



**NANYANG**  
TECHNOLOGICAL  
UNIVERSITY

College of Science

# GRADUATE PROGRAMMES (BY RESEARCH)

Asian School of the Environment  
School of Biological Sciences

School of Physical and Mathematical Sciences



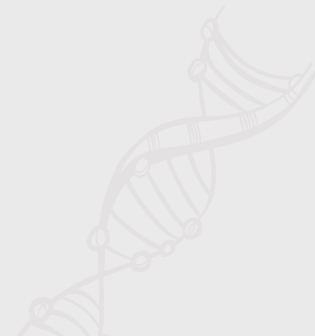
[www.cos.ntu.edu.sg](http://www.cos.ntu.edu.sg)





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# INTRODUCTION



The College of Science is home to three schools - School of Biological Sciences (established in 2001), School of Physical and Mathematical Sciences (established in 2004), and Asian School of the Environment (established in 2015).

The College boasts the best of building and laboratory design, infrastructure, equipment and facilities for the creative pursuit of academic and research excellence. Our faculty are drawn from the best researchers in Singapore and around the globe, which provides for worldclass learning and research experiences to undergraduates and graduates alike.

At the College of Science, interdisciplinary research is strongly encouraged, since it is the interface between the various disciplines that provides the conditions for major breakthroughs in knowledge and innovation. We also forge strategic collaborations with leading universities, institutions, research centres and industries from all over the world. This ensures our relevance on the global scene, as we help to transform Singapore into a knowledge-intensive economy. These partnerships are fostered in part through scholarships and joint Ph.D. research studies.



# ASIAN SCHOOL OF THE ENVIRONMENT

[www.ase.ntu.edu.sg](http://www.ase.ntu.edu.sg)

The Asian School of the Environment (ASE) at Nanyang Technological University (NTU) is a new interdisciplinary School that will be a world leader in environmental research focused on Asian environmental challenges. ASE integrates Earth and environmental life science, ecology, engineering and technology, human ecology, humanities, and the social sciences to address key issues of the environment and sustainability. The School offers Ph.D. in Earth Sciences.

## ASE graduate student observes Batur Volcano in Bali, Indonesia.

Mount Batur has three summit craters and a parasitic cone, rises about 700m above its surrounding fertile terrain, and sits within an impressive double caldera structure. It stretches 13.8 km by 10 km in dimension, with a deep crater lake, fumaroles and bubbling hot springs.

## RESEARCH AREAS

### Environmental change

Researchers in the coastal lab investigate coastal dynamics at scales stretching from minutes to millennia. The driving aim of this group is to make the coastlines of Asia safer places to live, work and play and provide insights into what might be expected in the future, and thereby to inform policy and planning decisions.

Inland, the isotope geochemistry team seeks to understand how hydro-climates change in the tropics during the late Pleistocene and the Holocene, how the changes relate to those in other parts of the world, if they are connected at all, and how tropical climate changes influence human society or vice versa. To achieve these, the team works with both terrestrial and marine samples from the tropics, including speleothems and corals. Sample ages are typically determined by high precision radiometric dating techniques, while their stable isotopic compositions and elemental ratios are often applied for semi-quantitative climate assessments and correlations.



*The coastal lab investigating a beach composed of coral rubble deposited as part of the coastal recovery after the 2004 Indian Ocean Tsunami in Thailand.*



*Ph.D. student Sujata Murty and colleagues drill a Porites coral head for palaeoenvironmental analysis.*

## Society and Complexity

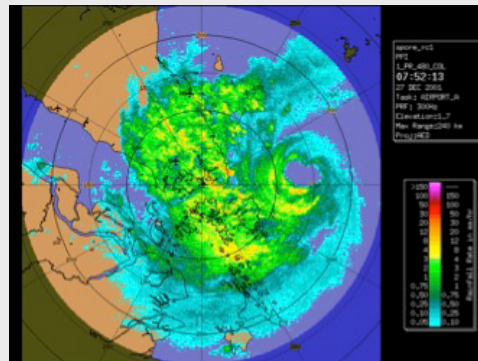
Complexity is a relatively new discipline to NTU. In ASE, our research is done in collaboration with the Complexity Institute at NTU. One example stems from research in the 1980s that showed that Balinese water temple networks can self-organize and over recent centuries, water temple networks expanded to manage the ecology of rice terraces at the scale of whole watersheds. Inspired by the water temple, the complexity team now focuses on other self-organizing processes elsewhere in Indonesia. Some of our complexity researchers at ASE are now working with Indonesian geneticists from the Eijkman Institute for Molecular Biology along with linguists and public health officials in Indonesia to study the co-evolution of social structure, language change and disease resistance across the Indonesian Archipelago.

## Oceans and Atmosphere

Our atmospheric chemistry team is working on developing new tools to improve our understanding on atmospheric chemistry in the region. The team aims to understand emission, atmospheric processes, deposition, and environmental impacts of atmospheric chemical species. Because of its nature, atmospheric chemistry is an interdisciplinary research area, which involves chemistry, physics, atmospheric and oceanic sciences, aerosol science, agricultural science, and others. Tropical Asia is an important and a unique place for atmospheric chemistry. For instance, wildfire in tropical Asian countries is one of the globally important sources of CO<sub>2</sub>. It is also a dominant source of particulate matter in this region, which affects air quality.

