Faculty of Science

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4.2.2.4 Master of Science in Mathematics (Part-Time or Full-Time)
4.2.2.5 Master of Science in Pharmaceutical Sciences and Technology
4.2.2.6 Master of Science in Physics (Part-Time or Full-Time)
4.2.2.7 Master of Science in Quantitative Finance (Part-Time or Full-Time)
4.2.2.8 Master of Science in Statistics (Part-Time or Full-Time)
4.2.2.9 Joint Masters of Science in Industrial Chemistry (NUS & TUM)
4.2.2.10 Masters of Science in Science Communication
4.2.2.11 Doctor of Pharmacy (PharmD)

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 4,600 undergraduates, 1,590 part-time graduate students, over 270 research-active academic staff and 290 non-academic and administrative staff.

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.

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 Christina CHAI	Assistant Dean, Research and Graduate Studies	8780	scicllc
Assoc Prof FAN Wai Yip	Assistant Dean, Outreach and Student Life	6601 1471	scifanwy
Dr NG Kah Loon	Assistant Dean, Undergraduate Studies	1306	scingkl

Title & Name	Designation/Responsibility	Telephone (6516-XXXX)	Email (XXXX@nus.edu.sg)
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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

Title & Name	Designation/Responsibility	Telephone (6516-XXXX)	Email (XXXX@nus.edu.sg)
Prof Paul Thomas Matsudaira	Head, Biological Sciences	2692	dbshead
Prof LOH Kian Ping	Head, Chemistry	2658	chmhead
Prof Zhu Chengbo	Head, Mathematics	2737	mathead
Assoc Prof CHUI Wai Keung	Head, Pharmacy	2646	phahead

Title & Name	Designation/Responsibility	Telephone (6516-XXXX)	Email (XXXX@nus.edu.sg)
Assoc Prof SOW Chorng Haur	Head, Physics	2603	phyhead
Prof LOH Wei Liem	Acting Head, Statistics and Applied Probability	2945	stahead
Assoc Prof TAN Hwee Huat	Director, Quantitative Finance Programme	6144	mattanhh
Prof Zhou Weibiao	Director, Food Science and Technology Programme	3501	chmzwb

Academic Advisors

Title & Name	Designation/Responsibility	Telephone (6516-XXXX)	Email (XXXX@nus.edu.sg)
A. Biological Sciences			
Assoc Prof Christoph Wolfram WINKLER	Level 5 Advisor	7376	dbswcw
B. Chemistry			
Dr HOANG Truong Giang	Level 1 Advisor	4554	chmhoan
Mrs Claire Anne TAYLOR	Level 2 Advisor	2843	chmcat

Title & Name	Designation/Responsibility	Telephone (6516-XXXX)	Email (XXXX@nus.edu.sg)
Dr Michael YUDISTIRA	Level 3 Advisor	5148	chmmiy
Prof LEE Hian Kee	Level 4 Advisor	2995	chmleehk
Assoc Prof Stephan JAENICKE	Level 5 Advisor	2918	chmsj
C. Computational Biology			
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
D. Food Science and Technology			
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
Asst Prof YUK Hyun-Gyun	Level 4 Advisor	1136	chmyukhg

Title & Name	Designation/Responsibility	Telephone (6516-XXXX)	Email (XXXX@nus.edu.sg)
Assoc Prof LIU Shao Quan	Level 5 Advisor	2687	chmlsq
E. Life Sciences			
Assoc Prof MOK Yu-Keung, Henry	Level 1/2/3/4 Advisor (Biological Sciences)	2967	dbsmokh
Assoc Prof Maxey CHUNG Ching Ming	Level 1/2/3/4 Advisor (Biochemistry)	3252	bchcm
Assoc Prof Fred Wong Wai Shiu	Level 3/4 Advisor (Pharmacology)	3263	phcwongf
Assoc Prof Herbert SCHWARZ	Level 3/4 Advisor (Physiology)	7773	phssh
F. Mathematics			
Dr TAN Ban Pin	Level 1 Advisor	2748	mattbp
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
Dr KU Cheng Yeaw	Level 4 Advisor	2750	matkcy
Assoc Prof Denny	Level 5 Advisor	6252	matlhh

Title & Name	Designation/Responsibility	Telephone (6516-XXXX)	Email (XXXX@nus.edu.sg)
LEUNG			
G. Pharmacy			
Dr HO Han Kiat	Advisor	7963	phahohk
Dr CHIU Ngar Chee, Gigi	Advisor	5536	phacncg
Ms TAN Mui Ling	Advisor	3877	phatml
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
Prof Ong Chong Kim	Level 2 Advisor	2984	phyongck
Assoc Prof Edward TEO	Level 3 Advisor	6351	phyteoe
Prof Christian	Level 4 Advisor	1250	phyck

Title & Name	Designation/Responsibility	Telephone (6516-XXXX)	Email (XXXX@nus.edu.sg)
KURTSIEFER			
Assoc Prof Kaszlikowski DAGOMIR	Level 5 Advisor	6880	phykd
I. Physics (Minor Programmes)			
Assoc Prof Edward TEO	Advisor for Minor in Physics	6351	phyteoe
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
J. Quantitative Finance			
Assoc Prof Tan Hwee Huat	Advisor All levels	6144	mattanhh
K. Statistics and Applied Probability			
Assoc Prof Sanjay CHAUDHURI	Level 1 Advisor	6624	stasc
Dr HO Man Wai	Level 2 Advisor	3953	stahwm
Dr Chan Yiu Man	Level 3 Advisor	2950	stacym
Assoc Prof LIM Tiong	Level 4 Advisor	7857	stalimtw

Title & Name	Designation/Responsibility	Telephone (6516-XXXX)	Email (XXXX@nus.edu.sg)
Wee			
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@nus.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 Emelyn TAN Sue Qing	Student Exchange Programme	2674	chmtsqe
Ms THYAGARAJAN	Polytechnic	2843	chmthyag

Title & Name	Role/Responsibilities	Telephone 6516-XXXX)	Email (XXXX@nus.edu.sg)
Saradha	Admission		
Dr Michael YUDISTIRA	File for Graduation (Level 3)	5148	chmmiy
Prof LEE Hian Kee	File for Graduation (Level 4)	2995	chmleehk
C. Computational Biology			
Prof Greg TUCKER-KELLOGG	Faculty Curriculum Committee	4740	dbsgtk
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-	Polytechnic	4740	dbsgtk

Title & Name	Role/Responsibilities	Telephone 6516-XXXX)	Email (XXXX@nus.edu.sg)
KELLOGG	Admission		
Prof Greg TUCKER-KELLOGG	File for Graduation	4740	dbsgtk

Title & Name	Designation/Responsibility	Telephone (6516-XXXX)	Email (XXXX@nus.edu.sg)
D. Food Science and Technology			
Dr YUK Hyun-Gyun	Faculty Curriculum Committee	1136	chmyukhg
Dr YUK Hyun-Gyun	Department Curriculum Committee	1136	chmyukhg
Prof ZHOU Weibiao	Class and Examination Timetable	3501	chmzwb
Prof ZHOU Weibiao	Professional Placement	3501	chmzwb
Assoc Prof LIU Shao Quan	Student Exchange Programme	2687	chmlsq
Prof ZHOU Weibiao	Polytechnic Admission	3501	chmzwb
Assoc Prof LIU Shao Quan	File for Graduation	2687	chmlsq

Title & Name	Designation/Responsibility	Telephone (6516-XXXX)	Email (XXXX@nus.edu.sg)
E. Life Sciences(Biological Sciences)			
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 Jacqueline LIM Siau Yen	Class and Examination Timetable	2703	dbsjlsy
Ms FOONG Choy Mei		2854	dbsfcm
Assoc Prof MOK Yu-Keung, Henry	Student Exchange Programme	2967	dbsmokh
Assoc Prof MOK Yu-Keung, Henry	Polytechnic Admission	2967	dbsmokh
Ms Jacqueline LIM Siau Yen		2703	dbsjlsy
Mr LIM Miah Kyan	File for Graduation	2698	dbslmk
F. Mathematics and Applied Mathematics			
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	2992	mattws

Title & Name	Designation/Responsibility	Telephone (6516-XXXX)	Email (XXXX@nus.edu.sg)
	Timetable		
Assoc Prof Fred LEUNG Pui Fai Dr Ku Cheng Yeaw	Student Exchange Programme	2772 2750	matfredl matkcy
Assoc Prof Ma Siu Lun	Student Advice Committee (Undergraduate)	3338	matmasl
Dr GONG Zheng	File for Graduation	8815	matgz

G. Pharmacy			
Dr CHIU Ngar Chee, Gigi	Faculty Curriculum Committee	5536	phacncg
Dr CHIU Ngar Chee, Gigi	Class and Examination Timetable	5536	phacncg
Ms TAN Mui Ling	Professional Placement	3877	phatml
Dr WONG Lilian	Professional Placement	66011237	phawll
Dr CHIU Ngar Chee, Gigi	Student Exchange Programme	5536	phacncg
Dr CHIU Ngar Chee, Gigi	Polytechnic Admission	5536	phacncg
Dr EE Pui Lai, Rachel	File for Graduation	2653	phaeplr

G. Pharmacy			
H. Physics			
Assoc Prof Thomas Osipowicz	Faculty Curriculum Committee	6745	phyto
Prof Belal E. BAAQUIE	Department Curriculum Committee	2963	phybeb
Assoc Prof Edward TEO		6351	phyteoe
Assoc Prof Tay Seng Chuan	Class and Examination Timetable	6757	phytaysc
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	mattanhh
Assoc Prof Tan Hwee Huat	Class and Examination Timetable	6144	mattanhh

Title & Name	Role/Responsibilities	Telephone (6516-XXXX)	Email (XXXX@nus.edu.sg)
Assoc Prof Tan Hwee Huat	Student Exchange Programme	6144	mattanhh
Assoc Prof Tan Hwee Huat	File for Graduation	6144	mattanhh
J. Statistics			
Assoc Prof LIM Tiong Wee	Faculty Curriculum Committee	7857	stalimtw
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

Title & Name	Designation/Responsibility	Telephone (6516-XXXX)	Email (XXXX@nus.edu.sg)
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Assoc Prof YEUNG Ying Yeung	EXCO member, Chemistry	7760	chmyyy

Title & Name	Designation/Responsibility	Telephone (6516-XXXX)	Email (XXXX@nus.edu.sg)
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
Assoc Prof GONG Jiangbin	EXCO member, Physics	1154	phygj
Prof Sun Defeng	EXCO member, Risk Management Institute	3343	matsundf
Prof XIA Yingcun	EXCO member, Statistics and Applied Probability	2943	staxyc

UROPS Coordinators

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Assoc Prof George YIP Wai Cheong	Anatomy	3206	antyipg
Assoc Prof TANG Bor Luen	Biochemistry	1040	bchtbl
Dr YEW Wen Shan	Biochemistry	8624	bchyws
Assoc Prof LIOU Yih-Cherng (regular semesters)	Biological Sciences	7711	dbslyc

Title & Name	Department	Telephone (6516-XXXX)	Email (XXXX@nus.edu.sg)
Dr WU Jinlu (special term)	Biological Sciences	8476	dbswjl
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	chmllp
Assoc Prof ZHANG Louxin	Mathematics	6579	matzlx
Asst Prof CHU Jang Hann, Justin	Microbiology	3278	miccjh
Dr LAI Kim Peng Mitchell	Pharmacology	6601 2678	phclkpm
Ms TENG Bee Choon, Christine	Pharmacy	1996	phatbcc
Assoc Prof PASTORIN, Giorgia	Pharmacy	1876	phapg
Assoc Prof Lim Hock Siah	Physics	2614	phylimhs
Assoc Prof WONG Chong Thim	Physiology	3232	phswct
Assoc Prof LIM Tiong Wee	Statistics and Applied Probability	7857	stalimtw

Title & Name	Department	Telephone (6516-XXXX)	Email (XXXX@nus.edu.sg)
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Assoc Prof LO Mun Hou	USP	4077	usplomh

UPIP Coordinators

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Prof Greg TUCKER-KELLOGG	Computational Biology	4740	dbsgtk
Assoc Prof LIOU Yih-Cherng	Life Sciences	7711	dbslyc
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

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Mr LIM Miah Kyan	Manager, Biological Sciences (Undergraduate Programmes)	2698	dbslmk
Ms Reena Devi A/P SAMYNADAN	Assistant Manager, Biological Sciences (Graduate Programmes)	2711	dbsrds
Mr Laurence GWEE	Assistant Manager, Biological Sciences (Graduate Programmes)	4439	dbsgel
Ms Carrie WONG Suk Tak	Manager, Chemistry (Undergraduate Programmes)	6361	chmwst
Ms Linda Janti OEI	Assistant Manager, Chemistry (Graduate Programmes (Coursework))	6318	chmljo
Ms Suriawati Binte SAAD	Executive, Chemistry (Graduate Programmes)	2660	chmss
Ms Linda Janti OEI	Assistant Manager, Chemistry (Graduate Programmes)	6318	chmljo
Ms ENG Pui Leng	Senior Executive, Mathematics	6948	matepl

Title & Name	Designation/Responsibility	Telephone (6516-XXXX)	Email (XXXX@nus.edu.sg)
Ms Adreana LIEW Kai Wei	Manager, Pharmacy (Undergraduate Programmes)	5878	phaalkw
Ms Chew Ying Ying	Senior Manager, Pharmacy (Undergraduate Programme)	8977	phacyy
Ms Sng Wee Lee	Manager, Physics	2619	physngwl
Ms THONG Siok Kay, Melissa	Senior Executive, Statistics and Applied Probability (Undergraduate Programmes)	8050	statskm
Ms Su Kyi WIN	Executive, Statistics and Applied Probability (Graduate Programmes)	4416	staskw
Ms TEO Chwee Hoon	Senior Manager, Dean’s Office (Graduate Programmes)	4092	scitch
Ms Kasie AU	Assistant Manager, Dean’s Office (Graduate Programmes)	2014	sciauk
Ms KOH Wei Kee	Associate Director Dean’s Office (Outreach and Admissions)	6890	scikwk
Mr Murugesan SETHU	Senior Manager Dean’s Office (Student Life)	8198	scims

Title & Name	Designation/Responsibility	Telephone (6516-XXXX)	Email (XXXX@nus.edu.sg)
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Dr ONG Chye Sun	Senior Associate Director, Dean’s Office (Undergraduate Studies)	8472	sciocs
Ms Dawn LEE Siok Peng	Manager, Dean’s Office (Undergraduate Studies)	4271	scileed
Ms LAU Pei Rong	Manager, Dean’s Office (Undergraduate Studies)	8849	scilpr
Ms SIM Xiu Juan	Manager, Dean’s Office (Undergraduate Studies)	8201	scisxj
Ms RAJENDRA Sangeetha	Assistant Manager, Dean’s Office (Undergraduate Studies)	4930	scirs
Ms TAN Wei Ling	Assistant Manager, Dean’s Office (Undergraduate Studies)	8211	scitwl
Ms GOH Hui Shi, Alista	Senior Executive, Dean’s Office (Undergraduate Studies)	66012020	scighsa

Title & Name	Designation/Responsibility	Telephone (6516-XXXX)	Email (XXXX@nus.edu.sg)
Ms ONG Wen Jing	Senior Executive, Dean’s Office (Undergraduate Studies)	6601 1725	sciowj
Mr Safwan Bin Sulaiman	Executive, Dean’s Office (Undergraduate Studies)	66018995	scissm

NUS Bulletin AY 2015/16

Provost's Welcome Message

Part I: General

1. About NUS
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3. Education at NUS
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Part II: Programmes

A. Faculty of Arts & Social Sciences
B. School of Business
C. School of Computing
D. Faculty of Dentistry
E. School of Design & Environment
F. Faculty of Engineering
G. NUS Graduate School for Integrative Sciences and Engineering
H. Faculty of Law
I. Yong Loo Lin School of Medicine
J. Saw Swee Hock School of Public Health
K. Faculty of Science
L. University Scholars Programme
M. Duke-NUS Graduate Medical School Singapore
N. Lee Kuan Yew School of Public Policy
O. Yale NUS College
P. Yong Siew Toh Conservatory of Music
Q. Teaching Institutions
1. Centre for English Language and Communication
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AY2012/13

Undergraduate Education

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3 Undergraduate Education

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
R = Department of Pharmacy
S = Department of Statistics and Applied Probability
D = Duke-NUS Graduate Medical School (for Pre-Medical Track Students only)

(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

The Faculty has jointly set up three multidisciplinary programmes—Physics and Life Sciences, Chemical Sciences (with undergraduate and graduate research scholarships from A*STAR) and Computational Biology—with the Faculty of Engineering, the Yong Loo Lin School of Medicine and the School of Computing. These programmes are designed with the objective of paving the way to specific graduate programmes and research in hot multidisciplinary areas like Biophysics, Medicinal Chemistry and Bioinformatics. As such, these programmes are 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 requirments, 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.

