SCIENCE FOCUS 科言

Issue 004, 2015

Teleportation: A Real Possibility?
隱形傳輸 — 有可能嗎？

Nature's Numbers
大自然的數字

Interviews with Hong Kong University's Prof. Kwok Yung Yuen and Nobel Laureate Dr. John C. Mather
香港大學袁國勇教授及
諾貝爾得獎者約翰·馬瑟博士 專訪

School of 理學院 Science
香港科技大學
THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

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Science Focus 科言
Issue 004, 2015

Message from the Editor-in-Chief 主編話語

Dear Readers,

Time sure flies! This time last year, the HKUST's School of Science published its very first issue of *Science Focus*. The positive responses we got over the course of last year served to be incredibly encouraging to our Student Editorial Board and we are delighted to be back with the fourth issue. With the experience of existing members and fresh ideas from new blood, we are excited to bring you even more interesting articles and brighter designs.

Again, I want to congratulate Chan Hoi Yue (Diocesan Girls' School) for winning the Article Submission Competition. You can read her article, "The Science of Hair", on page 20. If you fancy having your written work published in our magazine, send in your science articles to us at *sciencefocus@ust.hk* today and visit our website at *http://sciencefocus.ust.hk*! We look forward to reading them.

Our success depends on your feedback and suggestions. Send them in at *sciencefocus@ust.hk*.

Enjoy!

Prof. Yung Hou Wong
Editor-in-Chief

親愛的讀者：

時間過得真快！去年這個時候科大理學院出版了「科言」的創刊號。在過去的一年，我們收到了許多積極的回應，對於學生編委會而言是相當有鼓勵意義。我們很高興再次與你們見面。最新出版的一期，集合了舊委員的寶貴經驗，和新委員的新鮮創意，讓雜誌內容更有趣、更精彩。

在此我們恭喜這次「科言徵文比賽」的得獎者陳凱瑜同學（拔萃女書院）。她的得獎文章「毛髮的秘密」刊登在本期第二十頁。若你也想有機會發表你 的作品，請立即參觀我們的網站 *http://sciencefocus.ust.hk*，及將稿件發送到 *sciencefocus@ust.hk*。我們熱切期待閱讀你們的作品！

另外，我們衷心盼望能收到更多讀者的反饋，使我們得以繼續進步。請將意見與建議電郵至 *sciencefocus@ust.hk*。

主編 王殷厚教授
敬上

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2015 JAN - FEB - MAR - APR WHAT'S HAPPENING IN HONG KONG? 香港科技活動

By Thomas Lee 李浩賢

We are well aware of your busy exam schedules but all work and no play makes Jack a dull boy! Check out some of these events and learn while you're having fun. 我們深知你正為繁忙的日程和考試煩惱，不過同學可以考慮參加下列活動，增廣見聞，寓學習於娛樂。

The Volcano Discovery Centre

Located in down town Sai Kung, The Volcano Discovery Centre aims to give you an idea of what it was like 140 million years ago when massive volcano eruptions were common occurrences. These eruptions resulted in the formation of hexagonal rock columns, which can be seen in Sai Kung. Find out the science behind volcanic structure and eruptions through their free guided tours on a fun family day or pitch this to your teachers for an exciting school trip! For more details, please visit *http://www.volcanodiscoverycentre.hk/en/*

火山探知館

火山探知館位於西貢市海濱公園，讓訪客了解在一億四千萬年前，火山經常發生猛烈爆發的景象，亦會介紹標緻奇突的西貢六角岩柱形成過程。對火山結構和爆發有興趣的同學，可與家人參加公眾導賞團，也可請學校預先申請，組織戶外學習之旅！欲了解更多詳情，請瀏覽*http://www.volcanodiscoverycentre.hk/zh/*

Volcano Discovery Centre Guided Tour	展館導賞團	Time 時間	Target 團種
Every Monday, Wednesday and Friday	逢星期一、三、五	(A) 14:30~15:15	School / NGO* 公眾導賞團
Every Tuesday and Thursday	逢星期二、四	(A) 14:30~15:15	Public 公眾導賞團
Every Saturday, Sunday and Public Holidays	逢星期六、日及公眾假期	(A) 14:00~14:45 (B) 15:30~16:15	Public 公眾導賞團

Science Alive 2015

From March 7-20, experience the fun activities brought to you by Science Alive. This year's theme is Chemistry – learn about why it 'matters'. Activities range from fun workshops for the family to open lectures and student debates. Teachers can even get involved in the teacher development workshops. Visit their website for the full schedule now: *http://www.britishcouncil.hk/en/programmes/education/science/science-alive*

2015活的科學

「2015活的科學」將於本年三月七日至二十日舉行，帶給你形形色色的科學活動。今年主辦單位以化學為主題，讓公眾了解化學與現今世代息息相關。活動包括工作坊、科學互動講座和學生辯論。教師亦可參加教師工作坊。有興趣者可瀏覽以下網址：*http://www.britishcouncil.hk/en/programmes/education/science/science-alive*

Bird Watching Festival 2015

The hustle and bustle of city life isn't for everyone and the Hong Kong lifestyle can become a little overwhelming. Till March 30, get away from it all at the Hong Kong Wetland Park for some relaxing birdwatching and picture-taking. Guided tours are available at Wetland Reserve between November 12 and March 30. Visit their website at *www.wetlandpark.gov.hk now!*

2015觀鳥節

想在繁囂的大都市尋找一絲寧靜，為平凡的生活添點不平凡嗎？同學可於即日至本年三月三十一日，參加香港濕地公園舉辦的「濕地保護區」公眾導覽團。在濕地公園尋找鳥蹤，欣賞雀鳥展現的生命力，拍攝候鳥風采。詳情請參閱香港濕地公園網址：*www.wetlandpark.gov.hk*

Photo: Hong Kong Wetland Park of the Agriculture, Fisheries & Conservation Dept

圖：漁農自然護理系的香港濕地公園

GUIDE TO UNIVERSITY APPLICATION

AUSTRALIA

申請澳洲大學指南針

By Jacqueline Nicole Aw 歐婷梅

Australia is a leading global education hub, with an impressively large international student body size. Australia harbours top universities in areas of study such as Natural Sciences & Mathematics, Life & Agricultural Sciences, Clinical Medicine & Pharmacy, and Physics. Among the top 50 universities in the world are Australian National University, University of Melbourne, University of Sydney and University of Queensland; as of QS University Rankings 2014.

An undergraduate degree in Australia typically takes 3 to 5 years to complete, with an additional year for an honours degree. Most universities have two academic semesters, and the academic year begins in March.

Applicants without an Australian education qualification do not apply through the Australian central application system and

澳洲是全球重要的教育樞紐，匯聚大量不同國籍的學生，其大學在自然科學和數學、生命與農業科學、臨床醫學和藥學、以及物理等不同的領域均佔領先地位。根據2014年QS大學排名，澳洲的澳洲國立大學、墨爾本大學、悉尼大學、及昆士蘭大學位列全球首50名內。

澳洲的本科學位課程一般為期3至5年，榮譽學士學位課程額外多讀一年。多數大學採用雙學期制，即每學年分為兩個學期，學年於每年三月開始。

申請人若沒有澳洲學歷就不能夠透過當地的中央系統遞交申請。在這情況下，申請人應先選定心儀的學校和課程，再直接向有關院校辦理報讀手續，收到錄取通知書後，便可申請學生簽證及購買海外學生健康保險(OSHC)。

澳洲學府普遍接受非本地生以A-Levels課程和國際文憑課程(IB)成績申請入學。此外，各高校亦會要

THE

FIRST AUSTRALIAN

OF THE YEAR AWARD WAS AWARDED TO PROFESSOR

MACFARLANE BURNET

who had won the Nobel Prize in the same year of 1960 for his groundbreaking physiology research.

AUSTRALIA AND SCIENCE
澳洲和科學

於1960年, 第一年度澳大利亞年度人物第一名大獎頒發給**麥克法蘭· 伯內特**博士。他於免疫學方面的貢獻令他同年獲得諾貝爾獎生理學或醫學獎 。

apply directly to the individual universities of choice. An applicant must decide on a preferred course of study before applying. After receiving an offer letter, the prospective student can then apply for a student visa and the Overseas Student Health Cover (OSHC), a required insurance.

A-levels and International Baccalaureate (IB) are the commonly accepted qualifications for admission of students without Australian education qualifications. In addition, all universities require proof of English Language proficiency, which can be obtained by taking the International English Language Testing System (IELTS), Test of English as a Foreign Language (TOEFL), Pearson Test of English (PTE) - Academic tests or Cambridge English: Advanced (CAE). Universities may

求提交英語水平證明，例如：國際英語語言測試系統（IELTS）、託福(TOEFL)、培生學術英語考試（PTE）或劍橋英語：證書第四級（CAE）等測試成績。各院校可能要求不同的語文測試。英語水平要求亦會因學校和課程而有所差異；例如：法律和醫學學位課程普遍要求較高的成績。**表1**列出各英語測試的平均最低分數要求，讓讀者有個概念：

表2則列明澳洲數間著名院校的申請限期及學費。

學生生活費取決於分別城市和生活方式。作為參考，昆士蘭大學估算一學年（36周）綜合生活費大約需要HK$121,000， 期中包含校內食宿費。

國際學生除了自行向各大學遞交申請書外，亦可透過大學招生中心（UAC）報讀參與院校的大部分學位課

Test 英語水準測試	Average minimum requirement 平均最低分數要求
Academic IELTS 國際英語語言測試系統(IELTS)	An overall score of 6.5 with at least 6 in each component of the test 總分6.5分或以上; 每分項不少於6分
TOEFL paper based test 託福(TOEFL)	A score of 577 with TWE score of 4.5 總分577分或以上; TWE 4.5分或以上
Cambridge English: Advanced (CAE) 劍橋英語：證書第四級 (CAE)	70
PTE Academic 培生學術英語考試(PTE)	Overall 64, minimum score of 60 in each section 總分64分或以上; 每分項不少於60分

Table I 表1

have different requirements as to which test should be taken. The minimum scores for these proficiency tests vary among different universities and are dependent on the course to be taken; for example law and medical degrees typically have a higher English Language proficiency requirement. However, as a rough guide, we list the average minimum scores in **Table I**.