Moving to the sea, researchers in the marine geochemistry group use coral geochemistry to understand ocean-atmosphere interactions, climate behavior, and pollution histories over the past 500 years. The team extracts sub-annual data from coral skeletons that provides insights into climate behavior on seasonal to decadal time scales, improving our understanding of how changes to mean sea surface temperature, salinity and circulation interact with climate systems such as the Southeast Asian Monsoon. Understanding how these systems have changed and interacted in the past will be critical to predicting climate in the future.

Rainfall rate derived from Doppler radar reflectivity at 7:52 am on 27 December 2001. The eye of tropical storm Vamei is clearly visible. (With courtesy: Meteorological Services Division, National Environmental Agency).



## Volcanology

Volcanic arcs in Southeast Asia are among the most active on Earth and our researchers conduct geologic, geochemical and geophysical studies to improve understanding of volcanic activity, particularly processes related to eruptions. Our team aims to produce knowledge and tools that will aid forecasting of volcanic eruptions, assessment of their environmental and societal impacts, and efforts to mitigate the hazards.

ASE volcano scientists take a multidisciplinary approach and combine geophysics, geochemistry, petrology, stratigraphy, hydrology, geomorphology, kinetic and numerical modelling to determine the reasons of volcanic unrest and explain the processes at stake in the region.

They bring an intense focus on a small number of targets to reconstruct past eruptive behaviour and to monitor and model a wide range of processes occurring at depth. The models are then used to test hypotheses on degassing and other controls on eruptions, allowing for time series and eruption forecasting. The volcano team has laboratory volcanoes at Mayon (Southeast Luzon, Philippines) and Gede-Salak (West Java, Indonesia) where they investigate the timing, rates and other details of the magma supply of different volcanoes, in order to improve forecasts of future eruptions. The volcano group also manages WOVodat, a database that has begun to translate and compile these myriad data into common formats with the goal to make them freely web-accessible, for reference during volcanic crises, comparative studies, and basic research on pre-eruption processes.

## Active Tectonics and Earthquakes

The tectonically active landscapes of Asia provide a natural laboratory to study Earth deformation processes with global relevance. Asia has many large, active faults, as well as a number of major subduction zones that are responsible for some of the world's most complex movements by tectonic plates. Our researchers aim to increase fundamental knowledge of the region's tectonic and seismic behaviour, as a basis for more reliable forecasting of earthquakes and tsunamis as well as action to reduce the potential hazards. Our scientists help lay the groundwork to identify signs of previous earthquakes, their size, their recurrence, and eventually their capacity for destruction.

Some of our tectonics researchers study the tectonic evolution of the landscape using evidence such as disrupted riverbeds, escarpments and terraces. They then date these events and reconstruct the three dimensional tectonic blocks and faults with their associated earthquakes and, thereby, identify the seismic hazard of large regions. The earthquake geology team 'reads' the buried landscape from the topography of buried sediments while the structural geology team investigates structures using seismic investigations or study the past earthquake history of a region from geological layers and landforms to understand the geometries of active faults, the earthquakes they generate, and the crustal structure their movements produce.



Salak volcano is located in western Java, Indonesia. It is one of Earth Observatory of Singapore (EOS) Lab Volcanoes. This active stratovolcano is less than 60km from Jakarta, the capital of Indonesia. Its last known eruption occurred in 1938.

Our teams also investigate modern earthquake dynamics and look at the current deformation of the Earth's surface. The geodesy group uses surface measurements to infer the mechanics of earthquakes and the slow processes that prepare the Earth for strong shaking. On the other hand, the seismology and earthquake physics teams use seismic waveforms at wide distance ranges (from near field to thousands of kilometres away) and frequency ranges (from several Hz to static) to determine fundamental source parameters of earthquake such as location, origin time, magnitude, focal mechanism and finite rupture process and produce simulations to incorporate many of these direct observation to explore a range of realistic scenarios.



*Some earthquake features like surface ruptures of the Fuyun fault, in north-western China, are remarkably well preserved in the landscape thanks to minimal erosion in the region.*

### Ecology and Ecosystems

Our integrative microbiology team investigates the ways in which microorganisms evolve, adapt and function to drive the ecological processes that are critical for sustaining the health of global marine environments. They apply the latest “omic” technologies to a variety of microbiomes from the deep sea to indoor ventilation systems techniques that are essential for deriving a clear and thorough understanding of microbial communities and ecosystem function.

In the bacterial world our team applies molecular based studies of the mechanisms by which bacteria respond to prevailing conditions as well as environmental genomics of the biodiversity and function of natural microbial consortia.

ASE has recently partnered with the Smithsonian Institution, the world's largest museum and research complex based in the United States, to advance research in tropical ecology. The joint research and educational collaboration will be focused on areas such as biodiversity, forest and marine ecology, climate change, human-environment interactions and genomics.