- Professional Placement Programme

The Professional Placement Programme was first introduced in 1998 as an integral part of the previously existing Applied Science Programme (B.Appl.Sc.) where students are attached to companies over a period of six months 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 previous B.Appl.Sc. Programme, which is to serve the R&D manpower needs of pillar industries in Singapore. Such placements also serve to give our students a head start in their careers by enhancing their visibility within the industry. The Professional Placement Programme is now an essential component of the Food Science and Technology major which falls under the Bachelor of Science (B.Sc.)/Bachelor of Science (Honours) (B.Sc.(Hons.) degrees

- Undergraduate Professional Internship Programme (UPIP)

The Undergraduate Professional Internship Programme (UPIP) aims to provide Science undergraduates (with the exception of Food Science and Technology majors) the opportunity to perform structured internship in an organisation during their undergraduate study. This elective programme allows students to engage actively in career preparation and job seeking exercises, hone their interpersonal, communications and other soft skills, and experience day-to-day working professional life. Students will be presented the challenges of competing and securing a job position in the organisation, applying their discipline-related knowledge and professionalism in a working environment, and thus acquiring experiential learning that complements their course activity.

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 California, Los Angeles (UCLA), Tecnológico de Monterrey, University of Costa Rica, Hokkaido University, University of Copenhagen, Harvey Mudd College (HMC) and the Suzhou NUS Research Institute 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 the Massachusetts Institute of Technology's (MIT) Research Opportunities Programme, 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*
   - 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 and Computational Biology 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

3.3.1.1 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.F 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. 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, Para A for more details);
4. Obtained a cumulative average point (CAP) of at least 2.00;
5. 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
6. 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**
University Level Requirements	**20**
General Education	20
Programme Requirements** • B.Sc. (excluding FST major) • For FST major	**72 – 86** **88**
Faculty requirements • B.Sc. (excluding FST major) • B.Sc.(for FST major)	**12** 16
Major requirements [B.Sc.] B.Sc. (excluding FST major) B.Sc.(for FST major)	60 - 74 72
Unrestricted Elective Modules(NOT including additional MCs due to reduced programme requirements as a result of MAJOR REQUIREMENTS DOUBLE COUNTING AS FACULTY REQUIREMENTS) ** • B.Sc. (excluding FST major) • B.Sc.(for FST major)	14 - 28 12
Total	**120**

** 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.F 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. 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, Para A for more details);
4. Completed a mandatory year-long honours project module;
5. Obtained a cumulative average point (CAP) of at least 3.00;

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);
7. Any other requirements as stipulated by the Faculty for graduation; and
8. 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
PROGRAMME REQUIREMENTS** • B.Sc. (Hons.)(excluding FST major) • B.Sc. (Hons.)(for FST major)	108 - 122 124
Faculty requirements B.Sc. (Hons.)(excluding FST major) B.Sc. (Hons.)(for FST major)	 16 20
Major requirements [B.Sc. (Hons.)] B.Sc. (Hons.)(excluding FST major) B.Sc. (Hons.)(for FST major)	 92 - 106 104
UNRESTRICTED ELECTIVE MODULES(NOT INCLUDING ADDITIONAL MCS DUE TO REDUCED PROGRAMME REQUIREMENTS AS A RESULT OF MAJOR REQUIREMENTS DOUBLE COUNTING AS FACULTY REQUIREMENTS) ** B.Sc. (Hons.)(excluding FST major) B.Sc. (Hons.)(for FST major)	 18 - 32 16
Total	**160**

** 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 PR4199 Honours Project in Pharmacy; 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

Summary of Requirements for B.Sc. (Pharm.)/B.Sc (Pharm.) (Hons.)	MCs
University Level Requirements	20
General Education	20
Programme Requirements	132
Faculty requirements	16
Major requirements	116
Unrestricted Elective Modules	8
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

Scholars who read and pass the USP modules are deemed to have fulfilled 20 MCs of University Level Requirements. The remaining 28 MCs will be counted towards major/unrestricted electives requirements.

USP Independent Study Modules (ISMs)

Scholars who opt for the Academic Inquiry Track from the Faculty of Science 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)	A good H2 pass (or equivalent) in Chemistry, and at least a good GCE 'O' Level pass in Mathematics.
5. Computational Biology*†	Good H2 passes (or equivalent) in Mathematics and either Biology, Chemistry or Physics. Students without H2 passes (or equivalent) in any two of the three Science subjects (Biology/Chemistry/Physics) should have at least GCE 'O' Level or equivalent passes in them.

Major	Prerequisites
	Subject to departmental approval.
6. Food Science & Technology*	(1) Good H2 passes (or equivalent) in Chemistry and at least one other science subject, and good GCE'O' level or above pass in Biology Subject to departmental approval.
7. Life Sciences 8. Life Sciences (with specialisation in Biomedical Science) 9. Life Sciences (with specialisation in Environmental Biology) 10. Life Sciences (with specialisation in Molecular and Cell Biology)	Good H2 passes (or equivalent) in Biology, Chemistry and either Mathematics or Physics. Students without H2 Biology or Chemistry may read the relevant bridging modules to meet the eligibility requirements.
11. Mathematics 12. Applied Mathematics 13. Applied Mathematics (with specialisation in Mathematical Modelling and Data Analytics) 14. Applied Mathematics (with specialisation in Operation Research and Financial Mathematics) 15. Statistics 16. Statistics (with specialisation in Biostatistics) 17. Statistics (with specialisation in Finance and Business Statistics) 18. Quantitative Finance*	A good H2 pass (or equivalent) in Mathematics. Subject to departmental approval (applicable to Quantitative Finance only)
19. Physics 20. Physics (with specialisation in Astrophysics) 21. Physics (with specialisation in Nanophysics)	Good H2 passes (or equivalent) in Physics and Mathematics.
22. Pharmacy@†	Very good H2 passes (or equivalent) in Chemistry and in either H2 Biology or H2 Physics or H2 Mathematics.

* 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 programme is by direct application.
^ Pharmacy and Computational Biology 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.) 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)	8 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)	8 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

Programme	Faculty Requirements
	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*, CSD, CZ, 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)	
Mathematical & Statistical Sciences	Applied Mathematics (MA)	CZ, MA, QF, ST
	Applied Mathematics (Specialisation in Mathematical Modelling and Data Analytics) (MA)	
	Applied Mathematics (Specialisation in Operations Research and Financial Mathematics) (MA)	
	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)	

Subject Group	Majors	Module Code Prefix
Multidisciplinary & Interdisciplinary Sciences	--	FMS12XXB, FMS12XXC, FMS12XXD, 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.
University Scholars Programme (USP)	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: UITXXXX- Counted towards Computing Sciences subject group UPC2209 - Counted towards Physical Sciences subject group UPC2208-Counted towards Chemical Sciences subject group UPC2207- Counted towards Physical Sciences subject group UPC2206- Counted towards Physical Sciences subject group ULSXXXX- Counted towards Life Sciences

Programme	Provision for SPS/USP students
	subject group UQRXXXX- Counted towards Mathematical & Statistical Sciences group UNLXXXX- Counted towards Multidisciplinary & Interdisciplinary Sciences group

For more details on fulfilling Faculty requirements, students are advised to visit the following website:
http://www.science.nus.edu.sg/undergraduate-studies/ugreq/curriculum-structure/186-undergraduate/ugreq/curriculum-structure/212-facreq

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/ugreq/curriculum-structure/186-undergraduate/ugreq/curriculum-structure/708-es1541 for more information.

3.3.1.8 English Skills Requirements

Based on the Qualifying English Test results, students who do not meet exemption criteria have to take and pass ES1102 English for Academic Purposes. In addition, very weak students have to take and pass ES1000FC Basic English Course before proceeding to ES1102.

ES1000FC and ES1102 are not counted towards Modular Credits and CAP. However, they are counted as part of the workload for every semester. (Please refer to section 3.3.2)

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

(I) For B.Sc. (Hons.)

i. 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:

- 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.

- 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).

(II) 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.

(III) 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:

i. Modules for which grades obtained have no assigned grade points (for e.g. EXE, OCT, OVS, S/U, CS/CU, IC, IP); and
ii. ES1000FC Basic English Course and ES1102 English for Academic Purposes.

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

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

Classification	CAP cut-offs
Honours (Highest Distinction)	4.50 & above
Honours (Distinction)	4.00 – 4.49
Honours (Merit)	3.50 – 3.99
Honours	3.00 – 3.49
Pass [B.Sc./ B.Sc. (Pharm.)]	2.00 – 2.99
Fail	Below 2.00

(II) B.Sc.

Classification	CAP cut-offs
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

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: LSM1101, 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 3.50.
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.

3.3.2 Policies and Procedures

3.3.2.1 Advanced Placement/Exemptions

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. There is no limit to the number of times that students may read a module if they fail or obtain a U (Unsatisfactory) grade on it.

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://www.science.nus.edu.sg/undergraduate-studies/ugreq/curriculum-structure/186-undergraduate/ugreq/curriculum-structure/218-overlapping-modules. 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 SPS students, this CAP requirement does not apply to the ISM that they may read to fulfil SP3173.

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 Science Dean’s Office. All students reading ISM(s) for the semester whether taken for SPS/USP requirements or otherwise 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 15 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, AY2015/2016, you will have to file for honours project at the beginning of Semester 2, AY2014/2015 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/

File for Graduation (with option to do Honours)

Students who intend to graduate but would like to do Honours if they manage to meet the Honours eligibility criteria by the end of the semester should file for this option during the online registration period via CORS.

If students do not meet the Honours Eligibility criteria after the release of the semester’s results but meet the criteria to graduate, they will automatically proceed to graduate. If they meet the Honours Eligibility criteria, they will automatically proceed to the next semester to do their honours project.

Conversion of filing status after the release of examination results
Students who qualify for Honours after the release of the semester’s results, but would like to graduate instead have up to three (3) calendar days (from the date of release of the examination results) to withdraw from the project and “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

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 B.Sc.(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 B.Sc. or B.Sc. (Hons.) with a primary major in Chemistry, candidates must satisfy the following:

I. B.Sc. in Chemistry

LEVEL	BSC IN CHEMISTRY MINIMUM REQUIREMENTS	CUMULATIVE MCS
1000	CM1111 Inorganic Chemistry 1 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	24
2000	CM2101 Physical Chemistry 2 CM2111 Inorganic Chemistry 2 CM2121 Organic Chemistry 2 CM2142 Analytical Chemistry 1 CM2191 Experiments in Chemistry 2 CM2192 Experiments in Chemistry 3	48
3000	CM3291 Advanced Experiments in Inorganic and Organic Chemistry CM3292 Advanced Experiments in Analytical and Physical Chemistry *Any other four (4) CM elective modules from Level-3000 (excluding CM3289)#.	72

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

#UROPS CM3288 can be counted as 4 MC. However, if two semesters work of UROPS is completed, CM3289 is not counted.

II. B.Sc. (Hon) in Chemistry (No Specialisation)

LEVEL	B.SC. 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 CM2142 Analytical Chemistry 1	48

LEVEL	B.SC. HONS. IN CHEMISTRY MINIMUM REQUIREMENTS	CUMULATIVE MCS
	CM2191 Experiments in Chemistry 2 CM2192 Experiments in Chemistry 3	
3000	CM3291 Advanced Experiments in Inorganic and Organic Chemistry CM3292 Advanced Experiments in Analytical and Physical Chemistry	56
3000/4000	Any eight (8) CM modules at Level 3000 or 4000 with at least four such modules at Level 4000.[a]	88
4000	CM4199A Honours Project in Chemistry (16 MCs) OR CM4299 Applied Project in Chemistry (16 MCs)	**104**

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

* Level 3000 CM elective modules

CM3201 Principles of Chemical Processes
CM3211 Organometallic Chemistry
CM3212 Transition Metal Chemistry
CM3221 Organic Synthesis and Spectroscopy
CM3222 Organic Reaction Mechanisms
CM3225 Biomolecules
CM3231 Quantum Chemistry and Molecular Thermodynamics
CM3232 Physical Chemistry of the Solid State and Interfaces
CM3242 Instrumental Analysis II
CM3251 Nanochemistry
CM3252 Polymer Chemistry I
CM3253 Materials Chemistry I
CM3261 Environmental Chemistry
CM3288 Advanced UROPS in Chemistry I
CM3289 Advanced UROPS in Chemistry II
CM3296 Molecular Modelling: Theory & Practice

Level-4000 CM elective modules

CM4214 Structural Methods in Inorganic Chemistry
CM4215 Bioinorganic Chemistry
CM4225 Organic Spectroscopy
CM4227 Chemical Biology
CM4228 Catalysis
CM4238 Selected Topics in Physical Chemistry
CM4241 Trace Analysis
CM4242 Advanced Analytical Techniques
CM4251 Characterisation Techniques in Materials Chemistry
CM4252 Polymer Chemistry 2
CM4253 Materials Chemistry 2
CM4254 Chemistry of Semi-Conductors
CM4258 Advanced Polymer Science
CM4269 Sustainable and Green Chemistry
CM4271 Medicinal Chemistry
CM4273 Computational Drug Design
CM4274 The Art and Methodology in Total Synthesis
CM4282 Energy Resources

To be awarded a B.Sc. (Hons) with Specialisation in Chemistry, candidates must satisfy the following:

Level	B.Sc. (Hons.) in Chemistry with Specialisation Minimum Requirements	Cumulative MCs
1000	Identical to B.Sc. (Hons.) in Chemistry	24
2000	Identical to B.Sc. (Hons.) in Chemistry	48
3000	CM3291 Advanced Experiments in Inorganic and Organic Chemistry CM3292 Advanced Experiments in Analytical and Physical Chemistry	56
3000/4000	a. If CM4199A Honours Project in Chemistry is in area of Specialisation, any eight (8) CM modules at Level 3000 or 4000 with at least four (4) such modules at Level 4000[a] and at least four (4) such modules in area of Specialisation;[b] OR b. If CM4199A Honours Project in Chemistry is not in area of Specialisation or CM4299 Applied	88

Level	B.Sc. (Hons.) in Chemistry with Specialisation Minimum Requirements	Cumulative MCs
	Project in Chemistry is read, any eight (8) CM modules at Level 3000 or 4000 with at least four (4) such modules at Level 4000[a] and at least six (6) such modules in area of Specialisation;	
4000	CM4199A Honours Project in Chemistry (16 MCs) OR CM4299 Applied Project in Chemistry (16 MCs)	**104**

[a]Students may take ip to one level 5000 module in place of a Level 4000 module

[b]8 MCs of the Honours Project in Chemistry (16 MCs) could be counted toward Specialisation requirement.

A. B.Sc. (Hons.) in Chemistry with Specialisation in Materials Chemistry

To be awarded a B.Sc. (Hons.) in Chemistry with Specialisation in Materials Chemistry, students are required to read and pass all essential modules at Level 1000 and Level 2000 under Chemistry Major Requirements and the following modules at Level 3000 and Level 4000 as set out in the tables below:

(i) For students who complete CM4199A (Honours Project in Chemistry) in the area of Materials Chemistry.

Level	Module Code/Title	Prerequisites	Requirements
3000	CM3291 Advanced Experiments in Inorganic and Organic Chemistry CM3292 Advanced Experiments in Analytical and Physical Chemistry	CM2191 Experiments in Chemistry 2 CM2192 Experiments in Chemistry 3	8 MCs Essential modules for Chemistry Major
3000/4000	CM3251 Nanochemistry CM3252 Polymer Chemistry 1 CM3253 Materials Chemistry 1	SP2251 CM1131 and CM2121 CM1131 and CM2111	(1) 32 MCs of Level 3000 and 4000 CM (or non-specified CM) modules, excluding CM4199A, with at least four such modules at Level 4000[a] (2) Specialisation Requirement (24MC) a) At least four modules or 16MC from (1) selected from: CM3251, CM3252, CM3253, CM4251, CM4252, CM4253, CM4254 and CM4258 b) CM4199A (8MC can be counted towards Specialisation requirement)
	CM4251 Characterisation Techniques in Materials Chemistry CM4252 Polymer Chemistry 2 CM4253 Materials Chemistry 2 CM4254 Chemistry of Semi-Conductors CM4258 Advanced Polymer Science	CM3252 and CM3253 CM3252 CM3253 CM3232 CM3252	
	Other CM (or approved) modules		
4000	CM4199A Honours Project in Chemistry (in the area of Materials Chemistry)	Honours Eligibility Requirements for Specific Cohort	16 MCs CM4199A is a 16-MC module; 8 MCs could be counted toward Specialisation requirement.
		Total	56 MCs

[a]Students may take up to one Level 5000 module in place of a Level 4000 Module. This Level 5000 module cannot be used again to satisfy graduate studies requirement.

(ii) For students who complete CM4199A (Honours Project in Chemistry) not in the area of Materials Chemistry, or CM4299 Applied Project in Chemistry.

Level	Module Code/Title	Prerequisites	Requirements
3000	CM3291 Advanced Experiments in Inorganic and Organic Chemistry CM3292 Advanced Experiments in Analytical and Physical Chemistry	CM2191 Experiments in Chemistry 2 CM2192 Experiments in Chemistry 3	8 MCs Essential modules for Chemistry Major
3000/4000	CM3251 Nanochemistry CM3252 Polymer Chemistry 1 CM3253 Materials Chemistry 1	SP2251 CM1131 and CM2121 CM1131 and CM2111	(1) 32 MCs of Level 3000 and 4000 CM (or specified non-CM) modules, excluding CM4199A, with at least four

			such modules at Level 4000[a] (2) Specialisation Requirement (24MC) a) At least six modules or 24MC from (1) selected from: CM3251, CM3252, CM3253, CM4251, CM4252, CM4253, CM4254 and CM4258
	CM4251 Characterisation Techniques in Materials Chemistry CM4252 Polymer Chemistry 2 CM4253 Materials Chemistry 2 CM4254 Chemistry of Semi-Conductors CM4258 Advanced Polymer Science	CM3252 and CM3253 CM3252 CM3253 CM3232 CM3252	
	Other CM (or approved) Modules		
4000	CM4199A Honours Project in Chemistry (not in the area of Materials Chemistry) OR CM4299 Applied Project in Chemistry	Honours Eligibility Requirements for Specific Cohort	16 MCs
		Total	56 MCs

[a]Students may take up to one Level 5000 module in place of a Level 4000 Module. This Level 5000 module cannot be used again to satisfy graduate studies requirement.

