SCIENCE FOCUS 科言

Issue 014, 2018

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香港科技大學
THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

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Message from the Editor-in-Chief 主編話語

Dear Readers,

I hope you are enjoying the new school year so far. For some of you, it may be time to consider further education and decide if studying science in universities is the right choice. Have you been to open days in local universities? Do you know that the government has promised to inject an increasing amount of its revenue to support local research and development? It seems that the future is bright for academics and entrepreneurs in a variety of scientific disciplines.

At school, the boundary between different subjects in science are rather clear-cut. In reality, it is not uncommon for scientists to collaborate with others and break new grounds. In this issue, we explore how stained glass can be seen as a marriage of art and chemistry, and how physical principles are used to stimulate the brain in a more precise manner.

As a new way of communicating with our readers, *Science Focus* is now on Instagram (*@sciencefocus.hkust*). We will be launching a photo competition very soon for images that will inspire future articles in *Science Focus*. Bite-size articles will be forthcoming also. Please stay tuned!

Yours faithfully,
Prof. Ho Yi Mak
Editor-in-Chief

親愛的讀者：

我相信你們都已經習慣新學年的學校生活。現在可能也是考慮未來升學的路向，以及究竟該不該在大學修讀理學的時候。你有到本地各所大學的開放日參觀嗎？你知道政府最近承諾利用庫房收益向本地科研項目注資嗎？似乎在不同科學領域上，學術界及商界的未來也機遇處處。

在學校，不同科學學科之間都有著比較清晰的界線。現實上，不同範疇的科學家透過互相合作來尋求突破也是常見的事。在這一期，我們會探討為何彩色玻璃會被視為藝術與化學的結晶，以及如何利用物理定律，創造出能對腦部作出更精準刺激的方法。

另外，作為與讀者交流的全新方法：《科言》現已登錄 Instagram（*@sciencefocus.hkust*）！我們之後還會舉辦相片投稿比賽，希望透過相片啟發未來《科言》文章的寫作。短篇文章亦即將登場。請密切留意！

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敬上

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香港科技活動
WHAT'S HAPPENING IN HONG KONG ?

Fun in Winter Science Activities

Any plans for this winter? Check out these science activities!

The Shaw Prize 2018 Exhibition

Established in 2002, the Shaw Prize recognizes scientists with recent significant breakthrough in scientific work. It consists of 3 annual prizes: Mathematical Sciences, Life Science and Medicine, and Astronomy. In the exhibition, you can learn more about the 2018 Shaw Laureates and their scientific research.

Venue: Main Lobby,
Hong Kong Science Museum

Date: 21 September 2018 – 21 November 2018

冬季的科學好節目

計劃好這個冬天的好去處了嗎？不妨考慮以下活動！

2018邵逸夫獎展覽

「邵逸夫獎」於2002年設立，設有三個獎項：數學科學獎、生命科學與醫學獎和天文學獎，分別頒發給在相關學術領域有傑出貢獻或在近期有突破性研究成果的科學家。透過今次展覽，你可以更深入認識今年的得獎者以及他們的科研工作。

地點：香港科學館大堂

展期：2018年9月21日 至 11月21日

Hong Kong Butterfly Photo Competition 2018

The topic of the Hong Kong Butterfly Photo Competition 2018, held by the Fung Yuen Butterfly Reserve, Environmental Association, is "Appreciate our Ecosystems, Protect our Environment". With this opportunity, local residents can learn more about butterflies and appreciate the ecology of their natural habitats. The organizers also hoped to raise the awareness on environmental protection through this competition.

Contestants are required to send no more than 2 photos by email at *fungyuenbutterfly@gmail.com*. The beauty of butterfly (at any developmental stage) in its natural habitat needs to be shown in the photos. For further details about the competition, please visit *http://www.fungyuen.org/*.

Submission deadline: 30 November 2018

第十四屆香港蝴蝶攝影比賽2018

今年由環保協進會「鳳園蝴蝶保育區」主辦的「第十四屆香港蝴蝶攝影比賽2018」主題為「賞生態，保生境」。主辦機構希望市民能以此為契機，更深入地認識蝴蝶和欣賞其生境的自然生態，從而喚醒大家對保育生態環境的意識。

參賽者需要把最多兩張參賽相片電郵至 *fungyuenbutterfly@gmail.com*，相片需展現蝴蝶任何階段及其於生境中的自然美態。有關比賽詳情，請參閱：*https://www.fungyuen.org/*

截止日期：
2018年11月30日

Hong Kong Youth Science and Technology Innovation Competition 2018-19

The 21st competition will be held during the period of September 2018 to April 2019. Among the different categories, "Research and Invention" and "Outstanding STEM Activity" are the two that are suitable for high school students.

The secondary division of "Research and Invention" is divided into 5 sub-categories, namely "Mathematics, Physics and Engineering", "Chemistry and Materials", "Biology and Health", "Energy and Environmental Science" and "Computer Science and Information Technology". Participants can submit either a research project or an invention, and apply individually or in groups. The format of "Outstanding STEM Activity" can be extracurricular activities, research studies or social activities. Groups, classes or clubs/associations in secondary schools will be the basic unit of participation.

The deadline of online application is 31 January 2019. The deadline of submission of Research and Invention (Secondary Division) or projects by school societies is 16 February 2019.

For more details, please visit *http://stic.newgen.org.hk/*.

香港青少年科技創新大賽 2018-19

本屆賽事將於 2018 年 9 月至 2019 年 4 月期間舉行，其中適合高中生參與的項目包括「研究及發明」和「優秀 STEM 活動」。

「研究及發明」項目分為「數理及工程」、「化學及材料」、「生物及健康」、「能源及環境科學」和「電腦及資訊科技」5 個組別，參賽者可自行選擇以個人或小組為單位，以研究論文或發明品參賽。「優秀 STEM 活動」的形式可包括課外活動、研究性學習或社會實踐活動，同學可以學校小組、班級或學會組織為單位出賽。

網上報名截止日期為 2019 年 1 月 31 日，作品的截止遞交日期則為 2019 年 2 月 16 日。

有關賽事詳情，請參閱：
http://stic.newgen.org.hk/

STAINED GLASS

彩 色 玻 璃

"Stained glass." What word comes to mind when you hear this?

Common answers may be "art" or "cathedral." Surprisingly, "nanotechnology" is also a correct answer. Though the ancients did not realize it, they created art with one of today's most researched branches of science. Stretching as far back as the dawn of human civilization, the history of stained glass is one rich in art and science. In fact, it could be said that the art of making stained glass was the first work of nanotechnology and its craftsmen the very first nanotechnologists.

To appreciate this amazing story of how science and art intertwined, here's a brief history of stained glass. Historical records show that the earliest stained glass works were created in Ancient Egypt and Ancient Rome. They gained popularity in the Middle Ages. In the 12th century, the development of stained glass windows reached its height. The rise of stained glass at the time owed much to both the rise of Christianity and the Gothic style of architecture. This architectural design made it possible to increase the amount of glass paneling in a building. Instead of thick stone walls, Gothic churches had large openings in walls decorated with stained glass windows prominently displayed as works of art and a means to educate people of their religion.

One of the more famous examples of all time resides in the Chartres Cathedral in France. Constructed from 1194 until 1220, a grand total of 176 pieces of stained glass were installed in the cathedral, the most famous being the "Notre-Dame de la Belle-Verrière." It contains 24 segments showing scenes from the life of Christ. At the center of the window, there is a figure of the Blessed Virgin Mary on a throne with the Christ Child on her lap. Comprised of a myriad of red, blue and green, the window is a breathtaking sight to behold. Imagine standing in the soaring cathedral, gazing up at the play of light on the rich colors. The powerful images may make you wonder: What was the secret discovered by Medieval craftsmen? How did they create such awe-inspiring art work which shimmers in multiple colors?

Here's the science behind stained glass. It is not as complicated as you might imagine. Regular glass is produced by heating silica to a very high temperature. Stained glass is made from pretty much the same process, except that traces of metal oxides or metals are added to the silica when it is still molten. This very slight amount of metal makes a huge difference – a spectrum of colors is produced. The secret lies in the fact that the traces of metal trapped in the glass matrix are the size of nanoparticles. On the surface of metal nanoparticles there are loosely held electrons, and as light shines through the glass, these electrons interact with energy-carrying light waves and begin to oscillate. The oscillation at once absorbs and reflects light of specific wavelengths. A glass matrix containing spherical gold nanoparticles of 25 nanometers (i.e. 10^{-9} m) will appear ruby red to the eye because shorter wavelengths in the blue color range from visible light are being absorbed while longer wavelengths in the red color range are being reflected into your eyes. Slight variations in size of the nanoparticles will change the frequency of the oscillation, affecting the wavelengths of light being absorbed and reflected, consequently producing the different colors we see.

A rule of thumb is that when the size of the nanoparticles increases, the wavelengths they absorb are also increased, while the wavelengths they reflect are decreased. So if the size of the gold nanoparticles trapped within the glass matrix are bigger, they will absorb longer wavelengths of red colors and reflect the shorter wavelengths of a vivid blue color instead. To produce a wide array of colors on a piece of glass, gold, silver or other metal/metal oxide nanoparticles of different sizes can be trapped into glass matrices according to specific structures. Simply put, it all comes down to one thing when we talk about the kaleidoscope of colors in stained glass windows: size!

So there you have it. History, art and science all rolled into one fascinating story. Behind the beauty of art lies the art of science. Their combined creation bore witness to the history of men's attempts at creating beauty. Whoever thought all three would be so interconnected? Well, now you know.

THE HISTORY, THE ART AND 歷史、藝術和科學 THE SCIENCE

By Henry Lau 劉以軒

「彩色玻璃。」

當你聽到這四隻字的時候，會想到什麼詞語？

常見答案可能是「藝術」或「大教堂」。令人驚訝的是，「納米技術」也是一個正確的答案。古人原來沒有意識到，他們是用當今熱門的科研技術，來創造他們的藝術。自人類文明的曙光初現，彩色玻璃的發展就充滿藝術和科學的元素。可以說，製作彩色玻璃的藝術，是納米技術的第一份作品，那工匠也是最早的納米技術專家。

要欣賞這個關於科學與藝術交織在一起的驚人故事，要從彩色玻璃的簡史開始。歷史記錄顯示，最早的彩色玻璃作品，是在古埃及和古羅馬時期創作的，在中世紀開始受歡迎。到 12 世紀，彩色玻璃窗的發展達到了頂峰。當時彩色玻璃的興起，很大程度上歸功於基督教的興起，和哥德式建築風格的普及。這種建築設計，增加建築物中玻璃鑲板的數量。而哥德式教堂沒有厚厚的石牆，只有牆壁上的大窗戶，在窗戶加裝彩色玻璃，既可突顯藝術品味，又可導人歸向宗教信仰。

有史以來最著名的例子，就是法國沙特爾大教堂。從 1194 年建造，到 1220 年完工，總共在教堂裏安裝了 176 件彩色玻璃。著名的聖母 Notre-Dame de la Belle-Verrière 像，包含 24 個部分，顯示基督生平的場景。在窗戶的中央，聖母瑪利亞坐在寶座上，年幼的耶穌在她懷抱。窗戶由無數的紅色，藍色和綠色組成，令人嘆為觀止。想像一下，站在高聳的大教堂裡，凝視著色彩豐富的光線。震撼人心的圖像，不禁令你想知道：中世紀工匠到底發現了什麼秘密？他們是如何創造出如此令人驚嘆的藝術作品，以及多彩多姿閃爍的顏色？

