Science Focus 科言

Issue 027, 2024

School of Science 理學院

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

Contents

Science Focus Issue 027, 2024

Message from the Editor-in-Chief 主編的話

Dear Readers,

Welcome to the summer edition of *Science Focus*! As always, we bring you amazing and sometimes unexpected discoveries through the ages.

Would you choose a natural tan from performing outdoor activities or a fake tan? In this issue, you can read about the science behind fake tan while sunbathing on the beach next time. You can also learn more about a surprising connection between bacteria in the gut and muscle mass, the discovery of a widely used anti-cancer drug, and the contribution of bacteria to an oxygenated atmosphere. For those of you who are budding physicists, we have articles on Enrico Fermi and the James Webb telescope.

Finally, I would like to thank those of you who have participated in this year's "Science in Lyrics" Writing Competition. The number of entries doubled! Many congratulations to our prize winners, and I am sure they will appreciate your comments and encouragements on Instagram.

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

親愛的讀者：

歡迎閱讀夏季的新一期《科言》！我們將一如至往地橫跨不同年代，呈上新奇而有時出乎意料的科學發現。

如果想擁有一身古銅色肌膚，你會選擇從事戶外活動還是使用美黑霜？下次到海灘不妨一邊曬著日光浴，一邊閱讀今期關於美黑霜的科學吧！此外，你也可以在今期認識到腸道細菌與肌肉質量之間意想不到的關聯，還有一種常用抗癌藥物的發現，以及細菌如何使大氣層充滿氧。我們亦為可能成為未來物理學家的你準備了關於恩里科・費米和詹姆斯・韋伯太空望遠鏡兩篇精彩文章。

最後，我要感謝參加了今年「歌詞與科學」寫作比賽的同學。承蒙大家支持，參賽人數是去年的一倍！在此恭喜各位得獎同學，亦相信他們會樂於閱讀大家在 Instagram 的留言和祝賀。

主編 麥晧怡教授
敬上

What's Happening in Hong Kong? 香港科技活動

"Science in Lyrics" Writing Competition 2024 – Result Announcement
「歌詞與科學」寫作比賽 2024 – 結果公佈

冠軍 Champion:	許家和 Xu Jiahe	♫ 凡星 — 陳蕾
亞軍 First Runner-Up:	黃可兒 Wong Ho Yee	♫ 52 赫茲 – KOLOR
季軍 Second Runner-Up:	張子軒 Cheung Tsz Hin	♫ august – Taylor Swift
優異獎 Honorable Mentions:	隥楚熙 Tang Chor Xi	♫ The Moss – Cosmo Sheldrake
	趙天朗 Chiu Tin Long	♫ 夜曲 — 周杰倫
	呂羅斯 Lv Luosi Moses	♫ Tongue Tied Twisted – Suit Up, Soldier

Visit our Instagram page for the winning entries. To check out what other songs the contestants have written on, scan the QR code for the Spotify playlist!

歡迎到《科言》Instagram 專頁查看得獎作品。想看看參賽者還以甚麼歌曲參賽嗎？掃瞄 QR 碼收聽今次比賽的 Spotify 播放清單！

Fun in Summer Science Activities 夏日科學好節目

Any plans for this summer? Check out the following event!

計劃好這個夏天的好去處了嗎？不妨考慮以下活動！

Antarctica 3D

The Hong Kong Space Museum is currently featuring the breathtaking 3D Dome Show *Antarctica 3D*, which takes viewers on an awe-inspiring journey through the coldest, driest, and windiest place on Earth. The documentary includes never-before-seen footage that showcases a vibrant underwater world beneath the ice, vast penguin colonies, and the largest congregation of whales ever filmed. However, the movie is not just a visual spectacle as it serves as a wake-up call to the urgent need to protect Antarctica's fragile ecosystem which is susceptible to global warming. Narrated by Benedict Cumberbatch, this fully immersive 3D Dome Show is not to be missed!

Period: Now – January 13, 2025
Time: 2:00 PM and 6:30 PM (Mon, Wed to Fri)
12:30 PM and 5:00 PM (Sat, Sun and public holiday)
Venue: Space Theatre, Hong Kong Space Museum
Admission fee: Standard admission: $32 (stalls), $24 (front stalls)
Concession admission: $16 (stalls), 12 (front stalls)

Remark: Please refer to the museum's website for more details.

極南之地3D

香港太空館現正上映令人嘆為觀止的立體球幕電影《極南之地 3D》。觀眾將踏上旅程，前往地球最冷、最乾、最大風的地方，感受大自然的奧妙。這套紀錄片將展示前所未見的片段，將冰下多采多姿的水底世界、龐大的企鵝群及史上拍攝到最大的鯨魚群盡顯眼前。然而這套電影並不單是一場視覺奇觀，更是提醒我們要保護南極脆弱生態，避免其受全球暖化進一步影響的當頭棒喝。不要錯過這個由 Benedict Cumberbatch 娓娓道來的沉浸式 3D 電影體驗！

展期： 現在至 2025 年 1 月 13 日
時間： 下午二時及六時半（一、三至五）
下午十二時半及五時（六、日及公眾假期）
地點： 香港太空館天象廳
入場費： 標準票：32 元（後座）；24 元（前座）
優惠票：16 元（後座）；12 元（前座）

備註：更多詳情請參閱太空館網頁。

The Great Oxidation Event: How Earth's Atmosphere Became Oxygen-Rich

大氧化事件：地球大氣層的氧從何而來

By Helen Wong 王思齊

The history of life on Earth saw many pivotal moments, but perhaps none, other than the origin of life itself, is more significant than the Great Oxidation Event (GOE). Marking the period when the early Earth's atmosphere started to fill with free oxygen, the GOE set the foundation for the rise of aerobic life and ultimately, present-day humans [1, 2].

Imagine traveling back to 4.5 billion years ago, when Earth had just formed. The atmosphere was vastly different from what we have today – it consisted of water vapor, carbon dioxide, and methane, but not oxygen. Consequently, the earliest life forms that emerged approximately 3.8 billion years ago were anaerobic.

But the entire game changed when a group of bacteria diverged from their anaerobic ancestors around 3.4 billion years ago [3, 4]. These unique microbes developed one of the most crucial innovations in the history of life on Earth – oxygenic photosynthesis – and evolved into what we now know as cyanobacteria (commonly called blue-green algae, although they are not technically algae) (Figure 1).

Figure 1 A stromatolite fossil of cyanobacteria. The layered structure was formed from mats of cyanobacteria.

圖一 屬於疊層石的藍綠菌化石，當中的層狀結構由多層藍綠菌堆疊而成。

Photo credit 圖片來源：James St. John [5]

Through oxygenic photosynthesis, oxygen was generated as a by-product of water splitting. Initially, the oxygen levels in the atmosphere remained low, as the first oxygen released into seawater by cyanobacteria was quickly sequestered by chemical reactions with other elements, such as iron [2] (Figure 2). Over a period of 200–300 million years [1], seawater oxygen levels gradually increased, possibly due to a rapid expansion of cyanobacterial populations [3, 4], until the accumulated oxygen began to escape into the atmosphere. The escaped oxygen displaced the abundant methane, kicking off the GOE that took place between 2.4 and 2.1 billion years ago [1].

Figure 2 Banded iron formation as evidence of the GOE. Iron (II) ions in the ocean are thought to be oxidized and precipitated as red iron (III) oxides in the GOE [6].

圖二 條狀鐵層是大氧化事件的證據之一。科學家認為在大氧化事件中，海洋中的鐵（II）離子被氧化並沉澱為紅色的氧化鐵（III）[6]。

Photo credit 圖片來源：Graeme Churchard [7]

The implications of an oxygenated atmosphere were immense for both Earth's climate and its inhabitants. Methane, a greenhouse gas, traps heat from sunlight and keeps the Earth warm enough for organisms to survive. Therefore, when methane was displaced by oxygen, global temperatures dropped, causing Earth to enter a series of ice ages known as the Huronian glaciation [8]. Meanwhile, ultraviolet radiation (UV) from the Sun split oxygen molecules (O_2) into individual atoms, which then reacted with other oxygen molecules to create ozone (O_3), forming the ozone layer that now protects life on Earth from harmful UV radiation.

The omnipresence of oxygen on Earth also fundamentally changed the planet's biological landscape. To the anaerobic bacteria and archaea of the time, oxygen was toxic. This led to a mass extinction in which most anaerobes were wiped out.

However, some survivors found ways to adapt and even thrive in the newly oxygen-rich environment. They developed ingenious solutions in terms of oxygen binding, aerobic respiration, and oxygen detoxification. To protect themselves from oxygen, these anaerobic organisms made use of certain proteins to bind oxygen and incorporate it into other molecules they need such as melanin [9]. Scientists believe that some of these ancient proteins eventually evolved into oxygen-transporting respiratory pigments found in animal blood today [9, 10]. For example, hemocyanin was likely derived from the oxygen-binding protein tyrosinase. These organisms also harnessed the power of oxygen as the terminal electron acceptor in respiration, which releases much more energy than anaerobic respiration. On the other hand, they evolved more effective versions of detoxifying enzymes, including superoxide dismutase and catalase (footnote 1), to deal with the harmful reactive oxygen species resulting from aerobic respiration [1].

For those unable to adapt, alternative strategies were employed. Some chose to remain in anaerobic environments, while others "acquired" the ability to perform aerobic respiration by engulfing smaller aerobically respiring cells, as suggested by the famous endosymbiotic theory [11, 12]. The latter gave rise to the ancestors of eukaryotic cells, with the engulfed aerobically respiring cells eventually becoming today's mitochondria.

And the story of cyanobacteria did not end with the GOE – the endosymbiotic theory also suggests that they were engulfed by early non-photosynthetic eukaryotes [11] and became chloroplasts in modern plants and algae.

1. Editor's note: Superoxide dismutase converts harmful superoxide radicals ($O_2^{\cdot-}$) to molecular oxygen (O_2) and hydrogen peroxide (H_2O_2). Catalase further converts H_2O_2 to O_2 and water.

地球生命史有著許多關鍵時刻，但也許除了生命起源本身，沒有一件大事較大氧化事件（The Great Oxidation Event / GOE）的影響更為深遠。大氧化事件標誌著早期地球大氣層開始充滿遊離氧的時期，為需氧生物的出現以及最終現代人類興起奠定了基礎 [1, 2]。

試想像回到 45 億年前地球剛形成的時候，當時的大氣層與我們今天擁有的截然不同 — 它由水蒸氣、二氧化碳和甲烷組成，但不含氧氣。因此，最早約於 38 億年前出現的生物均是厭氧生物。

但在大約 34 億年前，一群細菌從這些厭氧祖先分化出一個分支，改變了整個局面 [3, 4]。這些獨特的微生物發展出地球生命史上其中一種最創新的能力 — 以光合作用製造氧氣，而這些微生物最終演化成我們現在熟知的藍綠菌（通常被稱作藍綠藻，但它們在分類上並不屬於藻類）（圖一）。

氧氣是產氧光合作用中，水的光解所產生的副產物。起初，由於藍綠菌釋放到海水中的氧很快就因與鐵等元素產生化學反應而被耗用（圖二），所以大氣中的氧氣含量一直維持於低水平 [2]。但在隨後兩三億年間 [1]，大概因為藍綠菌種群快速擴張，導致海水的氧含量逐漸增加 [3, 4]，最終令累積的氧氣逃逸到大氣中。這些逸出的氧氣取代了大氣中的甲烷，為發生於 21 至 24 億年前的大氧化事件揭開序幕 [1]。

有了氧氣的大氣層為地球氣候及棲息生物帶來深遠的影響。甲烷是一種溫室氣體，能困住從太陽而來的熱，使地球保持在能孕育生命的適當溫度。因此，當甲烷被氧氣取代時，全球氣溫下降，導致地球進入一系列冰河時期，史稱休倫冰川時期（Huronian glaciation）[8]。與此同時，來自太陽的紫外線將部分氧分子（O_2）分解成氧原子，這些氧原子進而與其他氧分子發生反應產生臭氧（O_3），最終形成今天保護地球生物免受紫外線侵害的臭氧層。