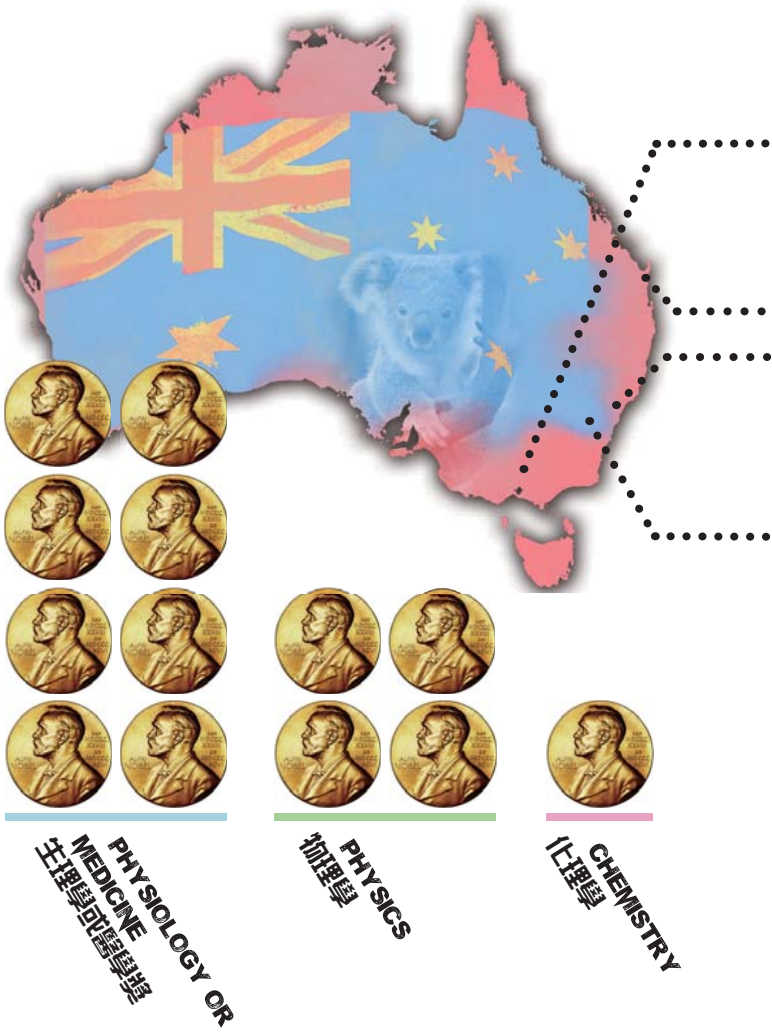
The application deadlines and tuition fees for certain majors are listed in **Table 2** for a few renowned Australian universities.

Student living expenses depend on the city of the university as well as lifestyle. As a reference, University of Queensland estimates comprehensive living expenses to be approximately HK$121,000 for one academic year (36 weeks), including on-campus room and board fees.

Aside from applications to individual universities, the Universities Admissions Centre (UAC) processes international applications for admission to most undergraduate courses at participating institutions. However, only a limited number of institutions adopt the use of this application system, and participating universities include the Australian National University and the University of Sydney.

Should applicants need more help with the application process or the application of visas, they may seek help from the Australia Consulate at *http://www.hongkong.china.embassy.gov.au/hkng/home.html*, who can provide information regarding studying and living in Australia.

NOBEL LAUREATES
澳洲和諾貝爾獎



程。然而，只有部分澳洲大學，如國立大學和悉尼大學，採用該機構的申請系統。

如有需要，申請人亦可聯絡澳洲總領事館，索取澳洲的教育與生活資訊，以及尋求協助辦理簽證和申請大學。

Institution 院校	Application deadline 申請限期 Semester 1 上學期	 Semester 2 下學期	Estimated fee examples (per academic year in HKD) 學費(每學年)港幣約：
The University of Melbourne 墨爾本大學	Late December 12月底	31st May 5月31日	The tuition amounts to total courses enrolled. The cost of each subject is determined by its discipline fee band and study load. You can visit this website for more details on calculation of tuition fees: 視乎課程而定，詳細計算方式請參考以下網站： *http://futurestudents.unimelb.edu.au/admissions/fees/ug-intl/subject-fees*
The University of Sydney 悉尼大學	*Course dependent 視乎課程而定		• Sciences 科學課程 : $211,000 • Psychology 心理學 : $201,000 • Medicine (7 years total) 醫學 (共七年) : $201,000 • Computer Science and Technology 計算機科學 : $214,000 • Sports Science (3 years total) 體育科學 (共三年) : $247,000
The University of Queensland 昆士蘭大學	15th November 11月15日	15th May 5月15日	UQ tuition is based on the course load and course selection for each semester. A standard semester consists of 8 credit hours (4 courses). A student's actual annual fee may vary in accordance with his or her choice of major and electives. 視乎課業負荷及選修科目而定。8學分的學期為標準，學費估算： • Biotechnology 生物技術 : $200,000 • Life Sciences, Physical Sciences and Psychology 生命科學、物理科學、心理學 : $149,000 • Medical Studies 醫學 : $360,000 • Pharmacy 藥劑學, Physiotherapy 藥學、物理治療 : $232,000
The Australian National University 澳洲國立大學	12th December 12月12日	31st May 5月31日	• Sciences, Biotechnology, Psychology, Medical Sciences 科學、生物技術、心理學、醫學 : $200,000 • Flexible double degrees (Engineering and Advanced Computing) 雙學位(工程及高級計算) : $200,000 • Environmental Studies 環境學 : $172,000

Table 2 表2

! GOOD LUCK !
！祝你好運！

ANTHRAX

THE BIOLOGY IN THE BIOWEAPON

生化武器：炭疽

By Raphaella So 蘇韋霖

It was seven days after 9/11 when the envelopes containing inhalational anthrax were first mailed out. Victims experienced symptoms similar to that of a common flu before the impact escalated into difficulty in breathing, high fever, and even death. From October to November 2001, officials reported a total of 22 cases of anthrax infection, 5 of which were fatal [1]. It was a bioterrorist attack.

While anthrax may appear to be a modern-day threat, it has, in fact, been described in scholarly writings in Ancient Greece and Rome. “Anthrax” refers to a bacterial infection by *Bacillus anthracis*. The first clinical trial of anthrax was performed in the 18th century. By the late 19th century, Robert Koch made a historical breakthrough in the study not only of anthrax but also in medicine. After isolating the bacteria and growing it in a culture, he was able to show that the diseases in animals manifest directly in response to the injection of specific microorganisms. His experiments also developed an understanding of the growth of *B. anthracis*, leading to the first use of anthrax as a biological weapon in the early 20th century. One famous example of bioterrorism involving the disease is Japan’s attack on Manchuria during World War II.

B. anthracis lays dormant on soil in its endospore form, resistant to extreme conditions such as heat, acidity, alkalinity, humidity, or even γ radiation. With its exceptional resilience, it can survive for decades on certain soil types. The lethality and ability for *B. anthracis* to survive in hostile environments are attributed to the protein products of its virulence plasmids. One plasmid codes for proteins that disrupt major signaling pathways - in this case, lethal factor and protective antigen. Another virulence plasmid codes for a capsule that protects the bacteria from phagocytosis by the host’s immune system.

Given the bacterial association with soil, anthrax understandably originated as an agricultural disease infecting grazing animals such as cows and sheep. The most common non-deliberate human infections thus occur in patients who have routine contact with farm animals or produce. Endospores of B. anthracis enter the human body through ingestion, open wounds, and inhalation.

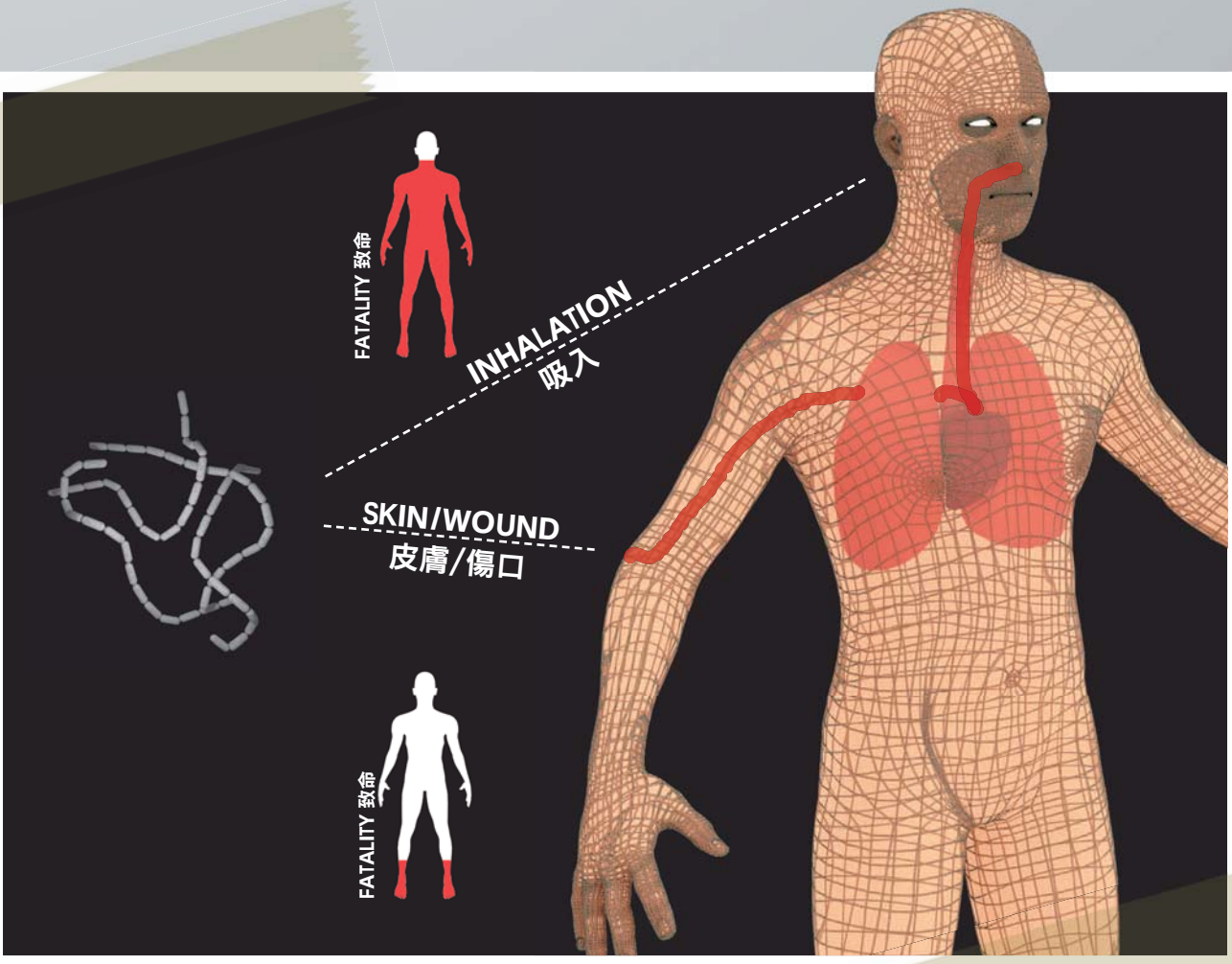
911事件發生後的第7天，有人把藏有吸入性炭疽的信件，寄給多間新聞媒體以及兩位美國參議員。受害者初期出現與傷風感冒相似的癥狀，病情會迅速惡化至呼吸困難、高燒不退、甚至死亡。2001年的10月至11月期間，美國政府錄到共22宗感染個案，期中5位患者死亡 [1] 。這是一次生化襲擊。