B. B.Sc. (Hons.) in Chemistry with Specialisation in Medicinal Chemistry

To be awarded a B.Sc.(Hons.) in Chemistry with Specialisation in Medicinal Chemistry, students are required to read and pass all essential modules at Level 1000 and Level 2000 under Chemistry Major Requirements and the following modules at Level 3000 and Level 4000 as set out in the tables below:

(i) For students who complete CM4199A (Honours Project in Chemistry) in the area of Medicinal Chemistry

Level	Module Code/Title	Prerequisites	Requirements
3000	CM3291 Advanced Experiments in Inorganic and Organic Chemistry CM3292 Advanced Experiments in Analytical and Physical Chemistry	CM2191 Experiments in Chemistry 2 CM2192 Experiments in Chemistry 3	8 MCs Essential modules for Chemistry Major
3000/4000	CM3221 Organic Synthesis and Spectroscopy CM3225 Biomolecules	CM2121 CM2121	(1) 32 MCs of Level 3000 and 4000 CM (or specified non-CM) modules, excluding CM4199A, with at least four such modules at Level 4000[a] (2) Specialisation Requirement (24MC) a) At least four modules or 16MC from (1) selected from: CM3221, CM3225, CM4271, CM4225, CM4227, CM4273, CM4274, CM4215, CM5224[a], CM5245[a] and PR4205 b) CM4199A (8MC can be counted towards Specialisation requirement)
	CM4271 Medicinal Chemistry CM4227 Chemical Biology CM4225 Organic Spectroscopy CM4273 Computational Drug Design CM4274 The Art and Methodology in Total Synthesis CM4215 Bioinorganic Chemistry CM5224 Emerging Concepts of Drug Discovery[a] CM5245 Bioanalytical Chemistry[a] PR4205 Bioorganic Principles of Medicinal Chemistry	CM2121 and CM3225 CM2121 and CM3225 CM2121 CM3221 or CM3222 CM3221 CM3211 or CM3212 or CM3268 By permission By permission PR3101	
	Other CM (or approved) modules		
4000	CM4199A Honours Project in Chemistry (in the area of Medicinal Chemistry)	Honours Eligibility Requirements for Specific Cohort	16 MCs CM4199A is a 16-MC module; 8 MCs could be counted toward Specialisation requirement.
		Total	56 MCs

[a]Students may take up to one Level 5000 module in place of a Level 4000 module. This Level 5000 module cannot be used again to satisfy graduate studies requirement.

(ii) For students who complete CM4199A (Honours Project in Chemistry) not in the area of Medicinal Chemistry.

Level	Module Code/Title	Prerequisites	Requirements

3000	CM3291 Advanced Experiments in Inorganic and Organic Chemistry CM3292 Advanced Experiments in Analytical and Physical Chemistry	CM2191 Experiments in Chemistry 2 CM2192 Experiments in Chemistry 3	8 MCs Essential modules for Chemistry Major
3000/4000	CM3221 Organic Synthesis and Spectroscopy CM3225 Biomolecules	CM2121 CM2121	(1) 32 MCs of Level 3000 and 4000 CM (or specified non-CM) modules, excluding CM4199A, with at least four such modules at Level 4000[a] (2) Specialisation Requirement (24MC) a) At least six modules or 24MC from (1) selected from: CM3221, CM3225, CM4225, CM4271, CM4227, CM4273, CM4274, CM4215, CM5224[a], CM5245[a] and PR4205
	CM4271 Medicinal Chemistry CM4225 Organic Spectroscopy CM4227 Chemical Biology CM4273 Computational Drug Design CM4274 The Art and Methodology in Total Synthesis CM4215 Bioinorganic Chemistry CM5224 Emerging Concepts of Drug Discovery[a] CM5245 Bioanalytical Chemistry[a] PR4205 Bioorganic Principles of Medicinal Chemistry	CM2121 and CM3225 CM2121 CM2121 and CM3225 CM3221 or CM3222 CM3221 CM3211 or CM3212 or CM3268 By permission By permission PR3101	
	Other CM (or approved) modules		
4000	CM4199A Honours Project in Chemistry (not in the area of Medicinal Chemistry) OR CM4299 Applied Project in Chemistry	Honours Eligibility Requirements for specific cohort	16 MCs
		Total	56 MCs

[a]Students may take up to one Level 5000 module in place of a Level 4000 module. This Level 5000 module cannot be used again to satisfy graduate studies requirement.

C. BSc Hons in Chemistry with Specialisation in Environment and Energy

To be awarded a B.Sc.(Hons.) in Chemistry with Specialisation in Environment and Energy, students are required to read and pass all essential modules at Level 1000 and Level 2000 under Chemistry Major Requirements and the following modules at Level 3000 and Level 4000 as set out in the tables below:

(i) For students who complete CM4199A (Honours Project in Chemistry) in the area of Environment and Energy.

Level	**Module Code/Title**	**Prerequisites**	**Requirements**
3000	CM3291 Advanced Experiments in Inorganic and Organic Chemistry CM3292 Advanced Experiments in Analytical and Physical Chemistry	CM2191 Experiments in Chemistry 2 CM2192 Experiments in Chemistry 3	8 MCs Essential modules for Chemistry Major
3000/4000	CM3242 Instrumental Analysis II CM3261 Environmental Chemistry	CM2142 or CM2166 CM3241 or CM2142 or CM2166 or by permission	(1) 32 MCs of Level 3000 and 4000 CM (or specified non-CM) modules, excluding CM4199A, with at least four such modules at Level 4000[a] (2) Specialisation Requirement (24MC) a) At least four modules or 16MC from (1) selected from: CM3242, CM3261, CM4241, CM4242, CM4269 and CM4282 b) CM4199A (8MC can be counted towards Specialisation requirement)
	CM4241 Trace Analysis CM4242 Advanced Analytical Techniques CM4269 Sustainable and Green Chemistry CM4282 Energy Resources	CM3242 or by permission CM3242 or by permission CM1121 CM1311 and CM2111	
	Other CM (or approved) modules		
4000	CM4199A Honours Project in Chemistry (in the area of Environment and Energy)	Honours Eligibility Requirements for Specific Cohort	16 MCs CM4199A is a 16-MC module; 8 MCs could be counted toward Specialisation requirement.
		Total	56 MCs

[a]Students may take up to one Level 5000 module in place of a Level 4000 module. This Level 5000 module cannot be used again to satisfy graduate studies requirement.

(iii) For students who complete CM4199A (Honours Project in Chemistry) not in the area of Environment and Energy

Level	Module Code/Title	Prerequisites	Requirements
3000	CM3291 Advanced Experiments in Inorganic and Organic Chemistry CM3292 Advanced Experiments in Analytical and Physical Chemistry	CM2191 Experiments in Chemistry 2 CM2192 Experiments in Chemistry 3	8 MCs Essential modules for Chemistry Major
3000/4000	CM3242 Instrumental Analysis II CM3261 Environmental Chemistry	CM2142 or CM2166 CM3241 or CM2142 or CM2166 or by permission	(1) 32 MCs of Level 3000 and 4000 CM (or non-specified non-CM) modules, excluding CM4199A, with at least four such modules at Level 4000[a] (2) Specialisation Requirement (24MC) a) 24MC from (1) read from: CM3242, CM3261, CM4241, CM4242, CM4269 and CM4282
	CM4241 Trace Analysis CM4242 Advanced Analytical Techniques CM4269 Sustainable and Green Chemistry CM4282 Energy Resources	CM3242 or by permission CM3242 or by permission CM1121 CM1131 and CM2111	
	Other CM (or approved) modules		
4000	CM4199A Honours Project in Chemistry (not in the area of Environment and Energy) OR CM4299 Applied Project in Chemistry	Honours Eligibility Requirements for Specific Cohort	16 MCs
		Total	56 MCs

[a]Students may take up to one Level 5000 module in place of a Level 4000 module. This Level 5000 module cannot be used again to satisfy graduate studies requirement.

SUMMARY OF REQUIREMENTS	B.SC.	B.SC. (HONS)	B.SC. (HONS.) WITH SPECIALISATION
University Requirements	20 MCs	20 MCs	20MCs
Faculty Requirements	4 MCs*	8 MCs	8 MCs*
Major Requirements	72 MCs	104 MCs	104 MCs
Unrestricted Elective Modules	24 MCs	28 MCs	28 MCs
Total	120 MCs	160 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 MA1421 and LSM1401 within the major.

Students undertaking the B.Sc. 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 B.Sc. (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 [1] LSM1101 Biochemistry Of Biomolecules [1] MA2213 Numerical Analysis 1 SP1541		16
Major Requirements		
Level-1000 / 2000 Essential [1]		40 – 44
CS1010S or CS1010FC or CS1010X Programming Methodology	4	
CS1020E or CS1020 Data Structures And Algorithms I	4	
CS1231 Discrete Structures or MA1100 Fundamental Concepts of Mathematics	4	
LSM1102 Molecular Genetics	4	
MA1101R Linear Algebra I	4	
MA1102R Calculus	4	
CS2220 Introduction to Computational Biology [4]	4	
LSM2241 Introductory Bioinformatics	4	

PROGRAMME REQUIREMENTS		MCS
LSM2101 Metabolism And Regulation OR LSM2102 Molecular Biology OR LSM2103 Cell Biology	4	
Either ST2334 Probability and Statistics OR a combined ST2131 Probability and ST2132 Mathematical Statistics*	4 - 8	
Level-3000 Essential		
MA3259 Mathematical Methods In Genomics	4	8
LSM3231 Protein Structure and Function	4	
Level-3000 Electives [3] (Choose Four Modules) – [Any two modules from option A and any two modules from option B] Option A 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 Option B LSM3211 Fundamental Pharmacology LSM3215 Neuronal Signaling and Memory Mechanisms LSM3223 Immunology LSM3232 Microbiology LSM3233 Developmental Biology LSM3241 Bioinformatics & Biocomputing LSM3243 Molecular Biophysics LSM3244 Molecular Biotechnology PC3267 Biophysics II MA3233 Combinatorics and Graphs II PR3203 Computer Aided Drug Design and Development ST3131 Regression Analysis ST3240 Multivariate Statistical Analysis ST3232 Design and analysis of experiments ST3233 Applied time series analysis ST3236 / MA3238 Stochastic Process 1 ST3243 Statistical methods in epidemiology ST3245 Statistics in molecular biology ST3247 Simulation		16
Level-4000 Essential		
ZB4199 Honours Project in Computational Biology	12	20
ZB4171 Advanced Topics in Bioinformatics	4	
LSM4241 Functional Genomics	4	
Level-4000 Electives (Choose Three 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] Option A 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 Option B 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 LSM4231 Structural Biology LSM4232 Advanced Cell Biology LSM4242 Protein Engineering		12
Option C MA4251/ ST4238 Stochastic Processes II PC4267 Biophysics III ST4231 Computer Intensive Statistical Methods ST4234 Bayesian Statistics		

PROGRAMME REQUIREMENTS		MCS
ST4235 ST4240 ST4241 ST4242 ST4243	Simulation Data Mining Design & Analysis Of Clinical Trials Analysis of Longitudinal Data Statistical Methods for DNA Microarray Analysis	
Unrestricted Elective Modules [4]		24 – 28
Total		**160**

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:
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 4:
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). Student without computing background may wish to read LSM2241 as a preparatory course before reading CS2220. In addition, as Computational Biology students already have stipulated Faculty requirements, they would read SP1541 as an Unrestricted Elective.

* 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	96-100 MCs
Unrestricted Elective Modules	24-28 MCs
Total	160 MCs

3.3.3.3 Food Science and Technology

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) course at NUS aims to produce highly motivated, numerate and responsible food scientists and technologists 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.

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 LSM1101 Biochemistry of Biomolecules ST1232 Statistics for Life Sciences For students without H2/A-level equivalent Biology, pass: LSM1301 General Biology	24
2000 (28 MCs)	Pass CM2142 Analytical Chemistry 1 FST2102B Chemistry of Food Components FST2106 Post Harvest Food Processing FST2107 Food Analysis Lab FST2108 Food Safety Assurance LSM2101 Metabolism and Regulation LSM2191 Laboratory Techniques in Life Sciences	52
3000 (20 MCs)	Pass FST3101 Food Microbiology and Fermentation FST3103 Advanced Food Engineering FST3105 Food Product Development and Packaging FST3106 Sensory and Flavour Science At least 4 MCs from the following: FST3201 Independent Study (Food Science & Technology) FST3202 Nutrition and Disease Prevention FST3203 Vitamins & Minerals in Health & Diseases FST3288 Advanced UROPS (Food Sc. & Tech) I DSC3202 Purchasing & Materials Management CM3242 Instrumental Analysis II	72
4000 (32 MCs)	Pass FST4199 Honours Project in Food Science & Technology FST4102 Advanced Food Processing Technologies FST4103 Food Colloids and Components Science At least 8 MCs from following: FST4201 Current Topics in Food Science and Technology FST4202 Nutritional Biochemistry FST4203 Food Forensics CM4241 Trace Analysis CM4242 Advanced Analytical Techniques CM4267 Current Topics in Analytical Techniques	104

	FST5201 Rheology and Textural Properties of Biomaterials FST5202 Advanced Food Fermentation FST5203 Advanced Food Microbiology and Safety FST5204 Evidence Based Functional Foods FST5225 Advanced Current Topics in Food Science CM5241 Modern Analytical Techniques	

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	12 MCs†	12 MCs ††
Major Requirements	72 MCs	104 MCs
Unrestricted Elective Modules	16 MCs	24 MCs
TOTAL	120 MCs	160 MCs

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

3.3.3.4 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, Pharmacology, and Physiology). The Life Sciences Major is designed to provide NUS undergraduates with the fundamentals in biological and biomedical sciences. With a mandatory broad-based foundation in the first two years of study, Life Sciences Major students can subsequently choose to focus in a particular area of Life Sciences or engage broadly across different areas during Year 3, and move on to specialise in an area while pursuing an Honours Year Project relevant to their focus at Year 4, namely Biomedical Science (BMS), Molecular and Cell Biology (MCB) or Environmental Biology (EVB). Graduates of the programme are well prepared to take on challenges in the knowledge-based economy and to contribute and support Singapore's initiatives in the field of Life Sciences.

Programme Structure & Curriculum Rationale

Broad-Based Foundation Curriculum
The Life Sciences Major is structured to provide a common, broad-based foundation in the first two years of study for all students in Life Sciences. Students study topics in Molecular, Cellular and Organismal Biology as well as Statistics and Physical, Analytical and Organic Chemistry. This is a reflection of the multidisciplinary nature of modern Life Sciences.

Core Skills
Fundamental concepts and principles in Life Sciences are taught through lectures, tutorials, discussions, presentations and independent studies. A significant laboratory component is integrated within the curriculum. This is augmented by experimental-based modules, and by research projects in the UROPS (Undergraduate Research Opportunities Programme in Science).

Three Specialisations
At Year 4, Life Sciences Major students eligible for Honours may decide on one of the three specialisations: Biomedical

Science (BMS), Molecular and Cell Biology (MCB) or Environmental Biology (EVB), and pursue a year-long Honours Research Project listed with the chosen focus.

