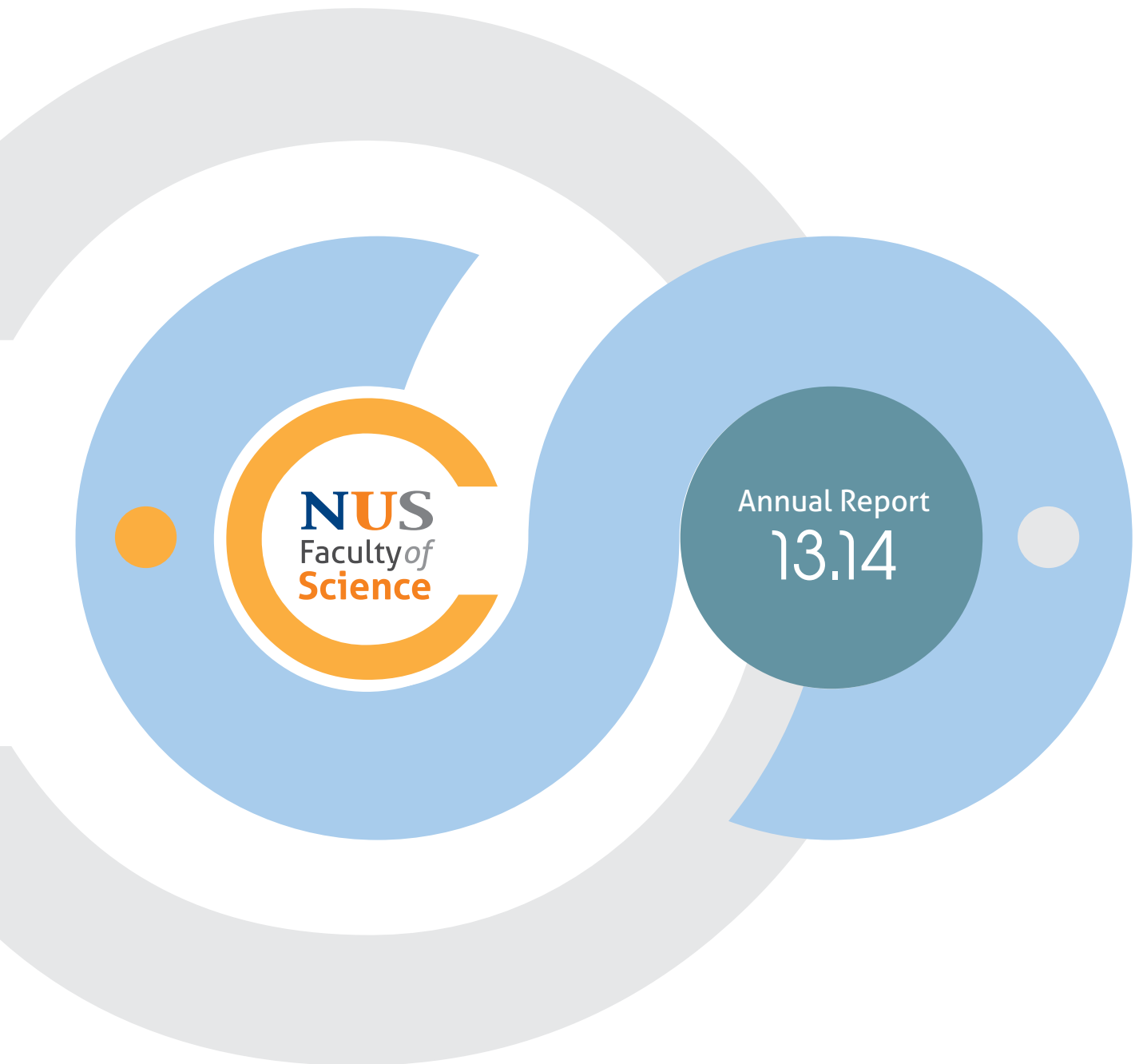


Transformative Science

EDUCATION, RESEARCH & SERVICE





Faculty of Science

VISION

To be among the world's best in science
education and research

MISSION

To provide quality education, foster the spirit of
enterprise and conduct leading edge research to
advance knowledge in Science and Technology for the
benefit of Singapore and the global community



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Transformative Science Transforming Lives

This academic year has been another successful and eventful year for the Faculty of Science. It was my privilege to take over the leadership from Prof Andrew WEE in April 2014. Under the leadership of Prof Wee, the Faculty successfully recruited top-notch faculty to further advance scientific research and teaching, deepened its research collaborations with industry and established world-class research facilities.

2014 marks the 85th anniversary of the Faculty. To commemorate this, a series of events has been planned to celebrate our journey in overcoming challenges and achieving remarkable progress since 1929 to become the successful Faculty it is today. With our long history and established track record of quality education and cutting-edge research, we are ranked amongst the best in Asia today.

Transformative Education The Faculty continues to transform its curricula and programmes to better prepare our students for the industry and the future. The Chemistry curriculum was extensively revamped and three new specialisations were introduced – Materials Chemistry, Medicinal Chemistry and Environment & Energy.

Two new concurrent degree programmes were launched. These were collaborations between the School of Biomedical Sciences, King's College London (KCL) and respectively, the Department of Biological Sciences, NUS and the Department of Chemistry, NUS. These programmes leverage on KCL's well-established forensic science programme with strong links to drug control centres and forensic laboratories to provide highly specialised skills training for the forensic sector in Singapore.

To deliver experiential learning in a multi-disciplinary and global environment, the first joint degree programme conducted by the Faculty of Science, NUS and the College of Arts and Sciences, University of North Carolina at Chapel Hill was also inaugurated.

Transformative Research We continued to produce high-quality research this past year to advance knowledge and benefit industry and society in the biological, chemical, mathematical,



Credit: W Architects Pte Ltd



pharmaceutical and physical sciences. Major breakthroughs have been made in numerous topics such as advanced materials, green chemistry, data science, pure mathematics, financial mathematics, plant genetics, molecular & cell biology, pharmacology and biodiversity. We also continued to collaborate intensively with industry and statutory boards to transform our scientific innovations into products and services that benefit society and create a sustainable future for Singapore.

Researchers from our Faculty continued to win highly competitive funding from the public sector. The Graphene Research Centre was awarded \$50 million by the National Research Foundation to set up the Centre for Advanced 2D Materials to study and develop applications for atomically-thin materials. The Lee Kong Chian Natural History Museum, a progeny of the Raffles Museum of Biodiversity Research, was established as an independent academic unit in the Faculty to curate, exhibit, teach and research biodiversity of plants and animals in Singapore and the region. This museum houses the largest Southeast Asian biodiversity collection.

We have also signed new agreements with industry and statutory board partners. These include GlaxoSmithKline in green catalysis, BASF in organic electronics and National Parks Board in green space creation.

Generous Support Our achievements would not have been possible without the generous support of our alumni and donors. The Lee Kong Chian Natural History Museum received a rare donation of a 200-year-old narwhal tusk from the family of the late Whampoa HOO Ah Kay. We also received a gift of \$2.24 million to establish the Lady Yuen Peng McNeice Graduate Fellowship to fund fellowships for postgraduate students conducting research on biodiversity and conservation in Southeast Asia.

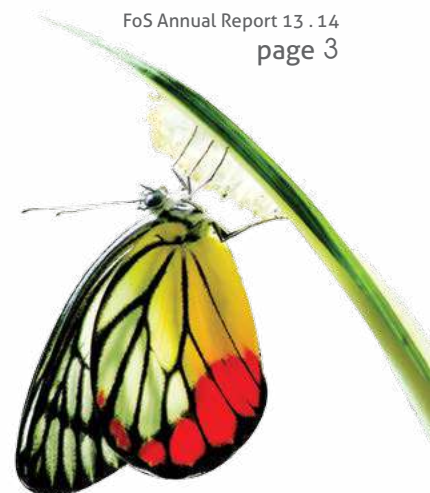
We are also grateful to our alumni who continue to give back to the Faculty in so many ways, such as developing new curricula, mentoring our students, providing internships and giving industrial talks.

2014 & Beyond Moving forward, I will continue to strengthen our educational programmes, expand our research collaborations and attract top students and faculty members to our Faculty. I look forward to working with my fellow colleagues to reach higher peaks of excellence in education, research and service. This will lead us to groom future generations of students and scientists who can transform the world and make it a better place.

SHEN Zuwei

Tan Chin Tuan Centennial Professor
Dean, Faculty of Science

With our long history and established track record of quality education and cutting-edge research, we are ranked amongst the **best in Asia** today.





Deanery Team



Sitting from left to right:

YU Hao

Vice-Dean
Graduate Studies

SHEN Zuwei

Dean

Roger TAN

Vice-Dean
Education and Special Duties

Eric CHAN

Vice-Dean
Undergraduate Studies and Student Life

Standing from left to right:

GOH Say Song

Vice-Dean
Outreach and Admissions

WONG Sek Man

Director
Alumni Relations and Special Duties

LIM Swee Huang

Director
Administration

Peter HO

Vice-Dean
Research

A leader is one who knows the way,
goes the way, and shows the way.

~ John Maxwell ~

The Year in Review

The Faculty of Science continues to upgrade its existing programmes and develop new ones to enhance the training of future ready graduates and the performing of high impact research. This year AY2013/2014, we launched two new international academic programmes, a new academic unit, a new research centre and our 85th Anniversary celebrations, amidst a host of other institutional activities.



Honing Forensic Science Skills at King's College London Aug 2013. Our Chemistry Honours graduate Shawn FOO (pictured) became the first student to enrol in the concurrent degree programme (CDP) leading to a B. Sc. (Hons) in Chemistry and an M. Sc. in Analytical Toxicology. This programme is jointly spearheaded by the Department of Chemistry, NUS and the School of Biomedical Sciences, King's College London (KCL). A related CDP offers a B.Sc. (Hons) in Life Sciences and an M. Sc. in Forensic Science, jointly spearheaded by the Department of Biological Sciences, NUS and the same school at KCL. These programmes leverage on KCL's well-established forensic science programme with its strong links to drug control centres and accredited forensic laboratories to provide highly specialised skills training for the forensic sector in Singapore. Shawn confides, "I've aspired to be a forensic scientist ever since I was fourteen. This concurrent degree programme helps me fulfil this dream."

Combining Liberal Arts and Science Education Jan 2014. Students enrolled in the first joint degree programme conducted by the Faculty of Science, NUS and the College of Arts and Sciences, University of North Carolina at Chapel Hill (UNC-CH). This programme pairs up liberal arts education offered by UNC-CH with science education at NUS. It provides for a unique experiential learning in a multidisciplinary environment that develops a global perspective in our graduates. Bhavya Kanti ALLENA (pictured, second from left), who was amongst the first batch of students to enrol in this programme says, "This programme gives me a new perspective on critical analysis and creates opportunities to develop new strengths." She majors in Life Sciences with specialisation in Biomedical Science.





85km

IN LESS THAN 6 HOURS

Launching 85th Anniversary Celebrations

Mar 2014. The Faculty of Science traces its roots to 1929 when Raffles College was established with classes in Chemistry, Mathematics and Physics. This year, the Faculty celebrates 85 years of history and accomplishments. The celebrations kicked off with the Resilience Run, a reminder that resilience brought us to where we are today and will bring us to where we need to go tomorrow. Dr William TAN (pictured, left top), our alumnus and prominent paraplegic athlete, completed 85 km on his paraplegic tricycle, together with friends, students and staff. Funds were raised to support activities organised by the NUS Enablers, a student-interest group for our special needs



students. WONG Zi-Heng, (pictured, left bottom) 2nd year Physics major, who sustained a devastating spinal injury last year, joined Dr Tan in this event. With his resilience, Zi-Heng has returned to NUS to resume his studies.

MORE THAN

500,000

FLORA AND FAUNA SPECIMENS

Spinning Off Lee Kong Chian Natural History Museum

Apr 2014. Singapore's first natural history museum, the Lee Kong Chian Natural History Museum (LKCNHM), has been spun off from the Department of Biological Sciences

as an independent academic unit within the Faculty to curate, exhibit, teach and research the biodiversity of plants and animals in Singapore and the region. The LKCNHM is a progeny of the Raffles Museum of Biodiversity Research which traces its roots to the Raffles collection in the 1820s. When the museum opens next year, it will house the largest Southeast Asian biodiversity collection and three almost-complete dinosaur fossils.

Credit: W Architects Pte Ltd





Hosting the 15th Asian Physics Olympiad May 2014.

The Department of Physics hosted the 15th Asian Physics Olympiad (APhO), a high-profile international competition amongst the best pre-university physics students around the world. Singapore was represented by a team of eight talented students who bagged three Gold medals, two Silver medals, one Bronze medal and two Honourable Mentions in this competition.