This is the Smithsonian Institution's first formal research agreement in Asia, and ASE will be established as the Asian scientific hub for the Smithsonian's Forest Global Earth Observatories programme (ForestGEO). ForestGEO is a global network of more than 60 tropical and temperate forest plots in 24 countries where scientists examine forest function and diversity. It is part of the Smithsonian's Global Earth Observatories programmes, which also includes MarineGEO, the first long-term, worldwide research programme with seven sites to focus on understanding coastal marine life and its role in maintaining resilient ecosystems around the world.



*Marine microbes are a focus of research in the Ecology and Ecosystems cluster at ASE.*

## STUDENT TESTIMONIALS



### SORIA JANELLI LEA ACIERITO

Ph.D., Earth Sciences, Batch 2011

*“ Being an ASE student is a great opportunity for me to conduct research on coastal hazards affecting Southeast Asia. Through the school's extensive interdisciplinary collaboration, I am able to work with and learn from an internationally diverse group of scientists. I am also gaining valuable learning experience beyond the academic environment by collaborating with government agencies, the private sectors and communities living along the coast. Such exposure does not only broaden my perspective on the utility of my research for various stakeholders of disaster management, but also equips me with new skills, such as communicating science to nonscientists. ”*

### LOUISA TSANG LOK HANG

Singapore International Graduate Award (SINGA)  
Ph.D., Earth Sciences, Batch 2010

*“ It has been incredibly eye-opening to be mentored by an international and diverse group of researchers at the Earth Observatory of Singapore (EOS). Studying here has both broadened and deepened my horizons in many research fields, including tectonics, volcanology and coastal hazards.*

*I am very excited to be part of the team at EOS in conducting sound geoscience research which aims to benefit and contribute towards safer societies for present and future generations! ”*



# SCHOOL OF BIOLOGICAL SCIENCES

[www.sbs.ntu.edu.sg](http://www.sbs.ntu.edu.sg)

The School of Biological Sciences (SBS), was established in 2001 with the mission to make strong contributions in research and education in biological and biomedical sciences. Since then, many talented individuals including scientific leaders, researchers, postgraduate students from around the world and Singapore have joined the school.

SBS has developed state-of-the-art research facilities and infrastructure. It collaborates with local and international research institutes, universities and hospitals, sharing a common goal to advance basic knowledge and translational application in biological and biomedical sciences.

## RESEARCH AREAS

The faculty and scientists at SBS are engaged in research in a wide range of topics across different fields. Some major areas are highlighted below.

### Cancer

The study of cancer biology at SBS is not limited to uncovering genes implicated in the development of cancer. Our scientists are also investigating the mechanisms that control cell Division, cell growth and cell death, processes that in turn impact on uncontrolled cell proliferation associated with tumor formation. Using mouse models, efforts are being made to elucidate the mechanisms of action of oncogenes, tumor suppressors and of proteins regulating tumor development. This is complemented by studies that attempt to delineate other associative aspects of cancer biology such as epithelial-mesenchymal transition, cancer cell migration and metastasis. Since tumor cells' survival is acutely dependent on their microenvironment, SBS scientists are also investigating tumor microenvironment's contribution to the development and maintenance of the disease.

### Cell Biology

The cell is the fundamental unit of life. This area of research aims to study the morphologies, functions and physiological properties of the cell. Understanding how different cell-types function will lead to insight into how cells regulate and entrain their activities in the context of higher level of cellular organization such as tissues, organs and organisms. Major focus areas of cell biology in SBS are in cell signaling, actin cytoskeleton regulation, cell Division and mitosis, autophagy, protein trafficking and protein folding. Our research activities are well supported by the microscopy and imaging core facilities with state-of-the-art instrumentation including high-end cryo-electron microscope.

### Chemical Biology

The chemical biology research programme in SBS focuses on the molecular mechanisms of biomolecules at the interface between chemistry and biology in a highly cross-disciplinary approach, which involves chemical and analytical tools. Current research themes involve studies on natural products, cyclic dinucleotide, signaling proteins in bacterial pathogenesis, biofilm formation, peptide and protein chemistry, design and engineering of peptides, proteomics, and herbalomics. Rapid advances in technology in recent years have allowed us to examine biological systems with much enhanced chemical and analytical capability. This will help in the elucidation of biochemical principles and consequently a more complete portrait of how these systems function in response to external stimuli. Outputs of our research will not only advance this field but can also facilitate the attempts to design strategies that will subsequently potentiate industrial and biomedical applications.



### Gene Regulation

Many different mechanisms are used by the cells to increase or decrease the production of specific gene products, namely proteins or RNA. Research themes in Gene Regulation actively pursued by SBS scientists are: (i) gene regulation in the vertebrate embryo, including the mechanisms by which Hox gene expression is temporally and spatially controlled, (ii) gene regulation in the malarial parasite *Plasmodium falciparum* as well as (iii) mechanisms of transcriptional and post-transcriptional control of gene expression. Epigenetic regulation of gene expression such as DNA methylation, histone modifications and RNA-associated silencing are also current topics under investigation at SBS.

