began as a single department in Raffles College in 1929, offering courses in Chemistry, Mathematics, and Physics, and having ten students and three staff members. Since then it has evolved into one of the largest faculties in the National University of Singapore, with six departments, a wide range of programmes, some 5,000 undergraduates, 1,500 graduate students, 383 research staff, 374 academic and teaching staff and 109 executive and professional staff.

The Faculty of Science also has a Lee Kong Chian Natural History Museum, which is home to over a million plant and animal specimens from the region. It is a leader in Southeast Asian biodiversity and conservation research, education and outreach, and is also the national centre for the cryo-preservation of biodiversity tissue samples of more than 3,000 species. The museum's 2,200 m<sup>2</sup> exhibition gallery is dedicated to the biodiversity of Southeast Asia and Singapore, and displays over 2,000 species and fossils of three sauropod dinosaurs. It complements and is integrated in the museum's research and education programmes.

Sharing the vision of the nation and the university, the Faculty of Science focuses on knowledge and research and their application to the education, industry and enterprise of the nation. Of equal essence is the imparting of knowledge and life skills to students, so that Science graduates are not only conversant with their fields but also have the versatility to learn new trades and adapt to a variety of jobs in today's knowledge-based economy.

Please refer to the Faculty website at: <http://www.science.nus.edu.sg> for up-to-date information on the Faculty.

## 2 Key Contact Information

### Deanery

TITLE & NAME	DESIGNATION/RESPONSIBILITY	TELEPHONE (6516-XXXX)	EMAIL (XXXX@NUS.EDU.SG)
Prof SHEN Zuowei	Dean	3333	scidean
Assoc Prof CHEW Fook Tim	Vice-Dean, Undergraduate Studies and Student Life	66013815	scicft
Prof GOH Say Song	Vice-Dean, Outreach & Admissions	6601 1480	scigohss
Assoc Prof Peter HO Kian Hoon	Vice-Dean, Research	2833	scihop
Assoc Prof Roger TAN Choon Ee	Vice-Dean, Education and Special Duties	6303	scitance
Prof YU Hao	Vice-Dean, Graduate Programmes	4234	sciyuhao
Assoc Prof CHAN Yin Thai	Assistant Dean, Research and Graduate Studies	8780	scichany
Assoc Prof FAN Wai Yip	Assistant Dean, Outreach and Student Life	4419	scifanwy
Dr NG Kah Loon	Assistant Dean, Undergraduate Studies	1306	scingkl
Assoc Prof TAN Meng Chwan	Assistant Dean, Outreach and Admissions	5376	scitmc



<b>TITLE &amp; NAME</b>	<b>DESIGNATION/RESPONSIBILITY</b>	<b>TELEPHONE (6516-XXXX)</b>	<b>EMAIL (XXXX@NUS.EDU.SG)</b>
Prof Thorsten WOHLAND	Assistant Dean, Research and Graduate Studies	6700	sciwt
Assoc Prof YAP Von Bing	Assistant Dean, Outreach and Admissions	3096	sciyvb
Dr YEO Ye	Assistant Dean, Student Life	6601 3745	sciyeoy
Assoc Prof CHUA Tin Chiu	Associate Dean, Undergraduate Matters	1416	scictc
Assoc Prof LAI Yee Hing	Associate Dean, Education and International Programmes	2774	scilaiyh

#### **Heads of Departments/Directors of Programmes**

<b>TITLE &amp; NAME</b>	<b>DESIGNATION/RESPONSIBILITY</b>	<b>TELEPHONE (6516-XXXX)</b>	<b>EMAIL (XXXX@NUS.EDU.SG)</b>
Prof YU Hao	Head, Biological Sciences	2692	dbshhead
Prof WONG Ming Wah Richard	Head, Chemistry	2658	chmhead
Prof Zhu Chengbo	Head, Mathematics	2737	mathead
Prof Chai Li Lin, Christina	Head, Pharmacy	2646	phahead
Assoc Prof SOW Chorng Haur	Head, Physics	2603	phyhead

<b>TITLE &amp; NAME</b>	<b>DESIGNATION/RESPONSIBILITY</b>	<b>TELEPHONE (6516-XXXX)</b>	<b>EMAIL (XXXX@NULLNUS.EDU.SG)</b>
Prof CHAN Hock Peng	Head, Statistics and Applied Probability	2945	stahead
Assoc Prof TAN Hwee Huat	Director, Quantitative Finance Programme	6144	mattanh
Prof Zhou Weibiao	Director, Food Science and Technology Programme	3501	chmzwb

#### **Academic Advisors**

<b>TITLE &amp; NAME</b>	<b>DESIGNATION/RESPONSIBILITY</b>	<b>TELEPHONE (6516-XXXX)</b>	<b>EMAIL (XXXX@NULLNUS.EDU.SG)</b>
<b>A. Biological Sciences</b>			
Assoc Prof Christoph Wolfram WINKLER	Level 5 Advisor	7376	dbswcw
<b>B. Chemistry</b>			
Dr HOANG Truong Giang & Dr Zhang Sheng	Level 1 Advisor	4554/2663	chmhoan/chmzs
Dr CHONG Yuan Yi	Level 2 Advisor	5148	chmcyi
Dr Michael YUDISTIRA & Dr Jeremiah CHEN Litai	Level 3 Advisor	5148/4328	chmmiy/chmchlj

<b>TITLE &amp; NAME</b>	<b>DESIGNATION/RESPONSIBILITY</b>	<b>TELEPHONE (6516-XXXX)</b>	<b>EMAIL (XXXX@NULLNUS.EDU.SG)</b>
Assoc Prof Ryan Phillip Anthony BETTENS	Level 4 Advisor	2846	chmbrpa
Assoc Prof Stephan JAENICKE	Level 5 Advisor	2918	chmsj
<b>C. Computational Biology</b>			
Prof CHEN Yu Zong	Advisor for all levels	6877	phacyz
Assoc Prof CHOI Kwok Pui	Advisor for all levels	2770	stackp
Prof Greg TUCKER-KELLOGG	Advisor for all levels	4740	dbsgtk
Assoc Prof LOW Boon Chuan	Advisor for all levels	7834	dbslowbc
Assoc Prof ZHANG Louxin	Advisor for all levels	6579	matzlx
<b>D. Food Science and Technology</b>			
Dr LEONG Lai Peng	Level 1 Advisor	2917	chmllp
Dr LIU Mei Hui	Level 2 Advisor	3523	chmlmh
Asst Prof YANG Hongshun	Level 3 Advisor	4695	chmynghs
Assoc Prof HUANG Dejian	Level 4 Advisor	8821	chmhdj

<b>TITLE &amp; NAME</b>	<b>DESIGNATION/RESPONSIBILITY</b>	<b>TELEPHONE (6516-XXXX)</b>	<b>EMAIL (XXXX@NULLNUS.EDU.SG)</b>
Assoc Prof LIU Shao Quan	Level 5 Advisor	2687	chmlsq
<b>E. Life Sciences</b>			
Assoc Prof MOK Yu-Keung, Henry	Level 1/2/3/4 Advisor (Biological Sciences)	2967	dbsmokh
Assoc Prof YEONG Foong May	Level 1/2/3/4 Advisor (Biochemistry)	8866	bchyfm
Assoc Prof CHU Jang Hann, Justin	Level 2/3/4 Advisor (Microbiology and Immunology)	3278	miccjh
Dr LAI Kim Peng Mitchell	Level 3/4 Advisor (Pharmacology)	6601 2678	phclkpm
Assoc Prof Herbert SCHWARZ	Level 3/4 Advisor (Physiology)	7773	phssh
<b>F. Mathematics</b>			
Dr TAN Ban Pin	Level 1 Advisor	2748	mattpb
Dr NG Wee Seng	Level 1 Advisor	4673	matnws
Dr Yap Weng Yin	Level 1 Advisor	6911	matyapwy
Prof CHAN Heng Huat	Levels 2/3 Advisor	2741	matchh
Assoc Prof Assoc Prof TAN Kai Meng	Levels 2/3 Advisor	2948	mattankm
Assoc Prof Ma Siu Lun	Level 4 Advisor	3338	matmasl
Assoc Prof Denny LEUNG	Level 5 Advisor	6252	matlhh

TITLE & NAME	DESIGNATION/RESPONSIBILITY	TELEPHONE (6516-XXXX)	EMAIL (XXXX@NUS.EDU.SG)
G. Pharmacy			
Assoc Prof HO Han Kiat	Advisor	7963	phahohk
H. Physics			
Dr Cindy NG Shao Chin	Level 1 Advisor (General Education modules)	2822	phynsc
Dr WANG Qinghai	Level 1 Advisor (PC1141/42/43/44 and PC1221/22)	2533	phywq
Mr Kenneth HONG Chong Ming	Level 1 Lab Advisor	2631	phyhcmk
Dr Yeo Ye	Level 1 Advisor (PC1431/32)	2821	phyyy
Dr WANG Qinghai	Level 1 Advisor (Engineering Physics Lab)	2533	phywq
Assoc Prof Ariando	Level 2 Advisor	7900	phyarian
Assoc Prof Edward TEO	Level 3 Advisor	6351	phyteoe
Prof Christian KURTSIEFER	Level 4 Advisor	1250	phyck
Assoc Prof Kaszlikowski DAGOMIR	Level 5 Advisor	6880	phykd
I. Physics (Minor Programmes)			
Assoc Prof Edward TEO	Advisor for Minor in Physics	6351	phyteoe

TITLE & NAME	DESIGNATION/RESPONSIBILITY	TELEPHONE (6516-XXXX)	EMAIL (XXXX@NUS.EDU.SG)
Prof Ji Wei	Advisor for Minor in Optics and Semiconductor Technology	6373	phyjiwei
Assoc Prof Sow Chorng Haur	Advisor for Nanoscience Minor	2957	physowch
Assoc Prof Johan R C VAN DER MAAREL	Advisor for Biophysics	2812	phyjrcvd
<b>J. Quantitative Finance</b>			
Assoc Prof Tan Hwee Huat	Advisor All levels	6144	mattanh
<b>K. Statistics and Applied Probability</b>			
Assoc Prof Sanjay CHAUDHURI	Level 1 Advisor	6624	stasc
Assoc Prof Ajay JASRA	Level 2 Advisor	11410	staja
Dr Chan Yiu Man	Level 3 Advisor	2950	stacym
Assoc Prof LIM Tiong Wee	Level 4 Advisor	7857	stalimtw
Prof XIA Yingcun	Level 5 Advisor	2943	staxyc
Assoc Prof LIM Tiong Wee	Overall Advisor	7857	stalimtw
L. Centre for English Language Communication – Please refer to CELC section of the Bulletin under “Teaching Institutions”			

#### Department/Programme Coordinators

## Undergraduate Programmes

TITLE & NAME	ROLE/RESPONSIBILITIES	TELEPHONE 6516-XXXX)	EMAIL (XXXX@NULLNUS.EDU.SG)
B. Chemistry			
Assoc Prof LAM Yulin	Faculty Curriculum Committee	2688	chmlamyl
Assoc Prof LAM Yulin	Department Curriculum Committee	2688	chmlamyl
Dr ZHANG Sheng	Class and Examination Timetable	7759	chmzs
Dr CHAN Sau Han Edith	Student Exchange Programme	2672	chmcsh
Ms THYAGARAJAN Saradha	Polytechnic Admission	2843	chmthyag
Dr Michael YUDISTIRA/ Dr CHEN Litai, Jeremiah	File for Graduation (Level 3)	5148/4328	chmmiy/chmchlj
Assoc Prof Ryan Phillip Anthony BETTENS	File for Graduation (Level 4)	2846	chmbrpa
C. Computational Biology			
Prof Greg TUCKER-KELLOGG	Faculty Curriculum Committee	4740	dbsgtk

TITLE & NAME	ROLE/RESPONSIBILITIES	TELEPHONE 6516-XXXX)	EMAIL (XXXX@NULLNUS.EDU.SG)
Prof Greg TUCKER-KELLOGG	Department Curriculum Committee	4740	dbsgtk
Prof Chen Yu Zong		6877	phacyz
Assoc Prof CHOI Kwok Pui		4387	stackp
Assoc Prof Low Boon Chuan		7834	dbslowbc
Assoc Prof Zhang Louxin		6579	matzlx
Prof Greg TUCKER-KELLOGG	Class and Examination Timetable	4740	dbsgtk
Prof Greg TUCKER-KELLOGG	Student Exchange Programme	4740	dbsgtk
Prof Greg TUCKER-KELLOGG	Polytechnic Admission	4740	dbsgtk
Prof Greg TUCKER-KELLOGG	File for Graduation	4740	dbsgtk

TITLE & NAME	DESIGNATION/RESPONSIBILITY	TELEPHONE (6516-XXXX)	EMAIL (XXXX@NULLNUS.EDU.SG)
<b>D. Food Science and Technology</b>			
Dr LIU Mei Hui	Faculty Curriculum Committee	3523	chmlmh
Dr LIU Mei Hui	Department Curriculum Committee	3523	chmlmh
Prof ZHOU Weibiao	Class and Examination Timetable	3501	chmzwb
Prof ZHOU Weibiao	Professional Placement	3501	chmzwb



TITLE & NAME	DESIGNATION/RESPONSIBILITY	TELEPHONE (6516-XXXX)	EMAIL (XXXX@NUS.EDU.SG)
Dr LIU Mei Hui	Student Exchange Programme	3523	chmlmh
Prof ZHOU Weibiao	Polytechnic Admission	3501	chmzwb
Assoc Prof LIU Shao Quan	File for Graduation	2687	chmlsq
<b>E. Life Sciences(Biological Sciences)</b>			
Assoc Prof MOK Yu-Keung, Henry	Faculty Curriculum Committee	2967	dbsmokh
Assoc Prof MOK Yu-Keung, Henry	Department Curriculum Committee	2967	dbsmokh
Mr LIM Miah Kyan		2698	dbslmk
Ms Yvonne FONG	Class and Examination Timetable	6601 1306	dbsyfcy
Assoc Prof MOK Yu-Keung, Henry	Student Exchange Programme	2967	dbsmokh
Ms Yvonne FONG		6601 1306	dbsyfcy
Assoc Prof MOK Yu-Keung, Henry	Polytechnic Admission	2967	dbsmokh
Mr LIM Miah Kyan		2698	dbslmk
Mr LIM Miah Kyan	File for Graduation	2698	dbslmk
<b>F. Mathematics and Applied Mathematics</b>			
Assoc Prof LEUNG Ka Hin	Faculty Curriculum Committee	3339	matlkh
Assoc Prof TANG Wai Shing	Department Curriculum Committee	2992	mattws
Assoc Prof TANG Wai Shing	Class and Examination Timetable	2992	mattws
Assoc Prof Fred LEUNG Pui Fai	Student Exchange Programme	2772	matfredl
Assoc Prof MA Siu Lun	Student Advice Committee (Undergraduate)	3338	matmasl
Assoc Prof MA Siu Lun	File for Graduation	3338	matmasl
<b>G. PHARMACY</b>			
Assoc Prof HO Han Kiat	Faculty Curriculum Committee	7963	phahohk
Assoc Prof HO Han Kiat	Class and Examination Timetable	7963	phahohk
Ms TAN Mui Ling	Professional Placement	3877	phatml
Dr WONG Lilian	Professional Placement	66011237	phawll
Dr ONG Pei Shi	FYP Coordinator	66011236	phaops
Dr CHNG Hui Ting/Dr YAU Wai Ping	Student Exchange Programme	8913	phacht/phaywp

G. PHARMACY			
Assoc Prof Priscilla HOW	Polytechnic Admission	4906	phahowp
Assoc Prof Priscilla HOW	Admission (All other categories)	4906	phahowp
Assoc Prof HO Han Kiat	File for Graduation	7963	phahohk
H. Physics			
Assoc Prof Thomas OSIPOWICZ	Faculty Curriculum Committee	6745	phyto
Assoc Prof Edward TEO	Department Curriculum Committee	6351	phyteoe
Assoc Prof Thomas OSIPOWICZ	Class and Examination Timetable	6745	phyto
Assoc Prof WANG Zhisong	Student Exchange Programme	2606	phywangz
Assoc Prof Phil CHAN	Polytechnic Admission	6390	phycahp
Assoc Prof Edward TEO	File for Graduation	6351	phyteoe

TITLE & NAME	ROLE/RESPONSIBILITIES	TELEPHONE (6516-XXXX)	EMAIL (XXXX@NUS.EDU.SG)
I. Quantitative Finance			
Assoc Prof TAN Hwee Huat	Faculty Curriculum Committee	6144	mattanh
Assoc Prof TAN Hwee Huat	Class and Examination Timetable	6144	mattanh
Assoc Prof TAN Hwee Huat	Student Exchange Programme	6144	mattanh
Assoc Prof TAN Hwee Huat	File for Graduation	6144	mattanh
J. Statistics			
Assoc Prof LIM Tiong Wee	Faculty Curriculum Committee	7857	stalimtw

<b>TITLE &amp; NAME</b>	<b>ROLE/RESPONSIBILITIES</b>	<b>TELEPHONE (6516-XXXX)</b>	<b>EMAIL (XXXX@NULLNUS.EDU.SG)</b>
Assoc Prof Lim Tiong Wee	Department Curriculum Committee	7857	stalimtw
Assoc Prof LIM Tiong Wee	Class and Examination Timetable	7857	stalimtw
Assoc Prof Ajay JASRA	Student Exchange Programme	66011410	staja
Assoc Prof LIM Tiong Wee	File for Graduation	7857	stalimtw

### Graduate Programme

<b>TITLE &amp; NAME</b>	<b>DESIGNATION/RESPONSIBILITY</b>	<b>TELEPHONE (6516-XXXX)</b>	<b>EMAIL (XXXX@NULLNUS.EDU.SG)</b>
Assoc Prof Christoph Wolfram WINKLER	EXCO member, Biological Sciences	7376	dbswcw
Assoc Prof ANG Wee Han	EXCO member, Chemistry	5153	chmawh
Assoc Prof LIU Shao Quan	EXCO member, Food Science and Technology	2687	chmlsq
Prof BAO Weizhu	EXCO member, Mathematics	2765	matbaowz
Assoc Prof YU Chun Kong, Victor	EXCO member, Pharmacy	8216	phayuv

<b>TITLE &amp; NAME</b>	<b>DESIGNATION/RESPONSIBILITY</b>	<b>TELEPHONE (6516-XXXX)</b>	<b>EMAIL (XXXX@NUS.EDU.SG)</b>
Assoc Prof GONG Jiangbin	EXCO member, Physics	1154	phygj
Prof XIA Yingcun	EXCO member, Statistics and Applied Probability	2943	staxyc

#### **UOPS Coordinators**

<b>TITLE &amp; NAME</b>	<b>DEPARTMENT</b>	<b>TELEPHONE (6516-XXXX)</b>	<b>EMAIL (XXXX@NUS.EDU.SG)</b>
Assoc Prof George YIP Wai Cheong	Anatomy	3206	antypg
Assoc Prof TANG Bor Luen	Biochemistry	1040	bchtbl
Dr YEW Wen Shan	Biochemistry	8624	bchyws
Dr HUANG Danwei	Biological Sciences	2696	dbshd
Dr CHUI Sin Yin, Stephen	Chemistry	3699	chmcsys
Prof Greg TUCKER-KELLOGG	Computational Biology (Under Science Dean's Office)	4740	dbsgtk
Dr LEONG Lai Peng	Food Science and Technology	2917	chmlp
Assoc Prof ZHANG Louxin	Mathematics	6579	matzlx
Assoc Prof CHU Jang Hann, Justin	Microbiology and Immunology	3278	miccjh
Dr LAI Kim Peng Mitchell	Pharmacology	6601 2678	phclkpm
Ms TENG Bee Choon, Christine	Pharmacy	1996	phatbcc

TITLE & NAME	DEPARTMENT	TELEPHONE (6516-XXXX)	EMAIL (XXXX@NULLNUS.EDU.SG)
Assoc Prof LIM Hock Siah	Physics	2614	phylimhs
Dr Mallilankaraman Karthik Babu	Physiology	6601 5181	phsmkb
Assoc Prof LIM Tiong Wee	Statistics and Applied Probability	7857	stalimtw
Assoc Prof LIOU Yih-Cherng	SPS	7711	dbslc
Assoc Prof LO Mun Hou	USP	4077	usplomh

### UIIP Coordinators

TITLE & NAME	MAJOR	TELEPHONE (6516-XXXX)	EMAIL (XXXX@NULLNUS.EDU.SG)
Assoc Prof Ryan Phillip Anthony BETTENS	Chemistry	2846	chmbrpa
Prof Greg TUCKER-KELLOGG	Computational Biology	4740	dbsgtk
Dr LIU Mei Hui	Food Science and Technology	3523	chmlmh
Assoc Prof Henry MOK	Life Sciences	2967	dbsmokh
Assoc Prof CHU Delin	Mathematics, Applied Mathematics and Quantitative Finance	6912	matchudl
Ms TAN Mui Ling	Pharmacy	3877	phatml
Assoc Prof Paul LIM Hock Siah	Physics	2614	phylimhs
Assoc Prof LIM Tiong Wee	Statistics	7857	stalimtw

### Administrative Coordinators

TITLE & NAME	DESIGNATION/RESPONSIBILITY	TELEPHONE (6516-XXXX)	EMAIL (XXXX@NULLNUS.EDU.SG)
Ms Jacqueline LIM Siau Yen	Manager, Biological Sciences(Graduate Programmes)	2703	dbsjlsy
Mr LIM Miah Kyan	Manager, Biological Sciences(Undergraduate Programmes)	2698	dbslmk

TITLE & NAME	DESIGNATION/RESPONSIBILITY	TELEPHONE (6516-XXXX)	EMAIL (XXXX@NUS.EDU.SG)
Mr Laurence GWE	Assistant Manager, Biological Sciences (Undergraduate Programmes)	4439	dbsgel
Ms Yvonne FONG	Executive, Biological Sciences (Undergraduate Programmes)	6601 1306	dbsyfcy
Ms Carrie WONG Suk Tak	Manager, Chemistry (Undergraduate Programmes)	6361	chmwst
Ms Linda Janti OEI	Manager, Chemistry (Graduate Programmes (Coursework))	6318	chmljo
Ms Suriawati Binte SAAD	Executive, Chemistry (Graduate Programmes)	2660	chmss
Ms Linda Janti OEI	Manager, Chemistry (Graduate Programmes)	6318	chmljo
Mr SOO Kok Ping	Assistant Manager, Mathematics	6948	TBA
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## **3 Undergraduate Education**

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## 3.1 Overview

### Core Educational Philosophy

The Science education is multidisciplinary and trains students to meet the increasingly complex needs of the future. Our degree programmes are constantly reviewed and revised to ensure that the education our students receive remains relevant. Course content is but a fraction of the education provided. Greater emphasis is placed on developing and sharpening the students' analytical and creative thinking skills, presentation skills, computer literacy, and problem solving techniques. These are the life skills that make science graduates versatile, articulate, and IT-savvy.

We offer an education that is inclusive and able to cater to a wide spectrum of student interests, aptitudes and abilities, developing and maximising the potential of each individual. In terms of undergraduate instruction, the Faculty has adopted specialised modes of delivery aimed at cultivating deeper approaches to learning. We also run various boutique programmes targeting different groups of students to stretch and enrich the educational experience of as many as possible.

### (1) Modules for Freshmen

The following module designed for freshmen was launched in AY2006/07, with emphasis on honing students' analytical, creative thinking, and writing skills:

- Freshman Seminar

FMS12XXY (where X stands for a running number and Y is an alphabet denoting the Department\*)  
Freshman Seminar provides an unparalleled opportunity for first-year students and faculty to explore a scholarly topic of mutual interest together in a small group setting. Designed with freshmen in mind, the module sparks students' intellectual curiosity as they are oriented to becoming an active member of the NUS intellectual community. Students can benefit from in-depth discussions on a specific scientific issue, and learn to present ideas clearly in oral and written form.

\* Different Symbols for Departments (Y)

B = Department of Biological Sciences

C = Department of Chemistry

M = Department of Mathematics

P = Department of Physics

S = Department of Statistics and Applied Probability

## **(2) Specialised Modes of Delivery**

Besides the standard modes of delivery through lectures, seminars and tutorials, students are also given ample opportunities to explore other more challenging learning options, such as independent study and research work, to stimulate their intellectual development.

- Independent Study Modules

Students who are in our Special Programme in Science, University Scholars Programme, as well as those who meet the minimum CAP criteria of at least 4.50, are allowed to register for Independent Study Modules (ISMs) in their respective major disciplines. In general, ISMs are structured upon existing modules and students are required to design their course material under the guidance of a supervisor with the objective of covering topics in greater depth and/or breadth than they will if they read the regular modules. Students are expected to benefit from the personalised instruction as well as the high-level discourses they are engaged in with their supervisors.

- Undergraduate Research Opportunities Programme in Science

The Undergraduate Research Opportunities Programme in Science (UROPS) offers many of our students the opportunity to do research in specific areas related to their discipline. The programme has been primarily designed with the aim of engaging students in the process of intellectual inquiry, problem-solving, creative thinking, and enhancing intellectual exchange and collaboration between undergraduates and Faculty members.

## **(3) Special Faculty-Based Programmes**

Besides the specialised modes of delivery employed to stretch our students, the Faculty also hosts a suite of special boutique programmes, each having its own specific aims and objectives targeting different groups of students. The Faculty is committed to promoting these programmes as well as identifying and selecting suitable candidates for participation in these programmes.

- Special Programme in Science

Introduced in 1996, the Special Programme in Science (SPS) aims to nurture talent among budding scientists. SPS is an intense programme for a selected group of undergraduates who have a strong passion and aptitude for Science. It is directed at students who delight in the rigorous training of the mind and character. Through this programme, participants are introduced to some of the broad areas of contemporary scientific concerns through an interdisciplinary approach, a cornerstone and hallmark of SPS.

- Multidisciplinary Undergraduate Programmes

Since 2016, the Faculty has offered a Data Science and Analytics major, a multidisciplinary programme

jointly offered by the Department of Mathematics and the Department of Statistics and Applied Probability in the Faculty of Science, with the collaboration of the School of Computing. Data science is an emerging field of study that involves statistical and computational principles, methods and systems for extracting and structuring knowledge from data. On a daily basis, large data sets are routinely generated by activities in the sciences, administration, leisure and commerce. Data scientists are constantly seeking patterns and predicting outcomes from these vast collections of data. The four-year direct Honours programme in Data Science and Analytics (DSA) is designed to prepare graduates who are ready to acquire, manage and explore data that will inspire changes around the world.

The Faculty also has a multidisciplinary Computational Biology Programme which involves the participation from 11 Departments spanning across three Faculties/School, including the Departments of Biological Sciences, Chemistry, Mathematics, Physics and Statistics and Applied Probability from the Faculty of Science, the Department of Computer Science from the School of Computing and the Departments of Biochemistry, Microbiology, Physiology and Pharmacology from the Yong Loo Ling School of Medicine. This programme is designed with the objective of paving the way to specific graduate programmes and research in hot multidisciplinary areas like Biophysics and Bioinformatics. As such, the Computational Biology programme is well suited for students who seek careers in the research-intensive track.

The growing list of challenging multidisciplinary study options also includes specially designed double degree programmes in Law and Life Sciences, Computer Science and Mathematics / Applied Mathematics, Materials Science & Engineering and Physics, as well as a Concurrent M.Sc. (Mgt.) and B.Sc. (Hons.) programme. Additionally, academically outstanding students who want to acquire competence in two disciplines may apply to do self-designed (free structure) double degrees. Some viable combinations of double degrees include a Science degree with Operations and Supply Chain Management (offered by the School of Business), Computing (offered by the School of Computing), Psychology [offered by the Faculty of Arts and Social Sciences (FASS)], or Economics (offered by FASS).

In order for Science students to fulfil graduation requirements, they must meet the graduation requirements for at least one primary major. Students are allowed to read a maximum of two majors. Pharmacy students are allowed to read only one major. Students who relish academic challenges may take a double major programme (one primary and one second major). The second major may be offered by FoS or other Faculties in disciplines complementing the primary major of the student.

#### Upfront Double Majors and Major-Minor Combinations

With effect from AY2017/18, the following upfront double majors and major-minor combinations are offered:

#### **1. Double Major Programmes**

Students can apply direct to the following double major programmes via the online admission application form:

<b>FoS Major</b>	<b>2nd Major (from Faculty of Science or other Faculties/Schools)</b>	<b>Admission requirements*</b>
Applied Mathematics	Economics (FASS)	Good H2 Pass or equivalent in Mathematics
Mathematics	Economics (FASS)	Good H2 Pass or equivalent in Mathematics
Statistics	Economics (FASS)	Good H2 Pass or equivalent in Mathematics
Life Sciences	Psychology (FASS)	Good H2 Passes or equivalent in Biology, Chemistry and either Mathematics or Physics
Applied Mathematics	Computer Science (SoC)	Good H2 Pass or equivalent in Mathematics
Mathematics	Computer Science (SoC)	Good H2 Pass or equivalent in Mathematics
Statistics	Computer Science (SoC)	Good H2 Pass or equivalent in Mathematics
Applied Mathematics	Information Security (SoC)	Good H2 Pass or equivalent in Mathematics
Mathematics	Information Security (SoC)	Good H2 Pass or equivalent in Mathematics

Applied Mathematics	Business Analytics (SoC)	Good H2 Pass or equivalent in Mathematics
Mathematics	Business Analytics (SoC)	Good H2 Pass or equivalent in Mathematics
Statistics	Business Analytics (SoC)	Good H2 Pass or equivalent in Mathematics
Applied Mathematics	Management (Biz)	Good H2 Pass or equivalent in Mathematics
Mathematics	Management (Biz)	Good H2 Pass or equivalent in Mathematics
Statistics	Management (Biz)	Good H2 Pass or equivalent in Mathematics
Life Sciences	Management (Biz)	Good H2 Pass or equivalent in Biology, Chemistry and either Mathematics or Physics.
Chemistry	Food Science (FoS)	Good H2 Pass or equivalent in Chemistry and at least a good 'O' level pass or equivalent in Mathematics.

\*Applicants satisfying the admission requirements will be subjected to selection criteria before being admitted into the programme

## 2. Major with Minor Programmes

Students can apply direct to the following major with minor programmes via the online admission application form:

<b>FoS Major</b>	<b>Minor (from other Faculties/Schools)</b>	<b>Admission requirements*</b>
Applied Mathematics	Information Security (SoC)	Good H2 Pass or equivalent in Mathematics

Computational Biology	Information Security (SoC)	Good H2 Passes or equivalent in Mathematics and either Biology or Chemistry
Quantitative Finance	Information Security (SoC)	Good H2 Pass or equivalent in Mathematics
Statistics	Information Security (SoC)	Good H2 Pass or equivalent in Mathematics
Life Sciences	Public Health (SSHSPH)	Good H2 Pass or equivalent in Biology, Chemistry and either Mathematics or Physics

\*Applicants satisfying the admission requirements will be subject to selection criteria before being admitted into the programme.

#### Legend

Biz: NUS Business School; FASS: Faculty of Arts and Social Sciences; FoS: Faculty of Science; SoC: School of Computing; SSHSPH: Saw Swee Hock School of Public Health

#### • New 2<sup>nd</sup> Majors

##### **Data Analytics**

Data Analytics is used in many industries to allow companies and organisations to make better business decisions and in the sciences to verify or disprove existing models and theories. The Second Major in Data Analytics will equip students from non-analytics domains with knowledge in data analytics and enable them to apply computing and statistical methods to analyse and model complex data in their respective domains.

##### **Food Science**

The Second Major in Food Science is for students with strong chemistry background. Food Science and Technology (FST) modules related to food analysis and flavour science are selected for the second major to provide students with the training and applied perspective in these areas. In addition, nutrition related modules will add breadth to students' understanding on the aspects of food beyond physical and chemical properties.

#### • Highlights of a Few Minors offered by Faculty of Science

##### ***Aquatic Ecology***

The Minor in Aquatic Ecology aims to expose students to the important disciplines of marine and freshwater ecological studies while developing relevant specific skills, knowledge, and experience among them. With the increasing governmental, private, and societal interest in aquatic sciences, there is a growing demand for manpower with expertise in freshwater and/or marine ecology. This Minor complements aptly the primary disciplines of students from the Life Sciences Major and Geography Major. It will also enhance the training for students keen in related career opportunities at relevant governmental and private institutions in Singapore, including Public Utilities Board (PUB), National Environment Agency (NEA), National Parks Board (NParks), The Maritime and Port Authority of Singapore (MPA), Tropical Marine Science Institute (TMSI), DHI Group, and Singapore - Delft Water Alliance (SDWA).

### ***Forensic Science***

The minor in forensic science aims to provide students with an understanding of the fundamental concepts and principles behind the application of scientific techniques to forensic investigations and to the criminal justice system. Advances in basic scientific research have had a rapid and dramatic impact in these fields and it is only through an understanding of these fundamental scientific concepts that the legal system may be effective in criminal investigations. A minor in forensic science would also offer a strong complement for students interested in criminal justice to major in areas of study such as biology, chemistry, physics, psychology or engineering.

### ***Medical Physics***

Medical Physics is the branch of physics that develops and applies the methods and techniques, often from Nuclear Physics, which form the basis of the advanced technologies used in medicine and healthcare today. Examples are imaging techniques such as X-ray Computed Tomography (CT), Magnetic Resonance Imaging (MRI) and Positron Emission Tomography (PET), as well as radiation therapy techniques such as Radiotherapy and Proton Therapy, relevant in cancer treatment.

The fact that life expectancy and population are increasing, and the tendency to adopt more affluent lifestyle habits, leads to an increase in the incidence of many chronic and degenerative diseases. For example, the prevalence of cancer is predicted to increase three-fold by 2030, and other aging related maladies will also be seen more frequently.

Because of the rising expectations for better quality healthcare, experts in Medical Physics are needed where specialized knowledge and skills are required in specific areas (e.g. Radiation Oncology, Proton Beam Therapy, Medical Imaging (MRI/CT) and Medical Technology).

The Medical Physics minor aims to teach the basics of Medical Physics and the constitutional knowledge that is required from Nuclear Physics as well as Biology & Life Science, in order to broaden the

knowledge of some of our graduates at the interface of these fields.

Those students who aim to become professional Medical Physicists will be able to utilize the solid foundation the minor represents to carry on towards such a professional degree.

### ***Pharmaceutical Sciences***

The pharmaceutical industry in Singapore is undergoing a phase of expansion, as more pharmaceutical and biopharmaceutical companies set up new manufacturing and research facilities here. Along with this expansion plans, manpower with relevant knowledge and skills will be sought after by the industry. In addition to the requisite domain knowledge which may be science, engineering, law or business; the employers are also seeking to hire graduates with supplementary knowledge relevant to the pharmaceutical industry. The relevant adjunct knowledge is based on foundation in pharmaceutical sciences. Having an understanding of pharmaceutical sciences will enable these graduates to quickly immerse in the environment of the industry and may ease the initial learning phase.

With this Minor in Pharmaceutical Sciences, graduates may also choose to pursue further studies either in the coursework MSc (Pharmaceutical Science and Technology) or pursue other PhD or MSc research programmes in their own majors at NUS or elsewhere. Together with a science or engineering based major, graduates will have a broader spectrum of technical knowledge and skills which will become useful in the research activities undertaken during their graduate study.

- Professional Placement Programme

The Professional Placement Programme of minimum 16 weeks is a major component of the International Union of Food Science and Technology (IUFoST) – certified Bachelor of Science (B.Sc.) and B.Sc. (Honours) in Food Science and Technology (FST). Students are attached to food related companies and organisations for on-the-job training and exposure. The programme seeks to give first-hand experience in the application of scientific knowledge to practical problems and is consistent with the objective of the FST B.Sc. and B.Sc. (Honours) Programmes, which is to serve the high quality manpower needs of the food and allied industries in Singapore. Such placements also serve to give our students a head start in their careers by enhancing their visibility within the industry.

- Undergraduate Professional Internship Programme (UPIP)

The Undergraduate Professional Internship Programme (UPIP) aims to provide Science undergraduates the opportunity to perform structured internship in an organisation during their undergraduate study. Internship helps students craft a fulfilling university journey through meaningful work experience. This programme allows students to engage in career preparation and job seeking exercises, hone their interpersonal, communications and other soft skills, and actively experience day-to-day operations in an organisation's ecosystem. Students will be presented with opportunities to apply their discipline-related



knowledge and professionalism in an actual work setting thus allowing students to gain experiential learning that complements their course activity. Upon successful completion of this elective internship module, students will also be awarded with Modular Credit (MC) that would count towards the Unrestricted Elective component of their graduation requirements.

For more information, visit URL: <http://science.nus.edu.sg/students/upip>

- Joint Minor Programme

Leveraging the competencies of the University of Toronto (UofT), one of the world's most prestigious universities, the Faculty offers joint minor programmes in Environmental Biology and Environmental Chemistry, for which NUS students study advanced courses for one semester at UofT. Successful participants are able to transfer both credits as well as grades to satisfy their graduation requirements. Under the terms of this partnership with UofT, NUS students need to pay their usual tuition fees to NUS only, for the duration of their studying stint at UofT. For more details, refer to 3.6.3.