165

COMPETITORS

27

COUNTRIES

Setting Up the Centre for Advanced 2D Materials Jul 2014. Researchers from the Graphene Research Centre, Faculty of Science and Faculty of Engineering became the first group to win a \$50 million National Research Foundation grant to set up the Centre for Advanced 2D Materials. 2D materials are atomically thin materials that have interesting electrical, mechanical, optical and other properties. These include graphene, molybdenum disulphide and other layered semiconductors.



This centre will bring together materials scientists and engineers to develop wide-ranging scientific studies and applications of 2D materials.

\$50

MILLION AWARD
OVER 10 YEARS

Grooming Future Ready Graduates

As a global city with few natural resources, Singapore's future lies in the development of its talent pool. The Faculty of Science is strongly committed to help realise this by providing quality university education that fosters a spirit of innovation and enterprise. Each of our departments develops quality courses that teach subject-based skill sets relevant to our national needs. In addition, the Faculty organises programmes to advance soft skills and enhance the global perspective of our graduates. These include the Undergraduate Research Opportunities Programme in Science, Study Abroad Programmes, Undergraduate Professional Internship Programme and Special Programme in Science. Together with department coursework, these provide powerful mechanisms to sharpen our graduates' analytical and creative thinking, communication, problem solving and outward-looking abilities.



Undergraduate Research Opportunities Programme in Science (UROPS)

The UROPS was established in the Faculty in 1994 to let undergraduates earn modular credits from participation in frontier science research projects. This programme provides advance training in analytical and creative thinking, communication and presentation skills. Some of our UROPS students subsequently pursue a career in research when they graduate. "UROPS showed me how knowledge is created and applied in real life. This helped prepare me for research in the field of translational regulation in stem cells," says NAZREEN Binti V M Abdul Muthaliff (pictured), a B. Sc. (Hons) graduate in Life Sciences, and now a Research Officer with the Institute of Medical Biology, A*STAR Singapore. Graduates working in other industries also find the skills gained from UROPS relevant in their workplace.

2276 Science students in **UROPS** over the past 10 years



More than **60%** of our Science students participate in the **Study Abroad Programmes** with 200 partner universities.

Study Abroad Programmes (SAP)

The SAP encourages our students to step out of their comfort zone and spend up to two semesters abroad with accredited universities to read modules not available in NUS, experience a different culture, learn a new language and expand social networks. The modules read can earn credit for graduation. "My experience is eye opening in many more ways than one. Learning and working with individuals from different cultural backgrounds have honed my critical and creative research thinking skills. This learning journey together with the opportunity to build lasting friendships with fellow overseas participants has enriched my university life," says Mark SEOW (pictured, bottom left), a Life Sciences major and a participant in the Elsinore summer programme with the University of Copenhagen, Denmark.



Regional Collaborations: The BES Programme The Faculty is engaging international partners more intensely, in particular those in Southeast Asian countries, to prepare our graduates for this rapidly growing region. We have put in place mechanisms to fund collaborative workshops and study trips for our undergraduates. Some of these have also been integrated into our courses, like the Bachelor of Environmental Studies (BES) programme where students spend time abroad to study regional wildlife and environmental issues in relation to local societal and government contexts.

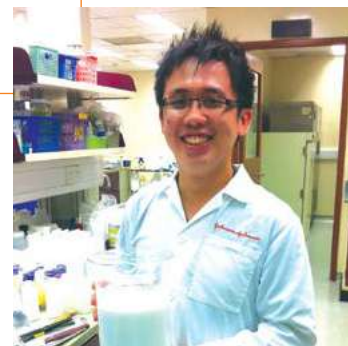
Grooming future ready graduates erudite in **science**, skilled in **reasoning** and predisposed to **lead** in an ever-changing global landscape



Special Programme in Science (SPS) The SPS was first mooted at the Faculty almost two decades ago in 1996 to provide a platform for integrated science learning and discovery through four specially designed modules namely Atoms and Molecules, The Cell, The Earth and The Universe. Students in this programme also work in groups to analyse and research a topic that is often outside their major field of study. This multidisciplinary approach to the study of science stimulates in our graduates a deeper appreciation of different scientific disciplines, which in turn helps them in their profession as scientists.

242 Science students have participated in **UPIP** since its inception in 2011

Undergraduate Professional Internship Programme (UPIP) NUS offers career readiness programmes beginning in the Freshmen year with the HeadStart module. At the Faculty of Science, we further provide our students with the UPIP option from their third year of studies. This module offers them the opportunity to experience corporate life, gain early insights into organisation management and understand business etiquette with industry or government-sector partners. "I did my UPIP with Johnsons & Johnsons (Singapore) and worked across two departments - consumer quality & compliance and skincare R&D. My interactions with people from different countries and cultures shaped my outlook. This greatly helped prepare me for a cosmopolitan working environment," says Elgin TING (pictured), a B. Sc. (Hons) graduate in Chemistry.



Celebrating Student Achievements

10

Students of the Faculty of Science continue to achieve academic and non-academic excellence in their fields of endeavour. In the following, we highlight excerpts from two valedictorian speeches, featuring two sports persons and present to postgraduate award winners. Their testimonials and accomplishments will inspire our current and future students to reach greater heights.



From the Graduating Class of 2014

Free yourself. "What I have learnt during the past six years of research is that we are bound only by our imagination. Only when you dare to try those crazy ideas would you possibly be able to create a significant piece of work. This applies to any field, scientific or otherwise. Always remember that you yourself define the boundary of your imagination," says Dr GONG Zheng (pictured), a Ph.D. graduate in Mathematics, in her valedictorian speech. She is now an instructor at the Department of Mathematics, NUS.



Chase your dreams. "We leave here with the skills ready to face the world, find our niche and chase our dreams. I know for sure that those of us graduating with the Statistics degree have the skills and knowledge versatile enough for us to find a field that we are passionate about. As the famous statistician John Tukey once said, 'The best thing about being a statistician is that you get to play in everyone's backyard'," says TAY Yu Xuan (pictured), a B. Sc. (Hons) graduate in Statistics and Saw Swee Hock Gold Medallist, in his valedictorian speech. He is now an actuarial analyst.

Student Achievement in Sports

Archery star. CHAN Jing Ru (pictured) won the SEA Games gold medal in archery at the 2013 SEA Games held in Myanmar. She graduated July 2014 with a B. Sc. (Hons) in Life Sciences and is pursuing post-graduate research at the Department of Biological Sciences. Jing Ru picked up archery during her studies at Temasek Polytechnic and has represented Singapore in numerous competitions. When asked how she balanced the rigour of study and competitive sports, Jing Ru says, "It is really hard at times. The key is discipline of the mind to focus on one activity at a time..."

SEA Games Gold Medallist
in Archery, from the Faculty





Student Achievement in Sports

NUS Sportswoman of the Year. Clara WONG (pictured) won the title of NUS Sportswoman of the Year 2013 for her accomplishments in triathlon. She is a 3rd year Life Sciences major. She started with aquathlon in 2006 and moved to triathlon. In 2010, she won a spot to represent Singapore in triathlon at the inaugural Youth Olympic Games. When asked the reason for doing a sport that is physically and mentally demanding, Clara replies, "The opportunity to race in different parts of the world makes triathlon exciting and romantic for me. Take Subic Bay in the Philippines, the water there is so clear you can see the ocean floor drop into a dark abyss..."

Post-Graduate Awards

Saving forests. Dr Jacob PHELPS (pictured) is dedicated to conservation policy. Currently, he is a scientist with the Centre for International Forestry Research, a non-profit organisation based in Bogor, Indonesia, that conducts research on forest management worldwide. His team analyses how Indonesian agencies deal with environmental valuation and environmental crimes. Jacob is also an editor of the Philippines' National REDD+ (Reducing Emissions from Deforestation and Forest Degradation) Strategy, which guides forestry development there. In addition, he reports for the United Nations World Institute for Development Economics Research and UNESCO's World Heritage Forests. Jacob won the 2014 Wang Gungwu Medal and Prize for his Ph.D. studies in forest ecology.



Rehabilitating giant clams. Dr NEO Mei Lin (pictured) pointed out in her Ph.D. studies that giant clams (*Tridacna gigas*), which once colonised the reefs here, are now highly endangered in Singapore waters, as in the rest of the Indo-Pacific region. This triggered National Parks Board to fund an effort to reintroduce the species back into local reefs. Mei Lin contributed to the breeding and culturing programme. The inaugural transplantation of a seven-year-old clam took place on 15 Jul 2014 at the Sisters' Islands Marine Park. Mei Lin won the 2014 World Future Foundation Ph.D. Prize in Environment and Sustainability. She is now a Research Fellow at the Tropical Marine Science Institute.



Making a Difference

Project Angel is a longstanding series of institutional social responsibility flagship projects organised by NUS Students' Science Club. This year Project Angel XVI focused on regional environmental conservation, reaching out to villagers in Mangkang, Indonesia. The highlight was an overseas expedition to this coastal village to rehabilitate a mangrove swamp. The rehabilitated swamp forms part of a "green belt" that will mitigate coastal erosion, stabilising the coastline to protect villagers' livelihood.



Mangkang Our Science Club students studied the local biodiversity, planted new mangrove seedlings and visited schools. They shared their knowledge on recycling and environmental sustainability with local school children and teachers, and learnt first-hand the livelihoods of their host families. "On the replanted mangrove, once the seedlings mature, their roots will provide a natural habitat for many animals, such as mud crabs, shrimps and fishes, which are important to the livelihood of these villagers. The local community could harvest the mangrove fruits and use them to make into food products which they could sell, and this will provide a source of income to the villagers. The roots will also protect the coast from storm surges," says PAE Jun-Zhi, a Chemistry major and Director, Project Angel XVI.



13000 MANGROVE SEEDLINGS PLANTED



Science Club worked with **NParks, NEA and Waterways Watch Society** to conduct beach clean-up at Ketam Beach in Pulau Ubin and East Coast Park, and a kayaking river clean-up at Kallang Basin

Pulau Ubin As part of the preparation for this expedition, the team conducted mangrove swamp familiarisation at Pulau Ubin. Our students also worked with NParks to clean up Ketam Beach.



Kallang Basin and East Coast Park After their return from Mangkang, the team conducted a kayaking river clean-up at Kallang Basin and led a coordinated effort by Science students to clean up the East Coast Park beach. "These activities are part of our institutional social responsibility effort towards environmental conservation in Singapore," says LOH Jun Yan, a Life Sciences major and volunteer.



Science Volunteer Corps (SVC) This is an organisation within the NUS Students' Science Club that engages in community work all around Singapore. This year, SVC continues to support the National University Hospital's (NUH) Club Rainbow programme to bring joy to children recovering from chronic illnesses at NUH. Every week, our Science students volunteer their services and time at the children's ward, culminating in a Christmas Party in December 2013.

Our Science students brought **joy and laughter** to over **70** young patients at NUH Club Rainbow this past year



ALIVE! stands for Appreciating Lives, Initiating Volunteerism, Everyday! ALIVE! is an annual event organised by SVC to celebrate and promote volunteerism. In May 2014, ALIVE! came to University Town where Science students reached out to the elderly in a skills-sharing carnival. These activities helped to bridge the generation gap between young and old in a light-hearted setting.

ALIVE! reached out to more than **50** elderly citizens from the Caregiving Welfare Association

The NUS Pharmaceutical Society This society of pharmacy undergraduates continue to operate their flagship "Know Your Medicines, Get it Right!" community help programme this past year. They partnered with voluntary pharmacists from the Pharmaceutical Society of Singapore to reach out to elderly patients, reviewing their medications and advising them on proper medicine use. In recognition of their work, the society received the North West Community Development Council We Care @ North West Award and the People's Association Community Spirit Excellence Award this year from Minister LIM Swee Say, Deputy Chairman of the People's Association.



Attracting Talents

The Faculty of Science, together with the Ministry of Education (MOE) and other partners, has run numerous pre-undergraduate research programmes, competitions, and other outreach events for many years. The objectives are to promote and sustain public awareness and interest in science education and to encourage students to read science at the Faculty. In AY2013/2014, we launched the inaugural masterclass lecture series and new workshops and programmes for junior college and secondary school students.



Masterclass Lecture Series at Junior Colleges This past year, the Faculty initiated a series of Masterclass Lectures at junior colleges. For example, at National Junior College, one of our professors gave a lecture and scientific demonstration of physics principles. At Anderson Junior College, our faculty shared in a series of talks how biology, chemistry, mathematics and physics have shaped society and industry. These lectures, delivered by award-winning academic staff of the Faculty, were well received by students and teachers.