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 (24 MCs)	Pass all LSM1101 Biochemistry of Biomolecules LSM1102 Molecular Genetics LSM1103 Biodiversity LSM1104 General Physiology CM1401 Chemistry for Life Sciences ST1232 Statistics for Life Sciences	24
Level 2000 (20 MCs)	Pass all LSM2101 Metabolism and Regulation LSM2102 Molecular Biology LSM2103 Cell Biology LSM2191 Laboratory Techniques in Life Sciences Pass one LSM2212 Human Anatomy LSM2241 Introductory Bioinformatics LSM2251 Ecology and Environment LSM2291 Fundamental Techniques in Microbiology	44
Level 3000 (20 MCs)	Pass 5 LSM32XX elective modules (except LSM3289), one of which may be a LSM-recognised elective module (up to 4 MCs). 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 LSM3221 Human Pharmacology LSM3223 Immunology LSM3224 Molecular Basis of Human Diseases LSM3225 Molecular Microbiology in Human Diseases LSM3231 Protein Structure and Function LSM3232 Microbiology LSM3233 Developmental Biology LSM3241 Bioinformatics and Biocomputing LSM3242 Translational Microbiology LSM3243 Molecular Biophysics LSM3245 RNA Biology and Technology LSM3246 Synthetic Biology LSM3252 Evolution and Comparative Genomics	64

Level	Life Sciences Major Requirements	Cumulative Major MCs
	LSM3254 Ecology of Aquatic Environments LSM3255 Ecology of Terrestrial Environments LSM3256 Tropical Horticulture LSM3257 Quantitative Methods for Ecological Research LSM3258 Comparative Botany 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 (24 MCs)	Pass all LSM1101 Biochemistry of Biomolecules LSM1102 Molecular Genetics LSM1103 Biodiversity LSM1104 General Physiology CM1401 Chemistry for Life Sciences ST1232 Statistics for Life Sciences	24
Level 2000 (20 MCs)	Pass all LSM2101 Metabolism and Regulation LSM2102 Molecular Biology LSM2103 Cell Biology LSM2191 Laboratory Techniques in Life Sciences	44
	Pass one LSM2212 Human Anatomy LSM2241 Introductory Bioinformatics LSM2251 Ecology and Environment LSM2291 Fundamental Techniques in Microbiology	
Level 3000 (20 MCs)	Pass 5 LSM32XX elective modules (except LSM3289), one of which may be a LSM-recognised elective module (up to 4 MCs).	64
	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 LSM3221 Human Pharmacology LSM3223 Immunology LSM3224 Molecular Basis of Human Diseases LSM3225 Molecular Microbiology in Human Diseases LSM3231 Protein Structure and Function LSM3232 Microbiology LSM3233 Developmental Biology LSM3241 Bioinformatics and Biocomputing LSM3242 Translational Microbiology LSM3243 Molecular Biophysics LSM3245 RNA Biology and Technology LSM3246 Synthetic Biology LSM3252 Evolution and Comparative Genomics LSM3254 Ecology of Aquatic Environments LSM3255 Ecology of Terrestrial Environments LSM3256 Tropical Horticulture LSM3257 Quantitative Methods for Ecological Research LSM3258 Comparative Botany LSM3262 Environmental Animal Physiology LSM3263 Field Studies in Neotropical Ecosystems LSM3264 Environmental Biochemistry LSM3265 Entomology LSM3266 Avian Biology and Evolution LSM3267 Behavioural Biology	

Level	Life Sciences Major Requirements		Cumulative Major MCs
	LSM3272 Global Change Biology LSM3273 Ecology, Conservation and Management of Sri Lankan Ecosystems LSM3288 Advanced UROPS in Life Sciences I		
Level 4000 (32 MCs)	Pass at least 32MCs via one of the following options: **Honours Research Project** Pass LSM4199 Honours Project in Life Sciences, AND pass another 4 LSM42xx elective modules. [If one of the three specialisations (BMS/MCB/EVB)* is to be pursued, LSM4199 and at least 2 of the 4 have to be completed, all listed with the chosen specialisation.] **Applied Internship Project** Pass LSM4299 Applied Project in Life Sciences, AND pass another 4 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 6 LSM42xx listed with the chosen specialisation.] **Coursework Taught Modules** Pass 8 LSM42xx elective modules. [If one of the three specialisations (BMS/MCB/EVB)* is to be pursued, at least 6 of the 8 LSM42xx elective modules have to be listed with the chosen specialisation.]		96
	LSM4210 Topics in Biomedical Science 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 LSM4225 Genetic Medicine in the Post-Genomic Era LSM4226 Infection and Immunity LSM4227 Stem Cell Biology LSM4228 Experimental Models for Human Disease and Therapy	Biomedical Science (BMS)	
	LSM4231 Structural Biology 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	Molecular and Cell Biology (MCB)	
	LSM4254 Principles of Taxonomy and Systematics LSM4255 Methods in Mathematical Biology LSM4261 Marine Biology LSM4262 Tropical Conservation Biology LSM4263 Field Studies in Biodiversity LSM4264 Freshwater Biology LSM4265 Urban Ecology LSM4266 Topics in Aquatic Biodiversity LSM4267 Animal Communications & Sensory Ecology	Environmental Biology (EVB)	

Summary of Requirements	B.Sc.	B.Sc. (Hons.)
University Requirements	20 MCs	20 MCs
Faculty Requirements	4 MCs*	8 MCs*
Major Requirements	64 MCs	96 MCs
Unrestricted Elective Modules	32 MCs	36 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:

i. 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.
ii. 4 MCs of non-LSM prefixed module from any subject group.

3.3.3.5 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 B.Sc. (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 B.Sc. or B.Sc. (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 the four modules in List I	16
Level-2000 (20-23 MCs)	2. Pass all the following modules: - MA2101/MA2101S Linear Algebra II - MA2108/MA2108S Mathematical Analysis I - MA2202/MA2202S Algebra I - MA2216/ST2131 Probability 3. Pass one additional module from List II, III, IV	36-39
Level-3000 (24-26 MCs)	4. Pass all the following modules: - MA3110/MA3110S Mathematical Analysis II - MA3111/MA3111S Complex Analysis I 5. Pass two modules from List MA3 6. Pass two additional modules from List III, IV	60-65
Level-4000 (36 MCs)	7. Pass MA4199 Honours Project in Mathematics 8. Pass four modules from List MA4 9. Pass two additional modules from List IV	96-101
UROPS	At most one Mathematics UROPS module may be used to fulfil the requirements of Major in Mathematics	

List I:
- MA1100 Fundamental Concepts of Mathematics
or
CS1231 Discrete Structures
- MA1101R Linear Algebra I
- MA1102R Calculus
- MA1104 Multivariable Calculus

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

List III:
- All MA modules at Level-3000, except MA3311 and MA3312
- CS3230 Design & Analysis of Algorithms
- CS4232 Theory of Computation
- CS3234 Logic and Formal Systems
- 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
- CS4236 Cryptography Theory and Practice
- CS5230 Computational Complexity
  CS5237 Computational Geometry and Applications
- 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	B.Sc.	B.Sc. (Hons.)
University Requirements	20 MCs	20 MCs
Faculty Requirements	4 – 12 MCs	4 – 16 MCs
Major Requirements	60 – 65 MCs	96 – 101 MCs
Unrestricted Elective Modules	36 – 23 MCs	40 – 23 MCs
Modules		
Total	120 MCs	160 MCs

Graduation Requirements (Applied Mathematics)

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

I. B.Sc. or B.Sc.(Hons.) with major in Applied Mathematics

Module Level	Major Requirements	Level MCs	Cumulative Major MCs
Level-1000 (20 MCs)	1. Pass the four modules in List I 2. Pass - CS1010/CS1010E/CS1010S/CS1010FC/CS1010X Programming Methodology	20	20
Level-2000 (20-23 MCs)	3. Pass all the following modules: - MA2101/MA2101S Linear Algebra II - MA2108/MA2108S Mathematical Analysis I - MA2213 Numerical Analysis I - MA2216/ST2131 Probability 4. Pass one additional module from List II, III, IV	20-23	40-43
Level-3000 (24-26 MCs)	5. Pass all the following modules: - MA3110/MA3110S Mathematical Analysis II - MA3111/MA3111S Complex Analysis I 6. Pass two modules from List AM3 7. Pass two additional modules from List III, IV	24-26	64-69
Level-4000 (36 MCs)	8. Pass MA4199 Honours Project in Mathematics 9. Pass four modules from List AM4 10. Pass two additional modules from List IV	36	100-105
UROPS	At most one Mathematics UROPS module may be used to fulfil the requirements of Major in Applied Mathematics		

II. B.Sc.(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 the 4 modules in List I 2. Pass CS1010/CS1010E/CS1010S/CS1010FC/CS1010X Programming Methodology	20	20
Level 2000	3. Pass all the following modules: - MA2101/MA2101S Linear Algebra II - MA2108/MA2108S Mathematical Analysis I - MA2213 Numerical Analysis I - MA2216/ST2131 Probability 4. Pass one additional module from List II, III, IV	20-23	40-43
Level 3000	5. Pass all the following modules: - MA3110/MA3110S Mathematical Analysis II - MA3111/MA3111S Complex Analysis I 6. Pass two modules from List AM3-MMDA 7. Pass two additional modules from List III, IV	24-26	64-69
Level 4000	8. Pass MA4199 Honours Project in Mathematics 9. Pass four modules from AM4-MMDA 10. Pass two additional modules from List IV	36	100-105
UROPS	At most one Mathematics UROPS module may be used to fulfil the requirements of Major in Applied Mathematics		

III. B.Sc.(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 the 4 modules in List I 2. Pass CS1010/CS1010E/CS1010S/CS1010FC/CS1010X Programming Methodology	20	20
Level 2000	3. Pass all the following modules: - MA2101/MA2101S Linear Algebra II - MA2108/MA2108S Mathematical Analysis I - MA2213 Numerical Analysis I - MA2216/ST2131 Probability	20-23	40-43

Module Level	Major Requirements	Level MCs	Cumulative Major MCs
	4. Pass one additional module from List II, III, IV		
Level 3000	5. Pass all the following modules: - MA3110/MA3110S Mathematical Analysis II - MA3111/MA3111S Complex Analysis I 6. Pass two modules from List AM3-ORFM 7. Pass two additional modules from List III, IV	24-26	64-69
Level 4000	8. Pass MA4199 Honours Project in Mathematics 9. Pass four modules from AM4-ORFM 10. Pass two additional modules from List IV	36	100-105
UROPS	At most one Mathematics UROPS module may be used to fulfil the requirements of Major in Applied Mathematics		

List I:

- MA1100 Fundamental Concepts of Mathematics or CS1231 Discrete Structures
- MA1101R Linear Algebra I
- MA1102R Calculus
- MA1104 Multivariable Calculus

List II:

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

List III:

- All MA modules at level 3000, except MA3311 and MA3312
- CS3230 Design & Analysis of Algorithms
- CS4232 Theory of Computation
- CS3234 Logic and Formal Systems
- 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
- CS4236 Cryptography Theory and Practice
- CS5230 Computational Complexity
- CS5237 Computational Geometry and Applications
- 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

AM4-ORFM

- MA4254 Discrete Optimization
- MA4260 Stochastic Operations Research
- MA4264 Game Theory
- MA4269 Mathematical Finance II

- ST4245 Statistical Methods for Finance

Summary of Requirements	B.Sc.	B.Sc. (Hons.)
University Requirements	20 MCs	20 MCs
Faculty Requirements	4 – 12 MCs	4 – 16 MCs
Major Requirements	64 – 69 MCs	100 – 105 MCs
Unrestricted Elective Modules	32 – 19 MCs	36 – 19 MCs
Total	120 MCs	160 MCs

3.3.3.6 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) Physics in Technology. 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
Level-3000 (20 MCs)	Pass PC3130 Quantum Mechanics II PC3193 Experimental Physics II And any three modules from the following electives: - PC3231 Electricity and Magnetism II - PC3232 Nuclear and Particle Physics - PC3233 Atomic and Molecular Physics I - PC3235 Solid State Physics I - PC3236 Computational Methods in Physics - PC3238 Fluid Dynamics	68

Module Level	Major Requirements	Cumulative Major MCs
	- PC3241 Solid State Devices - PC3242 Physics of Semiconductor Processing - PC3243 Photonics - PC3246 Astrophysics I - PC3247 Modern Optics - PC3251 Nanophysics - PC3267 Biophysics II - PC3274 Mathematical Methods in Physics II - PC3239 Special Problems in Undergraduate Physics II - PC3288 UROPS in Physics I^ - PC3289 Advanced UROPS in Physics II^ - MLE3101 Materials Characterisation - MLE3105 Dielectric and Magnetic Materials	
Level-4000 (32 MCs)	Pass PC4199 Honours Project in Physics And any five modules from the following electives: - PC4230 Quantum Mechanics III - PC4236 Computational Condensed Matter Physics - PC4240 Solid State Physics II - PC4241 Statistical Mechanics - PC4242 Electrodynamics - PC4243 Atomic and Molecular Physics II - PC4245 Particle Physics - PC4246 Quantum Optics - PC4248 General Relativity - PC4249 Astrophysics II - PC4253 Thin Film Technology - PC4259 Surface Physics - PC4262 Remote Sensing - PC4264 Advanced Solid State Devices - PC4265 Techniques for Computerised Experiments - PC4267 Biophysics III - PC4268 Biophysical Instrumentation and Biomolecular Electronics - PC4274 Mathematical Methods in Physics III - EE4401 Optoelectronics - EE4413 Low-dimensional Electronic Devices - MLE4201 Advanced Materials Characterisation# - MLE4204 Synthesis and Growth of Nanostructures# - MLE4205 Theory and Modelling of Materials Properties# - an approved module offered by other Departments	100

^ At most 4 MCs of UROPS 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	67 – 68 MCs	99 – 100 MCs
Unrestricted Elective Modules	24 – 25 MCs	32 - 33 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.

3.3.3.7 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:

a. Mathematical Theory and Tools
b. Statistical Tools
c. Computing Theory and Techniques
d. Financial Theory and Principles
e. 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 (24 MCs)	CS1010 / CS1010E / Programming Methodology CS1010S/ CS1010FC/ CS1010X CS1020 / Data Structures and Algorithms I CS1020E ACC1002 Financial Accounting MA1101R Linear Algebra I MA1102R Calculus MA1104 Multivariable Calculus	24
Level-2000 (20-22 MCs)	Pass FIN2004 Finance MA2213 Numerical Analysis I MA2216 / Probability ST2131 - MA2101 / Linear Algebra II MA2101S - MA2108 / Mathematical MA2108S Analysis I	44-46
Level-3000 (28 MCs)	Pass QF3101 Investment Instruments: Theory and Computation MA3269 Mathematical Finance I ST3131 Regression Analysis Two modules from the following: - CS3230 Designs and Analysis of Algorithms - MA3220 Ordinary Differential Equations - MA3236 Nonlinear Programming - MA3252 Linear and Network Optimisation - MA3264 Mathematical Modelling Two modules from the following: - FIN3101 Corporate Finance - FIN3103 Financial Markets - FIN3117 Bank Management - FIN3118 Financial Risk Management	72-74
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 - FIN4111 Research Methods in Finance - FIN4112 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	104-106

Summary of Requirements	B.Sc.	B.Sc. (Hons.)
University Requirements	20 MCs	20 MCs
Faculty Requirements	12 MCs*	12 MCs*
Major Requirements	72-74 MCs	104-106 MCs
Unrestricted Elective Modules	16 – 14 MCs	24-22 MCs

Summary of Requirements	B.Sc.	B.Sc. (Hons.)
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/undergrad.aspx?f=UP-QF#Application_Procedure for details regarding the admission requirements and the application form.

3.3.3.8 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, biostatistics is a specialization of statistics for quantitative research in the health sciences. The designs and analytic methods of biostatistics enable health scientists and professionals in academia, government, pharmaceutical companies, medical research organizations and elsewhere to efficiently acquire knowledge and draw valid conclusions from their ever-expanding sources of information.

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 Department's 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, regression analysis, and categorical data analysis. Honours students majoring in Statistics have the option to specialise in Biostatistics or in Finance and Business Statistics. The department has particular strengths in survival analysis, epidemiology, clinical trials and longitudinal data analysis for Biostatistics, and in time series analysis, statistical methods for actuarial science and finance, and data mining 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. The Chief Economist of Google has pointed out that "statistician is the dream job of the next decade." 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 or ST1232 Statistics for Life Sciences MA1101R Linear Algebra I MA1102R Calculus CS1010 Programming Methodology or CS1010E Programming Methodology or	16

Module Level	Major Requirements	Cumulative Major MCs
	CS1010S Programming Methodology or CS1010FC Programming Methodology or CS1010FX Programming Methodology	
Level-2000 (16-17 MCs)	Pass ST2131/ MA2216 Probability ST2132 Mathematical Statistics ST2137 Computer Aided Data Analysis MA2311 Techniques in Advanced Calculus or MA2108 Mathematical Analysis I or MA2108S Mathematical Analysis I (S)	32-33
Level-3000 (28 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	60-61
Level-4000 (36 MCs)	Pass ST4199 Honours Project in Statistics ST4231 Computer Intensive Statistical Methods ST4233 Linear Models - Two other modules from ST4xxx modules - Two additional modules from ST4xxx, ST5xxx or List B modules	96-97

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 Management Systems
CS3243 Introduction to Artificial Intelligence
CS3244 Machine Learning and Neural Networks
EC3304 Econometrics II

List B
MA4211 Functional Analysis
MA4229 Approximation Theory
MA4230 Matrix Computation
MA4233 Dynamical Systems
MA4254 Discrete Optimisation
MA4269 Mathematical Finance II
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
EC4303 Econometrics III

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

1. Biostatistics or
2. Finance and Business Statistics.

(A) To be awarded a specialisation in Biostatistics, a candidate must pass at least six modules (24 MCs) from the following, as part of the major requirements for B.Sc. (Hons.) with a primary major in Statistics:
ST3232 Design and Analysis of Experiments
ST3242 Introduction to Survival Analysis
ST3243 Statistical Methods in Epidemiology
ST3244 Demographic Methods

ST3245 Statistics in Molecular Biology
MA3259 Mathematical Methods in Genomics
ST4232 Nonparametric Statistics
ST4241 Design and Analysis of Clinical Trials
ST4242 Analysis of Longitudinal Data
ST4243 Statistical Methods for DNA Microarray Analysis

(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
ST3239 Survey Methodology
ST3240 Multivariate Statistical Analysis
ST4238 Stochastic Processes II
ST4240 Data Mining

Summary of Requirements	B.Sc.	B.Sc. (Hons.)
University Requirements	20 MCs	20 MCs
Faculty Requirements	8 MCs*	8 MCs*
Major Requirements	60 -61 MCs	96 - 97 MCs
Unrestricted Elective Modules	31-32 MCs	35-36 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/IT/CZ/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. Therefore, the pharmacist is specially trained to be knowledgeable in every aspect of drugs. The vast knowledge is multidisciplinary and 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 is a profession that is evolving continuously and new practices are introduced to provide better healthcare for people. If you are dedicated to helping the sick get well from the appropriate use of medicines and to promoting wellness and a healthy lifestyle, pharmacy will be a good choice of study. In addition, studying pharmacy may lead you to the exciting 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.