- Joint Summer Exchange Programme

The Faculty of Science has partnered reputable institutions such as University of Toronto (UofT), University of Copenhagen, Hokkaido University, Leiden University, Radboud University, University of California, Los Angeles (UCLA), Tecnológico de Monterrey, University of Costa Rica and Harvey Mudd College (HMC) to offer summer programmes.

The main objective of the programme is to provide an exciting yet academically challenging short-term study option that would allow more Science students to experience an overseas education. At the same time students would gain sensitivities and insights into cultures different from their own, in preparation for the more global and interconnected world of the future.

#### **(4) Special University-Level Programmes**

In support of the overarching objectives of many of the University-initiated programmes, the Faculty currently hand-picks outstanding scholars for intensive programmes like University of North Carolina at Chapel Hill Summer Lab, the Double Degree Programme with French Grandes Écoles and the NUS Overseas College Programme. Other programmes like the NUS Student Exchange Programme are also actively promoted to students as we believe that the exposure students receive outside the Singapore-NUS educational environment adds value to their undergraduate education and contributes to their personal growth.

## 3.2 Degrees Offered

The Faculty offers two full-time degree programmes:

1. Bachelor of Science/Bachelor of Science (Hons.)

Majors available under the Bachelor of Science Programme include:

- Applied Mathematics
- Applied Mathematics (with specialisation in Mathematical Modelling and Data Analytics)
- Applied Mathematics (with specialisation in Operation Research and Financial Mathematics)
- Chemistry
- Chemistry (with specialisation in Materials Chemistry)
- Chemistry (with specialisation in Medicinal Chemistry)
- Chemistry (with specialisation in Environment and Energy)
- Computational Biology\*
- Data Science and Analytics
- Food Science and Technology
- Life Sciences
- Life Sciences (with specialisation in Biomedical Science)
- Life Sciences (with specialisation in Environmental Biology)
- Life Sciences (with specialisation in Molecular and Cell Biology)
- Mathematics
- Physics
- Physics (with specialisation in Astrophysics)
- Physics (with specialisation in Nanophysics)
- Quantitative Finance
- Statistics
- Statistics (with specialisation in Biostatistics)
- Statistics (with specialisation in Finance and Business Statistics)

2. Bachelor of Science (Pharmacy)/Bachelor of Science (Pharmacy) (Hons.)\*

\* Pharmacy, Computational Biology and Data Science and Analytics are strict four year programmes, while all other programmes allow for graduation after three years with a general Bachelor of Science degree. The Chemistry, Life Sciences, Applied Mathematics, Physics and Statistics majors offer general B.Sc.(Hons.) programmes as well as B.Sc.(Hons.) programmes with specialisation. Specialisation is only awarded for B.Sc.(Hons.) programmes.

The Faculty also offers a spread of minors, multidisciplinary programmes and special programmes for the educational broadening and enhancement of our students.

## **3.3 Degree Requirements**

3.3.1 [Curriculum Structure and Graduation Requirements](#)

3.3.2 [Policies and Procedures](#)

3.3.3 [Bachelor of Science/Bachelor of Science \(Hons.\) Programme Requirements \[B.Sc./B.Sc. \(Hons.\)\]](#)

3.3.4 [Bachelor of Science \(Pharmacy\)/Bachelor of Science \(Pharmacy\) \(Hons.\) \[B.Sc. \(Pharm.\)/B.Sc. \(Pharm.\) \(Hons.\)\]](#)

### **3.3.1 Curriculum Structure and Graduation Requirements**

3.3.1.1 [Bachelor of Science](#)

3.3.1.2 [Bachelor of Science \(Hons.\)](#)

3.3.1.3 [Bachelor of Science \(Pharmacy\)/Bachelor of Science \(Pharmacy\) \(Hons.\) Requirements](#)

3.3.1.4 [University Scholars Programme \(USP\) Graduation](#)

3.3.1.5 [Major Prerequisites](#)

3.3.1.6 [Faculty Requirements](#)

3.3.1.7 [Computational Thinking Requirement](#)

3.3.1.8 [SP1541/ES1541 Exploring Science Communication through Popular Science](#)

3.3.1.9 [English Skills \(ES\) Requirements](#)

3.3.1.10 [Honours Eligibility and Honours Projects](#)

3.3.1.11 [Degree Classification](#)

### 3.3.1.1 Bachelor of Science

To be awarded a Bachelor of Science Degree, students must have:

1. Satisfied the General Education Requirements comprising:
  - a. 20 MCs from General Education Modules (GEM)
2. Satisfied the Programme Requirements comprising:
  - a. 12 MCs of Faculty requirements (for B.Sc., except for students in Food Science and Technology major). Students in Food Science and Technology major must fulfill 16 MCs of Faculty requirements [please refer to Section 3.3.1.6 for more details]
  - b. For all Science students (except Pharmacy, Environmental Studies students, students on special programmes like SPS, USP and UTown residential programme and students residing in RVRC), SP1541 Exploring Science Communication through Popular Science is a compulsory Faculty requirement;
  - c. One set of major requirements.
3. Completed and passed a Computational Thinking module, according to the requirements. Please refer to Section 3.3.1.7 Computational Thinking Requirement.
4. Accumulated a minimum of 120 Modular Credits (MCs)\* (of which no more than 60 MCs may come from Level-1000 modules; Polytechnic Diploma holders who are granted advanced placement credits should refer to Section 3.3.2.1, for more details);
5. Obtained a cumulative average point (CAP) of at least 2.00;
6. Passed the requisite English Skills module(s) by the fourth semester (only applicable to students who fail to meet the exemption criteria based on the Qualifying English Test (QET) results); and
7. Fulfilled all the above within a maximum candidature of four years unless under extenuating circumstances. Semesters spent on approved Leave of Absence (LOA) would be excluded from the period of candidature.

\* Students will read a set of Unrestricted Elective Modules (apart from those modules read in fulfilment of General Education and Programme Requirements) to meet the minimum number of MCs required for graduation.

SUMMARY OF REQUIREMENTS FOR B.SC.		MCS
<b>University Level Requirements</b>		<b>20</b>
General Education		20
<b>Programme Requirements**</b>		
• B.Sc. (excluding FST major)		<b>64 - 86</b>
• For FST major		<b>84</b>
<b>Faculty requirements</b>		
• B.Sc. (excluding FST major)		<b>12</b>
• B.Sc.(for FST major)		16

SUMMARY OF REQUIREMENTS FOR B.SC.		MCS
<b>Major requirements [B.Sc.]</b>		
• B.Sc. (excluding FST major)		52 - 74
• B.Sc.(for FST major)		68
<b>Unrestricted Elective Modules (NOT including additional MCs due to reduced programme requirements as a result of MAJOR REQUIREMENTS DOUBLE COUNTING AS FACULTY REQUIREMENTS) **</b>		
• B.Sc. (excluding FST major)		14 - 36
• B.Sc.(for FST major)		16
<b>Total</b>		<b>120</b>

\*\* For some multidisciplinary/interdisciplinary majors, part of the 12/16 MCs from Faculty requirements are built into the major. MCs required under programme requirements will vary from student to student depending on (1) the student's choice of major, (2) the extent to which the Faculty requirements have been built into the student's major, and (3) the combination of modules a student reads for his/her major. This will in turn determine the number of unrestricted elective modules a student has to read to meet the minimum MCs required for graduation. Students are advised to refer to Sections 3.3.3 and 3.3.4 for specific MCs requirements with respect to their chosen major.

### 3.3.1.2 Bachelor of Science (Hons.)

To be awarded a Bachelor of Science (Hons.) Degree, students must have:

1. Satisfied the General Education Requirements comprising:
  - a. 20 MCs from General Education Modules (GEMs)
2. Satisfied the Programme Requirements comprising:
  - a. 16 MCs of Faculty requirements [for B.Sc. (Hons.), except for students in Food Science and Technology major.] Students in Food Science and Technology major must fulfill 20 MCs of Faculty requirements [please refer to Section 3.3.1.6 for more details]
  - b. For all Science students (except Pharmacy and Environmental Studies students, students on special programmes like SPS, USP and UTown residential programme and students residing in RVRC ) SP1541 Exploring Science Communication through Popular Science is a compulsory Faculty requirement;
  - c. One set of major requirements.
3. Completed and passed a Computational Thinking module, according to the requirements. Please refer to Section 3.3.1.7 Computational Thinking Requirement.
4. Accumulated a minimum of 160 Modular Credits (MCs)\* (of which no more than 60 MCs may come from Level-1000 modules; Polytechnic Diploma holders who are granted advanced placement credits should refer to Section 3.3.2.1, for more details);
5. Completed a mandatory year-long honours project module or the stated alternatives to the honours project module;
6. Obtained a cumulative average point (CAP) of at least 3.00;
7. Passed the requisite English Skills module(s) by the fourth semester (only applicable to students who fail to meet the exemption criteria based on the Qualifying English Test (QET) results);
8. Any other requirements as stipulated by the Faculty for graduation; and
9. Fulfilled all the above within a maximum candidature of five years (applicable to students completing single and double majors) where semesters spent on Leave of Absence (LOA) would be excluded from the period of candidature.

\* Students will read a set of Unrestricted Elective Modules (apart from those modules read in fulfilment of University Level and Programme Requirements) to meet the minimum number of MCs required for graduation.

SUMMARY OF REQUIREMENTS FOR B.SC. (HONS.)/B.APPL.SC (HONS.)	MCS
University Level Requirements	20
General Education	20
<b>PROGRAMME REQUIREMENTS**</b>	
• B.Sc. (Hons.)(excluding FST major)	100 - 122
• B.Sc. (Hons.)(for FST major)	120

<b>SUMMARY OF REQUIREMENTS FOR B.SC. (HONS.)/B.APPL.SC (HONS.)</b>		<b>MCS</b>
<b>Faculty requirements</b>		
B.Sc. (Hons.)(excluding FST major)		16
B.Sc. (Hons.)(for FST major)		20
<b>Major requirements [B.Sc. (Hons.)]</b>		
B.Sc. (Hons.)(excluding FST major)		84 - 106
B.Sc. (Hons.)(for FST major)		100
<b>UNRESTRICTED ELECTIVE MODULES (NOT INCLUDING ADDITIONAL MCS DUE TO REDUCED PROGRAMME REQUIREMENTS AS A RESULT OF MAJOR REQUIREMENTS DOUBLE COUNTING AS FACULTY REQUIREMENTS) **</b>		
B.Sc. (Hons.)(excluding FST major)		18 - 40
B.Sc. (Hons.)(for FST major)		20
<b>Total</b>		<b>160</b>

\*\* For some multidisciplinary/interdisciplinary majors, part of the 12/16 MCs from Faculty requirements are built into the major. MCs required under programme requirements will vary from student to student depending on (1) the student's choice of major, (2) the extent to which the Faculty requirements have been built into the student's major, and (3) the combination of modules a student reads for his/her major. This will in turn determine the number of unrestricted elective modules a student has to read to meet the minimum MCs required for graduation. Students are advised to refer to Sections 3.3.3 and 3.3.4 for specific MCs requirements with respect to their chosen major.



### 3.3.1.3 Bachelor of Science (Pharmacy)/Bachelor of Science (Pharmacy) (Hons.) Requirements

To be awarded a Bachelor of Science (Pharm.)/ Bachelor of Science (Pharm.) (Hons.) Degree, students must have:

1. Satisfied the University Level Requirements comprising:
  - a. 20 MCs from General Education modules (GEMs)
2. Satisfied the Programme Requirements comprising:
  - a. 16 MCs of faculty requirements; and
  - b. One set of major requirements.
3. Accumulated a minimum of 160 Modular Credits (MCs)\* (of which no more than 60 MCs may come from level-1000 modules);
4. Obtained a cumulative average point (CAP) of at least 3.00 for the award of the B.Sc. (Pharm.) (Hons.) degree. Students who obtain a CAP of between 2.0 to 2.99 will be awarded a B.Sc. (Pharm.) degree.
5. Completed the modules PR4197 Pharmacy Internship I, PR4198 Pharmacy Internship II, and PR4196 Pharmacy Research Project and Scientific Communication; and
6. Passed the requisite English Skills module(s) by the fourth semester (only applicable to students who fail to meet exemption criteria based on the Qualifying English Test (QET) results).

\* Students will read Unrestricted Elective Modules (apart from those modules read in fulfilment of University Level and Programme Requirements) to meet the minimum number of MCs required for graduation.

SUMMARY OF REQUIREMENTS FOR B.SC. (PHARM.)/B.SC (PHARM.) (HONS.) MCS	
University Level Requirements	20
General Education	20
Programme Requirements	124
Faculty requirements	16
Major requirements	108
Unrestricted Elective Modules	16
Total	160

### 3.3.1.4 University Scholars Programme (USP) Graduation

In general, scholars are required to fulfil the following USP requirements\*:

- i. Three Foundation Tier modules worth 12 MCs
- ii. Eight Inquiry Tier modules worth 32 MCs
- iii. One Reflection Tier module worth 4 MCs

\* For specific breakdown of USP requirements, students should refer to the USP website at [www.usp.nus.edu.sg](http://www.usp.nus.edu.sg)

Scholars who read and pass the USP modules are deemed to have fulfilled 16 MCs of University Level Requirements. The remaining 32 MCs will be counted towards major/Faculty requirements/unrestricted electives requirements.

#### USP Independent Study Modules (ISMs)

Scholars are allowed to read three types of ISMs:

1. ISMs riding on a regular department module (e.g. PC3224)
2. UROPS-based ISMs (e.g. LSM3288)
3. Newly-designed ISMs

The following are some guidelines on how the different types of ISMs (listed above) may count towards a student's major requirements:

1. Scholars who read and pass an ISM riding on regular department module are deemed to have passed the regular module on which the ISM rides (e.g. PC3224).
2. Scholars who read and pass a UROPS-based ISM are deemed to have passed the UROPS module on which the ISM rides (e.g. LSM3288). Whether the UROPS module may be used to fulfil students' major requirements depends on each department's/ programme's policy regarding the use of UROPS modules for fulfilling major requirements (refer to Section 3.5.3 for more details).
3. For newly-designed ISM, what the module will count towards (major requirements or otherwise) will be decided by the Department at point of ISM approval. Typically, modules that do not fit into the major will be read as Unrestricted Elective Modules.

Scholars must take at least one and up to three ISMs in place of regular Inquiry modules.

### 3.3.1.5 Major Prerequisites

All students are expected to read one major in fulfilment of their degree requirements and will declare their major at the beginning of their first year of study. (For specific requirements of each major, please refer to Section 3.3.3).

They should meet the prerequisites (as stated in the table below) before choosing a particular major. Criteria are set to ensure that students have the necessary base knowledge to pursue studies in their selected major as well as to register for the relevant modules.

MAJOR	PREREQUISITES
1. Chemistry 2. Chemistry (with specialisation in Materials Chemistry) 3. Chemistry (with specialisation in Medicinal Chemistry) 4. Chemistry (with specialisation in Environment and Energy)	Good H2 pass (or equivalent) in Chemistry, and at least a good 'O' Level pass in Mathematics.
5. Computational Biology*^	Good H2 passes (or equivalent) in Mathematics and either Biology or Chemistry. Students without H2 passes (or equivalent) in either Biology or Chemistry should have at least an O-Level (or equivalent) pass in it. Subject to departmental approval.
6. Data Science and Analytics+	Very good H2 pass (or equivalent) in Mathematics and a good H2 pass (or equivalent) in Biology or Chemistry or Physics or Computing

MAJOR	PREREQUISITES
7. Food Science & Technology**	<p>Good H2 pass (or equivalent) in Chemistry and a good H2 pass or equivalent in Biology or Mathematics or Physics or Computing/Computer Science, and a good pass in O-Level or equivalent, or above in Biology.</p> <p>Students without H2 pass in Biology are required to read the bridging module in Biology (i.e. LSM1301) in Semester 1 to fulfil the pre-requisite for the relevant Level 1000 Life Sciences module in the syllabus.</p>
8. Life Sciences 9. Life Sciences (with specialisation in Biomedical Science) 10. Life Sciences (with specialisation in Environmental Biology) 11. Life Sciences (with specialisation in Molecular and Cell Biology)	<p>Good H2 passes (or equivalent) in Biology, Chemistry and either Mathematics or Physics.</p> <p>Students without H2 pass in Biology or Chemistry may read the relevant bridging modules as entry requirements.</p>
12. Mathematics 13. Applied Mathematics 14. Applied Mathematics (with specialisation in Mathematical Modelling and Data Analytics) 15. Applied Mathematics (with specialisation in Operation Research and Financial Mathematics) 16. Statistics 17. Statistics (with specialisation in Data Science) 18. Statistics (with specialisation in Finance and Business Statistics) 19. Quantitative Finance*	<p>Good H2 pass (or equivalent) in Mathematics.</p> <p>Subject to departmental approval (applicable to Quantitative Finance only)</p>

MAJOR	PREREQUISITES
20. Physics 21. Physics (with specialisation in Astrophysics) 22. Physics (with specialisation in Nanophysics)	Good H2 passes (or equivalent) in Mathematics and Physics.
23. Pharmacy <sup>@+^†</sup>	Very good H2 passes (or equivalent) in Chemistry and either Biology, Mathematics or Physics.
24. Environmental Studies <sup>#+^</sup> (Specialisation in Environmental Biology)	Good H1 pass or equivalent in Mathematics and good H2 pass or equivalent in either Biology or Chemistry.

\* These majors are capped with quotas; eligibility to read these majors will be determined by additional selection criteria set by the department/programme.

@ B.Sc. (Pharm.)/ B.Sc. (Pharm.) (Hons.) degree.

+ Admission into the Data Science and Analytics, Environmental Studies, Food Science and Technology and Pharmacy programmes is by direct application.

^ With the exceptions of Computational Biology, Data Science and Analytics, Environmental Studies and Pharmacy, students in other majors have the option to exit after three years with a Bachelor's degree. The Chemistry, Life Sciences, Applied Mathematics, Physics and Statistics majors offer general B.Sc.(Hons.) programmes as well as B.Sc.(Hons.) with specialisation programmes. Specialisation is only awarded for B.Sc.(Hons.) programmes.

### 3.3.1.6 Faculty Requirements

Listed in Table 1 are the Faculty requirements for the different programmes. This should be read in reference to Table 2.

**TABLE 1: TABLE OF FACULTY REQUIREMENTS FOR VARIOUS PROGRAMMES**

PROGRAMME	FACULTY REQUIREMENTS
B.Sc. (for Food Science and Technology major, there is a separate set of requirements - refer below to B.Sc. (For FST major)	12 MCs from three distinct subject groups outside the group(s) under which the major falls.
B.Sc. (Hons.)(for Food Science and Technology major, there is a separate set of requirements - refer below to B.Sc.(Hons.) (For FST major)	16 MCs from at least three distinct subject groups outside the group(s) under which the major falls (where 4 MCs may come from the subject group under which the major falls, but not bearing the prefix of the major).
B.Sc. (For FST major)	4 MCs from Professional Placement Programme, and 8 MCs from two distinct subject groups outside the subject group(s) under which the major falls.
B.Sc.(Hons.) (For FST major)	4 MCs from Professional Placement Programme, and 12 MCs from at least two distinct subject groups outside the group(s) under which the major falls (where 4 MCs may come from the subject group under which the major falls, but not bearing the prefix of the major.)
B.Sc. (Pharm.)/ B.Sc. (Pharm.) (Hons.)	Please refer to section 3.3.4

**TABLE 2: TABLE OF SUBJECT GROUPS**

SUBJECT GROUP	MAJORS	MODULE CODE PREFIX
Computing Sciences	Computational Biology (ZB)	CS*, COS2000, IT1001*, IT1002*, IT1006*, QF, ZB
	Quantitative Finance (QF)	
Chemical Sciences	Chemistry (CM)	CM, FST, PR
	Chemistry (Specialisation in Materials Chemistry) (CM)	
	Chemistry (Specialisation in Medicinal Chemistry) (CM)	
	Chemistry (Specialisation in Environment and Energy) (CM)	
	Food Science & Technology (FST)	
	Pharmacy (PR)	
Life Sciences	Food Science & Technology (FST)	FST, LSM, PR
	Life Sciences (LSM)	
	Life Sciences (Specialisation in Biomedical Science) (LSM)	
	Life Sciences (Specialisation in Molecular & Cell Biology) (LSM)	
	Life Sciences (Specialisation in Environmental Biology) (LSM)	
	Pharmacy (PR)	

SUBJECT GROUP	MAJORS	MODULE CODE PREFIX
Mathematical & Statistical Sciences	Applied Mathematics (MA)	CZ, DSA, MA, QF, ST
	Applied Mathematics (Specialisation in Mathematical Modelling and Data Analytics) (MA)	
	Applied Mathematics (Specialisation in Operations Research and Financial Mathematics) (MA)	
	Data Science and Analytics (DSA)	
	Mathematics (MA)	
	Quantitative Finance (QF)	
	Statistics (ST)	
	Statistics (with specialisation in Biostatistics) (ST)	
	Statistics (with specialisation in Finance and Business Statistics) (ST)	
Physical Sciences	Physics (PC)	PC
	Physics (with specialisation in Astrophysics) (PC)	
	Physics (with specialisation in Nanophysics) (PC)	
Multidisciplinary & Interdisciplinary Sciences	—	FMS12XXB, FMS12XXC, FMS12XXM, FMS12XXP, FMS12XXR, FMS12XXS, SP1202, SP1203, SP1541, SP2251, SP3201, SP3202, SP3203, SP3277

\* Modules CSxxxx, IT1001, IT1002 and IT1006 are offered by the School of Computing but if read,



may be counted towards Faculty requirements from the Computing Sciences Subject Group.

**TABLE 3: PROVISIONS FOR STUDENTS IN SPECIAL PROGRAMMES**

PROGRAMME	PROVISION FOR SPS/USP STUDENTS
Special Programme in Science (SPS)	Students in the B.Sc. (resp. B.Sc. (Hons.)) Programme who have passed three (resp. four) of the six SPS Programme modules, namely SP2171, SP2173, SP2174, SP3172, SP3175 and SP3176, are deemed to have completed 12 MCs (resp. 16 MCs) of the Faculty Requirement from 3 distinct subject groups outside the group under which their major falls.
	Students in the B.Sc. Programme who have passed two or fewer of the SPS Programme modules are required to read modules from any subject group outside the group(s) under which the major falls, to make up 12 MCs.
	Students in the B.Sc. (Hons.) Programme who have passed three or fewer of the SPS Programme modules are required to read modules from any subject group outside the group(s) under which the major falls, to make up 16 MCs. Up to one of these modules read may come from the subject group under which the major falls, but not bearing the prefix of the major.
	Students who may have part of their Faculty Requirements fulfilled by modules within their majors can use the remaining MCs as Unrestricted Electives.
	Note: SP2171 is a module that spans two semesters. Students who withdraw from the Programme while still reading SP2171 will not be allowed to continue enrolling in SP2171.

PROGRAMME	PROVISION FOR SPS/USP STUDENTS
University Scholars Programme (USP)	<p>Students who have passed the following Inquiry modules under the USP revised curriculum (for Cohort 2012/13 onwards) can count it towards Faculty requirements as follows:</p> <p>UITXXXX- Counted towards Computing Sciences subject group</p> <p>UPC2209 - Counted towards Physical Sciences subject group</p> <p>UPC2208-Counted towards Chemical Sciences subject group</p> <p>UPC2207- Counted towards Physical Sciences subject group</p> <p>UPC2206- Counted towards Physical Sciences subject group</p> <p>ULSXXXX- Counted towards Life Sciences subject group</p> <p>UQRXXXX- Counted towards Mathematical &amp; Statistical Sciences group</p> <p>UNLXXXX- Counted towards Multidisciplinary &amp; Interdisciplinary Sciences group</p>

For more details on fulfilling Faculty requirements, students are advised to visit the following website:

<http://science.nus.edu.sg/undergraduate-studies/ugreq/curriculum-structure?id=212>

### 3.3.1.7 Computational Thinking Requirement

#### Computational Thinking Requirement

To remain relevant in the workplace of tomorrow, undergraduates should acquire basic computational skills, i.e. computational thinking (CT).

For FoS Students admitted in AY2017/18 onwards, the options to fulfil the CT requirement, by the respective Major Programmes are described below:

MAJORS	OPTIONS TO FULFIL COMPUTATIONAL THINKING REQUIREMENT
<b>Computational Biology, Data Science &amp; Analytics, Mathematics &amp; Applied Maths, Quantitative Finance, Statistics</b>	These Majors will continue to acquire higher-order computational and programming skills in the form of CS1010S Programming Methodology (or its variants) (within the Major's core requirement)
<b>Life Sciences Physics</b>	Option 1: COS2000 - Computational Thinking for Scientists or Option 2: CS1010S (or its variants) - Programming Methodology
<b>Chemistry, Food Science &amp; Technology</b>	Option 1: COS2000 - Computational Thinking for Scientists or Option 2: CM3267 - Computational Thinking and Programming in Chemistry* or Option 3: CS1010S (or its variants) - Programming Methodology
<b>Pharmacy</b>	It has been decided that the undergraduates for Cohort 2017/18 would be exempted from taking separate CT modules. Rather, the Pharmacy Department will work with the School of Computing to incorporate CT or elements of programming into the major requirements of Pharmacy.

MAJORS	OPTIONS TO FULFIL COMPUTATIONAL THINKING REQUIREMENT
<b>Bachelor of Environmental Studies (BES)</b>	<p>All undergraduates (from FASS and FoS, in BES, inclusive of BES students in the UTCP or USP programme), will be required to do GET1031A.</p> <p>BES students doing the UTCP at Residential College 4 (RC4) are exempted from GET1031A as the RC4 programme encourages explicit use of representing thinking, using computer models.</p>

Notes:

- For all FoS majors, the option to take “CS1010S (or its variants) - Programming Methodology” is open (even if it is not within your major programme requirements), and can be used to fulfil the CT requirement. However, do note that the availability of this module is subject to successful bidding.
- COS2000 will count as a module from the Computing Sciences subject group of the FoS Faculty requirements.
- \*New elective module CM3267 will be finalised soon and is targeted to be offered with effect from Sem 2 of AY2018/19.

#### Special Programme in Science students

Students who have completed the Special Programme in Science (SPS)’s requirement, by successfully passing the following modules:

1. SP2171 Discovering Science,
2. SP2173 Atoms to Molecules,
3. SP2174 The Cell,
4. SP3172 Integrated Science Project,
5. SP3175 The Earth, and
6. SP3176 The Universe,

are deemed to have fulfilled the CT requirement.

A student who does not complete the SPS requirement by passing all 6 SPS modules, would need to ensure that he/she fulfils the CT requirement by reading a module that counts towards the CT requirement, according to the options to fulfil CT requirement for his/her major.

#### Double Degree Programmes (DDP)

Higher-order computational skills, such as coding or programming methodology, will be required for the following schools and faculties – Science, Business, Engineering, Design & Environment, and Computing. For FASS, basic skills in CT are required, and this is achieved via compulsory module, GET1031A.

1. For students doing DDP in Science and FASS, the CT requirement for FoS will prevail.
2. In the case of a student who is required to do higher-order CT (e.g., *BComp (Hons) - BSc (Hons) Double Honours Programmes*) in both degrees, the higher-order CT module which has been listed as a **common** requirement by both faculties, will apply. Otherwise, the Home Faculty's CT requirement should then take precedence.

### Double Majors (DMP)

The same set of principles to apply – refer to DDP (1) and (2) above, if your 1<sup>st</sup> major is from FoS, and your 2<sup>nd</sup> major is from another Faculty.

If both your majors are from FoS, as long as you have read a module fulfilling CT requirement in either one of your majors, you would be deemed to have fulfilled the CT requirement.

### Transfer cases (full credit transfer):

1. A student transferring out of FASS to FoS, who brings his or her grade obtained for GET1031A, should still fulfil the CT requirement stipulated by the new Home Faculty, FoS.
2. A student transferring out of a School or Faculty which has higher-order CT requirement, may fulfil CT requirement with this grade and credit obtained. Nevertheless, if the new Home Faculty has another CT module being listed as a compulsory programme requirement, he or she must still fulfil the new Home Faculty's programme requirement. FoS students transferring to another Faculty should check with their new Home Faculty on how to fulfil the CT requirement.

### **3.3.1.7 SP1541/ES1541 Exploring Science Communication through Popular Science**

In order to develop essential communication skills in all Science undergraduates so that they will be able to critically read and comprehend science-related publications as well as to articulate scientific arguments and perspectives coherently, the Centre for English Learning and Communication and Faculty of Science have co-developed a module SP1541/ES1541 Exploring Science Communication through Popular Science. This is a compulsory module for all Science students (except for students reading Pharmacy, Environmental Studies, students on special programmes like SPS, USP and UTown residential programme and students residing in RVRC) matriculated in AY2013/14 onwards and is in line with the educational goal of the University in offering a writing module for all NUS freshmen. Science students matriculated in AY2015/16 and onwards will read the module code SP1541 while students matriculated in AY2014/15 and before read the module code ES1541. SP1541 is counted towards the Multidisciplinary & Interdisciplinary Sciences subject group of the Faculty requirements.

Please refer to

<http://www.science.nus.edu.sg/undergraduate-studies/ugsap/ugsap-out/summer-programme/186-undergraduate/ugreq/curriculum-structure/708-es1541-sp1541> for more information.

### **3.3.1.8 English Skills (ES) Requirements**

Based on the Qualifying English Test results, students who do not meet exemption criteria have to take and pass ES1103 English for Academic Purposes. In addition, very weak students have to take and pass ES1000 Basic English Course before proceeding to ES1103.

ES1000 is not counted towards Modular Credits and CAP. However, it is counted as part of the workload for every semester. (Please refer to section 3.3.2)

ES1103 is worth 4MC and letter-graded (with the option to convert to S/U grade).

Students who need to clear ES requirements for graduation are strongly encouraged to do so by their second semester at the latest.

### **3.3.1.9 Honours Eligibility and Honours Projects**

#### **For B.Sc. (Hons.)**

1. Students who matriculated in and after AY2012/2013(excluding those majoring in Computational Biology and Quantitative Finance), and students who matriculate in and after AY2014/15 majoring in Quantitative Finance will be eligible for Honours if they have:
  - a. Fulfilled the requirements of one major at B.Sc. level; and
  - b. Obtained a minimum overall CAP of 3.20 on completion of 100 MCs or more.

#### Registering for Honours Projects:

1. Students in majors excluding Computational Biology must have fulfilled the minimum eligibility criteria (as stated in Para i. above) at the point of registering for the honours project module. Students from the Food Science and Technology major must have completed one semester of professional placement.
2. Students who choose not to proceed to Honours even though they are eligible may exit from the programme and graduate with a B.Sc. degree after satisfying graduation requirements at B.Sc. level (see Section 3.3.1, Para A).

#### **For B.Sc. (Hons.)**

The Computational Biology major is a four-year programme leading to a Bachelor of Science (Hons.) degree, subject to a minimum CAP attainment.

#### **For B.Sc. (Pharm.) (Hons.)**

Pharmacy is a four-year programme leading to a Bachelor of Science (Pharmacy) (Hons.) degree, subject to a minimum CAP attainment.

Students admitted to the programme from AY2014/2015 onwards have to complete PR4196 Pharmacy Research Project and Scientific Communication in Pharmacy in their final year.



### 3.3.1.10 Degree Classification

All students are on a track that leads to either the B.Sc./B.Sc. (Pharm.) or B.Sc. (Hons.)/B.Sc. (Pharm.) (Hons.) degree. CAP computation is based on all modules completed at all levels, excluding:

1. Modules for which grades obtained have no assigned grade points (for e.g. EXE, OCT, OVS, S/U, CS/CU, IC, IP); and
2. ES1000 Basic English Course.

Students' degree and Honours classification will be determined by their CAP as follows:

#### **B.Sc. (Hons.)/B.Sc. (Pharm.) (Hons.)**

<b>CLASSIFICATION</b>	<b>CAP CUT-OFFS</b>
Honours (Highest Distinction)	4.50 & above
Honours (Distinction)	4.00 – 4.49
Honour (Merit)	3.50 – 3.99
Honours	3.00 – 3.49
Pass [B.Sc. / B.Sc. (Pharm.)]	2.00 – 2.99
Fail	Below 2.00

#### **B.Sc.**

<b>CLASSIFICATION</b>	<b>CAP CUT-OFFS</b>
Pass with Merit	3.00 and above
Pass	2.00 – 2.99
Fail	Below 2.00

## **3.3.2 Policies and Procedures**

3.3.2.1 [Advanced Placement/Exemptions](#)

3.3.2.2 [Workload](#)

3.3.2.3 [Types of Modules](#)

3.3.2.4 [Repeating Modules](#)

3.3.2.5 [Overlapping Modules](#)

3.3.2.6 [Independent Study Modules \(ISM\)](#)

3.3.2.7 [Continuous Assessment](#)

3.3.2.8 [Filing for Graduation/Project Options](#)

### **3.3.2.1 Advanced Placement/Exemptions**

#### **Exemptions from Programme Requirements**

Before a student may read more advanced level modules within their chosen area of specialisation, they are assumed to possess a base of knowledge on which the subject matter of a particular advanced module will be built.

Advanced placement allows a student to read more advanced modules by being credited for the prerequisites of these higher level modules. This means that a student can graduate within a shorter time by gaining exemptions and Modular Credits from lower level modules.

Polytechnic Diploma Holders as well as students with H2, NUSHS diploma and International Baccalaureate (IB) or equivalent qualifications who have obtained good grades may be granted advanced placement credits of up to 20 MCs for programme requirements subject to their performance in placement tests and/or interviews carried out by the relevant departments. The placement tests would be taken at the point of admission to the University.

Modules for which advanced placement may be awarded are:

Chemistry: CM1121, CM1131

Life Sciences: LSM1102, LSM1401

Mathematics: MA1101R, MA1102R, MA1100\*, MA1505

Physics: PC1141, PC1142, PC1143, PC1144, PC1431

Statistics: ST1131

\* Only students who were medal winners in the International Mathematical Olympiad may apply to be considered for advanced placement credit for MA1100.

Students who have read and passed H3 modules at NUS are not allowed to sit for Advanced Placement Test for the module(s) that they have read and passed. Students have to declare the H3 modules that they have read at the point of application for the Advanced Placement Test.

Students are deemed to have successfully read and passed the module(s) for which they have been granted advanced placement credits and will not be allowed to register for this/these module(s) subsequently. The module(s) from which students have been granted exemption will not be included in the calculation of the CAP.

#### **Exemptions from Unrestricted Elective Modules (Only applicable to polytechnic diploma holders)**

Polytechnic Diploma holders admitted to the Faculty will be automatically granted advanced placement credits of 20 MCs (not subject to performance in placement tests) as follows:

1. 20 MCs from Unrestricted Elective Modules (UEM).

\* All 20 MCs of advanced placement credits are tagged at Level-1000. However, none of the MCs will be counted against the 60-MC limit on Level-1000 modules that students are allowed to read in fulfilment of the 120/160 MCs required for graduation.

### **3.3.2.2 Workload**

1. Minimum workload: 18 MCs per semester. Students are only allowed to read less than 18 MCs in their graduating semester or when they are undertaking industrial attachment. Recommended workload: 20 MCs per semester.
2. Existing students wishing to read more than 26 MCs must have a CAP of at least 3.20.
3. Newly-matriculated students who wish to read more than 26 MCs must seek approval from the Science Dean's Office via the Centralised Online Registration System (CORS).

### 3.3.2.3 Types of Modules

Modules are classified as follows:

TYPE OF MODULES	DESCRIPTION
Essential Modules	These are modules that candidates must pass in a subject major.
Elective Modules	These are modules that candidates may elect to read in order to fulfil the requirements for a Major. If they fail an elective, they may either retake it or read another elective.
Enrichment Modules	These are modules offered primarily to candidates who are not majoring in the subject, and may include modules offered by other Faculties.

The first digit of the four-digit code for a module represents the level (Level 1, 2, 3, 4 or 5) of the module. The second digit of each four-digit code is used to indicate the type of module, i.e., 1 for essential, 2 for elective, 3 for enrichment.

Modules (Level 1 to 5) may have prerequisites which a candidate must fulfil before he/she is eligible to read. Prerequisites may be “read” or “pass” prerequisites. For “read” prerequisites, the candidate needs only to read the module; a pass in the module is not required. For a “pass” prerequisite, the candidate must have been given exemption or Advanced Placement Credits for the module or have read and passed the module (D grade or better, or S (Satisfactory) grade). All prerequisites are “pass” prerequisites, unless otherwise stated.

Prerequisites indicate the base of knowledge on which the subject matter of a particular module will be built. Before taking a module, a student should complete the stated module prerequisites listed for that particular module.

### **3.3.2.4 Repeating Modules**

Students are not allowed to repeat modules they have passed i.e. grade D or better, or S (Satisfactory) grade. Both S (Satisfactory) and U (Unsatisfactory) grade will contribute towards the 32MCs worth of S/U Option entitlement.