OVER **1500** STUDENTS ATTENDED THE LECTURES

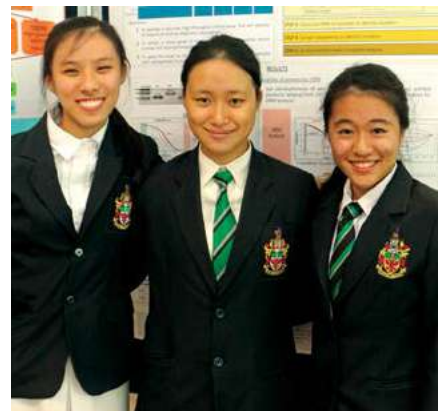
Workshops at the Chemistry Department In July 2014, the Chemistry Department held two half-day events for junior college students on campus to give them a first-hand experience of undergraduate life at NUS. The activities included a lecture on the impact of chemistry in daily lives, a Chemistry education programme talk, a hands-on experiment in one of our state-of-the-art teaching laboratories and visits to various research laboratories in the Department.

1000 STUDENTS AND TEACHERS PARTICIPATED IN THE EVENTS



104
STUDENTS
COMPLETED
THE SRP THIS
PAST YEAR IN
FACULTY OF
SCIENCE

Science Research Programme The Faculty co-organised with the MOE a one-and-a-half-year-long Science Research Programme (SRP) for Year 1 junior college students. Selected students conduct research under the mentorship of NUS faculty and staff from institutions. These students presented their research findings at the 26th Science Research Congress held at the University Town on 19 Apr 2014.





CHAOS Competition On 31 May 2014, the Faculty and MOE jointly held the annual Creative and Heuristic Applications of Science (CHAOS) final competition for lower-secondary school students at the Science Centre Singapore. The students presented their findings on biodiversity-themed questions set by the competition panel. As a highlight of the competition, the students toured the Island Adventurer Exhibition featuring the expeditions of Alfred Russel Wallace in Singapore and Southeast Asia, whereupon he co-discovered with Charles Darwin the theory of evolution by natural selection.

140 PARTICIPANTS AT THE EVENT



Surprising Supermarket Science Workshops with Dow Singapore Dow Chemical Pacific (Singapore) Pte Ltd, a subsidiary of The Dow Chemical Company, a leading global chemical company, made a gift of US\$50,000 to the Science Demonstration Laboratory (SDL) of the Faculty, to launch an initiative to train our undergraduates in science communication and to promote science among secondary school students. Staff of SDL together with scientists and engineers from Dow Singapore developed a series of 10 workshops on "Surprising Supermarket Science". Through these workshops, secondary school students learnt about the science that underpins supermarket products, such as hair sprays, erasers and diapers. This collaboration with Dow Singapore promotes science in an interesting way, de-mystifying the notion that science is difficult to grasp.

300
STUDENTS SURPRISED!

Xperiment! The Faculty celebrated scientific and engineering innovations at Xperiment! 2014, which was part of the Singapore Science Festival co-organised by A*STAR and the Science Centre Singapore. The event was held at the Marina Square Central Atrium from 18 to 20 Jul 2014. Staff from the Science Demonstration Laboratory and the Centre for Quantum Technologies, together with our Science students, dazzled the visitors with spectacular demonstrations of light spectroscopy.



ABOUT 3000 VISITORS OVER THE 3-DAY EVENT



Department of Biological Sciences



"Evolution". Since its founding some 70 years ago, the **Department of Biological Sciences** at NUS has reinvented itself several times to keep up with the demanding pace of biology, changes in the education and research missions of NUS, and the priorities of

Singapore. This transformation from a teaching-intensive department to a research-intensive department occurred through a series of strategic steps. In the first step in the 90's, the departments of Zoology and Botany were merged to give the Department of Biological Sciences. In the second step at the beginning of the new millennium, the department became research intensive through hiring top young talents and developing state-of-the-art core facilities. Now the department is just completing the next step by expanding into Environmental Biology and Biophysical Sciences, placing a much stronger emphasis on the development and application of quantitative and computational tools to analyse and model biological phenomena.

Ecology and Biodiversity Research

Our world-renowned Ecology and Biodiversity research groups increasingly focus their efforts on understanding climate change and urbanisation on biodiversity and conservation in the tropics. A notable achievement in AY 2013/2014 is the demonstration by Prof David BICKFORD, graduate student Luke GIBSON and their collaborators that fragmented forests are highly vulnerable to rapid biodiversity loss (see Box 1.1). This suggests urgent efforts need to be made to preserve large intact forest areas and to restore connectivity in fragmented ones. Also this past year, Dr John VAN WYHE, a historian of science, and founder and director of *Darwin Online* (<http://darwin-online.org.uk/>), has completed reconstructing Darwin's *Beagle* Library. The library was used by Darwin during his famous 1831–1836 voyage aboard HMS *Beagle* and includes 403 volumes and 195,000+ pages, providing unprecedented new insights into the young Darwin on his landmark expedition around the world. This voyage ultimately resulted in the creation of modern evolutionary biology, which changed science and our understanding of the world.

Molecular Cell and Developmental Biology

The department is a world centre for Molecular Cell and Developmental Biology of fish and plant models. Prof YU Hao and his group this past year have made a major breakthrough in linking environmental signals to the epigenetic regulation of key genes which control flowering (Box 1.2). This will have significant impact on the engineering of flowering traits in agricultural crops. Prof Christoph WINKLER and his collaborators, using the zebrafish model, have also made a major breakthrough in understanding spinal muscular atrophy, an important and often fatal motoneuron disease that afflicts humans. This research has vast implications in future therapies for spinal muscular atrophy (Box 1.3).

Biophysical Sciences

Our Biophysical Sciences group is anchored by the Mechanobiology Institute (a national Research Centre of Excellence) and the NUS Centre for BioImaging Sciences (CBIS). Prof Mike SHEETZ has led the MBI research to the forefront of understanding how cells sense their local mechanical microenvironment and relay such signals to alter genome regulation and tissue behaviour. MBI has developed state-of-the-art methods to manipulate, measure and detect forces at the molecular and cellular level. Also Prof Utkur MIRSAIDOV and his group are pushing electron microscopy in a new direction to image the dynamics of molecules. They are making use of new microscopy technologies developed almost exclusively by CBIS.

We anticipate that this broad range of cutting-edge research activities will continue to raise the international profile of our department and expose our undergraduates to cutting-edge laboratory experiences.

Infrastructure renewal

Keeping pace with these changes requires a constant "evolution" of the research and teaching infrastructure of the department. More than half of the research laboratories and all of the teaching laboratories within the department have now been recently renovated. Equally important, the department is continuing to build new capabilities. We have built a new state-of-the-art plant growth facility suitable for large-scale screening. We are now building a new insectary and a new mass spectrometry facility. Also,

we are planning to build a computational biology cluster to investigate and model the massive datasets needed to understand biological phenomena. These changes equip us for more advanced training of our undergraduate and

graduate students, and position us to continue to make the most significant research advances in the future.

Paul MATSUDAIRA
Head, Department of Biological Sciences

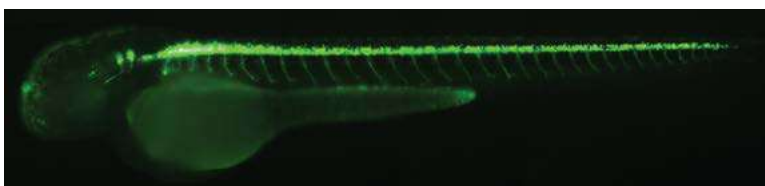
Research Commentary



Box 1.1: Extinction by fragmentation Deforestation – which is rapidly expanding throughout the tropics – has converted the biologically richest habitats on this planet into a landscape of forest patches surrounded by a “sea” of agriculture. Although these forest fragments are able to sustain some biodiversity, much of this biodiversity can disappear over time. A study by Prof David BICKFORD, graduate student Luke GIBSON and their associates has revealed that entire guilds of animals can become nearly extinct after a surprisingly short period of isolation, just 25 years, on islands in a hydroelectric reservoir. Therefore urgent efforts are needed to preserve large intact forest areas and to restore connectivity in fragmented ones in order to preserve the tropical biodiversity before it disappears.

Box 1.2: To flower or not to flower? Plants respond to various signals to determine when and how to flower. This is essential for their reproductive success. Current changes in global climate and other environmental factors are gradually altering the pattern of plant reproductive development and the life cycle of their pollinator species, which raises great concerns on plant productivity and the relevant ecosystem. Prof YU Hao and his group have reported major breakthroughs in linking climate-related signals with the epigenetic regulation of key flowering genes. The group has identified novel regulators and mechanisms which would allow the engineering of flowering traits in various crops.

Box 1.3: Spinal muscular atrophy: new insight from a zebrafish model Spinal muscular atrophy (SMA) is a devastating human disease that destroys nerve cells controlling muscles. This leads to muscle wasting and paralysis, which is often fatal. It is known that this is caused by mutations in SMN, a protein that performs housekeeper functions in all body cells. Why defects in SMN exclusively damage nerve cells remains unknown. Now Prof Christoph WINKLER and his collaborators have discovered using a zebrafish model that this is because SMN controls activity of Neurexin2a, a protein that is essential for nerve cell function. Importantly, replenishing Neurexin2a levels in SMN-deficient zebrafish prevented nerve cell degeneration. This opens possible new avenues towards future therapies.





Department of Chemistry



The **Department of Chemistry** at NUS continues to excel in research. This year the 2014 QS World University Rankings by subject places NUS Chemistry as top 12th globally.

The strategic research foci of the department include Catalysis, Environmental Chemistry,

Materials Chemistry and Medicinal Chemistry. These clusters have established their distinctive international presence. For example, the Environmental Chemistry cluster has formed strong links with the Singapore–Peking Oxford Research Enterprise (SPORE) and the NUS Environmental Research Institute (NERI). The Materials Chemistry cluster continues to lead NUS efforts to publish high-impact papers and to commercialise graphene science and technology, which are pivotal to the success of the Graphene Research Centre.

Publications

In AY2013/2014, the department has published more than 370 international journal articles. A significant number of our research papers have excited widespread interest across the scientific communities as cover pages and hot papers. The department also continues to publish in top-notch journals this year, including a paper each in *Nature* and *Science*, 13 papers in the *Nature* sister journals, including *Nature Chemistry*, *Nature Communications*, *Nature Nano-technology* and *Nature Materials*. In addition, 21 papers were published in the *Journal of American Chemical Society* and 28 papers in *Angewandte Chemie International Edition*. This publication profile places the department ahead of regional competitors. It also reflects our commitment to research excellence.

Research breakthroughs

Several major accomplishments were made this past year. Prof LOH Kian Ping and his group have developed a face-to-face transfer process for graphene from its growth surface on a metallic thin film to the underlying substrate, which overcomes a critical bottleneck for technological applications of these graphenes (see Box 2.1). Prof Christian NIJHUIS and his group have made the first measurements of tunnelling charge-transfer plasmons in nanometre-scale molecular junctions, which has possible applications in molecular plasmonics (Box 2.2). Prof LIU Xiaogang and his group have discovered a new

class of rare-earth nanocrystals that can produce efficient violet upconversion light, which may enable deep-tissue bioimaging (Box 2.3).

Research grants, awards and recognition

The department has won 5 MOE Tier 2 grants (\$3.5+ million) and several A*STAR and external grants (\$5 million). In addition, the department has also won two grants from the Environment & Water Industry Programme Office (\$2.5 million) to develop sensors and analytical methods for pathogen and toxin detection in water.

Several faculty members won prestigious research awards in AY2013/2014. Prof Loh Kian Ping won the American Chemical Society Nano Lectureship award, one of the three winners from Asia, Europe and U.S.A. Prof LU Yixin won the Faculty Outstanding Scientist Award, while Profs CHEN Wei and YEUNG Ying Yeung won the Young Scientist Award. Prof WU Jishan won the Dean's Chair Professorship for 2014-2017. Prof HUANG Dejian has been lauded in the Highly Cited Researchers 2014 report published by *Thomson Reuters*. Prof Loh Kian Ping was appointed associate editor of *Chemistry of Materials*, a prestigious American Chemical Society Journal. Prof LIU Xiaogang was appointed associate editor of *Journal of Luminescence* (Elsevier). Prof LEE Hian Kee was named by The Analytical Scientist as one of the 100 Most Influential People in the Analytical Sciences. Mr RAGHAVENDER Medishetty (graduate student) won the Best Poster Presenter Award at the "6th HOPE meeting with Nobel Laureates."