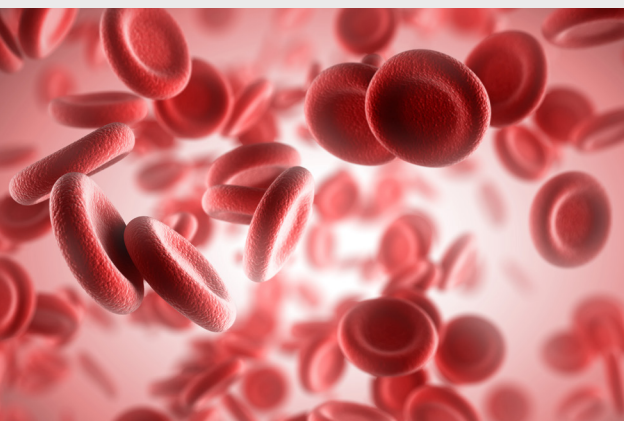
### Stem Cells & Ageing

Stem cells have remarkable potential to differentiate and develop into many different cell types in the body and also the ability to divide for a long period of time to renew themselves and to produce cells that retain the stem cell properties ('stemness'). Scientists at SBS are studying the intrinsic properties of how the embryonic stem cells maintain their "stemness" and other basic properties of stem cells. In addition, adult stem cells such as hematopoietic stem cells and mesenchymal stem cells are being exploited for tissue engineering research and clinical applications.

Population ageing is a national issue as well as a worldwide concern. At SBS, our approach is to understand ageing at cellular and molecular levels.

### Immunology

The immune system is central to the human body's natural ability to fight infection and disease. Research at SBS covers important topics in immunology which include (i) epigenetic control of the immune system, (ii) mouse models for immunology and inflammation research, (iii) the biology and developmental aspects of dendritic cells and macrophages and (iv) innate and adaptive immune responses in infectious diseases.



### Infectious Disease & Microbiology

Infectious diseases are caused by the infection, presence and growth of pathogenic biological agents in an individual host organism. The SBS teams studying infectious diseases have extensive collaborations with local and regional health providers and pharmaceutical companies. The range of organisms under investigation includes viruses, bacteria and parasites. Research groups at SBS perform genetic analysis of field isolates and lab lines of the malarial parasites and apply animal models to examine host-pathogen interaction. A second major area of research studies bacterial infections (e.g. *M. tuberculosis*, *E. faecalis*), drug resistance and the roles of bacterial biofilms in diseases. The virologists at SBS investigate the relationships between the viruses and hosts during infection. Understanding how different viruses such as corona virus, respiratory syncytial virus, influenza virus and dengue virus, infect and exploit the host cells for viral reproduction will allow scientists to develop therapeutic strategies against viral infections.

### Metabolism & Disease

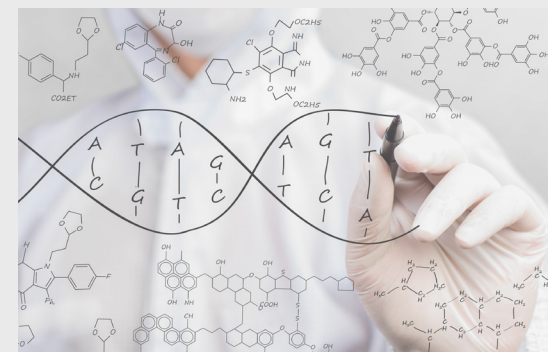
Obesity is a global medical problem because it is linked to a myriad of metabolic abnormalities, including diabetes, hypertension and hyperlipidemia. Obesity is primarily characterized by increased fat mass, attributed to the increase in the number and size of fat cells. Scientists at SBS are working towards understanding the functional relationship between insulin resistance and obesity.

### Neuroscience

At SBS, our research teams actively study how the brain develops specific synaptic connections between neurons, how neural stem cells in the adult brain contribute to plasticity of neural circuitry, and how the neural circuits are organized and maintained to control behavior.

### Structural Biology

The structural biology programme at SBS focuses on three-dimensional structural elucidation and molecular dynamics of key molecules involved in apoptosis, chromatin organization, energy and biological membrane regulation, protein folding and mis-folding. In addition, computer-modelling methods are used to complement and obtain additional structural information not accessible by experimental methods. Bioinformatics, required for mining and processing the surge of data resulting from genome sequences and functional genomics, is another area being explored. Problems related to the storage, retrieval and analysis of information about biological structures, sequences and functions are also addressed. The research is efficiently supported by a number of state-of-the-art technological platforms such as X-ray crystallography, solution X-ray scattering, high field nuclear magnetic resonance (NMR) spectroscopy, electron microscopy, mass spectrometry, fluorescence spectroscopy, surface plasmon resonance (SPR), dynamic laser scattering, and many other analytical techniques.