### 3.3.2.5 Overlapping Modules

Some modules offered may overlap substantially in content with each other. These modules would hence be cross-listed with or precluded by another. Students are discouraged from taking overlapping modules unless both are required to attain a double major or degree, etc. In the event that a student reads two or more modules that overlap, they will only be awarded with the Modular Credits of one module, unless otherwise stated.

Please refer to the list of modules and their respective overlaps at <http://science.nus.edu.sg/images/undergraduate/acadprog/Overlap.pdf>. It is the student's responsibility to check if their modules overlap with each other. When in doubt, they should consult the course instructor or an academic advisor.



### **3.3.2.6 Independent Study Modules (ISM)**

#### **Modules for ISM**

Unless there is a compelling reason, only modules from the current list of Level-2000 and higher modules, offered as regular modules in the semester under consideration, may be read as ISMs. Level-1000 modules are excluded because the material that is normally covered in a Level-1000 module should not require the level of special mentoring expected of an ISM.

#### **Eligibility to do ISMs**

Only students with CAP 4.50 and above are eligible to sign up for up to a maximum of two ISMs during their undergraduate candidature.

For USP students, this CAP requirement does not apply for the ISMs that they are expected to read in fulfilment of USP advanced module requirements.

Note:

Registration of ISMs will be done manually through the respective Department offering the ISMs. All students reading ISM(s) for the semester for USP requirements will need to submit a standard application form downloadable from the student portal.

### **3.3.2.7 Continuous Assessment**

Continuous assessment (CA) will be taken into account and it normally contributes between 20 percent and 40 percent of the final grade of a module unless otherwise stated by the department. Homework, quizzes, tests, practicals, essays, projects, seminar presentations, performance during tutorials, field trips and other project work etc. are bases for continuous assessment.

### 3.3.2.8 Filing for Graduation/Project Options

#### File For Graduation

Students will file for graduation online when they register for modules in their final semester. The filing can be done during the online registration period via the Centralised Online Registration System (CORS). Students must have obtained a minimum of 94 MCs (for bachelor's degree) or 120 MCs (for honours degree) before they can do so. Graduation will be delayed for students who miss the deadline for filing for graduation.

Students who wish to read additional modules after fulfilling the degree requirements are only allowed to stay for at most one additional semester in which at least 18 MCs of Level-3000 and higher modules have to be read.

#### Conversion of filing status after the release of examination results

Students who have filed for their graduation earlier in the semester but would like to pursue Honours (after meeting the Honours eligibility criteria) have up to three (3) calendar days (from the date of release of the examination results) to convert their filing status from "File for Graduation" to "File for Honours Project". Students may convert their filing status via the FFG Conversion website:

<https://neon.science.nus.edu.sg/intranet/student/undergraduate/ffg/convertffg/>

#### File for Honours Project

Students who intend to take honours projects in their respective majors have to file for Honours Project one semester before registering for their honours project. For example, if you intend to take the honours project in Semester 1, AY2017/2018, you will have to file for honours project at the beginning of Semester 2, AY2016/2017 during module registration. This filing may be done during the online registration period via CORS.

To qualify for honours projects, students must have fulfilled the minimum honours eligibility criteria as spelt out in Section 3.3.1, Para. H.

#### Conversion of filing status after the release of examination results

Students who filed for their honours project earlier in the semester but do not intend to pursue honours have up to three (3) calendar days (from the date of release of the examination results) to convert their filing status from "File for Honours Project" to "File for Graduation". Students may convert their filing status via the FFG Conversion website:

<https://neon.science.nus.edu.sg/intranet/student/undergraduate/ffg/convertffg/>



### **3.3.3 Bachelor of Science/Bachelor of Science (Hons.) Programme Requirements [B.Sc./B.Sc. (Hons.)]**

3.3.3.1 [Chemistry](#)

3.3.3.2 [Computational Biology](#)

3.3.3.3 [Food Science and Technology](#)

3.3.3.4 [Data Science and Analytics](#)

3.3.3.5 [Life Sciences](#)

3.3.3.6 [Mathematics and Applied Mathematics](#)

3.3.3.7 [Physics](#)

3.3.3.8 [Quantitative Finance](#)

3.3.3.9 [Statistics](#)

### 3.3.3.1 Chemistry

How can fish and other aquatic life survive when water freezes in winter? What are the components of the air you breathe in? Which has greater global warming potential methane or carbon dioxide? What happens when lightning streaks through the atmosphere? What is done to prevent barnacles from growing on the hulls of ships and what are the environmental consequences of this action? Have you ever wondered about questions like these? Chemistry supplies answers to these and countless other questions, and by its very nature, occupies a central position among the sciences. Our lives have benefited enormously from Chemistry. It is in our own interest, as literate citizens and consumers, to understand the far-reaching effects, whether positive or negative, that Chemistry has on our lives and to be able to make informed decisions about the role Chemistry has to play in our world. It is not surprising for topics in Chemistry to range from the mathematical such as Quantum Chemistry to the biological such as Bioactive Molecules.

#### Programme Structure & Curriculum Rationale

Aside from the foundational and introductory modules at Level-1000, the curriculum is built upon the following major branches of a chemistry education:

- Theoretical Chemistry
- Physical Chemistry
- Analytical Chemistry
- Inorganic Chemistry
- Organic Chemistry

Together with the spectroscopic applications they form the bulk of Level-2000 modules and lay out the important concepts of bonding, intramolecular and intermolecular interactions and transformations. Students are required to read all of these modules to obtain a solid foundation for more advanced topics in the latter stages of the course, such as:

- Instrument Analysis
- Biomolecules
- Transition Metal Chemistry
- Organic Reaction Mechanisms
- Quantum Chemistry and Molecular Thermodynamics

The course has been planned to incorporate maximum flexibility. The student can select predominantly from modules which provide a more detailed coverage of the area of focus, or opt for a larger proportion of modules which provide broadening into other chemical disciplines relevant to the industry and research.

Students who complete the BSc (Hons) Degree Programme and satisfy specific requirements have an option to file for graduation with specialisation in one of the following areas:

- Materials Chemistry
- Medicinal Chemistry

- Environment and Energy

Lecturers will impart knowledge gained from their own rich research experience in several frontier areas including Chemistry of Interfaces, Surface Chemistry, Asymmetric Synthesis, Specialty Polymers, Biomaterials, Drug Design, Supramolecular Chemistry, Computational Quantum Chemistry, Combinatorial Chemistry, Nanomaterials and various Modern Analytical Techniques in order to provide a stimulating learning environment for the students.

In addition to formal lectures, learning is also achieved through laboratory modules in order that the basis of all scientific knowledge on proper experimentation is fully appreciated. These include Advanced Experiments in Inorganic, Organic, Analytical and Physical Chemistry. The emphasis of this programme is on a hands-on problem-solving approach to Chemistry, drawing on knowledge gained during the lectures and tutorials, to obtain a critical evaluation and a high standard of presentation of experimental work, to gain proficiency in the use of advanced analytical instruments available in the Department and to attain familiarity with aspects of experimental design and laboratory safety.

## **Career Prospects**

Chemistry students have the best possible combination of numerical and literal credentials that a prospective employer looks for. Not only are chemistry-related jobs open to students, but those at first sight not even remotely resembling chemistry are there for the taking; banking and finance, business, public relations, sales, engineering, administration, management, writing and journalism, and even politics.

The Department's main mission is to train the vital human resource needed for the growth of the national economy. Our graduates, both generalists as well as specialists, are found in the private and public sectors. They can be found working in a myriad of jobs at all levels within the chemical, petrochemical, food, beverage, biomedical, pharmaceutical and electronics industries. Our graduates also serve in government and quasi-government organisations, as well as in our schools and junior colleges.

Graduates with advanced degrees also find ready employment in Singapore. Increasingly, R&D positions are becoming available in the universities, polytechnics, research institutes and industry.

## **Graduation Requirements**

To be awarded a BSc or BSc (Hons) with a primary major in Chemistry, candidates must satisfy the following:

### **I. BSC IN CHEMISTRY**

BSC IN CHEMISTRY			CUMULATIVE MCS
LEVEL	MINIMUM REQUIREMENTS		
1000	CM1111	Inorganic Chemistry 1	24
	CM1121	Organic Chemistry 1	
	CM1131	Physical Chemistry 1	
	CM1191	Experiments in Chemistry 1	
	MA1421	Basic Applied Mathematics for Sciences or	
	MA1102R	Calculus	
	LSM1401	Fundamentals of Biochemistry or equivalent	
2000	CM2101	Physical Chemistry 2	44
	CM2111	Inorganic Chemistry 2	
	CM2121	Organic Chemistry 2	
	CM2191	Experiments in Chemistry 2	
	CM2192	Experiments in Chemistry 3	
3000	CM3291	Advanced Experiments in Inorganic and Organic Chemistry	64
	CM3292	Advanced Experiments in Analytical and Physical Chemistry	
	*Any other three (3) CM elective modules from Level-3000 <sup>a</sup> (excluding		
	CM3289) <sup>#</sup> .		

\*Students are allowed to replace 4MCs of Level-3000 CM elective modules with Level-4000 CM prefixed modules.

<sup>#</sup>UOPS CM3288 can be counted as 4 MC. However, if two semesters work of UOPS is completed, CM3289 is not counted.

<sup>a</sup> Please refer to the Department of Chemistry webpage at

<http://www.chemistry.nus.edu.sg/education/undergrads/PrimaryMajor/chemistry.htm> for the list of Level 3 CM modules

## II. BSC (HONS) IN CHEMISTRY (NO SPECIALISATION)



LEVEL	BSC (HONS) IN CHEMISTRY MINIMUM REQUIREMENTS	CUMULATIVE MCS
1000	CM1131 Physical Chemistry 1 CM1111 Inorganic Chemistry 1 CM1121 Organic Chemistry 1 CM1191 Experiments in Chemistry 1 MA1421 Basic Applied Mathematics for Sciences or MA1102R Calculus LSM1401 Fundamentals of Biochemistry or equivalent	24
2000	CM2101 Physical Chemistry 2 CM2111 Inorganic Chemistry 2 CM2121 Organic Chemistry 2 CM2191 Experiments in Chemistry 2 CM2192 Experiments in Chemistry 3	44
3000	CM3291 Advanced Experiments in Inorganic and Organic Chemistry CM3292 Advanced Experiments in Analytical and Physical Chemistry	52
3000/4000	Any <u>seven</u> (7) CM modules (or specified non-CM modules) at Level 3000 or 4000 with at least four such modules at Level 4000. <sup>a,b</sup>	80
4000	CM4199A Honours Project in Chemistry (16 MCs) OR CM4299 Applied Project in Chemistry (16 MCs)	<b>96</b>

<sup>a</sup> Students may take up to one level 5000 module in place of a Level 4000 module.

<sup>b</sup> Please refer to the Department of Chemistry webpage at <http://www.chemistry.nus.edu.sg/education/undergrads/PrimaryMajor/chemistry.htm> for the list of Levels 3 and 4 CM modules

To be awarded a BSc (Hons) with Specialisation in Chemistry (in either Materials Chemistry, Medicinal Chemistry or Environment and Energy), candidates must satisfy the following:

LEVEL	BSC (HONS) IN CHEMISTRY WITH SPECIALISATION MINIMUM REQUIREMENTS	CUMULATIVE MCS
1000	Identical to BSc (Hons) in Chemistry	24
2000	Identical to BSc (Hons) in Chemistry	44
3000	CM3291 Advanced Experiments in Inorganic and Organic Chemistry CM3292 Advanced Experiments in Analytical and Physical Chemistry	52
3000/4000	<p>1. If CM4199A Honours Project in Chemistry is in area of Specialisation, any <u>seven</u> (7) CM modules (or specified non-CM modules) at Level 3000 or 4000 with at least <u>four</u> (4) such modules at Level 4000<sup>a</sup> and at least <u>four</u> (4) such modules in area of Specialisation;<sup>b,c</sup></p> <p>Note: Specialisation Requirement is made up of at least four modules or 16MC from Level 3000 or 4000 CM modules in area of specialization plus 8MC from CM4199A, totaling at least 24MC.</p> <p>OR</p> <p>2. If CM4199A Honours Project in Chemistry is <u>not</u> in area of Specialisation or CM4299 Applied Project in Chemistry is read, any seven (7) CM modules at Level 3000 or 4000 with at least <u>four</u> (4) such modules at Level 4000<sup>a</sup> and at least <u>six</u> (6) such modules in area of Specialisation<sup>c</sup>;</p> <p>Note: Specialisation requirement is made up of at least six modules or 24MC selected from Level 3000 or 4000 CM modules in area of specialization.</p>	80
4000	CM4199A Honours Project in Chemistry (16 MCs) OR CM4299 Applied Project in Chemistry (16 MCs)	<b>96</b>

<sup>a</sup>Students may take up to one level 5000 module in place of a Level 4000 module

<sup>b</sup>8 MCs of the Honours Project in Chemistry (CM4199A, 16 MCs) could be counted toward Specialisation requirement.

<sup>c</sup> Please refer to the Department of Chemistry webpage at <http://www.chemistry.nus.edu.sg/education/undergrads/PrimaryMajor/chemistry.htm> for the list of modules in each area of specialisation.

SUMMARY OF REQUIREMENTS	BSC	BSC (HONS)	BSC (HONS) WITH SPECIALISATION
University Requirements	20 MCs	20 MCs	20MCs
Faculty Requirements	4 MCs*	8 MCs	8 MCs*
Major Requirements	64 MCs	96 MCs	96 MCs
Unrestricted Elective Modules	32 MCs	36 MCs	36 MCs
Total	120 MCs	160 MCs	160 MCs

\* Faculty requirements of 12 MCs and 16 MCs required for the BSc and BSc (Hons) programmes respectively are partially fulfilled through the reading of MA1421 and LSM1401 within the major.

Students undertaking the BSc programme are required to fulfil the remaining 4 MCs of Faculty requirements from any one of the following subject groups: Computing Sciences, Physical Sciences and 'Multidisciplinary & Interdisciplinary Sciences'; but not from the following subject groups: Chemical Science, Life Sciences, Mathematical and Statistical Sciences.

Students undertaking the BSc (Hons) programme are required to fulfil the remaining 8 MCs of Faculty requirements as such:

1. 4 MCs from any one of the following subject groups: Computing Sciences, Physical Sciences and Multidisciplinary & Interdisciplinary Sciences; but not from the following subject groups: Chemical Sciences, Life Sciences, Mathematical and Statistical Sciences
2. 4 MCs of Non-CM prefixed module from any subject group

### 3.3.3.2 Computational Biology

Today, the field of Computational Biology is a well-recognised and fast-emerging discipline in scientific research, with the potential of producing breakthroughs likely to impact the whole spectrum of the life sciences. Its distinguishing feature is the explosive growth of data generated by the post-genomic era and proteomics research, which requires novel and state-of-the-art computational approaches and instrumentations for their most effective analysis. Since the unravelling of the three-dimensional structure of DNA half a century ago, molecular and structural biology has experienced extraordinary progress, resulting in enhanced understanding of biological systems. This deeper understanding is obtained through the interdisciplinary interaction of Biology with the Computational and Mathematical Sciences, which has led to the emergence and recognition of Computational Biology as a discipline at the interface of these sciences. This discipline has today a well-connected peer community, with a host of well-established conferences and publication venues. Research has also been concomitant with the emergence of a vigorous professional market, spearheaded by the pharmaceutical and biomedical industries.

#### Programme Structure and Curriculum Rationale

Launched in 2004, the main objective of this four-year programme aims to provide a multidisciplinary education that would produce graduates who would be equally at ease with algorithm design, mathematical and statistical analysis as they would be with biochemistry, biology/genetics, and wet-lab know-how.

Science students accepted into the programme will be on a four-year track that leads to a B.Sc. (Hons.) in Computational Biology. The structure of the programme will be such that students will read a basket of core multidisciplinary modules (lower division) in their first two years of study and proceed to an upper division specialised track in the next two years.

The lower division modules embrace a fundamental body of knowledge in which a computational biologist should be proficient in. This body of knowledge consists of the following:

- Discrete mathematics and combinatorics, i.e., logic, sets, graphs, counting techniques, etc.
- Probability and statistics, i.e., sample spaces, random variables, conditioning, distributions, design of experiments, significance tests, statistical inference, etc.;
- Algorithm design and proficiency in some current programming language, i.e., combinatorial algorithms, algorithmic paradigms, analysis and design, working knowledge of current languages (for example, C, C++, Java) and experience in writing actual nontrivial code;
- Organic chemistry and biochemistry;
- Biology and genetics, including a moderate amount of wet-lab experience

The upper division specialised track will strengthen the student's knowledge in the theoretical

foundations of DNA/protein sequence analysis, mathematical models of genetic interactions and metabolic and cell signalling pathways, as well as modelling and computational prediction of protein structures and its applications in drug design. Students taking this track will need to have strong foundations in numerical analysis, stochastic process, and advanced calculus.

### Career Prospects

Graduates from the programme will be equipped for a career as a researcher, analyst or engineer in the fast-paced pharmaceutical, biomedical or biotechnology industries. This will also help meet the demand of the local market for talents with such skill sets. Moreover, the breadth of instruction will pave the way for students with a passion for computational biology to pursue graduate studies in Bioinformatics.

### Graduation Requirements

PROGRAMME REQUIREMENTS		MCS
University Requirements		
5 x General Education Modules	20	20
Faculty Requirements		
CM1401 Chemistry for Life Sciences <sup>[1]</sup> LSM1102 Molecular Genetics <sup>[1]</sup> MA1101R Linear Algebra I SP1541 Exploring Science Communication through Popular Science <sup>[2]</sup>	16	
Major Requirements		

PROGRAMME REQUIREMENTS		MCS
Level-1000 / 2000 Essential <sup>[1]</sup>		32 - 36
CS1010S or CS1010X Programming Methodology <sup>[3]</sup>	4	
CS2040 Data Structures and Algorithms	4	
CS1231 Discrete Structures or MA1100 Fundamental Concepts of Mathematics	4	
LSM1106 Molecular Cell Biology	4	
MA1102R Calculus	4	
CS2220 Introduction to Computational Biology <sup>[4]</sup> <u>OR</u> LSM2241 Introductory Bioinformatics	4	
LSM2211 Metabolism and Regulation <u>OR</u> LSM2232 Genes and Genomes <u>OR</u> LSM2233 Cell Biology	4	
Either ST2334 Probability and Statistics <u>OR</u> a combined ST2131 Probability and ST2132 Mathematical Statistics*	4 - 8	
Level-3000 Essential		8
MA3259 Mathematical Methods In Genomics	4	
LSM3241 Genomic Data Analysis	4	

PROGRAMME REQUIREMENTS			MCS
Level-3000 Electives <sup>[4]</sup> (Choose <u>Four</u> Modules) - [Any two modules from option A <u>and</u> any two modules from option B] <u>Option A</u> CS2102 Database System CS3103 Computer Networks Practice CS3225 Combinatorial Methods in Bioinformatics CS3230 Design and Analysis of Algorithms CS3240 Interaction Design CS3241 Computer Graphics CS3243 Introduction to Artificial Intelligence CS3244 Machine Learning <u>Option B</u> LSM3211 Fundamental Pharmacology LSM3223 Immunology LSM3225 Molecular Microbiology LSM3231 Protein Structure and Function LSM3232 Microbiology LSM3233 Developmental Biology LSM3243 Molecular Biophysics PC3267 Biophysics II <sup>[5]</sup> MA3233 Combinatorics and Graphs II ST3131 Regression Analysis ST3240 Multivariate Statistical Analysis ST3232 Design and analysis of experiments ST3233 Applied time series analysis ST3236 / Stochastic Process 1 MA3238 ST3247 Simulation ST3248 Statistical Learning I			16
Level-4000 Essential			20
ZB4199	Honours Project in Computational Biology	12	
ZB4171	Advanced Topics in Bioinformatics	4	
LSM4241	Functional Genomics	4	

PROGRAMME REQUIREMENTS		MCS
Level-4000 Electives (Choose <u>Three</u> Modules) - [Any two modules from either option A or option B or option C, and the remaining third module to be selected from the Option not chosen] <u>Option A</u> CS4220 Knowledge Discovery Methods in Bioinformatics CS4221 Database Applications Design and Tuning CS4231 Parallel and Distributed Algorithms CS4234 Optimisation Algorithms CS4237 Systems Modelling and Simulations CS4243 Computer Vision and Pattern Recognition CS4244 Knowledge-Based Systems CS4248 Natural Language Processing <u>Option B</u> LSM4211 Toxicology LSM4212 Pharmacogenetics and Drug Response LSM4213 Systems Neurobiology LSM4221 Drug discovery and Clinical Trials LSM4222 Advanced Immunology LSM4224 Free Radicals and Antioxidant Biology LSM4226 Infection and Immunity LSM4231 Structural Biology LSM4232 Advanced Cell Biology LSM4242 Protein Engineering		12
<u>Option C</u> MA4251/ Stochastic Processes II ST4238 PC4267 Biophysics III ST4231 Computer Intensive Statistical Methods ST4234 Bayesian Statistics ST4242 Analysis of Longitudinal Data ST4248 Statistical Learning II		
<b>Unrestricted Elective Modules</b> <sup>[4]</sup>		32 - 36
<b>Total</b>		<b>160</b>

Note 1:



Modules are part of the lower division requirements for the Computational Biology Programme.

Note 2:

The following groups of students who are precluded from reading SP1541/ES1541:

- Students who are UTown residents and have read and passed the IEM, UTW and UWC modules
- Students who are RVRC residents and have read and passed ES1601 module
- Students who are in SPS and have read and passed the SP2171
- Students who are in USP and have read and passed the UWC2101% modules

will have to read another module instead of SP1541 to fulfil 4 MCs of Faculty requirements, except for students in SPS who have read and passed SP2171 as SP2171 can be used to fulfil 4 MCs of Faculty Requirements.

Note 3:

CS1101S Programming Methodology (5 MCS) may be read as an alternative to CS1010S. This module is suitable for those with prior experience in Python. Do note that registration to this module is subject to host availability.

Note 4:

ZB3288 UROPS in Computational Biology can be taken in fulfilment of 4 MCs from any of the options in the level-3000 elective list.

Note 5:

Students may wish to read PC2267 Biophysics I as an unrestricted elective module to meet the prerequisites required for PC3267 Biophysics II (Level-3000 major elective module).

\* Students should choose the combined ST2131 and ST2132 in place of ST2334 if they plan to pursue higher ST modules. ST2131 is a pre-requisite to ST2132.

Summary of Requirements	B.Sc. (Hons.)
University Requirements	20 MCs
Faculty Requirements	16 MCs
Major Requirements	88-92 MCs
Unrestricted Elective Modules	32-36 MCs
Total	160 MCs



### **3.3.3.3 Food Science and Technology**

A safe and adequate food supply is one of man's basic needs and the food industry today has grown into a multi-billion dollar industry to service this need. The modern food industry increasingly operates within the global market and requires academically well-qualified graduates to be its future researchers and managers. Such professionals will need to understand the science and technology of food the market needs and be capable of operating within the international food industry. In this increasingly competitive market, graduates will have to be technically competent, to grasp market opportunities and be able to transfer technology creatively and appropriately in different regions of the world. They need to be capable of dealing with change and be responsive to challenges whilst working and communicating effectively in a multi-cultural society. The Food Science and Technology (FST) programme at NUS aims to produce highly motivated, numerate and responsible food scientists and technologists who are able to demonstrate effective leadership, excellent data analysis and problem-solving skill to improve food products and processes, and identify and exploit new business opportunities for the food industry of the 21st century. The predecessor of the FST B.Sc. and B.Sc (Hons.) degrees ie. the FST B.Appl.Sc. and B.Appl.Sc.(Hons.) degrees at NUS were accredited by the International Union of Food Science and Technology (IUFoST) in September 2013. The FST B.Sc. and B.Sc (Hons.) degrees have successfully achieved reaccreditation in August 2016.

#### **Programme Structure and Curriculum Rationale**

Food Science is the study of the nature of foods, the causes of their deterioration, and the principles underlying food processing. The food scientist is an important link in the chain of events which ensures the widespread availability of nutritious, safe, and reasonably priced foods to the general population. Scientific principles are also applied to develop technological processes designed to produce sophisticated products. Food Technology is the application of physical, chemical and microbiological sciences to food processing and preservation, and in the development of new improved food products. The food technologist is primarily concerned with problems related to production of safe, nutritious and attractive food, using more efficient and less costly techniques.

By its very nature, the subject of Food Science and Technology is wide ranging and students need to understand not only the chemistry of foods (i.e., how the components of food might react together), but also nutrition, toxicology, food legislation, microbiology and process engineering. Many food products are potentially "high-risk" and unless they are handled and stored correctly, they could be the source of food poisoning and infection in man.

This programme, therefore, involves the study of the relevant sciences, including chemistry, biochemistry, microbiology, mathematics and engineering and of the application of these sciences to food systems. The curriculum also includes the study of the relationship of food to man in terms of nutrition, health, safety, food acceptability and consumer protection.

## Career Prospects

The course prepares students for food research and careers related to food and related industries. The opportunities for graduates in this programme are good. Graduates in Food Science and Technology (FST) may work in basic and applied research, quality control, production supervision, technical sales, food inspection or product development. This undergraduate programme also prepares students to pursue graduate studies in food science or related fields of physical and biological science. Graduates are well equipped to find employment in food and allied industries, government and non-government organisations, and in education.

Module Level	Major Requirements	Cumulative Major MCs
1000 (24 MCs)	Pass CM1501      Organic Chemistry for Engineers CM1191      Experiments in Chemistry 1 FST1101      Science and Technology of Foods FST1103      Fundamentals of Food Engineering LSM1106      Molecular Cell Biology ST1232      Statistics for Life Sciences  For students without H2/A-level equivalent Biology, pass: LSM1301      General Biology	24
2000 (20 MCs)	Pass FST2102B      Chemistry of Food Components FST2106      Post Harvest Food Processing FST2107      Food Analysis and Lab FST2108      Food Safety Assurance LSM2211      Metabolism and Regulation	44

3000 (20 MCs)	<p>Pass</p> <p>FST3101      Food Microbiology and Fermentation</p> <p>FST3103      Advanced Food Engineering</p> <p>FST3105      Food Product Development and Packaging</p> <p>FST3106      Sensory and Flavour Science</p> <p>At least 4 MCs from the following:</p> <p>FST3201      Independent Study (Food Science &amp; Technology)</p> <p>FST3202      Nutrition and Disease Prevention</p> <p>FST3203      Vitamins &amp; Minerals in Health &amp; Diseases</p> <p>FST3288      Advanced UROPS (Food Sc. &amp; Tech) I</p> <p>DSC3202      Purchasing &amp; Materials Management</p> <p>CM3242      Instrumental Analysis II</p>	64
4000 (32 MCs)	<p>Pass</p> <p>FST4199      Honours Project in Food Science &amp; Technology</p> <p>FST4102      Advanced Food Processing Technologies</p> <p>FST4103      Food Colloids and Components Science</p> <p>At least 8 MCs from following:</p> <p>FST4201      Current Topics in Food Science and Technology</p> <p>FST4202      Nutritional Biochemistry</p> <p>FST4203      Food Forensics</p> <p>CM4241      Trace Analysis</p> <p>CM4242      Advanced Analytical Techniques</p> <p>CM4267      Current Topics in Analytical Techniques</p> <p>FST5201      Rheology and Textural Properties of Biomaterials</p> <p>FST5202      Advanced Food Fermentation</p> <p>FST5203      Advanced Food Microbiology and Safety</p> <p>FST5204      Evidence Based Functional Foods</p> <p>FST5225      Advanced Current Topics in Food Science</p> <p>CM5241      Modern Analytical Techniques</p>	96

In addition to the above modules, the department also recommends that students read the following modules to fulfil the unrestricted elective requirement :

MKT1003    Marketing

DSC2006 Operations Management  
DSC3218 Physical Distribution Management  
FST2201 Introduction to Human Nutrition

Summary of Requirements	B.Sc. (FST)	B.Sc. Hons. (FST)
University Requirements	20 MCs	20 MCs
Faculty Requirements	8 MCs†	8 MCs ††
Major Requirements	64 MCs	96 MCs
Unrestricted Elective Modules	28 MCs†††	36 MCs†††
TOTAL	120 MCs	160 MCs

† 12 MCs of Faculty requirements are partially fulfilled through 4 MCs from ST1232 within the major. The remaining 8 MCs are fulfilled through (i) 4 MCs from FST3181 Professional Placement; and (ii) 4 MCs from any one of the following subject groups: Computing Sciences, Physical Sciences, Multidisciplinary & Interdisciplinary Sciences.

†† 16 MCs of Faculty requirements are partially fulfilled through 8 MCs from ST1232 and CM/LSM modules within the major. The remaining 8 MCs are fulfilled through (i) 4 MCs from FST3181 Professional Placement; and (ii) 4 MCs from any one of the following subject groups: Computing Sciences, Physical Sciences, Multidisciplinary & Interdisciplinary Sciences.

††† The remaining 8MCs from FST3181 (after fulfilling 4MCs of Faculty Requirements) would fulfil the Unrestricted Electives requirements.

### **3.3.3.4 Data Science and Analytics**

Data science is an emerging field of study that involves statistical and computational principles, methods and systems for extracting and structuring knowledge from data. On a daily basis, large data sets are routinely generated by activities in the sciences, administration, leisure and commerce. Data scientists are constantly seeking patterns and predicting outcomes from these vast collections of data.

The four-year direct Honours programme in Data Science and Analytics (DSA) is designed to prepare graduates who are ready to acquire, manage and explore data that will inspire changes around the world. Singapore is a financial hub, with key industries focusing on biomedical sciences, health care, manufacturing, e-commerce and sustainable energy, among others. The DSA programme will equip its graduates with the skills to contribute to the activities of these industries. They will be able to handle problems like uncovering hidden stock market indicators, extracting information from medical images, predicting consumer behaviour and a host of similar interesting questions.

#### **Programme Structure and Curriculum Rationale**

The DSA programme is jointly offered by the Department of Mathematics and the Department of Statistics and Applied Probability in the Faculty of Science, with the collaboration of the School of Computing.

Students will read modules in Mathematics, Statistics and Computer Science, and be exposed to the interplay between these three key areas in the practice of data science. In their third and fourth years of study, students will also delve deep into subject matters such as computation and optimisation, computer algorithms, database and data processing, data mining and machine learning, and high-dimensional statistics. Students will also undertake an industry-driven capstone project module, where they will work with real-life data, providing them with an opportunity to tackle real-life issues and problems in a workplace environment.

#### **Co-Operative Education**

The NUS Co-Operative (Co-Op) Education Programme formally integrates academic studies with relevant work experience, where students complete multiple internship stints alternating with regular academic semesters over their candidature at NUS thus forming an integral part of the student's learning experience.

Students in the DSA programme have the option to participate in co-op education which comprises the following study/internship sequence:

	Semester 1	Semester 2	Special Term
Year 1	Study	Study	Study
Year 2	Study	Study	Internship (full time)
Year 3	Study & Internship (full time)	Internship (full time)	Internship (full time)
Year 4	Study & Internship (part time)	Study	

The first three internship segments ride on the Undergraduate Professional Internship Programme (UPIP) of the Faculty of Science. The last two internship segments take the form of an Honours-level project (DSA4299).

### Career Prospects

As the need for extensive data collection, processing and analyses increases across various sectors, DSA graduates can expect to build a career as data science professionals in both public and private firms, in industries ranging from technology to infocomm, transportation, telecommunications, e-commerce, etc.

### Graduation Requirements

To be awarded a B.Sc. or B.Sc. (Hons.) with a primary major in Data Science and Analytics, candidates must satisfy the following:

Module Level	Major Requirements	Cumulative Major MCs
<b>Level 1000</b>  <b>(16 MCs)</b>	Pass - CS1010/CS1010S/CS1010X Programming Methodology - DSA1101 Introduction to Data Science - MA1101R Linear Algebra I - MA1102R Calculus	16



<b>Level 2000 (24 MCs)</b>	Pass - CS2040 Data Structures and Algorithms - DSA2101 Essential Data Analytics Tools: Data Visualisation - DSA2102 Essential Data Analytics Tools: Numerical Computation - MA2311 Techniques in Advanced Calculus or MA2104 Multivariable Calculus - ST2131/MA2216 Probability - ST2132 Mathematical Statistics	40
<b>Levels 3000 and 4000 (56 MCs)</b>	Pass - CS3244 Machine Learning - DSA3101 Data Science in Practice - DSA3102 Essential Data Analytics Tools: Convex Optimisation - ST3131 Regression Analysis - DSA4199 Honours Project in Data Science <u>or</u> DSA4299 Applied Project in Data Science - Six additional modules from List A and List B subject to the following restrictions: + There must be at least two modules each from List A and from List B1/ List B2 + There must be at least four modules at level 4000	96

#### List A – DSA modules

DSA4211 High-Dimensional Statistical Analysis

DSA4212 Optimisation for Large-Scale Data-Driven Inference

#### List B1 – DSA-recognised modules (no hidden pre-requisites)

MA3236 Nonlinear Programming

MA3252 Linear and Network Optimisation

ST3232 Design and Analysis of Experiments

ST3233 Applied Time Series Analysis

ST3239 Survey Methodology

ST3240 Multivariate Statistical Analysis

ST3247 Simulation

ST3248 Statistical Learning I

ST4231 Computer Intensive Statistical Methods

ST4234 Bayesian Statistics

ST4248 Statistical Learning II

**List B2 – DSA-recognised modules (with hidden pre-requisites) \***

CS3210 Parallel Computing

CS3223 Database Systems Implementation

CS3230 Design and Analysis of Algorithms

CS4224 Distributed Databases

CS4225 Massive Data Processing Techniques in Data Science

CS4231 Parallel and Distributed Algorithms

CS4234 Optimisation Algorithms

MA4230 Matrix Computation

MA4270 Data Modelling and Computation

\* Note: For List B2, i.e., the DSA-recognised modules with hidden pre-requisites, DSA students who wish to read these modules will be provided with academic advice by the Faculty/Department on their study plans where necessary, as such students would have to read ‘additional’ pre-requisite modules.

<b>Summary of Requirements</b>	<b>B.Sc. (Hons.)</b>
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University Requirements	20 MCs
Faculty Requirements	8 MCs*
Major Requirements	96 MCs
Unrestricted Elective Modules	36 MCs
Total	160 MCs

\* 8 MCs of Faculty requirements are fulfilled through the reading of a CS-coded module and a ST/MA-coded module within the DSA curriculum.

Students are required to fulfill the remaining 8 MCs of Faculty requirements from any two of the following subject groups: Chemical Sciences, Life Sciences, Physical Sciences or Multidisciplinary & Interdisciplinary Sciences; but not from the following subject groups: Computing Sciences and Mathematical & Statistical Sciences.

### **3.3.3.5 Life Sciences**

Hosted by the Department of Biological Sciences, Faculty of Science (FoS), the NUS Life Sciences Undergraduate Programme offers the Life Sciences Major. The curriculum is taught by eight departments at the Faculty of Science (Departments of Biological Sciences, Chemistry, and Statistics and Applied Probability) and Yong Loo Lin School of Medicine (Departments of Anatomy, Biochemistry, Microbiology and Immunology, Pharmacology, and Physiology). The Life Sciences Major is designed to give students a firm foundation in the underlying knowledge vital to all areas of Life Sciences in the first year of study, and allows selection of relevant advanced-level modules to focus on one of the three specialisations and other exciting themes in Life Sciences.

#### **Programme Structure & Curriculum Rationale**

The curriculum of NUS Life Sciences Major is structured to provide a common, broad-based foundation in the first year of study. Students study topics in Molecular Genetics, Evolutionary Biology and Molecular Cell Biology, as well as Statistics and Organic Chemistry. Selection of advanced-level modules are based on the interest profile of every Life Sciences Major. At Honours Year 4, students may choose from three specialisations to advance in the study track or decide to go for no specialisation:

- Biomedical Science focuses on human health and diseases, and its goal of clinical solutions.
- Molecular and Cell Biology emphasises the fundamental physical, chemical and biological mechanisms of living organisms;
- Environmental Biology affirms the importance and relevance of biodiversity and ecology and its applications towards environmental conservation.

#### **Career Prospects**

Our graduates are ready to contribute to the manpower required for Singapore's initiatives in Life Sciences and related fields and industries. Academically-driven graduates will be able to embark on graduate studies at NUS or overseas as well as enter graduate medical education such as the Duke-NUS Medical School.

NUS Life Sciences graduates are fully poised to pursue a diverse range of careers ranging from research and scientific services, to healthcare and medical industries, and to education and related professions. Having a general Science degree, coupled with the scientific thinking and analytical skills acquired during the undergraduate course, enables our graduates to be eligible for a wide array of professional careers that seek Bachelor degree as the entry qualification.

Life Sciences graduates are well suited for careers in biological, biomedical and biotechnological contexts, as well as agricultural, horticultural and environmental sectors. Prospective employers include Research Institutes, Government Ministries and Statutory Boards such as National Parks Board (NParks), National Environment Agency (NEA), Health Sciences Authority (HSA) and Agri-Food and Veterinary

Authority (AVA), specialist medical centres and clinics, government and private hospitals. Many of our graduates work as teachers in Schools, Junior Colleges, Polytechnics and Universities. MNCs and local companies from the private and industrial sectors involving biotechnology, medicine, pharmaceutical, food production and environmental technology are also common options considered by our graduates.