彩色玻璃背後的科學，其實並不複雜。普通玻璃是通過將二氧化矽，加熱到非常高的溫度來生產。彩色玻璃是由幾乎相同的工藝製成的，只是在二氧化矽仍然熔化時，將微量的金屬氧化物或金屬添加到二氧化矽中。這種微量的金屬卻會造成了巨大的差異 —— 它產生了一系列顏色。秘密在於：在玻璃基質中的微量金屬，是納米顆粒的大小。而在金屬納米顆粒的表面上，存在保持鬆散的電子，當光照射在玻璃上時，電子會發生振盪。而振盪會立刻被吸收，並反射特定波長的光線。例如：25 納米（又稱奈米，即 10^{-9} 米；nanometers）的球形金納米粒子，在肉眼看起來呈紅寶石色，因為可見光中，較小波長的藍色波長被吸收，而紅色的較大波長被反射。粒子大小的輕微變化將改變振蕩的頻率，影響納米顆粒吸收和反射的波長，從而產生我們看到的不同顏色。

根據經驗，當納米粒子的尺寸增加時，它吸收的波長也增加，而它反射的波長減少。因此，如果被困在玻璃基質中的金納米粒子的尺寸更大，則它將吸收更大波長的紅色並反射更鮮豔的藍色波長。為了在一塊玻璃上產生多種顏色，就要根據特定結構，將不同尺寸的金、銀、或其他金屬（或金屬氧化物）的納米顆粒，放進在玻璃基質中。簡單地說，當我們談論彩色玻璃窗中的萬花筒顏色時，這一切都歸結為一件事：顆粒的大小而已！

你現在可以理解到。歷史，藝術和科學，都共同融入了一個引人入勝的故事。在歷史長河中，有藝術之美，有科學的藝術。共同創建的結晶，就是人類嘗試創造美的的歷史見證。誰會料到這三者可以如此相互關聯？現在，你就是理解其中奧妙的一員了。

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[1] Aubrey, D. (2013, December 19). Two Romanesque masterpieces of stained glass [Blog post]. Retrieved from *https://vialucispress.wordpress.com/2013/12/19/two-romanesque-masterpieces-of-stained-glass-dennis-aubrey/*

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A Hidden Figure of GPS

By Long Him Cheung 張朗謙

Google Map is one of the most downloaded applications in mobile phone App stores. This is not surprising as Google Map makes life much more convenient by guiding you to your desired destination with precise instructions. In order to perform navigation, the application must first find out our location, and this cannot be done without the Global Positioning System (GPS). Not only for personal navigation, GPS is also widely used in transport, anti-theft and precision agriculture. It is not an exaggeration to say that the invention of GPS has changed the world. Many hidden figures contributed to the development of this world-changing technology, and Gladys West is one of them.

Born in the rural region of the United States in 1930, Mrs. West had to help with the field work in a small farm run by her family during her childhood. She found that it was not the life she would like to live – she did not want to work as a farmer nor a crop-processing factory worker. At school, she realized that education was the thing that could change her life. Although Mrs. West's family was not financially capable to support her to study further, she worked very hard and was awarded a scholarship to study at Virginia State College, where she pursued a mathematics degree. At that time, most of her classmates who were studying mathematics were men. She recalled that she was always competing and trying to survive because she was one of the "special ones" in class [1]. After graduation, Mrs. West had worked as a teacher for two years, like the few female classmates she had did, before she went back to school for her master's degree.

With her skills and knowledge in mathematics, Mrs. West was hired as a researcher at the naval base in Dahlgren in 1956. Besides spending most of her career developing computer programs for missile launching, she also collected and processed information from satellites and try to locate the satellites. It took a lot of effort for Mrs. West to solve and check the equations, along with analysis for the collected data using massive computers. Nonetheless, she overcame numerous times of miscalculations and finally completed the computer program which locates the position of satellites; the calculation that was done by Mrs. West eventually helped in the development of GPS.

Worked as a mathematician for the Government for more than 40 years, Mrs. West retired in 1998 and started to work towards a PhD. Unfortunately, only five months from retirement, Mrs. West suffered a stroke which damaged her hearing, vision and mobility of her right side. Nevertheless, it did not stop her from obtaining her PhD eventually.

Recently, Mrs. West revealed that actually she still finds it difficult to comprehend that her calculations have led to a revolutionary system. "When you are working every day, you're not thinking of 'What impact is this going to have on the world?' Instead, you are thinking 'I have got to get this right.'"

This story is an apt reminder that all of us can excel in science, regardless of gender, race and family background. By pursuing a scientific career, you may also bring new discoveries and technology to the world.

In the future, when you get lost and need to use GPS to find your way, you have to remember the hidden figure of GPS, Mrs. Gladys West.

谷歌地圖是手機應用程式市場中其中一個下載次數最多的應用程式。這並不令人意外，因為谷歌地圖能用準確的指示帶你輕鬆地前往目的地，令人們生活變得更方便。在進行導航的時候，程式首先要取得我們的位置，而這必須使用全球定位系統（Global Positioning System，或GPS）。GPS 不僅被運用於個人導航，在運輸、防盜和精準農業等不同方面都有廣泛的應用。無可否認，GPS 是一項改變世界的發明；而在這項強大技術的發展過程裡，有著不少無名英雄，而格拉德斯．韋斯特夫人就是其中之一。

韋斯特夫人於 1930 年在美國的鄉村地區出生。在韋斯特夫人的童年時期，她的家裡經營了一個小型農場，而她亦時常需要到田裡幫忙完成農務。可是，韋斯特夫人明白這並非她所嚮往的生活，她並不想當農民或農作物加工工人。在學校裡，她意識到教育能夠改變她的生活。然而，韋斯特夫人的家庭沒有足夠的經濟條件支持她升讀大學；但她並未因此卻步，她努力考上了獎學金以支援其升學到弗吉尼亞州立大學。在那時，大部分在她班上修讀數學的同學都是男生。她回想起在那時她總是努力與其他人競爭求存，因為她是班上少數的女生 [1]。在完成其數學學位後，像她班上的女同學一樣，韋斯特夫人當了兩年數學教師，但在其後回到大學深造完成碩士學位。

憑藉在數學方面的知識和技能，韋斯特夫人在 1956 年被聘為達爾格倫（Dahlgren）海軍基地的研究員。儘管花了大部份職業生涯開發發射導彈的電腦程式，韋斯特夫人在此工作以外亦有收集和處理從衛星傳來的信息，並試圖找出衛星的位置。經過多番努力，利用大型電腦進行分析並不斷檢查、改良計算方法，韋斯特夫人最終克服無數次的錯誤計算，成功完成定位衛星位置的電腦程式，韋斯特夫人的這項計算正正為日後發展 GPS 奠定基礎。

為政府工作了四十多年，韋斯特夫人於 1998 年退休並開始攻讀博士學位。不幸地，在退休後的短短五個月，韋斯特夫人便因中風導致視力、聽力、及右側的活動能力受損。可是，韋斯特夫人並沒因此氣餒，以驚人意志克服身體的困難完成博士學位。

在最近期的訪問中，韋斯特夫人透露，實際上她仍然覺得自己當時的計算能創造出革命性的定位系統是一件不可思議的事情：「當你每天都在工作時，你不會去想『這會為世界帶來甚麼影響？』；你在想的只會是『我得把這做好。』」

這故事亦適切地提醒了我們：所有人都可以在科學上有出類拔萃的表現，不論你的性別、種族和出身如何。透過以科研作為自己的事業，你可以為世界帶來一些新發現和新技術。

在將來，當你迷路並需要使用 GPS 導航時，或許你會記起 GPS 的無名英雄 —— 格拉德斯．韋斯特夫人。

GPS 的無名英雄

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[1] BBC. 100 Women: Gladys West - the 'hidden figure' of GPS. *https://www.bbc.com/news/world-43812053*. Updated May 20, 2018.

A RACE TO SAVE COMMERCIAL BANANAS

拯救香蕉產業

By Chantelle Sullivan
蘇盈安

Bananas are undeniably one of the, if not the, most common fruit around the world – more than 400 million people rely on bananas as a staple food. There are multiple modern cultivated varieties that are globally distributed and a majority of them are either hybrids or polyploids (having more than 2 sets of chromosomes) that have originated from two wild banana species [1]. The Cavendish, the most popular variety of banana since the 1950s, have been and still are thriving in production. However, the fungus Fusarium wilt tropical race 4 (TR4), which gives Cavendish bananas the deadly Panama disease, arose in the 1990s. Fusarium is a fungal parasite which uses the dead matter of the host as the source of nutrients. To be more precise, Fusarium induces programmed cell death (simply forcing the cells to commit suicide) in Cavendish bananas and feeds on the dead matter produced. Nowadays, Fusarium wilt has spread across all banana-growing regions worldwide, with the exception of America [2]. The fungal blight remains a current threat to the production of today's Cavendish bananas, until a field trial conducted in Australia showed promising results in a potential solution to eliminate the Panama disease once and for all – making use of genetic modification and DNA detection techniques.

Previous work done by biotechnologist James Dale and his colleagues at the Queensland University of Technology in Brisbane, Australia, have demonstrated that two genes, *ced-9*; derived from nematodes, and *RGA2*; derived from bananas, can independently confer resistance to Fusarium wilt [3]. In nematode *Caenorhabditis elegans*, *ced-9* inhibits programmed cell death to ensure normal development [4]. Previous research studies have shown that *ced-9* also works in banana plants to reduce programmed cell death, and hence confers resistance to Fusarium wilt [5,6]. As mentioned above, another resistance gene, RGA2, is naturally existing in banana plants, including Cavendish bananas [5]. However, the expression of endogenous *RGA2* (*RGA2* that originates from the plant) is not enough to confer an effective resistance to the plant, so extra copies of *RGA2* were inserted in this study. Therefore, the two genes, along with regulatory elements that control their gene expression, were inserted separately into Cavendish bananas. Ten transgenic lines of banana plants were produced.

The team then proceeded to confirm the presence of "foreign" DNA in the transgenic bananas using a technique called Southern blotting, invented by the British biologist Ed Southern. Subsequently, the ten transgenic lines of Cavendish banana plants are planted, along with unmodified controls. To ensure that the plants are exposed to Fusarium wilt TR4, infected plant material is buried near each plant. The trial lasted for three years, during which 67-100% of control plants died, or showed symptoms of the Panama disease. However, 80% of the transgenic lines remained free of symptoms, with two lines (one from *ced-9* and *RGA2* respectively) being completely invulnerable to the fungus [5]. Another advantage that was discovered is that the two resistance genes *ced-9* and *RGA2* do not reduce the size of the banana bunches produced from the transgenic banana plants.

A map showing places with TR4 presence reported (Map data: Google) [2]
已報告受 TR4 影響的地區 [2]

The encouraging results from the study gave rise to grounds of optimism amongst scientists. This method of genetic modifications has the potential to end the fungal threat towards Cavendish bananas, allowing for the continuation of its high production and for it to maintain its status as the world's most important banana.