## ALUMNI TESTIMONIALS



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*The skills and knowledge obtained and the chance to interact with researchers and industry personnel in the field, aided me in my path to be an entrepreneur.*

### TAN MING JIE

M.Sc. Biological Sciences, Batch 2014

*“ Never did I expect this exciting chapter of my life would unfold during the pursuit of my Master studies at SBS, where a partnership with several like-minded friends (Dr. Kelvin Chong and Mr. Daniel Tan) led to a start-up company – Denova Sciences. My decision to undertake SBS’s part-time Master of Science programme was mainly influenced by NTU’s growing international reputation as well as the vibrant, conducive learning and teaching environment at SBS. Flexibility in the programme allowed me to choose my*

*area of interest – skin biology, which played an important factor for my spin-off company in providing rigorous product testing and development using our proprietary in-vitro human skin models. In retrospect, my stint at SBS honed my abilities in problem solving and boosted my confidence exponentially. The skills and knowledge obtained and the chance to interact with researchers and industry personnel in the field, aided me in my path to be an entrepreneur. ”*



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*I was able to seamlessly integrate and begin my new research project thanks to the experience and exposure I obtained throughout my years at SBS.*

### ASSISTANT PROFESSOR WU BIN

Ph.D. Biological Sciences, Batch 2010

*“ Looking back at my days in SBS, I am very grateful that I made the right decision to continue my Masters and Doctorate at SBS. The world-class faculty members are exciting and energetic. Combined with the enriching atmosphere of openness, they gave a unique research synergy within NTU. As a Ph.D. student, I received good guidance from my direct supervisor and many esteemed professors and mentors in interdisciplinary fields. The accumulation of trainings and opportunities I gained*

*proved to be critical in my success as a researcher. This was apparent when I started my post-doctorate research at Harvard Medical School in Boston. I was able to seamlessly integrate and begin my new research project thanks to the experience and exposure I obtained throughout my years at SBS. I must say, the international community, well-equipped technology and most importantly the company of passionate scientists played an instrumental role in my journey as a researcher. ”*



# SCHOOL OF PHYSICAL & MATHEMATICAL SCIENCES

[www.spms.ntu.edu.sg](http://www.spms.ntu.edu.sg)

The School of Physical & Mathematical Sciences (SPMS) comprises three Divisions: Chemistry & Biological Chemistry, Mathematical Sciences and Physics & Applied Physics.

Since its establishment in 2005, SPMS has marked several achievements in conducting research, attracting and retaining strong faculty from all over the world, and nurturing talents. These include forging close partnerships with top overseas universities and securing more than SGD236.1 million of external grants for its various cutting-edge research. SPMS is home to the largest number (19) of National Research Foundation (NRF) Research Fellows in Singapore. With a strong foundation in the field of research and academia, SPMS has also attracted many top graduate and undergraduate students over the years.

With its growing number of dedicated faculty members and excellent research staff, SPMS is poised to scale greater heights and it will be the place for the next generation of scientists who will be positively impacting the future of our nation and society.



## DIVISION OF *CHEMISTRY & BIOLOGICAL CHEMISTRY*

The Division of Chemistry & Biological Chemistry aims to develop and maintain education and research programme of the highest standards. The Division is committed to fulfilling its core mission of excellence-in-research by providing an environment that promotes, supports and facilitates high impact research.

Our emphasis on safety, comfort and efficiency creates a modern research environment in what is already recognized as one of the best chemistry complexes in the world. Currently, the instrument laboratory houses instruments for high field nuclear magnetic resonance (NMR) spectrometry, mass spectrometry, confocal microscopy, X-ray diffraction, and transmission electron microscopy. There is also an atmospheric testing laboratory for analyzing environmental samples.



### MAIN RESEARCH FOCUS

- Analytical and Bio-analytical Chemistry
- Biological Chemistry and Chemical Biology
- Catalysis, Organic Chemistry and Synthesis
- Inorganic and Bio-inorganic Chemistry, and Organometallics
- Nano-materials and Materials Chemistry
- Pharmaceutical and Medicinal Chemistry
- Physical Chemistry, Chemical Physics and Computational Chemistry

$$E = mc^2$$

$$\omega = \frac{2\pi}{T} = 2\pi f$$

## STUDENT TESTIMONIALS



### NUR FILZA BINTE MOHAMED ASLAM

Economic Development Board-Industrial  
Postgraduate Programme (EDB-IPP)

Ph.D., Chemistry & Biological Chemistry, Batch 2012

*“ I had a very positive experience as an undergraduate at NTU, hence it was the most natural choice to further my studies here. CBC’s fantastic facilities, unparalleled in the academic world, together with its stimulating research environment and supportive supervisors were the main driving factors. I’m looking forward to an exciting 4 years here at NTU! ”*

*Our dynamic and vibrant international community of faculty, staff and students creates a unique multi-cultural diversity and flavour that provides different perspectives, experiences and collaborative opportunities. ”*

### TESSENSOHN EUGENE MALCOLM

Nanyang President’s Graduate  
Scholarship (NPGS)

Ph.D., Chemistry & Biological Chemistry, Batch 2012

*“ During my undergraduate years in CBC, I was privileged to have been guided by dedicated supervisors, to have interacted with passionate faculty members and staff and to have operated a variety of state-of-the-art equipment. I was also able to participate as a laboratory teaching assistant and peer tutor. Hence, the prospect of being able to continue working in this enriching environment and relive these fond memories made CBC my top choice for postgraduate studies. ”*



## DIVISION OF MATHEMATICAL SCIENCES

The Division of Mathematical Sciences is founded on the vision that mathematics is a continually evolving multidisciplinary science with widening roles in expanding applicability and deepening relevance across interdisciplinary interactions. Our brand new facilities are designed to encourage and inspire interaction among students and faculty members through open and functional spaces where discussions and formulation of ideas can take place. Supported by the latest powerful scientific software and high-performance data servers in our functional and innovative mathematics laboratories, research covers a broad range of areas in pure and applied mathematics as well as statistics.