Teaching infrastructure

The department has recently completed the renovation and air-conditioning of its synthesis, physical chemistry and general teaching laboratories, greatly expanding the number of available fume hoods and teaching equipment. Next year the department will be renovating and air-conditioning the analytical teaching laboratory. These upgrades would provide a better environment for the training of our undergraduates.

Teaching curriculum

The department has also extensively revised the teaching curriculum and implemented the revamp in AY2013/2014. We have merged the Applied Chemistry programme into the Chemistry major programme and introduced three new specialisations: Materials Chemistry, Medicinal Chemistry and Environment & Energy. We have also introduced new topics which are highly relevant to current chemical industry and updated our laboratory curriculum

to include the teaching of more relevant skills, such as multistep synthetic reactions and sophisticated techniques, and greater use of NMR reaction product analysis. Our revamped laboratory classes also include experiments in the emerging technology areas of environmental, energy and materials chemistry. We are currently developing new laboratory classes to train our undergraduate students in biochemical techniques, which are expected to be available next academic year. All these augmentations will greatly raise the proficiency of our students in a broad range of synthetic and analytical skills relevant to the future chemical industry.

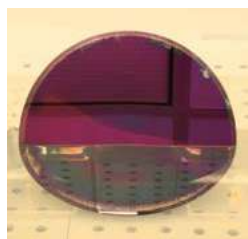
International Chemistry Olympiad (IChO)

The department has provided a notable service to the 46th IChO held in Hanoi, Vietnam, 20-29 July 2014. The Singapore team was trained and led by Mr FUNG Fun Man and Dr Stephen CHUI, both of whom are staff of the department. The Singapore team won 2 gold and 2 silver medals, finishing joint second in this competition. This year, Mr SUN Jiarui, a student of Raffles Institution, emerged the top IChO student amongst 291 competitors.

LOH Kian Ping

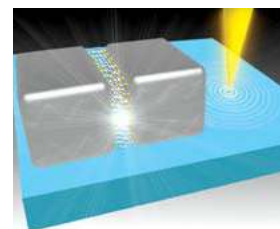
Head, Department of Chemistry

Research Commentary

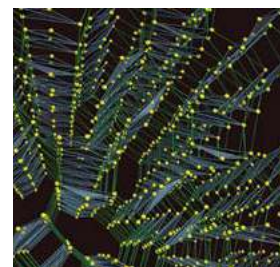


Box 2.1: Towards graphene technologies Graphene – single monolayer of carbon atoms bonded in a hexagonal honeycomb structure – has excited worldwide interest because of its numerous interesting properties. Graphene films can be grown on thin metal films that are first deposited onto inexpensive substrates such as silicon. However no method yet exists to transfer these graphene films to the desired substrates where they are to be finally applied. Prof LOH Kian Ping and his group have made a major breakthrough to transfer this graphene overlayer grown on a copper film to the underlying silicon substrate. The method relies on formation of nascent gas bubbles and capillary bridges between the graphene overlayer and the underlying substrate during etch removal of the intervening metal layer. This overcomes an important bottleneck to graphene technologies.

Box 2.2: Light in molecular tunnel junctions Light travels in space as waves. However it can also interact with matter to give plasmons which are collective oscillations of charge density. These plasmons can further be confined in nanostructures where their energies can be tuned. It has been predicted previously that quantum tunnelling of the oscillating charge can occur between two plasmonic resonators if the gap between them is small enough. Prof Christian NIJHUIS, Dr BAI Ping (Institute of High Performance Computing, A*Star), Dr Michel BOSMAN (Institute of Materials Research and Engineering, A*Star) and their groups, have reported the first observations of tunnelling charge-transfer plasmons across metallic gaps of 4 to 13 Ångstroms which were spaced by self-assembled monolayer molecules in molecular tunnel junctions. The electronic tunnel barrier width and height were controlled by the properties of the self-assembled monolayer molecules. This phenomenon bridges molecular electronics and plasmonics, potentially opening up a new field of study.



Box 2.3: Efficient violet light photon upconversion Photon upconversion is a process in which two or more photons are sequentially absorbed in a material to give emission of a single photon at a shorter wavelength than those absorbed. An example is the conversion of infrared light to visible light. Materials that can upconvert photons often contain ions of rare-earth metals, such as lanthanum. Prof LIU Xiaogang and his group have discovered a novel class of rare-earth nanocrystals that have unusually long excited state lifetimes. These can then produce efficient emission of violet light by sequentially absorbing three or four infrared photons, which was previously not possible. This upconversion process can potentially benefit high-contrast deep-tissue biological imaging, as it is less susceptible to background light contamination.



Department of Mathematics



The **Department of Mathematics** at NUS has experienced extraordinary growth in the last 20 years, in the breadth and scale of its undergraduate programmes, in the depth and vibrancy of its postgraduate programmes, and in the steadily increasing research capacity and

reputation of its faculty.

Education programmes

It has always been the department's mission and key focus to provide quality education. The Special Programme in Mathematics (SPM), which is designed for students with a strong passion and aptitude for the mathematical sciences, has produced very good results: some of our top honours students from SPM have gone on to excellent graduate schools such as Princeton and Harvard. With quality faculty and supervision, our Ph.D. graduates have also done equally well. Many of them have been offered attractive positions such as postdocs in excellent universities and faculty positions in research universities.

To equip Math students with the educational training to meet industrial needs, the department has introduced this past year two specialisations within the Applied Mathematics major. These are Mathematical Modelling & Data Analytics and Operations Research & Financial Mathematics. This will help our students develop useful skills in these emerging new areas besides the foundational training in applied mathematics, and help them become more employment ready.

For postgraduate education, the department operates a successful M.Sc. Programme in Quantitative Finance. This enhances the skills and knowledge of quantitative finance professionals. There is a large demand for this programme. The yearly cohort averages 50, while the number of applicants exceeds 300 this year.

Research breakthroughs

Notable research breakthroughs made by the department this past year include the resolution of several important mathematical conjectures on Ramsey's Theorem by Prof CHONG Chi Tat, Prof YANG Yue and their associate (see Box 3.1), in financial mathematics by Prof DAI Min and his associate (Box 3.2), and on the Howe Duality Conjecture

by Prof GAN Wee Teck and his associate (Box 3.3). These represent some of our contributions to fundamental advances in mathematics.

Faculty recruitment

In faculty recruitment, the department has been especially successful in attracting outstanding mid-career mathematicians with steep research trajectories. Their appointments have added significant strength to a number of research areas (such as those in dynamics systems, partial differential equations, representation theory & automorphic forms and quantitative finance) and have thus helped to reshape the department's research landscape in important ways.

International recognition

Faculty members of the department have been producing ground-breaking research across a number of sub-disciplines. As a result, an increasing number of our staff are being recognised in the international mathematical community. For instance, there have been more than ten publications in recent years in the most sought-after journals of mathematics, including *Annals of Mathematics*, *Inventiones Math.*, and the *Journal of the American Mathematical Society*. To cite another example, four members of the department (Profs BAO Weizhu, GAN Wee Teck, SHEN Weixiao and YU Shih-Hsien) have been invited to speak at the International Congress of Mathematicians, August 2014, in Seoul, South Korea. This is the most prestigious speaking engagement in mathematics.

Synergism with Institute for Mathematical Sciences

The department has a strong working relationship with the Institute for Mathematical Sciences. Our faculty members are actively involved in organising programmes, workshops and summer schools at the Institute. Leading mathematicians and scientists from around the world visit the department and the Institute to exchange research knowledge. This has contributed to the continuing expansion and vibrancy of mathematical research and to the training of the next generation of mathematicians in Singapore.

ZHU Chengbo
Head, Department of Mathematics

Research Commentary

Box 3.1: A conjecture on Ramsey's Theorem solved Ramsey's Theorem is a well-known theorem in combinatorics. It states that for any pair of positive integers n, k , any function f from the n -element subset of natural numbers into $\{0,1,\dots,k\}$, there is an infinite subset H of natural numbers such that f restricted to the n -element subset of H is a constant function. Since 1972, recursion theorists have been studying the effective content of Ramsey's Theorem. The case when $n = k = 2$ (called RT-2-2) and its weaker version SRT-2-2 have been the topic of major interest and extensively investigated. One of the most important problems in this area was the conjecture that RT-2-2 could not be derived from SRT-2-2. It was believed that new techniques and ideas were required for this. Prof CHONG Chi Tat and Prof YANG Yue in a joint work with Prof Theodore A. SLAMAN of UC Berkeley have now resolved this problem. A key idea involved the use of nonstandard models, a subject the NUS logic group has been studying for over 20 years.

Box 3.2: A conjecture in financial mathematics solved In finance, an investment strategy is a set of rules to guide the selection of the best investment portfolio that would maximise returns and minimise risks. This is a stochastic optimisation problem that can be rigorously analysed by mathematics in certain cases. For example, the solution for a risk-averse investor who can access a single risky asset or multiple uncorrelated risky assets is known. However the situation for an important case where this investor can access multiple correlated risky assets as well as a risk-free asset is not solved. Now Prof DAI Min and his associate have thoroughly characterised this case, and succeeded to prove that the trading region has the prerequisite shape for a well-defined optimal trading strategy to exist. In particular, the no-trading region has distinct corners. This shape has been conjectured and widely cited in the existing literature, but was never proven before.

Box 3.3: The Howe Duality Conjecture solved Prof GAN Wee Teck and Prof Shuichiro TAKEDA from University of Missouri have resolved a forty-year-old conjecture of Roger HOWE in representation theory. The Howe duality correspondence is a transfer of symmetry types from a group G to another group H . The Howe duality conjecture asserts that the transfer of an irreducible (or atomic) symmetry of G is an irreducible one for H . This basic conjecture was proved in many special cases by Howe, Kudla and Waldspurger, sometimes involving long and complicated proofs. Now the Gan–Takeda preprint resolves it definitively in only twelve pages!

$$\dim \text{Hom}_H (\Theta(\pi), \Theta(\pi')) \leq \delta(\pi, \pi')$$



Department of Pharmacy



The **Department of Pharmacy** at NUS is the only tertiary academic unit in Singapore that offers degree programmes in Pharmacy and Pharmaceutical Science. The department aims to be a leader in shaping healthcare through innovative pharmaceutical education,

research and practice. This vision guides the overall mission of the department to develop competent pharmacists and pharmaceutical scientists for the healthcare and pharmaceutical sectors. In addition, the department is also committed to innovative research to create new knowledge and advance healthcare practices to meet the evolving needs of society. AY2013/2014 has been another busy year for the department. The following are selected highlights of this year.

Pharmacy education with a difference

The undergraduate professional degree - Bachelor of Science (Pharmacy) – is recognised by the Singapore Pharmacy Council as a pre-requisite for registration as licensed pharmacists. We have conducted a curriculum review and developed a new revised programme. This has now been approved for implementation in AY2014/2015. This enhanced programme will provide our students with a more holistic education with a stronger emphasis on patient care. It aims to instil professional attitudes and skills through clinical and scientific experiential learning. The new curriculum organises the course content into four longitudinal themes where multidisciplinary subjects are integrated into single modules to help our students appreciate the inter-relationship of the subjects. In addition, all our Pharmacy undergraduate students in their final year will now conduct individual research projects and go through a six-month internship programme.

Research that impacts human health

Research is an integral part of the faculty's portfolio. Our faculty members in the department can be broadly classified into four research clusters: (i) Drug Discovery & Design, (ii) Product Innovation & Development, (iii) Molecular Pharmacology & Drug Disposition and (iv) Health Outcomes & Services Research. The ultimate research goal is to address pharmaceutical and health needs in society through scholarly endeavours.

Notable accomplishments in AY2013/2014 include

breakthroughs in drug design, pharmacology, and community healthcare programmes. Prof Brian DYMOCK and his group have developed novel slow-releasing hydrogen sulphide drugs that show promise for inhibiting cancer cell proliferation (see Box 4.1). Prof Joyce LEE and her team have pioneered the first pharmacist-led community healthcare programme in Singapore to help patients manage chronic conditions (Box 4.2). Prof HO Han Kiat and his group have demonstrated the potential for exosomes to mitigate drug-induced liver damage, a major unsolved clinical challenge (Box 4.3). These efforts are representative of the diversity in research activities within the department.