炭疽似是一種現代武器，其實在古希臘和羅馬學術著作裏已出現多次。「炭疽病」是指炭疽桿菌感染，首次臨床試驗是在18世紀進行。19世紀末期，羅伯特•科赫的炭疽和醫學研究，取得了歷史性的突破。他將桿菌隔離培育，注射入動物體內，從而證明疾病是由特定的微生物直接引起的。他的實驗也讓人們掌握了炭疽菌的知識，導致20世紀早期以炭疽作為生化武器。著名的例子包括在二戰期間，日本人利用炭疽菌攻擊滿洲。

炭疽以休眠狀態生存在土壤中，可以忍耐極端惡劣的環境，比如高溫、極酸、極鹼、潮濕，甚至輻射等，炭疽菌能夠在某些土壤中存活數十年。炭疽的殺傷力和頑強的存活力，都是出於毒性質體上的基因所製成的蛋白質，含有致死毒素和保護抗原，可以破壞重要的信號途徑。另一個質體編碼的莢膜，則會令到宿主的免疫系統無法將桿菌吞噬。

炭疽與土壤既有密切的關係，自然會成為農業病害，感染牛羊等牧畜。至於非蓄意的人類感染病例多出現在跟農場動物或農產品經常有接觸的病患者當中。炭疽芽孢可以通過消化道、皮膚傷口或呼吸道進入人體內。

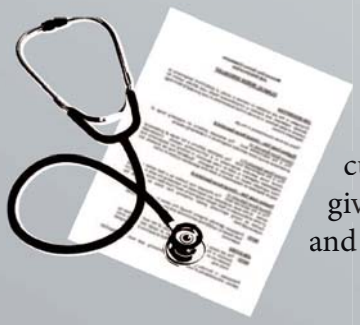
相對來說，通過傷口傳染的「皮膚炭疽」具有較低的威脅性，也較常見。八成到九成由炭疽所造成的皮損會完全康復，不會引起全身感染或其他併發症 [2]。食用受炭疽污染的肉類也會致病。芽孢由黏膜破損處進入體內，引發全身性感染，多個器官受影響。毒素令到身體嚴重浮腫以及組織壞死、器官衰竭、失血過多、體液與電解質流失、和休克狀態等。



A comparatively less threatening but more common infection route is through the skin, known as *cutaneous anthrax*. 80-90% of lesions recover without causing systemic infection or complications [2]. Anthrax can also enter through ingestion of contaminated meat. Endospores enter the body through breaches in the mucous lining, causing systemic infection. Systemic anthrax infection occurs when a number of organs are infected: the toxins cause large-scale edema and tissue necrosis in the body, leading to organ failure, heavy loss of blood, loss of fluids and electrolyte, as well as shock.

Inhalational anthrax is, however, the most lethal, even after diagnosis and antibiotic treatment. According to the Centre of Disease Control and Prevention (CDC), the rate of fatality among the most recent eighteen cases of inhalational anthrax was more than 85%. Inhaled endospores enter the lungs and trigger macrophages to surround the foreign body and phagocytosis (an initial immune response whereby phagocytes engulf the foreign body). Instead of dying, however, the bacteria germinate inside the cells and are eventually carried to lymph nodes and the blood stream, hence, increasing the lethality of the infection [3].

Antibiotics are the common course of treatment for an anthrax infection, but it must be administered in the early stages before the bacteria are able to secrete enough toxins when the infection reaches a point of "no return". Thus, its efficacy as a bioweapon comes from the infection's nonspecific initial symptoms, causing misdiagnosis and delayed treatment. Scientists have been investigating the possibility of creating antibodies that bind to and inhibit the three toxin-forming proteins. Currently, they have successfully targeted edema factor (one of the proteins responsible for the production of toxins that disrupt signaling pathways) with a drug called Adefovir, originally designed for Hepatitis B. The pursuit is however only at its infancy and much more remains to be researched.



1700s

The first clinical descriptions of cutaneous anthrax were given by Maret in 1752 and Fournier in 1769.

1881

Some scholars believe that in Moses' time, during the 10 plagues, anthrax may have caused what was known as the fifth plague, affecting horses, cattle, sheep, camels and oxen.

1918

During the first World War there is evidence that the German army used anthrax to secretly infect livestock and animal feed traded to the Allied Nations by neutral partners.

Louis Pasteur tried to fully prove how anthrax was spread and how it made people or animals sick. Pasteur successfully created a vaccine for anthrax.

不過殺傷力最強的還是吸入性炭疽感染，即使接受診斷和抗生素治療，死亡率仍是很高。根據美國疾病控制與預防中心的資料，錄得的18例吸入性炭疽病，死亡率逾85%。吸入肺內的芽孢觸發早期免疫反應，刺激巨噬細胞圍繞及吞噬異物。不過，炭疽桿菌非但不死，而且可以在細胞內發芽，並被輸送到淋巴結與血液內，因此增加桿菌的殺傷力[3]。

治療炭疽感染主要是給予抗生素，但要趕及在細菌分泌過多毒素前施救，否則病情就不可逆轉。炭疽會成為有效的生化武器，就是因為在感染初期呈現的癥狀為非特異性，容易導致誤診和延誤治療。專家一直在研發可以抑制三種毒素蛋白的抗體。目前為止，他們已成功利用藥物「Adefovir」抗阻水腫因子（產生毒素擾亂信號通路的蛋白之一）。Adefovir原是為針對B型肝炎而設計。有關研究還處於嬰兒期的階段，尚有很多工作要開展。

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Dan Anders miraculously survived inhalation anthrax. This case remains a medical mystery.

2011

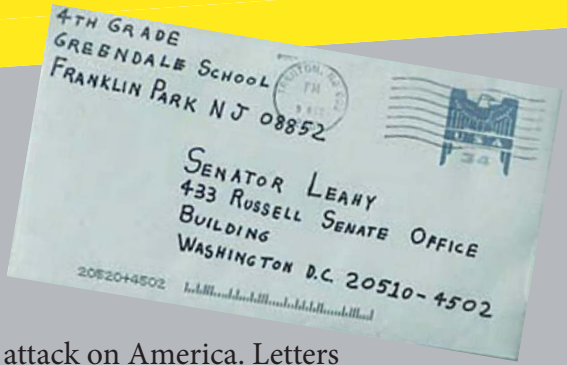
Treaty signed to prohibit biological and toxic weapons, including weaponised Anthrax.

1972

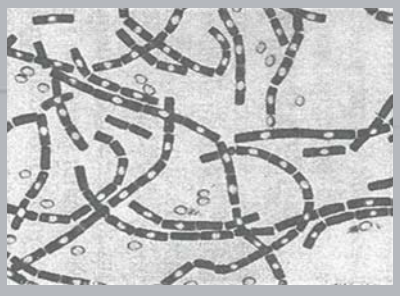
2001

1950

The first anthrax vaccine for humans was created. The study determined that the vaccine was 92.5% effective in preventing cutaneous anthrax.



Anthrax attack on America. Letters filled with a white powder containing anthrax spores were sent to two U.S. Senators' offices, the Pentagon among others. 22 people were inflicted, resulting in 5 casualties.



TELEPORTATION — A 隱形傳輸 — 有可能嗎？

By Thomas Lee 李浩賢

Imagine if humans had the ability to teleport to any location at a press of a button. Or better yet, teleport to the far-reaching boundaries of the unknown, allowing astronomical advances in our understanding of the universe. The allure of instantaneously appearing in a chosen location anytime, anywhere, explicably makes teleportation one of the most desirable supernatural powers to possess. Is teleportation simply limited to the supernatural or could it become a real possibility in the future?

This article may be useful for physics classes, based on the DSE syllabus. 根據 DSE 科目，這篇文章有助物理課程。

It is probably worth disclaiming that teleportation is more than just faxing a sheet of paper from one fax machine to another. A more accurate analogy is transporting the original matter in its entirety, with the original disappearing completely and appearing at the receiving end.

In 2012, four physicists at the University of Leicester brought the heartbreaking conclusion that human teleportation is not

Real Possibility?

