PPSMI
Internationalising the national education system via the teaching of Science and Mathematics in English

UNDERSTANDING EARTHQUAKES
Why do some earthquakes lead to tsunamis?

LIFE AS A SCIENTIST
Interview with a local scientist and articles on life as a postdoc/PhD student/engineer

FERMI’S PARADOX
Are humans alone in the universe?

SCIENTIFIC PUBLISHING
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## ON THE COVER:

“The image originally depicted a teacher and her class in space, but the illustrator decided on a less pedantic solution - one with students compelled to discover on their own out of a sense of awe and curiosity, not because someone was telling them to. Learning can be driven by many things, but the most effective are these two.”

**ILLUSTRATED BY:** Charis Loke  
http://www.charisloke.com

**SCIENTIFIC MALAYSIAN MAGAZINE** is published in a web format (http://magazine.scientificmalaysian.com) and in a downloadable digital magazine format (PDF). Our digital magazines are distributed to Malaysian societies around the world to reach out to as many Malaysian scientists as possible. The Scientific Malaysian Magazine will be published tri-annually and is FREE of charge.
T HE THIRD ISSUE

This issue of Scientific Malaysian Magazine is our thickest yet, more than 10 pages thicker than our previous issue! Thankfully, we have the help of several new members in the magazine team contributing as editors, columnists and illustrator. This issue would not be published without the enormous effort from all of the team members and high quality articles from our contributing authors. All credit goes out to them.

We start off this issue with an introduction to our new Advisory Board members (pg 4) and our newest team members (pg 6). From this issue onwards, we feature snippets of the latest news published on our website under the new News Highlights section (pg 8). We continue with the Understanding Earthquakes series with an informative article on tsunamis (pg 9), followed by an introduction to the scientific publishing metrics (pg 12). The debate on the PPSMI, the teaching of Science and Mathematics in English policy in Malaysia continues, this time with the viewpoints from the Parent Action Group for Education Malaysia (PAGE) (pg 16).

Next, we launch our new ‘Life as a Scientist’ section with an interview with a prominent local scientist (pg 20), a column on ‘Life at CERN - the world’s largest particle physics laboratory’ (pg 24), two articles on life as a PhD student (pg 26) and a postdoctoral researcher (pg 28) abroad. This section would be interesting to those interested in pursuing a career in science. In our creative writing section, we have a review of a science book (pg 32) and a science storytelling article (pg 36) to engage with our non-science readers. Finally, do not forget to follow the next part of “The Detective” series (pg 39) to find out what happens to Justin the molecular biologist; you might get an insight of the life as a molecular biologist!

Enjoy reading!

Andrew Chan
Editor-in-Chief
andrewchan@scientificmalaysian.com

WRITE FOR SCIENTIFIC MALAYSIAN MAGAZINE
Would you like to contribute articles for Scientific Malaysian Magazine? We welcome articles on any aspect of scientific research and development.

Please get in touch with us via email: magazine@scientificmalaysian.com

DISCLAIMER:
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Dr. Charles M. Wiener is the founding Dean/CEO of Perdana University Graduate School of Medicine (PUGSOM) in Selangor, Malaysia and Professor of Medicine and Physiology at the Johns Hopkins School of Medicine. PUGSOM was established in February 2011 in collaboration with Johns Hopkins as the first graduate entry medical school in Malaysia. Dr. Wiener will also be CEO of the Perdana University Hospital upon its completion in 2014.

Dr. Wiener attended the University of Miami School of Medicine after graduating from Duke University with a degree in Management Science. He was a resident and Chief Resident in Internal Medicine at the University of Washington Hospitals in Seattle from 1982-1986. Prior to beginning a fellowship in Pulmonary and Critical Care Medicine at Johns Hopkins in 1988, Dr. Wiener was an American Heart Association British-American Research Fellow in the Respiratory Physiology unit of the Hammersmith Hospital in London.

Dr. Wiener joined the faculty at Johns Hopkins in 1991. His clinical activities include attending physician on the Johns Hopkins Hospital MICU and Pulmonary services, and an outpatient clinic in the Johns Hopkins ALS center. His research interests have focused on vasomotor control of pulmonary circulation, HIF-1 expression and function in the lung, and respiratory management of patients with neuromuscular diseases. At Johns Hopkins, he was involved extensively in undergraduate and post-graduate medical education. He was the Director of the Year 2 Bridging Sciences Curriculum, Course Director of Human Pathophysiology, Section Director of Respiratory Organ Systems, and Core Instructor in Basic Medicine.

From 2000-2010, Dr. Wiener was the Vice Chairman-Education of the Department of Medicine and Director of the William Osler Internal Medicine Training Program. From 2003-2008, he was Chair of the School of Medicine Curriculum Reform Committee that created the novel “Genes to Society” Medical curriculum that was implemented at Hopkins in 2009.

Dr. Wiener won numerous awards at Johns Hopkins for medical student teaching and mentorship including the Johns Hopkins Professors Teaching Award, Osler Housestaff Teaching Award, and the George Stuart Award for Clinical Teaching. He is the author of scientific publications, Harrison’s Internal Medicine Self-Assessment and Board Review (editions 16, 17, 18), and is an Associate Editor of the American Journal of Medicine.

In January, 2011 Dr. Wiener relocated to Kuala Lumpur to establish PUGSOM which debuted in September 2011 with a pioneer class of 24 outstanding students. He is an enthusiastic sailor and squash player. Since moving to Malaysia with his wife, Professor Anne Rompalo, he has taken up badminton with exuberance.
PROF. DR. NOR HAYATI OTHMAN obtained her medical degree, MBBS, from University of Malaya in 1981 and Master of Pathology from University of Malaya in 1987. She is a general surgical pathologist and had undergone various sub-speciality pathology trainings: Neuropathology from University of Western Australia in 1989, Dermatolopathology from University of Sydney in 1994, Molecular Pathology from University of Toronto in 1999 and University of Cape Town in 2002. She is currently the Dean in Clinical Science Research for Universiti Sains Malaysia (USM) and a senior consultant pathologist to Hospital Universiti Sains Malaysia. She is also the chairperson of Pathology Post-graduate Education in her University.

She teaches Pathology to undergraduate and postgraduate students at Universiti Sains Malaysia since 1987. She was awarded exemplary lecturer award for 2 consecutive years (2003 and 2004) and also bestowed Excellence in Service awards by the University twice in 1994 and 2004. In 2008 she was the recipient of Tokoh Citra Ilmu, an award given annually to academician of high standing by the alumni of the Medical School.

Her research interests are in thyroid and gynae pathology especially on cervical cancer. She has 141 publications in peer-reviewed journals, presented 170 papers at national and international scientific conferences, 54 past and current research projects as main or co-investigators and supervised / co-supervised / supervising / co-supervising a total of 47 students at MMed, MSc and PhD levels to date. Together with electronic and electric engineers from the USM engineering campus, she invented NeuralPap (a diagnostic software to diagnose cervical cancer), DataPap (a management system for cervical cancer) and Neuralmammo (a diagnostic software to diagnose breast cancer). These 3 inventions won several awards at national and international invention competitions.

She also has a keen interest in medical education and did training in PBL curriculum at University of New Mexico in 1995 upon which she is the main facilitator for PBL tutor training workshops in USM. In 2002, she did training in standardised patient program from 3 Universities in Texas: University of Texas Houston (UTH), University of Texas, Galveston (UTMB) and Baylor College of Medicine (BCM). Both visits to the United States were sponsored by ECFMG. Her name was cited as the first recipient of ECFMG fellowship from Malaysia in 1995.

She was a Council member for Malaysian Medical Association from 1992-1996, Council member for College of Pathologist, Academy of Medicine Malaysia from 2000-2008, a member of the Editorial Board of Medical Journal of Malaysia from 2006-08 and currently sits on the editorial board of U.S. Chinese journal of Lymphology and Oncology [2009 - 2012] and Journal of Traditional and Complementary Medicine from 2012. She is a member of a few international and national academic bodies: International Academy of Cytology (MIAC), International Cancer Screening Network [ICSN], International Network of Women Engineers and Scientists (INWES) and a Fellow of Academy of Medicine (FAMM). She is an advisory board member of Bangladesh Sports Council since 2005. She also sits as Executive Board Member for Asia Pacific Council of Exercise and Sports Science [ACESS]. She used to be active in sports, playing hockey, netball and table tennis for her schools and Universities. In her spare time she writes poetry and plays keyboard for relaxation.
OUR NEW TEAM MEMBERS

Scientific Malaysian is run by a group of volunteers who dedicate a lot of their time and energy into this initiative. We introduce the latest addition to our team here.

JASMINE LEONG (NEWS EDITOR) holds an MSc. (Oxon) in Pharmacology from the University of Oxford, UK and a BSc. (1st Hons) in Chemistry from Universiti Tunku Abdul Rahman, Malaysia. Her research experience and interest are in medicinal chemistry and stem cell research with focus on cancer and neurodegenerative diseases. With aspiration to translate drug discoveries from bench to bedside, she has internship experiences with AstraZeneca Sdn. Bhd. and GlaxoSmithKline Consumer Healthcare Sdn. Bhd. in Kuala Lumpur Malaysia. Currently, she is a Product Specialist with Eli Lilly (Malaysia) in Kuala Lumpur. She believes that many Malaysians are driven and passionate professionals who choose to dedicate their career to what they believe in. To be able to share these motivations among peers, mentors and apprentices creates the beginning of a greater story and Scientific Malaysian provides the platform to facilitate this ambition.