香蕉是最常被食用的水果之一——世界上有超過四億人以香蕉作為主要糧食。現代的香蕉有多個被培育的種類，不同的種類分別遍佈全球，當中大部分都是雜種或多倍體（即有多於兩套染色體），而它們都是源自兩種野生的香蕉品種 [1]。自上世紀五十年代起直到現在，香芽蕉（Cavendish）都是世界上最受歡迎的香蕉種類，其產量豐富。可是，有一種可導致香芽蕉染上巴拿馬病（Panama disease；黃葉病的一種）而死亡的真菌：香蕉黃葉病菌第四生理小種（Fusarium wilt tropical race 4，下稱「TR4」），在九十年代起肆虐。黃葉病菌是一種屬於真菌的寄生蟲，它會以宿主已枯萎的部分作為營養來源。詳細來說，黃葉病菌會迫使香芽蕉的細胞進行程式性細胞死亡（programmed cell death；亦即是迫使細胞自殺），然後從那些已死的部分獲取營養。現時，除了美洲，黃葉病幾乎已傳遍所有種植香蕉的地方 [2]。這種由真菌引致的枯萎病繼續對香芽蕉的生產構成威脅，直至澳洲一項實地研究的結果指出，轉基因和 DNA 探測技術的使用可能為消滅巴拿馬病提供一條新的出路。

在澳洲布里斯本，昆士蘭科技大學的生物科技學家 James Dale 和同事的研究展示出有兩個基因：來自線蟲的 *ced-9* 和來自香蕉的 *RGA2*，分別可以賦予香蕉對抗黃葉病的抗性 [3]。在秀麗隱桿線蟲（*Caenorhabditis elegans*）中，*ced-9* 透過抑制程式性細胞死亡以確保線蟲的正常生長 [4]。先前的研究已經證明 *ced-9* 同樣能在香蕉植物上抑制程式性細胞死亡，因此能賦予香蕉對抗黃葉病的抗性 [5,6]。而先前所提及的抗性基因 *RGA2 則*是香蕉植物（包括香芽蕉）原有的基因 [5]；可是，內源性 *RGA2* 基因（即本身存在於該植物的 *RGA2* 基因）的表達並不足以給予香蕉植物有效的抗性，因此研究人員在基因組中加入了額外的 *RGA2* 拷貝。研究人員分別把這兩個基因，連同調控元件（regulatory elements），即一些可以控制基因表達的附帶序列，加入香芽蕉，產生出十個不同的轉殖品系（transgenic lines）。

研究人員然後用由英國科學家 Ed Southern 所發明的南方印漬術（Southern blotting）來確認上文提及的外來 DNA 存在於已轉化的香芽蕉。及後研究人員培植上述的十個轉殖品系，和沒有轉化的對照組。為確保植物曝露在黃葉病菌 TR4 下，研究人員把已受感染的植物物質埋在每棵植物的旁邊。實驗維持了三年，對照組內 67-100% 的植物死亡或出現巴拿馬病的症狀。但是，十個轉殖品系中的八成植物則沒有出現症狀，當中有兩個轉殖品系（一個來自 *ced-9* 和一個來自 *RCA2*）的植物則完全不受真菌影響 [5]。研究人員亦發現使用這兩個抗性基因（*ced-9* 及 *RCA2*）的另一個優點是它們不會影響香蕉束的大小。

這個令人鼓舞結果為科學家對消滅黃葉病帶來樂觀的態度。這種使用基因改造的方法或許能夠終止真菌對香芽蕉帶來的威脅，令香芽蕉的高產量得以維持，並保持其作為世界最重要香蕉的地位。

What is Southern blotting?
甚麼是南方印漬術？

Please refer to the following article for further details. The method is also discussed in the elective part (Biotechnology) of HKDSE Biology. [7]

請參閱下列的網址來知道更多詳情。HKDSE 生物科的選修部份（生物科技）亦有提及此方法。[7]

https://www.the-scientist.com/foundations-old/the-birth-of-the-southern-blot-1975-50795

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Caloric Restriction:
The Key to Good Health and Slower Aging?

卡路里限制：
通往健康和减慢衰老之路？

By Chantelle Sullivan 蘇盈安

Most of us have learnt to love eating, due to the multitude of delicious food options available for us to choose from on a daily basis. There are also recommended daily caloric intake information available online for everyone, calculated based on your age, gender, weight and more. Most of us wouldn't even consider restricting the number of calories we eat every day, which is a dietary regimen for cutting down caloric intake by around 30%, without inducing malnutrition or taking in an insufficient amount of essential nutrients. However, there is mounting evidence for caloric restriction having a range of benefits to health, such as the ability to extend life span, which is the case for organisms such as nematodes, mice, fruit flies and yeast. Studies on primates and humans are ongoing, and clear conclusions are yet to be drawn, but results from studies conducted so far seem promising to a certain degree.

First, it has been strongly suggested by studies that caloric restriction slows basal metabolic rate and reduces oxidative stress. When the mitochondria of our cells burn the food we eat, i.e. glucose, harmful particles called Reactive Oxygen Species get produced as a side product, which can go on to damage cell components such as DNA. DNA damage is strongly correlated to aging, and a study conducted on mice showed that mice that were given dietary restrictions had only 65% of the DNA damage that the control mice had [1], suggesting that caloric restriction slows aging. Moreover, it was shown that caloric restriction down-regulates certain metabolic pathways in mice. The downregulation of those pathways activates anti-aging pathways, which involve programmed suicide of cells that are damaged or under metabolic stress, leading to a longer life due to the elimination of unhealthy cells [2]. Calorically restricted monkeys also showed signs of slower aging. Their gray matter volume was preserved in various subcortical regions of the brain [3], such as parts responsible for motor function, and the caudate, which plays roles in learning.

However, the benefits from caloric restriction were only apparent for elderly rhesus monkeys. Younger monkeys obtained no benefits from being calorically restricted. This finding can potentially be extrapolated to the effect of caloric restriction on humans, due to the genetic similarity between humans and rhesus monkeys [4], meaning that younger people should not follow a caloric restriction regimen.

Furthermore, results from studies conducted on caloric restriction suggest the possibility of a lowered risk of cancer and age-related diseases. Primates used in the study for long term caloric restriction showed a reduction in metabolic and hormonal factors that are associated with increased risk of cancer [5]. Besides a positive effect on reducing cancer risk, the calorically restricted monkeys also had a 50% reduction of age related diseases such as those of the cardiovascular system. Caloric restriction also seemed to prevent obesity and Type II Diabetes, the main causes of morbidity and mortality in today's society [3].

Although there is a long way ahead for work on caloric restriction to be done on primates and humans, the results from studies done on mice and monkeys show a promising possibility for caloric restriction being the key to longer life and improved health for all organisms, which offers clear socioeconomic and health benefits for humanity. However as previously mentioned, the regime conferred no benefits to younger animals, and clearer conclusions are yet to be drawn. Therefore, do only take the knowledge you have learnt here as food for thought!

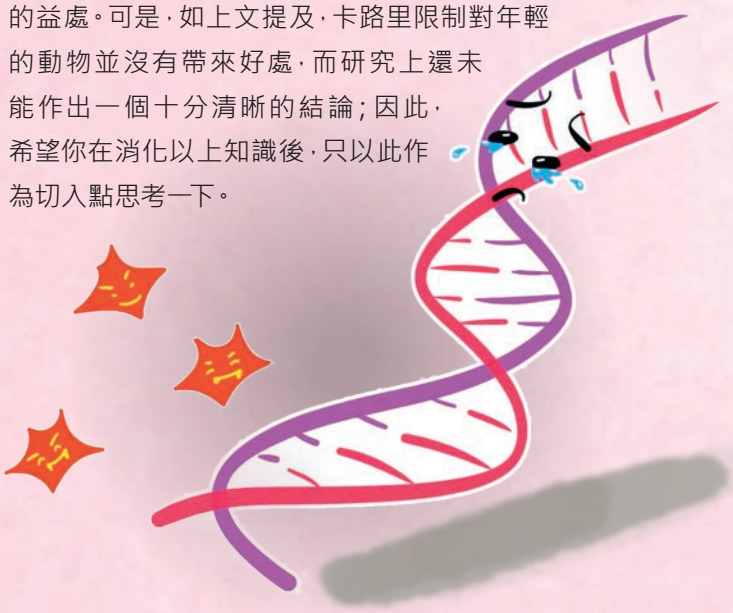
我們每天都要從各種美食佳餚中選擇自己的三餐，相信大家都知道不節制飲食的不良後果。在網上，你可能亦會找到不同根據年齡、性別、體重等計算而成的每日卡路里建議攝取量。大家又可有聽過一種主張只攝取每日建議攝取量七成的養生法？這方法不會導致營養不良或攝取不足的必需營養素，但是大多數人都通常不會考慮減少每日卡路里的攝取量。可是，在科學上有證據證明限制卡路里的攝取會對身體帶來一系列的好處，例如在線蟲、老鼠、果蠅和酵母的研究上都發現卡路里限制有延長壽命的作用。雖然在靈長類和人類的研究仍然在進行中，而確實結論仍有待提出，但從現有的研究來看，似乎有望得出同一結論。

首先，研究結果明確指出限制卡路里的攝取可以減慢基礎代謝率和減低氧化壓力。當細胞內的線粒體分解細胞的食物（即葡萄糖）時，線粒體會釋出一些叫活性含氧物（Reactive Oxygen Species 或 ROS）的有害物質，作為呼吸作用的副產物。產生的 ROS 然後會破壞細胞內的構造，例如 DNA。DNA 的損害與（身體上的）衰老有著密切的關係。研究指出限制卡路里攝取的老鼠的 DNA 損害只是對照組的 65% [1]，顯示限制卡路里的攝取有助延遲衰老。此外，研究表示限制卡路里攝取可以減慢老鼠身體內的一些代謝途徑（metabolic pathways），從而激活一些抗衰老的途徑。這些抗衰老的途徑涉及細胞自毀（學術上稱為細胞凋亡或程式性細胞死亡），透過令受損或受代謝壓力（metabolic stress）影響的細胞進行「自殺」行為，這些不健康的細胞便可能得以消除，從而帶來更長的壽命 [2]。在限制卡路里攝取的猴子上亦觀察到減慢衰老的跡象。猴子腦內多個皮質下（subcortical）區域 [3] 和尾狀核（caudate）中的灰質體積但以維持；前者負責控制運動功能（motor function），後者的功能則與學習有關。

可是，限制卡路里攝取的好處只在較年長的恆河猴（rhesus monkey）較為顯著，卡路里限制對較年輕的恆河猴並沒有帶來好處。由於人類與恆河猴的基因十分相似 [4]，由此可以推斷，限制卡路里的攝取對年青人未必有效，意味著這種養生法可能並不適合他們。

此外，研究結果顯示限制卡路里的攝取可以降低患上癌症和與年齡相關疾病的機會。在卡路里限制長期實驗的靈長類動物中可以發現，與高癌症風險相關的代謝和荷爾蒙因子的數量減少 [5]。除了在降低癌症風險方面有正面的作用，限制卡路里攝取的猴子患上與年齡相關疾病（例如心血管疾病）的風險亦下降一半。卡路里限制亦似乎有助預防肥胖症和二型糖尿病 [3]。

雖然在靈長類和人類上卡路里限制的研究還有一條很長的路要走，從在老鼠和猴子上已進行的實驗結果來看，卡路里限制有望作為令所有生物延長壽命和改善健康的方法，這明顯可減輕社會上的經濟負擔和對人類帶來健康上的益處。可是，如上文提及，卡路里限制對年輕的動物並沒有帶來好處，而研究上還未能作出一個十分清晰的結論；因此，希望你在消化以上知識後，只以此作為切入點思考一下。



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Healing the Heart with Induced Pluripotent Stem Cell

Stem cells are special because they are able to differentiate into other types of cells. There are two types of stems cells, namely adult stem cells and embryonic stem cells; adult stem cells can only differentiate into limited cell types, while embryonic stem cells are pluripotent, meaning that they are capable of differentiating into nearly all kinds of cells. The only place we can find pluripotent embryonic stem cells is from the blastocyst, an early stage embryo. In recent decades, scientists have developed the technique to produce Induced Pluripotent Stem (iPS) Cells, which are generated by reprogramming adult tissue cells, such as skin cells, with the use of genetic or chemical means. Similar to native pluripotent stem cells, scientists have shown that iPS cells have the potential to be coerced into different cell types to form tissues and organs *in vitro*, under certain suitable conditions. The beauty of using iPS cells in stem cell therapy is that stem cells are obtained without the need to destroy an embryo, thus overcoming a major ethical concern. So far, iPS cells transplantation has been tested in a pig model of myocardial infarction [1]. In the future, iPS cells may take an important role in curing diseases that have no effective treatment nowadays.