試想一下，如果人類能夠按鍵即可到達任何地方，甚至是九宵雲外，了解宇宙的森羅萬象，豈不是很好？因此，不少人渴望擁有這誘人的超能力。究竟瞬間移動只是遙不可及的憧憬還是有可能成為未來的科技呢？

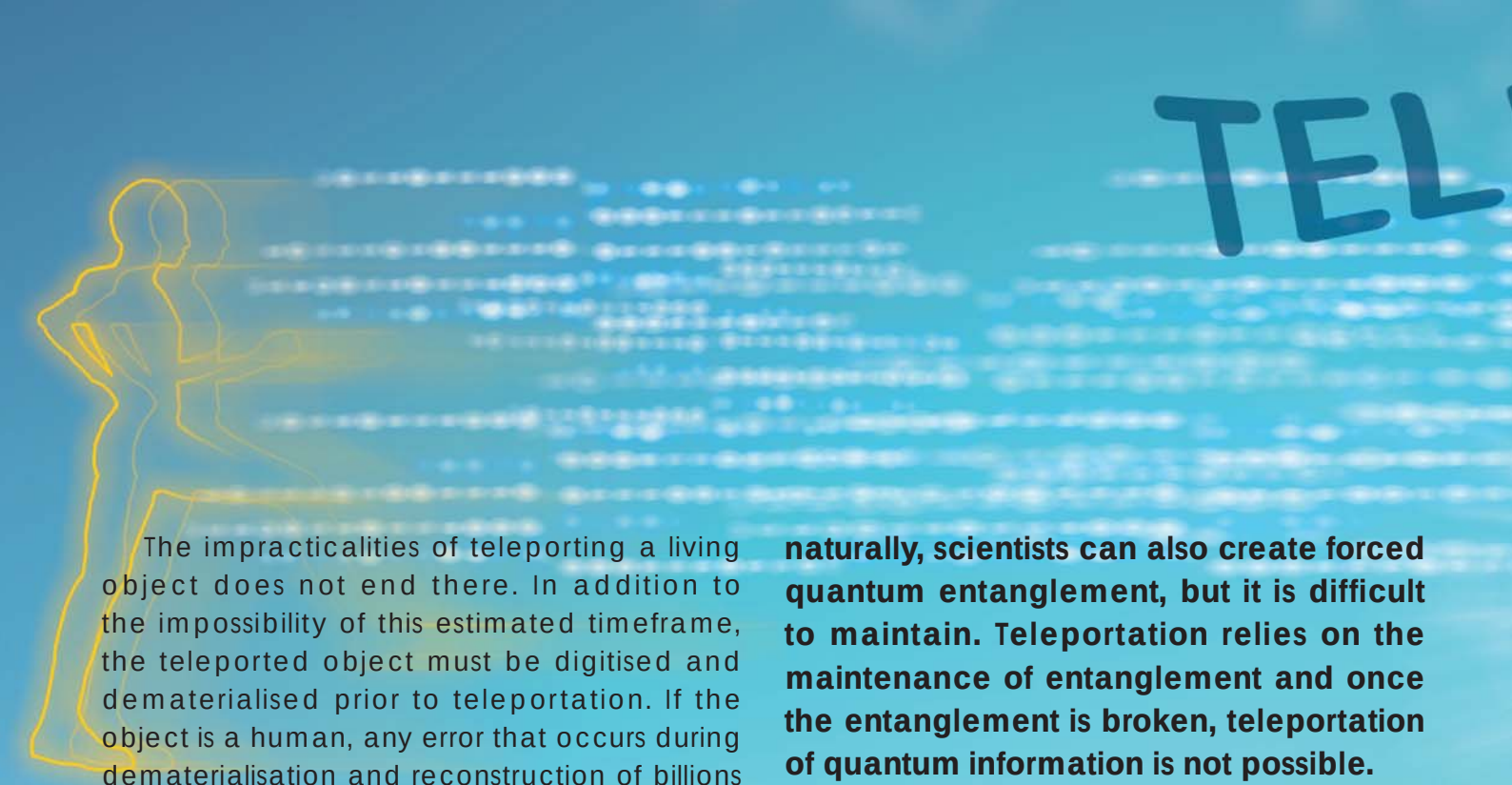
possible. They quantitatively calculated the time and power required to teleport a human to space to be $4.55x10^{42}$ bit (basic unit of information), which took into account the human genome sequence, mental data and errors due to interference. For all of this data to be successfully transferred, it is believed that it would require $4.58x10^{15}$ years and 5.76 megawatts per hour to power the signal communication between the two points [1]. Sadly, the time necessary for this communication would be more than sufficient for the birth and death of the universe many times over.

首先要說明的是，以傳真比喻瞬間移動並不恰當，因為物質會在一端消失，隨後在另一端出現。

2012年，英國萊斯特大學的四位物理學家估計瞬間移動是不可能的。他們計算瞬間移動人類到太空所需的時間和功率，並考慮到了人類基因組序列，心理數據和錯誤。得出的結論是要傳輸$4.55x10^{42}$位元（資訊基本單元）的數據。要達到這目的，就須要$4.58x10^{15}$年才能完成，其間要持續每小時供電5.76兆瓦[1]。也就是說當宇宙經歷終多次循環週期後，數據傳輸還未結束。

References:

[1] Roberts, D., Nelms, J., Starkey, D., Thomas, S. (2012). *P4_4 Travelling by Teleportation*. Journal of Physics Special Topics. Retrieved from http://physics.le.ac.uk/journals/index.php/pst/article/download/558/380



The impracticalities of teleporting a living object does not end there. In addition to the impossibility of this estimated timeframe, the teleported object must be digitised and dematerialised prior to teleportation. If the object is a human, any error that occurs during dematerialisation and reconstruction of billions and billions of cells in a destination hundreds of thousands of miles apart would cause irreparable damage. Another huge problem? In essence, dematerialisation of a living object means death.

Scientists have been exploring the possibility of teleportation since the late 20th century but not with physical matter. Rather, instantaneous teleportation of information is achievable through quantum teleportation. Quantum teleportation transfers a piece of information instead of an atom or molecules. In 1998, physicists at the California Institute of Technology (Caltech), along with two research groups from Europe, successfully teleported information carried by a photon across a coaxial cable, 1 metre in length. The original photon no longer existed in the aftermath of the creation of the replica [2].

Quantum teleportation is possible due to a phenomenon called quantum entanglement. This is when two or more particles interact in such a way that they are connected, without physical contact. If the state of one particle changes, the other particle is instantly affected, and knowing the information or state of one particle will tell us the state of its companion particle [3]. While quantum entanglement occurs naturally, scientists can also create forced quantum entanglement, but it is difficult to maintain. Teleportation relies on the maintenance of entanglement and once the entanglement is broken, teleportation of quantum information is not possible.

Recently, quantum teleportation has covered even more ground. In September 2014, a group of physicists from Switzerland were able to teleport the quantum state of a photon to a crystal port over 25 kilometres in length of optic fibre. They created the scenario of quantum entanglement by using a powerful laser to thrust photons. Once entanglement between two photons was achieved, one photon was deposited at the crystal port and one was propelled along the optic fibre. The group pumped another photon toward the propelled photon causing them to collide with each other, destroying the two travelling photons. Interestingly though, the information from the third photon appeared in the crystal [4].

Improvements in this novel technology can potentially create powerful quantum computers that operate at much faster rates than that of our current computers. In addition, information transmitted would be safer, allowing added security to banking and online businesses. Perhaps quantum teleportation wasn't what you quite had in mind and it is safe to say that teleportation of anything in the classical sense (including you) is by and large, impossible! Supernatural powers of teleportation will have to remain as fantasies, for now, but the implications of quantum teleportation are still incredibly exciting for technological advancement.

瞬間移動所須的時間固然是不切實際，還有其他考慮。被傳送的對象在移動前要經過數據化和非物質化。如果對像是人類，在非物質化和之後要重組數以十億計細胞的過程中，任何的錯誤都會帶來無可挽回的損害。更嚴重的問題是，生命體的非物質化就是死亡。

不過，從20世紀後期，科學家就一直在研究非物質的瞬間移動，他們研究的量子態隱形傳輸傳送的是資訊而非原子或分子。1998年，加州理工學院的物理學家，以及歐洲兩個研究組，成功透過一米長的同軸電纜以光子傳輸資訊。光子在終端重建時，原來的光子就不再存在 [2]。

量子態隱形傳輸可以發生，是因為量子糾纏現象。當兩顆或更多的粒子互動而產生非物理性的連接時，其中一顆粒子改變狀態時，另一顆粒子也會瞬間受影響。所以知道一顆粒子的狀態，就會取得同伴粒子的狀態 [3]。量子糾纏可以自然發生，也可以由科學家製造，但要維持粒子糾纏卻是很難。量子態隱形傳輸依賴著量子糾纏，一旦纏結受破壞，資訊傳輸便失效。

近年，量子態隱形傳輸的研究取得更多成果。2014年9月，瑞士的物理學家利用超過25公里長的光纖，瞬移光子的量子態至另一端的晶體。他們利用強大的鐳射迫使量子糾纏，然後將一顆光子存於晶體，另一顆則沿光纖推進。接著第三顆光子沿光纖送出，與高速移動中的光子碰撞並同時毀滅。但有趣的是，第三顆光子的資訊即時出現在晶體裏的光子 [4]。

這嶄新技術將有可能會導向研發更快更強的量子電腦。量子態隱形傳輸也有可能令資訊傳輸更安全，保障銀行和網上業務。也許，量子態隱形傳輸並不是你心中所想，而瞬間移動也是異想天開。現今世代超能力只能暫存於科幻世界，但量子態隱形傳輸卻是邁向未來的重大發現。

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Nocturnal vs. Diurnal Biogical Clocks

生物時鐘比較

By Jacqueline Nicole Aw 歐婷梅

Circadian rhythm, or circadian clock, is an internal biological clock that regulates sleeping and feeding patterns, as well as a whole host of other biological functions in all living organisms. Organisms most active in the daytime are diurnal, humans included, whereas nocturnal organisms come alive at night. With heightened senses most appropriate for nighttime, nocturnal organisms enjoy a multitude of advantages – most importantly a reduction in the direct competition for food. What biological factors administer to the internal clocks and what are the differences between diurnal and nocturnal circadian rhythms?

Nocturnal organisms typically possess enhanced eyesight, hearing and smell to compensate for the lack of light. Saucer-like eyes that allow maximum light are distinctive in characteristic nocturnal organisms such as owls and loris. Bats on the other hand, emit constant streams of high-pitched noises that bounce off objects to assist them in navigation in the dark. Meanwhile, many nocturnal organisms spend the daytime catching up on some shuteye or grooming. The activity levels of both diurnal and nocturnal organisms are governed by the circadian rhythm.

A self-sustaining oscillation, the circadian cycle in living organisms has a period of roughly over 24 hours. In addition to regulating sleep, it also affects the physiology, endocrine system and behaviour of organisms. Together, organisms make use of the circadian rhythm to derive maximum benefit from temporarily available resources. For instance, they are able to anticipate daily food availability and pressure from predators ahead of time; cycles are typically not 24 hours exact. External timing cues known as zeitgebers assist in synchronising the cycle with geophysical time by “resetting” or changing the phase of the circadian clock. The most powerful zeitgeber is light stimulation [1]. In addition, scheduled voluntary exercise or food shortages are also capable of shifting the phase.