In addition Life Sciences graduates have also embarked on a wide spectrum of non-life sciences related professions such as mass media productions, communications and information services, banking and finance, law and public services, defence and security. The more entrepreneurial graduates have also set up their own ventures.

## Graduation Requirements

To be awarded a B.Sc. with a primary major in Life Sciences, candidates must satisfy the following:

LEVEL	LIFE SCIENCES MAJOR REQUIREMENTS	CUMULATIVE MAJOR MCS
Level 1000 (20 MCs)	Pass all LSM1102    Molecular Genetics LSM1105    Evolutionary Biology LSM1106    Molecular Cell Biology CM1401*    Chemistry for Life Sciences* ST1232      Statistics for Life Sciences *If a precluding module to CM1401 (i.e. CM1121 or CM1501) is passed, the precluding module is accepted to be fulfilling the Life Sciences Major in lieu of CM1401.	20
Level 2000 (16 MCs)	Pass LSM2191    Laboratory Techniques in Life Sciences Pass <b>3</b> LSM2211    Metabolism and Regulation LSM2212    Human Anatomy LSM2231    General Physiology LSM2232    Genes and Genomes LSM2233    Cell Biology LSM2241    Introductory Bioinformatics LSM2234    Physical Concepts in Biology LSM2251    Ecology and Environment LSM2252    Biodiversity LSM2253    Applied Data Analysis in Ecology and Evolution LSM2254    Fundamentals of Plant Biology LSM2291    Fundamental Techniques in Microbiology	36

LEVEL	LIFE SCIENCES MAJOR REQUIREMENTS	CUMULATIVE MAJOR MCS
Level 3000 (16 MCs)	Pass four LSM32xx elective modules (except LSM3289), of which up to two (up to 8MC) may be LSM42xx (except LSM4299) and/or LSM-recognised elective modules.	52
	LSM3201 Research and Communication in Life Sciences	
	LSM3211 Fundamental Pharmacology	
	LSM3212 Human Physiology – Cardiopulmonary System	
	LSM3214 Human Physiology – Hormones and Health	
	LSM3215 Neuronal Signaling and Memory Mechanisms	
	LSM3216 Neuronal Development and Diseases	
	LSM3217 Human Ageing	
	LSM3218 Cardiopulmonary Pharmacology	
	LSM3219 Neuropharmacology	
	LSM3222 Human Neuroanatomy	
	LSM3223 Immunology	
	LSM3224 Molecular Basis of Human Diseases	
	LSM3225 Molecular Microbiology in Human Diseases	
	LSM3231 Protein Structure and Function	
	LSM3232 Microbiology	
	LSM3233 Developmental Biology	
	LSM3234 Biological Imaging of Growth and Form	
	LSM3241 Genomic Data Analysis	
	LSM3242 Translational Microbiology	
	LSM3243 Molecular Biophysics	
	LSM3245 RNA Biology and Technology	
	LSM3246 Synthetic Biology	
	LSM3247 Practical Synthetic Biology	
	LSM3252 Evolution and Comparative Genomics	
	LSM3254 Ecology of Aquatic Environments	
	LSM3255 Ecology of Terrestrial Environments	
	LSM3256 Tropical Horticulture	
	LSM3258 Comparative Botany	
	LSM3259 Fungal Biology	
	LSM3262 Environmental Animal Physiology	
	LSM3263 Field Studies in Neotropical Ecosystems	
	LSM3264 Environmental Biochemistry	
	LSM3265 Entomology	
	LSM3266 Avian Biology and Evolution	
	LSM3267 Behavioural Biology	
	LSM3272 Global Change Biology	
	LSM3273 Ecology, Conservation and Management of Sri Lankan Ecosystems	
	LSM3288 Advanced UROPS in Life Sciences I	

To be awarded a B.Sc. (Hons.) with a primary major in Life Sciences or Life Sciences (with specialisation in Biomedical Science, Molecular and Cell Biology or Environmental Biology), candidates must satisfy the following:

LEVEL	LIFE SCIENCES MAJOR REQUIREMENTS	CUMULATIVE MAJOR MCS
Level 1000 (20 MCs)	Pass all LSM1102 Molecular Genetics LSM1105 Evolutionary Biology LSM1106 Molecular Cell Biology CM1401* Chemistry for Life Sciences* ST1232 Statistics for Life Sciences *If a precluding module to CM1401 (i.e. CM1121 or CM1501) is passed, the precluding module is accepted to be fulfilling the Life Sciences Major in lieu of CM1401.	20
Level 2000 (16 MCs)	Pass LSM2191 Laboratory Techniques in Life Sciences Pass <b>3</b> LSM2211 Metabolism and Regulation LSM2212 Human Anatomy LSM2231 General Physiology LSM2232 Genes and Genomes LSM2233 Cell Biology LSM2241 Introductory Bioinformatics LSM2234 Physical Concepts in Biology LSM2251 Ecology and Environment LSM2252 Biodiversity LSM2253 Applied Data Analysis in Ecology and Evolution LSM2254 Fundamentals of Plant Biology LSM2291 Fundamental Techniques in Microbiology	36

LEVEL	LIFE SCIENCES MAJOR REQUIREMENTS	CUMULATIVE MAJOR MCS
Level 3000 (16 MCs)	Pass four LSM32xx elective modules (except LSM3289), of which up to two (up to 8MC) may be LSM42xx (except LSM4299) and/or LSM-recognised elective modules.	52
	LSM3201 Research and Communication in Life Sciences	
	LSM3211 Fundamental Pharmacology	
	LSM3212 Human Physiology: Cardiopulmonary System	
	LSM3214 Human Physiology - Hormones and Health	
	LSM3215 Neuronal Signaling and Memory Mechanisms	
	LSM3216 Neuronal Development and Diseases	
	LSM3217 Human Ageing	
	LSM3218 Cardiopulmonary Pharmacology	
	LSM3219 Neuropharmacology	
	LSM3222 Human Neuroanatomy	
	LSM3223 Immunology	
	LSM3224 Molecular Basis of Human Diseases	
	LSM3225 Molecular Microbiology in Human Diseases	
	LSM3231 Protein Structure and Function	
	LSM3232 Microbiology	
	LSM3233 Developmental Biology	
	LSM3234 Biological Imaging of Growth and Form	
	LSM3241 Genomic Data Analysis	
	LSM3242 Translational Microbiology	
	LSM3243 Molecular Biophysics	
	LSM3245 RNA Biology and Technology	
	LSM3246 Synthetic Biology	
	LSM3247 Practical Synthetic Biology	
	LSM3252 Evolution and Comparative Genomics	
	LSM3254 Ecology of Aquatic Environments	
	LSM3255 Ecology of Terrestrial Environments	
	LSM3256 Tropical Horticulture	
	LSM3258 Comparative Botany	
	LSM3259 Fungal Biology	
	LSM3262 Environmental Animal Physiology	
	LSM3263 Field Studies in Neotropical Ecosystems	
	LSM3264 Environmental Biochemistry	
	LSM3265 Entomology	
	LSM3266 Avian Biology and Evolution	
	LSM3267 Behavioural Biology	
	LSM3272 Global Change Biology	
	LSM3273 Ecology, Conservation and Management of Sri Lankan Ecosystems	
	LSM3288 Advanced UROPS in Life Sciences I	



LEVEL	LIFE SCIENCES MAJOR REQUIREMENTS		CUMULATIVE MAJOR MCS
Level 4000 (32 MCs)	<p>Pass at least 32MCs via one of the following options:</p> <p><b><u>Honours Research Project</u></b></p> <p>Pass LSM4199 Honours Project in Life Sciences, AND pass another <b>4</b> LSM42xx elective modules. [If one of the three specialisations (BMS/MCB/EVB) is to be pursued, LSM4199 and at least <b>2</b> of the <b>4</b> have to be completed, all listed with the chosen specialisation.]</p> <p><b><u>Applied Internship Project</u></b></p> <p>Pass LSM4299 Applied Project in Life Sciences, AND pass another <b>4</b> LSM42xx elective modules. [If one of the three specialisations (BMS/MCB/EVB) is to be pursued, 2 more LSM42xx elective modules have to be completed; all <b>6</b> LSM42xx listed with the chosen specialisation.]</p> <p><b><u>Coursework Taught Modules</u></b></p> <p>Pass <b>8</b> LSM42xx elective modules. [If one of the three specialisation (BMS/MCB/EVB) is to be pursued, at least <b>6</b> of the <b>8</b> LSM42xx elective modules have to be listed with the chosen specialisation.]</p>		
	LSM4199    Honours Project in Life Sciences		
	LSM4299    Applied Project in Life Sciences		
	LSM4210    Topics in Biomedical Science	Biomedical Science (BMS)	
	LSM4211    Toxicology		
	LSM4212    Pharmacogenetics and Drug Responses		
	LSM4213    System Neurobiology		
	LSM4214    Cancer Pharmacology		
	LSM4215    Extreme Physiology		
	LSM4216    Molecular Nutrition Science		
	LSM4217    Functional Ageing		
	LSM4221    Drug Discovery and Clinical Trials		
	LSM4222    Advanced Immunology		
	LSM4223    Advances in Antimicrobial Strategies		
	LSM4224    Free Radicals and Antioxidant Biology		
	LSM4225    Genetic Medicine in the Post-Genomic Era		
	LSM4226    Infection and Immunity		
	LSM4227    Stem Cell Biology		
	LSM4228    Experimental Models for Human Disease and   Therapy		
	LSM4229    Therapeutic and diagnostic agents from animal toxins		
	LSM4231    Structural Biology	Molecular and Cell Biology (MCB)	
	LSM4232    Advanced Cell Biology		
	LSM4234    Mechanobiology		
	LSM4235    Nuclear Mechanics and Genome Regulation		
	LSM4241    Functional Genomics		
	LSM4242    Protein Engineering		
	LSM4243    Tumour Biology		
	LSM4244    Oncogenes and Signal Transduction		
	LSM4245    Epigenetics and Chromatin Biology		
	LSM4251    Plant Growth and Development		
	LSM4252    Animal Reproduction		
	LSM4254    Principles of Taxonomy and Systematics	Environmental Biology (EVB)	
LSM4255    Methods in Mathematical Biology			
LSM4256    Evolution of Development			
LSM4261    Marine Biology			
LSM4262    Tropical Conservation Biology			
LSM4263    Field Studies in Biodiversity			
LSM4264    Freshwater Biology			
LSM4265    Urban Ecology			
LSM4266    Aquatic Biodiversity			
LSM4267    Animal Communications & Sensory Ecology			

SUMMARY OF REQUIREMENTS	B.SC.	B.SC. (HONS.)
University Requirements	20 MCs	20 MCs
Faculty Requirements	4 MCs*	8 MCs*
Major Requirements	52 MCs	84 MCs
Unrestricted Elective Modules	44 MCs	48 MCs
Total	120 MCs	160 MCs

\* Faculty requirements of 12 and 16 MCs for the B.Sc. and B.Sc.(Hons.) programmes respectively are partially fulfilled through the reading of CM1401 and ST1232 which are essential modules within the major requirements.

Students undertaking the B.Sc. programme are required to fulfill the remaining 4 MCs of Faculty requirements from one of the following subject groups: Computing Sciences, Physical Sciences and Multidisciplinary and Interdisciplinary Sciences; but not from the following subject groups: Chemical Sciences, Mathematical & Statistical Sciences and Life Sciences.

Students taking the B.Sc. (Hons.) programme are required to fulfill the remaining 8 MCs of Faculty requirements as such:

1. 4 MCs from any one of the following subject groups:  
Computing Sciences, Physical Sciences and Multidisciplinary and Interdisciplinary Sciences; but not from the following subject groups: Chemical Sciences, Mathematical & Statistical Sciences and Life Sciences.
2. 4 MCs of non-LSM prefixed module from any subject group.

### 3.3.3.6 Mathematics and Applied Mathematics

Mathematics is the science of quantification and the art of precise reasoning.

Mathematics conceptualises the concrete and generalises the specific. It has evolved its own symbolic language with which it builds general theories about numbers, curves, surfaces and solids, and constructs axioms for abstract mathematical ideas. Its foundations are built on three main areas: algebra, analysis and geometry. Mathematics provides a framework for the laws of physics and chemistry and a theoretical toolkit for applications in the physical and biological sciences, computer science, engineering, operations research, economic and statistical sciences and many areas of organised human knowledge. The specialisation of mathematics for applications, especially in science and engineering, has led to a broad discipline usually referred to as “Applied Mathematics”.

While mathematics is itself an achievement of various ancient and modern civilisations which has become part of the heritage of world culture today, many of its specific results have been successfully implemented by technological advances in raising the quality of and lengthening human life. Ubiquitous devices such as medical scanning machines, biomedical implants, cell phones and computers are now so much a part of modern life that the mathematical principles that make them possible have been taken for granted. As Edward E. David (former president of Exxon R&D) once said, “Too few people recognise that the high technology so celebrated today is essentially a mathematical technology.”

#### **Programme Structure and Curriculum Rationale**

The Department of Mathematics offers the following undergraduate programmes leading to the degree of BSc (Hons) :

1. Major in Mathematics

This is the flagship major that any leading university of the world is obliged to offer. Students will be exposed to all important areas of mathematical knowledge including algebra, logic, number theory and combinatorics, real and complex analysis, differential equations, geometry and topology with focus on mathematical foundations and fundamental techniques.

2. Major in Applied Mathematics

In this major, students focus on mathematics that deals with algorithms, problem-solving techniques and applications to other areas of human concern. Topics offered include financial mathematics, optimisation and operations research, mathematical modelling, numerical methods and simulations, coding and cryptography, computational biology and many others. Students may choose one of the three options – Major in Applied Mathematics; Major in Applied Mathematics with Specialisation in Mathematical Modelling and Data Analytics (MMDA); or Major in Applied Mathematics with Specialisation in Operations Research and Financial Mathematics (ORFM).

These major programmes share a fundamental set of basic mathematical knowledge. While each of them develops its own specialised expertise, the mathematical training in all of them is guided by an educational philosophy that (i) fosters logical and critical thinking, and (ii) develops capabilities to

conceptualise, improvise and innovate during the process of formulating, analysing and solving problems.

## Career Prospects

Mathematics and Applied Mathematics graduates find employment as operations research analysts in the airline, shipping and port industries; financial and risk analysts, actuaries, financial engineers and financial planners in banks, investment houses and insurance companies; data and system analysts, and cryptanalysts in multinational and defence organisations; software engineers in a range of organisations; lecturers, teachers, curriculum developers and publication officers in educational institutions and publishing houses; and administrators. Graduates are also well prepared for graduate studies in a range of disciplines, including mathematics, computer science, statistics and economics.

There are many mathematics courses that prepare a mathematics major student with the relevant skills to work in the specific area. The mathematics training in general also equips students with the analytical skills that are essential in many jobs, especially executive works. The list below serves as a guide:

Analysis, linear algebra	Engineering, science in general
Graph theory	Computer programming and algorithm design
Cryptography, number theory	Computer security
Numerical analysis, modelling	Engineering
Optimisation, operations research	Risk management, industrial scheduling and control
Probability, financial mathematics	Financial markets, insurance
Coding, wavelets	Signal processing, image and data compression

### Special Programme in Mathematics (SPM)

This programme is specially designed for a select group of students who has a strong passion and aptitude for the mathematical sciences. The programme consists of a number of specially designed modules ("S-modules") in foundational mathematics, which are taught in much greater depth and sophistication than their regular versions. In addition, under the close mentorship of Faculty members, students will participate in two semesters of undergraduate seminars in the form of topic modules. Participants of the SPM will have enhanced opportunities for undergraduate research programmes locally and overseas, as well as graduate programmes at the Department of Mathematics in NUS. Through SPM, students will build a firm foundation to pursue graduate programmes and future careers in mathematical sciences.

### SPM Enrolment Eligibility

Students who have passed (or have been exempted from) MA1101R and MA1102R with very good grades are welcome to apply. All applicants will be further assessed through interviews. Selected students will be enrolled in the SPM in the second semester of their first year or the first semester of their second year.

Participants of the SPM should generally be majoring in Mathematics or Applied Mathematics, though academically strong students majoring in Quantitative Finance, Statistics, Physics and Computer Science are also welcome to apply. In order to complete the SPM, a participant should pass 6 out of the following 7 modules:

- MA2101S Linear Algebra II (S)
- MA2108S Mathematical Analysis I (S)
- MA2202S Algebra I (S)
- MA3110S Mathematical Analysis II (S)
- MA3111S Complex Analysis I (S)
- MA4291 Undergraduate Topics in Mathematics I
- MA4292 Undergraduate Topics in Mathematics II

When an SPM student goes for student exchange programme, he/she may read an equivalent overseas module in place of one S-module. Each student is only allowed to replace one S-module this way.

### Graduation Requirements (Mathematics)

To be awarded a BSc or BSc (Hons) with a primary major in Mathematics, a candidate must satisfy the following:

MODULE LEVEL	MAJOR REQUIREMENTS	CUMULATIVE MAJOR MCS
Level-1000 (16 MCs)	1. Pass all the following modules <ul style="list-style-type: none"> <li>- MA1100 Fundamental Concepts of Mathematics or CS1231</li> </ul> Discrete Structures <ul style="list-style-type: none"> <li>- MA1101R Linear Algebra I</li> <li>- MA1102R Calculus</li> <li>- CS1010/CS1010E/CS1010S/CS1010X Programming</li> </ul> Methodology	20

MODULE LEVEL	MAJOR REQUIREMENTS	CUMULATIVE MAJOR MCS
Level-2000 (24-28 MCs)	2. Pass all the following modules: <ul style="list-style-type: none"> <li>• MA2101/MA2101S Linear Algebra II</li> <li>• MA2104 Multivariable Calculus</li> <li>• MA2108/MA2108S Mathematical Analysis I</li> <li>• MA2202/MA2202S Algebra I</li> <li>• MA2216/ST2131 Probability</li> </ul> 3. Pass one additional module from List II, III, IV	40-44
Level-3000 (20-23 MCs)	4. Pass all the following modules: <ul style="list-style-type: none"> <li>• MA3110/MA3110S Mathematical Analysis II</li> <li>• MA3111/MA3111S Complex Analysis I</li> </ul> 5. Pass two modules from List MA3 6. Pass one additional module from List III, IV	60-66
Level-4000 (32- 33 MCs)	7. Pass MA4199 Honours Project in Mathematics 8. Pass four modules from List MA4 9. Pass one additional module from List IV	92-98
UROPS	At most one Mathematics UROPS module may be used to fulfil the requirements of Major in Mathematics	

#### List II:

- All MA modules at Level-2000, except those coded MA23XX
- PC2130 Quantum Mechanics I
- PC2132 Classical Mechanics
- ST2132 Mathematical Statistics
- EC2101 Microeconomic Analysis I

#### List III:

- All MA modules at Level-3000, except MA3311 and MA3312
- BSE3703 Econometric for Business I
- CS3230 Design & Analysis of Algorithms
- CS3234 Logic and Formal Systems
- DSA3102 Essential Data Analytics Tools: Convex Optimisation
- EC3101 Microeconomic Analysis II

- EC3303 Econometrics I
- PC3130 Quantum Mechanics II
- PC3236 Computational Methods in Physics
- PC3238 Fluid Dynamics
- ST3131 Regression Analysis
- ST3236 Stochastic Processes I

**List IV:**

- All MA modules at Level-4000 or higher
- CS4232 Theory of Computation
- CS4234 Optimisation Algorithms
- CS4236 Cryptography Theory and Practice
- CS5230 Computational Complexity
- CS5237 Computational Geometry and Applications
- DSA4211 High-Dimensional Statistical Analysis
- DSA4212 Optimisation for Large-Scale Data-Driven Inference
- EC4301 Microeconomics Analysis III
- EC5104 Mathematical Economics
- PC4248 Relativity
- PC4274 Mathematical Methods in Physics III
- ST4238 Stochastic Processes II

**List MA3:**

- MA3201 Algebra II
- MA3205 Set Theory
- MA3209 Mathematical Analysis III
- MA3220 Ordinary Differential Equations
- MA3265 Introduction to Number Theory
- MA3266 Introduction to Fourier Analysis

**List MA4:**

- MA4203 Galois Theory
- MA4207 Mathematical Logic
- MA4211 Functional Analysis
- MA4221 Partial Differential Equations
- MA4247 Complex Analysis II
- MA4262 Measure and Integration
- MA4266 Topology
- MA4271 Differential Geometry of Curves and Surfaces

SUMMARY OF REQUIREMENTS	BSC	BSC (HONS)
University Requirements	20 MCs	20 MCs

SUMMARY OF REQUIREMENTS	BSC	BSC (HONS)
Faculty Requirements	4 – 8 MCs*	4 – 12 MCs*
Major Requirements	60 – 66 MCs	92 – 98 MCs
Unrestricted Elective Modules	26 – 36 MCs	30 – 44 MCs
Total	120 MCs	160 MCs

\* Faculty Requirements of 12 MCs and 16 MCs (required for the BSc and BSc (Hons) programmes respectively) are partially fulfilled through the reading of CS/PC/ST modules within the major.

### Graduation Requirements (Applied Mathematics)

To be awarded a BSc or BSc (Hons) with a primary major in Applied Mathematics, a candidate must satisfy the following:

#### I. BSc or BSc (Hons) with major in Applied Mathematics

MODULE LEVEL	MAJOR REQUIREMENTS	LEVEL MCS	CUMULATIVE MAJOR MCS
Level-1000	1. Pass all the following modules: - MA1100 Fundamental Concepts of Mathematics or CS1231 Discrete Structures - MA1101R Linear Algebra I - MA1102R Calculus - CS1010/CS1010E/CS1010S/CS1010X Programming Methodology	16	16



MODULE LEVEL	MAJOR REQUIREMENTS	LEVEL MCS	CUMULATIVE MAJOR MCS
Level-2000	2. Pass all the following modules: <ul style="list-style-type: none"> <li>• MA2101/MA2101S Linear Algebra II</li> <li>• MA2104 Multivariable Calculus</li> <li>• MA2108/MA2108S Mathematical Analysis I</li> <li>• MA2213 Numerical Analysis I</li> <li>• MA2216/ST2131 Probability</li> </ul> 3. Pass one additional module from List II, III, IV	24-27	40-43
Level-3000	4. Pass all the following modules: <ul style="list-style-type: none"> <li>• MA3110/MA3110S Mathematical Analysis II</li> <li>• MA3111/MA3111S Complex Analysis I</li> </ul> 5. Pass two modules from List AM3 6. Pass one additional module from List III, IV	20-23	60-66
Level-4000	7. Pass MA4199 Honours Project in Mathematics 8. Pass four modules from List AM4 9. Pass one additional module from List IV	32-33	92-98
UROPS	At most one Mathematics UROPS module may be used to fulfil the requirements of Major in Applied Mathematics		

II. BSc (Hons) with major in Applied Mathematics with specialisation in Mathematical Modelling and Data Analytics, MMDA

MODULE LEVEL	MAJOR REQUIREMENTS	LEVEL MCS	CUMULATIVE MAJOR MCS
Level 1000	1. Pass all the following modules: - MA1100 Fundamental Concepts of Mathematics or CS1231 Discrete Structures - MA1101R Linear Algebra I - MA1102R Calculus - CS1010/CS1010E/CS1010S/CS1010X Programming Methodology	16	16
Level 2000	2. Pass all the following modules: • MA2101/MA2101S Linear Algebra II • MA2104 Multivariable Calculus • MA2108/MA2108S Mathematical Analysis I • MA2213 Numerical Analysis I • MA2216/ST2131 Probability 3. Pass one additional module from List II, III, IV	24-27	40-43
Level 3000	4. Pass all the following modules: • MA3110/MA3110S Mathematical Analysis II • MA3111/MA3111S Complex Analysis I 5. Pass two modules from List AM3-MMDA 6. Pass one additional module from List III, IV	20-23	60-66
Level 4000	7. Pass MA4199 Honours Project in Mathematics 8. Pass four modules from AM4-MMDA 9. Pass one additional module from List IV	32-33	92-98
UROPS	At most one Mathematics UROPS module may be used to fulfil the requirements of Major in Applied Mathematics		

III. BSc (Hons) with major in Applied Mathematics with specialisation in Operations Research and Financial Mathematics, ORFM

MODULE LEVEL	MAJOR REQUIREMENTS	LEVEL MCS	CUMULATIVE MAJOR MCS
Level 1000	1. Pass all the following modules: - MA1100 Fundamental Concepts of Mathematics or CS1231 Discrete Structures - MA1101R Linear Algebra I - MA1102R Calculus - CS1010/CS1010E/CS1010S/CS1010X Programming Methodology	16	16
Level 2000	2. Pass all the following modules: • MA2101/MA2101S Linear Algebra II • MA2104 Multivariable Calculus • MA2108/MA2108S Mathematical Analysis I • MA2213 Numerical Analysis I • MA2216/ST2131 Probability 3. Pass one additional module from List II, III, IV	24-27	40-43
Level 3000	4. Pass all the following modules: • MA3110/MA3110S Mathematical Analysis II • MA3111/MA3111S Complex Analysis I 5. Pass two modules from List AM3-ORFM 6. Pass one additional module from List III, IV	20-23	60-66
Level 4000	7. Pass MA4199 Honours Project in Mathematics 8. Pass four modules from AM4-ORFM 9. Pass one additional module from List IV	32-33	92- 98
UROPS	At most one Mathematics UROPS module may be used to fulfil the requirements of Major in Applied Mathematics		

#### List II:

- All MA modules at level 2000, except those coded MA23XX
- PC2130 Quantum Mechanics I
- PC2132 Classical Mechanics
- ST2132 Mathematical Statistics

- EC2101 Microeconomic Analysis I

### **List III:**

- All MA modules at level 3000, except MA3311 and MA3312
- BSE3703 Econometrics for Business I
- CS3230 Design & Analysis of Algorithms
- CS3234 Logic and Formal Systems
- DSA3102 Essential Data Analytics Tools: Convex Optimisation
- EC3101 Microeconomic Analysis II
- EC3303 Econometrics I
- PC3130 Quantum Mechanics II
- PC3236 Computational Methods in Physics
- PC3238 Fluid Dynamics
- ST3131 Regression Analysis
- ST3236 Stochastic Processes I

### **List IV:**

- All MA modules at level 4000 or higher
- CS4232 Theory of Computation
- CS4234 Optimisation Algorithms
- CS4236 Cryptography Theory and Practice
- CS5230 Computational Complexity
- CS5237 Computational Geometry and Applications
- DSA4211 High-Dimensional Statistical Analysis
- DSA4212 Optimisation for Large-Scale Data-Driven Inference
- EC4301 Microeconomics Analysis III
- EC5104 Mathematical Economics
- PC4248 Relativity
- PC4274 Mathematical Methods in Physics III
- ST4238 Stochastic Processes II
- ST4245 Statistical Methods for Finance

### **List AM3:**

List AM3 consists of the following 3 baskets AM3-General, AM3-MMDA, AM3-ORFM.

#### AM3-General

- MA3209 Mathematical Analysis III
- MA3218 Applied Algebra
- MA3220 Ordinary Differential Equations

#### AM3-MMDA

- MA3227 Numerical Analysis II
- MA3233 Combinatorics and Graph II
- MA3264 Mathematical Modelling

- ST3131 Regression Analysis

#### AM3-ORFM

- MA3236 Nonlinear Programming
- MA3252 Linear and Network Optimization
- MA3269 Mathematical Finance I
- ST3131 Regression Analysis

#### **List AM4:**

List AM4 consists of the following 3 baskets AM4-General, AM4-MMDA, AM4-ORFM.

#### AM4-General

- MA4211 Functional Analysis
- MA4221 Partial Differential Equations
- MA4235 Topics in Graph Theory
- MA4261 Coding and Cryptography

#### AM4-MMDA

- MA4229 Approximation Theory
- MA4230 Matrix Computation
- MA4255 Numerical Methods in Differential Equations
- MA4268 Mathematics for Visual Data Processing
- MA4270 Data Modelling and Computation
- MA4272 Mathematical tools for Data Science
- DSA4211 High-Dimensional Statistical Analysis

#### AM4-ORFM

- MA4254 Discrete Optimization
- MA4260 Stochastic Operations Research
- MA4264 Game Theory
- MA4269 Mathematical Finance II
- ST4245 Statistical Methods for Finance

SUMMARY OF REQUIREMENTS	BSC	BSC (HONS)
University Requirements	20 MCs	20 MCs
Faculty Requirements	4 – 8 MCs*	4 – 12 MCs*
Major Requirements	60 – 66 MCs	92 – 98 MCs
Unrestricted Elective Modules	26 – 36 MCs	30 – 44 MCs

<b>SUMMARY OF REQUIREMENTS</b>	<b>BSC</b>	<b>BSC (HONS)</b>
Total	120 MCs	160 MCs

\*Faculty Requirements of 12 MCs and 16 MCs (required for the BSc and BSc (Hons) programmes respectively) are partially fulfilled through the reading of CS/PC/ST modules within the major.

### **3.3.3.7 Physics**

Physics is one of the most fundamental of all sciences, and is the basis of our scientific knowledge of the physical world. It seeks to explain the behaviour of matter, time and space in the universe and covers phenomena ranging from subnuclear interactions to cosmological events like the Big Bang. The traditional B.Sc. degree in Physics is centred on understanding scientific fundamentals and it is through this basic approach that advances in scientific knowledge and technological innovations are made.

#### **Programme Structure and Curriculum Rationale**

B.Sc. and B.Sc. (Hons.) in Physics are rigorous courses covering the core topics in physics. The broadness of the scope and the training in critical thinking and in analysis will enable graduates to choose from a wide variety of careers. B.Sc. (Hons.) students can choose to specialise in one of the following areas: (i) Astrophysics, and (ii) Nanophysics. These programmes will prepare graduates with in-depth knowledge in each area of specialisation.

#### **Career Prospects**

The Physics Department, which has research strengths in many frontier areas including nanoscience, quantum information technology, optical and magnetic materials, and biophysics, provides a stimulating learning environment for all students who wish to major in physics. Physics graduates will be able to embark on career paths in R&D in the physical sciences, engineering industries and microelectronics industries, as well as education and training, government scientific services sectors and IT. The unique problem solving skills our graduates acquire have enabled them to work and succeed in commerce, banking and finance.

#### **Graduation Requirements**

To be awarded a B.Sc. or B.Sc. (Hons.) with a primary major in Physics, candidates must satisfy the following:

MODULE LEVEL	MAJOR REQUIREMENTS	CUMULATIVE MAJOR MCS
Level-1000 (24 MCs)	Pass PC1141 Introduction to Classical Mechanics PC1142 Introduction to Thermodynamics and Optics PC1143 Introduction to Electricity & Magnetism PC1144 Introduction to Modern Physics MA1101R Linear Algebra I MA1102R Calculus	24
Level-2000 (24 MCs)	Pass PC2130 Quantum Mechanics I PC2131 Electricity and Magnetism I PC2134 Mathematical Methods in Physics I PC2132 Classical Mechanics PC2193 Experimental Physics I PC2230 Thermodynamics and Statistical Mechanics	48



MODULE LEVEL	MAJOR REQUIREMENTS	CUMULATIVE MAJOR MCS
Level-3000 (20 MCs)	Pass PC3130 Quantum Mechanics II PC3193 Experimental Physics II And any three modules from the following electives: <ul style="list-style-type: none"> <li>• PC3231 Electricity and Magnetism II</li> <li>• PC3232 Nuclear and Particle Physics</li> <li>• PC3233 Atomic and Molecular Physics I</li> <li>• PC3235 Solid State Physics I</li> <li>• PC3236 Computational Methods in Physics</li> <li>• PC3238 Fluid Dynamics</li> <li>• PC3241 Solid State Devices</li> <li>• PC3242 Physics of Semiconductor Processing</li> <li>• PC3243 Photonics</li> <li>• PC3246 Astrophysics I</li> <li>• PC3247 Modern Optics</li> <li>• PC3251 Nanophysics</li> <li>• PC3267 Biophysics II</li> <li>• PC3274 Mathematical Methods in Physics II</li> <li>• PC3239 Special Problems in Undergraduate Physics II</li> <li>• PC3288 UROPS in Physics I<sup>^</sup></li> <li>• PC3289 Advanced UROPS in Physics II<sup>^</sup></li> <li>• MLE3101 Materials Characterisation</li> <li>• MLE3105 Dielectric and Magnetic Materials</li> </ul>	68

MODULE LEVEL	MAJOR REQUIREMENTS	CUMULATIVE MAJOR MCS
Level-4000 (32 MCs)	<p>Pass</p> <p>PC4199 Honours Project in Physics</p> <p>And any five modules from the following electives:</p> <ul style="list-style-type: none"> <li>• PC4230 Quantum Mechanics III</li> <li>• PC4236 Computational Condensed Matter Physics</li> <li>• PC4240 Solid State Physics II</li> <li>• PC4241 Statistical Mechanics</li> <li>• PC4242 Electrodynamics</li> <li>• PC4243 Atomic and Molecular Physics II</li> <li>• PC4245 Particle Physics</li> <li>• PC4246 Quantum Optics</li> <li>• PC4248 General Relativity</li> <li>• PC4249 Astrophysics II</li> <li>• PC4253 Thin Film Technology</li> <li>• PC4259 Surface Physics</li> <li>• PC4262 Remote Sensing</li> <li>• PC4264 Advanced Solid State Devices</li> <li>• PC4267 Biophysics III</li> <li>• PC4268 Biophysical Instrumentation and Biomolecular Electronics</li> <li>• PC4274 Mathematical Methods in Physics III</li> <li>• EE4437 Photonics - Principles and Applications</li> <li>• EE4413 Low-dimensional Electronic Devices</li> <li>• MLE4201 Advanced Materials Characterisation<sup>#</sup></li> <li>• MLE4204 Synthesis and Growth of Nanostructures<sup>#</sup></li> <li>• MLE4205 Theory and Modelling of Materials Properties<sup>#</sup></li> <li>• an approved module offered by other Departments</li> </ul>	100

^ At most 4 MCs of UOPS module may be used to fulfil the Physics major requirements.

# These elective modules are only offered to students reading a double degree in Materials Science & Engineering and in Physics.

Note:

Level-4000 PC prefixed modules may be taken to replace up to 8 MCs of the Level-3000 PC elective modules above. In such an event, these Level-4000 modules cannot be counted towards the Level 4000 major requirements.

B.Sc. (Hons.) students majoring in Physics have the option to qualify for a specialisation in

1. Astrophysics, or
2. Nanophysics.

To be awarded a specialisation in Astrophysics, candidates must read and pass the following modules, as part of the major requirements for B.Sc. (Hons.) with a primary major in Physics.

MODULE LEVEL	SPECIALISATION REQUIREMENTS	CUMULATIVE MAJOR MCS
Level-3000	Pass PC3246    Astrophysics I	4
Level-4000	Pass PC4248    General Relativity PC4249    Astrophysics II PC4199    Honours Project in Physics (Astrophysics)**	24

To be awarded a specialisation in Nanophysics, candidates must read and pass the following modules as part of the major requirements for B.Sc. (Hons.) with a primary major in Physics.

MODULE LEVEL	SPECIALISATION REQUIREMENTS	CUMULATIVE MAJOR MCS
Level-3000 and Level-4000	Pass any 24 MCs from the following: PC3235 Solid State Physics I PC3241 Solid State Devices PC3242 Physics of Semiconductor Processing PC3243 Photonics PC4246 Quantum Optics PC4253 Thin Film Technology PC4199 Honours Project in Physics (Nanophysics)**	24

\*\* Honours Project has to be in the area of specialisation.

SUMMARY OF REQUIREMENTS	B.SC.	B.SC. (HONS.)
University Requirements	20 MCs	20 MCs
Faculty Requirements	8 MCs*	8 MCs*
Major Requirements	68 MCs	100 MCs
Unrestricted Elective Modules	24 MCs	32 MCs
Total	120 MCs	160 MCs

\* Faculty requirements of 12 MCs and 16 MCs [required for the B.Sc. and B.Sc. (Hons.) programmes respectively] are partially fulfilled through the reading of MA1101R and MA1102R within the major.

Students undertaking the B.Sc. and B.Sc. (Hons.) programmes are required to fulfil the remaining 8 MCs of Faculty requirements from any two (2) of the following subject groups: Computing Sciences, Chemical Sciences, Life Sciences and Multidisciplinary & Interdisciplinary Sciences; but not from the following subject groups: Physical Sciences and Mathematical & Statistical Sciences.

### **3.3.3.8 Quantitative Finance**

Quantitative Finance is a multidisciplinary honours-track programme that combines mathematics, finance and computing with a practical orientation that is designed for high-calibre students who wish to become professionals in the finance industry. The explosive growth of computer technology, globalisation, and theoretical advances in finance and mathematics have resulted in quantitative methods playing an increasingly important role in the financial services industry and the economy as a whole. New mathematical and computational methods have transformed the investment process and the financial industry. Today banks, investment firms, and insurance companies turn to technological innovation to gain competitive advantage. Sophisticated mathematical models are used to support investment decisions, to develop and price new securities and innovative products or to manage risk. Hence there is an increasing demand from the industry for persons with a high level of quantitative and analytical skills.