Research seminars and symposia

As part of our research culture, we conduct research seminars and symposia to facilitate exchange among academics. The following are some examples of activities conducted in this past year:

- ITB-NUS Pharmacy Scientific Symposium, organised by Prof GO Mei Lin, for students and staff from Institute Technology Bandung, Indonesia, and NUS (12 Nov 2013).
- The 6th Asian Association of Schools of Pharmacy Conference on "Integrating Science, Technology and Practice for Sustained Excellence in Pharmacy Education", organised by Profs Paul HENG and Celine LIEW (14-17 Nov 2013)
- A symposium on "Nanotechnology in Food – Past, Present and Future", organised by Prof Rachel EE in collaboration with the Food Science & Technology Programme, NUS, and Agri-Food & Veterinary Authority of Singapore (18 Nov 2013)
- The Annual Research Awareness Symposium organised by the department to showcase some 107 final-year projects and postgraduate research projects (8 Apr 2014)
- A symposium on "Age related neurodegenerative disorders", organised by Profs Christina CHAI and Giorgia PASTORIN (12 May 2014)
- A 4-day workshop on pharmaceutical pellet manufacturing and processing, organised by GEA-NUS Pharmaceutical Processing Research Laboratory (GEA-NUS PPRL) (19–22 May 2014)
- The 9th PharmSci@Asia Symposium 2014, co-organised (with advice provided by Profs KANG Lifeng and CHAN Sui Yung) by the Pharmacy postgraduate students from NUS and Fudan University, in Shanghai, P.R.C., for more than 200 delegates from 21 universities (5-6 Jun 2014)

Pharmacy students' service to the community

Led by Profs Christine TENG and CHEW Eng Hui, Pharmacy students from the NUS Pharmaceutical Society, together with volunteer pharmacists from the Pharmaceutical Society of Singapore, provided a community service, "Know Your Medicines, Get It Right!" (see p. 13). This is a free service that provides one-on-one advice to help the public understand and properly use their medications. The programme was conducted in partnership with welfare

organisations, neighbourhood links, senior activity centres and the People's Association (see p.13). This programme has received two awards in AY2013/2014: We Care @ North West 2014 Award (North West Community Development Council) and Excellence Award 2014 (People's Association Community Spirit Awards).

CHUI Wai Keung
Head, Department of Pharmacy

Research Commentary

NEW MEDICINE?



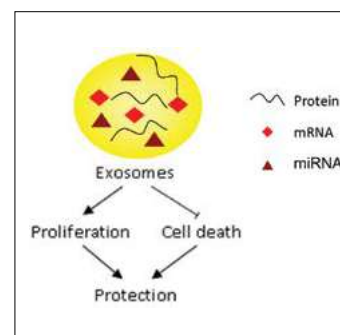
HYDROGEN SULFIDE GAS

Box 4.1: New Strategies to Stop Cancer The malodorous gas hydrogen sulphide is poisonous at high concentrations, but at low concentrations is essential for proper cellular regulation of sulphide concentrations in tissues. A deficiency in hydrogen sulphide can lead to diseases such as cancer. Prof Brian DYMOCK and his group have developed a novel series of drugs that can release hydrogen sulphide very slowly in a controlled manner under physiological conditions. These drugs were established to be highly effective in inhibiting proliferation in human tumor cell lines. The group is now combining these drugs with other novel molecules they have developed to target the key processes in cancer cell development to devise new effective treatment strategies for cancer.

Box 4.2: New healthcare role for community pharmacists

In Singapore, one out of five patients has diabetes. Diabetes is in general a rather challenging chronic condition to manage effectively. Prof Joyce LEE and her associates have now devised the first pharmacist-led community programme in Singapore to give diabetes patients timely and cost effective access to healthcare professionals. To achieve this, Prof Lee has trained community pharmacists based in retail stores to help patients understand their treatment regime and reach their treatment goals. A pilot study that was subsequently conducted to evaluate the programme has found it to be effective, with 76 out of 100 subjects attaining an improvement in their HbA1c, an indication of blood glucose concentration, at 6 months. This healthcare model can potentially be expanded to include the management of other chronic illnesses.

Box 4.3: Exosomes to the rescue Drug-induced liver injury (DILI) is a major clinical problem that arises as a side effect of taking some medications. Unfortunately there has been no therapeutically proven treatment to protect against this. Prof HO Han Kiat and his group have discovered that exosomes can mitigate the extent of liver injury. Exosomes are small organelles consisting of cellular contents enclosed by lipid membranes. The group obtained the exosomes from mesenchymal stem cells. Using both in vitro and animal models, the group established that exosomes have the ability to stimulate liver regenerative signals and cell proliferation. This approach has also been useful to treat acute heart injury. Thus exosomes may potentially lead to the development of new drugs to protect against DILI.





Department of Physics



The **Department of Physics** of NUS, with over 70 faculty members, conducts a wide variety of education and research activities. The mission of the department is threefold: to educate physics students to reach their full potential in areas like entrepreneurship, to

perform physics research at the frontiers of science and technology, and to provide scientific service to the nation and community.

Our current research strengths can be broadly classified into: Physics of Nanoscience, Condensed Matter Physics & Advanced Materials, Biological Physics, Atomic & Molecular Physics, Nonlinear Optics, Quantum Information, Graphene & Two-Dimensional (2D) Materials and Theoretical Physics. Members of the department are also developing research programmes in emerging areas in energy-related physics (such as batteries, solar cells, energy conversion efficiency), environmental, climate, geophysics and advanced materials (such as functional materials, quantum materials, topological insulator, exotic superconductor, meta-materials).

Research breakthroughs

The department continues to excel in research this past year. Notable achievements in AY2013/2014 include:

- Fundamental breakthroughs by Prof Andrivo RUSYDI and his collaborators in the understanding of electron-electron interactions in cuprates, an important high temperature superconductor model (see Box 5.1).
- First experimental evidence from Prof YAN Jie and his collaborators that alpha-catenin, a cellular surface protein, responds to physiological levels of forces, providing a key mechanosensor function to cells (Box 5.2).
- First theoretical prediction and experimental observation by Prof Shaffique ADAM and his collaborators of a new magnetoresistance mechanism in disordered graphene and other 2D materials (Box 5.3).
- First experimental demonstration by Prof LI Baowen and his collaborators of a bilayer thermal cloak.
- First experimental demonstration by Prof ONG Chong Kim and his collaborators of an unidirectional electromagnetic cloak designed by topology optimisation.

- Discovery of strain-induced electrical conductivity in ultrathin films of lanthanum strontium manganese oxide by Prof Andrivo RUSYDI and his collaborators.

The department is closely associated with several research centres within the University. These include the Centre for Quantum Technologies, Graphene Research Centre, NanoCore, Mechanobiology Institute and Singapore Synchrotron Light Source. Our faculty members have played pivotal roles in establishing these centres and are still intimately involved with their research and management. This helps to create a dynamic and vibrant research culture within the department.

This year, faculty members at the Graphene Research Centre have played a critical role to establish the Centre for Advanced 2D Materials to study and develop applications for atomically-thin materials. This centre has recently won a \$50 million grant from the National Research Foundation. It will build on the success of the Graphene Research Centre, which will have its activities folded into the new centre.

Research accolades

This past year, our faculty members have won several prizes and recognition.

- Prof Thirumalai Venky VENKATESAN, also at the Department of Electrical Engineering, NUS, has won the Institute of Physics Singapore (IPS) President's Award 2013 for contributions to scientific research, industrial leadership and guidance of new generations of physicists in the creation of new ventures in Singapore.
- Prof Barbaros OEZYILMAZ has won the IPS World Scientific Medal 2013 for his contributions to graphene research.
- Prof Goki EDA has won the IPS Omicron Nanotechnology Award 2013 for his contributions to 2D semiconductor crystal research.
- Prof LI Baowen was elected Fellow of the American Physical Society for his contributions to physics research.
- Prof FENG Yuan Ping has won the CN Yang Award in Science and Technology for New Immigrants (Singapore).
- Prof WANG Jian-Sheng has won the Provost's Chair Professorship, 2014.
- Prof YAN Jie has won the Dean's Chair Professorship, 2014.

Education

On the education front, the department has contributed strongly in AY2013/2014 to the Coursera online initiative. Prof Valerio SCARANI and his team have developed the online module "Unpredictable? Randomness, Chance and Free Will" that is available to the public. Prof CHUNG Keng Yeow and Dr YEO Ye developed the online version of the Engineering Physics module PC1431FC. This course consists eighteen weeks of video presentations and online assignments. It is the first of the online courses to be made available to incoming undergraduate students who have completed their national service, before they formally matriculate in NUS. Another notable accomplishment is the development of a new minor in Medical Physics.

This has now been approved and will be implemented in AY2014/2015. The programme will train a pool of medical physicists for the needs of the national healthcare sector.

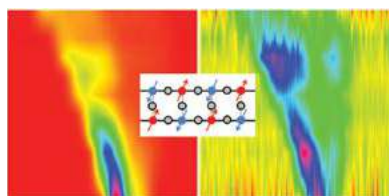
Asian Physics Olympiad 2014

In collaboration with Materials Research Society – Singapore, Institute of Physics – Singapore, National Institute of Education, Nanyang Technological University and with the strong support of Ministry of Education, the department has successfully organised Asian Physics Olympiad (APhO) 2014, held 11–18 May 2014 at NUS. A total of 27 teams participated in this event.

SOW Chong Haur

Head, Department of Physics

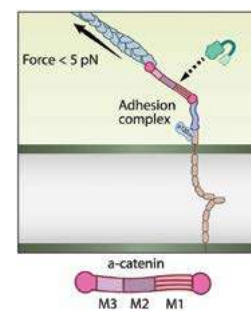
Research Commentary



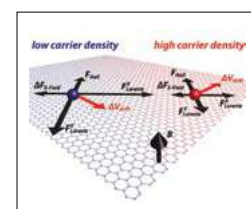
Box 5.1: Every electron counts Electron correlation is the interaction between electrons that are distributed among the quantum energy levels of a material. Such electron–electron interactions, though not well understood, can play particularly important roles in determining the properties of some materials such as superconductivity. Prof Andriwo RUSYDI and his collaborators have employed advanced spectroscopy methods at the Singapore Synchrotron Light Source, NUS, and the free-electron laser FLASH at DESY, Germany, to discover new electronic correlations and screening mechanisms in a high-temperature superconductor cuprate. They found that introducing a small quantity

of charges into the material can have an unexpectedly large impact on its electronic and superconducting properties. This challenges the common assumption that individual electrons have little influence on electronic structure. The findings could potentially provide the missing link to understand not only high-temperature superconductors but also other modern materials.

Box 5.2: How cells sense force Cell–cell interactions play a crucial role in cell biology, tissue development and cell communications. However the role of mechanical forces in changing protein conformations and hence protein binding is not well understood. Prof YAN Jie and Prof R MEGE (Institut Jacques Monod, University Paris Diderot, and CNRS) and their groups have demonstrated that mechanical forces that are present between cells can indeed determine the outcome of a vital cell–cell interaction. They showed that at a small force of about 5 picoNewtons exerted on alpha-catenin, a protein found at cell surfaces, is sufficient to trigger a conformation change that activates its binding to a signaling protein vinculin. The alpha-catenin retains the new conformation even after the mechanical force is removed. This provides the first experimental evidence for an important hypothesis that alpha-catenin is a mechanosensor with force-dependent interactions with vinculin.



Box 5.3: A new magnetoresistance phenomenon Magnetoresistance is the property of a material in which its electrical resistance changes in the presence of a magnetic field. Special thin-film multilayer materials that show giant magnetoresistance effects are now in widespread use as magnetic field sensors. These play a key role in magnetic hard disk drives, magnetoresistive memory, biosensors, electromechanical sensors and other device technologies. Several distinctive mechanisms can give rise to magnetoresistance in different materials configuration. Now Prof Shaffique ADAM and his experimental collaborators at Monash University, Australia, and the University of Maryland, U.S.A., have discovered a new mechanism for magnetoresistance in disordered graphene and other two-dimensional materials. They found that material imperfections result in large variations of the local electron density, and that this spatial variation of carrier density causes the electron trajectories to be strongly modified by an external magnetic field. This effect could potentially be used in new two dimensional magnetoresistive devices.





Department of Statistics and Applied Probability



The **Department of Statistics and Applied Probability** at NUS has done well this past year in terms of both research and education. The 2014 QS World University Rankings by subject places NUS "Statistics and Operational Research" as top 7th in the world, and 1st in

Asia. Below are some of the highlights of the department in AY2013/2014.

Our faculty members have contributed to impactful research in bioinformatics, high-dimensional statistics, time-series analysis, computational statistics, imaging data and probability theory. Our research findings have been published or accepted in highly competitive statistics and probability journals and also in multidisciplinary journals. The prestige of the department is also reflected in the editorial memberships of our faculty.

Bioinformatics Prof CHOI Kwok Pui, together with his Ph.D. student TAN Ngoc Hieu and a collaborator from the Department of Mathematics, has published a paper in *Nature Communications* (2013) describing an accurate method to gauge whether a biological motif is rare or abundant in a biological network.