Pharmacy is a four-year programme and the degree B.Sc. (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 B.Sc. (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), 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 B.Sc. (Pharm.) or B.Sc. (Pharm.) (Hons.), candidates must satisfy the following:

Module Level	Major Requirements	Cumulative Major MCs
Faculty Requirement (16 MCs)	Pass AY1130 Human Physiology & Anatomy I PA1113 Basic Pharmacology PY1131 Human Physiology & Anatomy II PX2108 Basic Human Pathology	16
Level-1000 (20 MCs)	Pass PR1110 Foundations for Medicinal Chemistry PR1111 Pharm Biochemistry PR1120 Microbiology for Pharmacy PR1140 Pharmacy Professional Skills Development I PR1142 Pharm Statistics	36
Level-2000 (30 MCs)	Pass 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 I PR2135 Pharmacotherapeutics II PR2143 Pharmaceutical Analysis for Quality Assurance	66
Level-3000 (40 MCs)	Pass PR3123 Formulation & Technology II PR3116 Concepts in Pharmacokinetics and Biopharmaceutics PR3122 Self Care II PR3124 Pharmacotherapeutics III PR3117 Formulation & Technology III 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	106
Level-4000 (26 MCs)	Pass PR4138 Pharmacy Professional Skills Development IV PR4197 Pharmacy Internship I PR4198 Pharmacy Internship II PR4196 Pharmacy Research Project and Scientific Communication	132

Summary of Requirement	B.Sc. (Pharm.)/B.Sc. (Pharm.) (Hons.)
University Requirement	20 MCs

Summary of Requirement	B.Sc. (Pharm.)/B.Sc. (Pharm.) (Hons.)
Faculty Requirements	16 MCs
Major Requirement	116 MCs
Unrestricted Elective Modules	8 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

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 and ST2131/MA2216 can be used to satisfy both major and minor requirements.
Major in Mathematics/Applied Mathematics and Minor in Statistics	Only MA1102R and ST2131/MA2216 can be used to satisfy both major and minor requirements.
Major in Statistics and Minor in Mathematics	Only MA1102R and ST2131/MA2216 can be used to satisfy both major and minor requirements
Major in Statistics and Minor in Financial Mathematics	Only MA1102R and ST2131/MA2216 can be used to satisfy both major and minor requirements.

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. Life Sciences	H2 passes or equivalent in Biology, Chemistry AND either Mathematics or Physics
3. Mathematics	H2 pass in Mathematics or equivalent
4. Physics	H2 pass in Physics or equivalent
5. Statistics	H2 pass in Mathematics or equivalent

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 B.Sc. 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 any three (3) modules from the following: CM2101 Physical Chemistry 2 CM2111 Inorganic Chemistry 2 CM2121 Organic Chemistry 2 CM2142 Analytical Chemistry 1 Pass any one module from the following: CM2191 Experiments in Chemistry 2 CM2192 Experiments in Chemistry 3	32
Level-3000 (16 MCs)	Pass CM3291 Advanced Experiments in Inorganic and Organic Chemistry or CM3292 Advanced Experiments in Analytical and Physical Chemistry and three (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 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 LSM1101 Biochemistry of Biomolecules LSM1102 Molecular Genetics LSM1103 Biodiversity LSM1104 General Physiology	16
Level 2000 (16 MCs)	Pass LSM2101 Metabolism and Regulation LSM2102 Molecular Biology LSM2103 Cell Biology LSM2191 Laboratory Techniques in Life Sciences	32
Level 3000 (16 MCs)	Pass four LSM32XX elective modules (except LSM3289), one of which may be a LSM recognised elective module (up to 4MCs).	48

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

3.4.2.3 Second Major in Mathematics

Host Department: Mathematics

Students with strong interest in mathematics but majoring in other disciplines such as computer science, economics/ business, engineering, physics or statistics, are encouraged to take up a second major in mathematics. This programme offers a broad-based education in mathematics and covers the same nine core mathematics modules as in the primary major in mathematics/applied mathematics. The three more elective modules in the requirements, from a list of interdisciplinary subjects, allow flexibility and ample scope for the student to design a programme which complements his/her primary major and other interests

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

Module Level	Second Major Requirements	Cumulative Major MCs
Level-1000 (16 MCs)	Pass MA1100 Fundamental Concepts of Mathematics or CS1231 Discrete Structures MA1101R Linear Algebra I or MA1506 Mathematics II or MA1508 Linear Algebra with Applications MA1102R Calculus or MA1505 Mathematics I or MA1507 Advanced Calculus or MA1521 Calculus for Computing MA1104 Multivariable Calculus or MA2501 Differential Equations and Systems	16
Level-2000 (16 – 19 MCs)	Pass MA2101/ MA2101S Linear Algebra II MA2108/ MA2108S Mathematical Analysis I MA2216/ ST2131 Probability One additional module from List II, III, IV	32 – 35
Level-3000 & Level-4000 (16 – 18 MCs)	Pass MA3110/ MA3110S Mathematical Analysis II MA3111/ MA3111S Complex Analysis I Two additional modules from List III, IV	48 – 53

List II:

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

List III:

- All MA modules at Level-3000, except MA3311 and MA3312
- CS3230 Design & Analysis of Algorithms
- CS4232 Theory of Computation
- CS3234 Logic and Formal Systems
- 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
- CS4236 Cryptography Theory and Practice
- CS5230 Computational Complexity
- CS5237 Computational Geometry and Applications
- EC4301 Microeconomics Analysis III
- EC5104 Mathematical Economics
- PC4248 Relativity
- PC4274 Mathematical Methods in Physics III
- ST4238 Stochastic Processes II

This second major is not offered with a primary major in Applied Mathematics, Mathematics or Quantitative Finance 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/undergrad.aspx?f=FAQ-2major.

3.4.2.4 Second Major in Physics

Host Department: Physics

To be awarded a B.Sc. with 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 one from the following: PC2132 Classical Mechanics PC2230 Thermodynamics and Statistical Mechanics	32
Level-3000 (16 MCs)	Pass Any four from the following PC3130 Quantum Mechanics II PC3193 Experimental Physics II PC3231 Electricity and Magnetism II PC3232 Nuclear and Particle Physics PC3246 Astrophysics I PC3274 Mathematical Methods in Physics II PC3233 Atomic and Molecular Physics I PC3235 Solid State Physics I PC3236 Computational Methods in Physics PC3238 Fluid Dynamics PC3241 Solid State Devices PC3242 Physics of Semiconductor Processing| PC3243 Photonics PC3267 Biophysics II PC3247 Modern Optics PC3251 Nanophysics PC3239 Special Problems in Undergraduate Physics	48

This second major is not offered with a primary major in Physics or 'Physics and Life Sciences' 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.

3.4.2.5 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

Module Level	Second Major Requirements	Cumulative Major MCs
Level-1000 (16 - 17 MCs)	Pass ST1131 Introduction to Statistics or ST1232 Statistics for Life Sciences MA1101R Linear Algebra I or MA1506 Mathematics II or MA1508 Linear Algebra with Applications MA1102R Calculus or MA1505 Mathematics I or MA1507 Advanced Calculus or MA1521 Calculus for Computing CS1010 Programming Methodology or CS1010E Programming Methodology or CS1010S Programming Methodology or CS1010FC Programming Methodology or CS1010X Programming Methodology	16
Level-2000 (16 MCs)	Pass ST2131/ Probability MA2216 ST2132 Mathematical Statistics ST2137 Computer Aided Data Analysis MA2311 Techniques in Advanced Calculus or MA2108 Mathematical Analysis I or MA2108S Mathematical Analysis I (S)	32 – 33
Level-3000 & Level-4000 (16 MCs)	Pass ST3131 Regression Analysis - Three other modules from ST32xx or ST4xxx modules	48 – 49

This second major is not offered with a primary major 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/opencms/currentstudents/cs_ugradfaq.html#course.

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 and 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 and subject to Departmental approval.

Minor	Prerequisites
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: PC1144 Introduction to Modern Physics PC1432 Engineering Physics PC2232 Physics for Electrical Engineers PC2130B Applied Quantum Mechanics
10. Nanoscience	H2 pass or equivalent in Chemistry or Physics
11.Optical & Semiconductor Technology 12.Physics	H2 pass in Physics or equivalent
13. Pharmaceutical Sciences	• 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.
14.Engineering Materials	H2 pass or equivalent in Chemistry or Physics

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
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.

3.4.3.2 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. LSM1103 Biodiversity
2. LSM2251 Ecology and Environment
3. GE2229 Water and Environment
4. SP3203 Aquatic Ecology Research
5. Choose 2 from the following elective modules:
    - 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
- GEK1548 How the Ocean Works
- LSM3254 Ecology of Aquatic Environments
- LSM3264 Environmental Biochemistry
- LSM4261 Marine Biology
- LSM4264 Freshwater Biology
- LSM4266 Topics in Aquatic Biodiversity

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

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:

<u>For students undertaking a major in Life Sciences</u>

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

To satisfy the Minor in Engineering Materials, students must read materials-related modules equivalent to at least 24 MCs, including the 8 MCs earned from the two core modules [(MLE1101 or ME2151) and MLE2101)], and at least two advanced elective modules (Level-3000 and Level-4000). In addition, they have to select one of three tracks offered, namely, Biomedical and Polymeric Materials, Electronic Materials, and Structural Materials. Modules to be taken, other than the core modules, must be selected from the basket of modules listed under the appropriate track:

Module	Module Title	Level
Biomedical and Polymeric Materials Track		
BN3301	Introduction to Biomaterials	Fundamental
BN4301	Principles of Tissue Engineering	Advanced

Module	Module Title	Level
CN4203	Polymer Engineering	Fundamental
CM3264	Petroleum and Industrial Organics	Advanced
CM4262	Advanced Materials Characterisation Techniques	Advanced
CM4264	Speciality Polymers: Synthesis, Characterisation and Applications	Advanced
MLE3104	Polymeric and Composite Materials	Fundamental
MLE4202	Selected Advanced Topics on Polymers	Advanced
MLE4203	Polymeric Biomedical Materials	Advanced
ME4253	Biomaterials Engineering	Advanced
Electronic Materials Track		
CM3263	Chemistry of Semiconductors	Advanced
CN4216	Electronic Materials Science	Fundamental
CN4217	Processing of Microelectronic Materials	Fundamental
CN4223	Microelectronic Thin Films	Advanced
CN4224	Transport Phenomena in Electronics Processing	Advanced
EE3406	Microelectronic Materials	Advanced
EE4411	Silicon Processing Technology	Advanced
EE4414	Magnetic Materials and Devices for Information Storage	Advanced
MLE2105	Electronic Properties of Materials	Fundamental
MLE3105	Dielectric and Magnetic Materials	Fundamental
MLE4207	Growth Aspects of Semiconductors	Advanced
PC3235	Solid State Physics 1	Advanced
PC3241	Solid State Devices	Advanced
PC3242	Physics of Semiconductor Processing	Advanced
PC4240	Solid State Physics 2	Advanced
PC4253	Thin Film Technology	Advanced
PC4264	Advanced Solid State Devices	Advanced
PC4259	Surface Physics	Advanced
Structural Materials Track		
CE2164	Structural Design and Materials	Fundamental
CE3166	CE Materials and Structural Steel Systems	Fundamental
CE5604	Advanced Concrete Technology	Advanced
ME3251	Materials for Engineers	Fundamental
ME4251	Thermal Engineering of Materials	Advanced
ME4254	Materials in Engineering Design	Advanced
ME4255	Materials Failure	Advanced
MLE2102	Thermodynamics and Phase Diagrams	Fundamental
MLE2104	Mechanical Properties of Materials	Fundamental
MLE2106	Metallic Materials and Processing	Fundamental
MLE2107	Ceramic Materials and Processing	Fundamental
PC4259	Surface Physics	Advanced

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.eng.nus.edu.sg/minor/materials/

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 the following six modules:

1. (MA1102R or MA1505 or MA1507 or MA1521) and (MA1104 or MA1506 or MA1508); and
2. MA2216/ST2131; and
3. MA3269 and (QF3101 or FIN3102 [for BIZ students]) ; and ST3131

Titles of the above modules are as listed below:
MA1102R Calculus
MA1104 Multivariable Calculus
MA1505 Mathematics I
MA1506 Mathematics II
MA1507 Advanced Calculus
MA1508 Linear Algebra with Applications
MA1521 Calculus for Computing
MA2216/ST2131 Probability
MA3269 Mathematical Finance I
QF3101 Investment Instruments: Theory and Computation
FIN3102 Investment Analysis and Portfolio Management
ST3131 Regression Analysis

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

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
    - 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 ofcertain activities, mitigating environmental hazards and assessing theimplications ofenvironmental 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 landuse.

Please refer to the FASS AY2015/16 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. LSM1101 Biochemistry of Biomolecules
    b. LSM1102 Molecular Genetics
    c. LSM1103 Biodiversity
    d. LSM1104 General Physiology
2. Pass two modules from the following:
    a. LSM2101 Metabolism & Regulation
    b. LSM2102 Molecular Biology
    c. LSM2103 Cell Biology
3. Two LSM32XX modules except LSM3288 and LSM3289.

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

Application is required to read this minor. For the application process and more information, please refer to http://www.lifesciences.nus.edu.sg.

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 six non-overlapping modules of the following type:

1. Any two of the following modules:
    a. MA1xxx modules except MA1301/MA1301X
    b. CS1231
2. Any two MA2xxx modules
3. 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 Applied Mathematics, Computational/Quantitative Finance, Mathematics and second major in Mathematics or Financial Mathematics.

3.4.3.10 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. LSM1104 General Physiology
3. LSM1401 Fundamentals of Biochemistry
4. LSM2103 Cell Biology
5. LSM4243 Tumour Biology
6. LSM3223 Immunology
7. LSM3243 Molecular Biophysics
8. 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 UROPS]*
      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 is undergoing a phase of expansion, as more pharmaceutical and biopharmaceutical companies set up new manufacturing and research facilities here. Along with these expansion plans, manpower with relevant knowledge and skills will be sought by 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 phase.

The Minor in Pharmaceutical Sciences will therefore help 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 offered by the Department of Pharmacy. Some modules have practical component that will allow students to acquire relevant basic laboratory skills.

Essential modules:
PR1101 or PR1110 Physicochemical Principles of Drug Action OR Foundations for Medicinal Chemistry
PR1102 or PR2114 Physical Pharmacy OR Formulation and Technology I
PR3101 or PR2115 Principles of Medicinal Chemistry OR 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 in 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 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 & Magnestism
    - 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

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
    - PC2230 Thermodynamics and Statistical Mechanics
    - PC2193 Experimental Physics I
    - PC3130 Quantum Mechanics II
    - PC3193 Experimental Physics II
    - PC3231 Electricity and Magnetism II
    - PC3232 Nuclear and Particle Physics
    - PC3233 Atomic and Molecular Physics I
    - PC3235 Solid State Physics I
    - PC3236 Computational Methods in Physics
    - PC3238 Fluid Dynamics
    - PC3243 Photonics
    - PC3246 Astrophysics I
    - PC3247 Modern Optics
    - PC3251 Nanophysics
    - PC3274 Mathematical Methods in Physics II
    - PC4130 Quantum Mechanics III
    - PC4236 Computational Condensed Matter Physics
    - PC4240 Solid State Physics II
    - PC4241 Statistical Mechanics
    - PC4242 Electrodynamics
    - PC4243 Atomic and Molecular Physics II
    - PC4245 Particle Physics
    - PC4246 Quantum Optics
    - PC4248 General Relativity
    - PC4249 Astrophysics II
    - PC4274 Mathematical Methods in Physics III
    - PC4259 Surface Physics
    - PC4262 Remote Sensing

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. 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, DSC3215 Stochastic Models in Management, FIN3116 Options and Future, FIN3119 Risk and Insurance, MA3259 Mathematical Methods in Genomics and LSM3241 Bioinformatics and Biocomputing.

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

3.4.4 Chemical Sciences Programme

The NUS Chemical Sciences programme is jointly offered by the Department of Chemical & Biomolecular Engineering and the Department of Chemistry in consultation with the Faculty of Engineering, Faculty of Science and the Life Sciences programme.

The objective of this programme is to provide students with a strong and broad foundation in the Life and Chemical Sciences so that while pursuing their undergraduate studies, they are also prepared to progress to a graduate programme and research in interdisciplinary areas such as medicinal chemistry, and other Life Sciences-related graduate programmes approved by NUS graduate school.

Programme Structure and Curriculum Rationale

This course of study is designed specifically for top students from the GCE 'A' Level cohorts, who would have gained entry to read Chemical Engineering or Chemistry as their major, and have keen interest in and the aptitude to pursue graduate research related to Medicinal Chemistry, and other NGS-approved Life Sciences-related programmes.