Coronary heart disease is one of the common fatal diseases in the modern society, which may lead to heart attack and cardiac arrest. It is caused by the accumulation of cholesterol plaque in major blood vessels of our heart, eventually causing irreversible damage to heart muscle because of low oxygen supply. In general, heart muscle does not regenerate by themselves and are replaced by scar tissue. Since scar tissue cannot exert contractile force, the damage to heart muscle decreases the heart performance and burdens the remaining heart muscle cells. Currently, there is no effective treatment to curb or repair the damage. However, regeneration of the heart muscle by iPS cells may be possible in the future.

In May 2018, a group of scientists and surgeons led by Professor Yoshiki Sawa from Osaka University, has been approved by the government to introduce iPS-derived tissue onto the diseased hearts in three patients. In order to use iPS cells to try to repair the damaged heart, Sawa and his colleagues developed a thin sheet of heart muscle cells, each of 0.1 mm thick and 4 cm long. Previously using pigs as experimental model, it has been shown that the grafting of heart muscle sheets could heal the damaged heart muscle and improve heart function. Although the detailed mechanism of the regenerative therapy is not fully understood, Sawa said that instead of directly repairing the damaged heart muscle, it is more likely that the sheet of iPS cells release growth factors to enhance the regeneration of the damaged heart muscles. Another advantage of this treatment is that the sheets of cells do not require any artificial scaffolding made from foreign materials to remain attached to the damaged heart. This is because they can create their own cellular matrix.

Under Japan's fast-track system for regenerative medicine, once the treatment is proved to be safe and somewhat effective in small pilot trials, expensive large-scale clinical trials can be bypassed and the therapy can be approved for sale [2]. Nevertheless, there are criticisms from researchers saying that the bar for approving therapies under the fast-track system is too low. In order to prove a medical therapy to be effective, the golden rule is to evaluate the treatment in randomized, controlled clinical trials with a larger number of participants. It will be hard to evaluate the efficacy of iPS cells for heart regeneration if the trial is limited to a small number of patients.

More research is needed before iPS cells can be used as standard treatments for previously incurable diseases, such as neurodegeneration. But the study from Osaka University certainly raises hopes that we are a step closer towards this goal.

以誘導多能幹細胞修復心臟

By Long Him Cheung 張朗謙

幹細胞的獨特之處是它能夠分化成其他類型的細胞。一般而言，幹細胞可以分成兩種：成人幹細胞和胚胎幹細胞。當中，成人幹細胞只能分化成有限的細胞類型，而胚胎幹細胞則是多能的，意味著它們能夠分化成幾乎任何類型的細胞。我們只能夠從胚囊，即胚胎的早期階段，找到多能的胚胎幹細胞。近數十年間，科學家開發出培育誘導多能幹細胞（iPS）的技術：通過轉基因或化學方法，把成人體組織細胞（如皮膚細胞）重新誘導成多能細胞。與天然的多能幹細胞一樣，科學家已經證明在適當條件下，iPS 細胞可以在體內被誘導分化成各種不同的細胞類型，形成不同的組織和器官。使用 iPS 細胞的好處是我們不再需要殺死胚胎，因此解決了使用胚胎幹細胞所帶來的道德問題。到目前為止，科學家已經成功在心肌梗塞的豬隻上測試 iPS 細胞的移植 [1]。在未來，iPS 細胞有機會成為醫治目前尚未能有效治療疾病的關鍵。

冠心病是現代社會常見的致命疾病之一，它可以導致心臟病發作和心跳停止。其成因是由於膽固醇斑塊在心臟的主要血管中積聚，最終因血氧供應不足，而對心肌造成不可逆轉的損傷。一般而言，心肌細胞並不會自行再生，而是會被瘢痕組織所取代。由於瘢痕組織不能為心臟提供收縮力，因此心肌的損害會直接減低心臟的效能，並給剩下健全的心肌細胞帶來負擔。目前，醫學上還未有有效的治療方法來抑制或修復心肌損傷。然而，iPS 細胞或許能帶來令心肌細胞再生的曙光。

在 2018 年 5 月，日本政府批准由大阪大學澤方樹教授所領導的一組科學家和外科醫生把由 iPS 細胞分化而成組織，移植至三名患者受損的心臟。為了嘗試使用 iPS 細胞來修復受損的心臟，澤教授與同事開發出一層由 iPS 細胞分化而成心肌細胞薄片，薄片每塊厚 0.1 毫米，長 4 厘米。利用豬隻作為模型的實驗顯示，植入心肌薄片能有效治療受損的心肌和改善心臟功能。儘管我們尚未完全了解這項再生技術的詳細機制，澤教授表示，iPS 細胞似乎透過釋放生長因子來促進受損心肌的再生，而不是直接修復心肌。這項治療方法的另一個優點是細胞薄片能直接附在受損心肌上，而不用外來的人工支架，因為它們能自己製造出細胞外基質（extracellular matrix）。

在日本對再生醫學的快速審批系統下，再生療法只需在小型試驗中證明其安全性和稍微的效用，便可以繞過昂貴的大規模臨床試驗，而獲准推出市場 [2]。然而，有學者批評指，快速審批系統下的批准門檻過於寬鬆。若要證明一項新研發療法的有效性，一貫的評估方法是進行隨機、有對照組的大型臨床試驗。因此，如果僅有少量患者參與測試的話，我們將難以評估 iPS 細胞對心臟再生的有效性。

在 iPS 細胞成為對現在無法根治疾病（例如神經退化）的主要治療方法之前，科學家還需要對其進行更多的研究。但大阪大學這項心肌再生的研究的確讓我們離目標更進一步，為人們對來希望。

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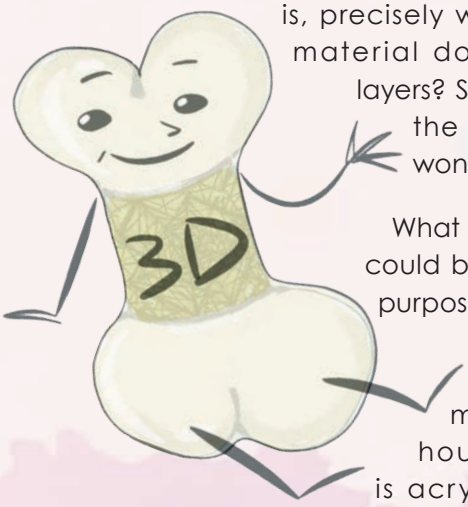
Printing. The word itself sounds anything but high-tech. Printing documents and/or photos has been around for a long time. I'm fairly certain all of you have used a printer before, at some point in your life. Sounds pretty boring, eh? But what if I told you that what you could print would no longer be limited to two dimensions? What if I told you that one could print out objects of all kinds, in different shapes and sizes? Yes, you've got it: I am talking about 3D printing, a technology hailed as revolutionary.

The principle of 3D printing actually isn't as complex as you might think. Say you want to print a cube. All you have to do is print a regular 2D square, repeat the process, then stack all the layers up together until it becomes a cube. Once you have enough layers, you can have any shape you want. Simple. And once you have a basic shape mastered, you can start moving onto the more complex shapes, for example, a sphere, using the same method. Or a basin, with some hollow internal parts. With 3D printing, almost all shapes can be visualized and crafted. This is achieved by simple mechanics: all you need is a platform that can move in 3 axes: X, Y and Z, and a nozzle gun to extrude printing material. But the question now is, precisely what kind of printing material do you use for those layers? Surely, regular ink from the age-old 2D printers won't work? Guess not.



What are the materials that could best fit the 3D printing purposes? The answer for this lies in chemistry. One of most common materials used in household 3D printers is acrylonitrile butadiene styrene. Well, what exactly is it? Let's just use its abbreviation: ABS plastic. You may have already encountered ABS before you've read this article: Lego blocks are in fact ABS plastic. Unlike the (ordinary) polymers you may have learnt in high school, ABS plastic is actually made out of not one, but three monomers, namely 1,3-butadiene, styrene and acrylonitrile. As such, ABS is known specifically as a terpolymer, with 'ter' meaning three. The terpolymer is made in a series of steps. First, 1,3-butadiene itself is polymerized, forming polybutadiene. Then, styrene and acrylonitrile are polymerized with polybutadiene. The resultant polymer is very strong as it combines the strength and rigidity of acrylonitrile and styrene polymers with the toughness of polybutadiene rubber. ABS is also a very resistant polymer, being able to withstand acid and alkali attacks as well as mechanical impacts. This, combined with the fact that ABS has a relatively high melting point, makes it a favorite material for 3D printers.

Alternatively, you could use PLA plastic in your household printer instead of ABS plastic. PLA stands for polylactic acid. Due to its name, people commonly mistake PLA for a polyacid, but it is actually a polyester. Since the lactic acid monomer contains both a carboxyl group (COOH) and a hydroxyl group (OH), PLA is simply produced by polymerizing lactic acid via condensation. Lactic acid used for PLA production is usually extracted from sugarcanes or any starch containing substance. As it comes from plants, PLA is considered a bioplastic, and since the ester bonds within the PLA chains can be broken down enzymatically, it is also a biodegradable plastic, unlike most thermoplastics. In comparison, PLA is less resistant to mechanical stress than ABS, making it more prone to warping during the 3D print process; this is mostly due to its lower melting point. However, it does produce a smoother surface that is harder for ABS to achieve. It is also able to print in much finer detail than ABS. So it would be more precise in molding the desired shape, making PLA another favorite for printing materials in 3D printers.

As of now, household 3D printing is mostly used to create quick prototypes for assessing their form and function. With the use of different printing materials, it also helps to rapidly manufacture products on a large industrial scale, especially those that require customization. In medicine, artificial bones and joints have been 3D-printed for use as prosthetics. Some companies have even dared to use 3D printing to construct housing, be it for long term use or for temporary refugee housing.

To sum up, 3D printing is a unique technology, an interdisciplinary force of chemistry and mechanics. It's quite like using play-doh to mold whatever objects you wish, but in a fancier, more precise way. It truly encapsulates the concept of bringing abstract ideas to the physical world.