無處不在的氧亦徹底改變地球的生物景觀。對於當時的厭氧細菌和古細菌來說，氧無疑是一種劇毒，因此帶氧的大氣層引發了一場大滅絕，當中厭氧生物幾乎被殲滅。

然而，倖存者在富氧的新環境裡找到生存之道。它們在與氧結合、有氧呼吸和氧解毒（oxygen detoxification）等方面均發展出巧妙的對應方案。為了保護自身免受氧的侵害，這些厭氧生物使用特定蛋白質抓住氧，並將其併入黑色素等它們本身就需要的生物分子裡 [9]。科學家認為今天動物血液中負責輸送氧的呼吸色素正是演化自這些遠古的蛋白質 [9, 10]，例如血藍蛋白很可能演化自能與氧結合的酪胺酸酶。另一方面，這些生物亦透過利用氧作為需氧呼吸中的最終電子受體，獲得比缺氧呼吸多很多的能量。它們還演化出更有效的解毒酶，例如過氧化物歧化酶和過氧化氫酶（註一），以處理需氧呼吸產生的有害活性含氧物 [1]。

至於無法適應新環境的生物則另闢蹊徑。它們有些選擇留在無氧環境中，有些則如著名內共生學說所提出的，透過吞噬較小但又能進行需氧呼吸的細胞，藉此獲得進行需氧呼吸的能力 [11, 12]。後者最終演化成真核細胞的始祖，而被吞噬的需氧呼吸細胞則成為了今天的線粒體。

等等，藍綠菌的故事並沒有隨著大氧化事件落幕而結束 — 內共生學說亦提出藍綠菌由於被不能進行光合作用的早期真核生物吞噬 [11]，最終演化為現代植物和藻類中的葉綠體。

1 編按：過氧化物歧化酶將有害的過氧自由基（$O_2^{\bullet -}$）轉化為氧分子（O_2）和過氧化氫（H_2O_2）。過氧化氫酶則進一步將 H_2O_2 轉化為 O_2 和水。

Related Article 延伸閱讀

Check out the following articles to learn more about mitochondria!

閱讀以下《科言》文章以了解更多關於線粒體的有趣知識！

Mitochondria: So Much More Than the Powerhouses of the Cell (Issue 020)
線粒體：遠不只是細胞的發電站（第二十期）

References 參考資料：

[1] Aiyer, K. (2022, February 18). *The Great Oxidation Event: How Cyanobacteria Changed Life.* American Society for Microbiology. *https://asm.org/Articles/2022/February/The-Great-Oxidation-Event-How-Cyanobacteria-Change*

[2] Blaustein, R. (2016). The Great Oxidation Event: Evolving understandings of how oxygenic life on Earth began. *BioScience, 66*(3), 189–195. *https://doi.org/10.1093/biosci/biv193*

[3] Chu, J. (2021, September 28). *Zeroing in on the origins of Earth's "Single most important evolutionary innovation".* MIT News. *https://news.mit.edu/2021/photosynthesis-evolution-origins-0928*

[4] Fournier, G. P., Moore, K. R., Rangel, L. T., Payette, J. G., Momper, L., & Bosak, T. (2021). The Archean origin of oxygenic photosynthesis and extant cyanobacterial lineages. *Proceedings of the Royal Society B: Biological Sciences, 288*(1959). *https://doi.org/10.1098/rspb.2021.0675*

[5] St. John, J. (n.d.). *STROMATOLITE* [Photograph]. *http://www.jsjgeology.net/Stromatolite.htm*

[6] The Stephen Hui Geological Museum. (n.d.). O_2 - Free Atmosphere - Banded Iron formation. *https://www.earthsciences.hku.hk/shmuseum/earth_evo_03_arc04_3.php*

[7] Churchard, G. (2014, January 24). *Dales Gorge* [Photograph]. Flickr. *https://www.flickr.com/photos/graeme/12116315164/*

[8] Bekker, A. (2015). Huronian Glaciation. In Gargaud, M., et al. (Eds.), *Encyclopedia of Astrobiology* (2nd ed.). Springer Berlin. *https://doi.org/10.1007/978-3-662-44185-5_742*

[9] Lutz, D. (2010, February). The Many Colors of Blood. *ChemMatters. https://teachchemistry.org/chemmatters/february-2010/the-many-colors-of-blood*

[10] van Holde, K. E., Miller, K. I., & Decker, H. (2001). Hemocyanins and Invertebrate Evolution. *Journal of Biological Chemistry, 276*(19), 15563–15566. *https://doi.org/10.1074/jbc.r100010200*

[11] Archibald, J. M. (2015). Endosymbiosis and Eukaryotic Cell Evolution. *Current Biology, 25*(19), R911-R921. *https://doi.org/10.1016/j.cub.2015.07.055*

[12] Sessions, A. L., Doughty, D. M., Welander, P. V., Summons, R. E., & Newman, D. K. (2009). The Continuing Puzzle of the Great Oxidation Event. *Current Biology, 19*(14). *https://doi.org/10.1016/j.cub.2009.05.054*

A Lucky Strike: Rediscovery of an Anti-Cancer Drug by Barnett Rosenberg

把握機遇： Barnett Rosenberg的抗癌藥物大發現

By Daria Zaitseva

Some scientific discoveries would not happen if it was not for luck. An apple falling next to Newton led to the notion of gravitation [1]; Roentgen's investigation into the mysteriously glowing little screen in his laboratory resulted in the discovery of X-ray [2]. Serendipitous discoveries are never lacking in the history of science. This article reveals yet another unintentional but life-saving discovery, or more precisely – the rediscovery of cisplatin by Barnett Rosenberg.

Rosenberg graduated from Brooklyn College with a bachelor's degree in physics in 1948, and obtained his master's and doctorate degrees in physics from New York University in 1950 and 1955 respectively [3]. Being trained as a physicist allowed him to come up with insights that may not be obvious to biologists: He noticed how the mitotic spindle in a dividing cell look like the electric field lines between two opposite charges (or the magnetic field lines between two opposite poles) (Figure 1). Is it just a coincidence? Or does electromagnetism have to do with cell division?

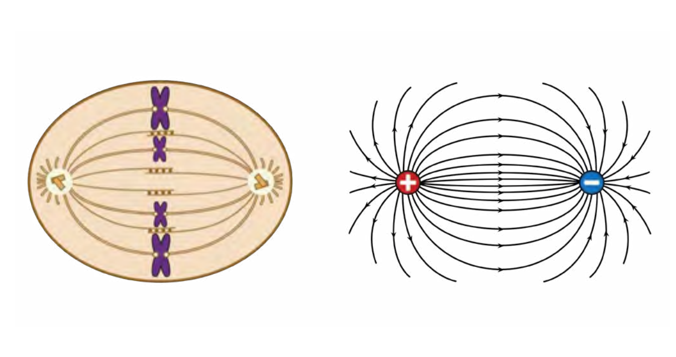


Figure 1 A dividing cell with chromosomes attached to the mitotic spindle (left) and the electric field lines between two opposite charges (right).

In 1965, Rosenberg tested his unusual idea on the bacteria *Escherichia coli* [4, 5], although it did not rely on the formation of mitotic spindle for cell division. Using platinum electrodes which were supposed to be both biologically and chemically inert, he sent a current through the bacterial solution containing ammonium chloride as a pH buffer [6]. Whatever his predictions had been, the results were simply mind-blowing. The microorganisms did not divide faster; instead, they stretched as if they wanted to divide but failed to do so. Their length increased up to 300 times compared to their normal size [7]! So, Rosenberg thought the current did affect cell division.

Nevertheless, this is not true. Over the next two years, Rosenberg found that it was not the electricity that stopped the cell division, but the chemical compound cisplatin (Figure 2) produced in the reaction [4, 5]. Cisplatin had already been discovered by the Italian chemist Michele Peyrone in 1854, but was not studied much until Rosenberg's rediscovery [4]. Together with many new substances which had the ability to inhibit cell proliferation, cisplatin was considered as a drug candidate for chemotherapy [4].

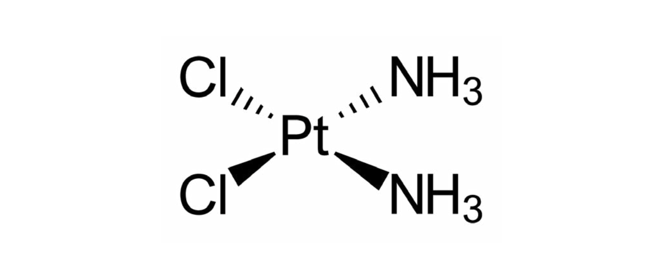


Figure 2 Chemical structure of cisplatin.

In 1969, Rosenberg's lab published the promising results on the antitumor property of cisplatin in mice [3, 8]. Then clinical trials followed. At first, it caused a public shock as heavy metal compounds were believed to be extremely toxic [4, 5]. Despite so, cisplatin turned out to be effective for many types of cancer when used in combination with other medications [4], especially for testicular cancer which had no known effective drug at that time [9]. In 1978, cisplatin was approved by the Food and Drug Administration (FDA) in the US, followed by other countries [4]. It remains as one of the key medicines for cancer treatment today [10].

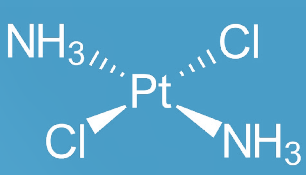
Modern research shed light on how cisplatin works. Cisplatin inhibits DNA replication mainly by "tying" (or, forming crosslinks between) two purine bases (adenine and guanine) on the same strand together [11, 12], which eventually leads to failure in cell division and apoptotic cell death [11]. From the non-specific mode of action of cisplatin, it can also harm actively dividing cells in normal tissues, such as the intestine, thus causing severe side effects [13]. This partly explains why researchers were looking for new generations of platinum-based drugs. Notably, carboplatin entered the market in 1989 with a much lower systemic toxicity [5, 13, 14], and oxaliplatin was approved in 1994 with a high efficacy against colon cancer [5, 14]. Thanks to the Rosenberg's serendipitous rediscovery, an array of platinum-based drugs was made available and saved the lives of many cancer patients.

The rediscovery of cisplatin was an extremely lucky combination of events. Yet, it was also the open mindset and curiosity of Rosenberg that brought this fundamental discovery to all of us. The story of cisplatin also serves as a reminder of how multiple scientific fields can powerfully intertwine, as there is no actual boundary between chemistry, physics and biology.

Chance favors only the prepared mind. Was it luck or a good grip? You decide for yourselves.

Fun fact: Is there transplatin?