This four-year programme augments the existing undergraduate Chemistry major programme with adequate Life Sciences and process -related components so as to provide a firm interdisciplinary foundation for Medicinal Chemistry research at the graduate level.

Cohorts will be admitted as Chemistry majors. They will be required to fulfil all course/modular requirements under the Chemistry programme. The major content will comprise 20 Chemistry modules and the Chemistry Honours year project (or about 55 percent of the total course content). In addition, they will need to read three Chemical Engineering and ten Life Sciences modules, and one Life Sciences related module, as conditions for the receipt of the A*Star scholarship. These additional modules outside Chemistry major modules are placed under the University, Faculty and unrestricted module requirements under the NUS degree structure. Students who complete the requirements of this programme will also be awarded a minor in Life Sciences.

Summary of module requirements and credits for cohort matriculated in AY2003/04 and later – B.Sc. (Hons.) (major in Chemistry with a minor in Life Sciences) under the A*STAR pre-graduate award (PGA) for the Chemical Sciences programme:

Modular Requirements	MCs
University Requirements	**20**
General Education modules	20
Faculty Requirements	**16**
Elective modules from at least two distinct subject groups outside the subject group of mathematical and statistical sciences (where 4 MCs may come from the subject group of chemical sciences but not having the CM prefix) (4 MCs to be satisfied by LSM1101; students need to only take 2 more elective modules)	12
MA1421 or any non-bridging MA module	4
English Skills*	0
Major Requirements‡	**100**
CM1191 Experiments in Chemistry 1	4
CM1111 Basic Inorganic Chemistry	4
CM1121 Basic Organic Chemistry	4
CM1131 Basic Physical Chemistry	4
CM2101 Physical Chemistry 2	4

Modular Requirements	MCs
CM2111 Inorganic Chemistry 2	4
CM2121 Organic Chemistry 2	4
CM2142 Analytical Chemistry 1	4
CM2191 Experiments in Chemistry 2	4
CM2192 Experiments in Chemistry 3	4
Level-3000 modules (excluding CMxx6x modules):	24
CM3291 Inorganic & Organic Laboratory CM3292 Analytical and Physical Laboratory CM3221 Organic Synthesis & Spectroscopy CM3222 Organic Reaction Mechanisms and Two more Level-3000 or above CM modules	
CM4199A Honours Project in Chemistry	16
Level-4000 CM & LSM modules:	20
CM42xx Any other Level-4000 elective CM4227 Chemical Biology CM4228 Catalysis LSM4211 Toxicology LSM4221 Drug Discovery & Clinical Trials	
Unrestricted Elective Modules The following modules must be taken: CN2121, CN2116, LSM2101, LSM2102, LSM2103, LSM2201A/LSM2202A, LSM3211 and LSM3231 (LSM1101 can be replaced by LSM1401)	32
Total	**168**

* For students who fail to meet the exemption criteria based on their QET results at the time of admission to the Faculty.

‡ Review of PGAs done upon completion of year one and subsequent years of studies. Candidates with CAP falling below 4.0 will be advised to revert to the normal Chemistry track.

Suggested Study Plan for Chemical Sciences:

Semester 1 (24 MCs)
GEMxxxx General Education
GEMxxxx General Education
GEMxxxx General Education
CM1131 Physical Chemistry 1
CM1111 Inorganic Chemistry 1
LSM1301 General Biology (if H2 Biology was not taken)
MA1421 Basic Applied Mathematics for Sciences

Semester 2 (20 - 24 MCs)
GEMxxxx# General Education
CM1121 Organic Chemistry 1
CM1191 Experiments in Chemistry 1
LSM1101 Biochemistry of Biomolecules
LSM1102 Molecular Genetics
CN1111 Chemical Engineering Principles

Semester 3 (24 MCs)
CM2101 Physical Chemistry 2
CM2111 Inorganic Chemistry 2
CM2191 Experiments in Chemistry 2
LSM2101 Metabolism & Regulation
CN2121 Chemical Engineering Thermodynamics
GEMxxxx General Education

Semester 4 (20 MCs)
CM2121 Organic Chemistry
CM2192 Experiments in Chemistry 3
CM2142 Analytical Chemistry
LSM2102 Molecular Biology
LSM2103 Cell Biology

Semester 5 (20 MCs)
CM3221 Organic Synthesis & Spectroscopy
CM3222 Organic Reaction Mechanisms
CM3292^ Analytical & Physical Lab.
LSM2201A/ Experimental Biochemistry (4 MCs) or
LSM2202A Experimental Molecular and Cell Biology (4 MCs)
LSM3211 Fundamental Pharmacology

Semester 6 (20 MCs)
CM3291^ Inorganic & Organic Lab.
CM3xxx (Elective) - 1
CM3xxx (Elective) - 2
LSM3231 Protein Structure & Function
CN2116 Chemical Kinetics & Reactor Design

Semester 7 (24 MCs)
CM4199A+ Honours Project in Chemistry (16 MCs)
CM4223 Asymmetric Synthesis
LSM4211 Toxicology

Semester 8 (16 MCs)
CM42xx Any other Level-4000 Elective
CM4222 Advanced Organic Synthesis & Spectroscopy
LSM4221 Drug Discovery & Clinical Trials
PR5212 Advanced Topics in Medicinal Chemistry

* Need to be taken if not taking LSM1301
# Not necessary if completing two GEMs in first semester
^ Option to read module in Special term after Semester 4
+ One-year honours project

Total MCs = 168 (if student has H2 Biology)
Total MCs = 172 (if student has no H2 Biology) (instead of the minimal MC of 160 for B.Sc. (Hons.))

3.4.5 Double Degree Programmes in Materials Science and Engineering (B.Eng.) and Physics [B.Sc./B.Sc. (Hons.)]

This double degree programme aims to provide a science-driven, engineering-oriented education to both science and engineering students. Why? Understanding the physics underlying material properties and their technological applications will be vital to the development of future technological innovations.
For more information, please refer to the URL http://www.physics.nus.edu.sg/student/double_deg_MSEPhysics.html and Section R of Part II of the Bulletin.

3.4.6 Double Degree Programmes in Law (LL.B.) and Life Sciences [B.Sc./B.Sc. (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.

3.4.7 Double Degree Programmes in Computing (B.Comp.) and Mathematics [B.Sc./B.Sc. (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 and "Other Multidisciplinary / Special Programmes" of the Bulletin.

3.4.8 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.

3.4.9 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.

3.4.10 Concurrent M.Sc. (Mgt.) and B.Sc. (Hons.) / B.Appl.Sc. (Hons.)

More information on this concurrent degree programme is available at "Other Multidisciplinary / Special Programmes" of the Bulletin.

3.4.11 Concurrent Programme in B.Sc. (Hons.) in Life Sciences – M.Res. 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 Section R of Part II of the Bulletin.

3.4.12 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)

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://www.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 (with the exception

of Food Science and Technology majors) the opportunity to perform structured internship in an organisation during their undergraduate study. This elective programme allows students to engage actively in career preparation and job seeking exercises, hone their interpersonal, communications and other soft skills, and experience day-to-day working professional life. Students will be presented the challenges of competing and securing a job position in the organisation, applying their discipline-related knowledge and professionalism in a working environment, and thus acquiring experiential learning that complements their course activity.

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

16 MCs (SP2173, SP2174, SP3175 and SP3176) of the above SPS curriculum may go towards fulfilling the Faculty requirements. Students who have passed SP2173, SP2174, SP3175 and SP3176 are deemed to have completed 16 MCs of the Faculty Requirement from 3 distinct subject groups outside the group under which their major falls. Students who may have part of their Faculty Requirements fulfilled by modules within their majors can use the remaining MCs as Unrestricted Electives.

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) and Lim Zhi Han (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 UROPS in the second semester would result in a "F" grade.

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

For students taking UROPS in Special Terms, the UROPS 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).

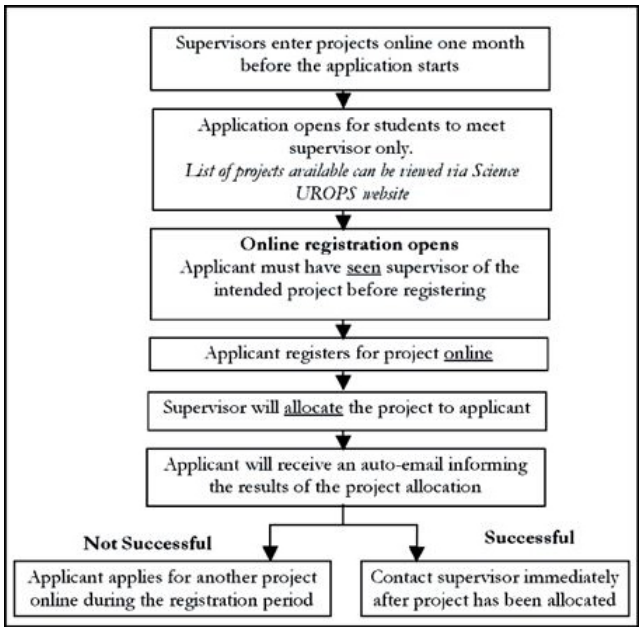
Project Duration: One semester (4 MCs)
Students undertaking a one-semester long project will register online for a 4 MCs UROPS module (i.e. XX2288 or XX3288). Students will be evaluated at the end of the semester and receive a grade for the module.

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:



	Semester 1 of AY2015/16*	**Semester 2 of AY2015/16***
Application opens for students to meet supervisors	1 Jun – 30 Jun 2015	16 Nov – 23 Dec 2015
Online Registration (UROPS Only)	3 Jul – 10 Jul 2015	26 Dec – 29 Dec 2015
Start UROPS project	13 Jul 2015	23 Dec 2015

	Semester 1 of AY2015/16*	Semester 2 of AY2015/16*
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	

	Special Term of AY2015/16*
Students from Partner Universities to liaise with supervisors and obtain email confirmation from supervisors	15 Feb 2016
Students from Partner Universities register online via Non-Graduating application system For more information, please refer to Summer UROPS website	1 Mar 2016
Application opens for NUS Science students to liaise with supervisors	21 Mar – 4 Apr 2016
Online Registration at student intranet (only for NUS Science students)	10 Apr – 22 Apr 2016
If application is successful, contact supervisor and start UROPS If application is unsuccessful, liaise and apply for another project	8 May 2016
Drop with “W” (4 or 8 MCs)	Refer to Special Term information in Registrar's Office website for AY14/15 Special Term Part 1
Drop with “F” (4 or 8 MCs)	Refer to Special Term information in Registrar's Office website for AY14/15 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 UROPS 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), UROPS modules cannot be read in fulfilment of the major requirement.
2. For all other majors, UROPS 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 UROPS modules may be read in fulfilment of the Chemistry major requirements.
Computational Biology	Only 4 MCs from Level-3000 ZB UROPS modules may be read in fulfilment of the Computational Biology major requirements.
Food Science and Technology (FST)	Only 4 MCs from Level-3000 FST UROPS 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 UROPS 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 UROPS modules may be read in fulfilment of the Mathematics/Applied Mathematics major requirements.

Majors	Fulfilling Major Requirements
Physics (PC)	Only 4 MCs from Level-3000 PC UROPS 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 website: http://www.science.nus.edu.sg/undergraduate-studies/ugenh/enhance-usp

3.6 Study Abroad Programmes

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 to be able to provide for your own airfare, accommodation and living expenses.
5. have completed the SP1541/ES14541 module before embarking for SEP

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

For more details on the Student Exchange Programme, log on to:
http://www.nus.edu.sg/iro/, https://share.nus.edu.sg/registrar/student/info/Admin-Details-SEP.pdf and
http://www.science.nus.edu.sg/undergraduate-studies/ugsap/ugsap-out/sep
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), the University of California, Los Angeles (UCLA), University of Costa Rica (UCR), Hokkaido University (HU), University of Copenhagen (KU) and The Hong Kong University of Science & Technology (HKUST), to jointly offer Summer Programmes for each university's students. This four-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 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 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/opps/summer/index.html.

3.6.3 Joint Minor Programme with University of Toronto (UofT)

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://www.overseas.nus.edu.sg/

3.6.5 University of North Carolina, Chapel Hill Summer Lab

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://www.science.nus.edu.sg/undergraduate-studies/ugsap/ugsap-out/fddp

3.7 Student Awards

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 and the top 7 percent of the Pharmacy students 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:

• Includes at most one General Education module/ Module taken outside Faculty of Science with Satisfactory/Unsatisfactory option;
• At least 15MCs for Science students and 16MCs for Pharmacy students must be letter-graded;
• Excludes modules ES1000/ES1000FC and ES1102;
• 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: ∑(Grade Point* MCs)/∑ (MCs)

The computation of SAP for the Dean's List:
• Excludes modules ES1000/ES1000FC and ES1102; and

• Allows students to receive the full contribution to SAP from their 8 MCs UROPS and Honours project modules in the second semester.

- 4 Graduate Education
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      - 4.2.2.4 Master of Science in Mathematics (Part-Time or Full-Time)
      - 4.2.2.5 Master of Science in Pharmaceutical Sciences and Technology
      - 4.2.2.6 Master of Science in Physics (Part-Time or Full-Time)
      - 4.2.2.7 Master of Science in Quantitative Finance (Part-Time or Full-Time)
      - 4.2.2.8 Master of Science in Statistics (Part-Time or Full-Time)
      - 4.2.2.9 Joint Masters of Science in Industrial Chemistry (NUS & TUM)
      - 4.2.2.10 Masters of Science in Science Communication
      - 4.2.2.11 Doctor of Pharmacy (PharmD)

4 Graduate Education

4.1 Research Programmes

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

Admission Requirements

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 Scholarship

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

Entry Requirements

1. 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.
2. 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.
3. 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.
4. 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.
5. The minimum and maximum period of candidature is as follows:

Graduate Programme (leading to)	Minimum	Maximum
M.Sc.	1 year	3 years
Ph.D.	2 years	5 years

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

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.

Course Requirements

1. Coursework
   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).
2. 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.

3. Any other additional requirements may be specified by the respective departments.

Continuation Requirements

1. 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.
2. 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.
3. Termination of candidature will result if a student fails to maintain the minimum CAP.

4.1.2.1 Ph.D. Programme in Medicinal Chemistry

(I) Programme Objectives
The Departments of Chemistry, Pharmacy and Biological Sciences of Faculty of Science, Pharmacology of YLLSoM, and Chemical and Biomolecular Engineering of Faculty of Engineering at the National University of Singapore, in collaboration with research institutes and local pharmaceutical companies, propose a graduate programme in Medicinal Chemistry to be implemented in support of the R&D needs of the pharmaceutical industry.

Medicinal Chemistry is an interdisciplinary research area incorporating Synthetic Organic Chemistry, Lead Optimisation, Pharmacology, Molecular Biology, Computer-aided Drug Design and Toxicology.

The aim of this programme is to provide graduate students with an integrated broad-based training in the various disciplines related to Medicinal Chemistry, including the most advanced research methodology in Organic Synthesis and the Biomedical Sciences

(II) Programme Rationale
The rationale for this programme is based on the following considerations:

Life Sciences Initiative in Singapore
Under the Singapore Industry 21 blueprint, the nation intends to create world-class capabilities across the whole value-added chain of Life Sciences activities and to develop Life Sciences as the fourth pillar of the manufacturing sector alongside Electronics, Chemicals and Engineering.

In view of these national ambitions and the expected growth in the Life Sciences Industry, there is a need for an integrated chain of expertise right across the spectrum, from basic research and development, product and process development, full-scale manufacturing, to clinical research and biotechnology. Trained researchers and chemists with a good knowledge of organic synthesis would also be needed to build a strong R&D foundation to sustain the long-term growth of this industry in Singapore.

Expansion of the Pharmaceutical Industry
The pharmaceuticals sector represents a major stalwart under the EDB Life Sciences Cluster map. To date, Singapore has established itself as a manufacturing base for the pharmaceuticals sector with multinationals such as Aventis, GlaxoWellcome, SmithKline Beecham, Kaneka, Schering-Plough and other pharmaceutical companies either have comprehensive operating facilities or assured their strong investment in Singapore.

Singapore aims to be home to 15 multinational Life Sciences companies by 2010 and the regional centre for clinical trials and drug development. One of the key challenges is to encourage world-class pharmaceutical companies to set up and carry out Research & Development (R&D) work in Singapore. A main consideration for such companies in deciding to locate/relocate R&D activities here would be the presence of a critical mass of appropriately trained R&D personnel within Singapore. On the basis of numerous dialogues and feedbacks from EDB and pharmaceutical firms, R&D personnel specially trained in Analytical Chemistry, Organic Synthesis and Combinatorial Chemistry at the graduate M.Sc. / Ph.D. level are amongst those in greatest demand. The current anticipated output level of trained manpower in this respect is however definitely inadequate for the intended pharmaceutical R&D efforts in Singapore.