GABRIELLE CHONG (COLUMNIST/MARKETING OFFICER) is currently pursuing philosophy at Wellesley College in the United States. She is fascinated by a plethora of topics in science, ranging from cosmology to artificial intelligence. She wonders what lies beyond the horizon of the observable universe, how organic materials give rise to mind and consciousness, if the technological singularity will ever arrive, how space and time appear beyond the third dimension, and if we will ever find concrete evidence of advanced extraterrestrial life within our lifetimes. She is also interested in the intersections between the sciences and the humanities, or what C.P. Snow termed “The Two Cultures”, and how the seemingly disjointed fields inform each other. As a student of philosophy, she hopes to provide epistemological inquiry to discourses in science. She thinks that we are living in exciting times for science, and hopes that Scientific Malaysian will be a living document of the Malaysian community’s vibrant engagement with the world of science.

CHARIS LOKE (MAGAZINE ILLUSTRATOR/DESIGNER) is a junior at Brown University, United States concentrating in Biochemistry and Molecular Biology. She’s interested in interdisciplinary connections between fields like art, science, and technology, having dabbled in everything from medieval history to programming to comparative literature, as well as studying at the neighbouring Rhode Island School of Design. She illustrates regularly for the College Hill Independent newspaper, and worked on game art and design for Virion, a web game about immunology in which you play as a virus evading the body’s defence mechanisms. Charis believes in the need for science communication, journalism, and storytelling, and is excited by the possibilities that the Scientific Malaysian platform brings in those areas.
**VALERIE SOO (EDITOR/COLUMNIST)** is an evolutionary biochemist. After four years of studying various promiscuous proteins (i.e., multifunctional proteins) and their roles in the evolution of new phenotypes, she has finally completed her PhD at Massey University, Auckland. She holds a BSc (Hons) from Monash University Malaysia, where she researched on bacteriophages, and the water-borne pathogen, *Legionella pneumophila*. She also had a brief stint as a research assistant at the Malaysian University of Science and Technology. Valerie strongly believes in scientific networking—building meaningful and long-lasting relationships. Therefore, she feels that Scientific Malaysian is a good place to establish connections and gather information from a variety of sources.

**VICTOR TAN (NEWS EDITOR)** is a rising freshman at the University of California, Berkeley, interested in Chemical Engineering, Physics, and Finance. In Physics, he is particularly fascinated with shear-thickening fluids such as ferromagnetic fluids and oobleck, as well as their potential applications in medicine as well as in excavation for oil, having completed his IB Extended essay project on them. Having served as a journalist at Malaysiakini for two months, Victor believes that Scientific Malaysian can serve not simply as a nexus to connect scientists, but also create them – He hopes that Scientific Malaysian will be able to dispel the ivory tower perception that scientists are different from other people, and that everyone in this country can and should participate in the most important global conversation we’ve ever started.

**INTERESTED IN JOINING THE SCIENTIFIC MALAYSIAN TEAM?**

We are currently looking for:

a) Website developers  
b) Marketing officers  
c) News editors  
d) Scholarship officers  
e) Magazine illustrators/designers

We also welcome people interested in helping us out in other areas.

Do contact us and let us know how you think you can help the Scientific Malaysian initiative!

**CONTACT US:** team@scientificmalaysian.com
NEWS HIGHLIGHTS

APRIL 2012
Commemorative Stamps and First Day Cover of the Malaysia Antarctic Research Programme
Commemorative Stamps and First Day Cover launched to highlight the achievements of the Malaysian Antarctic Research Programme (MARP). The government continued their strong support for Malaysian researchers in Antarctica by making it easier to conduct research there and providing more financial support.

Nanotubes by USM Researchers
Valuable nano-composite material produced at lower cost, greater efficiency and with care to the environment. Universiti Sains Malaysia (USM) researchers discovered the continuous production method of carbon nanotubes.

MAY 2012
Eppendorf Asia Supports Bionexus Companies
New and improved laboratory set-up for Bionexus status companies in year 2012. Eppendorf Asia shows support to BiotechCorp in developing biotechnology and life science based companies in Malaysia. A promising and sustainable incentive program launched as Eppendorf Asia and BiotechCorp shook hands.

JUNE 2012
Universiti Malaya ranked 35th in the QS Asian University Ranking 2012
Providing tertiary education since 1949, Malaysia's top university climbs the ladder of 500 universities in Asia achieving the best position since 2009. Hong Kong University of Science and Technology (HKUST) tops the list for two years in a row.

12 Tonnes of Oil Biomass Shipped to Italy
Leftovers turned into gold. In addition to being the second largest palm oil producer, Malaysia aims to be the world leader in high value green chemicals. MY Biomass Sdn. Bhd. explores the possibilities of converting palm oil biomass into industrial sugar.

JULY 2012
CREST calls out to E & E Global Investors
As the players of the E & E sector come together as CREST, RM 800 million are in store over the next decade to support R & D projects. Ten research projects to kick start this initiative and more demand on R & D to come.

Read the full news articles on our website at www.scientificmalaysian.com. We welcome press releases and research news articles; please get in touch with us at news@scientificmalaysian.com.
Why do some earthquakes lead to tsunamis?

by DR AFROZ AHMAD SHAH

Some of the past earthquakes, which have been followed by tsunamis, were of big magnitudes; for example, that of a Richter magnitude scale of 9.0 in Kamchatka, Russia (1952), of 9.1 in Andrean of Islands, Alaska (1957), of 9.5 in Chile (1960), and of 9.2 in Prince William Sound, Alaska (1964). However, the scale of destruction and the damage caused by these quakes were far less than the destruction which followed one on 26 December 2004 - the Aceh-Andaman earthquake and its tsunami. This catastrophe was a warning bell and it changed the perspective of people regarding earthquake dangers in oceans and therefore opened a variety of avenues to understand a virtually dead subject of oceanic earthquake research. More than 230,000 people died and several millions more were affected.

Tsunamis, unlike the earthquakes on land, have one advantage: they give us time to evacuate because the waves take some time to travel until they have reached the coast and thus provides an opportunity to save lives. However in 2004, the warning system was a complete failure, particularly in far-off places such as Thailand, Sri Lanka, India and East Africa. There was no tsunami warning in place because people tend to forget about disasters of the past, and this has caused further loss to life. This happened again in September 2009, where an earthquake that produced a tsunami in southwest Pacific killed nearly 200 people, again pointing to the miserable failure of authorities to deliver a timely warning system.

When a big earthquake and the subsequent tsunami hit Japan on 11 March 2011, it offered us an opportunity to test our preparedness to tackle such disasters. However, the reality is that we again failed miserably to warn people in advance about the coming disaster, which caused a serious loss of life and property. Its source was close to the coast and therefore, the warning system did not help. Some 20,000 people lost their lives to the devastating tsunami. This happened in a country, which to a large extent is a well-prepared nation for earthquakes and tsunamis. But they hadn’t been expecting an earthquake and tsunami of the magnitude that occurred on 11 March 2011. This clearly suggests an immediate need to thoroughly understand and map all the seismogenic faults and more so, the megathrusts, so that earthquake hazards could be traced to their respective sources and necessary precautions could be exercised.

All of these earthquakes, like the one in March 2011, were megathrust events (see Figure 1, pg 10), where one tectonic plate dives beneath another.
WHAT IS A TSUNAMI?
A tsunami is defined as a big wave or a series of big waves. They can be caused by any big disturbance in the ocean or any other body of water. For example, during an earthquake under water, an enormous amount of energy is released when a fault slips. It can cause the crust to move up or down, therefore forcing a great column of water to follow it. This can create a total imbalance in water body and form a big tsunami. For example, the recent tsunami along the coast of Sumatra was caused by an earthquake offshore, where a fault line of some 1,000 miles has long ruptured. A volcanic eruption in or close to the ocean can also result in the formation of big waves. The eruption of Krakatoa two centuries ago caused a tsunami throughout Southeast Asia and the tremors travelled throughout the world. Likewise, a meteorite or landslide can potentially cause big or small tsunamis.

Tsunamis are described as shallow-water waves and are different from the normal sea waves, which are generated by the wind. Normally, wind-generated waves have ‘small periods’ (time between two successive waves) of 5 to 20 seconds, and wavelengths of 100 to 200 meters. However, these numbers increase significantly during a tsunami, with periods in the range of 10 minutes to 2 hours and wavelengths of greater than 500 km. Due to this very large wavelength, a tsunami loses little energy as it moves ahead. The water near the shore can initially be the trough of the coming wave and the water may swirl out away from the shore. But as the leading edge of the fast moving wave comes into shallow water, it slows down. The water behind, however, continues to push forward. The edge of the wave gets higher. As more fast moving waves push into the slowing wave front, the wave gets higher and steeper. Eventually it can become a moving vertical wall of water, whose height depends on the geometry of the shore and the characteristics of the tsunami.

The earthquakes and the associated tsunamis are a result of the friction along the megathrust faults (see Figure 1, pg 10). For example, had there been no resistance to the continuous push, signifying a smooth journey of the Pacific plate underneath the North American plate, we would not have witnessed an earthquake or the tsunami. However, this is not the case with plates which are huge and heterogeneous bodies of rocks. When they rub against each other, a lot of friction is created that leads to fractures, which eventually becomes a fault or faults.