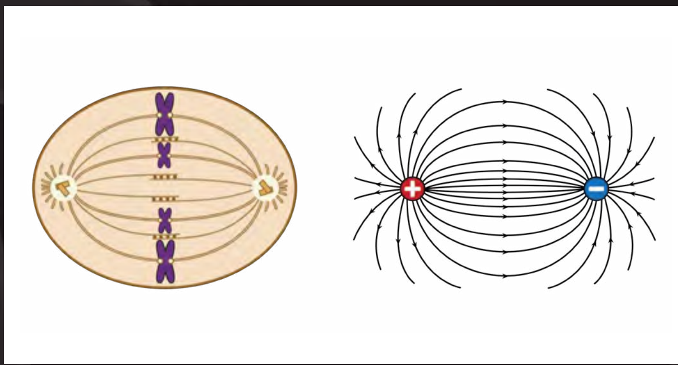
Yes, it is a stereoisomer of cisplatin with no anti-tumor activity [4].



transplatin

如果不是運氣，有些科學發現就不會發生：蘋果落在牛頓身旁使他想到萬有引力 [1]，Roentgen 對他實驗室裡神秘發光小屏幕的調查最終使他發現了 X 射線 [2]。科學史上從不乏偶然遇上的驚喜。本文將介紹另一個無意中的發現，它拯救了無數生命 — 這是 Barnett Rosenberg 對順鉑（cisplatin）的二次發現。

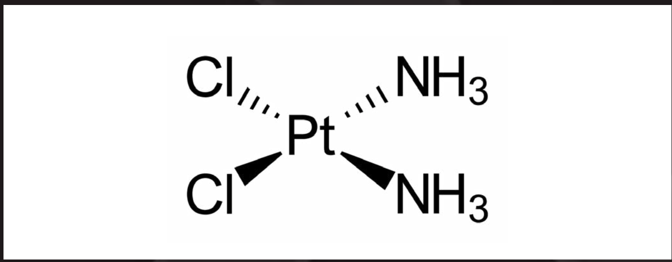
Rosenberg 於 1948 年從布魯克林學院取得物理學學士學位，並分別於 1950 和 1955 年從紐約大學獲得物理學碩士和博士學位 [3]。由於他一直接受物理學訓練，使他能提出生物學家未必能想到的獨特見解：他注意到細胞分裂中的有絲紡錘體看起來就像兩個相反電荷之間的電場線（或兩個相反極性之間的磁場線）（圖一）。這只是巧合嗎？還是電磁學與細胞分裂有關？



圖一　分裂中的細胞，當中有絲紡錘體與染色體連接（左）和兩個相反電荷之間的電場線（右）

儘管大腸桿菌（*Escherichia coli*）並不使用有絲紡錘體來進行細胞分裂，Rosenberg 還是於 1965 年在大腸桿菌上試驗了他這個不尋常的想法 [4, 5]。他使用了在生物和化學上也被認為是具惰性的鉑電極，向以氯化銨作為 pH 緩衝劑的細菌溶液傳送電流 [6]。不管他原來的預測結果是甚麼，他也不會猜到接下來的事情：微生物並沒有分裂得更快；反而，它們全部呈現被拉長，彷彿想分裂但不能成功的樣子。與正常大小相比，它們的長度增加了足足 300 倍 [7]！因此，Rosenberg 認為是電流影響了細胞分裂。

然而，這不是正確的結論。在接下來的兩年，Rosenberg 發現阻礙細胞分裂的不是電流，而是在反應中產生的順鉑（圖二）[4, 5]。這種化合物早於 1854 年已被意大利化學家 Michele Peyrone 發現，但在 Rosenberg 二次發現前並沒有人對其作出過深入研究 [4]。與當時許多具有抑制細胞分裂能力的新物質一樣，順鉑被視為化療的候選藥物之一 [4]。



圖二 順鉑的化學結構

1969 年,Rosenberg 的實驗室發表了有關順鉑在小鼠中具抗腫瘤特性的結果 [3, 8],臨床試驗也隨即展開。起初,它震驚了社會大眾,因為重金屬化合物被認為是具劇毒的物質 [4, 5]。儘管如此,當與其他藥物結合使用時,順鉑對不同類型癌症皆宣告有效,特別是當時沒有有效藥物治療的睾丸癌 [9]。1978 年,順鉑被美國食品及藥物管理局(FDA)批准使用,在其他國家也相繼獲得許可 [4]。它至今仍是治療癌症的關鍵藥物之一 [10]。

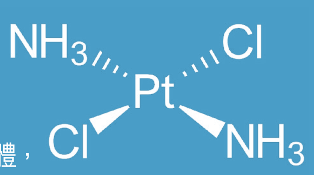
近年研究揭示了順鉑的運作原理,它主要透過「綁住」(更準確地說是使其形成交聯)同一條 DNA 鏈上的兩個嘌呤鹼基(腺嘌呤和鳥嘌呤)來抑制 DNA 複製 [11, 12],最終導致細胞分裂失敗及細胞凋亡 [11]。從順鉑無差別的運作方式來看,它同時亦會影響正常組織中經常需要分裂的細胞,例如腸道內的細胞,引起嚴重副作用 [13]。這在某程度上解釋了為甚麼研究人員在尋找新一代的鉑藥物。對身體毒性較低的卡鉑(carboplatin)在 1989 年進入市場 [5, 13, 14],對結腸癌尤其有效的奧沙利鉑(oxaliplatin)則在 1994 年被批准使用 [5, 14]。Rosenberg 的偶然發現最終使一系列鉑藥物得以問世,拯救了無數癌症患者的生命。

雖然順鉑的二次發現的確是由許多巧合交織而成,但正是 Rosenberg 勇於接受新觀點的心態和強烈的好奇心使他能將這重要發現帶給所有人。順鉑的故事亦提醒我們化學、物理和生物之間並沒有實質界限,不同科學領域的緊密合作可以帶來意想不到的重要成果。

機會只留給有準備的人。這是單純的運氣嗎?你自己決定吧。

知多一點點:有順鉑,有沒有反鉑(transplatin)?

有,它是順鉑的立體異構體,但沒有抗腫瘤活性 [4]。



反鉑

References 參考資料:

[1] Gefter, A. (2010, January 18). Newton's apple: The real story. *New Scientist. https://www.newscientist.com/article/2170052-newtons-apple-the-real-story/*

[2] This Month in Physics History – November 8, 1895: Roentgen's Discovery of X-Rays. (2001, November). *APS News, 10*(10), 2.

[3] Hoeschele, J. D. (2014). Biography of Professor Barnett Rosenberg: A Tribute to His Life and His Achievements. *Anticancer Research, 34*(1), 417–421.

[4] Barnett Rosenberg i ego schastlivyj sluchaj [Barnett Rosenberg and his lucky case]. (2021). Kvantik, 6. *https://elementy.ru/nauchno-populyarnaya_biblioteka/436262/Barnett_Rozenberg_i_ego_schastlivyy_sluchay*

[5] National Cancer Institute. (2014, May 30). *The "Accidental" Cure—Platinum-based Treatment for Cancer: The Discovery of Cisplatin. https://www.cancer.gov/research/progress/discovery/cisplatin*

[6] Department of Chemistry, College of Natural Science, Michigan State University. (n.d.). Barney Rosenberg. *https://www.chemistry.msu.edu/faculty-research/portraits/rosenberg-barney.aspx*

[7] Rosenberg, B., Van Camp, L., & Krigas, T. (1965). Inhibition of Cell Division in *Escherichia coli* by Electrolysis Products from a Platinum Electrode. *Nature, 205*(4972), 698–699. *https://doi.org/10.1038/205698a0*

[8] Rosenberg, B., Van Camp, L., Trosko, J. E., & Mansour, V. H. (1969). Platinum Compounds: a New Class of Potent Antitumour Agents. *Nature, 222*(5191), 385–386. *https://doi.org/10.1038/222385a0*

[9] In remembrance of Barnett Rosenberg. (2009). *Dalton Transactions*, (48), 10648–10650. *https://doi.org/10.1039/B918993A*

[10] Gandin, V., Hoeschele, J. D., & Margiotta, N. (2023). Special Issue "Cisplatin in Cancer Therapy: Molecular Mechanisms of Action 3.0". *International Journal of Molecular Sciences, 24*(9), 7917. *https://doi.org/10.3390/ijms24097917*

[11] Tchounwou, P. B., Dasari, S., Noubissi, F. K., Ray, P., & Kumar, S. (2021). Advances in Our Understanding of the Molecular Mechanisms of Action of Cisplatin in Cancer Therapy. *Journal of Experimental Pharmacology, 13*, 303–328. *https://doi.org/10.2147/JEP.S267383*

[12] Imai, R., Komeda, S., Shimura, M., Tamura, S., Matsuyama, S., Nishimura, K., Rogge, R., Matsunaga, A., Hiratani, I., Takata, H., Uemura, M., Iida, Y., Yoshikawa, Y., Hansen, J. C., Yamauchi, K., Kanemaki, M. T., & Maeshima, K. (2016). Chromatin folding and DNA replication inhibition mediated by a highly antitumor-active tetrazolato-bridged dinuclear platinum(II) complex. Scientific Reports, *6*. *https://doi.org/10.1038/srep24712*

[13] Zhang, C., Xu, C., Gao, X., & Yao, Q. (2022). Platinum-based drugs for cancer therapy and anti-tumor strategies. *Theranostics, 12*(5), 2115–2132. *https://doi.org/10.7150/thno.69424*

[14] Monneret, C. (2011). Platinum anticancer drugs. From serendipity to rational design. *Annales Pharmaceutiques Françaises, 69*(6), 286–295. *https://doi.org/10.1016/j.pharma.2011.10.001*

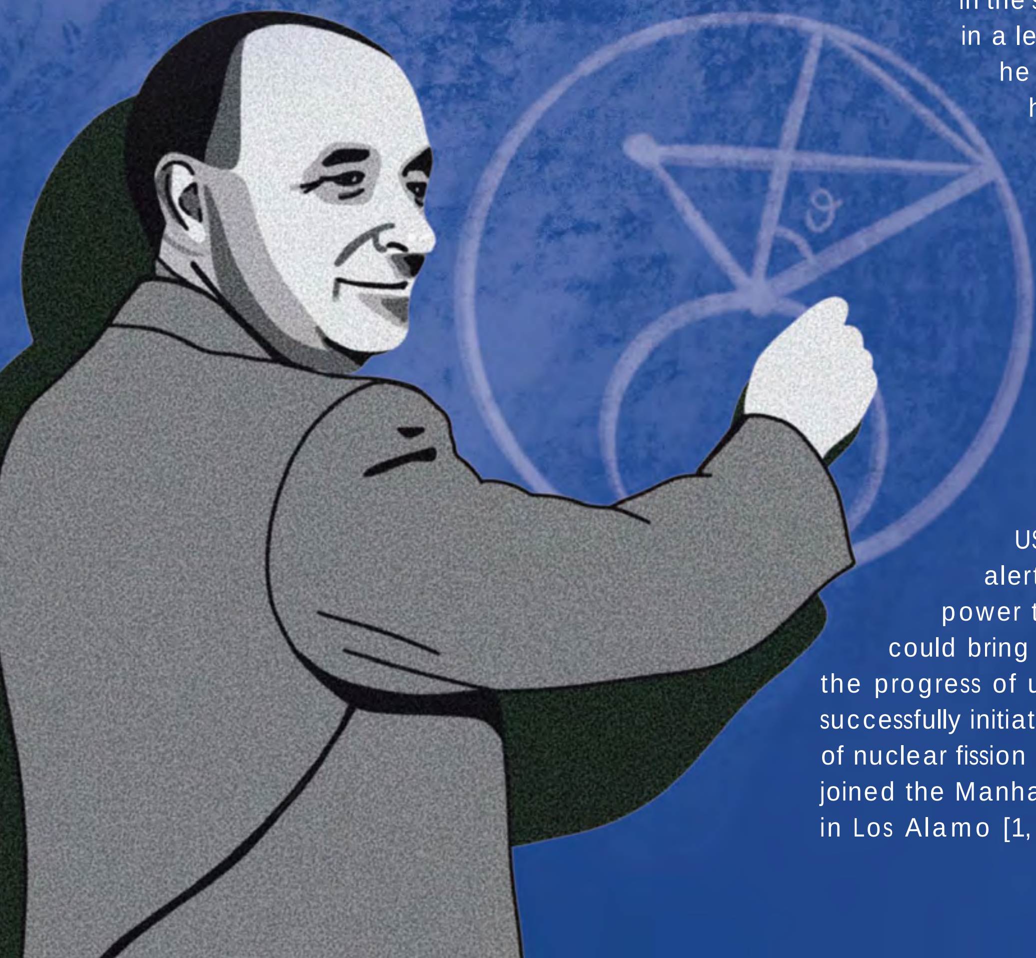
Enrico Fermi: FATHER OF THE NUCLEAR AGE

恩里科・費米：核子時代之父

By Minnie Soo 蘇慧音

The 20th century was a golden era for physics, with brilliant minds pushing the boundaries of scientific innovation. Prominent physicists include Albert Einstein, Werner Heisenberg, Niels Bohr, Richard Feynman, and one must not forget the legendary Enrico Fermi, a giant in the history of nuclear physics.