We aim to develop a strong tradition in research in mathematical sciences and encourage interdisciplinary interests in the following areas:

### MAIN RESEARCH FOCUS

#### Discrete Mathematics

- Combinatorics
- Coding Theory
- Cryptography
- Mathematical Logic
- Number Theory

#### Probability & Statistics

- Biostatistics
- Statistics
- Statistical Genetics
- Mixture Model
- Mathematical Economics

#### Scientific Computation

- Computational Biology
- Algorithms, Analysis and Applications
- Finite Element Methods
- Optimization
- Bioinformatics

#### Theoretical Computer Science

- Computational Geometry
- Discrete Algorithms
- Computational Number Theory
- Network and Combinatorial Optimization
- Computational Complexity

#### Analytics

- Data Mining and Machine Learning
- Financial Analytics
- Consumer Analytics
- Urban Analytics
- Health Analytics



## STUDENT & ALUMNI TESTIMONIALS



### QUEK JIA HAO

Ph.D., Mathematical Sciences, Batch 2014

*“ The style and format of teaching and grading of the first year coursework is similar to the undergraduate studies, also at NTU. Courses were offered to equip us with broader fields of knowledge, although at that point I felt it was skewed toward pure mathematics. Having completed these courses, however, they provided new perspective on my research. It is enlightening.*

*I initially thought graduate life comprises only study and research. Experience proved otherwise. There are many extra-curricular activities such as sports competitions, gatherings at East Coast Park, and even singles' parties. In short, it has been a fun and fulfilling start, and I look forward to the rest of this journey. ”*

### DR KIAH HAN MAO

Ph.D., Mathematical Sciences, Batch 2010

*“ Opportunities are abound in SPMS. Through the many research collaborations, I have had the benefit of attending international workshops and conferences, and interacting with internationally established researchers. Some of the universities I had visited were Tsinghua University, Suzhou University and the Massachusetts Institute of Technology. ”*



## DIVISION OF PHYSICS AND APPLIED PHYSICS

The Division of Physics and Applied Physics (PAP) is a world-class centre for research and education in physics with over 30 faculty members, 100 research staff and supporting staff, 100 graduate students and 400 undergraduate students.

The Division is home to a vibrant community of physicists, where faculty and students are partners in a mutually enriching education process, immersed in learning and research. We have a young and dynamic team of faculty members with diverse educational background from international top-notch universities, dedicated to both teaching and research.

Important discoveries have been made by the Division, yielding many exciting world firsts, from realising optical cooling in semiconductors to the creation of an invisibility cloak. Our research is published in influential journals including Nature, Science, Physical Review Letters, Journal of the American Chemical Society, Advanced Materials, Nano Letters and others.

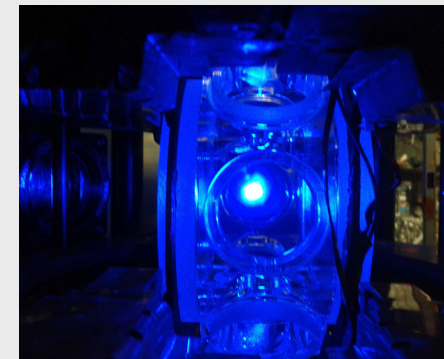
Our four main research areas are (i) Photonics, (ii) Quantum Physics and Quantum Information, (iii) Condensed Matter Physics, and (iv) Soft Condensed Matter, Fluid and Biophysics. These key areas are supported by state-of-the-art laboratories, ambitious research programmes and dedicated research centres.

Several research centres are home to our Division which contribute with their strong research focus to our successful research environment.

### Centre for Disruptive Photonic Technologies (CDPT)

The main objective of the Centre for Disruptive Photonic Technology programme is to generate a knowledge base for new light-based technologies with 10+ year outlook.

The CDPT Programme develops radically new nanotechnology-enabled artificial dynamic and reconfigurable photonic materials and components as a novel elemental base of revolutionary free-space, fibre and planar waveguide devices and optical nanocircuits, thus providing ground-breaking solutions for telecoms, energy, light generation, imaging, lithography, data storage, sensing, medicine, security and defence applications. By advancing the physics of control, guiding and amplification of light in nanostructures and by developing new nanofabrication techniques and methods of growth, hybridisation and integration into the waveguide and fiber environment of different novel material structures, the programme aims at developing disruptive technological solutions allowing for ultra-high-density integration, the lowest possible energy levels and the highest speeds of optical switching and data processing.