THE 26 DECEMBER 2004 ACEH-ANDAMAN EARTHQUAKE
The Indian/Australian oceanic plates, which are moving at a rate of 5 cm/year in a northeast direction with respect to the Sunda plate, subducted beneath the Sunda plate and the contact boundary thus formed, is called a megathrust fault (Sunda megathrust). On the 26 December 2004, a portion of the Sunda megathrust failed, which caused the earthquake and the associated tsunami. The rupture length was about 1,600 km, which caused a magnitude 9.2 earthquake. The strain energy (as elaborated in the previous Understanding Earthquakes article, Scientific Malaysian Magazine Issue 2), which was stored since centuries ago, was suddenly released along the fault, causing the destruction. The megathrust faults resemble the thrust faults that are found on land but are very large in extent. For example, the Sunda megathrust runs south from Bangladesh, curving around the western and southern flanks of Sumatra, Java, Bali and eastern Indonesia to northwestern Australia, which stretches to a distance of about 5,500 km. There are examples of megathrusts offshore of the Philippines, Taiwan, Japan and southeastern China. Similarly, there are megathrusts on land and the biggest one traverses Pakistan through India and Nepal, covering a distance of 2,500 km along the southern side of the Himalayan mountain range.
THE GREAT EAST JAPAN EARTHQUAKE OF 11 MARCH 2011

There are four tectonic plates in and near Japan, the Eurasian plate, the North American plate, the Pacific plate and the Philippines sea micro-plate (Figure 1). In the figure, the red lines show the faults that form the plate boundaries and the yellow arrows show the relative motion of the plates. The continuous push on the Pacific plate drags it down under the North American plate along the boundary called a megathrust fault. The resistance to its downward pull via friction builds up the strain energy along this boundary, which ultimately fails. The great earthquake and tsunami of 11 March 2011 was initiated on one of the portions of this fault, which slipped along an area of the fault roughly 500 km long and up to 200 km wide, shaded in orange in the figure. The big yellow dot shows the epicentre (the place directly above where the megathrust first started to fail) of the earthquake, while the smaller one shows the largest aftershock recorded to date. A number of smaller yellow dots show the aftershocks in the first few days, after the mega quake.

This is the second of a series of articles on geosciences. In the next issue, Dr Shah will write about “The Sunda Megathrust”.

Figure 1 Map shows the tectonic setting of Japan and the surroundings. There are four tectonic plates (Pacific plate, North American plate, Eurasian plate, Philippines Sea micro-plate). The plate boundaries are shown as red lines and the yellow arrows show the relative motion of the plates. The great earthquake and tsunami of March 11th resulted from sudden rupture along the portion of the megathrust fault below the area shaded in orange (just east of Japan). The largest yellow dot shows the epicenter of the earthquake - that is the place directly above where the megathrust first started to fail. The smaller yellow dot shows the largest aftershock to date. Smaller dots show lesser aftershocks in the first few days following the great March 11th earthquake.

Figure 2 Schematic side view of the subduction zone and source of the earthquake of March 11th. A tsunami was generated because the motion of the plates pushed and pulled on the ocean floor.

ABOUT THE AUTHOR:
Dr Afroz Ahmad Shah is a research fellow at the Earth Observatory Sciences (EOS), Nanyang Technological University, Singapore. He did his PhD in 2010 with Prof. Tim Bell in Structural and Metamorphic Research Institute (SAMRI), School of Earth & Environmental Sciences James Cook University, Townsville, Australia. He worked on tectono-metamorphic evolution of Precambrian rocks that lie in the foothills of Colorado Rocky Mountains, USA. He obtained an M.Tech. degree in engineering geosciences (2006) from IIT Kanpur India, where he worked with Prof. JN Malik on Active Tectonics of Himalayan foot hills, Nanital. Dr. Shah joined the EOS in 2010, and currently working with Prof. Kerry Edward Sieh on earthquake geology of New Guinea. He can be contacted at afroz@ntu.edu.sg.
Scientific publishing is an essential component in the dissemination of research findings to both the academic community and general public. Among scholars in contemporary academic settings, the maxim publish or perish is well-known since publications dictate the professional development of scholars and how well they will do in terms of academic promotion and attainment of tenure. The desire to publish research findings in indexed and archived journals is further augmented by the promise of financial reward or cash incentives in developing countries such as China, Malaysia and Pakistan1.

In this day and age, scientific publishing is rendered increasingly complex due to the proliferation of journals and introduction of various research metrics meant for representation (or proxy) of academic prestige. The two most pervasive modern-day research metrics since the onset of the information age are the Journal Impact Factor (JIF, which is published by Thomson Reuters) and the h-index2. The JIF, arguably one of the most established metrics within academia, is used to evaluate the relative influence, importance or prestige of scholarly journals. It is based on two elements: the numerator (the ratio of the number of citations in the current year to the items published in the previous two years) and the denominator (the total number of articles and reviews published in the same two years)3. For example, in the form of a mathematical expression, the JIF of a journal in 2007 can be calculated as follows:

\[
\text{JIF of a journal in the year 2007} = \frac{X}{Y}
\]

where \(X\) = the number of citations of articles (published in 2005 and 2006) received in 2007

\(Y\) = the total number of articles and reviews published in 2005 and 2006.

Even though the popularity of this metric among the scholarly community is never in doubt, it is frequently criticised for its limitations4. These limitations include bias towards journal popularity over prestige5, its
abuse by journal editors and insensitivity to journal self-citations whereby a citation can be categorised as a self-citation if any of the authors of the citing article is also an author of the cited article. The usage of JIF for absolute comparison between two journals of different fields (e.g. life sciences and engineering journals) is invalid since a prestigious life sciences journal may have a JIF more than 15 while a prestigious engineering journal may only have a JIF of about two. This discrepancy may stem from various factors such as (1) varying citation “densities” across different disciplines (e.g. in some disciplines, the literature list of an average article is longer than in other disciplines: more citations are given and thus higher number of citations can be received within that discipline), (2) some disciplines cite recently published documents more frequently than other disciplines, and (3) used publication channels (e.g. journals, monographs, conference papers) differ per discipline. The over-emphasis on JIF as a proxy for prestige has resulted in the shifted focus of certain academics in the abovementioned countries to publish review articles in discipline-specific journals (e.g. chemical engineering journals) with high JIFs but are rather generic and not as technically-based as good and top-notch journals in that particular discipline. This practice can be beneficial to postgraduate students attempting to gain a foothold on scholarly publishing but over-reliance on such practice to increase the number of publications and generate citations will ultimately prove detrimental to the academic credibility of the affected scholars.

“It is important for academics to use their discretion judiciously when deciphering the prestige of a particular journal...”

Another important research metric is the $h$-index, although it is used to assess the scholastic impact of individuals rather than an evaluation of journal popularity. The $h$-index ($h$ denotes high-impact) is originally intended to quantify an individual’s scientific research output and impact in which a scientist has index $h$ if $h$ of his or her $N_p$ papers have at least $h$ citations each and the other $(N_p - h)$ papers have $\leq h$ citations each. In other words, this is the highest number of papers that an individual has written that have each received at least that number of citations. The $h$-index of an individual can be determined by plotting a curve of his/her number of citations against paper number (Figure 1). A line from the origin can be drawn 45° from the x-axis and the intersection of this line with the curve determines the $h$-index. The Scopus database includes this curve as one of its features. Alternatively, one can obtain the $h$-index of a particular researcher by using a specific database (e.g. Scopus or Thomson Reuters Web of Knowledge SM). This can be accomplished by retrieving all published items (articles, reviews, etc.) of a particular researcher throughout his/her career and sorting them by the number of “Times Cited”.

The highest rank number which is still lower than the corresponding “Times Cited” value is the $h$-index of the researcher.

The $h$-index is not only used as a measure of scientific achievement for individual researchers but also to determine the scientific output of research groups, scientific facilities and countries. The $h$-index is meant to circumvent the main disadvantages of other research metrics such as total number of papers and/or citation counts. This is because the total number of papers does not indicate the quality of scientific publications whereas citation counts can be disproportionately affected by a single publication of major influence. Nonetheless, one of the main disadvantages of $h$-index is that the number does not decrease with time, making it biased when used to measure the impact of an individual who has been working for decades. It is therefore prudent to use the index within a stipulated citation time window (normally within a 5-year time window) when comparing the influence of researchers.

It is important for academics to use their discretion judiciously when deciphering the prestige of a particular journal based on JIF or the level of scholastic achievement of an academic based on his/her $h$-index. The ability to judge the impact/prestige of scientific journals can be honed by extensively reviewing published journal articles across a wide range of publishers, and not fixated on just a popular online database operated by a single publisher. In many cases, the most prestigious journals in
respective scientific fields are actually published by scholarly societies and institutes rather than highly commercialised publishers. Examples of such scholarly societies include The American Chemical Society/Royal Society of Chemistry (chemistry), American Physical Society (physics), The American Society for Biochemistry and Molecular Biology (biology), Institute of Electrical and Electronics Engineers (electrical/electronics engineering) and Princeton University and the Institute for Advanced Study (mathematics). After familiarisation with the good and prestigious journals in their respective fields, the relative achievement of academics can be ascertained by scrutinising their publication list coupled with information on citation counts and h-index rather than just relying on one research metric.