Although nocturnal and diurnal organisms exhibit an almost antiphase in physiology, metabolism and behaviour; the main characteristics of their circadian metabolisms are largely parallel. In both cases, the master clock in the circadian cycle is the suprachiasmatic nucleus (SCN), located in the hypothalamus [2]. The SCN receives light stimuli and “resets” the cycle in order to be synchronised with the environment. The hormone responsible

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for the regulation of the circadian rhythm is called melatonin, and its synthesis and release is controlled by the light-dark cycle. This hormone then regulates other biological processes to reset the clock depending on whether the animal is nocturnal or diurnal.

SCN is also responsible for the release of a hormone known as vasopressin. The main target of vasopressin is the neuroendocrine system (the hypothalamus-pituitary-adrenal (HPA) axis), which regulates numerous biological processes, such as digestion, immune system and stress levels. Recent studies have shown that most activity from the HPA axis happens when light diminishes in nocturnal organisms, whereas the opposite is true for diurnal organisms [3]. This allows the organism to adjust to the demands of the day's actions.

Along with features made optimal for night vision and sensitive hearing, nocturnal organisms are well-adapted to lightless environments with the help of nature's custom designed biological clocks. Intricate and complex systems in both nocturnal and diurnal animals, circadian rhythms are regulated by a whole host of factors and can influence sleep-wake cycles, body temperature and important biological functions. Recent research on this topic focuses a lot on identifying the genes which dictate how nocturnal and diurnal animals react to light stimuli, but much has yet to be done to fully decipher these intricate biological codes.

所有生物的體內都存有生物時鐘，調控睡眠週期、飲食習慣，以及多方面的生物機能。包括人類在內的晝行動物主要是在白天活動，而夜行動物則活躍於夜間。夜行動物的感知能力在晚間尤其突出，因此享有眾多優勢，更重要的是可減少直接競爭食物。究竟，生物體內的時鐘是受什麼機制調控的？ 晝行生物和夜行生物的生理節律又有什麼區別呢？

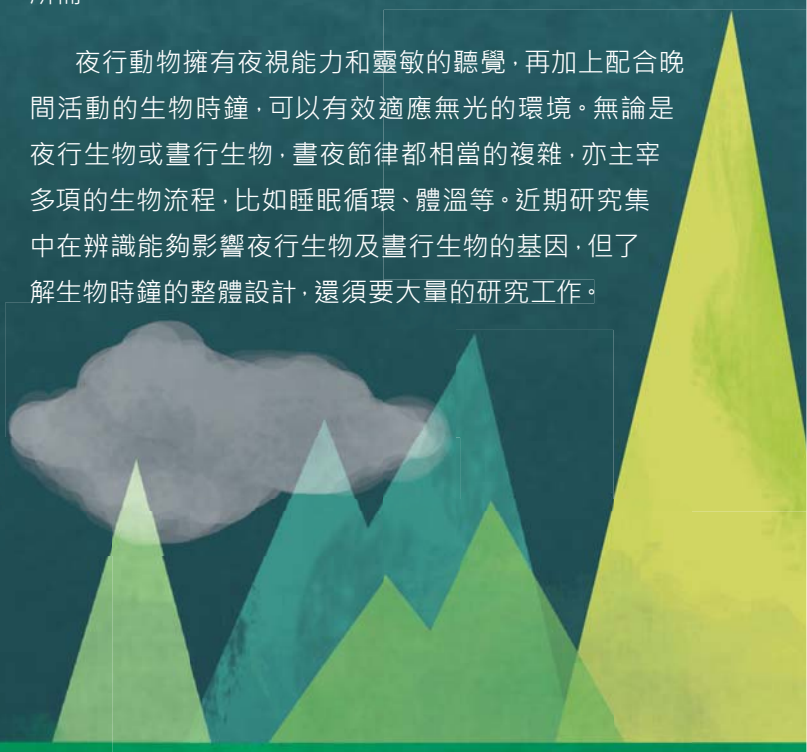
夜行動物通常具有更強的視力、聽力和嗅覺，以彌補光線不足帶來的不便。它們有著特別的身體構造，例如：貓頭鷹和蜂猴便擁有飛碟般的大眼睛，以接收最多的光線；蝙蝠則會發出連續的高頻聲音，再藉回聲在黑暗中找到方向。多數的夜行動物會於白天補充睡眠或梳理。晝行和夜行動物的活動量均受晝夜週期所支配。

生物的晝夜週期約為24小時，是一個可以自我持續的機制。除了能調節睡眠，它亦可影響動物的生理機能、內分泌系統運作和行為，讓其可從有限資源中獲得最大的利益。生物能夠預計每日食物的供應量和捕食壓力，再作出相應行動。事實上，生物時鐘週期並非固定為24小時，可以因應「授時因子」即是外界時間線索而調整，讓生物時鐘能與地理時間同步。最重要的授時因子是光線的刺激，但日常活動和食物攝入量也可以影響週期[1]。

雖然夜行和晝行動物的生理機制、新陳代謝和行為等週期，表現出近乎完全相反的相位，兩者的晝夜代謝規律基本上一致。控制它們晝夜週期的主時鐘都是位於下丘腦的視交叉上核（SCN）[2]。負責調節晝夜節律的激素稱為褪黑激素，而它的合成與釋放由光暗循環來控制。褪黑激素可指示其他的生物過程根據動物是夜行性或是晝夜性的， 將時鐘重置。

SCN則負責釋放稱為加壓素的激素。夜行和晝行生物有不同的晝夜節律，是因為丘腦 - 垂體 - 腎上腺軸（HPA）對加壓素的反應有所不同。HPA軸是神經內分泌系統的重要部分，調控多種生物過程，例如：消化、免疫系統和壓力水平。夜行動物的HPA軸會隨著光線減少而增加活躍度，晝行動物則相反 [3]。生物可以通過這機制應付其日常運作所需。

夜行動物擁有夜視能力和靈敏的聽覺，再加上配合晚間活動的生物時鐘，可以有效適應無光的環境。無論是夜行生物或晝行生物，晝夜節律都相當的複雜，亦主宰多項的生物流程，比如睡眠循環、體溫等。近期研究集中在辨識能夠影響夜行生物及晝行生物的基因，但了解生物時鐘的整體設計，還須要大量的研究工作。



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Why Does Paper Turn Yellow?

紙為何會變黃？

By Marco Wong 黃俊銘

This article may be useful for chemistry classes, based on the DSE syllabus. 根據 DSE 科目，這篇文章有助化學課程。

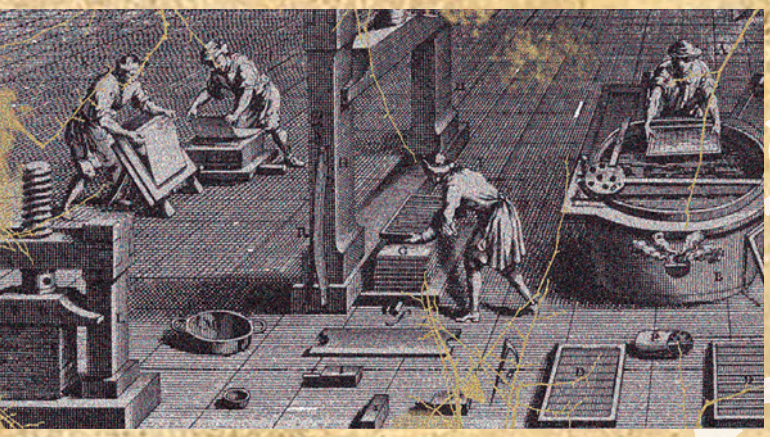
One of the four great inventions of ancient China, paper, as we know it, made its first appearance around 105 AD. Since this revolutionary invention, much of human history has been recorded on paper; but the frazzled yellow colour of old books, dated photographs and ancient documents serves as evidence of the unforgiving effects of time. However, paper discolouration is ascribed to more than just time, as it involves chemical reactions with specific conditions.

A closer inspection of the composition of paper is necessary in understanding paper discolouration. Paper manufacture involves the separation of individual fibres from wood, mixing of water and wood pulp, colouration (depending on application) and drying. The main components of paper are the same as that of wood fibres – cellulose, hemicellulose and lignin. Cellulose and hemicellulose are white polysaccharides (chains of glucose molecules), whereas lignin is a dark complex organic compound. To produce white paper, lignin is removed in the pulping and bleaching process.

In lignin-free paper, discolouration is mainly attributed to the oxidation of cellulose and hemicellulose. These compounds do not have delocalised electrons to absorb visible light. This means that the electrons are associated within the electron cloud of a specific atom (metallic bonding, for example, exhibits delocalised electrons). However, oxidation of hydroxyls forms carbonyl and carboxylic groups. The newly formed double-bonded functional groups (C=O and C=C) are chromophores, which are responsible for giving the colour of the organic compound. The reaction occurs in the presence of oxygen, which is also why the exposed edges of the pages in a book turn yellow more rapidly than the interior.

Not all paper is created equal either. Newspaper discolours much faster than does white paper, due to the former having a higher content of lignin. In addition to increasing the rigidity of paper, lignin also gives paper a rough and dark appearance. Removal of lignin in paper production is an expensive procedure and is skipped to lower newspaper costs. A study done in 1996 showed that UV light possesses enough energy to break down the ether linkage in lignin, producing phenyl radicals and ketyl radicals. The latter continues to breakdown lignin to yield more phenyl radicals. Oxidation of phenyl radicals produces phenyl acids, giving the aged newspaper a yellow appearance and a brittle texture.

Since oxidation and photooxidation are the main culprits responsible for paper yellowing, slowing down this process preserves the natural colour of the paper. The reactions are possible under the presence of heat, light and oxygen. Avoiding unnecessary exposure to heat and light would slow this process down considerably. In addition, there are certain coatings that claim to contain chemicals that are able to absorb UV light to prevent yellowing due to photooxidation, or reducing agents, which protect the polysaccharides from being oxidised.