When we think of the word "Fermi", a whole array of related notions comes to mind. Fermilab, a renowned scientific institution dedicated to the study of particle physics; fermions, particles with an odd half-integer spin such as electrons; Fermi's Paradox, a perplexing conundrum which challenges the possibilities of existence of extraterrestrial life. The use of such nomenclature highlights Fermi's contributions and status in the scientific community.



Enrico Fermi and the Atomic Bomb

Enrico Fermi is a consequential contributor to the atomic bomb launched on Hiroshima and Nagasaki. He was burdened with no less responsibility than J. Robert Oppenheimer, the leading scientist in the Manhattan Project [1].

The story started with racial discrimination in Fascist Italy. In 1938, the establishment of antisemitic policies by Mussolini [2] posed a significant threat to Fermi particularly because his wife is of Jewish heritage [3, 4]. When Fermi was awarded the 1938 Nobel Prize in Physics at the age of 37, he took this opportunity to go directly from Stockholm, the place where he received the award, to the United States and never returned to Italy [5, 6].

In the summer of 1939, Fermi met Heisenberg in a lecture tour in the States, during which he tried to convince Heisenberg to join him at the physics faculty of Columbia University [7]. However, to his bafflement, Heisenberg decided to head back and serve the Nazi's project to build an atomic bomb [7]. Disappointment in this unsuccessful recruitment has evolved into a fear that, with the great mind of Heisenberg, the Nazis would succeed in developing the atomic bomb and win the war. While the scientists in the US were making continuous efforts to alert the government to the destructive power that uranium fission chain reactions could bring [8], they teamed up to push forward the progress of uranium research [9]. In 1942, Fermi successfully initiated the first controlled chain reaction of nuclear fission [6]. As World War II progressed, Fermi joined the Manhattan Project as an associate director in Los Alamo [1, 4]. In three years, the first atomic bomb was built and dropped on Hiroshima, causing numerous deaths and catastrophic damage.

The Chicago Pile Experiment

As for the invention of the atomic bomb, one must mention the breakthrough in the Chicago Pile experiment. On a chilly winter day in 1942, Fermi and his colleagues placed a 6.1-meter wide by 7.6-meter high pile of graphite bricks with 6 tons of uranium metal and 40 tons of uranium-235 in the squash court under the University of Chicago football field, together with cadmium rods [1, 6, 10, 11].

The theory behind the experiment is as follows. As a neutron hits a uranium-235 atom, the latter splits into two smaller atoms and releases energy [6, 12]. This fission reaction also releases neutrons as by-products to split other uranium-235 atoms, resulting in a chain reaction to unleash gargantuan amounts of energy [6, 12]. For each mole of uranium-235 that goes under fission, the resulting products weigh approximately 0.2 grams less than the reactants [13]. By the famous equation $E = mc^2$, this loss in mass corresponds to the conversion of order of 10^{13} joules of energy. In fact, the fission reaction of one kilogram of uranium-235 produces energy that is 2.5 million times greater than the energy generated by burning one kilogram of coal [13]. Therefore, for the reaction to be controllable, cadmium rods were inserted to absorb some neutrons during the reaction, thereby controlling the reaction rate and the amount of energy produced [6]. If Fermi's calculations had been wrong and the cadmium rods had been insufficient to control the reaction, catastrophic amount of energies could have been unleashed, potentially destroying half of Chicago [6]. Fortunately, the experiment turned out to be a success, creating the first controlled, self-sustaining nuclear chain reaction. The pile was later refined by a substantial reduction in size, which made the controlled nuclear chain reaction possible to be incorporated into an atomic bomb that is small enough to be carried in an airplane.

A Mistake in Fermi's Nobel Prize

The Nobel Prize is widely regarded as one of the most prestigious awards in the scientific community. Consequently, Fermi was rightfully honored with this esteemed recognition. However, there was a critical mistake concerning the scientific discovery for which Fermi received the award [14].

This is actually a story about Fermi discovering nuclear fission without realizing it. In 1938, Fermi was granted the Nobel Prize "for his demonstrations of the existence of new radioactive elements produced by neutron irradiation, and for his related discovery of nuclear reactions brought about by slow neutrons [15]." At that time, the known heaviest element was uranium with an atomic number of 92. It was believed that Fermi had successfully produced transuranic (beyond uranium) elements with atomic numbers 93 and 94 by bombarding uranium with slow moving neutrons. They called the new elements Ausenium and Heperium, respectively. However, German chemists Otto Hahn and Fritz Strassmann subsequently made a pivotal discovery that the elements produced through uranium bombardment were not novel entities, but lighter elements like barium with an atomic number of 56 [14]. In fact, uranium split into two lighter elements upon neutron bombardment, through a reaction later known as nuclear fission. Based on the discovery of nuclear fission, Hahn was awarded the Nobel Prize in Chemistry in 1944 [16]. As for the actual elements 93 and 94, they were eventually created in 1940, and named neptunium and plutonium [17].

Fermi's Paradox

One question that bugged scientists, including an intelligent physicist like Fermi, is the possible existence of extraterrestrial creatures, a.k.a. aliens. From geocentrism to realizing that we are not the center of the universe, from thinking that the Milky Way was all that there was to discovering that there are billions of galaxies [18], we should be wise enough to know that we are not special in the vast universe. Fermi proposed that if we are not unique and the Earth is young compared to the copious stars and planets out there, extraterrestrial civilizations should have evolved and colonized nearby galaxies by now [19]. Yet, where did everyone go? Before making further discoveries on this subject, Fermi died in 1954, and the question fell to other scientists. Despite ongoing research and numerous papers being published on this topic, the question remains unresolved and highly debatable.

Fermi Problem

During the Trinity Test, the first detonation of the atomic bomb in history, Fermi tore paper into scraps and threw them from a height of 1.83 meters [20]. While standing 16 kilometers away from the explosion site [21], he utilized their displacement shift of 2.5 meters to estimate the energy produced by the detonation through a series of deductions and calculations. Fermi's estimate (10 kilotons of T.N.T.) was within the same order of magnitude of the true value (21 kilotons of T.N.T.) despite employing what initially seemed like an unrelated method. This led to the emergence of a new class of problems known as the Fermi problems, to be solved using this estimation method to approximate the order of magnitude of values when our knowledge is limited. It involves making educated guesses by breaking down complex problems to simpler components, with reasonable assumptions.

20 世紀是物理學的黃金時代，誕生了許多將科學推向嶄新領域的傑出科學家，其中包括阿爾伯特・愛因斯坦（Albert Einstein）、維爾納・海森堡（Werner Heisenberg）、尼爾斯・玻爾（Niels Bohr）和理查德・費曼（Richard Feynman）等物理學巨匠，但在這眾多科學巨擘中，我們不能忽視另一位同等傑出的核子物理學傳奇 —— 恩里科・費米 （Enrico Fermi）。

提起「費米」，人們會聯想到許多與之相關的重要概念和成就，例如費米實驗室 —— 專門研究粒子物理學的著名科學機構；費米子 —— 包括電子在內具奇數半整數自旋的粒子；以及費米悖論 —— 試圖推斷外星生命存在可能性的千古難題。從各種以費米命名的例子就能充分體現他在科學界無可替代的貢獻和卓越地位。

恩里科・費米與原子彈

恩里科・費米可算是有份研發出在廣島和長崎引爆的原子彈，要說的話其責任不次於曼哈頓計劃的首席科學家 J・羅伯特・奧本海默（J. Robert Oppenheimer）[1]。

故事始於法西斯意大利的種族歧視政策。墨索里尼於 1938 年頒布的反猶太政策 [2] 為妻子擁有猶太血統的費米帶來了切身威脅 [3, 4]。因此在同一年，費米以 37 歲之齡獲得諾貝爾物理學獎的同時，就由領獎地斯德哥爾摩直接前往美國，再也沒有回到意大利 [5, 6]。

1939 年夏天，費米在海森堡於美國進行巡迴演講時遇見他，並試圖說服他加入哥倫比亞大學物理學系一起共事 [7]，但最令費米費解的是海森堡竟然決定返回德國，為納粹德國的原子彈計劃效力 [7]。這次招攬失敗所帶來的失望最終演化成眾人的驚恐，擔心納粹最終能憑藉海森堡的機智頭腦搶先研發出原子彈，從而贏得戰爭。美國科學家在不斷提醒政府鈾裂變鏈鎖反應可能帶來的毀滅性威力同時 [8]，眾人亦決定團結起來全力加速推進鈾研究 [9]。1942 年，費米成功進行了史上第一次受控的核裂變鏈式反應 [6]。隨著第二次世界大戰的發展，費米加入了曼哈頓計劃，成為洛斯阿拉莫斯國家實驗室的副總監 [1, 4]。三年後，第一枚原子彈研發完成，被投放到廣島，造成大規模死亡和災難性的破壞。

芝加哥堆實驗

談到原子彈的發明，我們必須提及芝加哥堆實驗所帶來的突破。在 1942 年的一個寒冷冬日，費米和同事在芝加哥大學欖球場下的壁球場中放置了一座 6.1 米寬、7.6 米高的石墨磚堆，當中含有六噸鈾金屬和 40 噸鈾 -235，還有一些鎘棒 [1, 6, 10, 11]。

實驗原理是這樣的：當中子撞擊鈾 -235 原子時，後者會裂變成兩顆較小的原子並釋放能量 [6, 12]。這個裂變反應亦會釋出更多中子作為副產物，分裂其他鈾 -235 原子，從而引發連鎖反應，釋放巨大能量 [6, 12]。每摩爾鈾 -235 進行裂變後，產物的總重量會比反應前輕約 0.2 克 [13]。根據著名方程式 $E = mc^2$，上述物質質量的減少能轉化成約 10^{13} 焦耳的能量。事實上，一公斤鈾 -235 經裂變反應所產生的能量，比燃燒一公斤煤所產生的能量高出 250 萬倍 [13]。因此，為了使反應能受到控制，他們在實驗堆裡放入鎘棒，吸收反應中的一些中子，以控制反應速率和產生的能量 [6]。如果費米的計算出現錯誤或鎘棒不足以減慢反應，釋放的巨大能量甚至可以摧毀半個芝加哥 [6]。幸好實驗取得了空前成功，實現了史上首個受控、自我持續的核鏈鎖反應。科學家及後再對反應堆設計作大幅改良，大大減少了其體積，使受控的核鏈鎖反應能應用於體積小至可以用飛機承載的原子彈內。

費米諾貝爾獎的一個錯誤

諾貝爾獎是科學界最崇高的獎項之一，費米亦無容置疑地值得擁有這個卓越殊榮。但實際上，費米因著一個後來證明是錯誤的科學發現而獲獎 [14]。

這其實是一個關於費米發現了核裂變卻不自知的故事。1938 年，費米因「發現以中子撞擊所產生的新放射性元素，以及慢中子引發的核反應」獲得諾貝爾獎 [15]。那時已知的最重元素是原子序數為 92 的鈾，而科學界普遍相信費米成功透過以緩慢移動的中子撞擊鈾，製造出原子序數為 93 和 94 的超鈾（鈾外）元素，費米和同事當時分別把新元素命名為 Ausenium 和 Heperium。可是，德國化學家奧托・哈恩（Otto Hahn）和弗里茨・斯特拉斯曼（Fritz Strassmann）其後作出了一個關鍵性的發現，證明在費米的實驗中，鈾經過撞擊後所產生的元素並不是新元素，而是原子序數為 56 的鋇等較輕的元素 [14]。事實上，鈾在中子撞擊下分裂成兩個較輕的元素 —— 這個反應後來被稱為核裂變。基於核裂變的發現，哈恩在 1944 年獲得諾貝爾化學獎 [16]；至於其後在 1940 年成功被製造的真實元素 93 和 94，它們被正式命名為鎿（neptunium）和鈈（plutonium）[17]。

費米悖論

有一個問題一直困擾科學家，即使像費米如此聰明的物理學家也深受困擾，那就是外星生物存在的可能性 —— 對，我們指的是外星人！從地心說到意識到我們並非身處宇宙中心；從認為銀河系就是宇宙的全部，到發現宇宙其實擁有數十億個星系 [18]，我們至今應該知道，在這廣闊無垠的宇宙中，我們並非特殊的一群。費米曾提出，如果我們的地位並非超然，而地球與無數恆星和行星相比下亦算年輕，那麼外星文明應該早已演化並在附近星系殖民 [19]。然而，外星人呢？遺憾的是在這個問題有進一步發現之前，費米就已於 1954 年逝世，疑問只好留給後世科學家解答了。儘管科學家仍就這個範疇進行研究，亦有發表大量論文，但這個問題至今仍未得到解決，並存在廣泛爭議。

費米問題

在人類首次引爆原子彈的「三位一體」（Trinity Test）核試中，費米把紙張撕成碎屑，然後從 1.83 米的高度扔出紙屑 [20]。在距離爆炸點 16 公里的地方 [21]，他觀察到紙屑移動了約 2.5 米，利用這項資訊結合一系列推斷和計算，他嘗試估算爆炸釋放的能量。雖然他採取了看似風馬牛不

相及的行為，但費米的估計值(10,000 噸 T.N.T. 炸藥)與真實值(21,000 噸 T.N.T. 炸藥)非常接近，甚至屬於同一數量級。這使人們把此類問題定義為「費米問題」，在資訊有限的情況下，估計其答案的數量級。過程涉及將複雜問題分解為多個簡單部分，在一些合理假設下，進行有根據的猜測。

Physics Books in HKUST Library
科大圖書館裡的物理書

To get a sense of this estimation method, let's try to solve this problem: What is the order of magnitude of the number of physics books (including e-books) in the HKUST Library?