3D PRINTING
三維打印

By Henry Lau 劉以軒

打印。這個名詞未必聽起來很有高科技的感覺。打印文檔及照片已經存在了一段相當長的時間。我也敢肯定，你以前也用過打印機。只是平平無奇嗎？但是，如果我告訴你，你可以打印的內容，將不再局限於兩個維度呢？如果我告訴你，你可以打印出各種各樣的實物，形狀和大小各有不同呢？對了，你猜得沒錯：我說的是三維打印，一個被譽為前所未有的技術。

三維打印的原理，其實並不複雜。假設你想打印一個立方體。你所要做的，就是先打印一個普通的二維方形，然後再多次重複上述過程，那麼，你把所造的圖形，層疊加在一起，直到它成為一個立方體。一旦你有足夠多的圖層，你就可以有你想要的形狀。就是這樣簡單。一旦你掌握了基本造形及圖層的技巧，你就可以開始用同樣的方法，進行打印更複雜形體的製作，例如：球體，甚或盆，與及一些內部空心的零件。利用三維打印，幾乎所有的形狀都可造。只要你想像得到，就可製作出來。這是通過簡單的機械操作來實現的：你需要的，是能夠在三個軸移動的平台：X、Y 和 Z，和噴嘴槍擠出印刷材料。但現在的難題是，你是用哪一種材料，來印製這些圖層？想當然，用老式的二維打印機，和那些普通墨水，必然無法完成這個工序吧？

什麼物質最應成為三維打印的材料？這個答案可在化學領域裏找到。一個家用三維打印機，最常使用的材料是丙烯腈 –丁二烯 – 苯乙烯。那麼，這究竟是什麼呢？讓我們只是使用它的縮寫：ABS 塑料。你讀這篇文章之前，您可能已經見過 ABS：樂高積木，實際上是用 ABS 塑料造的。與你在高中時學到的（普通）聚合物有些不同。ABS 塑料，其實不是由一個單體（monomer）做出來的，而是由三個單體組合而成，即 1,3-丁二烯、苯乙烯和丙烯腈。因此，ABS，具體稱為三元共聚物「terpolymer」，「ter」的含義為 3。該三元共聚物（terpolymer）是由一系列步驟製成。首先，1,3-丁二烯聚合本身，從而形成聚丁二烯。然後，苯乙烯和丙烯腈與聚丁二烯聚合。所得的聚合物十分耐用，它既有丙烯腈和苯乙烯聚合物的高強度和剛性，又有聚丁二烯塑膠的韌度。ABS 也是非常具抗性的聚合物，能夠抵受酸和鹼的攻擊，以及機械性衝擊。另外，ABS 具有相對高熔點的特質，使它成為三維打印機最常用的材料。

另外，你也可以在你的家用三維打印機使用 PLA 塑料，而不用 ABS 塑料。PLA 代表聚乳酸。由於它的名字，人們通常誤以為 PLA 是一種聚酸，但它實際上是聚酯。因為乳酸單體具有一個羧基（COOH）和一個羥基（OH），PLA 就是簡單地通過經由縮合乳酸來聚合製造。用作製造聚乳酸的乳酸來源通常是甘蔗或任何含澱粉物質。因為它來自植物，PLA 被認為是生物塑料；亦因為 PLA 中的酯鍵可以被酶降解，它亦被分類為可生物降解塑膠，而不像大多數熱塑性塑膠。相對而言，由於其較低的熔點，PLA 比 ABS 抗機械性拉力的能力較差，令產品更容易產生翹曲現象。但是，PLA 產品有平滑的表面，這是 ABS 難以做到的。它還可以造出比 ABS 更精細的打印產品。因此，它可以更精確地倒模做出理想的形狀，令 PLA 成為三維打印機另一種受歡迎的印刷材料。

截至目前為止，家用三維打印通常是用於快速創建原型，將圖樣立體化，來測試其結構和功能。利用不同的印刷材料，三維打印有助快速地以工業規模製造出產品，尤其是一些需要訂做的產品。在醫療上，三維打印被用作製造人工骨骼和關節等義肢。有些公司甚至採用三維打印建房，供長期使用或難民臨時使用。

綜合而言，三維打印是一種獨特的技術，結合化學和力學的一種跨學科的領域。就像用泥膠捏塑出一個自己喜歡的物件，只是過程更有趣，成品更精細而已。三維打印是真正把抽象世界的概念，變成現實世界的物件的一座橋樑。

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控制人腦？—
可植入磁鐵的應用

Controlling the Brain

When we talk about how the brain control human actions, the actions could generally be classified into three types, including voluntary actions, reflex actions and involuntary actions. The cerebrum is the part of the brain most involved with voluntary actions; most involuntary actions such as breathing and heart rate are controlled by neurons in the hindbrain. Reflexes are located more broadly in the nervous system. Voluntary actions usually do not involve any receptors since the action is initiated by the cerebrum directly. For reflex actions, a stimulus is received usually by a receptor cell of some type that signals through a relatively small number of neurons to an effector cell such as a muscle. Reflex actions are not under what we recognize as conscious control (automatic), while voluntary actions are under conscious control. Involuntary action does not involve thought and is not under conscious control, and also does not need an external stimulus to be initiated. So

The human brain is the main organ of the human nervous system, consisting of five main parts: cerebrum, diencephalon, midbrain, cerebellum and hindbrain. Each of these parts has different functions regarding the control over human actions.

腦部是人類神經系統的核心器官，由五個主要部份組成：大腦、間腦、中腦、小腦和後腦，各部份都有其相應於控制人類動作的功能。

當我們談及人腦如何控制身體動作時，這些動作大致上可被分成三種，包括:自發性動作、反射動作及非自發性動作。大腦是腦內主要控制自發性動作的部分；而大部分的非自發性動作，例如呼吸和心率，則由後腦的神經元控制。負責反射動作的地方散佈在神經系統的不同角落。自發性動作多數不涉及感受器，因為動作是由大腦直接發起。反射動作大多數都是因為感受器受到外來刺激而產生的，信號經過數量相對上較少的神經元到達效應器（例如肌肉）。亦即是說，反射動作是不受意識控制的（自動產生的）；相反，自發性動作是受意識所控制的。非自發性動作則是不需要透過思考而發起的，既不是受意識所控制的，也不是由外來刺激引起的。由此可見，若一個動作是由外來刺激引起的，形成動作的過程必定涉及感受器 — 牽張感受器、痛覺感受器或溫度感受器。最近就有一項研究，容許科學家繞過感受器而直接刺激腦部。

這項新研究是由美國哈佛大學醫學院天然義肢實驗室的 Shelley Fried 博士及其團隊所負責的。他們以可以準確地控制人腦的 860 億條神經元為目標，最終希望把人腦轉為一個控制面板，利用開啟和關閉神經元來影響一個人的行為。

according to what we know, basically if an action is initiated by stimulus, it must involve a receptor cell – a stretch receptor, a pain receptor or a temperature receptor. However, a new study demonstrates how a receptor cell can be bypassed, which allows scientists to stimulate the brain directly.

The new study was led by, Shelley Fried, and his team at the Harvard Medical School neural prosthetics laboratory. They aimed to have accurate control over the 86 billion human brain neurons. Ultimately, they hoped to turn the human brain into a control panel, so that neurons can be switched on and off to modulate one's behavior.

Historically, this type of non-cellular neuron stimulation is achieved by inserting metal electrodes into the brain to send current to the surrounding brain cells. Unfortunately, these electrodes activate a wide region of neurons and scar tissues gradually build up, causing blockage of current flow. To bypass such problem, the new method entails the insertion of a tiny "microcoil" into the brain. When current runs through the insulated "microcoil", magnetic fields are generated that pass through any accumulated scar tissue. Neurons are activated by electromagnetic induction at locations that can be more precisely controlled. This "microcoil" has a width of only 100 micrometers (around two times of the human hair diameter) and is made of silicon and copper using microfabrication techniques. Tests proved that the sharply bent copper microwire of this microcoil generated a magnetic field that was strong enough to activate neurons near the bent part in its tip. The research team first tested the microcoil in anesthetized mice. They implanted the microcoils into a region of the mouse motor cortex that controls their whiskers. Results showed that the current sent through the microcoil led to the twitching of the whiskers.

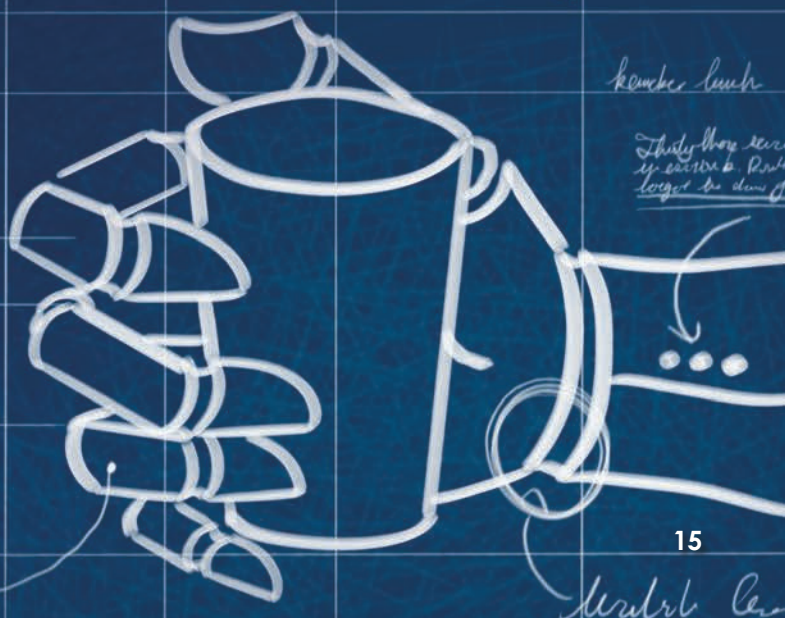
with an Insertable Magnet

By Melody Ma 馬嘉怡

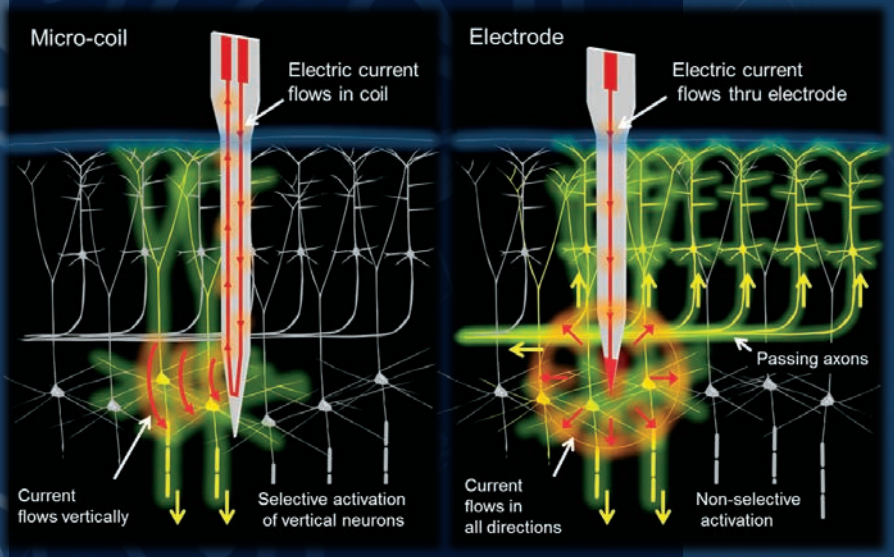
以前，這種非細胞性的神經元刺激是透過把電極植入在腦部，以其把電流傳至附近的腦細胞。可是，這種技術會刺激大範圍的神經元，而且造成的結痂組織會堆積起來，阻塞電流通過。為避免這個情況，新技術利用了在腦部植入微線圈的技術。當電流通過這個已絕緣的線圈時會產生磁場，產生的磁場可以通過任何先前堆積下來的結痂組織。我們從而可以利用電磁感應，準確激活目標位置的神經元。這個微型線圈只有 100 微米寬 (大約是人類頭髮直徑的兩倍)，以微型裝配技術用矽和銅製成。測試證實這個微型線圈中被彎曲成尖形的銅質微導線所產生的磁場，強度足以啟動在線圈尖端附近的神經元。研究團隊首先在被麻醉的老鼠身上測試微型線圈的效果：他們把微型線圈植入控制老鼠鬍鬚活動的一處運動皮層。結果顯示透過微型線圈所傳送的電流能使老鼠的鬚抽搐。