#### **Programme Structure and Curriculum Rationale**

The programme is conducted jointly by the Faculty of Science, NUS Business School and School of Computing. The curriculum is multidisciplinary with coverage in the following areas:

1. Mathematical Theory and Tools
2. Statistical Tools
3. Computing Theory and Techniques
4. Financial Theory and Principles
5. Core Financial Product Knowledge

The Quantitative Finance course enables students to have an integrated overview of how mathematical methods and computing techniques are applied to finance. With rapid developments of new financial products requiring quantitative skills, the curriculum also provides students with solid financial product knowledge and the know-how for creating new structured financial products.

#### **Career Prospects**

With the forthcoming implementation of Basel II, which requires quantitative modelling and risk management, there will be a big boost in demand for graduates in quantitative finance.

Career opportunities are available in financial institutions such as banks, securities firms, insurance companies, investment companies, IT firms that support the financial institutions and multinationals. Graduates could find jobs in financial product development and pricing, risk management, derivatives pricing, hedging and trading, quantitative modelling, IT support for derivatives trading and risk management, investment decision support, quantitative portfolio management and asset management and wealth management.

#### **Graduation Requirements**

To be awarded a B.Sc. or B.Sc. (Hons.) with a primary major in Quantitative Finance, candidates must satisfy the following:

MODULE LEVEL	MAJOR REQUIREMENTS	CUMULATIVE MAJOR MCS
Level-1000 (16 MCs)	CS1010 / CS1010E /    Programming Methodology CS1010S/ CS1010X ACC1701      Accounting for Decision Makers MA1101R      Linear Algebra I MA1102R      Calculus	16
Level-2000 (20-21 MCs)	Pass FIN2704      Finance MA2213      Numerical Analysis I    or DSA2102 Essential Data Analytics Tools: Numerical Computation MA2216 /      Probability ST2131 MA2108 /      Mathematical MA2108S      Analysis I MA2104      Multivariate Calculus	36-37

MODULE LEVEL	MAJOR REQUIREMENTS	CUMULATIVE MAJOR MCS
Level-3000 (28 MCs)	Pass QF3101 Investment Instruments: Theory and Computation MA3269 Mathematical Finance I ST3131 Regression Analysis Two modules from the following: • MA3220 Ordinary Differential Equations • MA3236 Nonlinear Programming • MA3252 Linear and Network Optimisation • MA3264 Mathematical Modelling Two modules from the following: • FIN3701 Corporate Finance • FIN3703 Financial Markets • FIN3713 Bank Management • FIN3714 Financial Risk Management	64-65

MODULE LEVEL	MAJOR REQUIREMENTS	CUMULATIVE MAJOR MCS
Level-4000 and above (32 MCs)	Pass QF4199 Honours Project in Quantitative Finance QF4102 Financial Modelling MA4269 Mathematical Finance II Three modules from the following: • QF5210 Financial Time Series: Theory and Computation • FIN4711 Research Methods in Finance • FIN4761 Seminar in Finance • MA4254 Discrete Optimisation • MA4255 Numerical Partial Differential Equations • MA4260 Stochastic Operations Research • MA4264 Game Theory • ST4233 Linear Models • ST4245 Statistical Methods for Finance • MA5245 Advanced Financial Mathematics • MA5248 Stochastic Analysis in Mathematical Finance	96-97

SUMMARY OF REQUIREMENTS	B.SC.	B.SC. (HONS.)
University Requirements	20 MCs	20 MCs
Faculty Requirements	12 MCs*	12 MCs*
Major Requirements	64-65 MCs	96-97 MCs
Unrestricted Elective Modules	23-24 MCs	31-32 MCs
Total	120 MCs	160 MCs

\* Up to 4 MCs of Faculty requirements of the total of 16 MCs required for the B.Sc. (Hons.) programme are fulfilled through the reading of MA/CS modules within the major.

Students of the B.Sc. and B.Sc. (Hons.) programmes are required to fulfil the remaining 12 MCs of



Faculty requirements from any three (3) of the following subject groups: Chemical Sciences, Life Sciences, Physical Sciences and Multidisciplinary & Interdisciplinary Sciences, but not from the following subject groups: Computing Sciences and Mathematical & Statistical Sciences.

To apply for this major, please refer to the application procedure given in <http://ww1.math.nus.edu.sg/undergraduates.aspx?f=UP-QF#scrolltop> for details regarding the admission requirements and the application form.

### **3.3.3.9 Statistics**

Statistics is the scientific application of mathematical principles to the collection, analysis, and presentation of numerical data. How does a business determine if an available site for a new restaurant is a potentially successful location? How does the health authority assess statistical evidence for the effectiveness of a new vaccine? How does an insurance company determine the risk level of a new proposal?

Statisticians contribute to scientific inquiry by applying their mathematical and statistical knowledge to the design of surveys and experiments; the collection, processing, and analysis of data; and the interpretation of the results. Statisticians may apply their knowledge of statistical methods to a variety of subject areas, such as biology, business, economics, education, engineering, finance, marketing, medicine, psychology, public health, and sports. In particular, data science is an interdisciplinary field, driven by statistical ideas, for obtaining insights from data in various forms. It is often, but not always, concerned with methodology for big data problems, those which are at the forefront of the challenges of modern science.

#### **Programme Structure and Curriculum Rationale**

Statistics is an interdisciplinary subject by nature. In the development of Statistics, Mathematics and Computer Science respectively provide the theoretical foundation and the computational tools while real-world problems stimulate and guide further research. These considerations are reflected in the curriculum. In addition to Statistics modules, Statistics students are encouraged to read modules in Mathematics and Computer Science.

The core statistical education consists of probability and stochastic processes, statistical principles, computer-aided data analysis, and regression analysis. Honours students majoring in Statistics have the option to specialise in Data Science or in Finance and Business Statistics. The department has particular strengths in computational statistics, high-dimensional statistical analysis and statistical learning for data science, and in time series analysis, statistical methods for actuarial science and finance, and stochastic processes for Finance and Business Statistics.

#### **Career Prospects**

The world is becoming increasingly quantitative and data-focused. Many professions, organisations and businesses depend on numerical measurements to make decisions in the face of uncertainty. Statistics graduates may look forward to being employed as statisticians in government, medical and pharmaceutical industry, manufacturing and engineering companies, banking and financial institutions, research and tertiary institutions.

Further, there are many jobs that do not bear the word “statistician” but will rely much on the knowledge

and training that a student can acquire from studying Statistics at NUS. Some of these are business analyst, quality assurance engineer, pharmaceutical engineer, marketing professional, financial analyst, banking executive, telecommunication executive, actuary, data analyst, and risk analyst.

### Graduation Requirements (Statistics)

To be awarded a B.Sc. or B.Sc. (Hons.) with a primary major in Statistics, candidates must satisfy the following:

MODULE LEVEL	MAJOR REQUIREMENTS	CUMULATIVE MAJOR MCS
Level-1000 (16 MCs)	Pass ST1131 Introduction to Statistics <u>or</u> ST1232 Statistics for Life Sciences MA1101R Linear Algebra I MA1102R Calculus CS1010 Programming Methodology <u>or</u> CS1010E Programming Methodology <u>or</u> CS1010S Programming Methodology <u>or</u> CS1010X Programming Methodology	16

MODULE LEVEL	MAJOR REQUIREMENTS	CUMULATIVE MAJOR MCS
Level-2000 (16-17 MCs)	Pass ST2131/      Probability MA2216 ST2132      Mathematical Statistics ST2137      Computer Aided Data Analysis MA2311      Techniques in Advanced Calculus <u>or</u> MA2104      Multivariable Calculus <u>or</u> MA2108      Mathematical Analysis I <u>or</u> MA2108S     Mathematical Analysis I (S)	32-33
Level-3000 (28-29 MCs)	Pass ST3131      Regression Analysis ST3236      Stochastic Processes I • Three other modules from ST32xx or ST4xxx modules • Two additional modules from ST32xx or ST4xxx modules or List A or List B modules	60-62
Level-4000 (32-33 MCs)	Pass ST4199      Honours Project in Statistics ST4231      Computer Intensive Statistical Methods ST4233      Linear Models • Two other modules from ST4xxx modules • One additional module from ST4xxx, ST5xxx or List B modules	92-94

#### List A

- MA3209    Mathematical Analysis III  
 MA3218    Applied Algebra  
 MA3227    Numerical Analysis II  
 MA3229    Introduction to Geometric Modelling

MA3233 Combinatorics and Graphs II  
 MA3236 Nonlinear Programming  
 MA3252 Linear and Network Optimisation  
 MA3256 Applied Cryptography  
 MA3259 Mathematical Methods in Genomics  
 MA3269 Mathematical Finance I  
 QF3101 Investment instruments: Theory and Computation  
 CS3230 Design and Analysis of Algorithm  
 CS3223 Database Systems Implementation  
 CS3243 Introduction to Artificial Intelligence  
 CS3244 Machine Learning  
 EC3304 Econometrics II

#### List B

MA4211 Functional Analysis  
 MA4229 Approximation Theory  
 MA4230 Matrix Computation  
 MA4233 Dynamical Systems  
 MA4254 Discrete Optimisation  
 MA4260 Stochastic Operations Research  
 MA4261 Coding and Cryptography  
 MA4262 Measure and Integration  
 MA4269 Mathematical Finance II  
 CS4231 Parallel and Distributed Algorithm  
 CS4220 Knowledge Discovery Methods in Bioinformatics  
 DSA4211 High-Dimensional Statistical Analysis  
 DSA4212 Optimisation for Large-Scale Data-Driven Inference  
 EC4303 Econometrics III

Honours students majoring in Statistics have the option to qualify for specialisation in

1. Data Science or
2. Finance and Business Statistics.

(A) To be awarded a specialisation in Data Science, a candidate must pass at least six modules (24 MCs) from the following two lists, with at least two modules (8 MCs) from list DS 1, as part of the major requirements for B.Sc. (Hons.) with a primary major in Statistics:

#### **DS 1**

ST3240 Multivariate Statistical Analysis

CS3244 Machine Learning\*

ST3248 Statistical Learning I

ST4248 Statistical Learning II

## **DS 2**

ST3247 Simulation

CS3210 Parallel Computing\*

MA3252 Linear and Network Optimisation

ST4234 Bayesian Statistics

CS4231 Parallel and Distributed Algorithms\*

DSA4211 High-Dimensional Statistical Analysis

DSA4212 Optimisation for Large-Scale Data-Driven Inference

MA4268 Mathematics for Visual Data Processing\*

\*Modules with hidden pre-requisites (indicated in brackets): CS3210 (CS2100 Computer Organisation), CS3244 (CS2040 Data Structures and Algorithms), CS4231 (CS3230 Design and Analysis of Algorithms or CS3210 Parallel Computing), MA4268 (MA2213 Numerical Analysis I). For students who wish to read these modules for the Data Science specialisation, the Faculty/Department will provide them with academic advice on their study plans (where necessary) as such students would have to read 'additional' pre-requisite modules.

(B) To be awarded a specialisation in Finance and Business Statistics, a candidate must pass at least six modules (24 MCs) from the following two lists, with at least two modules (8 MCs) from each of the lists (FBS 1, FBS 2), as part of the major requirements for B.Sc. (Hons.) with a primary major in Statistics:

#### FBS 1

ST3233 Applied Times Series Analysis  
 ST3234 Actuarial Statistics  
 ST3246 Statistical Models for Actuarial Science  
 MA3269 Mathematical Finance I  
 ST4245 Statistical Methods for Finance  
 MA4269 Mathematical Finance II

#### FBS 2

ST3232 Design and Analysis of Experiments  
 ST3239 Survey Methodology  
 ST3242 Introduction to Survival Analysis  
 ST3244 Demographic Methods  
 ST4238 Stochastic Processes II

<b>SUMMARY OF REQUIREMENTS</b>	<b>B.SC.</b>	<b>B.SC. (HONS.)</b>
University Requirements	20 MCs	20 MCs
Faculty Requirements	8 MCs*	8 MCs*
Major Requirements	60-62 MCs	92-94 MCs
Unrestricted Elective Modules	30-32 MCs	38-40 MCs
Total	120 MCs	160 MCs

\* Faculty requirements of 12 MCs and 16 MCs [required for the B.Sc. and B.Sc. (Hons.) programmes respectively] are partially fulfilled through the reading of CS/MA modules within the major.

Students undertaking the B.Sc. and B.Sc. (Hons.) programmes are required to fulfil the remaining 8 MCs of Faculty requirements from any two (2) of the following subject groups: Chemical Sciences, Life Sciences, Physical Sciences and Multidisciplinary & Interdisciplinary Sciences; but not from the following groups: Computing Sciences and Mathematical & Statistical Sciences.

### **3.3.4 Bachelor of Science (Pharmacy)/Bachelor of Science (Pharmacy) (Hons.) [B.Sc. (Pharm.)/B.Sc. (Pharm.) (Hons.)]**

A pharmacist is a healthcare professional who is an expert on drugs and is involved in dispensing, counselling and managing the use of drugs. Therefore, the pharmacist is specially trained to be knowledgeable in every aspect of drugs. The vast knowledge that is necessary to perform these functions is multidisciplinary. It ranges from the properties and actions of drugs to the technology and science behind the production of a medicinal product, to the rational use of a drug for optimal therapeutic outcome in patients.

Pharmacy as a profession is evolving continuously and new practices are introduced to provide better healthcare for people. If helping the sick recover from the appropriate use of medicines and promoting of wellness and healthy lifestyle gives you a sense of purpose, then pharmacy will be a good choice of study. In addition, pharmacy education provides one with the grounding in physicochemical, biomedical and pharmaceutical sciences. This can also open career opportunities into the exciting arena of pharmaceutical industry where you can be involved in the research and development of drugs, clinical trials, pharmaceutical marketing and pharmaceutical sales.

#### **Programme Structure and Curriculum Rationale**

The primary aim of the pharmacy course is to provide the relevant knowledge and skills that are required for entry into the profession. The course focuses on laying a strong foundation in topics related to pharmaceutical sciences and pharmacy practice so that graduates can readily apply these fundamental principles to their future employment, be it in the community practice, hospital service, healthcare business, pharmaceutical industry or research. In addition, interprofessional education is integrated into the curriculum as an essential component to prepare graduates for interprofessional collaborative patient-centred practice as healthcare professionals. The curriculum is enriched with experiential learning in the form of laboratory training, interactive flipped classroom learning models and one-on-one coaching on professional skills (such as patient counselling).

Pharmacy is a four-year programme. The degree in BSc (Pharmacy) with Honours will be awarded to candidates who have performed well throughout the course of study, as determined by their cumulative average points. Those who do not qualify for Honours degrees will be awarded a BSc (Pharmacy) degree.

#### **Career Prospects**

Upon completion of the Pharmacy degree course and registration with the Singapore Pharmacy Council (after a 12-month pre-registration training programme of which a 6-month equivalent is completed as part of in-course requirement), a wide variety of career options is open to the registered pharmacists. Pharmacists may seek to build a career and specialise in patient care practice either in the hospital or community pharmacy. Intensive care, oncology, infectious diseases, nutritional support, geriatric care



and drug information are some areas of specialisation that pharmacists may choose to pursue. Besides patient care, pharmacists may prefer to enter the pharmaceutical industry where they seek jobs related to clinical trial management, product registration, pharmaceutical manufacturing, sales and marketing of pharmaceuticals, healthcare products and medical devices. In addition, pharmacists may be involved in regulatory affairs of prescription drugs, health supplements, cosmetics and traditional Chinese medicines. Therefore a degree in Pharmacy certainly offers diversity and flexibility in career development.

## Graduation Requirements

To be awarded a BSc (Pharmacy) or BSc (Pharmacy) (Hons), candidates must satisfy the following:

MODULE LEVEL		MAJOR REQUIREMENTS	CUMULATIVE MAJOR MCS
Faculty Requirement (16 MCs)	Pass		16
	AY1130	Human Physiology & Anatomy I	
	PA1113	Basic Pharmacology	
	PY1131	Human Physiology & Anatomy II	
	PX2108	Basic Human Pathology	
Level-1000 (16 MCs)	Pass		32
	PR1110	Foundations for Medicinal Chemistry	
	PR1111	Pharm Biochemistry	
	PR1120	Microbiology for Pharmacy	
	PR1140	Pharmacy Professional Skills Development I	
Level-2000 (32 MCs)	Pass		64
	PR2114	Formulation & Technology I	
	PR2115	Medicinal Chemistry for Drug Design	
	PR2122	Biotechnology for Pharmacy	
	PR2131	Pharmacy Professional Skills Development II	
	PR2133	Pharmacotherapeutics I	
	PR2134	Self Care	
	PR2135	Pharmacotherapeutics II	
	PR2143	Pharmaceutical Analysis for Quality Assurance	

MODULE LEVEL	MAJOR REQUIREMENTS	CUMULATIVE MAJOR MCS
Level-3000 (32 MCS)	Pass PR3116 Concepts in Pharmacokinetics and Biopharmaceutics PR3124 Pharmacotherapeutics III PR3117 Formulation & Technology II PR3136 Pharmacotherapeutics IV PR3137 Pharmacy Professional Skills Development III PR3144 Principles of Research Methods PR3145 Compliance & Good Practices in Pharmacy PR3146 Pharmacy Law in Singapore	96
Level-4000 (28 MCS)	Pass PR4197 Pharmacy Internship I PR4198 Pharmacy Internship II PR4196 Pharmacy Research Project and Scientific Communication	124

SUMMARY OF REQUIREMENT BSC (PHARMACY)/BSC (PHARMACY) (HONS)	
University Requirement	20 MCS
Faculty Requirements	16 MCS
Major Requirement	108 MCS
Unrestricted Elective Modules	16 MCS
Total	160 MCS

Note:

Curricular content and graduation requirements may be subject to change.

## 3.4 Multidisciplinary Opportunities

3.4.1 [Double Major and Major-Minor Combinations](#)

3.4.2 [Second Major Programmes](#)

3.4.3 [Minor Programmes](#)

3.4.4 [Double Degree Programmes in Law \(LLB\) and Life Sciences \[BSc/BSc \(Hons\)\]](#)

3.4.5 [Double Degree Programmes in Computing \(BComp\) and Mathematics \[BSc/BSc \(Hons\)\]](#)

3.4.6 [NUS-ANU Joint Degree Programme: Bachelor of Science \(Hons\) from National University of Singapore and Bachelor of Philosophy \(Hons\) from Australian National University](#)

3.4.7 [Joint Bachelor of Science \(Honours\) in Life Sciences from National University of Singapore and Bachelor of Science in Biology from The University of North Carolina at Chapel Hill](#)

3.4.8 [Concurrent MSc \(Mgt\) and BSc \(Hons\) / BApplSc \(Hons\)](#)

3.4.9 [Concurrent Programme in BSc \(Hons\) in Life Sciences – MRes in Molecular Biophysics between Faculty of Science, National University of Singapore and Faculty of Life Sciences and Medicine, King's College London](#)

3.4.10 [Concurrent Programmes in Bachelor of Science \(Honours\) in Chemistry/Life Sciences of National University of Singapore and Master of Science in Forensic Science/Analytical Toxicology of King's College London](#)

### 3.4.1 Double Major and Major-Minor Combinations

While the minimum requirement for graduation is at least one major, students may read double majors or major-minor combinations during their candidature if they wish to enhance and broaden their undergraduate education.

Up to 8MC of the Minor may be double counted with the Primary Major or Second Major requirements, and up to 16 MCs of the Second Major may be double counted with the Primary Major requirements.

Please refer to the following Faculty of Science website for the double-counting rules:

<http://www.science.nus.edu.sg/undergraduate-studies/ugfaq/faq-current#dblcount>.

For certain major-minor combinations, departments have specified the number as well as the type of modules that can be read to fulfil two sets of requirements simultaneously (refer to Table 1).

**Table 1: Major-Minor Combinations**

MAJOR-MINOR COMBINATIONS	RESTRICTIONS
Major in Quantitative Finance and Minor in Statistics	Only MA1102R, ST2131/MA2216 and ST3131 can be used to satisfy both major and minor requirements. Please refer to <a href="http://www.stat.nus.edu.sg/opencms/currentstudents/cs_ugradfaq.html#majorMinor">http://www.stat.nus.edu.sg/opencms/currentstudents/cs_ugradfaq.html#majorMinor</a> for more details.
Major in Mathematics/Applied Mathematics and Minor in Statistics	Only MA1102R and ST2131/MA2216 can be used to satisfy both major and minor requirements. Please refer to <a href="http://www.stat.nus.edu.sg/opencms/currentstudents/cs_ugradfaq.html#majorMinor">http://www.stat.nus.edu.sg/opencms/currentstudents/cs_ugradfaq.html#majorMinor</a> for more details.
Major in Statistics and Minor in Mathematics	Only MA1102R and ST2131/MA2216 can be used to satisfy both major and minor requirements. Please refer to <a href="http://ww1.math.nus.edu.sg/undergraduates.aspx?f=UP-MAminor#scrolltop">http://ww1.math.nus.edu.sg/undergraduates.aspx?f=UP-MAminor#scrolltop</a> for more details.

MAJOR-MINOR COMBINATIONS	RESTRICTIONS
Major in Statistics and Minor in Financial Mathematics	Only MA1102R, ST2131/MA2216 and ST3131 can be used to satisfy both major and minor requirements. Please refer to <a href="http://ww1.math.nus.edu.sg/undergraduates.aspx?f=UP-FMminor#scrolltop">http://ww1.math.nus.edu.sg/undergraduates.aspx?f=UP-FMminor#scrolltop</a> for more details.

For certain major-second major combinations, departments have specified the number as well as the type of modules that can be read to fulfil two sets of requirements simultaneously:

Students reading a double major combination involving a Primary major in Statistics and Second Major in Mathematics may refer to the FAQ at <http://ww1.math.nus.edu.sg/undergraduates.aspx?f=UP-MA2#scrolltop> for more information.

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Students reading a double major combination involving a primary major in Applied Mathematics/Mathematics/Quantitative Finance and a second major in Statistics should refer to the FAQ at [http://www.stat.nus.edu.sg/opencms/currentstudents/cs\\_ugradfaq.html#course](http://www.stat.nus.edu.sg/opencms/currentstudents/cs_ugradfaq.html#course) for more information.

For prohibited double major and major-minor combinations, students should refer to departments offering the minor/major programmes.

### 3.4.2 Second Major Programmes

Prerequisites for Second Major Programmes:

SECOND MAJOR	PREREQUISITES
1. Chemistry	H2 pass in Chemistry or equivalent
2. Data Analytics	A very good pass in H2 Mathematics or equivalent. Existing students from cohort 2016/2017 or later may apply to read a Second Major in Data Analytics after completing CS1010 (or its equivalent), MA1101R (or its equivalent) and MA1102R (or its equivalent) with a B+ grade or above in each of these modules.
3. Life Sciences	H2 passes or equivalent in Biology, Chemistry AND either Mathematics or Physics
4. Mathematics	H2 pass in Mathematics or equivalent
5. Physics	H2 pass in Physics or equivalent
6. Statistics	H2 pass in Mathematics or equivalent

3.4.2.1 [Second Major in Chemistry](#)

3.4.2.2 [Second Major in Data Analytics](#)

3.4.2.3 [Second Major in Food Science](#)

3.4.2.3 [Second Major in Life Sciences](#)

3.4.2.4 [Second Major in Mathematics](#)

3.4.2.5 [Second Major in Physics](#)

3.4.2.6 [Second Major in Statistics](#)

### 3.4.2.1 Second Major in Chemistry

Host Department: Chemistry

Chemistry has played an important role in the rich and varied history of human civilisation and remains an integral part of our modern technological society. The second major in chemistry provides essential training in inorganic, organic, physical, and analytical chemistry. In addition to learning essential concepts of chemistry, the course also emphasises hands-on training in laboratory techniques. Students will learn how to synthesise, analyse and separate molecules. Chemistry is the central science, linking many diverse subjects from the microscopic world of molecular biology to space and beyond. This second major will value add to students who wish to consider managerial career in the chemical and financial industries, as well as provide a good training ground in interdisciplinary research career in the life sciences, materials chemistry or physics

To be awarded a BSc with a second major in Chemistry, candidates must satisfy the following:

MODULE LEVEL	SECOND MAJOR REQUIREMENTS	CUMULATIVE MAJOR MCS
Level-1000 (16 MCs)	Pass CM1111 Inorganic Chemistry 1 CM1121 Organic Chemistry 1 CM1131 Physical Chemistry 1 CM1191 Experiments in Chemistry 1 Processes	16
Level-2000 (16 MCs)	Pass • CM2101 Physical Chemistry 2 • CM2111 Inorganic Chemistry 2 • CM2121 Organic Chemistry 2 Pass any <u>one</u> module from the following: • CM2191 Experiments in Chemistry 2 • CM2192 Experiments in Chemistry 3	32

MODULE LEVEL	SECOND MAJOR REQUIREMENTS	CUMULATIVE MAJOR MCS
Level-3000 (16 MCs)	Pass CM3291    Advanced Experiments in Inorganic and Organic Chemistry <u>or</u> CM3292    Advanced Experiments in Analytical and Physical Chemistry and <u>three</u> (3) other CM32XX modules (excluding CM3289)*	48

\* UROPS CM3288 can be counted as 4 MCs. However, if two semesters work of UROPS is completed, CM3289 will not be counted.

This second major is not awarded with a primary major in Chemistry or a minor in Analytical Chemistry.

Note:

Level-4000 CM prefixed modules may be taken to replace up to 4 MCs of the Level-3000 CM elective modules above.



### 3.4.2.2 Second Major in Data Analytics

Host Department: Statistics

To be awarded a B.Sc. with a second major in Data Analytics, candidates must satisfy the following:

LEVELS	SECOND MAJOR REQUIREMENTS	CUMULATIVE MAJOR MCS
Level 1000(10 - 12 MCS)	<p>Pass</p> <p>One of the following modules:</p> <p>CS1010/CS1010E/CS1010J/CS1010S/CS1010X Programming Methodology</p> <p>IT1007 Introduction to Programming with Python and C</p> <p>One of the following modules:</p> <ul style="list-style-type: none"><li>• MA1101R Linear Algebra I</li><li>• MA1311 Matrix Algebra</li><li>• MA1508E Linear Algebra for Engineering</li><li>• MA1513 Linear Algebra with Differential Equations (2 MCS) †</li></ul> <p>One of the following modules:</p> <ul style="list-style-type: none"><li>• MA1102R Calculus</li><li>• MA1312 Calculus with Applications</li><li>• MA1505 Mathematics I</li><li>• MA1507 Advanced Calculus</li><li>• MA1511 Engineering Calculus (2 MCS) <u>and</u> MA1512 Differential Equations for Engineering (2 MCS)</li><li>• MA1521 Calculus for Computing</li></ul>	10 - 12

LEVELS	SECOND MAJOR REQUIREMENTS	CUMULATIVE MAJOR MCS
Level 2000(16 MCs)	Pass CS2040 Data Structures and Algorithms ST2131/MA2216 Probability ST2132 Mathematical Statistics One of the following modules: • DSA2101 Essential Data Analytics Tools: Data Visualisation • DSA2102 Essential Data Analytics Tools: Numerical Computation	26 - 28
Level 3000 and 4000 (20 - 24 MCs)	Pass ST3131 Regression Analysis One of the following modules: • DSA3102 Essential Data Analytics Tools: Convex Optimisation* • DBA3701 Introduction to Optimisation • MA3236 Nonlinear Programming* • MA3252 Linear and Network Optimisation One module from List I One module from List II One other module from List I or List II One additional module from List I or List II †	48 - 50

† Applicable only to students who use MA1513 Linear Algebra with Differential Equations (2 MCs) to fulfil the second major requirements.

#### List I^

DSA4211 High-Dimensional Statistical Analysis

DSA4212 Optimisation for Large-Scale Data-Driven Inference\*

#### List II

CS3244 Machine Learning

ST3240      Multivariate Statistical Analysis

ST3247      Simulation

ST3248      Statistical Learning I

ST4248      Statistical Learning II

\* Students may need to read additional modules outside the second major requirements to satisfy the pre-requisites of these modules.

^ (1) As part of the Data Science and Analytics programme, FoS is planning to co-develop modules on data analytics for functional areas such as business, healthcare and public policy making with other Faculties/Schools. These modules will be coded as DSA modules and added to List I. (2) Students who participate in credit-bearing full-time internships/industrial attachments/professional placements as part of their degree requirements may be approved to double-count up to 8 MCs into List I if their internships/industrial attachments/professional placements have substantial data-analytics content, provided the limit of 16 MCs of double-counting in primary and second major requirements is not exceeded.

This second major is not offered with the following primary majors and minors:

Primary Majors: Applied Mathematics, Computational Biology, Data Science and Analytics, Mathematics, Quantitative Finance, Statistics.

Minors: Financial Mathematics, Mathematics, Statistics.

## Second Major in Food Science

Host Department: Chemistry; Food Science and Technology Programme

To be awarded a B.Sc. with a Second Major in Food Science, candidates must satisfy the following:

MODULE LEVEL	SECOND MAJOR REQUIREMENTS	CUMULATIVE MAJOR MCS
Level 1000 (16 MCs)	Pass FST1101 Science and Technology of Foods CM1501 Organic Chemistry for Engineers CM1191 Experiments in Chemistry 1 LSM1106 Molecular Cell Biology	16 MCs
Level 2000 (16 MCs)	Pass FST2102B Chemistry of Food Components FST2108 Food Safety Assurance FST2201 Introduction to Human Nutrition LSM2211 Metabolism and Regulation	32 MCs
Level 3000 (16 MCs)	Pass FST3106 Sensory and Flavour Science FST3202 Nutrition and Disease Prevention  Any two of the following: CM3242 Instrumental Analysis II CM3201 Principles of Chemical Processes CM3291 Advanced Experiments in Inorganic and Organic Chemistry CM3292 Advanced Experiments in Analytical and Physical Chemistry	48 MCs

*Note: A precluding module to CM1501 (e.g. CM1121 and CM1401) may be used to fulfil the second major requirements in lieu of CM1501.*

This second major is not offered with the primary major in Food Science and Technology.

### 3.4.2.3 Second Major in Life Sciences

Host Department: Biological Sciences

The curriculum for Life Sciences as a second major allows students to get an in-depth knowledge in modern Life Sciences to complement their primary majors. Core skills in the Life Sciences will be developed through emphasis on fundamental concepts and principles, laboratory competence and research techniques.

To be awarded a B.Sc. with a second major in Life Sciences, candidates must satisfy the following:

MODULE LEVEL	SECOND MAJOR REQUIREMENTS	CUMULATIVE MAJOR MCS
Level 1000 (16 MCs)	Pass LSM1102    Molecular Genetics LSM1105    Evolutionary Biology LSM1106    Molecular Cell Biology CM1401    Chemistry for Life Sciences* OR ST1232    Statistics for Life Sciences *If a precluding module to CM1401 (i.e. CM1121 or CM1501) is passed, the precluding module is accepted to be fulfilling the Second Major in Life Sciences in lieu of CM1401.	16
Level 2000 (16 MCs)	Pass LSM2191    Laboratory Techniques in Life Sciences Three LSM22xx modules (except LSM2288 and LSM2289)	32
Level 3000 (16 MCs)	Pass four LSM32xx elective modules (except LSM3289), of which up to two (up to 8MC) may be LSM42xx (except LSM4299) and/or LSM-recognised elective modules.	48

This second major is not awarded with a primary major in Life Sciences and minor in Life Sciences.



### **3.4.2.4 Second Major in Mathematics**

Arising from the recent revamp of the Engineering Mathematics curriculum, the Department of Mathematics has introduced four new modules MA1511 Engineering Calculus (2 MCs), MA1512 Differential Equations for Engineering (2 MCs), MA1513 Linear Algebra with Differential Equations (2 MCs) and MA1508E Linear Algebra for Engineering (4 MCs) to be offered from AY2017/18, for which students in different engineering departments will take prescribed combinations to suit their need. To allow flexibility for students from the Faculty of Engineering and other schools and faculties to take a Second Major in Mathematics, it is necessary to revise the relevant parts of the requirements of the programme.

To be awarded a BSc with a second major in Mathematics, candidates must satisfy at least 48 MCs from non-overlapping modules of the following:

MODULE LEVEL	SECOND MAJOR REQUIREMENTS	CUMULATIVE MAJOR MCS
Level-1000 (16 - 18 MCs)	Pass MA1100      Fundamental Concepts of Mathematics <u>or</u> CS1231      Discrete Structures MA1101R      Linear Algebra I <u>or</u> MA1506      Mathematics II <u>or</u> MA1508      Linear Algebra with Applications <u>or</u> MA1508E      Linear Algebra for Engineering <u>or</u> (MA1513 Linear Algebra with Differential Equations and one additional module from List II) MA1102R      Calculus <u>or</u> MA1505      Mathematics I <u>or</u> MA1507      Advanced Calculus <u>or</u> MA1521      Calculus for Computing <u>or</u> (MA1511 Engineering Calculus and MA1512 Differential Equations for Engineering) MA1104/MA2104      Multivariable Calculus <u>or</u> MA2501      Differential Equations and Systems	16 - 18



MODULE LEVEL	SECOND MAJOR REQUIREMENTS	CUMULATIVE MAJOR MCS
Level-2000 (16 - 19 MCs)	Pass MA2101/     Linear Algebra II MA2101S MA2108/     Mathematical Analysis I MA2108S MA2216/     Probability ST2131 <u>One</u> additional module from List II, III, IV	32 - 37
Level-3000 & Level-4000 (16 - 19 MCs)	Pass MA3110/     Mathematical Analysis II MA3110S MA3111/     Complex Analysis I MA3111S <u>Two</u> additional modules from List III, IV	48 - 56

List II:

- All MA modules at Level-2000, except those coded MA23XX
- PC2130    Quantum Mechanics I
- PC2132    Classical Mechanics
- ST2132    Mathematical Statistics
- EC2101    Microeconomic Analysis I

List III:

- All MA modules at Level-3000, except MA3311 and MA3312
- BSE3703 Econometrics for Business I
- CS3230    Design & Analysis of Algorithms
- CS3234    Logic and Formal Systems
- DSA3102 Essential Data Analytics Tools: Convex Optimisation
- EC3101    Microeconomic Analysis II
- EC3303    Econometrics I
- PC3130    Quantum Mechanics II
- PC3236    Computational Methods in Physics
- PC3238    Fluid Dynamics
- ST3131    Regression Analysis
- ST3236    Stochastic Processes I

List IV:

- All MA modules at Level-4000 or higher
- CS4232    Theory of Computation
- CS4234    Optimisation Algorithms
- CS4236    Cryptography Theory and Practice

- CS5230 Computational Complexity
- CS5237 Computational Geometry and Applications
- DSA4211 High-Dimensional Statistical Analysis
- DSA4212 Optimisation for Large-Scale Data-Driven Inference
- EC4101/EC4301 Microeconomic Analysis III
- EC5104/EC5104R Mathematical Economics
- PC4248 Relativity
- PC4274 Mathematical Methods in Physics III
- ST4238 Stochastic Processes II
- ST4245 Statistical Methods for Finance

This second major is not offered with a primary major in Applied Mathematics, Mathematics, Quantitative Finance or Data Science and Analytics, and minor in Mathematics or Financial Mathematics.

Students reading a primary major in Statistics with second major in Mathematics should refer to the FAQ at <http://ww1.math.nus.edu.sg/undergraduates.aspx?f=UP-MA2>.

### 3.4.2.5 Second Major in Physics

Host Department: Physics

To be awarded a second major in Physics, candidates must satisfy the following:

MODULE LEVEL	SECOND MAJOR REQUIREMENTS	CUMULATIVE MAJOR MCS
Level-1000 (16 MCs)	Pass PC1141 Introduction to Classical Mechanics PC1142 Introduction to Thermodynamics and Optics PC1143 Introduction to Electricity & Magnetism PC1144 Introduction to Modern Physics	16
Level-2000 (16 MCs)	Pass PC2130 Quantum Mechanics I PC2131 Electricity and Magnetism I PC2193 Experimental Physics I Any <u>one</u> from the following: • PC2132 Classical Mechanics • PC2134 Mathematical Methods in Physics I • PC2230 Thermodynamics and Statistical Mechanics	32

MODULE LEVEL	SECOND MAJOR REQUIREMENTS	CUMULATIVE MAJOR MCS
Level-3000 (16 MCs)	Pass Any <u>four</u> from the following <ul style="list-style-type: none"> <li>• PC3130 Quantum Mechanics II</li> <li>• PC3193 Experimental Physics II</li> <li>• PC3231 Electricity and Magnetism II</li> <li>• PC3232 Nuclear and Particle Physics</li> <li>• PC3246 Astrophysics I</li> <li>• PC3274 Mathematical Methods in Physics II</li> <li>• PC3233 Atomic and Molecular Physics I</li> <li>• PC3235 Solid State Physics I</li> <li>• PC3236 Computational Methods in Physics</li> <li>• PC3238 Fluid Dynamics</li> <li>• PC3241 Solid State Devices</li> <li>• PC3242 Physics of Semiconductor Processing </li> <li>• PC3243 Photonics</li> <li>• PC3267 Biophysics II</li> <li>• PC3247 Modern Optics</li> <li>• PC3251 Nanophysics</li> <li>• PC3239 Special Problems in Undergraduate Physics</li> </ul>	48

This second major is not offered with a primary major in Physics and minor in Optical & Semiconductor Technology or Physics.