讓我們嘗試用「費米估算」的方法解答以下問題：哪個是香港科技大學圖書館物理學書藏（包括電子書）數量的數量級？

A) 10 B) 100 C) 1,000 D) 10,000

This is an open-ended question. You are free to tackle the problem in your own way, and make any useful assumptions, e.g. science books can be generally divided into four subjects. A basic fact: The six-story HKUST Library has a collection of 2,442,592 books (including e-books).

這是一道開放式問題，你可以用自己的方法解題，隨意作任何有用的假設，譬如假設科學書大致可以分成四個科目等。以下一項基本資訊：科大圖書館是個有合共六層的圖書館，共收藏2,442,592本書（包括電子書）。

Example solution: 題解一例：

References 參考資料：

[1] Badash, L. (2024, April 12). *American career of Enrico Fermi*. Encyclopædia Britannica. *https://www.britannica.com/biography/Enrico-Fermi/American-career*

[2] Burgwyn, H. J. (2018). Persecution of the Jews. In *Mussolini and the Salò Republic, 1943–1945* (pp. 141-164). Palgrave Macmillan Cham. *https://doi.org/10.1007/978-3-319-76189-3_8*

[3] Goodchild, P. (1986, August 10). Time Bomb!FERMI, HEISENBERG, AND THE RACE FOR THE ATOMIC BOMB by Malcolm C. MacPherson (Dutton: $18.95; 293 pp., illustrated). *Los Angeles Times*. *https://www.latimes.com/archives/la-xpm-1986-08-10-bk-2027-story.html*

[4] Whitacre, M., & Belotti, A. (2022, January 28). *How science earned Enrico Fermi a Nobel Prize (and saved his Jewish wife and children)*. Los Alamos National Laboratory. *https://discover.lanl.gov/news/0127-enrico-fermi/*

[5] U.S. Department of Energy. (n.d.). *The Life of Enrico Fermi*. *https://science.osti.gov/fermi/The-Life-of-Enrico-Fermi*

[6] PBS. (n.d.). *A science odyssey: People and discoveries: Fermi creates controlled nuclear reaction*. *https://www.pbs.org/wgbh/aso/databank/entries/dp42fe.html*

[7] MacPherson, M. (1987). *Time Bomb: Fermi, Heisenberg, and the race for the Atomic Bomb*. Berkley Books.

[8] U.S. Department of Energy. (n.d.). *EINSTEIN'S LETTER*. The Manhattan Project–an interactive history. *https://www.osti.gov/opennet/manhattan-project-history/Events/1939-1942/einstein_letter.htm*

[9] U.S. Department of Energy. (n.d.). *EARLY URANIUM RESEARCH*. The Manhattan Project–an interactive history. *https://www.osti.gov/opennet/manhattan-project-history/Events/1939-1942/uranium_research.htm*

[10] Allardice, C., & Trapnell, E. R. (1946). *The First Pile*. *https://www.iaea.org/sites/default/files/publications/magazines/bulletin/bull4-0/04005004147su.pdf*

[11] Dean, K. M. (2022, December 1). *Chicago Pile 1: A bold nuclear physics experiment with enduring impact*. Argonne National Laboratory. *https://www.anl.gov/article/chicago-pile-1-a-bold-nuclear-physics-experiment-with-enduring-impact#:~:text=An%20unassuming%20pile%20of%20black,to%20deliver%20on%20its%20promise*

[12] Hellman, M. E. (2012). *The Physics of Nuclear Weapons* [Class handout]. *https://ee.stanford.edu/~hellman/sts152_03/handout02.pdf*

[13] Flowers, P., Theopold, K., & Langley, R. (n.d.). *21.6: Nuclear Fission*. LibreTexts Chemistry. *https://chem.libretexts.org/Bookshelves/General_Chemistry/Map%3A_Chemistry_-_The_Central_Science_(Brown_et_al.)/21%3A_Nuclear_Chemistry/21.06%3A_Nuclear_Fission*

[14] Galison, P. (2005). Author of Error. *Social Research: An International Quarterly, 72*(1), 63-76. *https://doi.org/10.1353/sor.2005.0032*

[15] *The Nobel Prize in Physics 1938*. (n.d.). The Nobel Prize. *https://www.nobelprize.org/prizes/physics/1938/summary/*

[16] Spence, R. (2024, March 11). *Otto Hahn*. Encyclopædia Britannica. *https://www.britannica.com/biography/Otto-Hahn*

[17] American Chemical Society. (n.d.). Discovery of Transuranium Elements at Berkeley Lab. *https://www.acs.org/education/whatischemistry/landmarks/transuranium-elements-at-berkeley-lab.html*

[18] Gunn, A. (2024, March 18). How many galaxies are there in the universe? *BBC Sky at Night Magazine*. *https://www.skyatnightmagazine.com/space-science/how-many-galaxies-in-universe*

[19] Howell, E. (2023, August 24). *Fermi paradox: Where are the aliens?* Space.com. *https://www.space.com/25325-fermi-paradox.html*

[20] Tanner, B. (2022, January 10). *Fermi Problems Part 1: Envelopes at the Ready!* Tom Rocks Maths. *https://tomrocksmaths.com/2022/01/10/fermi-problems-part-1-envelopes-at-the-ready/*

[21] Fermi, E. (n.d.). *My Observations During the Explosion at Trinity on July 16, 1945*. Atomarchive.com. *https://www.atomicarchive.com/resources/documents/trinity/fermi.html*

JAMES WEBB SPACE TELESCOPE

詹姆斯·韋伯太空望遠鏡

By Roshni Printer

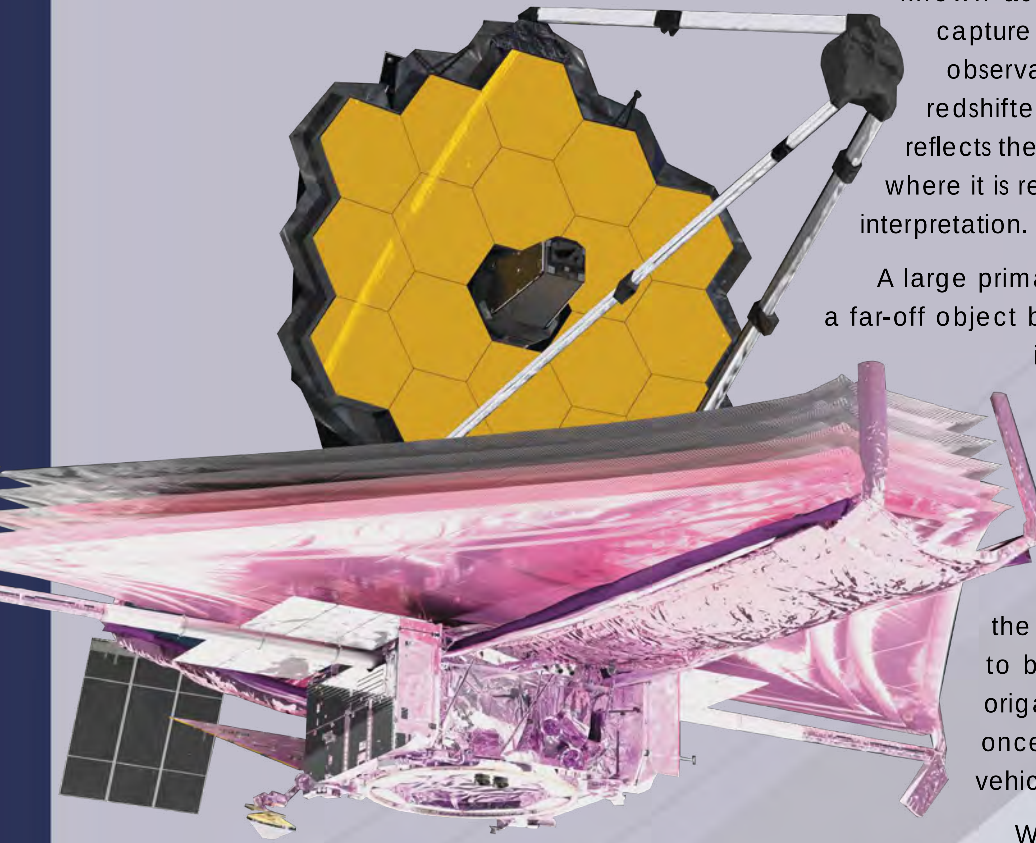


Photo credit: NASA GSFC/CIL/Adriana Manrique Gutierrez

In the vast realm of space, a revolutionary tool has been geared up to propel our exploration of the cosmos – the James Webb Space Telescope. Set up as a successor to the Hubble Space Telescope, Webb was launched in December 2021 with the aim of uncovering the formation of galaxies, stars, and planets [1]. As an extremely long duration is needed for the light from a very distant object to reach us, the observation we make today is actually reflecting their appearance in the past, providing us a peek into the early universe. Observing the conditions during the formation of the first galaxies enables scientists to trace the origins of our own galaxy, along with the planets and stars it encompasses.

Named after a prior administrator of NASA [2], Webb represents key advancements in the usage of space telescopes, and is the largest and most intricately designed observatories ever sent into space. The main component of the telescope, known as the primary mirror, functions to capture red and infrared light to facilitate the observation of far-off objects that are highly redshifted (footnote 1) [3, 4]. The mirror then reflects the light onto a smaller secondary mirror, where it is redirected to scientific instruments for interpretation.

A large primary mirror can reveal more details of a far-off object by collecting more light signals from it. Webb has a light collecting area 6.25 times greater than that of the Hubble Space Telescope [4], but one of the biggest challenges was the technical restriction of launching such a large mirror into space. To overcome this hurdle, the telescope was innovatively designed to be a folding telescope – much like origami – where the mirror would unfold once they had detached from the launch vehicle.

Webb is also an incredible feat of engineering that has the capability of adjusting its focus with very fine precision. The primary mirror is made up of 18 hexagonal segments of beryllium [3], whose position can be adjusted independently by the tiny mechanical motors called actuators behind each segment. Controlled by the team on the ground, adjustments as fine as about 1/10,000th of the width of a human hair can be made to produce focused, sharp images [5].

Designed to detect infrared light from distant sources, Webb itself requires extremely low temperatures in order not to interfere with those faint heat signals. To shield the telescope from heat and light from external sources such as the Sun, Earth, and Moon, scientists designed a five-layered sunshield as large as a tennis court to allow the telescope to work at extremely cool temperatures below -220°C by passively deflecting heat from between the sunshield layers [6].