雖然這是一項相當創新的方法，但它要比其他類似設計有明顯及獨特的優勢，才能正式被臨床使用。與傳統的電刺激方法比較，使用微型線圈能提供一個更準確、長期上更可靠的神經刺激。電極和微型線圈在植入後皆會有一些膠囊化組織形成，導致金屬與附近的神經元絕緣。若是使用電極的話，所產生的電流會因膠囊化組織而受到阻塞，令電刺激因而變得不奏效；相反地，微型線圈所產生的磁場卻可以穿透這些膠囊化組織。在準確度方面，電極產生的電流會向所有方向流動，導致太多非目標神經元被啟動；相反，微型線圈感生的電流具方向性，能避免啟動過多的非目標神經元。

事實上，正如 Shelley Fried 博士所提及，微型線圈在醫生們要作極之精準的刺激時大派用場。視覺假體 (又名電子眼) 便是其中一個例子。美國一個名為 Second Sight 的



Precise Brain Stimulation with Microcoils
利用微型線圈對腦部作準確刺激



Microcoil *(left)* and electrode *(right)*: The electric current induced by the microcoil is directional, while the electric current from the electrode radiates in all directions.

左圖為微型線圈，右圖為電極：微型線圈感生的電流則具方向性；電極傳遞的電流會向所有方向流動。

Sources 來源: Seung Woo Lee (Harvard Medical School) [1]

Though the design sounds really fascinating, it ought to have distinctive and significant benefits over similar designs prior to its application in a clinical setting. Compared to conventional electrical stimulation, the use of the microcoil could provide a more precise and reliable neural stimulation over a longer period of time. Both the electrode and microcoil would have encapsulation tissues formed around them after insertion, it causes the metal to be insulated from surrounding neurons. For the electrode, the current generated is blocked by encapsulation and thus electrical stimulation is ineffective. However, the magnetic field generated by the microcoil can permeate the encapsulation. As for the precision issue, the electric current from the electrode radiates in all directions, leading to unintended activation of too many neurons. In contrast, the electric current generated by the microcoil is directional, which reduces superfluous activation.

Controlling the Brain 控制人腦？— 可植入磁鐵的應用 with an Insertable Magnet

集團開創了 Orion 皮層視覺假體系統，最近更把系統植入了第一位病人的體內。他們在病人的眼鏡設置了一個微型攝錄機，把病人眼前的景像拍下。接着，這些影像會被轉化為一組微小的電脈衝。他們亦在病人視覺皮層的表面植入了一列整齊排列的電極，這些電極能無線接收微小的電脈衝。現時系統利用的是電極而非微型線圈，但利用微型線圈可能會為系統帶來確切的改善。

微型線圈可以應用於更多不同的情境嗎？可以透過這項技術來控制某個區域的神經元，以緩和抑鬱症和癲癇症嗎？可是，要找出正確的神經元來刺激在實際操作上卻有一定的難度。機械臂亦是另一個值得思考的應用範疇。Shelley Fried 博士提出可以同時植入電極和微型線圈，利用兩者的功能便有可能設計出可被意識控制的機械臂。如果一名癱瘓人士嘗試操縱機械臂拿起一杯水，電極會負責記錄由運動皮質接收到的動作指令，而微型線圈則負責金屬手指的觸覺。Shelley Fried 博士說：「使用者應該知道拇指能幫助抓住杯子，但其他手指要按得更用力。」機械臂的構思變得可行，是因為微型線圈能作出極精細的刺激，這令機械臂可以作出更精準的活動。

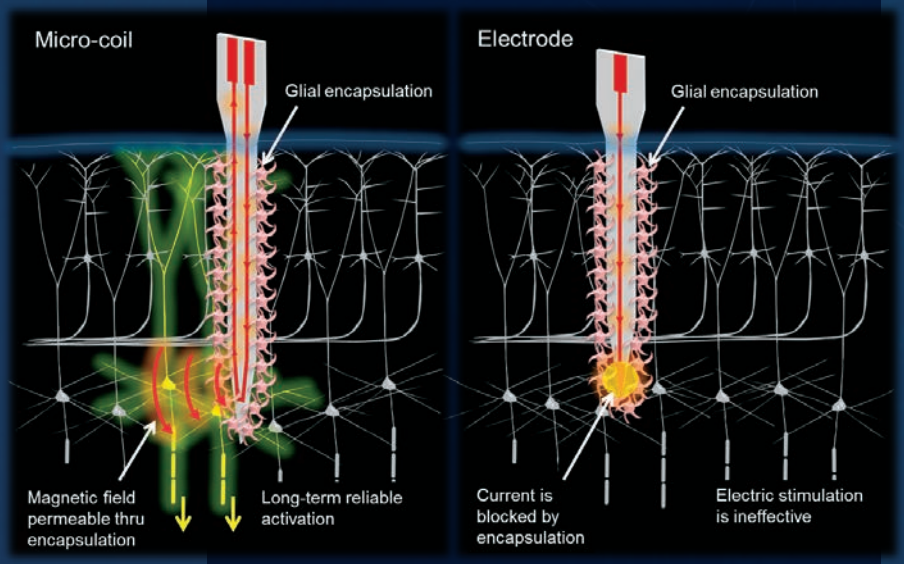
在未來的計劃中，研究團隊將會把微型線圈植入猴子腦部中，測試微型線圈能否在猴子清醒時正確地激活特定範圍的神經元。他們亦會在實驗室內用人腦組織切片測試微型線圈，希望發掘出更多把微型線圈用於人腦的可能性。當然這項技術還要克服很多障礙，例如微型線圈應有能維持多年使用而不需要更換的耐用性。無論如何，這項技術讓我們對控制和修復大腦功能的探索又邁進了一步。

In fact, as mentioned by Fried, the microcoil would be extremely useful when very accurate stimulation is required by the doctors. One of the examples is visual prosthetics. The company Second Sight developed the Orion cortical visual prosthetic system, one of which was recently implanted into the first human patient. A miniature video camera is fixed on the glasses of the patient to capture images. These images are then converted to a set of small electrical pulses. An ordered array of electrodes implanted on the visual cortex surface receives these small electrical pulses wirelessly. The current system uses electrodes instead of microcoils. However, it is possible that the adaptation of microcoils can provide tangible improvement.

Can we use microcoils in additional scenarios? Can this technique be used to ease disorders like depression and epilepsy by targeting certain areas of neurons? However, finding exactly the right neurons to activate, is easier said than done. The control of robotic limbs is another area worth considering. Professor Fried proposed that implanted electrodes and implanted microcoils could be used together to enable mind-controlled robotic limbs. If a paralyzed person is attempting to use a mind-controlled robotic arm to pick up a cup of water, the electrode could be responsible for recording movement commands received from the motor cortex and the microcoil could be responsible for tactual response by the metal fingers. "The person ought to know the thumb can provide a good grip, but the fingers have to give a harder press," Fried said. This could be achieved as microcoils allows really fine stimulation, thus supporting a more nuanced movement by the robotic arm.

Next, the group would be implanting these microcoils into brains of monkey and would be doing tests to check whether the microcoils could correctly stimulate the specified areas of neurons when the monkeys are awake. The effect of the microcoils would also be tested on human brain tissue slices in their laboratory to discover more about the possibilities of microcoils in human brain. There are additional hurdles to clear. For example, the microcoil has to be durable enough for years of usage without the need for replacement. Nevertheless, we are one step closer in our quest to control or restore brain function.

Long-term Reliable Brain Stimulation with Microcoils
利用微型線圈作出長期可靠的刺激



Microcoil *(left)* and electrode *(right)*: Magnetic field generated by microcoil can penetrate encapsulation to induce current, while the current directly passed by electrode is blocked by encapsulation.

左圖為微型線圈，右圖為電極：微型線圈產生的磁場可以穿過膠囊化組織然後感生電流；但經電極直接傳遞的電流會被膠囊化組織堵塞。

Sources 來源: Seung Woo Lee (Harvard Medical School) [1]

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How Long Can You Stay Underwater?

Do you know the maximal amount of time that you can stay underwater without any breathing apparatus? Have you ever thought that the ability to stay underwater in humans correlates with the size of the spleen?

Genetic studies have shown that humans evolved over tens of thousands of years to live in extreme environments. For example, indigenous people of the Himalayas and Andes [1] thrive in high altitudes because they carry genetic variations that allow them cope with less oxygen in the environment. Indigenous people in the artic on the other hand, are genetically programmed to tolerate more fat in their diet of seals.

In a recent study, researchers sought after adaptations in people who spent a large amount of time under water. The Bajau people, who are also known as the "Sea Nomads", have spent thousands of years diving underwater without any use of tanks or snorkels. Bajau divers spent as much as sixty percent of their working day under water, aiming to hunt for sea cucumbers and fish. Modern Bajau people have an impressive ability to dive into great depths. In fact, they are capable of diving at depth greater than 70 metres with a set of weights and traditional wooden mask [2].

Many mammals, including humans, have so called a "dive reflex" [3]. It is triggered when you plunge your face into water. Once submerged, your heart rate slows down, blood vessels in your extremities constrict, shunting blood to your body and your spleen gets a big squeeze. This pumps oxygen-rich red blood cells into the bloodstream.

The researchers from this study found that the Bajau people have spleens that are fifty percent larger than non-diving people in neighbouring regions [4]. These larger spleens may be served as reservoirs for extra oxygenated blood needed for long periods of breathless dives. The researchers then wondered if there was a genetic component to control the size of the spleens.

After comparing the DNA of the Bajau people and the DNA of their non-diving neighbours, the Saluan, the team found a change in the gene called PDE10A in Bajau people. The gene, PDE10A, controls the level of thyroid hormone T4. Other researchers discovered that this gene in mice could affect their thyroid activity, which in turn altered the spleen size. Therefore, researchers suggest that a change in PDE10A function may contribute to spleen enlargement in Bajau people.

It is increasingly clear that humans have evolved multiple ways to adapt to low-oxygen, or hypoxic, conditions. Our understanding on the genetic basis of such adaptations points to biological pathways that may be manipulated to treat patients with hypoxia-related conditions, including cardiopulmonary disease and sleep apnea.