Note:

Level-4000 PC prefixed modules may be taken to replace up to 8 MCs of the Level-3000 PC elective modules above.

### **3.4.2.6 Second Major in Statistics**

Host Department: Statistics

To be awarded a B.Sc. with a second major in Statistics, candidates must satisfy the following:

MODULE LEVEL	SECOND MAJOR REQUIREMENTS	CUMULATIVE MAJOR MCS
Level-1000 (14 - 16 MCS)	Pass ST1131 Introduction to Statistics <u>or</u> ST1232 Statistics for Life Sciences MA1101R Linear Algebra I <u>or</u> MA1508E Linear Algebra for Engineering <u>or</u> MA1513 Linear Algebra with Differential Equations (2 MCS) ^ MA1102R Calculus <u>or</u> MA1505 Mathematics I <u>or</u> MA1507 Advanced Calculus <u>or</u> MA1511 Engineering Calculus (2 MCS) <u>and</u> MA1512 Differential Equations for Engineering (2 MCS) <u>or</u> MA1521 Calculus for Computing CS1010 Programming Methodology <u>or</u> CS1010E Programming Methodology <u>or</u> CS1010J Programming Methodology <u>or</u> CS1010S Programming Methodology <u>or</u> CS1010X Programming Methodology <u>or</u> IT1007 Introduction to Programming with Python and C	14 - 16

MODULE LEVEL	SECOND MAJOR REQUIREMENTS	CUMULATIVE MAJOR MCS
Level-2000 (16 - 17 MCs)	Pass ST2131/ Probability MA2216 ST2132 Mathematical Statistics ST2137 Computer Aided Data Analysis MA2311 Techniques in Advanced Calculus <u>or</u> MA2104 Multivariable Calculus <u>or</u> MA2108 Mathematical Analysis I <u>or</u> MA2108S Mathematical Analysis I (S)	30 - 33
Level-3000 & Level-4000 (16 - 20 MCs)	Pass ST3131 Regression Analysis - Three other modules from ST32xx (except ST328x) or ST4xxx modules - One additional other module from ST32xx (except ST328x) or ST4xxx modules ^	48 - 51

^ Applicable only to students who use MA1513 Linear Algebra with Differential Equations (2 MCs) to fulfil the second major requirements.

This second major is not offered with a primary major in Statistics, Data Science and Analytics, and minor in Statistics.

Students reading a primary major in Applied Mathematics/Mathematics/Quantitative Finance with a second major in Statistics should refer to the FAQ at

<http://www.stat.nus.edu.sg/index.php/current-students/undergraduate-programme/faq>.

### 3.4.3 Minor Programmes

#### Prerequisites for Minor Programmes

MINOR	PREREQUISITES
1. Analytical Chemistry	H2 pass in Chemistry or equivalent
2. Aquatic Ecology	Open to all for application <u>and</u> subject to Departmental approval
2. Biophysics	H2 pass or equivalent in Physics, Biology or LSM1301
3. Financial Mathematics 4. Mathematics 5. Statistics	H2 pass in Mathematics or equivalent
6. Forensic Science	Good grades for GEK1542 and a CAP of at least 3.00
7. Geosciences	Nil
8. Life Sciences	H2 pass or equivalent in Biology or LSM1301 <u>and</u> subject to Departmental approval.
9. Medical Physics	H2 pass in Physics or equivalent and H2 Biology (or equivalent, e.g. LSM1301 General Biology) Must have read and passed one of the following: <ul style="list-style-type: none"> <li>• PC1144 Introduction to Modern Physics</li> <li>• PC1432 Engineering Physics</li> <li>• PC2232 Physics for Electrical Engineers</li> <li>• PC2130B Applied Quantum Mechanics</li> </ul>
10. Nanoscience	H2 pass or equivalent in Chemistry or Physics
11. Optical & Semiconductor Technology 12. Physics	H2 pass in Physics or equivalent



MINOR	PREREQUISITES
13. Pharmaceutical Sciences	<ul style="list-style-type: none"> <li>• H2 pass or equivalent in Biology or Chemistry</li> <li>• Diploma from local polytechnics (Biology-related or Chemistry-related modules) <u>or</u></li> <li>• NUS High School Diploma (Biology or Chemistry) or</li> <li>• IB Diploma (Biology or Chemistry) or</li> <li>• A bridging module in either Biology or Chemistry taken at the NUS.</li> </ul>
14. Engineering Materials	H2 pass or equivalent in Chemistry or Physics

3.4.3.1 [Minor in Analytical Chemistry](#)

3.4.3.2 [Minor in Aquatic Ecology](#)

3.4.3.3 [Minor in Biophysics](#)

3.4.3.4 [Minor in Engineering Materials](#)

3.4.3.5 [Minor in Financial Mathematics](#)

3.4.3.6 [Minor in Forensic Science](#)

3.4.3.7 [Minor in Geosciences](#)

3.4.3.8 [Minor in Life Sciences](#)

3.4.3.9 [Minor in Mathematics](#)

3.4.3.10 [Minor in Medical Physics](#)

3.4.3.11 [Minor in Nanoscience](#)

3.4.3.12 [Minor in Optical and Semiconductor Technology](#)

3.4.3.13 [Minor in Pharmaceutical Sciences](#)

3.4.3.14 [Minor in Physics](#)

3.4.3.15 [Minor in Statistics](#)

### 3.4.3.1 Minor in Analytical Chemistry

Host Department: Chemistry

The Department of Chemistry offers a minor which comprises modules related to the theoretical and practical aspects of modern analytical techniques, used widely in the petrochemical, fine chemical, polymer, pharmaceutical, environmental, electronic and materials industries, as well as research laboratories.

The Analytical Chemistry minor is especially useful to Biological Sciences, Materials Science and Physics graduates who will thus be suitably trained in essential aspects of analytical science. This training will place such graduates in good stead when they seek employment, specifically giving them an edge in terms of employability over their more specialised counterparts.

To be awarded a minor in Analytical Chemistry, a student must pass all the following six modules:

1. CM1401 and CM1111 Chemistry for Life Sciences and Inorganic Chemistry 1 OR
2. CM1402 and CM1191 General Chemistry and Experiments in Chemistry 1
3. CM2101 Physical Chemistry 2
4. CM2142 Analytical Chemistry 1 OR CM2192 Experiments in Chemistry 2
5. CM3242 Instrumental Analysis II
6. CM3295 Selected Experiments in Analytical Chemistry

This minor is not awarded with the primary major in Chemistry and second major in Chemistry.

### **3.4.3.10 Minor in Medical Physics**

Host Faculties: Faculty of Science (Physics)

Faculty of Engineering

With an aging society and lifestyle changes one will see an increase in the prevalence of cancers and other diseases which often requires radiation systems and applications for diagnosis and therapy. Hospitals and other parts of the medical sector will therefore need Medical Physicists. The minor in Medical Physics is, to a large extent, based on nuclear physics. This programme enables students to get a solid grounding in many aspects of Medical Physics, e.g. Radiation Oncology, Proton Beam Therapy, Medical Imaging (MRI/CT/PET) and Medical Technology. It will lay the foundations for the enrolment in in professional programmes, e.g. a Master of Science in Medical Physics.

The Medical Physics minor is jointly offered by FoS & FoE. It is available for Physics majors (FoS) and other Science and Engineering majors (FoE & FoS) with:

H2 Physics (or its equivalent; e.g. PC1221/PC1221X and PC1222/PC1222X) and H2 Biology (or its equivalent, e.g. LSM1301/LSM1301X General Biology) who have read and passed one of the following:

1. PC1144 Introduction to Modern Physics
2. PC1432/PC1432X Physics IIE
3. PC2232 Physics for Electrical Engineers
4. PC2130B Applied Quantum Physics

Invitations to apply for the Medical Physics minor programme will be published at the beginning of each academic year. Applicants who meet the pre-requisites and have a good academic standing will be invited for an interview.

The Medical Physics minor programme will consist of the following set of common core modules (12 MCs):

1. GEH1032 Modern Technology in Medicine and Health
2. PC3232 Nuclear & Particle Physics (for physics majors) or PC3232B Applied Nuclear Physics
3. PC3294 Radiation Lab

Students in the Medical Physics minor programme are also required to read at least 12 MCs of modules from the following set of electives:

Module (4 MC each)

1. LSM2212 Human Anatomy

2. LSM1106 Molecular Cell Biology
3. LSM1104 or LSM2231 General Physiology
4. LSM1401 Fundamentals of Biochemistry
5. LSM2103 or LSM2233 Cell Biology
6. LSM4243 Tumour Biology
7. LSM3223 Immunology
8. LSM3243 Molecular Biophysics
9. EE4603 Biomedical Imaging Systems

### 3.4.3.11 Minor in Nanoscience

Host Department: Chemistry and Physics

Nanoscience and nanotechnology encompass the ability to understand and manipulate matter at the molecular level, to create artificial structures at the nanoscale with potentially novel functions

Structures behave differently when their dimensions are reduced to the range of between one and one hundred nanometers (nm). Such structures exhibit novel and very much improved physical, chemical and biological properties, due entirely to their nanoscopic size. Once we can control feature sizes on the nanometer scale, it is possible to enhance material properties and device functions beyond those that we presently know or even consider possible. Nanotechnology is defined as the ability to work at the molecular level, atom by atom, to create large structures with fundamentally new molecular organisation. Nanoscience is an exciting new multidisciplinary realm that brings together the traditional disciplines of Physics, Chemistry and Biology.

The objective of the Nanoscience minor programme is to provide a comprehensive introduction to the field of nanoscience, and would be suitable not only for students in the sciences and engineering, but also for students from any discipline who show a keen interest in the latest developments in science.

This Nanoscience minor programme covers the latest research and technology trends which may soon revolutionise the world's economy. .

This Minor would be particularly attractive to Physics, Chemistry and Engineering majors.

To qualify for a Minor in Nanoscience, a student should pass six modules as follows:

1. Two compulsory Level-1000 modules:
  - a. CM1131 Physical Chemistry or CM1502/CM1502X General and Physical Chemistry for Engineers and
  - b. PC1144 Introduction to Modern Physics or PC1432/PC1432X Physics IIE
2. Two Level-2000 modules:
  - a. SP2251 Science at the Nanoscale and
  - b. CM2101 Physical Chemistry 2 or PC2130 Quantum Mechanics 1
3. Two Level-3000 modules:
  - a. CM3251 Nanochemistry; or
  - b. PC3251 Nanophysics; or
  - c. CM/LSM/ [Advanced UOPS]\* PC3288
  - d. SP3277 Nano: from Research Bench to Industrial Applications\*\*

\* Must be a Nanoscience-related project.

\*\* SP3277 involves a compulsory nanotechnology study tour to Japan

Note:

Chemistry and Physics majors are only allowed to read at most three CM- and three PC- coded modules respectively; out of which only two modules (at most) are allowed to overlap with a student's major requirements.

### 3.4.3.12 Minor in Optical and Semiconductor Technology

Host Department: Physics

This minor comprises modules related to the fundamentals of optics and semiconductors. It is aimed at familiarising students with both the physics and the processing of semiconductor and photonic devices. It would be especially useful for preparing students for employment in the microelectronics and optical industry.

To be awarded a minor in Optical & Semiconductor Technology, a student must pass the following six modules:

1. PC1143 Introduction to Electricity & Magnetism or  
PC1432/PC1432X Physics IIE
2. PC2131 Electricity and Magnetism I or  
EE2005 Electronics
3. PC3247 Modern Optics
4. PC3243 Photonics
5. PC3241 Solid State Devices or  
EE2004 Electronic Devices
6. PC3242 Physics of Semiconductor Processing

This minor is not awarded with the primary major in Physics or Physics (with specialisations in Astrophysics or Nanophysics) and second major in Physics.



### **3.4.3.13 Minor in Pharmaceutical Sciences**

Host Department: Pharmacy

The pharmaceutical industry in Singapore has expanded tremendously in the past two decades, as more pharmaceutical and biopharmaceutical companies set up new manufacturing and research facilities here. Physical expansion draws in manpower with relevant knowledge and skills to the industry. In addition to the requisite domain knowledge which may be science, engineering, law or business; these organizations are also seeking to hire graduates with supplementary knowledge relevant to the pharmaceutical industry. This adjunct knowledge is based on a foundation in pharmaceutical sciences. Having an understanding of pharmaceutical sciences will enable these graduates to quickly immerse themselves in the environment of the industry, and may ease the initial learning curve and towards greater proficiency in practice.

The Minor in Pharmaceutical Sciences therefore serves to enrich the education of undergraduates in the following ways:

1. To build a fundamental technical language, knowledge and skill set relevant to the pharmaceutical industry.
2. To help raise awareness among undergraduates from different majors of the potential applications of their domain knowledge in the pharmaceutical industry.

There are many career opportunities in the pharmaceutical and allied industries for graduates who have a background in pharmaceutical sciences. Graduates who major in biology, chemistry, mathematics, statistics, food science, materials science, computing and engineering are needed to fill positions in research laboratories, manufacturing plants, quality assurance laboratory of pharmaceutical companies. In addition, those with degrees in law, economics, marketing or business may also develop rewarding careers as finance, human resource, intellectual property and legal, as well as business and market development professionals in the industry. It definitely takes multi-disciplinary teams with a variety of skills to develop and produce effective and safe health products.

#### **Prerequisites**

- H2 pass or equivalent in Biology or Chemistry
- Diploma from local polytechnics (Biology-related or Chemistry-related modules) or
- NUS High School Diploma (Biology or Chemistry) or
- IB Diploma (Biology or Chemistry) or
- A bridging module in either Biology or Chemistry taken at the NUS.

#### **Curriculum Structure and Requirements**

Candidates accepted into the minor programme are required to pass five (5) essential modules and one (1) elective module (for students enrolled in AY2014/15 and before) offered by the Department of Pharmacy. For students enrolled in AY2015/16 and after, the requirement is to pass four (4) essential

modules and two (2) elective modules as shown below. Some modules have practical component that will allow students to acquire relevant basic laboratory skills.

Essential modules:

PR1110 Foundations for Medicinal Chemistry

PR2114 Formulation and Technology I

PR2115 Medicinal Chemistry for Drug Design

PR3301 Pharmaceutical Dosage Forms

Choose TWO from the following elective modules:

PR1301 Complementary Medicine and Health

PR4205 Bioorganic Principles of Medicinal Chemistry

PR4206 Industrial Pharmacy

CN4241R Engineering Principles for Drug Delivery

The target applicants for this minor programme are students who are pursuing science or engineering-based majors. In addition, students who major in law, economics, computing, marketing or business may also apply, provided the pre-requisites are met.

This minor is not awarded to those with a primary major in Pharmacy.

### 3.4.3.14 Minor in Physics

Host Department: Physics

The Department of Physics offers a minor in Physics which comprises modules related to the fundamentals of physics, leading to a basic understanding of an important area of knowledge. It is aimed at engineering and science students to widen their intellectual horizons and prepare them for greater challenges ahead.

To be awarded a minor in Physics, a student must pass the following six modules:

1. Any one from the following:
  - PC1141 Introduction to Classical Mechanics
  - PC1142 Introduction to Thermodynamics and Optics
  - PC1143 Introduction to Electricity & Magnetism
  - PC1431 Physics IE or PC1431X Physics IE
2. Any one from the following:
  - PC1144 Introduction to Modern Physics
  - PC1432/PC1432X Physics IIE
  - PC2232 Physics for Electrical Engineers or PC2020 Electromagnetism for Electrical Engineers
3. Any four modules from the following of which at least two modules must be Level-3000 & above:
  - PC2130 Quantum Mechanics I
  - PC2131 Electricity and Magnetism I
  - PC2132 Classical Mechanics
  - PC2134 Mathematical Methods in Physics I
  - PC2230 Thermodynamics and Statistical Mechanics
  - PC2193 Experimental Physics I
  - PC3130 Quantum Mechanics II
  - PC3193 Experimental Physics II
  - ALL PC32XX and PC42XX modules

This minor is not awarded with a primary major in Physics or Physics (with specialisation in Astrophysics or Nanophysics) and second major in Physics.

### 3.4.3.15 Minor in Statistics

Host Department: Statistics and Applied Probability

Statistics is an interdisciplinary subject in nature. It has played a very important role in many scientific discoveries and social science studies. The aim of this minor programme is to introduce students to the basic concepts and practices in statistics as a pathway to enhance the analytical skill and statistical reasoning in dealing with information related to their majors.

To be awarded this minor, students must:

1. Pass one of the following:
  - a. MA1102R Calculus
  - b. MA1312 Calculus with Applications
  - c. MA1507 Advanced Calculus
  - d. MA1505 Mathematics I
  - e. MA1511 Engineering Calculus (2 MCs) and MA1512 Differential Equations for Engineering (2 MCs)
  - f. MA1521 Calculus for Computing
2. Pass ST2131 Probability or ST2334 Probability and Statistics;
3. Pass ST2132 Mathematical Statistics and ST3131 Regression Analysis; and
4. Pass one module from ST32xx, and one other module from ST32xx/ST4xxx, EC3304 Econometrics II, EC4303 Econometrics III, IE3101 Statistics for Engineering Applications, DBA3711 Stochastic Models in Management, FIN3712 Options and Future, FIN3715 Risk and Insurance, MA3259 Mathematical Methods in Genomics and LSM3241 Genomic Data Analysis.

This minor is not awarded with a primary major in Statistics, Statistics with specialisation in Data Science, Statistics with specialisation in Finance and Business Statistics, or Data Science and Analytics, and second major in Data Analytics or Statistics.

### 3.4.3.2 Minor in Aquatic Ecology

Host Faculties:

- Faculty of Arts and Social Sciences (Department of Geography)
- Faculty of Science (Department of Biological Sciences)

The Minor in Aquatic Ecology aims to expose students to the important disciplines of marine and freshwater ecological studies while developing relevant specific skills, knowledge, and experience among them. With the increasing governmental, private, and societal interest in aquatic sciences, there is a growing demand for manpower with expertise in freshwater and/or marine ecology. This Minor complements aptly the primary disciplines of students from the Life Sciences Major and Geography Major. It will also enhance the training for students keen on related career opportunities at relevant governmental and private institutions in Singapore, including Public Utilities Board (PUB), National Environment Agency (NEA), National Parks Board (NParks), the Maritime and Port Authority of Singapore (MPA), Tropical Marine Science Institute (TMSI), DHI Group, and Singapore-Delft Water Alliance (SDWA).

To be awarded a minor in Aquatic Ecology, a student must pass the six modules as set out below:

1. LSM2251 Ecology and Environment
2. LSM3254 Ecology of Aquatic Environments
3. GE2229 Water and Environment
4. SP3203 Aquatic Ecology Research
5. Choose 2 from the following elective modules:  
[For students reading Life Sciences Major, please select at least one non-LSM prefixed module.]
  - GE2215 Introduction to GIS and Remote Sensing
  - GE2220 Terrestrial and Coastal Environments
  - GE2228 Weather and Climate
  - GE3216 Applications of GIS & Remote Sensing
  - GE3221 Ecological Systems
  - GE3223 Environmental Change in the Tropics
  - LSM2253 Applied Data Analysis in Ecology and Evolution
  - LSM2252 Biodiversity
  - LSM4257 Aquatic Vertebrate Diversity
  - LSM4261 Marine Biology
  - LSM4264 Freshwater Biology

This Minor is not awarded with a Bachelor of Environmental Studies (BES) degree from Cohort AY2016/17 and onwards.

Application is required to read this minor. For the application process and more information, please refer to [http://www.lifesciences.nus.edu.sg/info/AE\\_Minor.pdf](http://www.lifesciences.nus.edu.sg/info/AE_Minor.pdf)



### **3.4.3.3 Minor in Biophysics**

Host Department: Physics and Life Sciences

Biophysics is a molecular science that seeks to explain biological function in terms of the molecular structures and properties of specific molecules. These molecules, the sole building blocks of living organisms, assemble into cells, tissues, and whole organisms by forming complex individual structures with dimensions of 10, 100, 1000, 10,000 nm and larger. Proteins assemble into the casein micelles of milk, which aggregate to form the curd of cheese; proteins and ribonucleic acids assemble into ribosomes, the machinery for building proteins; lipids and proteins assemble into cell membranes, the external barriers and internal surfaces of cells; proteins and DNA wind up into chromosomes, the carriers of the genetic code; and so on.

Biophysics is an interdisciplinary science that applies the theories and methods of physical sciences, especially those of physics, to the study of biological systems. Biophysicists have contributed significantly to the understanding of life sciences. For example, the discovery of the structure of the DNA double helix was attributed to Professor Francis Crick (co-winner of the Nobel Prize in Medicine, 1962) who was a physicist by training. More recently, physicist Sir Peter Mansfield won the Nobel Prize in Medicine (2003) for discoveries concerning magnetic resonance imaging. Such studies can be divided into these different areas of interest:

- Bioenergetics
- Biophysical Theory and Modelling
- Cell Biophysics Channels, Receptors, and Transporters
- Electrophysiology
- Bio Membranes
- Nucleic Acids
- Photobiophysics
- Assemblies and folding/unfolding of proteins and other biological macromolecules
- Spectroscopy, Imaging, and other techniques

### **Objective of Minor Programme in Biophysics**

The primary objective of this programme is to educate and train students with the core knowledge of physical sciences to tackle biological problems. Biophysics students will learn the fundamentals of biology and physics to prepare them for further studies at an advanced level. These students will be capable of meeting the challenges of modern-age biophysics, and to carry out independent or collaborative research work. Students equipped with the Minor in Biophysics will gain an advantage in their challenging careers in research, academia and industry related to the high value-added and knowledge-intensive Life Sciences industry.

### **Curriculum Structure and Requirements**

The Biophysics Minor Programme is jointly offered by the Department of Physics and the Office of Life

Sciences for students matriculated in and after AY2006/07. To be awarded a minor in Biophysics, the students are required to pass six modules (24 MCs), of which not more than two modules may be Level-1000 modules and three essential modules namely PC2267 (Biophysics I), PC3267 (Biophysics II), and LSM3243 (Molecular Biophysics) must be included.

Students of ANY major may read the Biophysics Minor, including Physics and Life Sciences majors.

To be awarded a minor in Biophysics, the following are the requirements:

For students undertaking a major in Life Sciences

1. Read and pass the following three essential modules:
  - a. PC2267 Biophysics I
  - b. PC3267 Biophysics II
  - c. LSM3243 Molecular Biophysics
2. Read and pass three modules from the following (Maximum of two Level-1000 modules):
  - a. PC1142 Introduction to Thermodynamics and Optics or PC1431/PC1431X Physics IE
  - b. PC1143 Introduction to Electricity & Magnetism or PC1432 Physics IIE
  - c. CM1402 General Chemistry
  - d. PC2131 Electricity & Magnetism
  - e. PC2230 Thermodynamics & Statistical Mechanics
  - f. LSM2102 Molecular Biology
  - g. LSM2241 Introductory Bioinformatics
  - h. PC4267 Biophysics III
  - i. PC4268 Biophysical Instrumentation and Biomolecular Electronics

For students undertaking a major in Physics

1. Read and pass the following three essential modules:
  - a. PC2267 Biophysics I
  - b. PC3267 Biophysics II
  - c. LSM3243 Molecular Biophysics
2. Read and pass three modules from the following (Maximum of two Level-1000 modules):
  - a. LSM1101 Biochemistry of Biomolecules
  - b. LSM1102 Molecular Genetics
  - c. CM1131 Physical Chemistry 1
  - d. PC2131 Electricity & Magnetism
  - e. PC2230 Thermodynamics & Statistical Mechanics
  - f. LSM2102 Molecular Biology
  - g. LSM2241 Introductory Bioinformatics
  - h. PC4267 Biophysics III
  - i. PC4268 Biophysical Instrumentation and Biomolecular Electronics

For students not undertaking a major in Life Sciences or Physics

1. Read and pass the following three essential modules:
  - a. PC2267 Biophysics I
  - b. PC3267 Biophysics II
  - c. LSM3243 Molecular Biophysics
2. Read and pass three modules from the following (Maximum of two Level-1000 modules):
  - a. PC1142 Introduction to Thermodynamics and Optics or PC1431/PC1431X Physics IE



- b. PC1143 Introduction to Electricity & Magnetism or PC1432 Physics IIE
- c. LSM1101 Biochemistry of Biomolecules
- d. LSM1102 Molecular Genetics
- e. CM1131 Physical Chemistry 1
- f. PC2131 Electricity & Magnetism
- g. PC2230 Thermodynamics & Statistical Mechanics
- h. LSM2102 Molecular Biology
- i. LSM2241 Introductory Bioinformatics
- j. PC4267 Biophysics III
- k. PC4268 Biophysical Instrumentation and Biomolecular Electronics

### **3.4.3.4 Minor in Engineering Materials**

Host Faculties:

- Faculty of Engineering (Department of Materials Science and Engineering)
- Faculty of Science

Engineering materials have played a key role in shaping the evolution of the industry in the past. All the more so, in recent times, materials played a catalytic role in influencing the technological advancement and economic growth of nations. It is not a coincidence that the most advanced nations of the world are also most advanced in the know-how of materials which ranges from synthetic to biological materials. Rapid strides in advancement in cutting edge technologies, whether related to life sciences such as in biomaterials, or engineering such as in thin films, are dependent on the further growth in the knowledge related to materials. Some of the materials-sensitive technologies include Bioengineering, Nanotechnology, Information Technology and Wafer Level Packaging. In order to align ourselves with most of the leading economies and universities of the world, it is imperative that we create a network of programmes that drive our students into the world of engineering materials.

The objectives of this multidisciplinary minor programme are as follows:

- To equip students with the fundamentals related to engineering materials, placing particular emphasis on advanced materials, design, manufacturing and processes,
- To enable students to be more aware of the behaviour of materials in engineering applications, and
- To enable students to select the materials for various engineering applications.

### **Requirements**

Please refer to the Faculty of Engineering Bulletin or Faculty of Engineering website for this minor <http://www.mse.nus.edu.sg/undergraduate.php> for the curriculum requirements.

### **Application Procedures**

Science students who wish to apply for the minor in Engineering Materials must complete the application form and return it to the Science Dean's Office, Blk S16 Level 2. Selected students will be notified by email. The form is available from the following website: <http://www.mse.nus.edu.sg/undergraduate.php>

### 3.4.3.5 Minor in Financial Mathematics

Host Department: Mathematics

The minor in Financial Mathematics allows non-mathematics majors to obtain a basic understanding of how modern mathematics is being applied in finance, banking and insurance.

To be awarded a minor in Financial Mathematics, a student must pass at least 24 MC's from non-overlapping modules of the following type:

1. Pass at least 8 MCs from MA1xxx, except MA1301/MA1301X; and
2. Pass MA2216/ST2131 or ST2334; and
3. Pass MA3269 and (QF3101 or FIN3102 [for BIZ students] or FIN3702 [for BIZ students]) ; and ST3131

Titles of the above modules are as listed below:

MA2216/ST2131 Probability

MA3269 Mathematical Finance I

QF3101 Investment Instruments: Theory and Computation

FIN3102 Investment Analysis and Portfolio Management

FIN3702\* Investment Analysis and Portfolio Management

ST2334 Probability and Statistics

ST3131 Regression Analysis

\*School of Business has amended the module code of FIN3102 to FIN3702 for cohort AY2017 and after.

This minor is not awarded with the primary major in Applied Mathematics, Quantitative Finance, Mathematics, Data Science and Analytics, and second major in Mathematics, Data Analytics.

### 3.4.3.6 Minor in Forensic Science

Host Department: Chemistry and Biological Sciences

The minor in Forensic Science aims to provide students with an understanding of the fundamental concepts and principles behind the application of scientific techniques to forensic investigations and to the criminal justice system.

Advances in basic scientific research have had a rapid and dramatic impact in these fields and it is only through an understanding of these fundamental scientific concepts that the legal system may be effective in criminal investigations.

A minor in Forensic Science offers a strong complement in criminal justice to students whose major is in the areas of study such as biology, chemistry, physics, psychology or engineering.

To be awarded a minor in Forensic Science, a student must pass the six modules as set out below:

1. GEK1542 or LSM1306 Forensic Science
2. CM3301 Advanced Forensic Science
3. SP3202 Evidence in Forensic Science
4. Choose 3 from the following elective modules:
  - CM2101 Physical Chemistry 2
  - CM2142 Analytical Chemistry1 OR CM3242 Instrumental Analysis II
  - LSM1102 Molecular Genetics
  - LSM3211 Fundamental Pharmacology

Please refer to <http://www.chemistry.nus.edu.sg/education/undergrads/Minor/forensic.htm> for more information on the minor, the admission requirements as well as the application form.

### **3.4.3.7 Minor in Geosciences**

Host Faculties:

- Faculty of Arts and Social Sciences (Geography)
- Faculty of Science

Geosciences – the sciences of the Earth and its environment – are concerned with exploring ideas about the natural world, understanding the physical and chemical processes that determine the distribution of resources, location of hazards and operation of surface processes. Geosciences provide advice and guidance on preserving the environment, rehabilitating damaged ecosystems, determining the environmental impact of certain activities, mitigating environmental hazards and assessing the implications of environmental change. How the earth system will respond to human impact is one of the most pressing issues facing society.

Given the increasing significance of environment on national and international agendas it is timely to consider how to improve awareness of geosciences. A Minor in Geosciences would appeal to students who are interested in the functioning of environmental processes and concerned about the key issues of climate and environmental change, natural hazards and risk management and sustainable land use.

Please refer to the Faculty of Arts and Social Science bulletin on this minor for the requirements and more information.

### 3.4.3.8 Minor in Life Sciences

Host Department: Biological Sciences

The minor in Life Sciences is designed for non-Life Sciences majors to receive significant training in selected Life Sciences topics. Students of this Minor will receive a good grounding in their choice of topics in Life Sciences as well as an insight into contemporary Life Sciences principles and techniques.

To be awarded a minor in Life Sciences, a student must pass six of the following modules:

1. Two modules from the following
  - a. LSM1102 Molecular Genetics
  - b. LSM1105 Evolutionary Biology
  - c. LSM1106 Molecular Cell Biology
2. Two LSM21xx/22xx modules except LSM2288 and LSM2289.
3. Pass two LSM32xx elective modules (except LSM3288 and LSM3289), of which one (up to 4MC) may be LSM42xx (except LSM4299) or LSM-recognised elective module.

This minor is not awarded with the primary or second major in Life Sciences.

### 3.4.3.9 Minor in Mathematics

Host Department: Mathematics

The minor in Mathematics encourages and gives due recognition to students who have read enough modules to reach a sound level of mathematical competence at the university level.

To qualify for a minor in Mathematics, a student should pass at least 24 MCs from non-overlapping modules of the following type:

1. Pass at least 8 MCs from the following modules:
  - a. MA1xxx modules except MA1301/MA1301X; or
  - b. CS1231
2. Pass any two MA2xxx modules
3. Pass any two MA3xxx or higher modules, excluding MA3311 and MA3312

Note that these ST and MA modules are crosslisted: ST2131 with MA2216, ST3236 with MA3238, and ST4238 with MA4251.

This minor is not awarded with the primary major in Mathematics, Applied Mathematics, Quantitative Finance, Data Science and Analytics, and second major in Mathematics or Financial Mathematics or Data Analytics.

### **3.4.4 Double Degree Programme in Law (LLB) and Life Sciences [BSc (Hons)]**

The intersection between Law and Life Sciences is an expansive one, cutting across many critical and controversial areas including biotechnology, bioethics, environmental regulation, forensic science, and the protection of intellectual property. The Double Degree Programme in Law and Life Sciences leverages on the strength of the Faculty of Law in the legal dimensions of these issues and the depth of technical expertise of NUS Life Sciences, Faculty of Science and Yong Loo Lin School of Medicine in these areas. It will enable students to discover the broad connections between law and life sciences and acquire a broad expertise occupying the niche position linking up both disciplines.

For more information, please refer to the URL <http://www.nus.edu.sg/prog/lawlifesciences> and [“Other Multidisciplinary / Special Programmes”](#) of the Bulletin.



### **3.4.5 Double Degree Programmes in Computing (BComp) and Mathematics [BSc/BSc (Hons)]**

Computer Science and Mathematics share a synergistic relationship in many ways — the foundation of computer science has its roots in mathematics, starting from the notion of computation (the Turing machine); discrete mathematics is an indispensable tool in understanding structures and systems in computer science. On the other hand, inventions and advances in computer science have generated new frontiers for research in mathematics. As a result, many fundamental areas in Computer Science such as computability and computational complexity are very much part of Mathematics and vice versa. The Double Degree Programmes in Computer Science and Mathematics/Applied Mathematics celebrate and leverage the synergistic relationship between the two disciplines.

For more information, please refer to the URL

[http://www.comp.nus.edu.sg/undergraduates/dd\\_cs\\_math.html](http://www.comp.nus.edu.sg/undergraduates/dd_cs_math.html) and [“Other Multidisciplinary / Special Programmes”](#) of the Bulletin.

### **3.4.6 NUS-ANU Joint Degree Programme: Bachelor of Science (Hons) from National University of Singapore and Bachelor of Philosophy (Hons) from Australian National University**

More information on this double degree programme is available in [“Other Multidisciplinary / Special Programmes”](#) of the Bulletin.

### **3.4.7 Joint Bachelor of Science (Honours) in Life Sciences from National University of Singapore and Bachelor of Science in Biology from The University of North Carolina at Chapel Hill**

More information on this joint degree programme is available at [“Other Multidisciplinary / Special Programmes”](#) of the Bulletin.

### **3.4.8 Concurrent MSc (Mgt) and BSc (Hons) / BApplSc (Hons)**

More information on this concurrent degree programme is available at [“Other Multidisciplinary / Special Programmes”](#) of the Bulletin.

### **3.4.9 Concurrent Programme in BSc (Hons) in Life Sciences - MRes in Molecular Biophysics between Faculty of Science, National University of Singapore and Faculty of Life Sciences and Medicine, King's College London**

More information on this concurrent degree programme is available at [“Other Multidisciplinary / Special Programmes”](#) of the Bulletin.

### **3.4.10 Concurrent Programmes in Bachelor of Science (Honours) in Chemistry/Life Sciences of National University of Singapore and Master of Science in Forensic Science/Analytical Toxicology of King's College London**

More information on this concurrent degree programme is available at [“Other Multidisciplinary / Special Programmes”](#) of the Bulletin.

## **3.5 Special Programmes**

3.5.1 [Professional Placement Programme \(PPP\)](#)

3.5.2 [Undergraduate Professional Internship Programme \(UPIP\)](#)

3.5.3 [Special Programme in Science \(SPS\)](#)

3.5.4 [Undergraduate Research Opportunities Programme in Science \(UROPS\)](#)

3.5.5 [University Scholars Programme \(USP\)](#)

### **3.5.1 Professional Placement Programme (PPP)**

In order to provide the necessary hands-on training and exposure, professional placement is an integral part of the Food Science and Technology major. The placement period is five to six months.

For more information, please visit the URL

<http://science.nus.edu.sg/undergraduate-studies/ugenh/professional-placement-programme>



### **3.5.2 Undergraduate Professional Internship Programme (UPIP)**

The Undergraduate Professional Internship Programme (UPIP) aims to provide Science undergraduates\* the opportunity to perform structured internship in an organisation during their undergraduate study. Internship helps students craft a fulfilling university journey through meaningful work experience. This programme allows students to engage in career preparation and job seeking exercises, hone their interpersonal, communications and other soft skills, and actively experience day-to-day operations in an organisation's ecosystem. Students will be presented with opportunities to apply their discipline-related knowledge and professionalism in an actual work setting thus allowing students to gain experiential learning that complements their course activity. Upon successful completion of this elective internship module, students will also be awarded with Modular Credit (MC) that would count towards the Unrestricted Elective component of their graduation requirements.

For more information, visit URL: <http://science.nus.edu.sg/students/upip>

\*with the exception of Food Science and Technology majors

### 3.5.3 Special Programme in Science (SPS)

SPS is an intense programme designed for a small cohort of undergraduates who have a strong aptitude and passion for science. It is directed at students who delight in rigorous training of the mind and character. The programme introduces participants to some of the broad areas of contemporary scientific concerns through an inter-disciplinary approach. Opportunities abound for participants to participate in scientific investigations and to embark on in-depth studies of advanced topics that are at the forefront of modern scientific endeavour. Participants get to enjoy close interaction with their peers and mentors through project work and seminar discussions. The programme also provides students with a rare opportunity to interact with renowned scientists visiting the university. With the goal of encouraging a free exchange of opinions and ideas, it is hoped that students will imbibe among other things, some of the wit and wisdom that these visitors may bring.