ABOUT THE AUTHOR:
Dr Chun-Yang Yin is a lecturer at the School of Chemical and Mathematical Sciences, Murdoch University, Western Australia. He has had industrial experience in the environmental engineering sector and taught at several Malaysian universities and Monash University (Malaysian campus) before joining Murdoch University as a full-time faculty member in November 2010. Dr Yin received his Ph.D. in chemical engineering from University of Malaya and has been appointed as visiting scholar at Columbia University and Harvard University. Dr Yin has published more than 40 international journal articles mostly as first/corresponding author. His current research interests are application of microfluidics in minerals extraction, synthesis of carbon microspheres and porous materials for various industrial applications and determination of ionic liquids toxicities. He can be contacted at c.yin@murdoch.edu.au. Visit his Scientific Malaysian profile at http://www.scientificmalaysian.com/members/yinchunyang/

REFERENCES:


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INTERNATIONALISING THE NATIONAL EDUCATION SYSTEM VIA THE TEACHING AND LEARNING OF SCIENCE AND MATHEMATICS IN ENGLISH (PPSMI)

by TUNKU MUNAWIRAH PUTRA

It is apparent that English is the way forward as far as science and technology is concerned. It has become the dominant language and the lingua franca of scientific communication since the 20th century1.

Technological advancement and intellectual property are the focal points for the creation of wealth of a nation. Technologically advanced non-English speaking countries such as Japan and Korea are paying increasing attention to internationalising their research and development (R&D) capabilities, and allowing wider access to knowledge. The internationalisation of Japan’s R&D effort has been associated with the establishment of major R&D centres in Western countries. Even these economic power houses of the East need to collaborate with the West on their scientific and technology efforts2.

Malaysia too has embarked on various technological developments. One of the strategic reform initiatives recommended under the Ninth Malaysia Plan is to promote innovation and technology by strengthening the delivery of high quality education3.

The teaching of Science and Mathematics in English (PPSMI) in national schools was designed primarily to enable the acquirement of scientific and technological knowledge in its lingua franca, with the intention that it will propel the nation forward as a country of innovators and inventors instead of just consumers. It is to ensure that we have access to the latest and the state-of-the-art scientific knowledge, which is widely available in English4. PPSMI was also tasked with bringing the various ethnic groups together under the national school system.

In 2011, approximately 12% of the student population proceed to sixth form, of which merely 16% of them were in the Science stream5. Note that this data excludes students who further their studies in other equivalent pre-university programmes. This forms one of the reasons for the shortage of scientists in the country. The Ninth Malaysia Plan (2006 -2010) targets 60 researchers, scientists and engineers for every 10,000 people in the workforce, but in October 2009, only 18% of the target was achieved6. We are currently in the period covered by the Tenth Malaysia Plan (2011-2015), tasked to nurture and retain first world talent base. The human capital we need must be highly skilled7. PPSMI will aid a smooth and seamless transition into tertiary education. Allowing this option, and giving it a chance to run its course, could address this shortfall.

PPSMI is a Bahasa Malaysia acronym - Pengajaran dan Pembelajaran Sains dan Matematik dalam Bahasa Inggeris.
Since the announcement to abolish the policy in 2009, students have abandoned the national school system for alternatives. Top alternatives for national schools are international schools and private schools, followed by church-based schools, tuition centres offering O-levels and Chinese/Tamil vernacular schools. Chinese vernacular schools, for example, have been experiencing a record number of intakes for Malay students highlighting this phenomenon. Incidentally, the national school is the only type of school which upholds the Malaysian language (Bahasa Malaysia) as the national language, while all the others are excused.

Isn’t this an indicator that the abolition of the policy has failed the national school system? The abolition has not helped integration either, seeing that there are more fortunate Malaysians opting for international schools with the liberalisation of the private school education sector.

Liberalisation in education must not be limited to that of the private and international school sector. PPSMI should not be a privilege made available only to the few who can afford international schools. If this is so, then liberalisation in education stands only to benefit the elite at the expense of the struggling masses. Everyone deserves to receive quality education regardless of their socioeconomic status.

The decision to abolish PPSMI was made just months after the new cabinet was formed, when the government did not have a blueprint nor a motion set in mind. Thankfully, with some lobbying and pressure by certain quarters, the abolishment date of PPSMI was extended to the year 2020, which means that those who started with PPSMI will be able to complete their primary and secondary education in its entirety with PPSMI. However, not all welcome with the implementation of the policy. Some students have been short-changed and are not able to continue with PPSMI, especially when they were keen to learn the two subjects in English previously.

“Liberalisation in education must not be limited to that of the private and international school sector.”

To be able to speak English as a second language and maintain a high level of English competency takes more than learning English as a subject in school. Clearly, too little emphasis on English has resulted in substandard achievements that we see happening today.

The concept of PPSMI is a clever idea that allows Memorandum to the Prime Minister at the Prime Minister's Office, Putrajaya.
for the Bahasa Malaysia to remain the main medium of instruction in school, while utilising the English language for the teaching of Science and Mathematics. English is the universal language of science, so the teaching of these subjects in English will benefit the students in the future, while at the same time, increasing the exposure of this language to the student. Although PPSMI is a science policy and not a language policy (i.e. it is not intended to improve English per se), the positive effect of PPSMI can be observed in the marked improvement in the national examination results of English subject.

The PPSMI policy is to be replaced by “Upholding Bahasa Malaysia and strengthening the English language” (MBMMBI) policy. The irony is that MBMMBI is a language policy and it is made to supersede a science policy. Both policies uphold Bahasa Malaysia as the national language, whereby more than 50% of subject hours are in Bahasa Malaysia. However, without PPSMI, the teaching of science and mathematics subjects in English is eliminated, thus exposure to English in terms of subject hours will be significantly reduced. The context to apply English has been taken away and the students are left with elementary English communication skills.

Brain drain is inevitable but what we can do as a nation is to instil loyalty and patriotism into our young generations. Whether we like it or not, meritocracy has to kick in, better sooner than later, as the crutch mentality that has benefited earlier Bumiputeras has created an over-dependence on such privileges making them weak and uncompetitive. The Education Act 1996 has provided a leeway for parents in that “pupils are to be educated in accordance with the wishes of their parents”. We must remain pragmatic and sensible with the choices we make to gain the most benefit for the economic growth that we aspire to achieve.

For as long as Chinese and Tamil vernacular schools and a whole spectrum of other schools exist, we must also be given a choice to benefit from PPSMI. English as a second language requires that we master both Bahasa Malaysia and English language. Needless to say, languages are tools, and the right tools are needed to complete the job in the most effective way.

Notwithstanding, we still need to address the issue of developing Bahasa Malaysia as a language of unity and its usage across all ethnic lines, even to the extent of ‘internationalising’ this beautiful and artistic language. However, in addressing these efforts, the command of the English language as a language of knowledge must never be allowed to decline. A right balance must be struck and neither must be allowed to deteriorate at the expense of the other.

For 50 years we have tried to develop Bahasa Malaysia to be on par with English so that it could be used to impart advanced knowledge. This seems like an ambitious and overzealous move, since the language was not designed to achieve these aims.

b Bumiputera is a Bahasa Malaysia term to describe the Malay race and the indigenous people of Southeast Asia.
c MBMMBI is a Bahasa Malaysia acronym - Memartabatkan Bahasa Melayu dan Mengukuhkan Bahasa Inggeris.
Bahasa Malaysia has its own edge especially in the arts, but in the field of science and technology, it is trailing far behind.

According to the US patent and trademark office, Indonesia and Brunei recorded the least amount of patents (1963 to 2011) within Southeast Asia, while Singapore being the highest followed by Malaysia, Philippines and Thailand11. Patents create intellectual properties, and they are developed along with new ideas and innovations. The rate of growth of these innovations is dependent on each country’s science and technology strategy. Based on the growth rates recorded in countries adopting similar language to our national (Indonesia and Brunei), their growth rates are among the lowest in the Southeast Asia, compared to Singapore (a country adopting the English language). There are more opportunities to collaborate in the science and technology field in English compared to in Bahasa Malaysia, and this will drive the number of patents being created.

Several countries are also undergoing this tug-of-war between English and their national language. No nation will allow their national language and mother tongue to become extinct, at least not us.

One of the priorities of our nation is to develop knowledge and commercialise ideas to drive the economy. These innovations impact our national prosperity, security and global influence. The education system must therefore be geared up for these innovations to take place. English is not foreign to us; it is our second language. We are here in this world to seek knowledge, and if that knowledge is to be acquired in the English language, so be it.

ABOUT THE AUTHOR:
Tunku Munawirah Putra (M. Sc. in Mass Communication, Boston University, USA) is the Honorary Secretary of Parent Action Group for Education Malaysia (PAGE). PAGE is an educational lobbyist that serves as a channel between concerned parents, the Ministry of Education and other educational stakeholders. With PAGE, parents have a platform to voice their opinion and feedback on educational issues collectively as a bigger voice. PAGE is optimistic that Malaysia will be able to produce more first world talents.

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The rally in Dataran PJ in March 2012. Parents and students rally for PPSMI to be reinstated and continued indefinitely as an option for the current Standard 1 and 2 students.
Professor Sheila Nathan from the School of Biosciences and Biotechnology of Universiti Kebangsaan Malaysia (UKM) is truly a molecular biologist. She uses a diverse array of techniques at the molecular level to dissect the host-pathogen interaction for melioidosis. Melioidosis is a disease caused by a tropical pathogen, *Burkholderia pseudomallei* (formerly known as *Pseudomonas pseudomallei*). Prof. Nathan is also the Director of the Comparative Genomics and Genetics Research Centre at the Malaysia Genome Institute (GENOM Malaysia). Recently, Dr Valerie Soo from the SciMy team asked Prof. Nathan five questions about her research and beyond doubt, her answers reflect a life-long passion for science.