Since its launch in 2021, Webb has not only provided us with an array of findings and breathtaking images, but also context to the images captured previously by Hubble. One such image was that of the Pillars of Creation, captured in the Eagle Nebula (Figure 1). While Hubble had captured the brown clouds of the structure, Webb was able to leverage its infrared imaging to capture also the individual new stars forming within it [7].

Figure 1 Hubble telescope (left) vs. James Webb Space Telescope (right) on the Pillars of Creation [7].

Photo credit: NASA, ESA, CSA, STScI; Joseph DePasquale (STScI), Anton M. Koekemoer (STScI), Alyssa Pagan (STScI)

In addition, Webb was able to capture images of the most distant galaxies known to scientists [8]. There were also data that shed light on the collision of galaxies (Figure 2) [9], and the atmospheres of planets inside and outside our solar system [10-12].

Figure 2 NGC 3526, the spiral galaxy shown in this image as the wreckage of a collision between two similarly massive galaxies occurred around 500 million years ago [13].

Photo credit: ESA/Webb, NASA & CSA, L. Armus, A. Evans

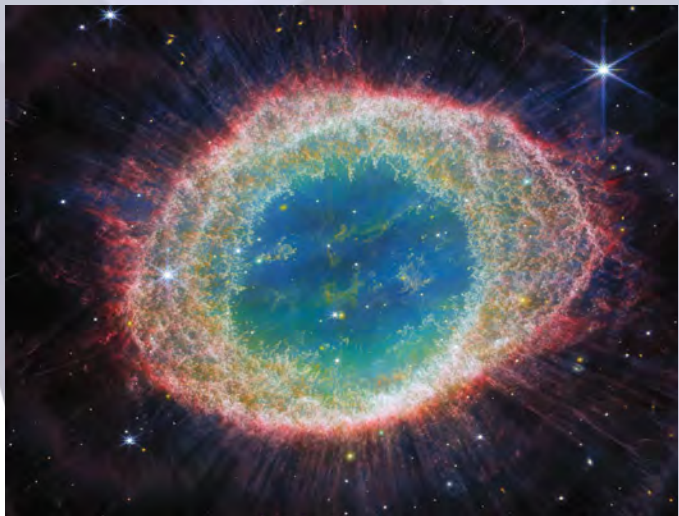
The James Webb Space Telescope marks a historic leap in humans' quest to understand the universe. Its innovative design and cutting-edge technology make it an ideal tool to revolutionize our comprehension of the cosmos. Keep up with the latest discoveries by the James Webb Space Telescope – one of the greatest scientific feats of today's day and age!

1. Cosmological redshift: It was discovered in 1920s by the cosmologists Georges Lemaître and Edwin Hubble that the universe is expanding, meaning that every object is becoming further apart in the universe, so the incoming light waves from far objects have to travel an increasing distance before reaching us [14]. As a result, the wave is stretched in terms of wavelength and appears "redder" towards the infrared side of the spectrum.

Webb Gallery: A Collection of Stunning Images!

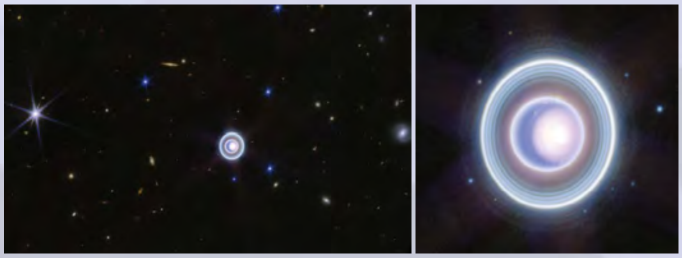
The Cosmic Cliffs. The image depicts the edge of a star-forming cavity within a cluster, called NGC 3324, located in the Carina Nebula. The ultraviolet radiation and intense winds from the young stars in the center of the cavity carve the area into what is called the "Cosmic Cliffs" [15, 16].

Photo credit: NASA, ESA, CSA, STScI



The Ring Nebula. A dying star which previously expelled its outer layers in concentric circles now ionizes and heats up its ejected gas to form this colorful ring-shaped planetary nebula. The bright ring is mainly composed of molecular hydrogen gas [17, 18].

Photo credit: ESA/Webb, NASA, CSA, M. Barlow (University College London), N. Cox (ACRI-ST), R. Wesson (Cardiff University)



Uranus and its moons. The wider image (left) depicts the planet Uranus along with 14 of its 27 moons, and some distant background galaxies. The close-up (right) shows Uranus and its rings in great detail, surrounded by nine of its moons [19, 20].
Photo credit: NASA, ESA, CSA, STScI

在浩瀚無垠的太空中，一件革命性的工具已經悄然準備好推動我們對宇宙的探索 — 詹姆斯·韋伯太空望遠鏡（James Webb Space Telescope）。作為哈勃太空望遠鏡（Hubble Space Telescope）的繼任者，韋伯望遠鏡於 2021 年 12 月升空，旨在揭示星系、恆星和行星形成的秘密 [1]。由於從極遠距離物體發出的光需要極長的時間才能到達我們所在的位置，因此我們今天觀察到的實際上是過去的景象，這為我們提供了一個窺探早期宇宙的機會。觀察早期星系形成的環境有助科學家追溯我們星系，以及它所包含行星和恆星的起源。

韋伯望遠鏡以前美國太空總署（NASA）署長命名 [2]，它代表了人類在使用太空望遠鏡方面的重大發展，亦有史以來發射到太空最大和設計最複雜的觀測儀器。望遠鏡的主要組件是主鏡，用於捕捉紅色可見光和紅外線，這有利於觀察高度紅移的遠距離物體（註一）[3, 4]。主鏡會將光線反射到較小的副鏡上，然後再反射到儀器進行分析。

一塊大面積的主鏡可以透過從遠距離物體收集更多光信號以提供更細緻的影像。韋伯望遠鏡的主鏡面積比哈勃望遠鏡大 6.25 倍 [4]，但隨之而來的技術難題是怎樣把如此巨大的鏡子送上太空。為了克服這個障礙，技術人員活用創意，將望遠鏡像摺紙一樣，設計為一個可折疊的結構，當中鏡子只會在望遠鏡脫離運載火箭後展開。

韋伯望遠鏡亦是工程技術上一項非凡傑作，皆因它擁有非常精密的對焦能力。主鏡由 18 塊以鈹元素製成的六邊形鏡片組成 [3]，每塊鏡片背後都有稱為致動器的微小的機械馬達，可以獨立微調鏡片位置。地面團隊可以透過對鏡片進行微細至頭髮寬度 10,000 分一的精細調整，來對焦並產生清晰影像 [5]。

由於韋伯望遠鏡在設計上是用於偵測遙遠物體發出的紅外線信號，因此它需要維持極低的運作溫度，才能避免自身的熱干擾外來微弱的熱信號。為了使望遠鏡能隔絕來自太陽、地球和月球等外來的熱和光，科學家設計了一個網球場大小的五層遮光罩，使熱力被動地從遮光罩各層之間反射離開，使望遠鏡能在低於零下 220° C 下運作 [6]。

自 2021 年發射以來，韋伯望遠鏡不僅為我們帶來一系列的發現和令人驚嘆的影像，還為哈勃望遠鏡之前拍攝的影像提供了更深入的資訊。其中一個例子是拍攝在鷹星雲內的「創生之柱」（Pillars of Creation）（圖一），儘管哈勃望遠鏡已經捕捉到了當中的棕色雲，但韋伯望遠鏡利用其紅外線成像技術，捕捉到當中正在形成的新恆星 [7]。

圖一 由哈勃望遠鏡（左）及詹姆斯·韋伯太空望遠鏡（右）所拍攝的「創生之柱」[7]。
相片來源: NASA, ESA, CSA, STScI; Joseph DePasquale (STScI), Anton M. Koekemoer (STScI), Alyssa Pagan (STScI)

此外，韋伯望遠鏡不僅能拍攝科學家已知最遙遠的星系 [8]，還收集了一些數據解釋星系之間發生的碰撞（圖二）[9]，以及讓我們了解太陽系內外行星的大氣層 [10-12]。

圖二 NGC 3526 — 圖中的螺旋星系為大約五億年前兩個質量相近星系碰撞後的殘骸 [13]。
相片來源：ESA/Webb, NASA & CSA, L. Armus, A. Evans

詹姆斯·韋伯太空望遠鏡標誌著人類探索宇宙的一大進程，其創新設計和尖端技術使其成為一件理想的工具去加深我們對宇宙的認識。就讓我們繼續關注韋伯太空望遠鏡的最新動向，緊貼現今科技的最前線！

1 宇宙紅移：宇宙學家 Georges Lemaître 和 Edwin Hubble 在上世紀 20 年代發現宇宙正在膨脹，意味著宇宙中每樣物體正相距越來越遠，所以遠距離物體發出的光在到達我們之前必須行進一段不斷延長的距離 [14]，光波會因此被拉長，移向光譜中近紅外線的一端，讓星體看起來「更紅」。

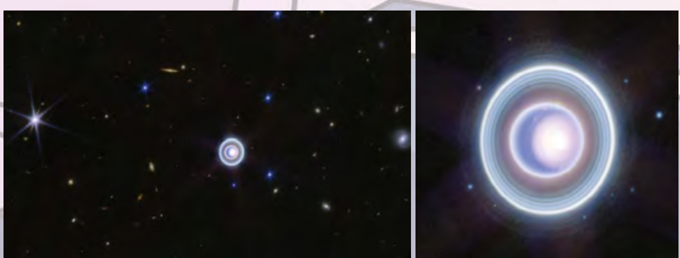
韋伯相簿：一系列令人驚嘆的相片！

「宇宙懸崖」(The Cosmic Cliffs) 圖中展示位於船底座星雲中一個名為 NGC 3324 的星團內部，一個正在孕育恒星的空腔的邊緣。空腔中間由年輕恒星散發的紫外輻射和強風掏空了該區域，形成了圖中的「宇宙懸崖」[15, 16]。

相片來源：NASA, ESA, CSA, STScI

環狀星雲 垂死的恆星噴出同心圓狀的外層，在使其離子化和加熱後，這些噴出的氣體形成色彩繽紛呈環狀的行星狀星雲。圖中明亮的環主要由氫氣組成 [17, 18]。

相片來源：ESA/Webb, NASA, CSA, M. Barlow (University College London), N. Cox (ACRI-ST), R. Wesson (Cardiff University)



天王星及其衛星 廣角圖(左)顯示天王星及其27顆衛星中的14顆，還有一些遙遠的背景星系。特寫(右)細緻展示了天王星和它的環，周圍還有九顆衛星 [19, 20]。

相片來源：NASA, ESA, CSA, STScI

References 參考資料：

[1] Kalirai, J. (2018). Scientific discovery with the James Webb Space Telescope. *Contemporary Physics, 59*(3), 251-290. *https://doi.org/10.1080/00107514.2018.1467648 https://www.tandfonline.com/action/showCitFormats?doi=10.1080/00107514.2018.1467648*

[2] Witze, A. (2022, November 21). NASA really, really won't rename Webb telescope despite community pushback. *Nature. https://www.nature.com/articles/d41586-022-03787-1*

[3] NASA. (n.d.). *Webb's Mirror.* James Webb Space Telescope. *https://webb.nasa.gov/content/observatory/ote/mirrors/index.html*

[4] NASA. (n.d.). *Webb vs Hubble Telescope.* James Webb Space Telescope. *https://webb.nasa.gov/content/about/comparisonWebbVsHubble.html*

[5] Fisher, A. (2022, January 13). Mirror, Mirror…On Its Way! *NASA Blogs. https://blogs.nasa.gov/webb/2022/01/13/mirror-mirroron-its-way/*

[6] NASA. (n.d.). *The Sunshield Webb.* James Webb Space Telescope. *https://webb.nasa.gov/content/observatory/sunshield.html*

[7] NASA Webb Telescope Team. (2022, October 19). *NASA's Webb Takes Star-Filled Portrait of Pillars of Creation.* NASA. *https://www.nasa.gov/universe/nasas-webb-takes-star-filled-portrait-of-pillars-of-creation/*