Students in the programme will read six modules in all:

SP2171 Discovering Science (4 MCs) – read over two semesters in the first year of study

SP2173 Atoms to Molecules (4 MCs) – read in semester I of the first year of study

SP2174 The Cell (4 MCs) – read in semester II of the first year of study

SP3175 The Earth (4 MCs) – read in semester I of the second year of study

SP3176 The Universe (4 MCs) – read in semester II of the second year of study

SP3172 Integrated Science Project (4 MCs) – can be read in either semester I or II of the second year of study

#### **SP3277 Nano: from Research Bench to Industrial Applications**

SP3277 Nano: from Research Bench to Industrial Applications is a new elective SPS module offered with effect from Sem 2 AY2013/14.

This module exposes senior students to nanoscience research and nanotechnology-based industry. This is done through a series of weekly seminars by principal investigators and industrial experts in the field, laboratory and industrial visits, and by completion of nanosynthesis/nanocharacterization-related mini projects. The course culminates in an intensive one-week study tour to Japan, organised in collaboration with La Trobe University and Tokyo University.

For both SPS and non-SPS students, this module can be counted towards the Multidisciplinary & Interdisciplinary Sciences subject group of the Faculty Requirements. This module can count towards requirements for Nanoscience minor.

Kindly contact Andreas Dewanto ([phyda@nus.edu.sg](mailto:phyda@nus.edu.sg)) and Lim Zhi Han ([matlzh@nus.edu.sg](mailto:matlzh@nus.edu.sg)) for more information.



### **3.5.4 Undergraduate Research Opportunities Programme in Science (UROPS)**

The Faculty introduced USRP (Undergraduate Science Research Programme) in AY1994/95. USRP was renamed UROPS in 1998. The aim of this programme is to provide undergraduates with a unique opportunity to work with one or more scientists in a specific area of study. It allows undergraduates to engage actively in research, discussions, intellectual communications and other creative activities, and to experience first-hand the exhilaration of discovery and invention. Students will be presented the challenge of working at, or near, the frontiers of Science and this exposure will complement conventional classroom learning. Through participation in research in the UROPS, a student will get a chance to:

- enhance his/her knowledge of the latest developments in science and technology;
- experience an intellectual process of inquiry and creative thinking;
- interact and form ties with established scientists and members of their groups;
- hone his/her communication and presentation skills;
- have the opportunity to mature professionally; and
- become a value-added graduate.

Students will undertake all phases of research activities, which include reading scientific journals, designing and execution of experiments, analysing data and presenting results.

To ensure some degree of standardisation, the programme will be administered by the Undergraduate Research Opportunities Programme in Science (UROPS) Committee formed by representatives from the respective departments and chaired by an Assistant Dean or Vice-Dean, with the Dean as Advisor.

#### **Eligibility**

To apply for Level-2000 UROPS module/s, the applicant must have:

1. Completed at least one semester upon application; and
2. Attained a CAP of at least 3.00.

To apply for Level-3000 UROPS module/s, the applicant must have:

1. Completed at least three semesters upon application; and
2. Attained a CAP of at least 3.00.

#### **Module Registration & Evaluation**

The module codes for the UROPS projects are: XX2288, XX2289, XX3288 and XX3289 where the first digit in the module code refers to the level at which the project is being undertaken. Each module is worth 4 MCs.

For 8 MCs UROPS, students will read XX2288/XX3288 in one regular semester and XX2289/XX3289 in the following regular semester. Completing the project during Special Term will not be allowed. If a student wishes to withdraw from an 8 MCs UROPS, he/she would need to do so by the first semester in

accordance to the modules dropping deadlines in CORS. Withdrawing from an 8 MCs UOPS in the second semester would result in a “F” grade.

A student can only undertake one UOPS project during an academic semester. Also, the same module code cannot be repeated. For e.g., a student who has done a Level-3000 UOPS from the Department of Chemistry (i.e. CM3288) is not allowed to do the same level of UOPS from the same Department again.

For students taking UOPS in Special Terms, the UOPS project must be of 4 MCs workload and completed during the Special Terms. In other words, students must start the project in Special Term (Part 1) and complete it in Special Term (Part 2).

**Project Duration: One semester (4 MCs)**

Students undertaking a one-semester long project will register online for a 4 MCs UOPS module (i.e. XX2288 or XX3288). Students will be evaluated at the end of the semester and receive a grade for the module.

**Project Duration: Two semesters (8 MCs)**

Students undertaking a two-semester long project will register online for one 8 MCs project (XX2288 or XX3288 will be preallocated at the beginning of the first semester that they embark on the project). They will only receive an IP (in progress) grade for that module at the end of the first semester since evaluation only takes place at the end of two semesters. The Dean’s Office will preallocate XX2288/XX3288 and XX2289/XX3289 at the beginning of the second semester. Upon evaluation at the end of second semester, students will receive a final grade on both modules XXx288 and XXx289.

Departments will decide on the format of evaluation/ examination.

## Application Procedures

The application procedure is outlined below:



Application opens for students to meet supervisors	01 Jun - 17 July 2017	24 Nov - 27 Dec 2017
Online Registration (UOPS Only)	19 Jun - 17 July 2017	28 Dec 2017 - 4 Jan 2018
Start UOPS project	14 Aug 2017	15 Jan 2018
Drop with “W” (4 or 8 MCs)	Refer to CORS website	Refer to CORS website
Drop with “F” (4 or 8 MCs)	Refer to CORS website	Refer to CORS website

Submission of full report to Dept Coordinator	Before reading week for regular semester
<b>SEMESTER 1 OF AY2017/18*</b> <b>SEMESTER 2 OF AY2017/18*</b>	
	<b>Special Term of AY2017/18*</b>
Students from Partner Universities to liaise with supervisors and obtain email confirmation from supervisors	01 Dec 2017 - 15 Feb 2018
Students from Partner Universities register online via Non-Graduating application system For more information, please refer to Summer UOPS website	1 Mar 2018
Application opens for NUS Science students to liaise with supervisors	26 Mar - 9 Apr 2018
Online Registration at student intranet (only for NUS Science students)	10 Apr - 20 Apr 2018
If application is successful, contact supervisor and start UOPS If application is unsuccessful, liaise and apply for another project	14 May 2018
Drop with "W" (4 or 8 MCs)	Refer to Special Term information in Registrar's Office website for AY17/18 Special Term Part 1
Drop with "F" (4 or 8 MCs)	Refer to Special Term information in Registrar's Office website for AY17/18 Special Term Part 2
Submission of full report to Dept Coordinator	By the last week of Special Term Part 2 (exact date to be decided by the Department)

\* Dates are subject to change. For latest updates, please visit

<http://www.science.nus.edu.sg/undergraduate-studies/ugenh/urops-main/176-undergraduate/ugenh/322-urops-registration>

## Reading UOPS modules in fulfilment of Major Requirements

1. For majors in Pharmacy, Statistics and Statistics (with specialisation in Biostatistics) and Statistics (with specialisation in Finance and Business Statistics), UOPS modules cannot be read in fulfilment of the major requirement.
2. For all other majors, UOPS modules may be read in fulfilment of the respective major requirements but subject to conditions laid out in the table below:

MAJORS	FULFILLING MAJOR REQUIREMENTS
Chemistry (CM)	Only 4 MCs from Level-3000 CM UOPS modules may be read in fulfilment of the Chemistry major requirements.
Computational Biology	Only 4 MCs from Level-3000 ZB UOPS modules may be read in fulfilment of the Computational Biology major requirements.
Food Science and Technology (FST)	Only 4 MCs from Level-3000 FST UOPS modules may be read in fulfilment of the Food Science and Technology major requirements.
Life Sciences / Life Sciences (with specialisations) (LSM)	Only 4 MCs from Level-3000 LSM UOPS modules may be read in fulfilment of the Life Sciences major requirement (within or outside area of specialisation/study).
Mathematics / Applied Mathematics (M.A.)	Only 4 MCs from either Level-2000 or Level-3000 MA UOPS modules may be read in fulfilment of the Mathematics/Applied Mathematics major requirements.
Physics (PC)	Only 4 MCs from Level-3000 PC UOPS modules may be read in fulfillment of the Physics major requirements.

### 3.5.5 University Scholars Programme (USP)

The University Scholars Programme is an interdisciplinary academic programme for NUS undergraduates. It offers students in this programme the freedom to explore across disciplines, a wide range of extracurricular and overseas opportunities, and a community of exceptionally motivated and talented students.

FoS students may wish to enrol in this programme for a more vibrant science education. Students in this programme would also get the chance to enroll for the Joint Degree Programme with the Australian National University or the Double Degree Programme with Waseda University.

(["Other Multidisciplinary / Special Programmes"](#) of the Bulletin)

For more information, please visit the websites:

<http://www.usp.nus.edu.sg/aboutusp/index.html>

[https://myportal.nus.edu.sg/studentportal/sci/ug/Academics\\_USP.html](https://myportal.nus.edu.sg/studentportal/sci/ug/Academics_USP.html)



## **3.6 Study Abroad Programmes**

3.6.1 [Student Exchange Programme \(SEP\)](#)

3.6.2 [Summer Programme](#)

3.6.3 [Joint Minor Programme with University of Toronto](#)

3.6.4 [NUS Overseas College Programme](#)

3.6.5 [University of North Carolina, Chapel Hill Summer Lab Exchange Programme](#)

3.6.6 [French Double Degree Programme](#)

### 3.6.1 Student Exchange Programme (SEP)

NUS has established many Memoranda of Understanding (MOU) with reputable foreign universities for our Student Exchange Programme (SEP). In this programme you can study abroad for up to two semesters but pay only local university fees. It is a great way to learn independence, to broaden your experience and to open up your mind. This is especially valuable as our nation is a global city with constant interactions in the international arena. It is a golden opportunity for you as a student who will soon step out of the university to establish your career. You will meet interesting people, make new friends and form networks that may influence your future profoundly.

Tuition fees at the partner universities are waived and students will only need to pay their home university fees. With the appropriate mapping, students will be given credits which can be counted towards their graduation requirements.

If you wish to apply, you:

1. must be a full-time undergraduate of NUS; and
2. must have completed at least one semester when you apply for the SEP and two semesters when you leave for the SEP; and
3. have attained a minimum CAP of 3.00 and no less than a C grade in any module; and
4. have completed the SP1541/ES1541 module before embarking for SEP; and
5. have a clean disciplinary record; and
6. have to be able to provide for your own airfare, accommodation and living expenses.

SEP students can apply for the NASA Exchange Awards to partially fund their exchange overseas.

For more details on the Student Exchange Programme, log on to:

<http://www.nus.edu.sg/IRO/prog/sep/student-exchange.html> and

<http://www.science.nus.edu.sg/education/undergraduate/ug-programmes/sap-outgoing>

Students should also look out for announcements on SEP talks organised by the Dean's Office.

### 3.6.2 Summer Programme

The Faculty of Science partners the following universities: University of Toronto (UofT), University of California, Los Angeles (UCLA), University of Costa Rica (UCR), Hokkaido University (HU), University of Copenhagen (KU), Leiden University and Hong Kong University of Science & Technology (HKUST), to jointly offer Summer Programmes for each university's students. This two-to-seven-week short-term exchange programme takes place during May to August, offering students the opportunity to sample student exchange without disrupting academic schedules. The summer programmes are multidisciplinary and involve participation from various departments spanning across Faculties/Schools at NUS, UofT, UCLA, UCR, HU, KU, Leiden and HKUST.

In the host country, students will discover the true meaning of "learning outside the classroom" — observe and experience many of the things you study, including the country's history, culture, art, and religion. For more information, please visit the URL

<http://www.science.nus.edu.sg/undergraduate-studies/ugsap/ugsap-out/summer-programme>

The International Relations Office (IRO) of the National University of Singapore also offers university-wide summer programmes with universities such as Aarhus University, Korea University, University of Ulm and Tec de Monterrey, Mexico. For more information, please visit the URL

<http://www.nus.edu.sg/iro/prog/isp/index.html>

### 3.6.3 Joint Minor Programme with University of Toronto

Leveraging on the expertise of the UofT, renowned for its environmental sciences, this Joint Minor Programme offers students a comprehensive curriculum that broadens and deepens the education they receive in NUS. Unlike other short overseas studying stints, it integrates the overseas study period into the degree programme, allowing grades as well as credits to be transferred. This first international joint minor programme offered by NUS was launched in AY2008/09 with two minors offered to NUS students: Environmental Biology and Environmental Chemistry.

#### Joint Minor in Environmental Biology

Host Departments: Department of Ecology & Evolutionary Biology (UofT) and the Department of Biological Sciences (NUS).

To be awarded the joint minor in Environmental Biology, a student is currently required to read and pass the modules as prescribed:

- LSM1103 Biodiversity
- LSM2251 Ecology and Environment
- LSM3252 Evolution and Comparative Genomics

and any four of the following UofT courses:

- EEB403H Tropical Field Biology (May)
- EEB405H Temperate Field Biology (May)
- EEB407H Alpine Ecosystems (July or August)
- EEB410H Lake Ecosystem Dynamics (August)
- ENV234H Environmental Biology: Structure and Function of Ecosystems
- EEB318H Principles of Evolution
- EEB321H Community Ecology
- EEB322H Behaviour and Behavioural Ecology
- EEB323H Evolutionary Genetics
- EEB328H Physiological Ecology
- EEB331H Introduction to the Fungi
- EEB362H Introduction to Macroevolution
- EEB375H Organisms and Their Environment
- EEB382H Diversity of Fishes
- EEB388H Biology of Mammals
- EEB319H Population Ecology
- EEB324H Evolutionary Ecology
- EEB330H Systematic Botany
- EEB356H Insect Biology
- EEB365H The Biology of Conservation
- EEB386H Avian Biology

For NUS students whose major includes the LSM modules taken for this minor, not more than 8 MCs are allowed to be double-counted. The duration of the overseas exchange is one semester at UofT.

Students specialising in Environmental Biology are allowed to count the UofT modules taken for this programme to their major requirements and will not be awarded a joint minor in Environmental Biology upon completion of the modules. Module mappings will be advised upon application.

### **Joint Minor in Environmental Chemistry**

Host Departments: Department of Chemistry (UofT), the Centre for Environment (UofT), and Department of Chemistry (NUS).

To be awarded the joint minor in Environmental Chemistry, a student is required to read and pass the modules as prescribed:

- CM2121 Organic Chemistry
- ENV237H/ENV238H Physics of the Changing Environment (UofT Module)
- CHM317H Introduction to Instrumental Methods of Analysis (UofT Module) or CM3242 Instrumental Analysis II
- CM3261 Environmental Chemistry
- CHM310H Environmental Chemistry (UofT Module)
- CHM415H Topics in Atmospheric Chemistry (UofT Module)

For NUS students whose major includes the CM modules taken for this minor, not more than 8 MCs are allowed to be double-counted. The duration of the overseas exchange is one semester in UofT.

### **Eligibility**

The joint minors in Environmental Biology and Environmental Chemistry are open to all NUS students, including students whose majors are Life Sciences and Chemistry respectively. To be allowed to apply for this Joint Minor Programme, students must

1. Have a CAP of at least 3.00;
2. Have read and passed the following modules:

#### For Environmental Biology

- H2 Biology or equivalent or LSM1301 General Biology
- H2 Mathematics or equivalent or any first year NUS Mathematics module
- Any 4 MCs of NUS Statistics or Probability module
- LSM1102 Molecular Genetics
- LSM1104 General Physiology
- LSM2102 Molecular Biology

#### For Environmental Chemistry

- H2 Physics or equivalent or NUS Physics Bridging module
- H2 Mathematics or equivalent or any first year NUS Mathematics module
- CM1111 Inorganic Chemistry 1
- CM1121 Organic Chemistry 1
- CM1131 Physical Chemistry 1
- CM2142 Analytical Chemistry

For more information, please visit the website:

<http://www.science.nus.edu.sg/undergraduate-studies/ugsap/ugsap-out/nus-toronto-joint-minor-programme>

### **3.6.4 NUS Overseas College Programme**

NUS Overseas Colleges is a university level unit of the NUS Enterprise Cluster that manages the highly innovative NUS Overseas Colleges programme. The programme targets NUS undergraduates with academic ability and entrepreneurial drive, keen to be interns in start-ups located in leading entrepreneurial and academic hubs of the world. At the same time, they will study entrepreneurship-related courses at highly prestigious partner universities. The aim is to cultivate and nurture them into enterprising, resourceful, independent self-starters who will eventually blossom into successful entrepreneurs.

Today, there are colleges in Silicon Valley and New York, USA; Shanghai and Beijing, China; Stockholm, Sweden; and Tel Aviv, Israel.

For more information, please visit the website:

<http://enterprise.nus.edu.sg/educate/nus-overseas-colleges>

### **3.6.5 University of North Carolina, Chapel Hill Summer Lab Exchange Programme**

The Faculty of Science partnered the University of North Carolina, Chapel Hill (UNC-CH), on the Summer Research Exchange Programme for the first time in May 2009. This programme, a collaboration between FoS and UNC-CH, facilitates an exchange of up to five students every semester from each university to conduct research in the laboratories of the partner university. FoS students will be able to perform research part-time from mid-May to late-July in laboratories in the Departments of Biology, Chemistry and Physics & Astronomy at UNC-CH. Likewise, UNC-CH students will receive credits for full-time research in laboratories in the Departments of Biological Sciences, Chemistry and Physics at FoS.



### **3.6.6 French Double Degree Programme**

The Grandes Écoles are the top French Engineering schools which provide higher education and quality research in Engineering Science. A common feature of all Grandes Écoles is the strong emphasis on Mathematics and Physics curricula in the first year which are equivalent to those in the Honours level in NUS. Stemming from a collaboration with the Grandes Écoles, FoS students enrolled in the French Double Degree Programme will be awarded a Bachelor's degree with Honours and Master's degree from NUS, and the "Diplôme d'Ingénieur" from the French Grande Écoles.

For more information, please visit the website:

<http://science.nus.edu.sg/undergraduate-studies/ugsap/ugsap-out/fddp>

## 3.7 Student Awards

### 3.7.1 [Dean's List](#)

### 3.7.1 Dean's List

A Dean's List will be prepared for both Semesters I and II, but excluding the Special Terms. It comprises the top 5 percent of the total undergraduate Science students (excluding those who are in their 1<sup>st</sup> two semesters of studies and whose course codes are SCI1<sup>^</sup>) and the top 7 percent of the Pharmacy students (excluding those who are in their 1<sup>st</sup> two semesters of studies and whose course codes are PMC1<sup>^^</sup>) based on the following criteria:

#### A) Minimum Workload

Students reading a workload of at least 19 MCs (for Science Students) and 20 MCs (for Pharmacy Students) will be considered. This workload includes all modules read in the semester under consideration, with the following conditions:

- At least 15MCs for Science students and 16MCs for Pharmacy students must be letter-graded;
- Excludes module ES1000;
- Excludes modules with 'EXE', 'IP', 'IC' or 'W' grades;
- Includes half of the MCs of an 8 MCs UROPS module, or 4 MCs, in the computation of the student's workload in the first semester, and the remaining 4 MCs in the computation of the second semester's workload; and
- No MCs from the Honours project module to be included in the student's workload in the first semester, and the full MCs to be counted in the second semester.

#### B) Semester Average Point (SAP)

Semester Average Point (SAP) is computed from grades achieved within the semester under consideration. Only students with SAP of at least 4.30 will be considered.

Formula for computation of SAP:  $\sum(\text{Grade Point} * \text{MCs}) / \sum(\text{MCs})$

The computation of SAP for the Dean's List:

- Excludes module ES1000; and
- Allows students to receive the full contribution to SAP from their 8 MCs UROPS and Honours project modules in the second semester.

<sup>^</sup>SCI1 is a course code given to all Science students who have just matriculated. Science students who have read and passed 40MCs will be promoted to SCI2. Science students who are not in their first two

semesters of studies and have been promoted to SCI2 and above, and who have met the above mentioned criteria are eligible for Dean's List.

^^PMC1 is a course code given to all Pharmacy students who have just matriculated. Pharmacy students who have read and passed all year 1 Pharmacy graduation requirement will be promoted to PMC2.

Pharmacy students who are not in their first two semesters of studies and have been promoted to PMC2 and above, and who have met the above mentioned criteria are eligible for Dean's List.

## **4 Graduate Education**

4.1 [Research Programmes](#)

4.2 [Coursework Programmes](#)

## **4.1 Research Programmes**

4.1.1 [Degrees Offered](#)

4.1.2 [Degree Requirements](#)

4.1.3 [Financial Assistance and Awards](#)

### **4.1.1 Degrees Offered**

The Faculty of Science offers full-time and part-time graduate research programmes in all six departments leading to the Master of Science (M.Sc.) and Doctor of Philosophy (Ph.D.) degrees.

## **4.1.2 Degree Requirements**

### **Programme Overview**

The research degree provides training in a particular subject area through independent investigation, study and experimental work, culminating in the submission of a thesis on the research undertaken. A supervisor or supervisors will be appointed for each candidate. Students are required to attend appropriate lectures and sit for written examinations.

The following degrees are awarded upon completion of the research programme:

- Master of Science (M.Sc.) or
- Doctor of Philosophy (Ph.D.)

All applicants are admitted into the M.Sc. or Ph.D. programme. For students pursuing Ph.D. candidature, they must pass the Qualifying Examination by the fourth semester.

### **Candidature**

The period of candidature ranges from a minimum of one year to a maximum of three years for M.Sc. and a minimum of two years to a maximum of five years for Ph.D.

Research candidates may be admitted as full-time or part-time students. The minimum and maximum periods of candidature are the same.

### **Research Scholarship**

All applicants who wish to pursue full-time research studies may apply for the NUS Research Scholarship.

### **Admission Requirements**

The normal minimum entry qualifications for admission to the Graduate Programmes is a good relevant bachelor's degree (applicants who are NUS graduates should have a bachelor's degree with honours at least at second class upper level) and/or master's degree and the ability to pursue research in the candidate's proposed field of advanced study.

All applicants must submit either their GRE or GATE test score. The minimum requirement is 1800 or 90 percentile respectively. Under the new GRE format, the requirements are Verbal 500, Quantitative 700 and Analytical Writing 3.5.

As the medium of instruction at NUS is in English, applicants whose native tongue or medium of undergraduate instruction is not English should submit their TOEFL or IELTS score as evidence of their proficiency in the English Language. The minimum TOEFL score is 580 (Paper-based Test) , 260 (Computer-based Test) and 85 (Internet-based Test with a minimum of 22 for the writing component). The minimum requirement for IELTS score is 6.



Applicants who are not residing in Singapore or would like to do their research in overseas institutions must spend a period in residence in Singapore for a minimum of six months (master's degree) or one and a half years (doctoral degree) during his candidature.

## **Programme Intake**

There are two intakes per academic year: one in January and the other in August. Application forms can be obtained from the respective departments or online. Please note that applications must be submitted to the departments by 15 May for the January intake, and by 15 November (for international students) for the August intake respectively.

## **Degree Requirements**

### A.Coursework Requirements

Candidates pursuing higher degrees by research are required to attend and pass examinations in a minimum of three modules (two coursework modules and one compulsory seminar module) for M.Sc. and a minimum of six modules (five coursework modules and one compulsory seminar module) for Ph.D. These courses are to be chosen in consultation with their thesis supervisor(s) and/or department(s). The specific coursework requirements for the respective departments in the Faculty of Science are as follows:

### **1.Department of Biological Sciences**

#### PhD

- Complete a minimum of twenty (20) modular credits (MCs) consisting of
- BL5198 Graduate Seminar Module in Biological Sciences
- Five (5) BL-coded graduate modules
- MB5104 - An Integrative Approach to Understanding Cell Functions (only for students under the Biophysics and Cell & Molecular Biology research groups. This is to be read during student's first semester of study)
- Students may read up to two graduate-level modules from other departments (subject to approval)

#### MSc

- Complete a minimum of twelve (12) modular credits (MCs) consisting of
- BL5198 Graduate Seminar Module in Biological Sciences
- Two (2) BL-coded graduate modules
- MB5104 - An Integrative Approach to Understanding Cell Functions (only for students under the Biophysics and Cell & Molecular Biology research groups. This is to be read during student's first semester of study)
- Students may read one graduate-level modules from other departments (subject to approval)

### **2.Department of Chemistry**

#### PhD

- Complete a minimum of twenty-four (24) modular credits (MCs) consisting of
- CM5198 Graduate Seminar Module in Chemistry
- CM5161 Advanced Chemical Laboratory Safety
- Four (4) CM-coded graduate modules
- Students may read up to two graduate-level modules from other departments (subject to approval)

MSc

- Complete a minimum of twelve (12) modular credits (MCs) consisting of
- CM5198 Graduate Seminar Module in Chemistry
- CM5161 Advanced Chemical Laboratory Safety
- Two (2) CM-coded graduate modules
- Students may read up to one graduate-level modules from other departments (subject to approval)

## **2A. Food Science and Technology Programme**

The Food Science and Technology Programme is hosted by the Department of Chemistry.

PhD

- Complete a minimum of twenty-four (24) modular credits (MCs) consisting of
- CM5198 Graduate Seminar Module in Chemistry
- Five (5) FST-coded or CM-coded graduate modules
- Students may read up to two graduate-level modules from other departments (subject to approval)

MSc

- Complete a minimum of twelve (12) modular credits (MCs) consisting of
- CM5198 Graduate Seminar Module in Chemistry
- Two (2) FST-coded or CM-coded graduate modules
- Students may read up to one graduate-level modules from other departments (subject to approval)

## **3. Department of Physics**

PhD

- Complete a minimum of twenty-four (24) modular credits (MCs) consisting of
- PC5198 Graduate Seminar Module in Physics
- Five (5) PC-coded graduate modules
- Students may read up to two graduate-level modules from other departments (subject to approval)

MSc

- Complete a minimum of twelve (12) modular credits (MCs) consisting of
- PC5198 Graduate Seminar Module in Physics
- Two (2) PC-coded graduate modules
- Students may read up to one graduate-level modules from other departments (subject to approval)

#### **4.Department of Pharmacy**

PhD

- Complete a minimum of twenty-four (24) modular credits (MCs) consisting of
- PR5198 Graduate Seminar Module in Pharmacy
- Five (5) PR-coded graduate modules
- Students may read up to two graduate-level modules from other departments (subject to approval)

MSc

- Complete a minimum of twelve (12) modular credits (MCs) consisting of
- PR5198 Graduate Seminar Module in Pharmacy
- Two (2) PR-coded graduate modules
- Students may read up to one graduate-level modules from other departments (subject to approval)

#### **5.Department of Mathematics**

PhD

*Either*

A. For students who attained Master of Science (M.Sc.) in Mathematical Sciences from a reputable university (subject to departmental approval):

- MA5198 Graduate Seminar Module in Mathematics
- Six (6) at level 5000 or above MA-coded modules, with at least two (2) from Department's Basic Graduate module list amounting to a minimum of twenty-four (24) modular credits (MCs).
- Students may read up to two (2) Level 5000 and above modules from other departments (subject to departmental approval).

*Or*

B. For students without a M.Sc. qualification:

- MA5198 Graduate Seminar Module in Mathematics
- Eight (8) level 5000 or above MA-coded modules, with at least four (4) from Department's Basic Graduate module list amounting to a minimum of thirty-two (32) modular credits (MCs).
- Students may read up to two (2) Level 5000 and above modules from other departments (subject to departmental approval).

MSc

- MA5198 Graduate Seminar Module in Mathematics
- Five (5) other Level 5000 or above MA-coded modules, with at least three (3) from Department's Basic

Graduate module list amounting to a minimum of twenty (20) modular credits (MCs).

- Students may read up to two (2) Level 5000 and above modules from other departments (subject to departmental approval).

#### Department's Basic Graduate Module List

- MA5203 Graduate Algebra I
- MA5204 Graduate Algebra IIA or MA5218 Graduate Algebra IIB
- MA5205 Graduate Analysis I
- MA5206 Graduate Analysis II or MA5217 Graduate Complex Analysis
- MA5209 Algebraic Topology
- MA5210 Differentiable Manifolds
- MA5213 Advanced Partial Differential Equations
- MA5232 Modeling and Numerical Simulations
- MA5233 Computational Mathematics
- MA5241 Computational Harmonic Analysis
- MA5243 Advanced Mathematical Programming
- MA5245 Advanced Financial Mathematics
- MA5248 Stochastic Analysis in Mathematical Finance
- MA5259 Probability Theory I
- MA5260 Probability Theory II
- MA5269 Optimal Stopping and Stochastic Control in Finance

### **6.Department of Statistics and Applied Probability**

#### PhD

- Complete a minimum of twenty-four (24) modular credits (MCs) consisting of:
- ST5198 Graduate Seminar Module in Statistics
- ST5214 Advanced Probability Theory
- ST5215 Advanced Statistical Theory
- ST5222 Advanced Topics in Applied Statistics
- ST5224 Advanced Statistical Theory II
- Any other one (1) ST-coded graduate module
- Students may read up to two graduate-level modules from other departments (subject to approval)

#### MSc

- Complete a minimum of twenty-four (24) modular credits (MCs) consisting of:
- ST5198 Graduate Seminar Module in Statistics
- ST5214 Advanced Probability Theory
- ST5215 Advanced Statistical Theory
- Any other three (3) ST-coded graduate module
- Students may read up to two graduate-level modules from other departments (subject to approval)

#### B.Thesis/Dissertation

Candidates must submit, through the supervisor(s) and the Head of Department, his thesis/dissertation

for examination within the maximum period of candidature. The thesis/dissertation must be on a topic approved by the respective departments and must make some contribution to knowledge and not be a mere collation of existing materials. The thesis/dissertation must contain original work or critical interpretation worthy of publication.

### C. Other Requirements

Any other additional requirements that is specified by the respective departments.

## **Continuation Requirements**

### **Masters**

For continuation in the Master's programme, a student's CAP should not fall below 2.5 or equivalent for two consecutive semesters, or 3.0 for three consecutive semesters.

### **Ph.D.**

For continuation in the Ph.D. programme, a student's CAP should not fall below 3.0 or equivalent for two consecutive semesters, or 3.5 for three consecutive semesters.

Termination of candidature will result if a student fails to maintain the minimum CAP.

### **4.1.3 Financial Assistance and Awards**

#### **NUS President's Graduate Fellowships (PGF)**

The President Graduate Fellowship (PGF) is awarded to candidates who show exceptional promise or accomplishment in research. A number of Ph.D. research students are selected each semester by the University for the award. The bond-free fellowship is open to students of all nationalities who gain admission to a PhD programme in NUS.

The monthly stipend for Singapore citizens, Singapore Permanent Residents and foreigners are \$3,500, \$3,200 and \$3,000 respectively. The award also covers one-off air travel allowance and settling allowance. The award is tenable for an initial one year and, subject to the awardee's satisfactory progress, renewable annually up to a maximum of four years.

#### **NUS Research Scholarships**

The University offers Research Scholarships to outstanding candidates to pursue a full-time graduate research degree at NUS. The bond-free scholarship is open to students of all nationalities. Applicants must be university graduates with at least a Class II Honours degree or equivalent and, at the time of award of the Scholarship, must have been offered admission as a candidate for a full-time higher degree by research at NUS.

The Research Scholars will be given a monthly stipend and a full tuition fee subsidy. For Research Scholars in a Ph.D. programme, monthly stipends for Singapore citizens, Singapore Permanent Residents and foreigners are currently S\$2,700, S\$2,200 and S\$2,000 respectively. Research Scholars in a Ph.D. programme may be eligible for an additional stipend of up to \$500 per month upon passing the Ph.D. qualifying examination, which is normally held 12 to 18 months after registration of candidature.

The Scholarship is tenable for an initial 1 year and, subject to the Research Scholar's satisfactory progress, renewable annually up to a maximum of four years for Ph.D. candidates, as determined by the University.

## 4.2 Coursework Programmes

4.2.1 [Degrees Offered](#)

4.2.2 [Degree Requirements](#)

### 4.2.1 Degrees Offered

- Master of Science in Applied Physics (Full-Time or Part-Time)
- Master of Science in Chemistry (Full-Time or Part-Time)
- Master of Science in Chemistry for Energy & Environment (Full-Time or Part-Time)
- Master of Science in Financial Engineering (Full-Time, Part-Time or Distance Learning)
- Master of Science in Mathematics (Full-Time or Part-Time)
- Master of Science in Pharmaceutical Sciences and Technology (Part-Time)
- Master of Science in Physics (Full-Time or Part-Time)
- Master of Science in Quantitative Finance (Full-Time or Part-Time)
- Master of Science in Statistics (Full-Time or Part-Time)
- Joint Masters of Science in Industrial Chemistry (NUS & TUM) (Full-Time)
- Joint Master of Science in Science Communication (Full-Time or Part-Time)
- Doctor of Pharmacy (PharmD) (Full-Time or Part-Time)



## 4.2.2 Degree Requirements

- 4.2.2.1 [Master of Science in Applied Physics \(Part-Time or Full-Time\)](#)
- 4.2.2.2 [Master of Science in Chemistry \(Part-Time or Full-Time\)](#)
- 4.2.2.3 [Master of Science in Chemistry for Energy & Environment \(Part-Time or Full-Time\)](#)
- 4.2.2.4 [Master of Science in Financial Engineering \(Part-Time, Full-Time or Distance Learning\)](#)
- 4.2.2.5 [Master of Science in Mathematics \(Part-Time or Full-Time\)](#)
- 4.2.2.6 [Master of Science in Pharmaceutical Sciences and Technology \(Part-Time only\)](#)
- 4.2.2.7 [Master of Science in Physics \(Part-Time or Full-Time\)](#)
- 4.2.2.8 [Master of Science in Quantitative Finance \(Part-Time or Full-Time\)](#)
- 4.2.2.9 [Master of Science in Statistics \(Part-Time or Full-Time\)](#)
- 4.2.2.10 [Joint Masters of Science in Industrial Chemistry \(NUS & TUM\) \(Full-Time only\)](#)
- 4.2.2.11 [Masters of Science in Science Communication \(Part-Time and Full-Time\)](#)
- 4.2.2.12 [Doctor of Pharmacy \(PharmD\) \(Part-Time and Full-Time\)](#)

### 4.2.2.1 Master of Science in Applied Physics (Part-Time or Full-Time)

The Master of Science in Applied Physics is a coursework programme initiated as a part-time programme in July 2002. It can be enrolled on a full-time basis now.

#### Programme Objectives

- Advanced training in Applied Physics (especially in semiconductor manufacturing, photonics and biophysics).
- Opportunities for Physics graduates and other professionals who have relevant working experience, to upgrade their professional skills and qualifications, or to switch to the hi-tech industry.

#### Admission Requirements

- An Honours degree in Physics or an equivalent qualification approved by NUS, or
- A Bachelor's pass degree in Physics or related discipline, or
- Completed three years of Physics study in a university with a minimum Cumulated Average Point (CAP) of 3.00.

#### Programme Structure

A candidate in the M.Sc. Programme in Applied Physics by coursework must complete the following in order to be awarded the M.Sc. degree:

**Track 1:** 40 modular-credit programme (for applicants who have an Honours degree or equivalent qualifications)

EITHER

1. Read and pass **four** PC level 5000 modules (excluding PC5198) amounting to 16 MCs. *Subject to approval, students are allowed to choose not more than 12 MCs from Level 5000 modules offered by other Departments.*
2. Read and pass **two** PC level 4000 modules amounting to 8 MCs
3. Complete a research project PC5289 equivalent to 16 MCs
4. Obtain a minimum Cumulative Average Point (CAP) of 3.00

OR

1. Read and pass **seven** PC level 5000 modules (excluding PC5198) amounting to 28 MCs. *Subject to approval, students are allowed to choose not more than 12 MCs from Level 5000 modules offered by other Departments.*
2. Read and pass **three** PC level 4000 modules amounting to 12 MCs.
3. Obtain a minimum Cumulative Average Point (CAP) of 3.00

**Track 2:** 80 modular-credit programme (for applicants who have a Bachelor's pass degree or completed a three-year study in Physics or related discipline)

EITHER

1. Read and pass **five** PC level 5000 modules (excluding PC5198) amounting to 20 MCs. *Subject to approval, students are allowed to choose not more than 12 MCs from Level 5000 modules offered by other Departments.*
2. Read and pass **six** PC level 4000 modules amounting to 24 MCs
3. Read and pass **one** PC level 4000 module or PC level 5000 module amounting to 4 MCs
4. Read and pass **four** PC level 3000 modules amounting to 16 MCs
5. Complete a research project PC5289 equivalent to 16 MCs
6. Obtain a minimum Cumulative Average Point (CAP) of 3.00

OR

1. Read and pass **six** PC level 5000 modules (excluding PC5198) amounting to 24 MCs. *Subject to approval, students are allowed to choose not more than 12 MCs from Level 5000 modules offered by other Departments.*
2. Read and pass **eight** PC level 4000 modules amounting to 32 MCs
3. Read and pass **two** PC level 4000 modules or PC level 5000 modules amounting to 8 MCs
4. Read and pass **four** PC level 3000 modules amounting to 16 MCs
5. Obtain a minimum Cumulative Average Point (CAP) of 3.00

## **Period of Candidature**

The programmes may be undertaken over a period of two to eight semesters for Track 1 or four to ten semesters for Track 2, and will comprise of coursework or coursework and a written report based on project work. Some classes will be conducted during the university semesters in the evening.