西元105年，蔡倫用廉價的原料造出了中國四大發明之一——紙。自此，紙張就一直承載著人類歷史。不過，歲月的痕跡亦刻印在舊書和老照片那無力的淡黃色上。可是，紙張泛黃不能只歸咎於時間流逝，當中的原兇是在特定條件下產生的化學反應。

若要理解紙張變黃的原理，必先了解紙張的成分。造紙先要分拆木材的纖維，然後加水製成木漿，經漂白和染色（視乎紙的用途）等工序之後晾在紙網上烘乾就成了。製成的紙張主要成份不異於木頭，包括纖維素，半纖維素和木質素。當中纖維素和半纖維素是無色的多醣（由葡萄糖組成的線性聚合物），而木質素則是結構複雜的深色多醣。在製造白紙時，木質素一般都在製漿和漂白過程中被除去。

沒有木質素的白紙也會變黃，主因是纖維素和半纖維素的氧化。纖維素和半纖維素雖然沒有吸收可見光的離域電子（例如金屬鍵的「電子海」中的電子），羥基的氧化卻會形成羰基和烯基，由此產生帶有雙重鍵的官能基（C=O，C=C）是發色團，令有機化合物具有顏色。氧化過程在氧氣中自動進行，這也是外露的書頁邊較快變黃的原因。

紙張也不是「生而平等」的，由於報紙的木質素成分較高，所以比白紙更容易變黃。木質素不單令紙質較硬，也讓成品暗啞粗糙。但去除木質素的工序昂貴，所以大部份報業都跳過這步以減低成本。根據1996年的一項研究，紫外線提供足夠能量給木質素分解醚鍵，從而產生苯自由基和羰遊基；後者繼而攻擊木質素，製造更多的苯基。苯基自由基再經氧化產生黃色的苯基酸，也就是舊報紙變黃和變脆的原兇。

Can Yellowed Paper be Restored?
變黃的紙還能不能恢復原狀？

Yes! But it depends on how heavy the damage is. It is possible to de-acidify aged paper by creating a bath of milk of magnesia and soda water. Leave for 8 hours, soak the paper in the bath and then dry completely. However, be careful that the ink does not run!

可以！但取決於變黃的程度有多嚴重。用溶解了氧化鎂的蘇打水水浴的方法可以將發舊的紙去酸化。溶解之後靜置8個小時，再將紙水浴其中，最後徹底風乾。但是在過程中要小心避免筆墨的脫落。

Does glossy paper turn yellow?
光面紙也會變化嗎？

Glossy paper is typically coated with polymers or other compounds that protect the paper against UV radiation or water, making it much more difficult to age.

一般的光面紙塗層著聚合物或其他的化合物，能夠防紫外線輻射和防水，而且降低紙張的老化。

氧化及光氧化是令紙張變黃的主因，減慢這些過程可以保持紙張原有的顏色。這些反應是在熱、光和氧氣的存在下發生，避免讓紙張不必要地曝露在光和熱之下，可以相當有效地減慢氧化。除此之外，塗上保護層也是防止紙張變黃的方法之一。有些保護塗層聲稱含有可吸收紫外線的化學物，從而防止光氧化及紙張變黃。有些塗層則含有還原劑，以免多醣被氧化。

References and Further Reading

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13 petal ragwort. Photography credits to Trish Steel.

Picture a model of immortal female and male rabbits that are only able to reproduce one female and one male rabbit at one time. A month into their lives they will be able to mate. At the end of the second month, they will give birth to a new pair of immortal rabbits with the same reproduction limitations. Now there are two pairs of rabbits. The new rabbits also mate a month after they are born; meanwhile the old pair gives birth to a new pair of rabbits for a total of three pairs of rabbits. With me so far? In other words, the number of pairs of rabbits is now 0, 1, 1, 2, 3 and in the next month, 5. How many pairs of rabbits will there be in the month after? How many pairs will there be in a year? These were questions posed by the Italian mathematician, Leonardo Fibonacci, in the 13th century.

On closer inspection, each new term is determined from summing the current and previous term. At the end of the nth month, the total number of rabbit pairs (F_n) is equal to the sum of the number of rabbit pairs in the previous month (F_{n-2}) and the new-born rabbit pairs (F_{n-1}). As an equation, this is expressed as $F_n = F_{n-1} + F_{n-2}$ with the general term for the Fibonacci sequence as

$$a_n = \frac{1}{\sqrt{5}}\left[\left(\frac{1+\sqrt{5}}{2}\right)^n - \left(\frac{1-\sqrt{5}}{2}\right)^n\right]$$

Let's take this a step further. When we divide two sequential Fibonacci numbers, we obtain a series like so:

1/1 = 1, 2/1=2, 3/2=1.5, 5/3=1.666..., 8/5 = 1.6, 13/8 = 1.625 etc.

This results in a new series of numbers that converge into what we call the 'Golden ratio', ~1.618034, represented by the Greek letter φ (phi).

What is more interesting is that the numbers of the Fibonacci sequence frequently appear in nature, which is related to its property of converging to the Golden ratio. For example, many types of flowers exhibit numbers of petals that belong to the Fibonacci sequence. The ragwort, for example, has 13 petals and daisies with 13, 21, 34 or 55 petals are commonly found. Another famous example of Fibonacci numbers seen in plants is the arrangement of seeds in sunflowers, which possess either 34 levo-spirals or 21 dextro-spirals.

While no explanations fully backed by scientific evidence exist, some experts have suggested that plants adopt the Fibonacci arrangement in order to better utilise limited space for a higher chance of producing more progenies. The number of petals is decided based on the size of the flower disc to produce as many petals as possible to attract pollinating insects. Similarly, spirals in sunflowers allow the maximum number of seeds available for propagation.

Human beings may not be exempt from this ratio either. Some studies have shown that phi is intimately connected to how we perceive aesthetics. Test subjects were asked to rate the attractiveness of random faces. The results indicated that the faces which received the highest ratings were ones that exhibited ratios between the width of the face and the width of the eyes, eyebrows and nose, closest to the Golden ratio. In fact, the Golden ratio may be present even on molecular levels. A full cycle of a molecule of DNA is approximately 34 angstroms long and 21 angstroms wide. A coincidence?

Tell us what you think by e-mailing us at *sciencefocus@ust.hk*! Can you find more examples of the Fibonacci sequence or the Golden ratio in nature?

Nature's Numbers 大自然的數字

This article may be useful for mathematics classes based on the DSE syllabus. 根據 DSE 科目，這篇文章有助數學課程。

By Yi Qi 戚益

假設有一對不死的雌雄兔子，每次只能生育一對雌雄兔子。出生一個月就可以交配，一個月後誕下另外一對有同樣生育限制的雌雄兔子。現有兩對兔子。新一對兔子在出生一個月後交配，舊一對兔子同時再生育一對相同的兔子，總共有3對兔子。也就是說，從開始算起，每個月兔子數目分別是0、1、1、2、3，到下一個月就有5對兔子。再下一個月有多少對兔子呢？一年之後又怎樣？這個模型是由13世紀義大利數學家，斐波那契所提出的。

仔細看看，每一個數其實是前兩個數的和。在n個月結束時，兔子數(F_n)應當等於上一個月兔子數(F_{n-2})加上新出生的兔子數(F_{n-1})。於是斐波那契數列便可以寫作$F_n = F_{n-1} + F_{n-2}$，經歸納法又可以得出斐波那契數列的通項公式，即

$$a_n = \frac{1}{\sqrt{5}}\left[\left(\frac{1+\sqrt{5}}{2}\right)^n - \left(\frac{1-\sqrt{5}}{2}\right)^n\right]。$$

當我們把兩個連續斐波那契數除在一起就會獲得一系列的數字如下：

1/1 = 1, 2/1=2, 3/2=1.5, 5/3=1.666..., 8/5 = 1.6, 13/8 = 1.625...

由此而產生了新的數字系列，得出以希臘字母φ來代表的「黃金分割比例」，即是~1.618034。

更有趣的是，因為斐波那契數列的數字接近「黃金分割比例」，在自然界隨處可見。有很多花類的花瓣數目就屬於斐波那契數列，例如千里光有13片花瓣，常見的雛菊花瓣數是13、21、34、或55。另一個著名的例子就是向日葵種子排列方式，包括34道左螺旋和21道右螺旋，都是斐波那契數字。

雖然未有確實的科學依據，專家推論植物可能利用了斐波那契數列的性質來有效利用空間，從而提高繁殖率。花瓣的數目受限於花盤的大小，植物使用斐波那契數字，就可以最多的花瓣數吸引昆蟲前來授粉；向日葵的螺旋亦讓盡量多的種子得以傳播。

斐波那契數列的黃金分割比例亦體現在人類的身上。研究表明黃金分割數與我們如何看待美學有著密切的關係。接受測試者為隨機挑選的面孔的吸引力評分。結果顯示得分最高的面孔，面部寬度與眼睛、眉毛和鼻子的寬度比例接近黃金分割數。事實上，黃金分割率也出現在分子水平上。一個完整的脫氧核糖核酸分子單位長約34埃，寬21埃。這是巧合嗎？

你有甚麼想法，請電郵至*sciencefocus@ust.hk*告訴我們！你能在大自然裏找到更多斐波那契序列或黃金分割率出現的例子嗎？

Sunflower seeds arranged in a Fibonacci arrangement. Photography credits to Alvasgaspar.

THE SCIENCE OF

By Hoi Yue Chan 陳凱瑜 *(Diocesan Girls' School, 拔萃女書院)*

毛髮的秘密

Winning article of the ***Science Focus*** Article Submission Competition.
「**科言**」徵文比賽得獎文章。

Human hair grows in different lengths, colours and textures. Aside from our heads, common areas of hair growth are apparent on arms and legs, face and pubic areas after we hit puberty. While hair on our heads grows continuously, requiring regular grooming, our body hair seems to stop getting longer after reaching a certain length, suggesting that these hairs are of dissimilar types. What exactly are the differences exhibited in these types of hair and what governs their growth and appearance?

There are generally three types of hairs, namely vellus hair, terminal hair and scalp hair. Vellus hair is short, delicate, not incredibly visible and produced all over the body. It is most easily observed on children and female adults. In comparison, terminal hair is thicker, longer and darker in colour, more visible on males than on females. Finally, scalp hair refers to the self-explanatory hairs on our heads.

To begin understanding the different types of hair, it is noteworthy to understand the general growth stages of hair. Our heads, alone, carry over 100,000 hairs and each independent strand undergoes stages of growth at a different rate. The birth of a hair begins in a hair follicle, tucked snugly beneath the skin. Three distinct growth phases can be observed throughout the life cycle of a hair:

1 Anagen (growth stage)

At the anagen phase, hair grows at about just over a centimetre per month. The length of this phase corresponds with the length of the hair, and is predetermined by genetics, but also depends on hormones and other environmental factors.