**Q1. How did, or what made, you get into science?**
It was a general interest in disease and trying to understand the mechanisms of disease and cancer. The undergraduate Biochemistry programme at the Faculty of Life Sciences (as it was known then) of UKM was also instrumental in instilling an even deeper interest in the biochemistry of disease, cancer and the human system. The ability to work in a laboratory and to explore unknown territory leading to new clues and answers eventually set my path towards an MSc and DPhil in the UK.

**Q2. You seem to have a broad interest in unravelling the molecular mechanisms that underlie microbial infections. Can you tell us more about your research?**
My DPhil training at the Trafford Centre for Medical Research (University of Sussex) was on DNA repair, specifically on gene-specific repair in UV-induced disorders. This project involved the use of a number of molecular biology-based approaches to solve the issue in hand, and the opportunities to work in collaborating labs in the Netherlands.

Upon my return to UKM, it was evident that the local research scenario did not encourage pursuing research on DNA repair -- which was understandable -- as it was not a critical problem in Malaysia. In lieu of this, I joined the research group in UKM working on *B. pseudomallei*. This is a very intriguing pathogen in the sense that not very much was known about its mechanism of pathogenesis at that time. Unfortunately, this lack of understanding remains a bottleneck today. The research group in UKM was then investigating the potential presence and role of an exotoxin from *B. pseudomallei*, and I was responsible for producing and characterising monoclonal antibodies for this protein. Furthermore, we were able to produce recombinant antibodies with partial neutralization properties using phage display technology. We extended the use of this technology to the construction and characterisation of recombinant antibodies against the protease protein secreted by the same pathogen. These antibodies were constructed during my sabbatical at the Scripps Research Institute in California.

In 2005, I was invited to initiate a collaborative research project with the Department of Genetics, Stanford University (USA) on investigating the host-pathogen relationship of *B. pseudomallei* using the host model *Caenorhabditis elegans*. The *C. elegans* Research Facility was established in UKM and it was

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**MEET THE SCIENTIST - PROFESSOR SHEILA NATHAN**

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The nematode Caenorhabditis elegans is used as a host model in our studies on host-pathogen interaction. Data from this infection model are complemented by data using mice models.

Our findings have intimated the ability of the bacterium to either up- or down-regulate its essential genes in order to escape recognition by host receptors during the invasion process, as well as to acclimatise itself to the intracellular environment of the host. In another collaboration with the University of Sheffield, UK, we have reported on the presence and three-dimensional structure of a potent B. pseudomallei toxin. We further provided evidence of the toxin interaction with its human target, leading to inhibition of protein synthesis and eventual cell death.

Other work has also identified immunogenic antigens that have been evaluated as potential vaccine and diagnostic candidates. This has led to a number of patents being filed and granted locally as well as internationally.

The C. elegans Research Facility was established in UKM and it was the first C. elegans-associated lab in Malaysia.
Q3. In which direction do you foresee your research is heading?
There is still a vast amount of information on \textit{B. pseudomallei} that has yet to be unearthed in terms of its pathogenesis as well as the host response towards its infection. This bacterium is unlike many other pathogens, and has only succeeded in confounding those working on \textit{B. pseudomallei} and its closely related family members. This has culminated in the lack of a proper drug regimen, as well as rapid and effective diagnostics, although the international group of researchers working on \textit{B. pseudomallei} is growing.

We are currently using various high-end approaches that are reliant on both laboratory experiments, as well as \textit{in silico} analyses to identify as many virulence factors produced by this bacterium that appear to cause a diverse range of symptoms in different individuals. Broad plasticity is also apparent among different isolates of the same species at the genome level, which makes the identification of species-specific virulence molecules (that would aid in the development of drugs and vaccines) more tedious. In terms of how our current and future research findings can be translated into biotechnological applications, the immediate scope would be in diagnostics and vaccinology. Diagnosis of melioidosis is currently reliant on bacterial culture and its identification as the gold standard used in reference laboratories and clinical settings. This diagnostic method requires contained facilities, trained personnel and an extended length of time. Treatment for melioidosis is antibiotics-dependent; however, an increasing rate of antibiotic resistance has been observed. The use of individual proteins as vaccine candidates fails to provide complete protection while disease manifestation is multi-factorial. Hence, this has called for urgent identifications of all potential virulence molecules in the quest to design the most effective vaccine, particularly for the most susceptible population.

Q4. What do you consider to be the highlight of your career so far?
I would have to say that it is a combination of graduating my first student, publishing a piece of work that is deemed as a scientific breakthrough and getting appointed as a full professor. Yet, in particular, the most prominent highlight is the excellence of my PhD and MSc students who have graduated from my research group. This is reflected by the BSc and MSc graduates being accepted into prestigious international universities to pursue their doctoral degrees [e.g. University of Sheffield and University of Bristol (UK), Stowers Institute (USA), NUS and NTU (Singapore)], as well as the PhD graduates acquiring postdoctoral positions in international research groups based in the USA.

“...this has called for urgent identifications of all potential virulence molecules in the quest to design the most effective vaccine, particularly for the most susceptible population.”

Burkholderia pseudomallei with its characteristic bacterial colony morphotype.

Prof. Sheila Nathan and her group of graduate students and research assistants.
Q5. What bit of research has caught your eye recently? Why?
I would probably have to say “bacteria and the evolution of pathogenesis”. Whilst this is not new in terms of the research being carried out, there is an insatiable desire to understand why a harmless soil-dwelling bacterium decides to turn nasty once it has found its way into a completely different environment, even though, genotypically, it is still the same organism. If bacteriologists succeed in dissecting this enigma, we could be more successful in predicting or preventing disease, and of course, in the development of new drug therapies.

Prof. Nathan can be contacted at sheila@ukm.my for more information on her research.

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CERN is a particle physics laboratory. At CERN, there is a certain formula to introductory conversations in a social setting. The compulsory name-exchanging is often followed by a tell-tale question:

“Are you a physicist or an engineer?”

More than any other question, this one is most likely to set the mood for the rest of the conversation, and by extrapolation, determine the course of the relationship between these two people. So what is so fascinating about this distinction? Cernois¹ talk about the great physicist and engineer divide, coffee corner gossips build around the enticing interaction between them, they strut the CERN compound doning vastly distinctive apparels (physicists in sweatpants and t-shirts with nerdy equations printed on them²; engineers in carefully ironed shirts tucked in their equally creaseless pants) and indulge in wildly different past-time. So, what is it really about these two species that make them love and hate each other? What underlies this nuanced relationship? And the most important question of all - who really rule CERN?

Physicists and engineers at CERN are in a state of perpetual friendly rivalry. As the biggest physics laboratory in the world, CERN’s mission is to find out the ingredients of the universe and solve the conundrum of its birth. This is the domain of particle physicists (be it theorists or experimentalists). Theories were developed to explain the recipe of the universe, with the Standard Model³ being by far the most elegant and compelling one. However, the bedrock of any scientific endeavour lies in its absolute reliance on empirical evidence. In order for CERN physicists to prove their theory, big and complex detectors and accelerators need to be built. And this is where the engineers come in. The latest in CERN’s repertoire is the Large Hadron Collider (LHC). Aside from the buzz around its mission to find the Higgs boson⁴ (conspicuously named ‘The God particle’) and thus complete the Standard Model, the LHC also shone the spotlight on CERN’s magnificent engineering feat. The size and complexity of its detectors are a marvel of engineering virtuosity. What is less known though, is the tug of war between the physicists and engineers in the process of building this giant machine.

Although both placing the utmost importance on mathematics and analytical thinking, physicists and engineers have fundamentally different attitude in solving puzzles. An engineer will not start a project

1 A term referring to those affiliated with CERN.  
2 My favourite one says “RESISTANCE IS FUTILE (if R < 1 ohm)”.  
3 A mathematical description of the elementary particles of matter and the electromagnetic, weak, and strong forces by which they interact.  
4 A hypothetical particle that explains the origin of mass.
unless he knows the answer, while a physicist will not start a project if he knows the answer. Physicists are often driven by imagination, while engineers by well-defined rules and specifications. If it was up to the physicists, the LHC could have been twice its size and with far more frills. But the reality of matter is, in the realm of science, imagination is often limited by technology. When a physicist is free-wheeling in his wonderland, it is often up to the engineer to slow him down and say "No, we can't do this. At least not yet". Engineers are like the prosaic twin to the physicist's unruly one. The physicist thinks that the engineer is a kill-joy to his unorthodoxy ways, while the engineer regards the physicist as unreasonable and other-worldly. Engineers value order, but physicists take pride in creative chaos - they are, afterall, exploring the unknown.

Great discovery can depend on serendipity. For physicists, experiments that don’t work might lead to greater discovery. Indeed, at CERN, there is an unspoken agreement among the physicists that the worst possible outcome of the LHC experiments would be that if only the Higgs boson, and nothing else, is discovered. That would mark the end of the journey, leaving many pressing questions (e.g. What is dark energy made of? Why are we made of matter and not antimatter?) unanswered. On the contrary, in engineering, things that don’t work can spell disaster. Who can forget the collapse of the Tacoma Narrows Bridge as a famous example of engineering disasters?

With the demarcation so clear between the two seemingly divorced worlds of engineers and physicists, what makes their relationship work?

The truth is, they both can’t live without each other.

As is true for most relationships, their differences drive them crazy, but also cultivate in them a capacity to learn and compromise. They rub off each other's mentality and approach, each providing a balancing effect to the other’s temperament. In dispensing outrageous demands, physicists encourage engineers to stretch their imagination, motivating them to push the envelope of technological possibilities. By repeatedly asking “why not?”, they spur the engineers on to develop innovations which turn No’s into Yes's. On the other side of the coin, engineers provide structure to the at times chaotic scientific process and set the necessary boundaries to the physicists’ otherwise unrestrained explorations. Engineers build the skeleton, upon which imagination is free and safe to roam.