你能在水下待多久？

By Twinkle Poon 潘晴

你有沒有測試過在沒有任何裝備的情況下，你可以在水下停留的最長時間？你有沒有想過停留在水下的能力與脾臟的大小有關？

遺傳研究表明，人類進化了數萬年來適應在極端環境中的生活。例如，喜馬拉雅山脈和安第斯山脈 [1] 的土著所以能在高海拔地區安然成長，是因為他們的遺傳變異使得他們能夠適應低氧環境。另一方面，北方土著的基因則能讓他們適應以海豹為主的高脂肪飲食。

在最近的一項研究中，研究人員希望找出長時間在水底活動的民族，身體上究竟會發展出怎樣的變化來適應水底環境。Bajau 人被稱為「海上游牧民族」，他們數千年以來都在沒有氧氣瓶和水下呼吸管的幫助下潛水。Bajau 潛水員會花百分之六十的工作時間在水底尋找海參和魚類。現代 Bajau 人具有令人印象深刻的深潛能力。事實上，它們能夠在只有一些重物和傳統木製面具的裝備下進行超過 70 米的深度潛水 [2]。

許多哺乳動物，包括人類，都有一套被稱為「潛水反射」的反射系統 [3]，當你把臉浸入水中時便會觸發。一旦整張臉都被浸沒在水中，你的心率便會減慢，四肢血管收縮，血液會分流到你的軀幹，你的脾臟會進行很大的擠壓。將含氧的紅血細胞泵入血液。

研究人員發現，Bajau 人的脾臟比鄰近地區的非潛水人士大百分之五十 [4]，較大的脾臟可以儲存額外的含氧血作長時間無呼吸潛水之用。然後研究人員想進一步了解是否有一些基因控制脾臟大小。

在比較 Bajau 人的 DNA 和他們非潛水鄰居 Saluan 人的 DNA 之後，該團隊發現 Bajau 人的 PDE10A 基因與其鄰居有所不同。PDE10A 基因負責控制甲狀腺素 T4 的水平；其他研究人員發現，白老鼠中的 PDE10A 基因可以影響他們的甲狀腺活動，從而改變脾臟的大小。因此，研究人員認為，PDE10A 的改變可能是令 Bajau 人脾臟變大的原因。

愈來愈多證據顯示，人類以不同的方式進化出多種適應低氧，或缺氧環境的特徵。我們對於這些適應在遺傳學上的理解將有助我們針對生化途徑，治療一些與缺氧情況相關的疾病，例如心肺疾病及睡眠窒息症。

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How the Tongue Tastes

舌頭如何「感受」味覺

By Chantelle Sullivan 蘇盈安

The tongue is a specialized, muscular organ that helps us taste the food we eat. Our tongues contain structures called papillae which house taste buds. Each taste bud is a bundle of taste receptor cells, which all release neurotransmitters to a nerve that travels to the gustatory cortex of the brain. The tips of the taste receptors form a small pore, through which taste molecules enter and contact the receptors. The signal from the nerve which originates from the release of neurotransmitters by taste receptor cells makes us aware of the taste we are perceiving.

In principle, there are 5 tastes that our taste receptors can sense. They include sweet, bitter, umami, sour and salty. Each taste is sensed by, or activates, a different receptor. You may have grown up seeing and learning about the tongue map, showing the different regions of the tongue and the taste it is responsible for sensing. However, studies have proven it incorrect, and that each different type of taste receptor is actually distributed all across the tongue [1], but the possibility of certain areas being more sensitive to a specific taste exists [2], such as the back of the tongue having the highest sensitivity to bitter tastes [3]. Moreover, when we eat foods with a more complex taste, such as sushi, olfactory receptors in our nose actually also contribute to the overall taste we experience when we put it in our mouth. Hence, being able to 'taste' food is the resultant property from the interplay between our olfaction and gustation.

There are a multitude of benefits of being able to taste the food you put in your mouth. First, it provides as a good detector for sources of calories. Sweet tasting foods are most appealing to most animals as they indicate the food as having a high energy content. Moreover, they can also help animals

舌頭是一個幫助我們感受食物的味道，由肌肉組成的特化器官。味蕾藏在我們舌頭中有一些叫乳突的結構內。每個味蕾都是一束味覺感受細胞，它們都會釋放神經遞質至一條通往大腦皮層味覺區的神經。味覺感受器的一端形成一個小孔，帶味道的粒子可以穿過小孔然後接觸感受器。由神經傳送至大腦的味覺信號最初源自味覺感受器釋放出的神經遞質，信號經大腦分析後，令我們可以感覺到食物的味道。

基本上，我們的味覺感受器可以感受到五種不同的味道，包括甜味、苦味、旨味、酸味和鹹味。每一種味覺感受器都可以感受到一種味道，又或者可以說是被一種味道所激發。你小時候讀書可能見過一張舌頭的味覺分佈圖，但其實研究已經證明那是不正確的，因為負責每一種味道的味覺感受器都分佈在舌頭上的不同區域 [1]，只是某些區域對某一種味道較為敏感而已 [2]，例如舌頭後方對苦味最為敏感 [3]。

detect poisonous substances. Bitter receptors are highly concentrated towards the back of the tongue, so as to allow for the animal to spit out spoiled or harmful food before they enter the throat and are swallowed. Lastly, it is found that attraction to salty tastes changes depending on the physiological state of an animal. A low concentration of sodium in the extracellular fluid within organisms may cause an increased craving or need of salty foods [4].

In terms of relaying the sensory information to the brain, the main contributors include G-protein coupled receptors (GPCR) and ion channels, both located on the cell membrane. In the case for tasting sweetness, glucose, the taste molecule, binds to the taste receptor GPCR. After the binding, the GPCR becomes activated and opens an ion channel in the cell membrane of the taste receptor cell, causing sodium ions to rush in the cell and depolarize it.

另外，當我們品嚐味道較為複雜的食物，例如壽司，鼻腔內的嗅覺感覺器亦會影響我們對口腔內食物味道的感覺。因此，我們所感受到的其實是嗅覺和味覺相互作用下的「味道」。

能夠感受食物味道對於我們當然有很多的好處。首先，它是偵測卡路里的好幫手。甜的食物對大部分動物最為吸引，因為這通常表示食物含有大量的能量。此外，它可以幫助動物偵測有毒的物質。負責苦味的味覺感受器集中在舌頭後方，這令動物可以把腐壞和有害的食物在吞進喉嚨之前被吐下。最後，研究發現鹹味對動物的吸引力視乎動物當時的生理狀況。如果體液中的鈉離子的濃度偏低，就可能增加動物對鹹味食物的渴求 [4]。

在傳送感覺信息至大腦方面來說，主要是由味覺感受器上一種名為 G 蛋白偶聯受體（G protein-coupled receptor 或 GPCR）的蛋白質負責，還有讓離子進出細胞的離子通道。以感覺甜味為例，帶甜味的葡萄糖粒子與味覺感受器上的 GPCR 結合，受激發的 GPCR 把味覺感受器細胞膜上鈉離子通道開啟，令鈉離子湧入細胞並把細胞膜去極化。

The depolarization of the taste receptor cell causes it to release neurotransmitters to the nerve it is synapsing with, or connected to, called the gustatory afferent nerve. This causes the initiation of an action potential, which means the nerve is activated, and fires the signal to the brain, allowing you to perceive the taste of the food touching your tongue.

Eating is something that we do on a daily basis, and that we may have taken for granted. This intricate process of signal transduction from the tongue to the brain happens each time we eat, and is responsible for giving us the wonderful experience of being able to enjoy our food.

DID YOU KNOW 你知道嗎？

Two scientists, Robert J. Lefkowitz and Brian K. Kobilka, were awarded the Nobel Prize for their studies of G-protein-coupled receptors.

兩個科學家，Robert J. Lefkowitz 和 Brian K. Kobilka 都因 G 蛋白偶聯受體的研究而獲得諾貝爾獎。

https://www.nobelprize.org/prizes/chemistry/2012/press-release/

味覺感受器的去極化令其釋放神經遞質至由突觸連接的鄰近神經元，該神經元被稱為味覺傳入神經元。這引發動作電位，亦即是神經元被激發。它然後會向大腦發放信號，繼而令我們可以舌頭上食物的味道。

我們每天都會進食，因此我們可能習以為常。但別忘記這個由舌頭至腦部、錯綜複雜的訊息傳遞過程在每次我們進食時都會發生，讓我們享受到美味的食物。

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Bringing the International Biology Olympiad to Local Students —

An Interview with **Professor King Chow**

By Teresa Fan 樊銘姍

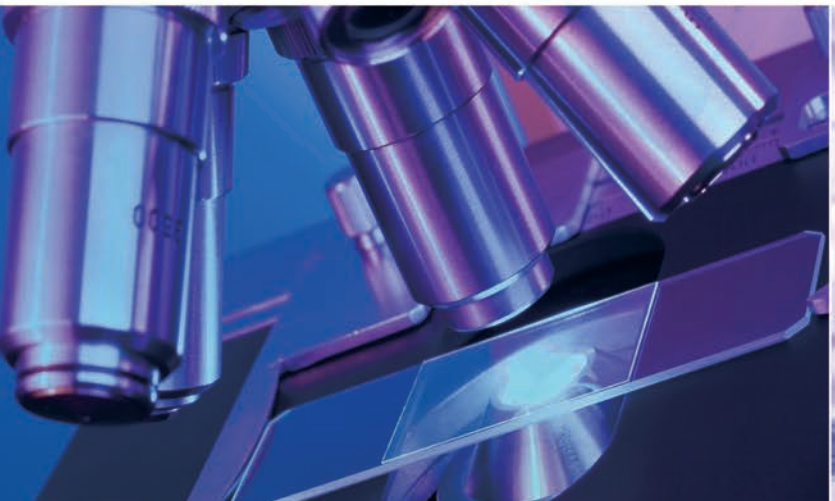
Science is changing every single day. New ideas crop up in research laboratories frequently. New results published force us to reconsider the validity of the previous findings. Therefore, learning science is neither about memorizing nor focusing on specific facts nor information gathered in specific experimental cases. However, I believe most of you, especially biology students, might hold a different point of view. As a biology student under the HKDSE system, I used to see memorizing textbook content and capturing keywords is a way to learn biology. However, there is much more about biology than the major topics covered in the public examination syllabus.

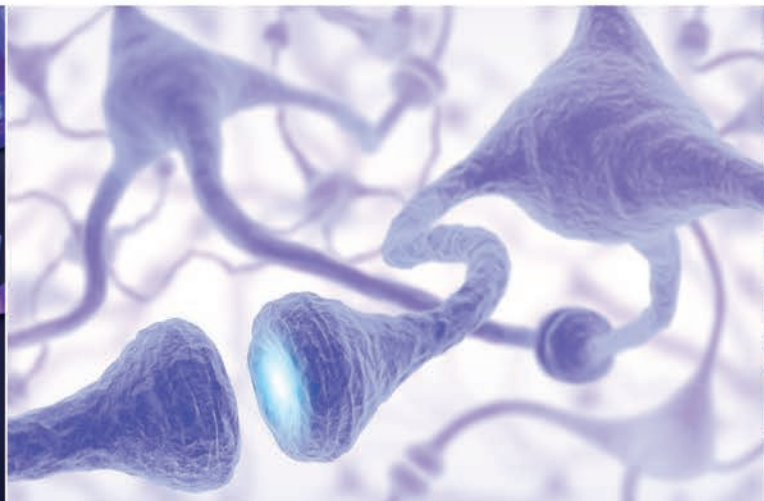
Now you may wonder, what is the better way of studying biology?