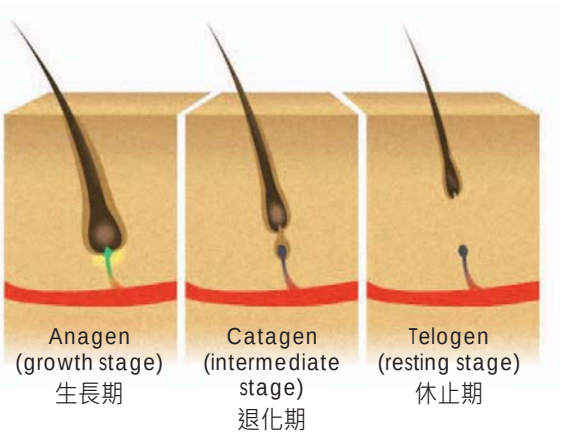
2 Catagen (intermediate stage)

The catagen phase occurs at the conclusion of the anagen phase. It is a short-lived intermediate stage where the blood supply and cells required in growing and producing hair is closed off.

3 Telogen (resting stage)

Hair at this stage becomes stale and gradually falls out. During this phase, the hair follicle is inactivated for about 3 months, where no growth occurs, before the cycle begins at the anagen phase once again. Poor nutrition or illnesses can force hair follicles to enter the telogen phase prematurely, where problems such as hair loss occur.

This article was edited to fit the needs of the Science Focus publication. 本文以「科言」所需而被更改。



Life cycle of hair 頭髮生長週期

When compared with scalp hair, vellus and terminal hair have much shorter anagen stages, indicating that their lengths will grow to be much shorter than hair on our heads. In addition, they exhibit longer telogen stages, so that the rate of new hair follicle activity is also lower. In particular, terminal hair replaces vellus hair at the presence of an increase in androgenic hormone levels at puberty, such as testosterone, also explaining why males tend to have more body hair than females.

The science behind hair tells us that the commonly believed myth of body hair growing back thicker and darker after shaving is largely untrue. What does happen after shaving is that the hair becomes shorter and less flexible to the touch, giving the illusion that it becomes coarser. However, body hair seems to serve the evolutionary purpose of acting as a first-line warning system for unwelcome threats. Perhaps we should think twice before getting rid of them?

我們毛髮的長度、顏色和髮質各有不同。進入青春期後，除了頭部之外，毛髮還會明顯地生長在手臂、腿部、面部和恥骨區等部位。頭髮停生長，須要定期梳理，但體毛達到一定長度後，便會停止生長。究竟這兩種毛髮有甚麼分別？它們的生長和外觀又受什麼支配？

總括來說，毛髮可以分成三種：毳毛、終毛和頭髮。毳毛短而纖細，不太明顯，佈滿全身，在兒童及婦女身上最易觀察到。相比之下，終毛較粗長而深色，多見於男性。頭髮即指生長在我們頭皮上的毛髮。

要理解不同類型的毛髮，我們需要了解毛髮生長週期的每個階段。我們頭上有超過十萬株毛髮，各自以不同速度經歷週期變化。頭髮出於皮下的毛囊，生長週期可分為三個不同的階段：

1 *生長期*

生長初期，毛髮每月大約增長1厘米。階段的長短與毛髮的長度相應，由我們的遺傳基因所決定，也受激素和其他環境因素影響。

2 *退化期*

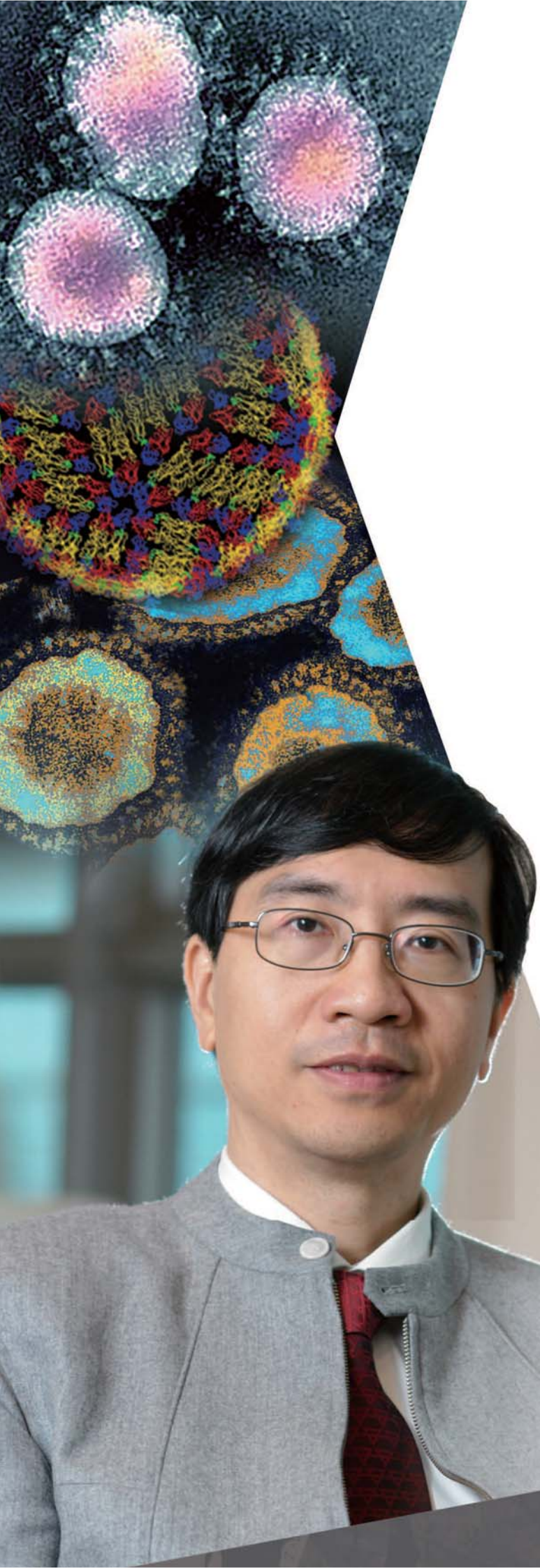
退化期緊接於生長期後，是短暫的過渡期，生長所需的血液供應和細胞停止運作。

3 *休止期*

頭髮在這個階段失去生機，逐漸脫落，毛囊休眠約三個月，然後重新進入生長期。當我們營養不良或身體有病時，毛囊會被迫提前進入休止期，引至脫髮等問題。

毳毛和終毛的生長期遠比頭髮短，這意味著它們最終的長度會比頭髮短；此外，它們的休止階段較長，毛囊在新週期的活力也較低。男性進入青春期後，睾丸素等雄性激素分泌增加，引致終毛取代毳毛，所以男性比女性傾向於有更多體毛。

毛髮背後的秘密告訴我們，一般相信剃毛後重新長出的體毛，會變得更濃更深色，其實是不確的。新體毛是變得更短和更硬，讓人有一種變粗了的錯覺。不過從進化過程考慮，體毛的功用可能是為身體提供第一度預警系統，提示有不受歡迎的威脅。所以當我們考慮剃走體毛時，或許應先仔細想清楚。



A Silent Hero:

Hong Kong is particularly susceptible to emerging infectious diseases. The over-crowded living environment and frequent migration of people in and out of Hong Kong have facilitated the spread of infectious diseases within the local community, leading to devastating consequences. In 1997, the first known human cases of influenza A (H5N1) virus infection (commonly known as avian influenza or bird flu) were found in Hong Kong. 6 out of the 18 infected succumbed to the virus and 1.5 million birds were slaughtered. In 2003, Severe Acute Respiratory Syndrome (SARS) spread from hospitals to communities, infected 1755 people and caused 299 deaths in Hong Kong. Originating from southern China, SARS rapidly spread to 37 other countries within a matter of weeks before it reached Hong Kong. In 2014, large-scale outbreaks of dengue fever took place in Guangdong Province and across Southeast Asia. As of 28 Nov 2014, 104 cases of dengue fever were reported by the Centre for Health Protection, 3 cases of which were locally contracted. Aside from frontline medics, many research experts behind the scenes have made important contributions in understanding these epidemics and protecting lives from emerging infectious diseases. Prof. Yuen Kwok-yung, the Chair of Infectious Diseases at the Department of Microbiology of the University of Hong Kong, is one of them.

Ranked at one of the top 1% researchers in the world by the Essential Science Indicator, Prof. Yuen has published over 700 papers in prestigious peer-reviewed journals with over 15,000 citations. His career as a microbiologist began in 1988. Over the years, he and his team have made important discoveries of novel microbes and disease agents, such as the SARS coronavirus, Human Coronavirus HKU1 and the bat SARS coronavirus. He published the first clinical and laboratory diagnostic paper on Influenza A H5N1.

Prof. Yuen graduated from the Faculty of Medicine at the University of Hong Kong in 1981 and originally trained as a surgeon. He then made the switch to become a physician and eventually

to a microbiologist. He believes that his knowledge as a physician has helped him immensely in his research and that both roles are interesting and rewarding. He explains that research establishes long-term benefits, whereas treatment is mostly immediate, making both equal in importance.

Seemingly somewhat spontaneous in nature, Prof. Yuen's career path and decisions in the choice of research were largely coincidental. His reason in selecting microbiology as opposed to other fields was simply that "only microbiology was open in HKU at that time". But what he originally just "fell into", would become a fruitful and significant career of success and contribution to society.

The HKSAR government has awarded him with the Silver Bauhinia Star for his contributions in containing infectious diseases with his leadership and expertise in this field. His success as a microbiologist, a surgeon and a physician is acknowledged by numerous Fellowships at distinguished institutions from all over the world. He continues to plough forward in identifying emerging infections, specifically in avian influenza and MERS coronavirus. Despite being hailed as a hero, Prof. Yuen simply responds that "we only want to get our job done – this is our responsibility".