### Centre for Physics of Novel Electronics

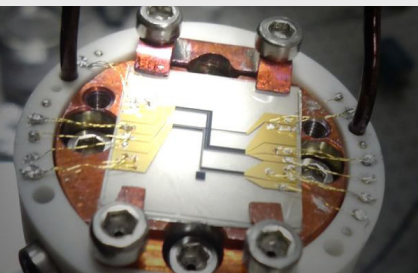
This programme is a coordinated effort to understand and employ properties of quantum mechanics to develop systems with functionalities arising from a collective interaction of electrons. Typically, combining a wide range of experimental tools developed in our laboratory or in close collaboration with industry, we utilise the spin, charge and orbital degrees of freedom and tune these using e.g., electric field, magnetic field, temperature, dimensionality, pressure and chemical composition.

Prototype civil engineering comprising a 30-metre deep structure elevates an entire laboratory housing a custom-made network of equipment for the growth, characterisation, manipulation and analysis of novel materials. We employ both experimental and theoretical methods to investigate problems such as unconventional superconductivity, electron-density variation across interfaces in atomically precise hetero-structures, new collective behaviour in the vicinity of quantum phase transitions and electron motion through materials at their quantum limits.

Experimental techniques developed in-house include miniature magnetometers, scanning probes, thermal and electrical measurement apparatuses to the milli-Kelvin regime and high fields. In the longer term, this effort entails a wider range of capabilities essential to products in key high-growth sectors, national security, human health and welfare like, and materials for clean energy systems.

### Quantum Technology @ NTU

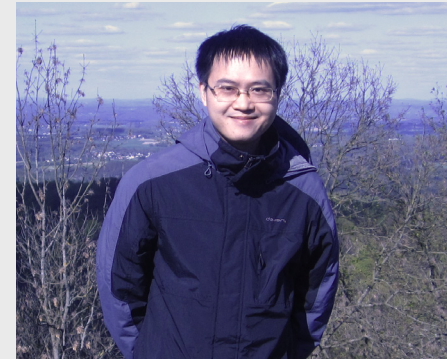
Quantum Technology is rapidly advancing towards realistic applications. Progress has been achieved as the physics community has been combining ideas and techniques from several fields, including quantum optics, quantum information and condensed matter physics. Although devising new technological applications remains a defining goal in the field, quantum technologies already allow us also to explore new physical regimes disclosing new fundamental science.



We have formed a specialized research team to tackle two main topics in this area (Quantum Simulation and Quantum Sensing) which will have a future impact in the understanding of quantum mechanical systems and possibly lead to the development of future key technologies. Five research teams with expertise in experimental and theoretical research are joining forces to tackle these topics. This research is strongly linked with the national research centre of excellence, the Centre for Quantum Technologies.



## STUDENT & ALUMNI TESTIMONIALS



### DR TA VAN DUONG

Singapore International Graduate Award (SINGA)  
Ph.D., Physics & Applied Physics, Batch 2010

*“ NTU provides an excellent environment for doing research and study. It was my great opportunity to be here with leading scientists, well-equipped labs, and a beautiful campus. Talented and hardworking students come to NTU, leading to a competitive and exciting multicultural atmosphere. I believe that my time here prepares me well for a challenging world. ”*

### DR CHRISTOPHER BRIAN HENRY JACQUES LECH

Singapore International Graduate Award (SINGA)  
Ph.D., Physics & Applied Physics, Batch 2009

*“ Educated as an Engineer and a Physicist, it was my dream to be able to continue my education while performing research that allowed me to apply computational and physical knowledge to biological and chemical systems. The College of Science has provided the perfect interdisciplinary research environment in which to fulfil these scientific ambitions. ”*



## GENERAL ADMISSION REQUIREMENTS

- **A good B.Sc. (Hons) degree** or equivalent, and the ability to pursue research in the candidate's proposed field of advanced study.
- **Good TOEFL or IELTS** (for international applicants whose native language is not English) and GRE scores are required for applicants who are not graduates from the autonomous universities in Singapore.

### FULL-TIME

| PROGRAMMES           | MINIMUM CANDIDATURE | MAXIMUM CANDIDATURE |
|----------------------|---------------------|---------------------|
| Doctor of Philosophy | 2 years             | 5 years             |
| Master of Science    | 1 year              | 3 years             |

### PART-TIME

| PROGRAMMES           | MINIMUM CANDIDATURE | MAXIMUM CANDIDATURE |
|----------------------|---------------------|---------------------|
| Doctor of Philosophy | 2 years             | 7 years             |
| Master of Science    | 1 year              | 4 years             |

## INTAKE

Admission is in August and January each year.

Please submit your application before the deadline for each intake.

Deadline for **August intake**: 31 January

Deadline for **January intake**: 30 June

*“Inspiring dreams, developing skills and confidence, celebrating talents and passions, touching lives and engaging excellence as we together discover science and achieve goals and ambitions – this is the College of Science!”*

## GRADUATE COURSEWORK

Graduate coursework forms the basis of the intensive preparation for research work. Students are required to attend classes and pass the examinations in a certain number of graduate courses.