## **Programme Intake**

There are two intakes per academic year: one in January and the other in August.

#### **4.2.2.2 Master of Science in Chemistry (Part-Time or Full-Time)**

This programme is designed for Chemistry graduates with a 4-year Honours degree who would like to pursue a postgraduate degree in Chemistry. This programme lays the scientific foundation in chemistry for attendees for senior positions in the chemistry industry as well as to qualify for other advanced degree programmes such as Ph.D. in Chemistry.

At the end of the programme, the student will be equipped with advanced knowledge and skills pertaining to recent developments in the Chemical Science which will enable him/her to perform with confidence leading roles as scientists, managers and entrepreneurs in Chemistry R&D and related industries.

#### **Track 1 (40 MC Programme)**

##### **Admission Requirements**

- An applicant must have completed a degree in Chemistry with at least a 2<sup>nd</sup> Class Honours, or its equivalent.
- Applicants who do not fulfill the requirement above must have at least 2 years of working experience in a relevant chemistry industry and a GRE Subject Test Score (Chemistry) above 60.
- Applicants whose native tongue or medium of undergraduate instruction is not completely in English must have a minimum TOEFL (IBT) score of 85 (with a minimum score of 22 in the writing component) or a minimum IELTS score of 6.

##### **Programme Structure**

The minimum candidature requirement is 2 semesters (for full-time candidature) and 4 semesters (for part-time candidature).

Students have to fulfill one of the following conditions:

Option 1 :

1. Read and pass essential module CM5198 amounting to 4 MCs
2. Read and pass five Chemistry level 5000 modules amounting to 20 MCs
3. Complete an advanced M.Sc. project module CM5100A equivalent to 16 MCs
4. Obtain a minimum Cumulative Average Point (CAP) of 3.00

Option 2 :

1. Read and pass essential module CM5198 amounting to 4 MCs
2. Read and pass five Chemistry level 5000 modules amounting to 20 MCs
3. Read and pass two Chemistry / other Major level 5000 modules amounting to 8 MCs
4. Complete a M.Sc. project module CM5100 equivalent to 8 MCs

5. Obtain a minimum Cumulative Average Point (CAP) of 3.00

### **Programme Intake**

There are two intakes per academic year, in August and January.

### **Track 2 (80 MC Programme)**

#### **Admission Requirements**

1. This track is only for applicants under the Soochow 3+2 programme.
2. Applicant must have completed their 3<sup>rd</sup> year Chemistry degree in Soochow University.
3. Applicants must have a minimum TOEFL (IBT) score of 85 (with a minimum score of 22 in the writing component) or a minimum IELTS score of 6.

#### **Programme Structure**

The minimum candidature requirement is 4 semesters (for full-time candidature).

Students have to fulfill the following conditions:

1. Read and pass two Chemistry level 3000 modules amounting to 8 MCs
2. Read and pass four Chemistry level 4000 modules amounting to 16 MCs
3. Read and pass five Chemistry level 5000 modules amounting to 20 MCs
4. Read and pass essential module CM5198 amounting to 4 MCs
5. Complete a Chemistry Honours Project module CM4199A equivalent to 16 MCs
6. Complete an advanced M.Sc. project module CM5100A equivalent to 16 MCs
7. Obtain a minimum Cumulative Average Point (CAP) of 3.00.

### **Programme Intake**

There is one intake per academic year, in August.

### **4.2.2.3 Master of Science in Financial Engineering (Part-Time, Full-Time or Distance Learning)**

The Master of Science in Financial Engineering (MFE) is a multi-disciplinary programme that combines finance, mathematics, and computing with a practical orientation to solve problems in finance. The MFE was launched in 1999 by the Centre for Financial Engineering at NUS, the predecessor to RMI. It aims to equip finance and banking industry professionals and fresh graduates with current knowledge and skills in financial innovations and technology. The domain knowledge includes financial product development, modelling of prices, hedging, investment technology, risk analyses and computational methods.

The degree is awarded by the National University of Singapore, administered through the Risk Management Institute (RMI) and comprises teaching staff from the Departments of Finance, Mathematics, Statistics and Applied Probability, Economics and practitioners from the finance industry. It is a multidisciplinary programme that draws from the established strengths of the various NUS Faculties.

There are many MFE programmes available and the RMI MFE distinguishes itself by striving to shape its students into 'doers' - people with the theoretical background necessary to approach complex financial problems and the practical know-how to solve these problems.

#### **Admission Requirements**

- Good four-year undergraduate degree or an honours degree
- Good GMAT or GRE score
- Good TOEFL or IELTS score if English was not the medium of instruction in undergraduate studies
- Relevant work experience will be an advantage

#### **Programme Structure**

To graduate from the programme, each candidate is required to complete 40 modular credits (MCs). Of these, there are five core (compulsory) modules and a compulsory financial engineering project equivalent to 4 MCs each. Candidates must also choose additional elective modules. There are also elective modules held overseas that are conducted at an intensive pace over one week.

#### **(I) Graduation Requirements**

**Students have to fulfill all the following conditions to graduate:**

##### **a. Read and pass the following six essential modules:**

- FE 5101 Derivatives and Fixed Income
- FE 5107 Risk Analyses and Management
- FE 5110 Financial Engineering Project
- FE 5112 Stochastic Calculus and Quantitative Methods

- FE 5116 Programming and Advanced Numerical Methods
- FE 5209 Financial Econometrics

**b. Read and pass four or more elective modules, totaling a minimum of 16 modular credits, from the following list:**

- FE 5103 Equity Products and Exotics
- FE 5105 Corporate Financing and Risk
- FE 5108 Portfolio Theory and Investments
- FE 5208 Term Structure and Interest Rate Derivatives
- FE 5210 Research Methods in Finance
- FE 5211 Seminar in Financial Engineering
- FE 5215 Seminar in Financial Product Innovations
- FE 5216 Financial Technology Innovations Seminar
- FE 5217 Seminar in Risk Management and Alternative Investment
- FE 5218 Credit Risk
- FE 5219 Credit Analytics Practicum
- FE 5221 Trading Principles & Fundamentals
- FE 5222 Advanced Derivatives Pricing
- FE 5223 Introduction to Electronic Financial Market
- FE 5224 Current Topics in Applied Risk Management
- FE 5226 C++ in Financial Engineering

For students admitted into the programme, a minimum Cumulative Average Point (CAP) of 3.00 is required for graduation.

## **(II) Intake**

The MFE in Financial Engineering has one intake per year, with candidates joining the programme in August every year.

## **(III) Duration of the Programme**

The minimum and maximum periods of candidature are 18 months and four years for part-time and distance learning students. The minimum and maximum periods of candidature are one year and two years for full-time students.

## **(IV) Semester**

The programme operates in the two regular University Semesters 1 and 2 from August-November, and January-April, and also in the special term from May-July. The Financial Engineering project may be taken in any semester or term.

## **(V) Classes**

In all modules, students will meet teaching staff 12 times for each module. Lectures for both the part-time and full-time programmes are held in the evenings from 7.00pm to 10.00pm or on Saturdays. Each lecture lasts three hours.

**(VI) Leave of Absence**

A leave of absence may be granted to a candidate for up to one year only. A candidate who has to leave the programme for longer than that will need to withdraw from the programme. The leave of absence will be included in the maximum period of candidature.

**(VII) Termination of Candidature**

The candidature may be terminated if a candidate failed twice in the examination of a module, or failed in more than two modules throughout the course of study. No extension of the maximum period of candidature will be permitted. A candidate should also attain a minimum Cumulative Average Point (CAP) of 3.00 to remain in good standing.



## **Master of Science in Chemistry for Energy & Environment**

This programme provides students with a good broad knowledge of the latest energy and environmental technologies, including some background in regulatory policies and risk assessments. Students will gain a deep understanding in modern materials design and synthesis strategies, advance characterization and analytical techniques, and the study of chemical structures and materials properties. They will be trained hands-on also in practical R&D skills in synthesis and characterization, fabrication and performance testing, information and literature retrieval, as well as critical interpretation and analysis.

### **Admission Requirements**

1. An applicant must have a degree in Chemistry or related subject with at least a 2<sup>nd</sup> Class Honours, or its equivalent.
2. Applicants whose native tongue or medium of undergraduate instruction is not completely in English must have a minimum TOEFL (IBT) score of 85 (with a minimum score of 22 in the writing component) or a minimum IELTS score of 6.
3. Applicants with other qualifications and achievements suitable for the programme may also apply and will be considered case by case.

### **Programme Structure**

Complete 2 full-time or 4 part-time semesters of course requirements.

Students have to fulfil the following conditions:

1. Read and pass the three essential modules : CM5101, CM5151, CM5152 amounting to 12 MCs
2. Read and pass three Chemistry level 5000 modules amounting to 12 MCs
3. Complete a research & development project CM5199 equivalent to 16 MCs
4. Obtain a minimum Cumulative Average Point (CAP) of 3.00.

### **Programme Intake**

There is one intake per academic year in August.

### **More information about the programme**

[http://www.chemistry.nus.edu.sg/education/graduates/msc\\_ee.htm](http://www.chemistry.nus.edu.sg/education/graduates/msc_ee.htm)

#### 4.2.2.4 Master of Science in Mathematics (Part-Time or Full-Time)

Master of Science in Mathematics by coursework is a postgraduate programme offered by the Department of Mathematics, which may be pursued full-time or part-time. This programme aims to provide advanced training in mathematics with an emphasis on coursework. It offers opportunities to those who have an Honours degree or a Bachelor's degree in mathematics to build and enhance their professional skills and qualifications in advanced mathematics in general and/or in some specialised areas of applied mathematics.

##### Admission Requirements

A candidate may be admitted to one of two study tracks depending on his/her level of qualification upon entry into the programme.

For admission into Track 1 (40 MCs), a candidate must have

- An Honours degree in mathematics or an equivalent qualification, or
- An Honours degree in a discipline with strong training in mathematics at university level.

For admission into Track 2 (80 MCs), a candidate must have

- A three-year Bachelor's degree in mathematics or an equivalent qualification, or
- A three-year Bachelor's degree in a discipline with strong training in mathematics at university level.

A candidate whose Honours or Bachelor's degree is not in mathematics must complete the GRE subject test in mathematics.

In addition, a candidate whose native tongue or medium of undergraduate instruction is not English must complete TOEFL or IELTS. A minimum TOEFL score of 85 is required for the internet-based test (with a minimum of 22 for the writing section), or 580 for the paper-based test, or 260 for the computer-based test; while a minimum IELTS score of 6.0 is required.

##### Programme Structure

Students have to fulfil all the following conditions:

###### Track 1

1. EITHER
  - a. Read and pass two MA modules at Level 4000 (or above) and eight MA modules at Level 5000 (or above);
  - OR
  - b. Read and pass two MA modules at Level 4000 (or above), six MA modules at Level 5000 (or above), and complete an individual project and written report (equivalent to 8 MC) over a maximum period of two semesters.
2. Obtain a minimum Cumulative Average Point (CAP) of 3.00.

## Track 2

### 1. EITHER

- a. Read and pass two MA modules at Level 3000 (or above), nine MA modules at Level 4000 (or above) and nine MA modules at Level 5000 (or above);  
OR
- b. Read and pass two MA modules at Level 3000 (or above), nine MA modules at Level 4000 (or above), seven MA modules at Level 5000 (or above), and complete an individual project and written report (equivalent to 8 MC) over a maximum period of two semesters.

### 2. Obtain a minimum Cumulative Average Point (CAP) of 3.00.

## **Candidature & Application**

### Track 1

The candidature for full-time students is from a minimum of two semesters to a maximum of six semesters.

The candidature for part-time students is from a minimum of four semesters to a maximum of eight semesters.

### Track 2

The candidature for full-time students is from a minimum of four semesters to a maximum of eight semesters.

The candidature for part-time students is from a minimum of seven semesters to a maximum of ten semesters.

## **Programme Intake**

There are two intakes per academic year, one in January and the other in August.

#### **4.2.2.5 Master of Science in Pharmaceutical Sciences and Technology**

The Master of Science in Pharmaceutical Sciences and Technology is designed to cater to special interest groups of prospective students who are already working or aspiring to enter the pharmaceutical industry. This may be in areas of manufacturing and quality assurance of active pharmaceutical ingredients (API) and/or finished pharmaceutical products, regulatory affairs, medication utilisation review and drug registration.

According to the feedback from the pharmaceutical industry, there is a lack of knowledge and skills in the area of formulation science, pharmaceutical process validation and pharmaceutical product quality assurance among the current workforce in Singapore, compared to those of India, Ireland, USA and UK. However, it remains necessary for the pharmaceutical industry to continue hiring people equipped with relevant core competencies, for example chemical engineering, organic synthetic chemistry, chemical analysis, biotechnology, biomedical sciences etc. Therefore, it will be useful for these people to have gained on-the-job skills and sufficient work experience to enable them to appreciate how their core competency is related to the general operations in pharmaceutical manufacturing and development of drug products.

This programme aims to address the gap in manpower training by introducing topics in pharmaceutical sciences and pharmaceutical technology that focus on the processing and manufacturing of the active pure drugs right through to the formulation and quality assurance of the final product.

#### **Learning Outcomes**

Graduates from this programme will enhance their on-the-job competency by:

- Gaining in-depth knowledge and practical skills for formulation and process manufacturing of chemical and biological drugs into a range of pharmaceutical dosage forms, ranging from tablets to injectables.
- Acquiring understanding of the regulatory and quality compliance of pharmaceuticals in the process of drug development and manufacturing.

#### **Admission Requirements**

To be admitted into the programme (part-time option only), candidates must be holders of one of the following degrees, or their equivalent:

- Bachelor of Science (Honours) in Chemistry
- Bachelor of Science (Honours) in Life Sciences
- Bachelor of Applied Science (Honours) in Food Science & Technology
- Bachelor of Applied Science (Honours) in Applied Chemistry (Drug Option)
- Bachelor of Science in Pharmacy (Honours)
- Bachelor of Engineering (Chemical Engineering) (Honours).

Candidates without a Bachelor degree in Pharmacy will have to read and pass PR3301 Pharmaceutical Dosage Forms as a bridging module.

## **Special Criteria for Admission**

- Candidates who do not have Honours classification in the degree prerequisites as stipulated above may apply for admission with GRE results.
- Candidates who hold equivalent degrees from overseas universities may apply for admission with GRE and TOEFL results.

## **Programme Structure**

Candidates admitted into the Master degree program must read and pass a total of 10 modules (40 MC), comprising 6 essential modules and 4 elective modules:

Six Essential Modules, 4 MCs each:

1. PR5301 Food and Drug Laws
2. PR5302 Regulation of Drug Development
3. PR5303 Good Regulatory Practices
4. PR5213 Pharmaceutical Process Validation
5. PR5217 Formulation Science
6. PR5218 Practical In Product Development – Lab rotation

Four Elective Modules, 4 MCs each – choose from the following:

1. PR5211 Pharmaceutical Analysis IV
2. PR5212 Advanced Topics in Medicinal Chemistry
3. PR5214 Advances in Tablet Technology
4. PR5216 Advances in Drug Delivery
5. PR5219 Product Quality Management
6. PR5220 Bioprocess Technology
7. PR5221 Molecular Targets in Drug Discovery

## **Graduation Requirements**

To graduate with the degree in Master of Science (Pharmaceutical Sciences & Technology), candidates must have achieved a CAP of at least 3.00. The maximum candidature for a part-time student is four years.

#### 4.2.2.6 Master of Science in Physics (Part-Time or Full-Time)

The Master of Science in Physics is a coursework programme initiated as a part-time programme in January 2000. It also can be enrolled on a full-time basis now.

##### Programme Objectives

- Advanced training in fundamental aspects of Physics
- Opportunities for Physics teachers and other professionals to further upgrade their professional skills and qualifications

##### Admission Requirements

- An honours degree in Physics from NUS or such other universities approved by NUS, or
- A Bachelor's pass degree in Physics or related discipline, or completed three years of Physics study in a university, or other qualifications as NUS may approve.

##### Programme Structure

A candidate in the M.Sc. Programme in Physics by coursework must complete the following in order to be awarded the M.Sc. degree:

**Track 1** : 40 modular-credit programme (for applicants who have an Honours degree or equivalent qualifications)

EITHER

1. Read and pass **five** PC level 5000 modules (excluding PC5198) amounting to 20 MCs and at least 8 MCs must be from the following list of modules. *Subject to approval, students are allowed to choose not more than 12 MCs from level 5000 modules offered by other Departments.*
  - PC5201 Advanced Quantum Mechanics
  - PC5202 Advanced Statistical Mechanics
  - PC5203 Advanced Solid State Physics
  - PC5210 Advanced Dynamics
  - PC5214 Principles of Experimental Physics
2. Read and pass **two** PC level 4000 modules amounting to 8 MCs
3. Complete a research project PC5288 equivalent to 12 MCs
4. Obtain a minimum Cumulative Average Point (CAP) of 3.00

OR

1. Read and pass **eight** PC level 5000 modules (excluding PC5198) amounting to 32 MCs and at least 8 MCs must be from the following list of modules. *Subject to approval, students are allowed to choose not more than 12 MCs from level 5000 modules offered by other Departments.*
  - PC5201 Advanced Quantum Mechanics
  - PC5202 Advanced Statistical Mechanics
  - PC5203 Advanced Solid State Physics
  - PC5210 Advanced Dynamics
  - PC5214 Principles of Experimental Physics

2. Read and pass **two** PC level 4000 modules amounting to 8 MCs
3. Obtain a minimum Cumulative Average Point (CAP) of 3.00

**Track 2:** 80 modular-credit programme (for applicants who have a Bachelor's pass degree or completed a three-year study in physics)

#### EITHER

1. Read and pass **five** PC level 5000 modules (excluding PC5198) amounting to 20 MCs and at least 8 MCs must be from the following list of modules. *Subject to approval, students are allowed to choose not more than 12 MCs from level 5000 modules offered by other Departments.*
  - PC5201 Advanced Quantum Mechanics
  - PC5202 Advanced Statistical Mechanics
  - PC5203 Advanced Solid State Physics
  - PC5210 Advanced Dynamics
  - PC5214 Principles of Experimental Physics
2. Read and pass **eight** PC level 4000 modules amounting to 32 MCs
3. Read and pass **one** PC level 4000 module or PC level 5000 module amounting to 4 MCs
4. Read and pass **three** PC level 3000 modules amounting to 12 MCs
5. Complete a research project PC5288 equivalent to 12 MCs
6. Obtain a minimum Cumulative Average Point (CAP) of 3.00

#### OR

1. Read and pass **eight** PC level 5000 modules (excluding PC5198) amounting to 32 MCs and at least 8 MCs must be from the following list of modules. *Subject to approval, students are allowed to choose not more than 12 MCs from level 5000 modules offered by other Departments.*
  - PC5201 Advanced Quantum Mechanics
  - PC5202 Advanced Statistical Mechanics
  - PC5203 Advanced Solid State Physics
  - PC5210 Advanced Dynamics
  - PC5214 Principles of Experimental Physics
2. Read and pass **eight** PC level 4000 modules amounting to 32 MCs
3. Read and pass **one** PC level 4000 module or PC level 5000 module amounting to 4 MCs
4. Read and pass **three** PC level 3000 modules amounting to 12 MCs
5. Obtain a minimum Cumulative Average Point (CAP) of 3.00

### Period of Candidature

The programme may be undertaken over a period of two to eight semesters for Track 1 or four to ten semesters for Track 2, and will comprise of coursework or coursework and a written report based on project work. Some classes will be conducted during the university semesters in the evening.

### Programme Intake

There are two intakes per academic year, one in January and the other in August.





#### **4.2.2.7 Master of Science in Quantitative Finance (Part-Time or Full-Time)**

The Master of Science in Quantitative Finance by coursework is a postgraduate programme offered by the Department of Mathematics with the cooperation of the Department of Economics and the Department of Statistics and Applied Probability. The objective of the programme is to provide advanced training in quantitative finance with an emphasis on coursework. Students in the programme are expected to acquire advanced knowledge in quantitative finance as well as a deep understanding of the background and implications of the use of quantitative methods in the financial industry. The programme offers opportunities to those who have an Honours degree in quantitative finance or mathematics to build and enhance their professional skills and qualifications in quantitative finance at masters level.

#### **Admission Requirements**

Candidates applying for admission into the programme should ordinarily possess or be expecting to obtain an Honours degree (or a 4-year Bachelor's degree) in a discipline with strong training in quantitative finance or mathematics at university level, or an equivalent qualification.

In addition, a candidate whose native tongue or medium of undergraduate instruction is not English must complete TOEFL or IELTS. A minimum TOEFL score of 85 is required for the internet-based test (with a minimum of 22 for the writing section), or 580 for the paper-based test, or 260 for the computer-based test; while a minimum IELTS score of 6.0 is required.

#### **Programme Structure**

Students have to fulfil all the following conditions:

1. Read and pass the following six essential modules:
  - i. MA4269 Mathematical Finance II
  - ii. QF4102 Financial Modelling
  - iii. QF5210 Financial Time Series: Theory and Computation
  - iv. QF5201 Interest Rate Theory and Credit Risk
  - v. QF5202 Structured Products
  - vi. QF5203 Risk Management
2. Read and pass four elective modules chosen from the following list:
  - i. MA5233 Computational Mathematics
  - ii. MA5248 Stochastic Analysis in Mathematical Finance
  - iii. QF5204 Numerical Methods in Quantitative Finance
  - iv. QF5205 Topics in Quantitative Finance I
  - v. QF5206 Topics in Quantitative Finance II
  - vi. EC5102 Macroeconomic Theory
  - vii. EC5103 Econometric Modelling & Applications I
  - viii. EC5332R Money and Banking
  - ix. ECA5315 Financial Econometrics
  - x. ECA5334 Corporate Finance
  - xi. ST5207 Non-parametric regression
  - xii. ST5210 Multivariate Data Analysis

- xiii. ST5218 Advanced Statistical Methods in Finance
- 3. Obtain a minimum Cumulative Average Point (CAP) of 3.00.

Modules coded MAxxxx or QFxxxx are offered by the Department of Mathematics. Modules with codes QF5xxx (except QF5210) are offered exclusively to students in the Master of Science in Quantitative Finance programme.

Modules coded ECxxxx or ECAxxxx are offered by the Department of Economics.

Modules coded STxxxx are offered by the Department of Statistics and Applied Probability.

## **Candidature & Application**

The candidature for full-time students is from a minimum of two semesters to a maximum of six semesters.

The candidature for part-time students is from a minimum of four semesters to a maximum of eight semesters.

## **Programme Intake**

There is one intake per academic year in August.

#### 4.2.2.8 Master of Science in Statistics (Part-Time or Full-Time)

The objective of the programme is to provide a sound knowledge of the statistical principles and methods required by practising statisticians.

##### Admission Requirements

Candidates may be admitted to one of two study tracks which are catered to candidates with different levels of qualification.

For admission to Track 1 (40 MCs), a candidate must have

- A local honours degree in related fields, or equivalent
- An equivalent overseas degree (a four-year Bachelor's degree)

For admission to Track 2 (80 MCs), a candidate must have

- At least a three-year Bachelor's degree in related fields or equivalent, with a satisfactory GPA.

In addition, a candidate whose native tongue or medium of undergraduate instruction is not English must have a TOEFL score of at least 580 for Paper-based test, 260 for Computer-based test or 85 for Internet-based test (with at least 22 for the writing component) or an IELTS score of at least 6.

##### Programme Structure

###### Track 1

Students have to fulfil the following conditions:

- Read and pass the following **two** essential modules amounting to 8 MCs:
  - ST5201 Basic Statistical Theory
  - ST5202 Applied Regression Analysis
- Read and pass **eight** ST level 5000 modules or higher amounting to 32 MCs
- Obtain a minimum Cumulative Average Point (CAP) of 3.00

A candidate who has an Honours degree in Statistics or Mathematics might be exempted from reading one or more compulsory modules upon the approval of the Head of Department of Statistics and Applied Probability, but an exempted module must be replaced by an elective module.

###### Track 2

Only the full-time programme will be offered for this track.

Students have to fulfil the following conditions:

- Read and pass **six** ST level 4000 modules amounting to 24 MCs. Subject to department approval, not

more than two modules can be taken from other departments.

- Read and pass **ten** ST level 5000 modules amounting to 40 MCs
- Complete a project ST5199 amounting to 16 MCs
- Obtain a minimum Cumulative Average Point (CAP) of 3.00

## **Course of Study**

The programme will be conducted by coursework. Courses will be conducted during the university semesters. Level-4000 courses will normally be conducted during day time and most of the level-5000 courses will be conducted in the evenings.

## **Period of Candidature**

### Track 1

The candidature for full-time students is from a minimum of two semesters to a maximum of six semesters.

The candidature for part-time students is from a minimum of four semesters to a maximum of eight semesters.

### Track 2

The candidature for full-time students is from a minimum of four semesters to a maximum of eight semesters.

## **Programme Intake**

There is only one intake per academic year in August.

#### **4.2.2.9 Joint Masters of Science in Industrial Chemistry (NUS & TUM)**

##### **Objective**

This programme aims to groom future leaders in selected areas of technology. Specifically, the Masters of Science in Industrial Chemistry will be an enabling postgraduate course for specialist engineers for the pharmaceutical, as well as the fine and speciality chemical industries. The degree will be jointly awarded by Technische Universität München (TUM) and the National University of Singapore (NUS).

##### **Admission Requirements**

1. An applicant must have completed at least a 3-year Bachelor Degree (Honors) or European/German FH Diploma or its equivalent in areas of Chemical Engineering / Chemistry or closely related discipline from a university with recognized standing with at least a 2nd Upper Honors or equivalent.
2. The applicant must be able to demonstrate a satisfactory level of the language. Applicant whose native tongue or medium of instruction from previous studies (Bachelor / FH Diploma) is not English must submit the TOEFL result with a minimum of 605 for Paper-based test, or 88 for Internet-based test, or 234 for Computer-based test OR IELTS result of at least 6.5 OR CAE grade A, B, or C.
3. Additionally, an Akademische Prüfstelle (APS) certificate is required for applicants with education qualifications from China, Vietnam or Mongolia. The APS certificate is compulsory if your Bachelor studies was completed in a Chinese, Vietnamese or Mongolian university, regardless of nationality.

##### **Curriculum and Course Structure**

The Master of Science in Industrial Chemistry degree is a 20 month full-time programme. Students must complete 11 months of coursework with 3 months of internship placement and 6 months of Master Thesis / Dissertation.

In 11 months of coursework, candidates must successfully complete 2 pre-essential compulsory modules, 4 core modules, 6 elective modules, and 3 cross-discipline modules.

##### **Continuation and Termination of Candidature**

In order for a student to graduate on time, the student must obtain a minimum overall CAP score of 2.50. TUM-Asia will issue an academic warning to students if their CAP scores fall below 2.50. There is also a risk of candidature termination for failure in any modules if overall CAP score falls below 2.50.

##### **Programme Intake**

There is one intake per academic year in August.

##### **More Information**

For more details of the programme, please refer

to: <http://tum-asia.edu.sg/admissions/graduate/msc-industrial-chemistry/>

#### **4.2.2.10 Masters of Science in Science Communication**

The M.Sc. in Science Communication is a joint M.Sc. degree offered by NUS and the College of Science, Australian National University (ANU). The programme aims to foster the skills necessary to:

- be competent, confident communicators of science and technology to the general public and school-age audiences;
- develop materials for effective communication to non-specialist audiences;
- propose and supervise project work and other scientific activities; and
- develop confidence in lifelong learning.

#### **Admission Requirements**

Applicants have to fulfil the admission requirements for both universities in order to gain admission to the joint degree programme.

Applicants seeking admission must have:

- a Bachelor degree in Science with Honours (or equivalent) from a reputable university
- Applicants whose native tongue or medium of instruction is not completely in English should submit TOEFL/IELTS scores as evidence of their proficiency in the English Language.
- The minimum requirement for TOEFL score is:
  - Paper-Based Test: 580
  - Computer-Based Test: 260
  - Internet-Based Test: 85 with at least 22 for the Writing component
- The minimum requirement for IELTS score is 6.
- Applicants without an honours degree in science will be considered on a case-by-case basis.

#### **Programme Structure**

The course can be taken full-time over one year or part-time over two years with a maximum candidature of three years for full-time and four years for part-time.

Full-time students will spend one semester at NUS and one semester at ANU. Part-time students will complete the entire programme at NUS. The ANU modules will be conducted in intensive mode at the ANU Campus or via E-Learning mode.

All students can work on their dissertation (project) concurrently with their modules or during the subsequent year.

Students have to fulfill the following conditions:

a. Read and pass the following 2 essential modules (9 MCs)

- *NUS Module*: MW5201 Topics in Science Communication (4 MCs)

- *ANU Module*: SCOM8014 (MW5152) Communicating Science with the Public (5 MCs)

b. Read and pass 1 elective module from *List A* (4 MCs) and 3 elective modules from *List B* (15 MCs)

#### *List A*

- *NUS Module*: MW5202 Innovations in Science Teaching (4 MCs)
- *NUS Module*: MW5203 Frontier Topics in Science (4 MCs)

#### *List B*

- *ANU Module*: SCOM6015 (MW5255) Speaking of Science (5 MCs)
- *ANU Module*: SCOM6003 (MW5258) Science in Popular Fiction (5 MCs)
- *ANU Module*: SCOM6012 (MW5271) Science Communication and the Web (5 MCs)
- *ANU Module*: SCOM6016 (MW5256) Science in the Media (5 MCs)
- *ANU Module*: SCOM6017 (MW5254) Public Events for Science Engagement (5 MCs)
- *ANU Module*: SCOM6029 (MW5259) Cross Cultural Perspectives in Science Communication (5 MCs)
- *ANU Module*: SCOM6030 (MW5272) Science Dialogue Theory and Practice (5 MCs)
- *ANU Module*: SCOM6032 (MW5273) Making Modern Science (5 MCs)
- *ANU Module*: SCOM6501 (MW5270) Strategies in Science Communication (5 MCs)
- *ANU Module*: SCOM6027 (MW5257) Science and Public Policy (5 MCs)
- *ANU Module*: SCOM6031 (MW5151) Science, Risk and Ethics (5 MCs)
- *ANU Module*: SCOM8020 (MW5150) Science Communication in Schools and Public (5 MCs)
- *ANU Module*: POPH8115 (MW5264) Health Promotion and Protection (5 MCs)

c. Complete a research project (MW5200) amounting to 12 MCs

d. Obtain a minimum Cumulative Average Point (CAP) of 3.00

## **Coursework Requirements**

Students must read and pass NUS and ANU modules amounting to 40 NUS modular credits (MCs), with a minimum CAP (NUS) of 3.0 or its equivalent over their approved candidature period. Each ANU module is 6 ANU credits which is equivalent to 5 NUS modular credits.

## **Continuation and Graduation Requirements**

Student's CAP should not fall below 3.0 for two consecutive semesters. A student who fails to maintain the minimum CAP as stipulated will have his/her candidature terminated.

## **Programme Intake**

There is only one intake per year in January.



### **4.2.2.11 Doctor of Pharmacy (PharmD)**

This programme is available in full-time and part-time mode.

In response to the changing health care environment, Pharmacy as a profession is continually evolving to expand its scope of services and responsibilities to meet the needs of patients, health care systems, and other professionals. Traditionally, the primary responsibility of the pharmacist was the safe and accurate dispensing of drugs prescribed by the physician. Today, pharmacists are involved in the clinical care of their patients. To face the challenges in the practice of pharmacy in Singapore and abroad, pharmacists have to be equipped with not only the knowledge, but also the skills, attitudes and values required to deliver high quality, consistent and safe treatments to patients in collaboration with other health care professionals.

The primary objective of the NUS Doctor of Pharmacy (PharmD) programme is to train pharmacy practitioners to possess leadership qualities, advanced expertise and clinical experience that enable them to be at the forefront of the Pharmacy profession and health care in a variety of settings – institutional, community practice, government, academia, industry, translational research and drug development. The curriculum emphasizes a patient-centred course of study and involves a structure that will enable the students to develop into reflective practitioners with skills and attitudes to evaluate critically and modify practices in a timely and effective manner.

#### **Criteria for Admission**

- Candidates must be holders of the following degree, or its equivalent:  
Bachelor of Science in Pharmacy (Honours).
- Candidates must have fulfilled the pre-registration pharmacist training requirements and registered to practise Pharmacy.
- Preference for those with relevant work experience as a pharmacist (hospital, community etc.)
- Candidates will also be evaluated based on an interview, their written statement of career goals and at least three letters of recommendation.

#### **Special Criteria for Admission**

- Candidates, who do not have Honours classification in the degree pre-requisites as stipulated above, may apply for admission with GRE results. Candidates, who hold equivalent degrees from overseas universities, may apply for admission with GRE and TOEFL results. Such candidates, if found to be suitable, would be submitted for approval by Board of Graduate Studies on a case-by-case basis.
- Candidates, who have not read and passed the following 6 essential Pharmacy modules or their equivalents, will have to read and obtain good passes for them prior to admission.
  - PR1103 Pharmacy Practice I
  - PR3105 Pharmacotherapy I
  - PR3107 Pharmacy Practice II
  - PR4101 Pharmacotherapy II
  - PR4102 Pharmacotherapy III
  - PR4104 Pharmacy Practice III

## Programme Structure

### 1. Length of Study

Full-Time Programme may be completed over 2 academic years. The didactic component may be completed during the first 10-months followed by the clerkship rotations over the following 40-50 weeks.

Part-Time Programme may be completed over 4-6 academic years. The didactic component may be completed over a period of 22 to 34 months followed by the clerkship rotations during the following 2 to 3 academic years, by completing 2-3 rotations per academic year.

### 2. Curriculum

The didactic component of the programme consists of 12 modules, comprising 8 essential Level 5000 modules and 4 elective Level 5000 modules as described below:

#### **Didactic Coursework**

Essential Modules (28 MC)

- PR5113 Clinical Pharmacokinetics and Therapeutic Drug Monitoring (4 MC)
- PR5130 Advanced Pharmacotherapy I (Infectious Diseases, Neuropsychiatric Disorders) (4 MC)
- PR5131 Advanced Pharmacotherapy II (Thyroid Disorders, Fluid and Electrolyte Disorders, Cardiovascular Therapeutics, Toxicology, Emergency Medicine) (4 MC)
- PR5132 Advanced Pharmacotherapy III (Haematologic, Oncologic and Immunologic disorders) (4 MC)
- PR5133 Advanced Pharmacotherapy in Special Populations (Paediatric and Geriatric Diseases/Conditions) (2 MC)
- PR5134 Physical Assessment and Diagnostic Tests (Medication History, Communication Skills, Physical Assessment Skills) (4 MC)
- PR5135 Foundations in Advanced Pharmacy Practice (Literature Evaluation & Drug Information, Biostatistics, Research Methodology & Clinical Research) (4 MC)
- PR5136 PharmD Seminar (2 MC)

Elective Modules (16 MC) – undertake all coursework modules OR the clinical research project (PR5239) + coursework module(s)

- PR5230 Pharmacoeconomics and Outcomes Research (4 MC)
- PR5231 Complementary and Alternative Medicine (4 MC)
- PR5232 Nutrition, Disease Prevention and Health Promotion (2 MC)
- PR5233 Pharmacy Practice Management (4 MC)
- PR5234 Pharmacogenomics and Pharmacogenetics (4 MC)
- PR5235 Ethics in Pharmacy Practice (2 MC)
- PR5239 Clinical Pharmacy Research Project (12 MC)

#### **Clerkships**

All PharmD candidates must complete 40 weeks of clerkship consisting eight 5-week attachments at various practice settings. The clerkship component of the programme aims to provide hands-on

application of the knowledge gained in the first-year modules, and to develop the clinical skills necessary to provide advanced pharmaceutical care.

- Compulsory clerkships (25 MC) (5 weeks each, total of 25 weeks)

This will consist of clerkships in the following areas:

- PR5150 Ambulatory Care (5 MC)
- PR5151 Adult Acute Care Medicine (5 MC)
- PR5152 Adult General Medicine (5 MC)
- PR5153 Critical Care Medicine (5MC)
- PR5154 Drug Information (5 MC)

- Elective clerkships (15 MC) (5 weeks each, total of 15 weeks)

This will consist of three 5-week attachments to allow students to gain exposure to a broad range of pharmacy practice settings, as well as to allow them to pursue areas of personal interest. Options for elective clerkships will depend on available resources and clerkship sites.

- PR5250 Elective Clerkship I (5 MC)
- PR5251 Elective Clerkship II (5 MC)
- PR5252 Elective Clerkship III (5 MC)

## **Graduation Requirements**

Candidates will need to complete 44 MC worth of modules plus clerkships (40 MC) as indicated in the curriculum. To graduate with the PharmD degree, the candidate must have achieved a CAP of at least 3.5 for all 12 modules, in addition to passes for all eight clinical clerkships.