[8] Cooper, K. (2023, November 14). *James Webb Space Telescope finds 2 of the most distant galaxies ever seen.* Space.com. *https://www.space.com/james-webb-space-telescope-distant-galaxies*

[9] Lea, R. (2023, July 5). *James Webb Space Telescope spots the wreckage of a cosmic clash of the Titans (image).* Space.com. *https://www.space.com/webb-telescope-galactic-collision-image*

[10] Sanders, R. (2023, July 27). *James Webb Space Telescope sees Jupiter moons in a new light.* Berkeley News. *https://news.berkeley.edu/2023/07/27/james-webb-space-telescope-sees-jupiter-moons-in-a-new-light*

[11] Cable News Network. (2023, December 20). *Uranus' mysterious features on display in new Webb image.* CBS News. *https://www.cbsnews.com/baltimore/news/uranus-mysterious-features-on-display-in-new-webb-image/*

[12] NASA. (n.d.). *Other Worlds.* James Webb Space Telescope. *https://webb.nasa.gov/content/science/origins.html*

[13] European Space Agency. (2023, July 3). *Clash of the Titans.* ESA/Webb. *https://esawebb.org/images/potm2306a/*

[14] Schilling, G. (2023, February 8). Why galaxies look redder the further away they are. *BBC Sky at Night Magazine. https://www.skyatnightmagazine.com/space-science/galaxies-redshift*

[15] NASA Webb Telescope Team. (2022, July 12). *NASA's Webb Reveals Cosmic Cliffs, Glittering Landscape of Star Birth. NASA. https://www.nasa.gov/image-article/nasas-webb-reveals-cosmic-cliffs-glittering-landscape-of-star-birth/*

[16] Space Telescope Science Institute. (2022, July 12). *"Cosmic Cliffs" in the Carina Nebula (NIRCam Image).* Webb Space Telescope. *https://webbtelescope.org/contents/media/images/2022/031/01G77PKB8NKR7S8Z6HBXMYATGJ*

[17] Cesari, T. (2023, August 21). Webb Reveals Intricate Details in the Remains of a Dying Star. *NASA Blogs. https://blogs.nasa.gov/webb/2023/08/21/webb-reveals-intricate-details-in-the-remains-of-a-dying-star/*

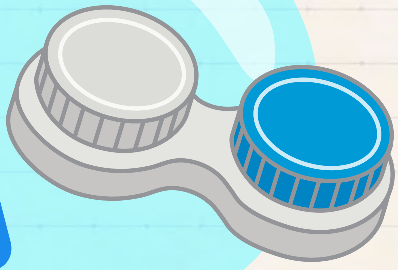
[18] Space Telescope Science Institute. (2023, August 21). *Ring Nebula (NIRCam Image).* Webb Space Telescope. *https://webbtelescope.org/contents/media/images/01H82G0PP38P6PBXQ11BEVSMY0*

[19] Space Telescope Science Institute. (2023, December 18). *Uranus Wide (NIRCam Image).* Webb Space Telescope. *https://webbtelescope.org/contents/media/images/2023/150/01HHFPR4A292D6X984CZ5QWD7J?page=3&filterUUID=91dfa083-c258-4f9f-bef1-8f40c26f4c97*

[20] Space Telescope Science Institute. (2023, December 18). *Uranus Close-up (NIRCam image).* Webb Space Telescope. *https://webbtelescope.org/contents/media/images/2023/150/01HHFNNWQTA69J6K680PVZN4A1?news=true*

Getting Rid of Glasses: A Beginner's Guide to Contact Lenses

擺脫眼鏡：隱形眼鏡新手指南



By Jane Yang 楊靜悠

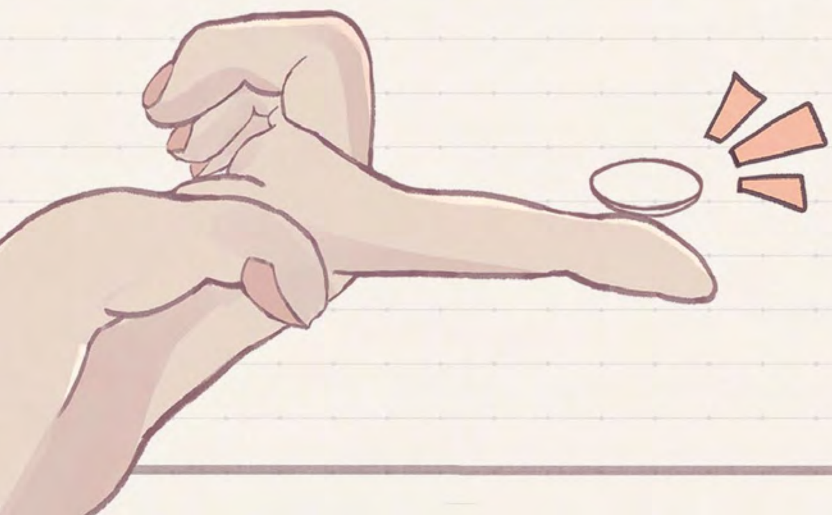
Introduction

For those of you who wear glasses, you should have experienced the frustration on a scorching summer day. Can you recall the annoyance of sweat trickling down your temples, fogging up your lenses and obscuring your vision? During physical activities, your glasses constantly slip down your nose, interrupting your focus and hindering your performance. Besides, have you noticed how glasses can sometimes make your eyes appear smaller and less expressive?

Unfortunately, myopia, or short-sightedness, is a common problem among teenagers. In Hong Kong, the rate of myopia is about 18% in 6-year-old, and 62% in 12-year-old students [1]. While glasses are a common solution, if you're tired of being restricted by glasses, contact lenses are an alternative option.

The History of Contact Lenses

The prototype of contact lenses has been around for centuries. Leonardo da Vinci first conceived the idea of wearing a huge glass hemisphere filled with water in front of the eyes to correct eyesight in 1508 [2]. It was not until 1887 that we are technologically capable of creating the first glass lenses in direct contact with the cornea [3]. Unfortunately, these glass lenses were very uncomfortable and inconvenient to wear, and could only be worn for a few hours [4].



From the 1930s, the development of polymer chemistry provided a new option for producing contact lenses [3, 4]. Poly(methyl methacrylate) (PMMA) was the first polymer used to make thinner contact lenses with better clarity, flexibility, and lighter weight. Despite the huge improvement in comfort level, PMMA lenses were still rigid and considered uncomfortable to wear [4, 5].

Other than rigidity, contact lenses made of PMMA have a more serious drawback: The oxygen can barely pass through the lenses [4, 5]. Low oxygen transmissibility can cause complications like corneal swelling, corneal neovascularization (the formation of new blood vessels into the transparent cornea) and loss of corneal transparency [6]. Therefore it is important to choose a material with a high oxygen transmissibility [7].

Contact Lenses Today

Soft contact lenses made of hydrogel are the most common types of contact lenses used today [4]. Hydrogel consists of a hydrophilic (water-loving) but insoluble cross-linked polymer network (see Figure 1). Due to the highly electronegative atoms such as oxygen atoms in the polymer, water molecules can be trapped in the network to create a soft, flexible jelly-like structure by forming hydrogen bonds with the electronegative atoms in the structure. As a result, the material can absorb as much as 85 to 90 percent of water by weight [3].

Poly(2-hydroxyethyl methacrylate) (pHEMA) was found suitable to make soft hydrogel lenses due to its higher oxygen transmissibility [4]. To further enhance the oxygen transmissibility, co-polymers were created by adding other monomers to the hydrogel mix to modify the properties of the material. But still, the lenses could not be worn for extended periods [4].

Further efforts led to the development of silicone hydrogel contact lenses [4]. Silicones,

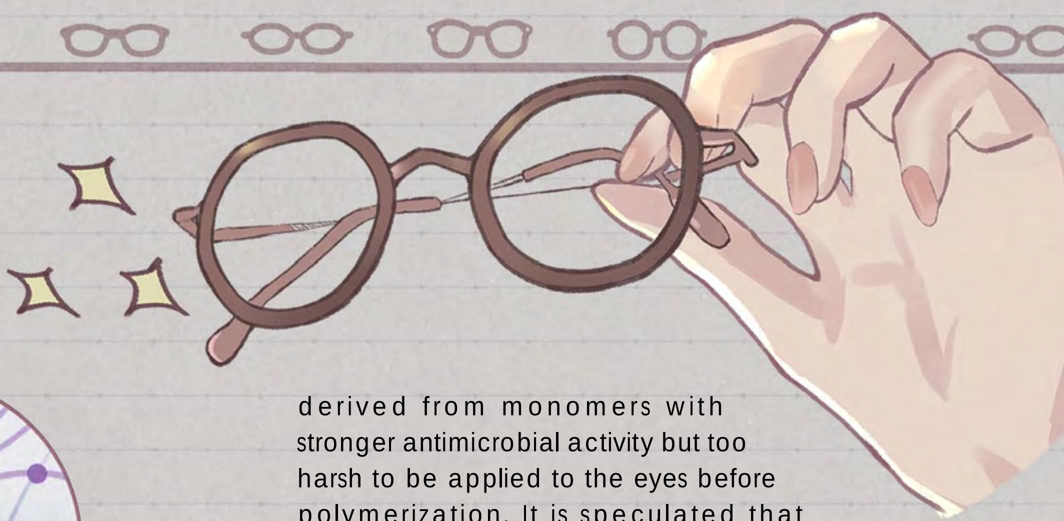


Figure 1 Hydrophilic cross-linked polymer network in hydrogel.

which have an even higher oxygen transmissibility than water, are polymers that contain silicon and oxygen. The use of silicone hydrogel enabled the invention of continuous-wear contact lenses, which can be worn overnight. However, silicone is a hydrophobic (water-repelling or lipid-loving) material so it is prone to problems like sticking to the eye surface which is covered by the tear film lipid layer [8]. After a few attempts to increase the hydrophilicity, bioengineers eventually solved the problem also by modifying the polymer.

Contact Lens Solutions

Contact lens solutions play a vital role in maintaining the cleanliness and functionality of contact lenses. They are specifically designed to disinfect, clean, and store the lenses, ensuring optimal comfort and vision for wearers. These solutions contain various chemical compounds that serve specific purposes.

There are two main types of contact lens cleaning solutions: peroxide solutions and multi-purpose solutions [4, 9]. They differ by the way they disinfect. Peroxide solutions utilize hydrogen peroxide (H_2O_2) as a disinfectant, typically at a 3% concentration. To make them safe for the eyes when lenses are reinserted after disinfection, a neutralization catalyst, such as platinum, palladium, or silver, present in the contact lens case is used to speed up the degradation of peroxide into water and oxygen.

Multi-purpose solutions commonly contain disinfection agents such as polyhexamethylene biguanide or polyquaternium-1 [4, 9]. These polymers possess optimal antimicrobial properties, and are derived from monomers with stronger antimicrobial activity but too harsh to be applied to the eyes before polymerization. It is speculated that polyhexamethylene biguanide works by selectively binding and condensing bacterial DNA, eventually blocking cell division [10, 11]. Polyquaternium-1 was found to cause leakage of cellular contents in ocular pathogens by disrupting the cell membrane [12, 13].

In addition to disinfection, contact lens solutions also include other compounds to maintain lens cleanliness and performance [4, 9]. Bisphosphonates help break down proteins that accumulate on the lens during wear, while moisturizing and conditioning chemicals ensure that the lenses remain in good condition while stored. There are also buffers to keep the pH gentle on the eyes, and preservatives to increase shelf life.

Tried-and-True Techniques & Tips for Beginners

For those who are new to contact lenses, the prospect of putting them on and taking them off can be quite intimidating. The thought of touching your eye or inserting a foreign object into it may seem daunting, but fear not! There are techniques that can make this process easier and potentially less frightening.

Since most contact lenses sold today are hydrophilic, you should use a dry hand to put on contact lenses so that the lenses will not stick to your hand. When you remove contact lenses, using a wet hand will make the task easier, but always make sure you wash your hands thoroughly before handling contact lenses.