Selection of courses is made after consultation with the research supervisor.

The Academic Unit (AU) requirements for the degrees are as follows:

- **M.Sc.** - 9 AUs for SBS and 12 AUs for SPMS
- **Ph.D.** - 12 AUs for SBS, 16 AUs for SPMS, and 24 AUs for ASE

Exemption of courses may be granted by the Chair of the School if the candidate is deemed to have already done sufficient coursework in relevant areas in a Master's degree programme at a recognized university.

## THESIS SUBMISSION

Students are required to submit a thesis in a form ready and acceptable for examination before the expiry of their maximum candidature.

**For M.Sc.** - Oral defense of the thesis may not be required.

**For Ph.D.** - An open seminar and oral defense of the thesis are necessary.



## TRANSFERABLE SKILLS PROGRAMME

At the College of Science (CoS), we believe that apart from research and intellectual skills, interpersonal skills, communication skills and other professional skills and attributes are also integral to post-graduate training. The Transferable Skills Programme aims to impart our students skills that are relevant to both research and other career options beyond their stint at NTU.

### COMPONENTS OF THE TRANSFERABLE SKILLS PROGRAMME

| TIMELINE   | CORE PROGRAMMES  | ELECTIVE MODULES (STUDENTS TO CHOOSE ANY FOUR COURSES)  |
|--|--|---|
| <b>Early Stage</b><br><br><b>0-12 months</b>     | <b>2-Day Residential Programme</b> <ul style="list-style-type: none"> <li>Effective Communication</li> <li>Networking</li> <li>Project Management</li> <li>Relationship Management</li> <li>Stress Management</li> <li>Team Building</li> </ul>  | <b>Courses by NTU Library</b> <ul style="list-style-type: none"> <li>Research Data Management</li> <li>Essentials of Copyrights and Licensing for Graduate Research</li> <li>Academic Research with EndNote, Basic</li> <li>Academic Research with EndNote, Advanced</li> <li>Academic Research with Mendeley</li> <li>Advanced Features of Key Resources in the Discipline</li> <li>Counting Citations and Beyond</li> </ul> |
| <b>Mid Stage</b><br><br><b>9-24 months</b>       | <b>Scientific Thesis Writing</b> <ul style="list-style-type: none"> <li>Scientific Communication</li> <li>Introductions and Signposting</li> <li>From Introduction to Literature Review</li> <li>Research Proposals and Citations</li> <li>Research Presentation</li> <li>Conclusions and Summaries</li> </ul> | <b>Programming Skills</b> <ul style="list-style-type: none"> <li>Computational Chemistry with Gaussian</li> <li>Basic HTML</li> </ul>   |
| <b>Late stage</b><br><br><b>36 months onward</b> | <b>Career Preparation Workshop</b> <ul style="list-style-type: none"> <li>Career Management</li> <li>Job Search Strategies</li> <li>Cover Letter &amp; CV Writing</li> <li>Interview Skills</li> </ul>   | <b>Computer and Software Skills</b> <ul style="list-style-type: none"> <li>Power Point (Intermediate)</li> <li>Photoshop (Intermediate)</li> </ul><br><b>Other Enrichment Skills</b> <ul style="list-style-type: none"> <li>Presentation Skills</li> <li>Professional Grooming</li> <li>Statistics for Scientists</li> <li>Intellectual Property &amp; Patent</li> <li>Research Integrity and Ethics</li> </ul>               |

## FREQUENTLY ASKED QUESTIONS (FAQ):

- Q** **Is it compulsory?**
- A** YES. From AY2015/16, this programme is a compulsory requirement for all full-time Ph.D. students. All other graduate students are encouraged to take advantage of the programme as well.
- Q** **How much time commitment would be required on my part?**
- A** We expect each student to spend between 50 to 60 hours on the transferable skills programme during their Ph.D. candidature.
- Q** **How do I register for the courses?**
- A** Students may be nominated by their respective schools for certain courses. Registration is not required for such cases. In addition, regular email circulars will be sent to students informing them of upcoming courses. Links for course registration will be provided in those emails.
- Registration for courses under this programme is currently not offered via the Student Link's Course Registration System.
- Q** **Is there additional fee involved?**
- A** No. This programme will be provided without additional cost to students.
- Q** **Can I submit my final thesis if I do not complete this programme?**
- A** Yes. However, the school will withhold its recommendation of your graduation, until such time that you have fulfilled the requirements for this programme.
- Q** **Will I be graded for the courses in this programme? Do I get Academic Unit (AU) credit for the course modules?**
- A** No. Some courses may require group work and presentation. However, there will be no formal classroom assessments. No AU will be assigned to the courses in this programme.
- Q** **I am currently pursuing my Master's degree. Can I participate in this programme or take some of the courses offered?**
- A** YES. This programme is open to all College of Science Graduate Students. Registration of courses would be based on availability.

## COLLEGE OF SCIENCE

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## Asian School of the Environment

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 [ase\\_postgrad@ntu.edu.sg](mailto:ase_postgrad@ntu.edu.sg)

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## School of Biological Sciences

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## School of Physical and Mathematical Sciences

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