Science in the 21st century is never a one-man show. The collision of character and style, as well as the resulting synergy, is a staple of large collaborative projects such as CERN’s research. For better or for worse, the wacky t-shirts and the neat tucked-in shirts are both here to stay.

Disclaimer: The views and opinions expressed in this article are those of the author and do not reflect in any way the official policy or position of CERN.

ABOUT THE AUTHOR:
Yi Ling Hwong graduated from the University of Applied Sciences Karlsruhe, Germany with a Master in Power Engineering. She worked for 6 months in the Cryogenics group of CERN as a technical student and 3 years as a data acquisition engineer in the Compact Muon Solenoid experiment of the LHC. She is now a web editor for the Doctors without Borders organization. Find out more about Yi Ling by visiting her Scientific Malaysian profile at: http://www.scientificmalaysian.com/members/cirnelle/profile/
A kiwi used to mean a type of fruit, or bird, to me. It dawned on me four years ago that a Kiwi could also refer to a nation, and its culture, from two islands in the Pacific Ocean. These islands form the country of what we know as New Zealand (NZ).

From the moment I started to apply for a PhD studentship in NZ and subsequently a student visa, the child in me protested vehemently against my sudden development into a level-headed adult. Throughout my life till then, I was used to getting things done according to—well, mostly—my way. However, throwing juvenile tantrums did not, and certainly, would not help when there were gazillions of forms to be completed and submitted. I was left to deal with the unnecessary bureaucracy on my own, as there was little useful information tailored for my studentship1 and visa application2.

Of course, the bureaucratic process did not just end there. On the first day of my PhD, which I had naïvely imagined to be filled with intellectual discussions over cups of flat white3, it was instead filled with another round of forms filling to confirm my enrolment at the university, and to set up a payment method for my monthly stipend. I soon found myself agreeing with the saying about the lack of structure in PhD programmes in NZ4 Nevertheless, a loose framework that appears to shape every doctoral programme has become evident over the years. For instance, the official working hours for a PhD student are from 9 a.m. to 5 p.m. although many students work longer hours, including weekends. Those who use biological cell lines in their studies have to drop in everyday to feed their cells, or else there would be no materials to start an experiment. This unspoken rule also applies to me as many time-course experiments of mine had to be run for seven days consecutively. Coffee breaks and lunchtime became invaluable moments, when diligence and sheer determination, the commonly recognized attributes of PhD students, are redundant.

A few universities in NZ offer a graduate committee for every PhD student, i.e., a team comprising of 4–5 Principal Investigators (PIs). A PI is a senior scientist (who is usually a faculty member) appointed

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1 Application for PhD programmes in a NZ university typically takes 2 months to complete. It is advisable to work closely with these two departments during the application process: the Graduate Research School that oversees the postgraduate programmes in the university, and the International Office that handles issues relevant to international students.

2 Application for a NZ Student Visa is a tedious process -- it involves obtaining a medical check-up, a chest X-ray (both should be completed within the last 3 months), a police record certifying one’s behavioural record and an evidence of financial funds (at least NZ$15,000 per year). Visa approval typically takes a month, after all the relevant documents have been submitted.

3 Flat white is a type of coffee added with steamed milk. It is a popular beverage in Australia and NZ, mainly for its creaminess and velvety texture.

4 PhD programmes in NZ are 100% research-based, and generally last for 3–4 years for full-time students, or 5–6 years for part-time students. While PhD thesis can be prepared in the traditional format, many departments in Massey University are encouraging and adopting the manuscript-format.
by the university, who supervises or oversees a PhD student's research progress. However, most universities let one or two main PIs take charge of the student's development. In the first year (which is also a provisional period for PhD students), the PIs usually exercise all their power to ensure that their protégés remain on the right track. Every PhD student will have to undergo a confirmation exam at the end of their first year to ensure that they are on the right track and have a good grasp of their research. Students who failed this exam in their first attempt are allowed to have a second try at a later date. Failing that, they will either be downgraded to a Masters degree (such as an MSc.) or in the worst case scenario, they could be expelled from the university without any qualification. I was lucky that my supervisors gave me plenty of pep talks before sitting for the exam (and of course, I passed!).

After proceeding smoothly into the second year, I assumed that my days of backbreaking work would lessen. I have settled into living like a Kiwi by then, and I was eager to visit some interesting places featured in travel brochures (e.g. the Hobbiton village that made its way to the 'Lord of the Rings' movies; and the Fiordland National Park that houses many deep fiords). How wrong I was! A large chunk of my second year was spent attending local and international conferences. Most international students in NZ have to apply for travel grants from external sources, as travel funds from the universities are barely sufficient for the local students, let alone the international ones. Travel awards from various societies, such as those from the NZ Society for Biochemistry and Molecular Biology, are major financial sources for overseas trips.

Yet I somehow managed to wrap up the experimental work and got my thesis completed and submitted early this year. As usual, the submission was accompanied by numerous forms with various signatures. After what seemed like an eternity (three months, actually), two local examiners and an international examiner finally finished examining my thesis and called for a viva voce⁵. Their genuine interest in my work was unexpected, and that led to a stimulating discussion during my viva. Three hours later, I found myself being congratulated for passing the biggest exam in my life. And the night was a bit of a blur after that...

ABOUT THE AUTHOR:
Valerie Soo has just defended her PhD thesis at Massey University, NZ. At the time of writing this article, she is preparing to move to the US for a postdoctoral training. Find out more about Valerie by visiting her Scientific Malaysian profile at: http://www.scientificmalaysian.com/members/valwcsoo/profile/

⁵ Viva voce is also commonly known as the PhD defense. It is a closed oral examination, in which the examiners critique the scientific and technical aspects of the PhD thesis and/or the research. In Massey University, the examined student has to “defend” his/her work, as he/she is not given the written comments and concerns of the examiners prior to the viva. Three examiners are appointed for the viva voce: a PI from Massey University, a PI from another NZ university (both are termed as the local examiners), and a PI from outside NZ (the international examiner).
Life as a postdoc at Karolinska Institutet, Sweden

by Dr. Oon Chern Ein

Upon completion of my PhD in Medical Oncology at the University of Oxford UK, I was confronted with the daunting question of “Should I or should I not do a postdoctoral training and if yes, where?” According to the US National Postdoctoral Association, a postdoctoral researcher is defined as an individual with an existing doctoral degree who is involved in a temporary period of mentored research and training towards the aim of obtaining the necessary professional skills in order to grow into a professional identity in his/her chosen career path. Hence, a quality postdoctoral training is a crucial step in the development and maturation of a scientist, or at least I believe so.

To reap the most out of my postdoctoral experience, I decided to spend a year or two in another foreign country to establish my research niche in the field of oncology. Karolinska Institutet (KI) in Sweden was my choice of host institute because it offers plenty of opportunities for widening my network, thereby fostering potential scientific collaborations.

Stretching over 14 islands and forming a part of the famous archipelago of around 24,000 islands lies the picturesque city of Stockholm, the capital of Sweden. This beautiful city is sometimes called the Venice of the North. The vibrant city is spotted with an array of rich terracotta coloured buildings surrounded by clean glistening water and clear blue skies in the summertime. In stark contrast, speckles of bright lights can be seen lighting up the exquisite white wonderland in winter. With a population of just nine million people, the Swedes lead a wealthy and peaceful life, thanks to its booming economy and excellent social security.

Located just outside Stockholm city centre is the world-famous KI which ranks 32nd globally, 6th in...
Europe, and 1st in the Nordic region according to the 2012 Times Higher Education World University Rankings. In the 2010 “Best Places to Work: Postdoc” survey by The Scientist magazine, KI was voted 9th in the top 10 list of international organizations for postdoctoral research opportunities, making it one of the most popular and highly competitive places for postdoctoral researchers.

As a postdoctoral researcher in KI, one has ample opportunities for networking. Recognized for its cutting-edge competence in medical research, KI has successfully established research and educational collaborations with a number of countries including USA, Singapore, China, India and Japan. The many scientific breakthroughs made in KI have placed it in the forefront of medical sciences, further attracting the cream of the crop in the scientific community from around the world for research collaborations, seminars and conferences. I am impressed!

The institute’s success is also due in part to its role as the proud home to the Nobel Prize. Since 1901, the Nobel Assembly at Karolinska Institutet has awarded the Nobel Prize in Physiology or Medicine every year. As described in Alfred Nobel’s will, the Prize is dedicated to “the person who shall have made the most important discovery within the domain of physiology or medicine”. The Nobel Assembly is made up of 50 reputable professors from KI who meet five times a year to discuss the nominations for the Prize, elect the Nobel Committee who is responsible for nominating the candidates would finally decide on vote(s) for the recipient(s) of the Nobel Prize.

KI has excellent state-of-the-art infrastructures to sustain high quality educational and research activities. Its close collaboration with

**HOW ARE THE NOBEL LAUREATES SELECTED?**

A brief description of the process involved in selecting the Nobel Laureates in Physiology or Medicine Prize.

**September – Nomination forms sent out.** The Nobel Committee for Medicine sends out confidential forms to around 3,000 persons — selected professors at universities around the world, Nobel Laureates in Physiology or Medicine, and members of the Nobel Assembly, among others.

**February – Deadline for submission.** The completed forms must reach the Nobel Committee no later than 31 January of the following year. The Committee screens the nominations and selects the preliminary candidates.