High-dimensional statistics Prof CHEN Zehua and his Ph.D. student LUO Shan have a paper on the Lasso method accepted by the *Journal of the American Statistical Association* (2014). Prof LI Jialiang has a joint paper on high-dimensional longitudinal studies accepted by the *Annals of Statistics* (2014). Prof XIA Yingcun and his former student Dr KONG Efang have a paper on sufficient dimension reduction accepted by the *Annals of Statistics* (2014) (see Box 6.1).

Time series analysis Prof XIA Yingcun and his Ph.D. student WANG Tianhao have a paper accepted by the *Journal of the American Statistical Association* (2014).

Computational statistics Prof CHAN Hock Peng has a joint paper on particle filtering published in the *Annals of Statistics* (2013) (Box 6.2).

Imaging Data Prof YU Tao has a joint paper on imaging data science published by the *Journal of the American Statistical Association* (2013) (Box 6.3).

Probability theory Prof ZHOU Wang has a joint paper on SLE curves published in the *Annals of Probability* (2013). Prof FANG Xiao has a joint paper on Stein identities published in the *Annals of Probability* (2013).

Editorship

Prof LOH Wei-Liem and Prof XIA Yingcun are Associate Editors of the *Annals of Statistics*. Prof Loh Wei-Liem is an Editor of the *Journal of Statistical Planning & Inference*.

Education

Our Ph.D. students and undergraduates have made important research contributions and have been hired by top U.S. universities.

- Dr TAN Ngoc Hieu (supervised by Prof CHOI), has a paper published in *Nature Communications* (2013).
- Dr LUO Shan (supervised by Prof CHEN), has a paper accepted by the *Journal of the American Statistical Association* (2014).
- Ms NEW Jin Rou (supervised by Prof Leontine ALKEMA), has a paper accepted by the *Annals of Applied Statistics* (2014).
- Four of our recent Ph.D. graduates have secured post-doctoral fellowships in the United States, namely Carnegie Mellon University (Dr JIANG Binyan), University of Pennsylvania (Dr WANG Tianhao) in 2013 and Columbia University (Drs LI Xiang and Linda TAN) in 2014.

Centre for Statistical Science

Through its Centre for Statistical Science, the department has successfully organised several events this past year to promote awareness of statistical science among the general public, and its correct applications among the community of researchers in Singapore.

- A workshop on high-frequency trading in finance was conducted to bridge the gap between the increasing importance of high frequency trading and the relative lack of public understanding in this aspect of the financial markets (Nov 2013). Workshop participants included academics and financial professionals.
- The 4th Singapore Conference on Statistical Science was organised, covering topics in biostatistics, financial statistics, econometrics, actuarial science, statistical methodologies and applied probability (Feb 2014). The conference was well-attended by both local and overseas participants.

- Two public outreach events were organised to promote statistics appreciation among pre-university students. The 9th Statistics Enrichment Camp was held in Jun 2014, and the 11th Singapore Statistics Poster Competition was held in Jul 2014. Both events generated keen interest among students from secondary schools, junior colleges and the polytechnics.

In summary, the department has achieved its strategic objectives for AY2013/2014 to provide quality statistics education, research and services.

LOH Wei-Liem

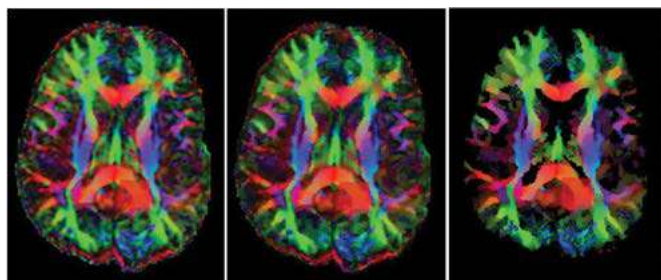
Head, Department of Statistics and Applied Probability

Research Commentary

Box 6.1: Faster and better Sufficient Dimension Reduction Sufficient dimension reduction (SDR) is an important paradigm used in statistical modelling to extract features for pattern recognition. SDR enables the number of independent variables to be reduced without losing the ability to predict the outcome. Although several methods exist to do this, they have some limitations. Prof XIA Yingcun and his collaborators have now pioneered a new local linear kernel smoothing approach to SDR that is applicable to more complicated data and proposed the Minimum Average Variance Estimation (MAVE) method that enjoys the highest statistical efficiency. Recently, he is developing another SDR approach based on composite quantile regressions. This method can adapt automatically to the data structure and is numerically more stable.

Box 6.2: Predicting outcomes in processes with randomness Particle filters are sequential Monte Carlo methods that enable the estimation of hidden states from observations of their outcomes, through the application of hidden Markov models. Such models can describe phenomena which contain inherent randomness. These include many real-world, highly complex phenomena such as those found in finance and genetics. Crucially particle filters in conjunction with hidden Markov models enable the prediction of future observations, and hence the future behaviour of these systems. Prof CHAN Hock Peng and associates have succeeded to derive an asymptotic theory of particle filters from martingale representations, and consistent standard error estimators that allow the evaluation of how good the estimators are. This provides a strong foundation for key assumptions in hidden Markov models.

Box 6.3: Enhancing brain images Images perform a vital function across the entire spectrum of science and technology to display information visually for human interpretation. However images inevitably contain noise. An important objective of imaging data science is thus to develop appropriate mathematical and/or statistical methods to improve the quality and visual clarity of these images, in an efficient way. This is particularly important when the images contain a massive amount of data, such as those arising from brain imaging. Prof YU Tao and associates have developed a new statistical methodology based on the spatial shrinkage estimation method to efficiently remove noise from brain imaging data. This method incorporates spatial information, an L1-type method, and locally weighted least square function in the estimation of the diffusion tensor from the diffusion-weighted imaging data. The method significantly enhances medical imaging of the physical structure of the human brain in vivo, in particular by allowing for fibre tracking of the neurons. This will enable neuroscientists and biomedical professionals to more accurately understand brain activities.





LKCNHM

Lee Kong Chian Natural History Museum



On 1 Apr 2014, the Raffles Museum of Biodiversity Research transitioned into the Lee Kong Chian Natural History Museum (LKCNHM). The museum is presently housed at Block S6, but will move to its new premises at Conservatory Drive in 2015. With the transition, the LKCNHM now functions as an academic unit within the Faculty of Science. It strives to be a leader in Southeast Asian biodiversity and conservation research, education and outreach. The

museum continues to discover new species, with more than thirty new species in Southeast Asia described in AY2013/2014 (see Box 7.1). Below are some of the other highlights for the year.

Outreach and Education Unit (OEU)

Over 1,650 members of the public, schools and other organisations have attended activities organised by the OEU of the museum. These workshops and nature walks promote natural history and ecology among the participants. The museum has led trips to Bukit Timah Nature Reserve, Changi Beach, Kusu Island, Pulau Semakau, Pulau Ubin and Sungei Buloh Wetland Reserve.

LKCNHM Toddycats

The LKCNHM Toddycats programme (formerly Raffles Museum Toddycats) was conceived in 1999 to promote an appreciation for Singapore's biodiversity and natural heritage. In the past year, the Toddycats have engaged some 6,000 members of the public through various activities such as public seminars and heritage events. LKCNHM partnered with National Parks Board and other organisations at the 3rd "Festival of Biodiversity" (FOB) held 12 and 13 Jul 2014 at Vivocity, which attracted 11,000 people.

Exhibitions

The Museum's conservator was involved in *Unearthed*, an exhibition at Singapore Art Museum that featured installations used to stuff two historical LKCNHM specimens – a tortoise and a crocodile. Specimens from the LKCNHM are also on display at the National Museum of Singapore as part of the *Balik Pulau* exhibition on the island heritage of Singapore.

The International Commission on Zoological Nomenclature (ICZN)

In Nov 2013, the museum organised and hosted a meeting of the ICZN, the governing body on how animal names are created. The LKCNHM (with support from NUS) has since taken over the prestigious role of ICZN Secretariat.

The Raffles Bulletin of Zoology (RBZ)

The Science Citation Index listed RBZ has gone completely electronic since the start of 2014. A change in zoological nomenclature meant that scientific names are no longer required to be published in a paper journal, which allowed the journal to speed up its publication.

The Museum now stands at the threshold of moving to a new home and we look forward to an even more exciting year ahead.

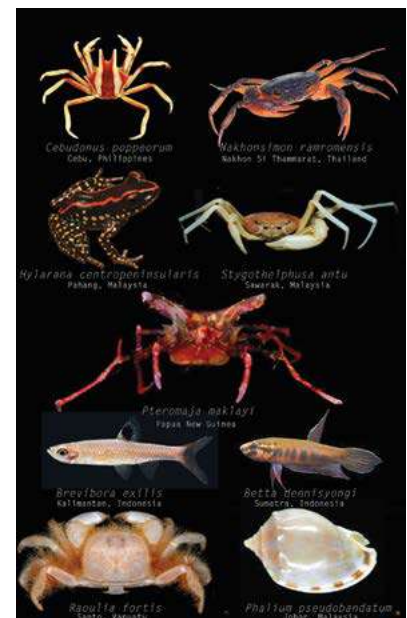
Peter NG

Head, Lee Kong Chian Natural History Museum

Commentary

Box 7.1: Discovery of new species continues unabated

The Lee Kong Chian Natural History Museum continues to be at the forefront of biodiversity research in Singapore and Southeast Asia, even though activities had to be substantially reduced due to the preparations for the new museum building and the move in late 2014. Despite the redeployment of manpower and resources, staff of the museum still made numerous discoveries of new species in the last academic year, as well as conduct novel studies on conservation, ecology and general biology. More than 30 new species from Southeast Asia were discovered and described. One highlight - the description of the Malaysian frog (*Hylarana centropeninsularis*) was also featured on the biodiversity news website Mongabay.

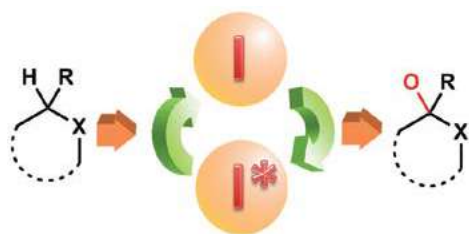


For other breakthroughs from Lee Kong Chian Natural History Museum, please visit: lkcnhm.nus.edu.sg

For recent research news from Faculty of Science, please visit: www.science.nus.edu.sg/research/news

Transforming the Future

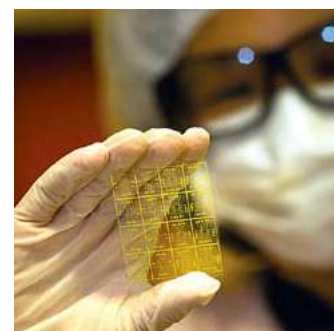
The Faculty of Science conducts research to advance knowledge, industry and society. One of the overarching themes is enhancing sustainability. This is research that improves society's capacity to use natural resources to meet the needs of the human population on a trajectory that can persist into the far future. Our researchers excel in many of the key research areas in this theme, which includes green chemistry, advanced materials, data science, biodiversity, sustainable agriculture, clean water and safe food. We work increasingly closely with industry to transform our scientific innovations into services and products that benefit society, and with statutory boards to create a sustainable future for Singapore. Here are some of our largest partnership deals signed in AY2013/2014.



Innovating industrial oxidation catalysts The synthetic chemistry research group led by Prof YEUNG Ying Yeung partners with global pharmaceutical manufacturer, GlaxoSmithKline (GSK) to develop novel catalysts that can perform chemical oxidations without relying on the use of heavy metals. Oxidation is an important industrial process used worldwide for the manufacture of pharmaceuticals and fine chemicals. This research programme will develop novel iodine reagents

to replace the conventional heavy-metal-based reagents which are costly and environmentally unfriendly. The computational insights for this programme are provided by Prof Richard WONG's research group.

Developing plastic electronic devices The device chemistry and physics research groups of Profs CHUA Lay-Lay and Peter HO partner with global chemical manufacturer BASF to develop high performance organic thin-film transistors. These are electronic devices which use organic carbon-based materials as semiconductors. Such organic semiconductors can be inexpensively processed using solution methods to produce flexible and large-area electronics. This research programme will leverage on photocrosslinking and doping breakthroughs developed by these groups to create innovative organic semiconductor device architectures with higher performance. These researchers have also won two large intellectual property pipeline licensing agreements with industry in the organic electronic space recently.