"We can acquire general information first in order to perform data analysis and interpretation and then deduce the principles by ourselves. The generic skill set allows us to go free to study any biological subjects not constrained only by examples we have covered in classes," answered Professor King L. Chow.

Professor Chow has recently led an effort, with the support from colleagues of other local tertiary institutions, to bring the International Biology Olympiad to the secondary community.

The International Biology Olympiad, Hong Kong Contest (IBO-HKC) was finally launched this year as a concerted effort supported by colleagues of eight Hong Kong universities and many secondary school teachers. The winner of IBO-HKC will have the opportunity to go to Hungary for the competition in July 2019. Before the IBO-HKC was launched this year, the organizing committee initiated the Hong Kong Joint School Biology Olympiad as a pilot test run last year. The contest consisted of 4 sessions. First, around 600 secondary school students were challenged with a series of multiple choice questions, which focused on the interpretation of experimental data. The top scoring 70+ students were then invited to attend training lectures, that explored broader areas of biology for 4 to 5 weeks. Students were then required to sit for a 3-hour test with content totally alien to them. Professor Chow noted that no one left the test early and everyone was making their best effort to solve the problems through their own analysis, not simply by





把國際生物奧林匹克推廣至本地學生——專訪周敬流教授

科學每一天都在變化。新的研究想法經常會在實驗室中出現。新的研究結果亦會令我們反思原有發現的有效性。因此，學習科學既不是背誦，也不是只關注個別事例或實驗的結果。可是，相信大多數人，尤其是修讀生物的學生，可能會持不同的觀點。作為新學制（香港中學文憑考試）的生物學學生，我曾經嘗試以背誦教科書內容和捕捉關鍵詞來學習生物。然而，生物學的範圍遠遠大於考試大綱中涉及的主要議題。

現在你可能想知道，學習生物學的更好方法是甚麼？

周敬流教授答道：「我們可先搜集資料再做數據分析，然後用其推理出原理。這些通用技能使我們可以自由地學習任何與生物相關的科目，而不受課堂例子所局限。」

最近，在周教授與其他院校同事的共同努力下，國際生物奧林匹克得以推廣至中學學界。

由香港八所大學的教職員和許多中學教師共同支持下，「國際生物奧林匹克 – 香港區比賽」（IBO-HKC）終於在今年推出。IBO-HKC 的獲獎者將有機會於 2019 年 7 月前往匈牙利參加比賽。在 IBO-HKC 今年啟動之前，籌備委員會於去年以「香港聯校生物奧林匹克」作為初步試驗。比賽分為四節。首先，大約 600 名中學生挑戰回答一系列的多項選擇題，重點在於對實驗數據的解釋。最高分的 70 多位學生獲邀參加歷時 4-5 週的培訓講座，探索更多的生物學議題。學生然後會參加 3 小時的測驗，回答內容上對他們完全陌生的問題。周教授發現沒有人提前離開考試，每個人都在盡最大努力通過他們自己的分析解決問題，而不是單純地把知識生吞活剝。他認為這是學生投入參與的一個現象，學生對測驗內容感興趣，而內容與他們學到的高度相關；內容上這測驗亦正是在現實的生物學研究中會遇到的情況。13 名學生被選中參與在不同大學內舉行的 4 個下午培訓課程，其中以實驗和分析技能為重點。在最後一輪中，該 13 名學生被邀請進行為期一天的實驗技能測試，評估他們在不熟悉的環境中設計和執行實驗的能力，例如如何設置控制組、如何獲得更準確的結果、如何用最好的方法把觀察記錄等。最後，4 名學生獲勝。周教授還解釋說：「獲獎者不一定是那些在學校考試中得分最高的人」，這可能因為測驗主要考核了邏輯思維、數據解釋和組織技能，這些香港中學文憑考試大綱沒有涉獵到的能力。

regurgitation of information. He took this as a sign that students were engaged, and they found the test interesting and highly relevant to what they learned. That was what they would practice in real life biology studies. 13 students were selected for 4 more afternoon training sessions in different universities, where experimental and analytical skills were the focuses. For the final round, the 13 students were invited for a day-long test on their laboratory performance. They were assessed for their abilities to design and execute experiments in an unfamiliar setting, like how to set up controls, how to obtain more accurate results and make the best documentation of observation. Finally, 4 students won. "The winners were not necessarily the one who scored the highest in school exams," Professor Chow also explained that this might be due to the fact that the tests were mainly examining logical thinking, data interpretation and organizational skills that are not referenced to the current HKDSE syllabus.

When asked about the purpose of putting together a team for the international competition, Professor Chow said the organizing committee had two. Neither one is about winning the competition. First, we want to create a broad-based platform for learning biology by the public, to spread the wonders and emphasis of studying biology. Second, perhaps more importantly, we want to change the way biology is being taught and perceived in the local community, and we suggest ways the biology can be learned in a fun way even during the examination. Biology in the traditional education system is about memorization and keywords, so that high scores are rewarded to those who excel in these two aspects.

Most information can be found online with today's technology. What we need to learn is how to integrate those pieces of information and to formulate a principle underlying specific observation and findings which can stand experimental scrutiny. "Nowadays, students learn from marking schemes and standardized answers as facts," Professor Chow said, "Students even take tutorial classes to learn how to assemble key words in the most efficient way to score in examinations." However, those answers are not always accurate nor universally valid. Let's say, the function of saliva. I believe most of you would say that it is for the digestion of starch. However, can it digest bacteria? The answer is YES! The saliva of many animals carries enzymes that lyse bacteria and thus serves a disinfectant function. Why would this disinfectant function not score any mark in public examinations? Therefore, Professor Chow emphasized the importance of flexibility and open mindedness in both teaching and learning. After all, it is vital to nurture the curiosity of students, which is the key that drove students into science in the first place.

In order to be a successful scientist, Professor Chow encouraged students to remain open-minded about knowledge from lessons and books, as science is changing every day. You have to keep on observing the world, appreciating the nature, asking why something would happen the ways it is. One day you may come up with your own ideas to be tested in the laboratory. Professor Chow also gave a final piece of advice – think beyond examinations, there is a lot more to be learned in the living world!

"Learning biology is indeed about logical thinking, data interpretation and analysis within a relevant biological context," Professor Chow believed.

"It is a process of exploration!" he said.

Bringing the International Biology Olympiad to Local Students —

An Interview with **Professor King Chow**

By Teresa Fan 樊銘姍

把國際生物奧林匹克推廣至本地學生——專訪周敬流教授

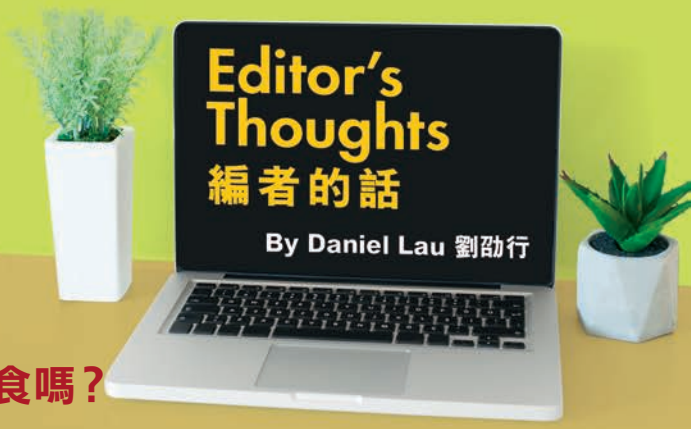
當被問及為國際生物奧林匹克組建團隊的目的時，周教授說委員會有兩個目標，但沒有一個是為了贏得比賽的。首先，我們希望建立一個供大眾學習生物學的廣泛平台，以推廣學習生物學及其有趣之處。其次，更重要的是，我們希望改變生物科在本地學校的教學方式和大眾一貫對其的印象；我們還提議即使在考試內我們也能以有趣的方式學習生物學。傳統教育系統中的生物科是關於背誦和關鍵詞，因此高分只是給予在這兩個方面表現優異的人。

周教授認為：「生物學的學習應該是與在特定實驗情景下的邏輯思維、數據闡釋和分析技能相關。」

他又說：「這應該是一個探索的過程！」

大多數資訊都可以透過現今科技在互聯網找到。我們需要學習的是如何整合這些信息，並歸納出一個定律，而當中的觀察結果和發現應該是可以經得起實驗證明的。周教授說，「現在，學生把評分參考內的答案當成知識（來背誦）。學生都在補習班上學習如何把關鍵詞拼合，以在考試裡有效地取得分數。」然而，這些答案未必準確，亦未必在各個情況下正確。找個例子吧：唾液的功能。我相信大多數人會說這是用作消化澱粉。但是，它可以消化細菌嗎？答案是可以的！許多動物的唾液攜帶溶解細菌的酶，因此有消毒的功能。為什麼這種消毒功能在公開考試中不能得分？因此，周教授強調靈活性和開放的態度在教學和學習中的重要性。畢竟，培養學生的好奇心至關重要，這才是推動學生學習科學的關鍵。

要成為一名成功的科學家，周教授鼓勵學生對課堂上和書籍的知識保持開放的態度，因為科學知識每天都在變化。你必須繼續留意世界上的事物，欣賞大自然，問問為什麼事情會這樣發生。有一天，您可能想出自己一些想在實驗室測試的想法。周教授還給了最後一條建議——除了考試之外，在我們生活的世界中還有很多東西需要學習！



To Eat or not to Eat?

As we all know, we must eat to stay alive. Ironically, after reading the article about caloric restriction in this issue, you will probably notice that how much we eat may affect how fast we age. In nature, it is often observed that some vital, fundamental processes (e.g. respiration) are associated with aging and death, not only in animals but also plants. From an evolutionary point of view, you may have already heard that, "survival of the fittest." Then, why have we evolved in this way? Here are some questions for you to think about.

1. If cutting down caloric intake by 30% can lengthen our lifespan, through the long history of evolution, why don't we feel full and stop eating at that "optimal" point?
2. Isn't it better, or will a species be "fitter", if their caloric intake is independent of aging?
3. Why is aging not selected against during evolution? Or can it be selected against?

Science Focus encourages our readers to share your thoughts on our Facebook page. If you have some exciting thoughts that you want to share on the next issue, just send us an email at *sciencefocus@ust.hk*!

那麼，還要進食嗎？

大家都知道，我們一定要進食來維持生命。但很諷刺地，讀完今期關於卡路里限制的文章後，您會意識到我們進食多少會影響我們老化的速度。在自然界中，我們可以觀察到一些最基本、用以維持生命的過程（例如呼吸作用），與老化或死亡掛鈎。不但在動物，我們還在植物上觀察到這種情況。在演化的角度來看，您可能聽過「適者生存」；那麼，為甚麼要演化成這樣呢？以下是一些您可能感興趣的問題：

1. 如果把卡路里攝取量減少30%可以延長壽命，那為甚麼漫長的演化歷史上，演化出的機制沒有令我們在感到飽足的時候及時停止進食？
2. 如果攝取卡路里與老化沒有掛鈎，那不是更好嗎？或者說這會令一個物種在進化上更具優勢嗎？
3. 為甚麼老化沒有在演化的過程被淘汰？或者說，它能被淘汰嗎？

《科言》歡迎讀者把想法分享至我們Facebook專頁。如果您想把想法在下一期向大家分享的話，亦歡迎發電郵至 *sciencefocus@ust.hk* 給我們。

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