(III) Programme Planning

Figure 1: Flow Chart for Drug Discovery & Development

Drug discovery and development of novel pharmaceutical/medicinal products (before actual clinical trials) is a rigorous and lengthy endeavour that involves talents from various fields of science and medicine. Figure 1 above depicts an overview of the process, which cover four main phases:
(a) Therapeutic targets identification: This involves motif discovery and analysis for families and subfamilies of therapeutic targets and understanding of their mechanism of action.
(b) Lead selection: This process involves the organic synthesis of classes of compounds, determining the biological signals produced by a given target and assessing the affinity and selectivity of the most powerful compound(s) (“hits”) for these targets. Development and implementation of assays for screening of active ingredients and/or metabolites would be required via combinatorial technology.
(c) Lead optimisation: This entails the assessment of the compound's chemical stability, bioavailability, pharmacokinetics, pharmaceutical formulation, acute toxicity, structure-activity relationships (SAR), molecular modelling of drugs etc.
(d) Pre-clinical tests: This stage essentially involves the testing of potential drugs on animals. Apart from assessing their viability, suitable formulations are also developed for human application and sufficient quantities of the compound are prepared to support further clinical trials.

In view of the demands listed in each step of the process, a singular Ph.D. programme in support of the whole drug discovery & development chain by the various departments (mentioned earlier) has to be established. A M.Sc. programme is considered to be too short without adequate training to serve the highly research-oriented purposes of the pharmaceutical R&D.

The overall curriculum is normally a four-year programme, with a possible extension to four-and-a-half years:
two to three semesters: Five course-based modules; one experiment-based module
six to seven semesters: Research specialisation/Thesis (with at one to two semesters of attachment to Industry/ Research Institute)

(IV) Integrated Broad-based Course Requirement
Students are required to read appropriately-designed modules so that they will gain sufficient oversight to the whole drug discovery and development chain. Candidates will be required to do all the five courses. Coursework will normally be completed within the first year of study.

The following areas are considered essential:

(a) BN5103 Advanced Molecular Biology (4 MCs)*

This module focusses on cell functions at the molecular level, the molecular recognition that forms the basis of cell signalling networks that are used in various organisms to regulate their responses to extra-cellular and intracellular stimuli. A basic understanding of the mechanism of these protein-protein interactions should provide key insights on how a specific pathway can be inhibited or modulated as targets for the rational design and development of therapeutics in applied biotechnology.
This is an existing module offered by the Division of Bioengineering. - Please refer to the Faculty of Engineering for module details.
*Students with B.Sc. (Hons.) in Life Sciences admitted to the Medicinal Chemistry Programme have to take one of the following modules in place of BN5103: BL5201 (Structural Biology and Proteomics), BL5202A (Biophysical Methods in Life Sciences) or BL5203 (Molecular Recognition and Interactions).

(b) PR5212 Advanced Topics in Medicinal Chemistry (4 MCs)
This module gives an overview of drug development process which focusses on the use of high throughput bioassays and structural activity relationship studies for identification of potential lead compounds from natural products (plant extracts, toxins, proteins) for the purpose of drug development. It will cover the principles of high throughput screening of natural products; characterisation of potential ligands; application of principles in medicinal chemistry for enhancing the drug-like property of isolated natural products and identification of appropriate lead structures to be used as templates for combinatorial synthesis, to explore the relationship between molecular diversity and pharmacological action.

(c) CM5221 Advanced Organic Synthesis (4 MCs)
This module covers topics in biomimetic reactions, the application of organometallics to organic synthesis, synthesis of complex molecules, and other emerging areas in organic synthesis. Students will be required to write a proposal and a review on a topic related to organic synthesis. Topics covered include: parallel organic synthesis, solution, liquid and polymer-supported syntheses, strategies in combinatorial synthesis, library design, analytical methods and screening, and the applications of combinatorial chemistry. Bead technology and methods of deconvolution of lead compounds will be included.

(d) CM5236 Computer-Aided Drug Design (4 MCs)
The principles of computer-aided drug design are covered as well as the basic concepts of molecular modelling, molecular mechanics, molecular orbital method, conformational analysis and solvation effects. Quantitative structure-activity relativity (QSAR) and 3-D QSAR and pharmocophore mapping will also be taught in this module. Chemical, protein and sequence databases and search tools are used together with molecular modelling softwares like Spartan, Sybyl and Dock to this module. Molecular surfaces and molecular superimposition techniques are used to understand the algorithm of automated docking of drugs into receptor sites. Computer-aided drug design also looks at De Novo ligand design, molecular dynamic simulations and the prediction of binding free energy.

(e) PP5201 Pharmacology and Toxicology (4 MCs)
This module covers pharmacological principles of drug actions, receptor pharmacology, drug absorption, distribution, metabolism, and elimination, toxicology including toxicokinetics and quantitative pharmacology for the evaluation of drug actions.
Please refer to Yong Loo Lin School of Medicine for module details.

(f) Essential Laboratory Training
This module aims to provide students a better understanding and appreciation of medicinal chemistry research. Research laboratories will be broadly categorised as synthetic and non-synthetic, and students are required to be attached to two different

laboratories for a period of two months each. During the laboratory rotation, students will be required to undergo an introductory course in molecular modelling and computational drug design.

(V) Research Specialisation
A student in this programme will work on a research project supervised by one or more Faculty members involved in this programme. The research proposal should be designed in collaboration with ongoing activities in the pharmaceutical industry and/or research institutions. Collaborative efforts of Faculty members with overseas partners may also allow students to go on international exchange.

The planning of the research proposal should be finalised before the end of semester two of study, when the research project commences immediately after completion of course work requirement. Each candidate should spend at least the equivalent of two semesters or more in the industry and/or research institution doing his/her research. The student will have to submit a thesis upon completion of his/her research work.

(VI) Candidature
The maximum scholarship duration is four years and the maximum candidacy is five years.

Although the programme aims to nurture Ph.D. candidates, all students will be admitted initially as graduate students to the programme. Students will have to sit for a qualifying examination between 12-16 months of their study, similar to the procedure for all graduate students at the Faculty of Science. Those who pass will continue to complete their Ph.D. programme. Those who fail (expected to be a very small number) will be advised to embark on a research project at an appropriate level for the fulfilment of a M.Sc. degree.

4.1.2.2 ANU-NUS Joint Ph.D. Programme

Programme Structure

The Joint Degree Programme (JDP) is offered by the Department of Physics at NUS and the Department of Physics, Faculty of Science and the Research School of Physical Sciences and Engineering at the ANU.

A student’s period of candidature will commence at the beginning of any semester of an academic year.

Students at NUS and ANU will be expected to earn their doctoral degrees after three to four years of study. For ANU students the minimum period of candidature for this JDP will be four semesters and the maximum will be eight semesters, with extensions of the JDP possible if approved by ANU. For NUS students the minimum period of candidature for this JDP will be four semesters and the maximum will be ten semesters, with extensions of the JDP possible if approved by NUS.

Students will be required to spend at least two semesters in residence at the Host Institution.

Students enrolled in the JDP will be required to meet the degree requirements of their Home Institution.

Students enrolled in the JDP will be required to undertake a minimum of four physics graduate courses/modules:

- In the first instance it is envisaged that NUS will offer graduate modules which students from ANU and NUS will be required to undertake.

- NUS students undertaking the JDP must ensure that they complete NUS' modules requirements as specified in Schedule 1.
- NUS students will be required to enrol in up to two ANU graduate courses. The credits earned from undertaking such graduate courses will be transferable to NUS.
- ANU students will be required to enrol in up to two NUS graduate modules. The credits earned from undertaking such graduate modules will be transferable to the ANU.
- A student's requirement to comply with the provisions may be varied by approval of the JDP Committee on the recommendation of the student's thesis advisors.

Students who successfully complete a JDP will be issued with a joint testimony: Doctor of Philosophy: The Field of Study Being Physics. Students will have their degree conferred by their Home Institution, but may elect to have their degree presented in either Singapore or Australia.

SCHEDULE 1: Syllabi of Level-5000 Modules Offered by Department of Physics at NUS

Graduate Modules offered by the Department of Physics, NUS
PC5201 Advanced Quantum Mechanics
PC5202 Advanced Statistical Mechanics
PC5203 Advanced Solid State Physics
PC5204 Special Topics in Physics
PC5205 Topics in Surface Physics
PC5206 Selected Topics in Quantum Field Theory
PC5207 Topics in Optical Physics
PC5208 Superconductivity
PC5209 Accelerator Based Materials Characterisation
PC5210 Advanced Dynamics
PC5211 Advanced Electrodynamics
PC5212 Physics of Nanostructures
PC5213 Advanced Biophysics
PC5214 Principles of Experimental Physics
PC5215 Numerical Recipes with Applications
PC5228 Quantum Information and Computation
PC5234 Quantum Finance
PC5239 Special Problems in Physics
PC5247 Photonics II

Subject to the approval of the Head of Physics Department, a candidate may be allowed to choose up to three modules (12 MCs) at Level-5000 or higher from other Departments.

In addition, an NUS student is required to pass the Graduate Seminar Module in Physics (PC5198).

Entry requirements

- If applicable, the student must meet the English language proficiency
- The student must have been admitted into graduate studies of the Department of either ANU or NUS;
- The student must be a Ph.D. candidate approved for admission by the Home Institution;
- The student must be accepted by not less than two Faculty members as supervisors, and at least one supervisor must be from each Party;
- The student must obtain a student visa to enter and study in the Host Institution's country; and
- The student's admission must be recommended by the JDP Committee.

Assessment and Credit

- For the JDP, an NUS student will be required to complete coursework comprising six modules at graduate level (including PC5198) with an average CAP of 3.5 (the list of graduate modules offered by the Department of Physics, NUS, is provided in Schedule 1). ANU students will be required to complete a total of at least four physics graduate courses, with an average grade equivalent to a CAP of 3.5.
- The Ph.D. thesis will be examined by a Ph.D. Examination Panel of three members, one nominated by the Head of Department of each Party, and an external referee nominated by the JDP Committee, and approved in accordance with the Home Institution's usual Ph.D. practices.
- Assessment of each student's Ph.D. thesis will include an oral examination by video-conference between the ANU and NUS.
- The award of the JDP to a student will be discussed and recommended by the Head of Departments, the Deans and the respective authorities of both Parties.

Financial Matters

- Students will pay fees to their respective Home Institutions, even while they are undertaking courses at the Host Institution. The student will be exempted from paying fees to the Host Institution.
- Students will have secured an approved funding plan from their Home Institution prior to consideration of their application for enrolment by the JDP Committee. Ph.D. candidates who have been awarded a research scholarship from their Home Institution will be bound by terms and conditions of the research scholarship of their Home Institution.
- The airfare and travelling expenses incurred by students travelling to the Host Institution, accommodation and all living expenses, including medical/health insurance will be borne by students with possible support from either Party if available and merited.

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 $3,000, $3,200 and $3,300 respectively. The award also cover 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 Masters/Graduate Programme, the monthly stipend is S$1,500. For Research Scholars in a Ph.D. programme, monthly stipends for Singapore citizens, Singapore Permanent Residents and foreigners are currently S$2,300, 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 one to two-and-a-half years for Masters candidates and three to four years for Ph.D. candidates, as determined by the University.

4.2 Coursework Programmes

4.2.1 Degrees Offered

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

4.2.2 Degree Requirements

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

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

The objectives of the programme are as follows:

- 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 on a full scale of 4.

(I) Programme Structure

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

Track 1 (for applicants who have an Honours degree or equivalent qualifications)

EITHER

1. Complete coursework amounting to at least 24 MCs from physics modules (which the candidate should not have passed before) at Level-4000 or higher,
2. Obtain at least 16 of the 24 MCs in (i) from Level-5000 physics modules, excluding PC5198. The candidate is also allowed to choose up to 8 MCs from PC4xxx modules, in Group B, which the candidate should not have passed before, and
3. Complete a project and a written report, equivalent to 16 MCs, in an area specified by the Department.

OR

1. Complete coursework amounting to at least 40 MCs from physics modules (which the candidate should not have passed before) at Level-4000 or higher; and
2. Obtain at least 24, of the 40 MCs in (i), from Level-5000 physics modules, excluding PC5198. The candidate is also allowed to choose up to 12 MCs from PC4xxx modules (Group B) which the candidate should not have passed before.

Track 2 (for applicants who have a Bachelor's pass degree or completed a three-year study in physics or related discipline)

EITHER

1. Complete coursework amounting to at least 64 MCs from physics modules (which the candidate should not have passed before) at level 3000 or higher
2. Obtain at least 20 of the 64 MCs in (i) at Level-5000 (excluding PC5198), obtain at least 24 of the 64 MCs in (i) at Level-4000, and obtain no more than 16 of the 64 MCs in (i) at Level-3000 which the candidate should not have passed before; and
3. Complete a PC5289 project and a written report, equivalent to 16 MCs, in an area specified by the Department.

OR

1. Complete coursework amounting to at least 80 MCs from physics modules (which the candidate should not have passed before) at level 3000 or higher; and
2. Obtain at least 24 of the 80 MCs in (i) at Level-5000 (excluding PC5198), obtain at least 32 of the 80 MCs in (i) at Level-4000 and obtain no more than 16 of the 80 MCs in (i) at Level-3000 which the candidate should not have passed before.

In both tracks above, subject to the approval of the Head of Physics Department, a candidate may be allowed to choose no more than three Level-5000 modules (12 MCs) from other Departments.

The modules under Groups A and B are as follows:

Group A

PC5201 Advanced Quantum Mechanics
PC5202 Advanced Statistical Mechanics
PC5203 Advanced Solid State Physics
PC5210 Advanced Dynamics
PC5211 Advanced Electrodynamics
PC5214 Principles of Experimental Physics

Group B

PC5204 Special Topics in Physics
PC5205 Topics in Surface Physics
PC5206 Selected Topics in Quantum Field Theory
PC5207 Topics in Optical Physics
PC5208 Superconductivity
PC5209 Accelerator Based Materials Characterisation

PC5212 Physics of Nanostructures
PC5213 Advanced Biophysics
PC5215 Numerical Recipes with Applications
PC5228 Quantum Information and Computation
PC5239 Special Problems in Physics
PC5247 Photonics II

Note:
At present, one module is worth 4 MCs.

The Department may change the modules offered from time to time and not all modules listed are necessarily offered every academic year. You are also advised to check the website: http://www.physics.nus.edu.sg periodically for any additional modules which may become available for the programme.

For students admitted into the programme, a minimum Cumulated Average Point (CAP) of 3.00 is required for graduation.

(II) Period of Candidature

The programmes may be undertaken over a period of two to eight semesters for Track 1 or to ten semesters for Track 2, and will comprise coursework or coursework and a written report based on project work. Some classes will be conducted during the university semesters in the evening.

(III) Programme Intake

There are two intakes per academic year: one in January and the other in August.

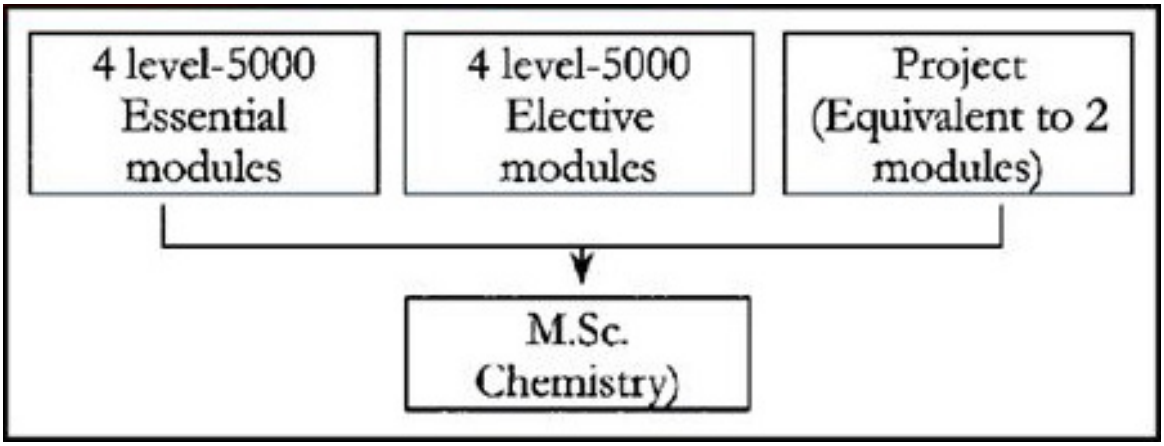
4.2.2.2 Master of Science in Chemistry (Part-Time or Full-Time)

This programme is designed for students with either a four-year Honours degree, or a three-year degree with two years of working experience, who would like to pursue a graduate degree in Chemistry. It is expected that the graduates of this programme will be well-equipped to secure senior industrial positions, or apply for advanced degree programmes (e.g., Ph.D.).