Creating green spaces in Singapore The biodiversity research group of Prof Edward WEBB collaborates with the National Parks Board to understand the factors influencing tropical bird and butterfly biodiversity at roof gardens in Singapore. Roof gardens are expected to become an increasingly important source of greenery across Singapore because of the limited space for ground-level vegetation. Already a surprising number of butterfly and bird species have been found to use these roof gardens. This research programme will devise a set of design and management guidelines for roof gardens to sustain and enhance this biodiversity.

Realising Dreams

The Science Student Overseas Exposure Fund (SSOEF) was established in 2006 to support financially-challenged students in their pursuit of various study abroad programmes. In 2008, the Faculty initiated the Science Student Fund (SSF) that comprises the SSF Bursary and the SSF Emergency Aid. The broad aim of SSF is to provide financial assistance to our needy students who are from low income families. Over the years, the total number of SSF bursaries has increased significantly due to the generous donations by our alumni, staff, students and friends.



Your special gift means a lot to me... I've been inspired to not only do better academically but to better myself as a person, to work hard in everything I do and to help others in every little way possible.

~ A Life Sciences major and beneficiary of the SSF Bursary who wished to remain anonymous

Lady Yuen Peng McNeice Graduate Fellowship The Lady Yuen Peng McNeice Graduate Fellowship was established this past year by her son, Mr Terry MCNEICE, through the Cheng Kim Loke Foundation in honour of the life and work of the late Lady Yuen Peng MCNEICE, a renowned conservationist and philanthropist. Lady Yuen Peng had been unwavering in her enthusiastic support for Singapore's biodiversity community. The Fellowship will support at least one postgraduate student each year to carry out research on biodiversity and conservation efforts in Southeast Asia. This will contribute to strengthening NUS as a world leader in this field. Prof YU Hao, Vice-Dean of Graduate Studies, says, "We are honoured to have this opportunity to establish the Lady Yuen Peng McNeice Fellowship to continue her legacy in conservation. It will allow us to work towards understanding the region's biodiversity and contribute to its conservation and sustainable utilisation."



Credit: National Parks Board (NParks)



A gift of an heirloom from the Whampoa family Mdm HOO Miew Oon, great-granddaughter of the late HOO Ah Kay, better known as Whampoa, donated a 2.7-metre-long tusk of the narwhal (*Monodon monoceros*) to the Lee Kong Chian Natural History Museum. The narwhal is an Arctic toothed whale that possesses a long, straight but helical tusk derived from a protruding canine tooth which may have inspired the unicorn myth. This tusk has been a family heirloom of the Whampoa family. Prof Peter NG, Director of the museum, says, "This is a rare and very precious gift! Narwhal tusk specimens of this size are now hard to come by as it is not acceptable today to hunt these magnificent animals. The museum is deeply honoured to receive, curate and exhibit this treasure from the illustrious Whampoa family."

We thank Mdm Hoo Miew Oon and her family for this generous gift."



Honouring Our Alumni

After graduation, our alumni work in a diverse range of professions. Many of them continue to keep in touch with each other, separately or through events that we organise, often contributing their expertise and services to enhance the education of the undergraduate students of the Faculty of Science. A number of these alumni reach outstanding heights in professional and/or personal accomplishments.

This year, we feature three of our alumni for their recent **achievements in entrepreneurship, science & technology**, and a third one for her remarkable **resilience** to excel and reach out to the physically challenged despite her own disability.

Ms Olivia LUM graduated 1986 in Chemistry with a B.Sc. (Hons). She started out as a chemist at Glaxo Pharmaceutical where she also worked on water treatment technologies. Three years later, she founded Hyflux with just two staff. Today Hyflux is a leading global water solutions company operating some of the world's largest desalination plants across the globe. In 2010, she won the Ernst and Young Singapore Entrepreneur of the Year award; and then in 2011 the Ernst and Young World Entrepreneur Award, the first Singaporean and the first woman to receive this accolade.



Prof NG Huck Hui is an internationally renowned scientist in stem cell research. He completed his undergraduate studies 1996 in Biological Sciences with a B.Sc. (Hons), and went on to do his Ph.D. at the University of Edinburgh and post-doctoral work at Harvard University. In 2003, he returned to Singapore to take up concurrent appointments at the NUS Department of Biological Sciences and at the Genome Institute of Singapore (GIS) to study the control of gene expression in cells. His research has opened new possibilities in personalised regenerative medicine and drug discovery. Prof Ng and his team were awarded the President's Science Award in 2011. He is now the Executive Director of GIS.



Dr YEO Sze Ling lost her sight to glaucoma at the age of four but was determined not to let this stop her from pursuing her passion. She had an innate affinity for Mathematics. With the help of family, teachers and close friends, she has realised her dream and obtained her Ph.D. in Mathematics in 2006. She now works as a research scientist at the A*STAR Institute for Infocomm Research and teaches at the Nanyang Technological University. Dr Yeo also volunteers at the Society for the Physically Disabled to help members apply technology to enhance their daily life. In 2012, she was awarded the Singapore Youth Award, the highest national accolade for youth.

Awards & Prizes

Top National Award



President's Science Award

Prof YU Hao, Department of Biological Sciences, won the President's Science Award 2013 for his outstanding research in plant functional genomics and its biotechnological applications to economically important crops. His research group has pioneered ground-breaking work in the past ten years to uncover the molecular genetic mechanisms of plant reproductive development, in particular, flowering time control (see p. 17).

Making Waves Abroad



American Chemical Society (ACS) Nano Lectureship Award

Prof LOH Kian Ping, Department of Chemistry, was recognised this past year by the ACS Nano Lectureship Award 2013 for his ground-breaking studies of the science and applications of nano-diamonds, graphenes and other two-dimensional materials (see p. 19). The ACS Nano Lectureship annually honours three individuals who have made major impact on nanoscience and nanotechnology, one from America, one from Europe & Africa and one from Asia-Pacific.



Feng Kang Prize of Scientific Computing

Prof BAO Weizhu, Department of Mathematics, won the Feng Kang Prize in Scientific Computing in 2013 for his contributions to numerical methods and mathematical analysis for Bose-Einstein condensation and numerical analysis of the Schrödinger equation. His work has applications in solid-state dewetting problems, computational fluid dynamics, and wave motion in quantum and plasma physics.



Outstanding Statistical Application Award

Prof LOH Wei-Liem, Department of Statistics and Applied Probability, was awarded together with Prof Robert KASS and Dr Ryan KELLY, the Outstanding Statistical Application Award 2013, for their development of a powerful class of time-varying loglinear point process models to investigate synchrony between neural spike trains. This award, given by the American Statistical Association, honours the authors of the most outstanding paper in statistical application.

Promising New Star

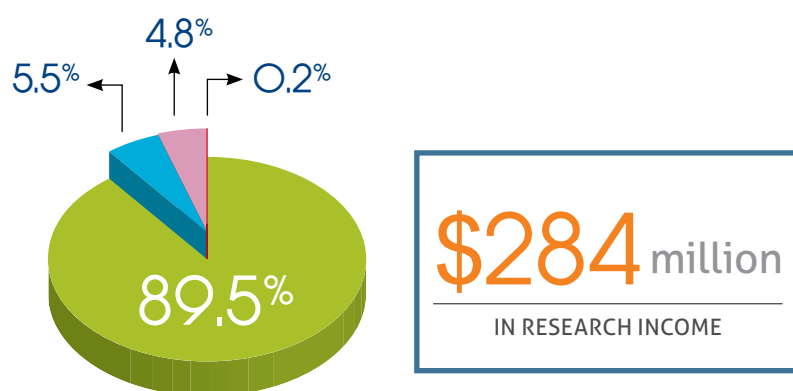


New Clinical Practitioner Award

Prof Joyce LEE, Department of Pharmacy, became the first Asian to win the New Clinical Practitioner Award given by the American College of Clinical Pharmacy that honours annually one new clinical practitioner for outstanding contributions to clinical pharmacy practice within six years of practice. Her research focus is in diabetes management and pharmacist-led ambulatory care clinics (see p. 23).

Research Grants & Students

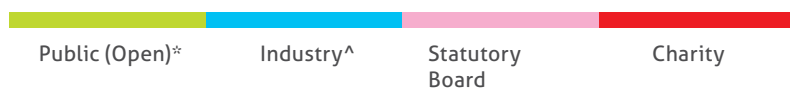
Who funds our research: Research grant income, FY2009 to FY2013



\$284 million
IN RESEARCH INCOME

This chart shows the funding sources for research grants which our researchers have won over the last five years. A typical research project runs for three to five years. Thus this chart provides a snapshot of the research intensity at the Faculty over the past years.

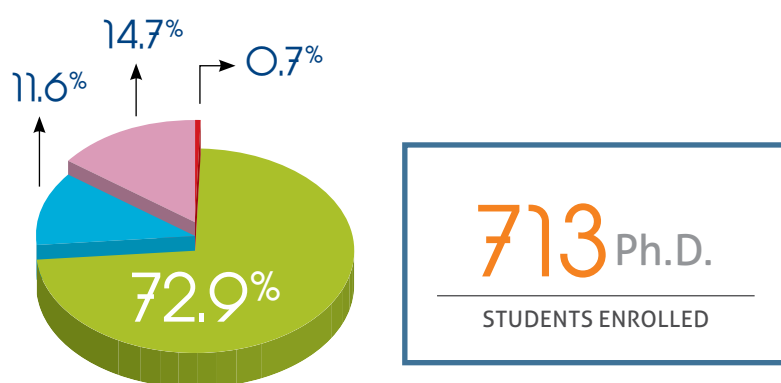
While the public sector grant agencies together remain as the largest grantor for our research programmes, the Faculty has been increasingly successful in developing significant funded partnerships with companies and statutory boards. These increase the direct impact of our work on industry and society. We expect to expand the number and depth of these partnerships in the coming years.



* Includes MOE, NRF and A*STAR open grant calls administered by the Government of Singapore

^ Includes funding from licensing agreements

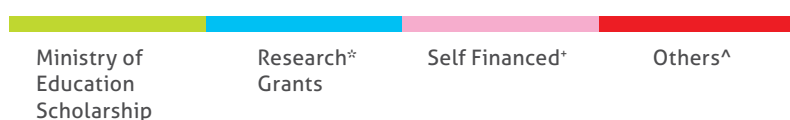
Who funds our Ph.D. research students: Research scholarship funding, FY2010 to FY2013



713 Ph.D.
STUDENTS ENROLLED

This chart shows the funding sources for Ph.D. students enrolled in our programmes over the past four years. A typical Ph.D. scholarship lasts four years. Thus this chart provides a snapshot of the funding support for students who are with us in the reporting year.

While the Ministry of Education still provides the bulk of the support for our Ph.D. students, the Faculty has started to diversify the sources of funding through research grants and partnerships with the industry and statutory boards.



*Refers to scholarships linked to research grants, including those from government agencies and industry

*Includes students sponsored by their employers, students funded by scholarships not disbursed through NUS and students who are self-funded

^Includes scholarships funded by donations

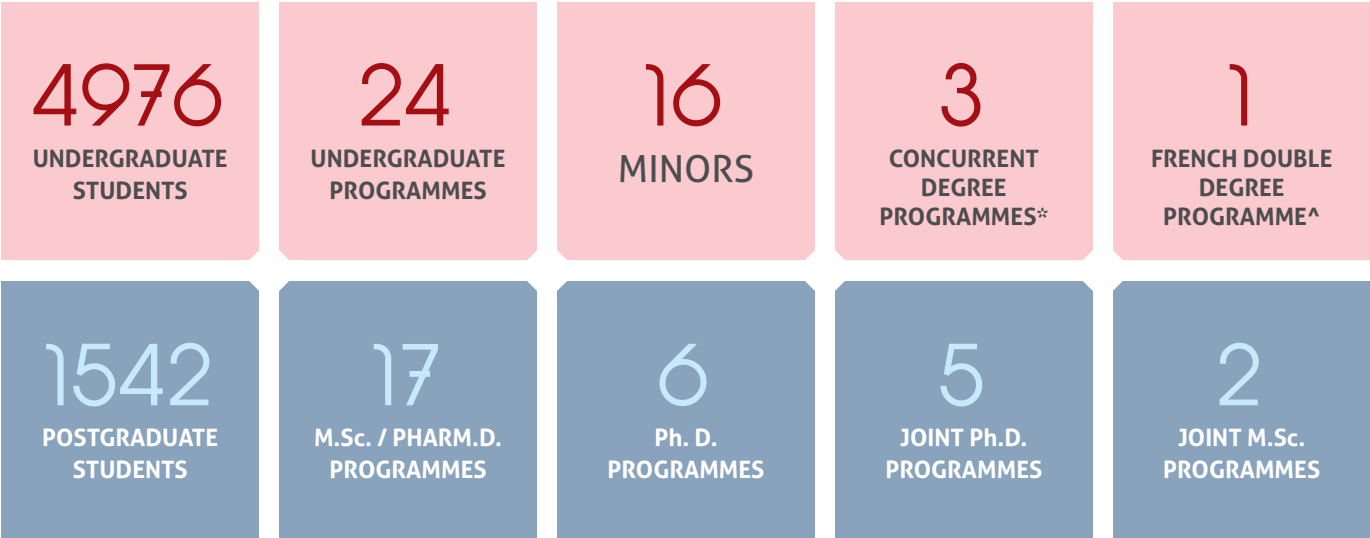
Note: Percentages of allocation may not add up to 100% due to rounding errors