香港是一個易受新型傳染病威脅的地方。擠迫的居住環境，眾多的出入境旅客，都有利於傳染病在本地社區傳播，導致災難性的後果。1997年，香港確認全球首宗人類感染甲型流感H5N1亞型病毒（又稱H5N1禽流感）的個案。18名染病者中，6人不幸死亡，香港政府緊急撲殺150萬隻家禽。2003年，香港爆發嚴重急性呼吸系統綜合症（俗稱沙士），疫情由醫院擴展至社區，感染1755人，其中299人死亡。源於中國南方的沙士在傳入香港僅數週內，便迅速蔓延到其他37個國家。2014年，登革熱在廣東省和整個東南亞地區大規模爆發。香港的衛生防護中心在2014年11月28日公佈，當年錄得104宗登革熱病例，其中3宗為本地感染個案。除了前線醫務人員外，研究專家亦為遏止新型傳染病疫症和保衛生命作出重大貢獻，其中一位是香港大學醫學院微生物學系講座教授袁國勇教授。

根據「基本科學指標」(Essential Science Indicators)的數據，袁教授獲評為全球首1%具影響力的學者之一，在享負盛名的國際同行評審期刊發表700多篇論文，被引用超過15,000次。1988年，袁教授開始以臨床微生物學家的身分進行研究工作，主要研究新型傳染病。多年來，他和他的團隊發現不少新品種的微生物和病原體，例如沙士冠狀病毒、新型人類冠狀病毒HKU1及蝙蝠沙士冠狀病毒。另外，他亦發表了全球第一篇關於H5N1甲型流感的臨床及實驗室診斷報告。

袁教授在1981年於香港大學醫學院畢業，最初接受訓練成為外科醫生，後來轉做內科醫生，之後，更成為一名微生物學家。袁教授認為醫生的知識對他的研究有極大的幫助，醫生和研究員的角色都是有趣和有意義的。他指出研究影響比較長遠，而治療病人則是當務之急，兩者同樣重要。

無論是事業路向還是研究領域，袁教授的決定原來大多是巧合。當被問及選擇了微生物學的原因，袁教授的回答是「當年香港大學只開設了微生物學系」。昔日的「偶遇」卻成為成果豐碩的事業，為社會作出重要貢獻。

袁教授曾獲香港特區政府頒授銀紫荊星章，表揚他以領導才能和專業知識對抗疫病所作出的貢獻。教授在微生物學、外科和內科多方面的成就，受到眾多世界知名的相關機構和協會認可。袁教授繼續耕耘，致力研究新型傳染病，特別是禽流感和中東呼吸道症冠狀病毒。雖然備受推崇，被譽為抗疫前線英雄，對此袁教授淡然回應：「我們只想做好本分，這是我們的責任。」

Prof. Kwok Yung Yuen
沉默英雄：袁國勇教授

By Cherry Chow 周卓瑩

Rocket Science with Dr. John C. Mather

By Cherry Chow 周卓瑩

"I really can't guess," Dr. John C. Mather answered, when he was asked what he would see himself doing if he had not become a scientist. The Nobel Laureate has been interested in science since he was a child. "My parents took me to the natural history museum and I saw dinosaur bones and the planetarium show and I was hooked immediately. My parents also read out loud to me and my sister from biographies of Darwin and Galileo, when I was about 8 years old. It was obvious that science was exciting, very important, and a little dangerous. How could you not want to do it?" His undying passion seems to be the key for his success.

Dr. Mather is a Senior Astrophysicist in the Observational Cosmology Laboratory at the U.S. space agency's (NASA) Goddard Space Flight Center. After obtaining his Ph.D. in Physics at the University of California, Berkeley in 1974, he became an NRC Postdoctoral Fellow at the Goddard Institute for Space Studies (New York City). Over the years, he has served on advisory and working groups for projects from NASA and the National Science Foundation among others. He has also received numerous awards and honors in recognition of his contributions, particularly in infrared astronomy and cosmology. In 2006, Dr. Mather and Prof. George Smoot shared the Nobel Prize in Physics for their discovery of the blackbody form and anisotropy of cosmic microwave background radiation (CMB), during their work on the Cosmic Background Explorer Satellite (COBE).

The COBE satellite was launched on November 18, 1989 to measure the spectrum of the CMB radiation, and compare the spectrum of the CMB with a precise blackbody. Dr. Mather and his team found that CMB radiation has a blackbody spectrum within 50 ppm, providing support for the Big Bang Theory. According to the Big Bang theory, multiple scattering photons in the universe's infancy, just as optical light wanders through a dense fog, produces a blackbody spectrum of photons. The data from the instruments on the COBE showed a perfect fit between the frequency spectrum of the CMB and the theoretical curve for a black body. "The fact that the measured spectrum has the perfect blackbody form is very strong evidence for the Big Bang Theory. None of the alternative theories include the high temperature equilibrium that produces the perfect spectrum," Dr. Mather explained.

The mission proved to be a challenge from the get go. "The biggest problem was that nobody knew how to design the mission, at first. We asked for extreme sensitivity and precision, and we needed instruments to work at liquid helium temperatures, around 1.5 Kelvin." In addition, Dr. Mather and the COBE team experienced an unexpected crisis while working on the project. When the COBE mission was almost ready to be assembled, the Space Shuttle Challenger tragically disintegrated after launch, leading to the deaths of seven crew members. The original plan to launch the COBE became a seemingly impossible task. "So we had to redesign the equipment for launch on a Delta rocket. Engineers and technicians worked round the clock for almost 3 years to do that," Dr. Mather recalled, "But it worked."

As the Senior Project Scientist, Dr. Mather now dedicates most of his time on the James Webb Space Telescope (JWST), the planned successor to the Hubble Space Telescope to be launched in 2018. Due to its sensitivity to infrared radiation from stars and from cooler objects below room temperature, he foresees that the JWST will extend the scientific discoveries of the Hubble to "greater distances, farther back in time". He is also working on what telescope should be built after the JWST. "It needs to be even bigger and more powerful, so that it can detect signs of life on planets around other stars."

火箭科學 — 約翰·馬瑟博士

「我真的無法想像。」被問給如果沒有成為科學家，自己會在做甚麼事情，約翰·C·馬瑟博士這樣回答。這名諾貝爾獎得主對科學的興趣，萌生於孩提的時候。「我父母帶我參觀自然史博物館。我看到恐龍骨架和天文館的節目之後，頓時著迷了。父母又給我和姐姐朗讀達爾文和伽利略的傳記，當時我大約8歲。很明顯地，科學是刺激的、非常重要的，也帶點危險。你怎麼可能不想觸碰它呢？」看來，不息的熱情正是他成功的關鍵。

馬瑟博士是美國太空總署（NASA）戈達德太空飛行中心觀測宇宙學實驗室的高級天體物理學家。1974年在柏克萊加州大學獲得物理學博士學位後，他成為戈達德太空研究所（紐約市）的一名NRC博士後研究員。馬瑟博士曾出任NASA、國家科學基金會（NSF）等多個組織的項目顧問或工作組成員。他亦獲取過無數的獎項和榮譽，肯定了他多年來作出的貢獻，尤其是在紅外天文學和宇宙學等方面的成就。2006年，馬瑟博士與喬治·斯穆特教授共同獲頒授諾貝爾物理學獎，以表彰他們在宇宙背景探測者衛星（COBE）的研究，發現了黑體形式和宇宙微波背景（CMB）輻射的各向異性。

COBE衛星於1989年11月18日發射，測量宇宙微波背景輻射，並將宇宙微波背景輻射的光譜和特定黑體作比較。馬瑟博士及其團隊發現宇宙微波背景輻射的黑體光譜在50ppm的範圍以內，支持宇宙大爆炸曾經發生的想法。根據大爆炸理論，在早期的宇宙裡，光子多重散射，就像可見光線在濃霧當中散射般，產生黑體光譜。一如該理論的預測，FIRAS的數據顯示，宇宙微波背景輻射光譜的黑體理論曲線完全吻合。「測得的光譜具有完美黑體的形式，為宇宙大爆炸這理論提供非常有力的證據。沒有其他牽涉高溫熱平衡的理論能夠產生這樣完美的光譜。」馬瑟博士總結道。

任務從一開始就有相當的挑戰性。「最大的問題是，最初根本沒有人知道如何去設計任務。我們要求極高的靈敏度和精確度，而且我們需要儀器在液態氦的溫度下工作，大約是1.5K。」另外，馬瑟博士和COBE的團隊在項目進行期間還經歷了出乎意料的危機。就在COBE差不多可以組裝時，悲劇發生，挑戰者號穿梭機在發射後解體，機上七名人員喪生。原本打算以挑戰者號運載COBE上太空的計畫無法實現。「因此，我們不得不重新設計，使COBE可改用三角洲火箭發射。工程師和技術人員日以繼夜，足足花了接近3年來做這件事。」馬瑟博士回憶道：「但我們成功了。」

作為項目的高級科學家，馬瑟博士現正投放大部分時間於詹姆斯·韋伯太空望遠鏡（JWST）。JWST計劃於2018年發射，接替哈勃太空望遠鏡。由於JWST對恆星、甚至低於室溫物體所發出的紅外線極其敏感，馬瑟博士預料JWST將會比哈勃望遠鏡取得「更廣闊之外，更久遠以前」的發現。另外，他亦在計劃JWST之後應該建造怎樣的望遠鏡。「它必須是更大，功能更強，可以在其他恆星周圍的行星檢測出生命跡象。」

Test Yourself! 測一測

1. What is the name given to a bacterium or virus that causes disease?
引起疾病的細菌或病毒叫做？
   a. Antibody 抗體
   b. T-cell T 細胞
   c. Macrophage 巨噬細胞
   d. Pathogen 病原

2. The alloy created when mixing copper and tin is called?
銅和錫的合金是什麼？
   a. Aluminum 鋁
   b. Bronze 青銅
   c. Steel 鋼
   d. Iron 鐵

3. The Amazon Rainforest produces approximately what percent of the world's oxygen?
亞馬遜熱帶雨林產生大約地球上百分之多少氧氣？
   a. 10%
   b. 15%
   c. 20%
   d. 25%

4. Which of the following insects do not require sleep?
以下哪種昆蟲不需要睡眠？
   a. Cockroach 蟑螂
   b. Termite 白蟻
   c. Bee 蜜蜂
   d. Ant 螞蟻

5. Chalk is primarily made up of what chemical compound?
粉筆主要用以下哪種化學和物造成的？
   a. Calcium sulphate 硫酸鈣
   b. Calcium carbonate 碳酸鈣
   c. Iron oxide 氧化鐵
   d. Aluminum oxide 氧化鋁

6. True or False: Human saliva contains a painkiller called opiorphin that is more powerful than morphine.
是非題：人類唾液裏包含一種叫「opiorphin」的止痛物質，效果比嗎啡更強。

Answers 答案: d, b, c, d, b, T

For detailed answers and explanations, please visit our website.
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