**March-May – Consultation with experts.** The Nobel Committee sends the list of the preliminary candidates to specially appointed experts for their assessment of the candidates’ work.

**June-August – Writing of reports.**

**September – Committee submits recommendations.** The Nobel Committee submits its report with recommendations on the final candidates to the members of the Nobel Assembly. The report is discussed during two meetings of the Nobel Assembly.

**October – Nobel Laureates are chosen.** In early October, the Nobel Assembly chooses the Nobel Laureates in Physiology or Medicine through a majority vote. The decision is final and without appeal. The names of the Nobel Laureates are then announced.

**December – Nobel Laureates receive their prize.** The Nobel Prize Award Ceremony takes place on 10 December in Stockholm, where the Nobel Laureates receive their Nobel Prize, which consists of a Nobel Medal and Diploma, and a document confirming the prize amount.

**Source:**
http://www.nobelprize.org/nobel_prizes/medicine/nomination/
the Karolinska University Hospital makes it possible for scientists to interact with clinicians at a research institute-hospital interface for translational medical research. This has successfully paved the way for the growth and progression of the current modern Swedish healthcare system. The finest example is the world's first successful artificial trachea transplantation seeded with the patient's own stem cells carried out at the Karolinska University Hospital.3

The working environment is generally very international and diverse in culture, despite some departments having more Swedes than others. Since most Swedes speak excellent English, foreigners are not required to learn Swedish prior to coming to Sweden. ‘Fika’, which means coffee break, is an important culture in the Swedish community. Most people, if not all, will take time off – even in the midst of work – to enjoy a cup of coffee accompanied by a cinnamon roll (‘kanel bulle’) or sometimes, a sandwich (‘smörgås’) with fellow colleagues.

On the darker side, postdoctoral researchers have a relatively unfair deal when it comes to pay. A postdoc's salary in KI is barely higher than the average stipend of a PhD student! In fact, many postdocs are paid stipend without additional benefits; the law allows KI to do so within the first two years of working in KI. In most cases, employers choose to pay by stipend because it is very competitive to get a postdoctoral fellowship in KI due to its brand recognition. Sadly, this situation is very taken advantage of.

A major drawback faced by most guest researchers in KI is the lack of accommodation and the high cost of living. One has to get in the apartment rental queues at least two years in advance to secure a roof over the head, although accommodation contracts typically last for a maximum of only two years. Therefore, it is advisable to discuss with employers and to arrange a few months of accommodation through all means before arriving in Stockholm.

Despite these setbacks, I very much appreciate the opportunity to be part of the scientific society in KI. Being able to work with some world-leading scientists close to the Nobel Prize happenings, this postdoctoral experience is an unforgettable journey.

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One of the most stunning revelations in any scientific field in the last half-century came in 1998, when Saul Perlmutter, Brian P. Schmidt, and Adam G. Riess discovered that the expansion of the universe is accelerating. This subsequently earned them a shared Nobel Prize in Physics. The Book of Nothingness, written by noted British astrophysicist/mathematician John D. Barrow and published just four years later, was one of the earliest attempts to explain the profound implications of this discovery to the general public.

Unlike more recent books on the same topic, such as the current bestseller A Universe Out of Nothing: Why There is Something Rather Than Nothing by Lawrence Krauss - which dive rather straightforwardly into the heady technicalities of physics, The Book of Nothingness is more of a generalist treatise on the broad history of ideas on the vacuum. In fact, the first 40% of the book is completely devoted to the concept of vacuums in a wide variety of non-scientific literature.
The Book of Nothingness begins with a charming overview of the historical development of the number zero. Although the cipher figure was invented independently among a number of primitive civilizations, it was the Indians who gave it its additive value that enabled the emergence of the decimal system. Curiously, Barrow points out the only civilizations that invented the zero were all highly superstitious practitioners of mysticism. The Indians, for example, also associated the digit with a number of religious and philosophical themes of nothingness. Conversely, the ancient Greeks, who were otherwise the most scientifically significant early civilization, could not tolerate the idea of zero. For the Greek philosophers, the concept of a cipher was logically dissonant, as encapsulated by Parmenides’ maxim, ex nihilo nihil fit (nothing comes from nothing), or Aristotle’s “Nature abhors a vacuum”.

As the ancient philosophers argued over the unsettled debate on how something can come out of nothing, the concept of zero gained prominence in the realm of literature and theology in the following millennium. While writers like Shakespeare made the best out of innocuous puns and wordplay on nothing (e.g. his prominent comedy “Much Ado About Nothing”), theologians faced a significant challenge on the philosophical implications of nothing; if a vacuum could exist, it would disprove the omnipresence of God. As the feud between theologians, philosophers and scientists escalated towards the end of the middle ages, interest in the ancient engineering challenge of creating a vacuum revived. By the mid 1600s, the first vacuum pump - the Magdeburg hemispheres - was invented by Otto von Guericke and memorably demonstrated with the failure of 32 horses to pull it apart, highlighting the power of atmospheric pressure. At about the same time, Blaise Pascal began his experiments in measuring air pressure. The results dealt a significant blow to the church - as air pressure decreased proportionately with height above sea level, one could extrapolate the measurements to postulate that there exists a certain point above earth where air pressure was zero. This dark chasm, which we know now as space, shattered any beliefs of an infinite extension of the earth’s dominion.

But, as Barrow notes, the concept of vacuum would undergo several more cycles of derision and revival among the scientific elite as scientific revolutions come and go. The first major effort to develop a coherent picture of the vacuum came after Newton. While Newtonian physics were astoundingly successful in predicting a wide variety of physical phenomena (on a human scale), physicists struggled with the idea of planets exerting gravitational forces over vast distances of empty space. In order to explain physical actions in the absence of mass and energy, the ether was created - an elusive substance thought to permeate the universe. This was, of course, debunked with the advent of Einstein’s theory of general relativity. With this, the ether retired and the vacuum assumed another period of scientific dormancy.

Though it is foreseeable that more technically-minded readers will find the entire first half of the book - dedicated to the history of the vacuum - as somewhat incoherent and even tiring (Barrow has been rather ambitious in attempting to weave the philosophical, literary, theological,
Barrow has been rather ambitious in attempting to weave the philosophical, literary, theological, historical, and scientific elements of the concept of nothing into a seamless story, it provides a fun warm-up for the more generalist reader in making a transition into the much more dense second half of the book. The last half deals with the implications of the latest discoveries in quantum mechanics and astrophysics on the nature of the spatial vacuum. Here, the explanations are about as lucid as those found in Krauss’s *A Universe From Nothing*.

As Barrow skillfully narrates, the latest conundrum on the vacuum began almost a century ago when Einstein arbitrarily added a ‘cosmological constant’ to one of his field equations that would result in a static universe. By 1929, Hubble discovered the expansion of the universe, shattering the image of an unmoving universe. Einstein later lamented to George Gamow that the cosmological constant was the biggest blunder of his life. However, the 1998 discovery that the universe is not only expanding, but that its expansion is also accelerating, resurrected conjectures on the nature of the vacuum. As it turns out, even if one removes every single bit of mass-energy that it is possible to remove from a spatial region, what remains is not an absence of energy, but the lowest state of energy possible. This vacuum energy, an innate feature of space itself, acts as an anti-gravitational force that speeds up the expansion of the universe and is set to become the dominant force in the universe someday as space grows forever. Cosmological constant has been currently used to explain vacuum energy, perhaps Einstein’s ‘biggest blunder’ (though wrongly applied) was really just an amazing prediction!

Overall, I enjoyed *The Book of Nothingness*, and Barrow surely has a gift for scientific narration. Being a regular reader of popular physics books, I would rank the book intermediate in terms of accessibility for the educated layman. However, anyone who picks up the book today should bear in mind that developments in astrophysics move at light speed, and that many of the latest discoveries uncovered in this book were published a decade ago.

**ABOUT THE AUTHOR:**
Gabrielle Chong Yong Wei is a philosophy student at Wellesley who is fond of science.
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Sometimes I think we’re alone in the universe. Sometimes I think we’re not. In either case the idea is quite staggering. - Arthur C. Clarke

We are living in a significant era in the history of mankind. As I am writing this article in late May 2012, almost 800 exoplanets (planets beyond our own solar system) have been discovered. Given that exoplanet detection had only begun in earnest since the past decade and detection techniques will continue to improve greatly, we are poised to discover many more exoplanets and start investigating their habitability in the near future.

Despite advances in the search for extraterrestrial life, they aggravate one of the greatest unsolved mysteries of our times. Given the age and size of the Universe, and the possibility that Earth’s habitability is not unique, it is quite likely that at least one other intelligent civilization capable of interstellar contact besides ourselves has arisen sometime in the past, and yet we have not had any evidence for its/their existence. But this question, often known as the Fermi’s Paradox, is not really contradictory at all; either extraterrestrial intelligence exists, or it does not, and the answer must lie in one of several possibilities.
The most straightforward and historically popular answer is that the intelligent life on Earth is really unique. Advocates of the Rare Earth Hypothesis and anthropic principle point out that life on Earth is a highly improbable event that arose out of a great number of favourable events, starting from the Earth’s fortunate position in the habitable zone of the solar system, the favourable geoclimatic conditions that allowed complex life to arise on earth, the fortuitous history of evolution on Earth that allowed humans to emerge and flourish as a unique species, to other conditions that led to our present capability for interstellar contact. This view, however, can only remain speculative because the absence of evidence for extraterrestrial intelligence cannot disprove the existence of extraterrestrial intelligence. Moreover, this view violates the Copernican nature of astronomical research; almost every discovery in modern astronomy has shown our world to be less and less unique.