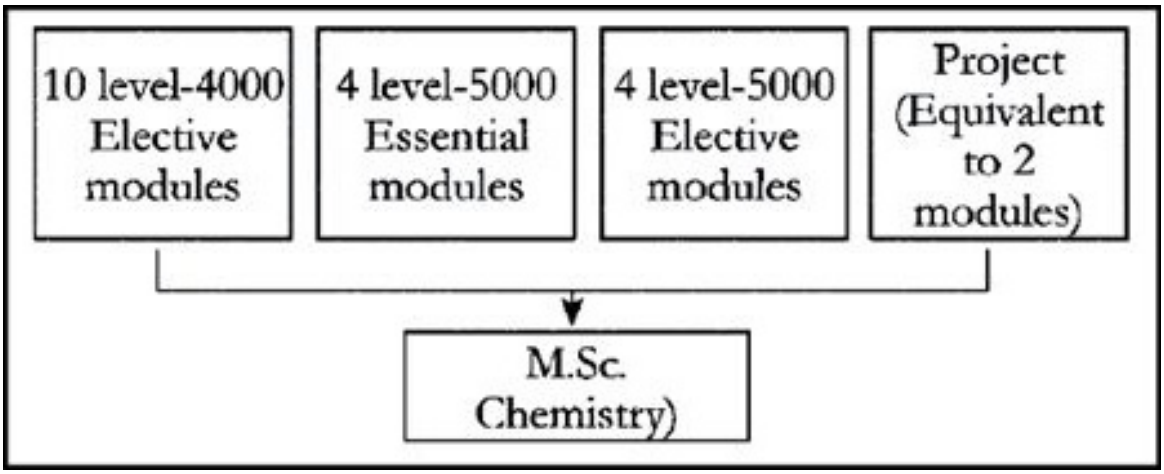
At the end of the course, the student will be equipped with up-to-date knowledge and skills that will enable him/her to execute and lead with confidence and perform leading roles as R&D scientists, managers and entrepreneurs in the practice of complex chemical processes.

Admission Requirements & Programme Structures

Structure 1
For students with a four-year (Hons.) degree:
Complete two full-time or four part-time semesters of course requirements. Structure 1 is a 40-modular-credit programme consisting of four Level-5000 essential module (each of 4 MCs), four Level-5000 elective modules (each of 4 MCs) of coursework, and a research project equivalent to two coursework modules (8 MCs).



Structure 2
For students with a three-year degree and two years of relevant working experience: Complete four full-time or eight part-time semesters of course requirements. Structure 2 will be an 80 Modular Credit programme consisting of 10 Level-4000 elective modules (each of 4 MCs) (including up to two Level-4000 modules which may be replaced by two Level-3000 modules and up to four Level-4000 modules may be replaced by four Level-5000 modules towards the fulfillment of this requirement), four Level-5000 essential modules (each of 4 MCs), four Level-5000 elective modules (each of 4 MCs) of coursework, and a research project equivalent to two coursework modules (8 MCs).



Note:
Students in Structure 2 have the option to read two Level-3000 modules in lieu of two Level-4000 modules.

Area of Specialisation

In order to cater to Singapore's growing need for skilled manpower in chemicals, electronics and biomedical industries, there are four areas of specialisation available for students to choose from:

1. Analytical Chemistry
2. Synthetic Chemistry
3. Materials Chemistry
4. Medicinal Chemistry

To fulfil the requirements for each area of concentration, students are required to read at least three modules from one of the three Level-5000 subject groups (Analytical, Synthetic, Materials or Medicinal).

Please refer to the course website:
http://www.chemistry.nus.edu.sg/graduates/msc_coursework.htm for more details.

Course of Study

The programme will be conducted by coursework. Majority of the courses will be conducted in the evenings during the university semesters.

Programme Intake

There are two intakes per academic year in August and January.

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.

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.

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 the TOEFL, IELTS, or Diagnostic English Test (DET) administered by the NUS Centre for English Language Communication. The minimum acceptable scores are: TOEFL – 580, IELTS – 6, and DET – pass.

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. 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.

Degree Prerequisites for Admission
To be admitted into the programme (full-time or part-time), 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 programme must read and pass a total of ten modules (40 MCs), comprising six essential modules and four 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 (Laboratory Rotation)

Four Elective Modules, 4 MCs each - choose from the following:

7. PR5211 Pharmaceutical Analysis IV
8. PR5212 Advanced Topics in Medicinal Chemistry
9. PR5214 Advances in Tablet Technology
10. PR5216 Advances in Drug Delivery
11. PR5219 Product Quality Management
12. PR5220 Bioprocess Technology

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 shall be four years, and that of a full-time student shall be two years.

4.2.2.6 Master of Science in Physics (Part-Time or Full-Time)

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.

The objectives of the programme are as follows:

- 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 part-time M.Sc. Programme in Physics by coursework must complete the following in order to be awarded the M.Sc. degree:

Track 1 (for applicants who have an Honours degree or equivalent qualifications)

EITHER

1. Complete coursework amounting to at least 28 MCs* from physics modules (which the candidate should not have passed before) at Level-4000 or higher,
2. Obtain at least 20 of the 28 MCs in (i) at Level-5000 excluding PC5198 (at least 8 MCs should be Group A). The candidate is also allowed to choose up to 8, of the 28 MCs in (i) from Level -4000 Physics modules which the candidate should not have passed before; and
3. Complete a PC5288 project and a written report, equivalent to 12 MCs, in an area specified by the Department.

OR

1. Complete coursework amounting to at least 40 MCs from physics modules (which the candidate should not have passed before) at Level-4000 or higher; and
2. Obtain at least 20 of the 40 MCs in (i), at Level-5000 Physics modules, excluding PC5198 (at least 8 MCs should be Group A). The candidate is allowed to choose up to 8, of the 40MCs in (i) from level-4000 Physics modules which the candidate should not have passed before.

Track 2 (for applicants who have a Bachelor's pass degree or completed a three-year study in physics)

EITHER

1. Complete coursework amounting to at least 68 MCs from physics modules (which the candidate should not have passed before) at Level-3000 or higher,
2. Obtain at least 20 of the 68 MCs in (i) at Level-5000 excluding PC5198 (at

least 8 MCs should be Group A), obtain at least 32 of the 68 MCs in (i) at Level-4000 Physics modules. The candidate is also allowed to choose up to, 12 of the 68 MCs in (i) at Level-3000 Physics modules which the candidate should not have passed before; and
3. Complete a PC5288 project and a written report, equivalent to 12MCs, in an area specified by the Department

OR

1. Complete coursework amounting to 80 MCs from physics modules (which the candidate should not have passed before) at Level-3000 or higher; and
2. Obtain at least 32 of the 80 MCs in (i) at Level-5000 Physics modules excluding PC5198 (at least 8 MCs should be Group A) and obtain at least 32 of the 80 MCs in (i) from Level-4000 Physics modules. The candidate is also allowed to choose up to 12, of the 80 MCs in (i) from Level-3000 Physics modules which the candidate should not have passed before

In both tracks above, subject to the approval of the Head of Physics Department, a candidate may be allowed to choose no more than 12 MCs) from level-5000 modules offered by other Departments.

The modules under Groups A and B are as follows:

Group A

PC5201 Advanced Quantum Mechanics
PC5202 Advanced Statistical Mechanics
PC5203 Advanced Solid State Physics
PC5210 Advanced Dynamics
PC5211 Advanced Electrodynamics
PC5214 Principles of Experimental Physics

Group B

PC5204 Special Topics in Physics
PC5205 Topics in Surface Physics
PC5206 Selected Topics in Quantum Field Theory
PC5207 Topics in Optical Physics
PC5208 Superconductivity
PC5209 Accelerator Based Materials Characterisation
PC5212 Physics of Nanostructures
PC5213 Advanced Biophysics
PC5215 Numerical Recipes with Application
PC5228 Quantum Information and Computation
PC5239 Special Problems in Physics
PC5247 Photonics II

Note:
At present, one module is worth 4 MCs.

The Department may change the modules offered from time to time and not all modules listed are necessarily offered every academic year. You are also advised to check the website: http://www.physics.nus.edu.sg periodically for any additional modules which may become available for the programme.

For students admitted into the programme, a minimum Cumulated Average Point (CAP) of 3.00 is required for graduation.

Period of Candidature

The programmes may be undertaken over a period of two to eight semesters for Structure 1 or to ten semesters for Structure 2, and will comprise 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 the TOEFL, IELTS, or Diagnostic English Test (DET) administered by the NUS Centre for English Language Communication. The minimum acceptable scores are: TOEFL – 580, IELTS – 6, and DET – pass.

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. QF5205 Topics in Quantitative Finance I
    ii. QF5206 Topics in Quantitative Finance II
    iii. EC5102 Macroeconomic Theory
    iv. EC5103 Econometric Modelling & Applications I
    v. EC5332 Money and Banking
    vi. ECA5315 Financial Econometrics
    vii. ECA5334 Corporate Finance
    viii. ST5207 Non-parametric regression
    ix. ST5210 Multivariate Data Analysis
    x. ST5218 Advanced Statistical Methods in Finance
    xi. MA5233 Computational Mathematics
    xii. MA5248 Stochastic Analysis in Mathematical 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 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 or an IELTS score of at least 6.

A GRE general test score of the following minimum scores would be an advantage:
Verbal Ability: 500,
Quantitative Ability: 700,
Analytical Writing: 3.5

Programme Structure

Track 1
A candidate for the programme must successfully complete coursework consisting of two compulsory modules and eight elective modules. Among the eight elective modules, two modules can be taken from other departments subject to departmental approval.

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.

A successful candidate should have passed all the ten modules within the maximum period of the candidature.
In addition, the candidate must receive a CAP of minimum 3.00 (an average grade of at least B- for all the modules sat for).

Track 2
Only the full-time programme will be offered for this track.

A candidate must first complete a coursework requirement of 40 MCs at Level-4000. It includes six modules (24 MCs) and a project, ST5199 (16 MCs). Among the six modules, two modules can be taken from other departments subject to departmental approval. Courses will be conducted in the daytime.

In addition, the candidate must also complete the requirement of 40 MCs of modules at Level-5000 required for Track I candidates.

The total number of credits required for Track II is 80 MC. The required overall CAP for graduation is 3.00 or higher.

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

The minimum period of candidature will be one academic year and the maximum period will be four academic years, both counted from the date of the candidate's admission to the programme.

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)

Objectives

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.

This programme differentiates itself from M.Sc. courses currently offered by the Department of Chemistry and the Department of Chemical and Environmental Engineering:

- An experienced international teaching staff with a considerable proportion of specialists from the industry.
- Laboratory skills taught in compact whole day courses of one week each (four courses).
- Development of cultural awareness through student exchange, language programmes, and cultural immersion.
- The inclusion of economics, business administration, and management science in the curriculum.

For admission into the Masters programme, a candidate must:

- Have a good Honours or equivalent degree in chemistry or related disciplines.
- Satisfy the Joint Academic Board of the Faculty of Chemistry of TUM and the Department of Chemistry NUS on the basis of an interview and/or written test.

- Have good language skills in English [see Para (5) (c) for details].

Programme Structure

Candidates must successfully complete a programme of study comprising all the following:

1. Five essential (Four Chemistry + One Business/ Management) and a minimum of four elective graduate modules,
2. Cross Discipline Courses to improve general knowledge, skills and social competence,
3. One industrial project of nine weeks' duration, and
4. A six-month research project.

If the English language is not the candidates' native language, candidates will be required to take and pass the Diagnostic English Test, conducted by NUS Centre for English Language Communication. Candidates, who failed in the Diagnostic English Test, will be required to complete and pass the PE5001 English Language Course — Intermediate Level. Alternatively, the internationally recognised TOEFL test from the candidate is acceptable.

Each essential graduate module CM5101, CM5102, CM5103 and CM5104 is based on 45 teaching hours with an additional laboratory component of one week (40 hours) and carries 6 MCs. The remaining essential chemistry module CM5105 which has 45 teaching hours with no practical component will be accorded 4 MCs. Elective modules are taken from existing modules offered by Department of Chemistry and the Department of Chemical & Environmental Engineering at NUS and/or from the Faculty of Chemistry at TU Munich.

With the exception of CM5105 which has no practical components, each essential graduate module (CM5101, CM5102, CM5103 and CM5104) comprises 45 contact hours of lectures/tutorials/assignments with an additional laboratory component of one week (40 hours) is assigned 6 MCs. CM5105 is accorded 4 MCs.

Graduation requirement
Nine modules with a total of 44 MCs (consisting of five core/essential and four elective modules) of graduate modules, successful completion of a two-month (nine weeks) industrial attachment, and completion of a project/thesis of six months' duration. The thesis is accepted after an oral defence in the presence of four members of the examination board.

Programme Essentials
Each module: 30 Hours of Lectures + 15 Hours of tutorials unless otherwise specified. (Each essential module apart from CM5105 will have one week of practical work comprising a total of 40 hours.)

- Five essential modules (Four Chemistry + One Business/Management)
- Four (out of twelve) elective modules (Chemistry/Chemical & Environmental Engineering /TUM)
- Two weeks of language course (Business/Technical English)
- Nine weeks of industrial internship
- Six-months project (Master Thesis)

Cross Discipline Courses in evening and weekend: (10 hours for each module)

- Selected Topics in Chemical Business Administration
- Management Methods in Chemical Industry
- Legal Aspects in Chemical Industry (e.g. Environmental Laws)
- International Patent Law
- Aspects of European and Asian History and Culture

Period of Candidature

The current full-time programme spans one and a half years comprising two full

semesters of course work and six months of research work culminating in a written Masters Dissertation. The programme also entails nine weeks of internship in industry (Germany or Singapore).

Graduation Requirements/Conferment/Award of Degree

For graduation, a student must:

1. Obtain a minimum CAP for all modules of 3.0 (B-);
2. Complete and pass the five core/essential modules and at least four elective modules;
3. Obtain a 'P' (Pass) Grade for the industrial project; and
4. Obtain at least a Grade D for the English Language Course -Intermediate Level (if not exempted from the English Language requirement).

NUS and TUM will confer the degree jointly. The degree scroll will be a common one for the joint programme.

Continuation and Termination of Candidature

For continuation of candidature, students are to obtain either a Cumulative Average Point (CAP) or a Semester Average Point (SAP) of at least 2.50. Students will be issued an academic warning if the CAP and SAP are < 2.50.

Students' candidature will be terminated (and refused re-admission) if:

1. In the first semester of study, the SAP for NUS modules < 1.0; or
2. For two consecutive semesters of study, both CAP and SAP for NUS modules are < 2.50

Examinations

Candidates will be examined at the end of their study for the coursework modules including cross discipline courses. The Joint Academic Board will decide on the examination results of the modules offered at each university.

A committee comprising a minimum of four academics from both Universities will examine the Masters Dissertation. The examination process will entail a presentation of the research work done by the candidate followed by a question and answer session by the examiners. The location of the examination will be conducted where the candidate has performed the major part of the work.

Programme Intake

There is one intake per academic year in July.

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:

1. be competent, confident communicators of science and technology to the general public and school-age audiences;
2. develop materials for effective communication to non-specialist audiences;
3. propose and supervise project work and other scientific activities; and
4. develop confidence in lifelong learning.

Admission Requirements

Applicants have to fulfill the admission requirements for both universities in order to gain admission to the joint degree programme.

Applicants seeking admission must have:

- a good bachelor's degree (or equivalent) from a reputable university
- a postgraduate diploma from National Institute of Education for teachers without an honours degree
- good TOEFL score if English was not the medium of instruction in their undergraduate studies

Applicants without an honours degree in science will be considered on a case-by-case basis.

Programme Structure

The minimum candidature is 1 year (2 semesters) and the maximum candidature is 4 years (8 semesters). Full-time students can expect to graduate within 1 – 1.5 years. Part-time students can expect to graduate within 2 – 2.5 years. Full-time students will spend one semester (January to June) at NUS and one semester (July to December) at ANU. Alternatively, they may complete the whole programme at NUS. Part-time students will read the ANU core modules in intensive mode at the Singapore Science Centre (SCS) and the ANU elective modules through ANU online facilities.

<u>The 4 core modules are:</u>
NUS MW5201 Topics in Science Communication
NUS MW5202 Innovations in Science Teaching
ANU SCOM8020 Science Communications and Creative Teaching
ANU SCOM8021 Ethics, Issues and Consequences of Science

<u>Elective modules from ANU are:</u>
BIOL6191 Biotechnology in Context
BIOL8021 Health and Disease in a Changing World
BIOL8020 Genomics & Biotechnology
EMSC8015 Imaging Earth Structure
MATH8001 Poetry of the Cosmos
MATH8020 Computational Science
PHYS8510 Lasers and Photonics
PHYS8511 Optical Fibre Communications
PSYC8020 Visual Sensation and Perception
ENVS8005 Climate Change Science
SCOM8015 Speaking of Science
SCOM6003 Science in Popular Fiction
SCOM6012 Science Communication and the Web
SCOM6016 Science in the Media
SCOM6029 Cross Cultural Perspectives in Science Communication
SCOM6501 Strategies in Science Communication|
SCOM8027 Science and Public Policy

In addition to the core and elective modules, students are required to complete a research project worth 12 NUS modular credits.

Coursework Requirements

Students must read and pass NUS and ANU modules worth 40 NUS modular credits (MCs) or 48 ANU credits, with a CAP (NUS) of 3.0 or its equivalent over their approved candidature period.

Programme Intake

There is only one intake in January per year.

4.2.2.11 Doctor of Pharmacy (PharmD)

Only available in full-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.
    - PR1105 Pharmacy Practice I
    - PR3105 Pharmacotherapy I
    - PR3107 Pharmacy Practice II
    - PR4101 Pharmacotherapy II
    - PR4102 Pharmacotherapy III
    - PR4103 Pharmacy Practice III

Programme Structure

1. Length of Study

The NUS PharmD programme requires 2 full-time academic years of study consisting of a 1 year didactic component and 40 weeks of clerkships.

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, Gender Specific Diseases/ Conditions, Cardiovascular Therapeutics, 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 (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. The maximum candidature for a full-time student will be 3 years. 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.