Education and Research Output

34

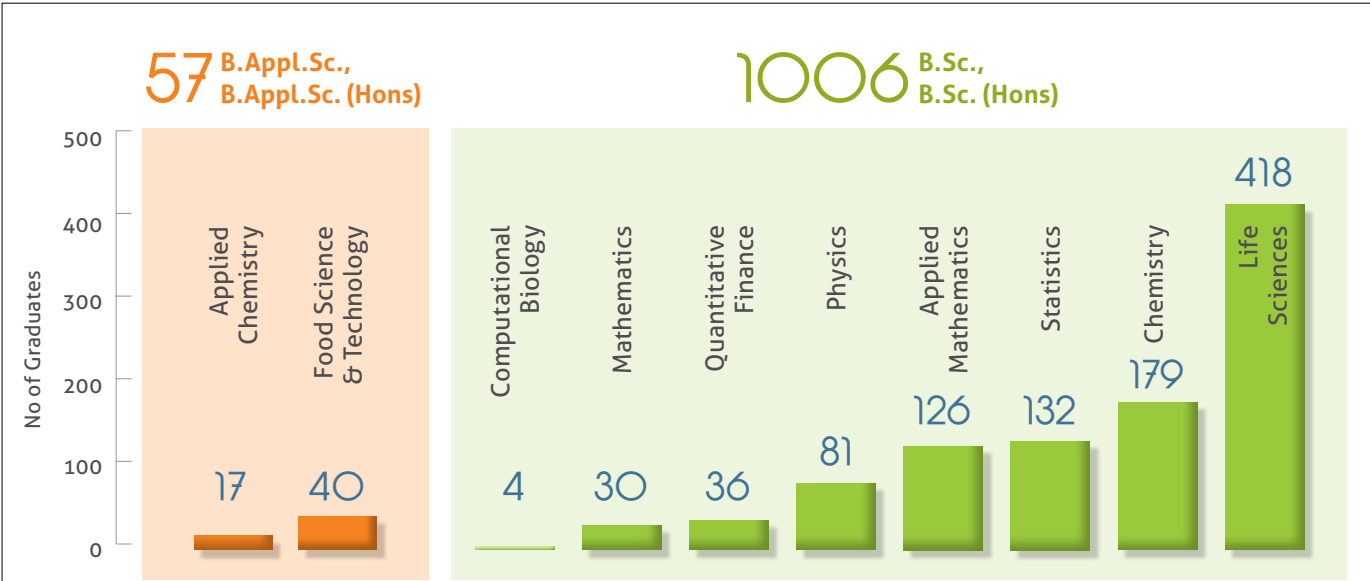
Figures at a Glance



* Includes B.Sc. (Hons) & M.Sc.

^ Refers to B.Sc. (Hons), Diplôme d'Ingénieur & M.Sc.

Graduating Class of 2014



154 B.Sc. (Pharmacy) & B.Sc. (Pharmacy) (Hons) graduates

9 double-degree Honours graduates**
 ** Includes graduates from Applied Mathematics-Computer Science, Mathematics Computing, Physics-Materials Science, Statistics-Psychology

Research Output and Recognition



1st in Asia[^]:

Environmental Sciences •
Mathematics • Materials
Science[#] • Pharmacy &
Pharmacology • Statistics &
Operational Research

2nd in Asia[^]:

Biological Sciences •
Chemistry

All in Top 20 globally[^]:

Biological Sciences •
Chemistry • Environmental
Sciences • Mathematics •
Materials Science[#] •
Pharmacy & Pharmacology •
Statistics & Operational
Research

[^]Research subject ranking
Source: QS World University
Ranking 2013/2014

[#]Includes contributions from materials
physics & materials chemistry

1385

Research articles published⁺

53,000

Citations received⁺

⁺Source: Web of Science

47

New patent families filed

4

New patent licensees[%]

[%]Includes 2 expressions of interest

38

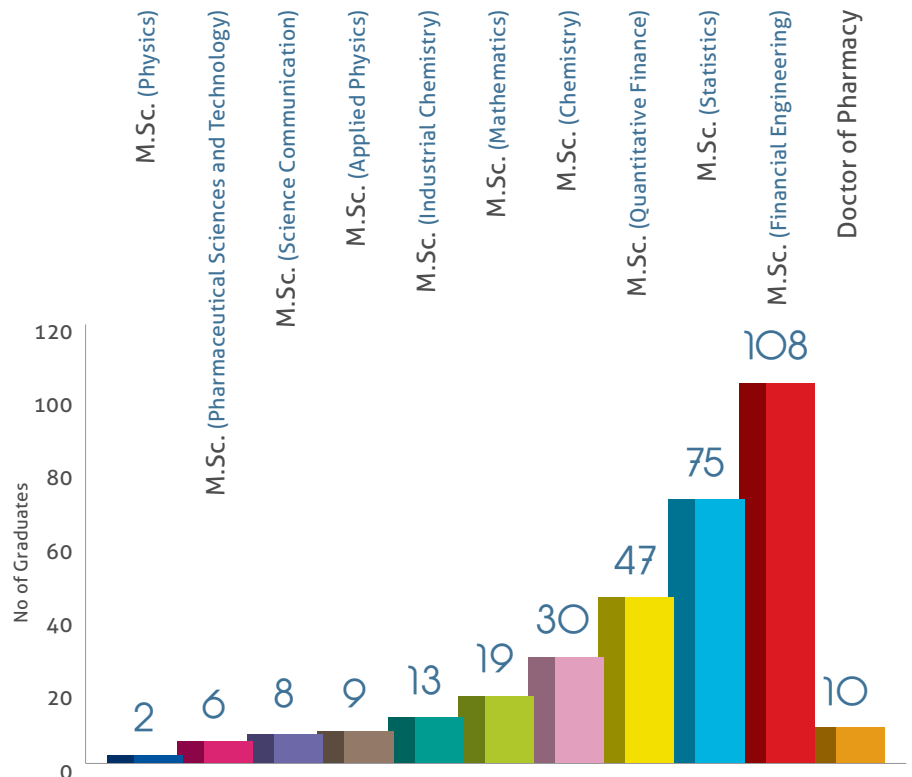
Research collaborations
with industry

24

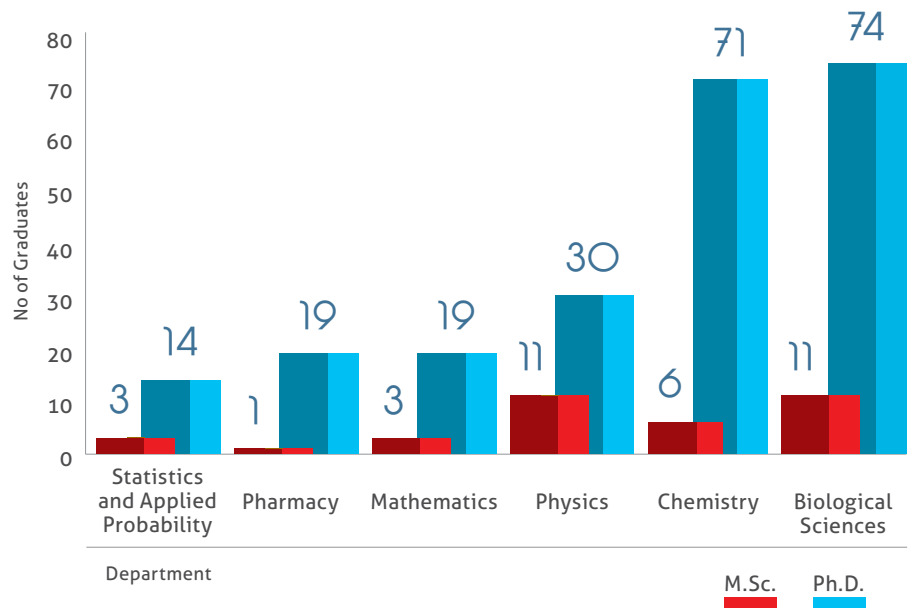
Research collaborations
with statutory boards

Graduating Class of 2014 (Graduate Studies)

Graduate Coursework Programmes

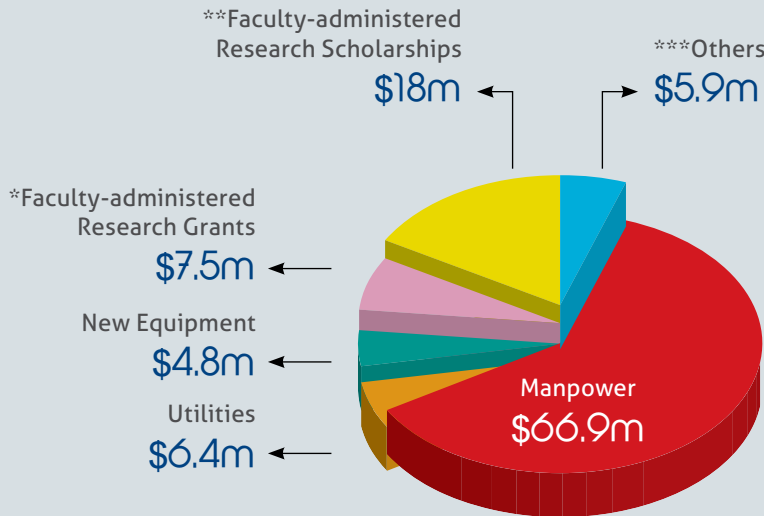


Graduate Research Programmes





Facts and Figures



Budget Administered By Faculty

Total Budget

\$110million

- * Refers to MOE Tier-1 Academic Research Fund
- ** Refers to MOE Research Scholarship Block
- *** Refers to Other Operating Expenditure and Strategic Budget for Undergraduate Overseas Initiatives

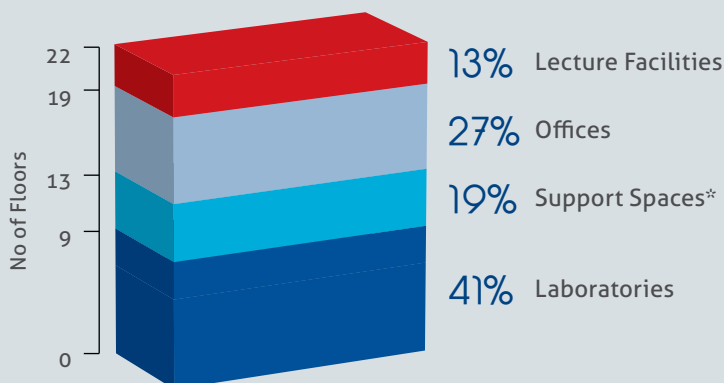
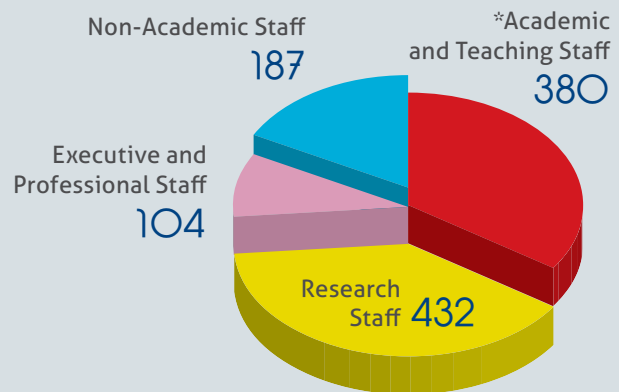
Staff Population

Total Staff Population

1,103

- * Includes Professors, Associate Professors, Assistant Professors, Senior Lecturers, Lecturers, Instructors and Teaching Assistants

Note: Data correct as at 31 Jul 2014



Space Administered By Faculty

Total Gross Floor Area

110,000m²

- * Includes core facilities, storage, safety, utilities and other spaces

Note: On the right, the total gross floor area is presented as a hypothetical building with each floor having an area of 5,000 m², 4 times the size of an Olympic swimming pool

Transformative Science

EDUCATION, RESEARCH & SERVICE

Faculty of Science

Annual Report 2013 - 2014

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