Other views allow for the existence of extraterrestrial civilizations, but suspect that interstellar contact is constrained by matters of scale, i.e. time, distance, technology, and economy. Such views hold that given the vastness of space and the chances for cosmic accidents (gamma ray bursts, black holes, etc.) over long distances, it is difficult for even the most technologically advanced civilizations travelling at the cosmic speed limit to come into contact with each other. Moreover, they might have encountered engineering problems that we do not understand yet, or they simply do not have sufficient resources to power high energy-consuming pursuits such as interstellar transmission. These constraints, in parallel to the limiting factors in the Rare Earth Hypothesis, reinforce each other to make inter-civilizational contact a highly improbable event.

However, there are also several possible multipliers that may compensate, if not displace, these constraining factors. Firstly, it is foreseeable that a highly advanced civilization would also be a high energy-consuming civilization, and we should be able to detect the enormous energy mines, such as Dyson spheres and other gigantic artifacts which they leave behind. Secondly, it is not necessary for interstellar travel to be operated by singular probes powered by a singular energy source - an advanced civilization would be capable of building von Neumann machines that utilize resources at various checkpoints to make replicas of themselves, filling an entire region of the universe with such machines. Moreover, though most people often envision space travel and colonization to take place in a linear direction, an advanced civilization with adequate resources should be capable of sending out probes in all directions, expanding the region of colonization at a cubic growth rate and thereby significantly increasing the detectability of such civilizations.

Some other sociological speculations posit that the assumptions we make regarding the motives for interstellar travel are false. Perhaps the need for exploration and discovery is unique to humans, and advanced civilizations would simply be uninterested in expanding their colonies – for reasons unknown to us. But this, too, seems counterintuitive. Scientific inquiry, if not an evolutionary urge for colonization, would be a necessary trait of any technologically advanced society. Another sociological explanation would be that intelligent societies are predisposed...
to becoming unstable and self-destructing after reaching a certain threshold of technological progress. This is probable and chilling, considering that humanity currently possesses enough nuclear arms to wipe out the entire human population many times over, though it would be quite tragic and ironic that extreme intelligence – the principal enabler for the rise of intelligent civilizations – would also be the principal enabler for their extinction.

Another possible situation is that extraterrestrial intelligence exists, and may even be amongst us, but we simply cannot detect them, either because they are unrecognizable to us, or they have chosen to be invisible. For example, it is possible that an advanced society would prefer to transfer all their memories and energy into more stable depositories such as dark matter, or decentralize themselves into picobots, and that such post-biological life forms and societies would completely elude us. On the other hand, the Zoo Hypothesis postulates that extraterrestrial life would designate life on Earth as an ecological sanctuary, in the same way we create wildlife sanctuaries for purposes of conservation and observation. Under such circumstances, there would be no way for us to observe beyond the sanctuary borders that have been imposed on us. Calculations in game theory also suggest that intelligent civilizations might choose to lie low to avoid interstellar wars, given that competition for cosmic resources and/or inter-civilizational hostility are inevitable traits of advanced societies.

Last but not least, one philosophical solution that is possible but rarely discussed as a solution to Fermi’s Paradox, is that we are living in a computer simulation, and that the rest of the Universe is simply a filler to life on Earth that is the chief subject being studied in the simulation. In such a matrix, we cannot even search for ‘real life’ on Earth.

“Calculations in game theory also suggest that intelligent civilizations might choose to lie low to avoid interstellar wars…”

We have discussed many possible solutions to Fermi’s Paradox. The answer must lie in either one of these, or a yet unknown case. Regardless of the correct answer, the silence of the Universe is quite deafening.

ABOUT THE AUTHOR:
Gabrielle Chong Yong Wei is a philosophy student at Wellesley who is fond of science. Her Science Storytelling Column breaks down speculative questions at the intersection of science and philosophy into digestible bits.
THE DETECTIVE

Part 3

by DR WONG KAH KENG

Previously on “The Detective” (Scientific Malaysian Issue II), Justin was embroiled in a direct competition in research. This is the continuation of the story.

Melody of the 90s ballad waved in the air of the Pret a Manger sandwich chain just a few metres away from the Malaysian embassy at Trafalgar Square. Justin was holding a tray with a Swedish meatball hot wrap and a bottle of elderflower drink while trying to decide which table to settle into. Round table with two seats facing the entrance but close to the corner, Justin thought, like an amateur holding a compass and putting feng shui principles into practice.

The date was 31st of October, Halloween day. Rather than roaming around in the laboratory all day and night like a ghost, Justin decided on impulse to dump the intensity of the Terry-Stephen saga that had gotten the better of him for the past three weeks, hopped on a train to King’s Cross St. Pancras from Whiteforest, and spent a day of sightseeing in central London. He needed time off, a day-break, with the freedom to explore, unplanned and following instinct, be anonymous and conversation-less, mischievously hoping that he would not run into someone he knew and engaged in banal what-are-you-doing-here natter. His Android-powered smartphone was turned off on purpose, so without access to the Internet, he was fully disconnected from the entire human race digitally while immersed into a sea of strangers.

Strangers were whom he met at the Natural History and V&A Museums, purposefully avoiding the adjacent Science Museum in conjunction with his self-declared science-free-day celebration, a day free of any thoughts about science. He craved for arts instead, letting his right brain to predominate the day and ventured into the Tate, Saatchi and finally the National Portrait Gallery.
He had visited some of the galleries and was still amazed by the grandeur of the baroque European paintings, ranging from the then controversial Caravaggio’s work depicting violence to the beautiful portraits with detailed nature by John Everett Millais. He embraced historical European works more than the modern arts which often seemed far-fetched, and to his personal conviction, more than the Asian arts.

He documented his journey with a new Olympus E-5 coupled with a Zuiko digital camera lens made in Japan. Justin’s tendency of using Zuiko lenses since the mid-2000s earned him a nickname 水哥 in Cantonese, whose words pronounced as ‘suigor’ which figuratively means ‘rich guy’, thanks to Zachary, one of his Malaysian peers at Whiteforest who was fond of coining nicknames.

After close to 10 hours of capturing and consuming arts, it was time for dinner. He settled for sandwiches at Pret a Manger due to a heavy late lunch at Partridges. While flipping through the Geek Stuff magazine which he bought at a grocery and enjoying his Scandinavian sandwich, a bunch of teenagers made loud, wailing noises at the entrance. One of them opened the door and greeted unsuspecting diners with a huge “Arghhhhh!” groan. This larger-than-life boy in his late teenagehood was dressed in torn up denim jacket and cargo jeans, sporting dark-coloured eyelids and brow bone resembling a punched eye, and a red painting from the edge of his lips to the chin desperately resembling blood. They were apparently stopping by to buy God-knows-what they needed for their Halloween party at God-knows-where. A second ‘ghost’ made an entrance. She was carrying a broom, dressed in an all-black attire cleverly matched with a pointed hat and sporting a protruding prosthetic nose. By now, Justin could not resist clicking the shutter button of his camera to capture these amusing creatures.

When one of the teenagers spotted Justin’s snapping their photos in his attention-grabbing bulky camera, he started to wail and walked towards Justin in zombie-like mode, and the rest of his gang followed suit. Within a few seconds, there were six of them zombie-zoomed towards Justin.

Unflinching and confidently, Justin said, “Care to join for a family portrait?” “Yeeesss!” replied the witch.

Snapshots of them posing with Justin’s bulky camera were taken using auto-mode, with a snapshot of Justin as the centrepiece for vampire ‘consumption’ and several other otherworldly poses with the ‘ghosts’. Out of courtesy, Justin endured a few minutes of amusing yet used-as-a-fodder photography session, before the teenagers left for their

“He craved for arts instead, letting his right brain to predominate the day...”
actual party. The witch dropped him an e-mail address.

When the night set in, Justin decided to do some exterior sightseeing along the River Thames before taking a train back to Whiteforest. While on the journey back that would take another 2 hours, he turned on his Android for the first time since he left to check his e-mails and found a few unread text messages and voicemails.

Hey rich bag, where on earth have you disappeared to? Tried to reach you for dinner at GBK, hope you were not kidnapped. Zac.

Being awake for the past 18 hours and a day of sightseeing, his thoughts lurched into slow motion. He flipped through the messages without replying to any while yawning at some. However, one of them unexpectedly came from Gordon, the postdoctoral researcher.

Hi Justin, hope you’ve enjoyed your day. You might want to come back and take a look at the FACS graphs. I’ve left it on your table. Gordon.

“After experiencing numerous setbacks, ‘negative’ results labelled as the ‘false alarms’, he had since been more sceptical.”

The FACS! Justin exclaimed to himself. Two days ago, he performed an initial set of experiments to see if the cells purified by Carlos were in fact behaving like cancer stem cells. The queen ant. However, the departmental FACS machine, a vital life sciences tool, was down and it was required to investigate the final result of the experiments. Gordon volunteered to run its final set of experiments using a FACS machine at a nearby research institution that he had links with, and it was agreed upon by Justin and Prof Stephen themselves.

Have we really nailed it? After experiencing numerous setbacks, ‘negative’ results labelled as the ‘false alarms’, he had since been more sceptical. But the internal sense of urgency rose. It was already twenty past midnight with another 90-minute journey into Whiteforest. Venturing into the bed or going into the lab? Justin debated. With the senses originating from his right brain being tickled the whole day, it was time to utilise his left brain. To the lab I will go.

-To be continued-

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