It is advised not to use eyedrops when wearing contact lenses because that may cause problems with the lenses [14]. Nevertheless, you may consider

wetting drops or preservative-free lubricating drops approved by your eye doctor if you often feel dry with contact lenses on. However, never use peroxide solution as wetting eyedrops – eyedrops and contact solution are not the same!

Conclusion

Contact lenses are a great alternative to glasses for those who feel bothered by the inconvenience and discomfort of wearing glasses. There are also lenses of different colors and graphic diameters for people who want to change their eye appearance. By understanding the different types of contact lenses available and how to wear them properly, you can make an informed decision about which contact lenses are right for you.

引言

戴眼鏡的人應該都經歷過炎炎夏日的苦惱。你是否有過這樣的體驗 — 汗水順著太陽穴流下，鏡片起霧，視線模糊的煩惱？在體育活動中，眼鏡不斷滑落鼻梁，擾亂注意，導致發揮失誤。此外，你有否在意眼鏡有時使你眼睛看起來細小而無神？

不幸的是，近視在青少年間十分常見。在香港，六歲學生的近視率約為 18%，十二歲學生的近視率則約為 62% [1]。雖然傳統眼鏡是常見對策，但如果你厭倦了眼鏡的束縛，隱形眼鏡是一個不錯的選擇。

隱形眼鏡發展史

隱形眼鏡的雛形已有數世紀的歷史。1508 年，達文西首次提出在眼睛前佩戴由水填充的玻璃半球以矯正視力的想法 [2]。直到 1887 年，當代技術才足以製造出第一副與角膜直接接觸的玻璃鏡片 [3]。可惜的是，這些玻璃鏡片戴起來有諸多不便與不適，而且只能戴幾個小時 [4]。

從上世紀 30 年代開始，聚合物化學的發展為生產隱形眼鏡提供了新的可能性 [3, 4]。聚甲基丙烯酸甲酯（PMMA）是第一種用於製造輕薄隱形眼鏡的聚合物，成品在清晰度、柔韌度和重量上也有改善。儘管舒適度大大提高，但 PMMA 鏡片仍然很硬，佩戴起來並不舒服 [4, 5]。

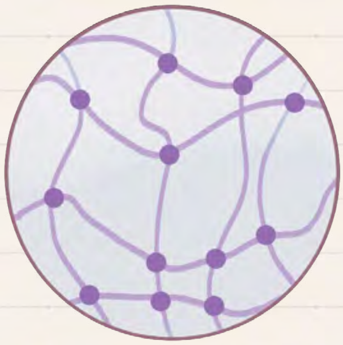
除了硬度問題，PMMA 製成的隱形眼鏡還有一個更嚴重的缺點，就是氧氣幾乎無法穿透鏡片 [4, 5]。低透氧度會導致角膜腫脹、角膜新生血管（透明角膜上長出血管）和角膜透明度下降等併發症 [6]。因此，選擇透氧度高的材料非常重要 [7]。

現今的隱形眼鏡

由水凝膠製成的軟式隱形眼鏡是目前最常用的隱形眼鏡之一 [4]。水凝膠由親水但不溶於水的交聯聚合物網絡組成（見圖一）。由於聚合物中含有氧等電負性很強的原子，水分子可被困在網絡中，與結構中的高電負性原子形成氫鍵，從而構成柔軟、有彈性的果凍狀結構。因此，水凝膠可吸收高達其重量百分之 85 至 90 的水分 [3]。

聚（2- 羥乙基甲基丙烯酸酯）（pHEMA）因其較高的透氧度被用於製造軟式水凝膠隱形眼鏡 [4]。為了進一步提高透氧度，不同種類的單體被添加到水凝膠混合物中以聚合出性質有所改良的共聚物，但製造出的鏡片仍然不能長時間佩戴 [4]。

經過進一步努力，矽水凝膠（silicone hydrogel）隱形眼鏡應運而生 [4]。矽樹脂（silicone）是一種含有矽和氧的聚合物，其透氧度甚至高於水，正是由矽樹脂構成的矽水凝膠使人們發明了可隔夜配戴的連續配戴型隱形眼鏡。然而，矽樹脂是一種疏水性（親脂性）材料，因此容易黏附於淚膜脂質層而不易從眼球表面拿走 [8]。為了增加其親水性，生物工程師進行了多次嘗試，最後亦透過改良聚合物結構解決了這個問題。



圖一 水凝膠中的親水性交聯聚合物網絡。

隱形眼鏡護理液

隱形眼鏡護理液在保持隱形眼鏡清潔和功能方面起著至關重要的作用，專為鏡片消毒、清潔和儲存而設計，確保配戴者獲得最佳的舒適度和視力。護理液含有各種具特定用途的化學物質。

隱形眼鏡清潔液主要有兩種:雙氧水和多用途溶液 [4, 9]。它們的區別在於消毒方式的不同。雙氧水使用過氧化氫（H_2O_2）作為消毒劑，濃度通常為 3%。為了確保重新戴上鏡片時不會傷害眼睛，隱形眼鏡盒中會裝上如鉑、鈀或銀等的中和催化劑，以加速過氧化氫降解為水和氧的化學反應。

多用途溶液通常含有聚己亞甲基鹽酸或聚季銨鹽-1 等消毒劑 [4, 9]。這些聚合物的單體其實具有更強的抗菌活性，但由於在聚合作用前單體對眼睛的刺激太大，因此這兩種消毒劑以聚合物的形式存在於溶液內。至於抗菌原理，據推測聚己亞甲基鹽酸能透過選擇性地與細菌 DNA 結合，使其凝聚，最終阻礙細胞分裂 [10, 11]；研究亦發現聚季銨鹽-1 可透過破壞眼部病原體的細胞膜導致其內含物外洩 [12, 13]。

除了消毒，隱形眼鏡護理液中還含有其他化合物，以保持鏡片的清潔度和性能 [4, 9]。雙磷酸鹽有助分解配戴過程中在鏡片上堆積的蛋白質，而保濕和調理化學物質則可確保鏡片在儲存過程中保持良好狀態。此外，緩衝劑可使鏡片維持對眼睛溫和的 pH 值，防腐劑則可延長鏡片的保存期限。

新手上路的小技巧

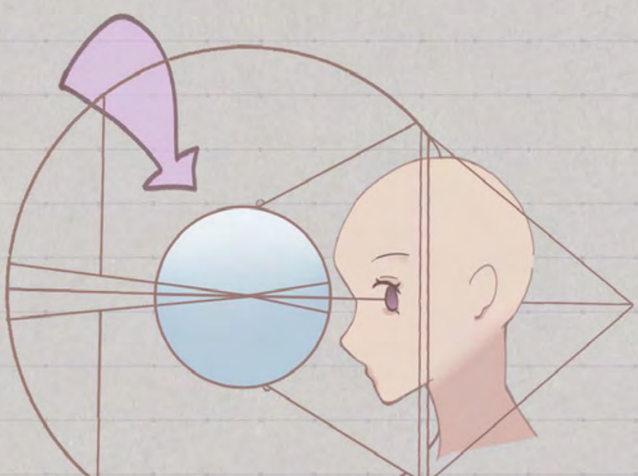
對於初次接觸隱形眼鏡的人來說，單想到戴上和摘下隱形眼鏡的過程就已經使人畏懼，觸摸眼球或將異物放入眼睛的想法確實讓人望而卻步。但不用擔心！有些技巧能使這個過程變得容易，而不那麼嚇人。

由於現今市面上售賣的大多數隱形眼鏡都是親水的，所以戴隱形眼鏡時應使用乾燥的手，這樣鏡片就不會黏在手上。取下隱形眼鏡時，用濕手會更容易，但一定要在觸碰隱形眼鏡前徹底洗手。

戴上隱形眼鏡後不建議使用眼藥水，因為兩者可能不相容 [14]。不過，如果配戴隱形眼鏡時經常感到眼睛乾澀，可以考慮使用眼科醫生推薦不含防腐劑的的滋潤眼藥水。不過，千萬不要使用雙氧水作為潤眼液，因為眼藥水和隱形眼鏡溶液是兩樣不同的東西！

結論

對於嫌戴眼鏡不方便、不舒服的人來說，隱形眼鏡是傳統眼鏡的絕佳替代品。市面上還有不同顏色和著色直徑的隱形眼鏡，適合想改變眼睛外觀的人。透過深入了解不同類型的隱形眼鏡以及如何正確配戴隱形眼鏡，我們就可以做出更明智的決定，選擇適合自己的隱形眼鏡。



References 参考資料：

[1] Department of Health. (2022, June). *Myopia*. Student Health Service. *https://www.studenthealth.gov.hk/english/health/health_ev/health_ev_nea.html*

[2] Novak, J. F., & Saul, R. W. (1971). Contact Lenses in Industry. *Journal of Occupational Medicine, 13*(4), 175-178.

[3] Schifrin, L. G., & Rich, W. J. (1984, December). *The Contact Lens Industry: Structure, Competition, and Public Policy*. U.S. Congress, Office of Technology Assessment. *https://www.princeton.edu/~ota/disk3/1984/8409/8409.PDF*

[4] Brunning, A. (2015, October 13). *The Chemistry of Contact Lenses*. Compound Interest. *https://www.compoundchem.com/2015/10/13/contactlenses/*

[5] Wu, S. (2021). A Brief Review of Contact Lens Development in China. *Boli tangci yu yanjing [Glass, Enamel and Eyeglasses], 49*(7), 41-44. *https://doi.org/10.13588/j.cnki.g.e.2096-7608.2021.07.007*

[6] Lee, S. E., Kim, S. R., & Park, M. (2015). Oxygen permeability of soft contact lenses in different pH, osmolality and buffering solution. *International Journal of Ophthalmology, 8*(5), 1037-1042. *https://doi.org/10.3980/j.issn.2222-3959.2015.05.33*

[7] Alipour, F., Khaheshi, S., Soleimanzadeh, M., Heidarzadeh, S., & Heydarzadeh, S. (2017). Contact Lens-related Complications: A Review. *Journal of Ophthalmic & Vision Research, 12*(2), 193-204.

[8] Cwiklik, L. (2016, October). Tear film lipid layer: A molecular level view. *Biochimica et biophysica Acta, 1858*(10), 2421-2430. *https://doi.org/10.1016/j.bbamem.2016.02.020*

[9] Kemsley, J. (2008, November 7). What's that stuff? Contact Lens Solutions. *Chemical & Engineering News, 86*(46). *https://cen.acs.org/articles/86/i46/Contact-Lens-Solutions.html*

[10] Worsley, A., Vassileva, K., Tsui, J., Song, W., & Good, L. (2019). Polyhexamethylene Biguanide:Polyurethane Blend Nanofibrous Membranes for Wound Infection Control. *Polymers, 11*(5), 915. *https://doi.org/10.3390/polym11050915*

[11] Sowlati-Hashjin, S., Carbone, P., & Karttunen, M. (2020). Insights into the Polyhexamethylene Biguanide (PHMB) Mechanism of Action on Bacterial Membrane and DNA: A Molecular Dynamics Study. *The Journal of Physical Chemistry B, 124*(22), 4487–4497. *https://doi.org/10.1021/acs.jpcb.0c02609*

[12] Codling, C. E., Maillard, J., & Russell, A. D. (2003). Aspects of the antimicrobial mechanisms of action of a polyquaternium and an amidoamine. *The Journal of Antimicrobial Chemotherapy, 51*(5), 1153–1158. *https://doi.org/10.1093/jac/dkg228*

[13] Codling, C. E., Hann, A. C., Maillard, J., & Russell, A. D. (2005). An investigation into the antimicrobial mechanisms of action of two contact lens biocides using electron microscopy. *Contact Lens & Anterior Eye, 28*(4), 163–168. *https://doi.org/10.1016/j.clae.2005.08.002*

[14] Boyd, K. (2022, April 22). *How to Take Care of Contact Lenses*. EyeSmart, American Academy of Ophthalmology. *https://www.aao.org/eye-health/glasses-contacts/contact-lens-care*

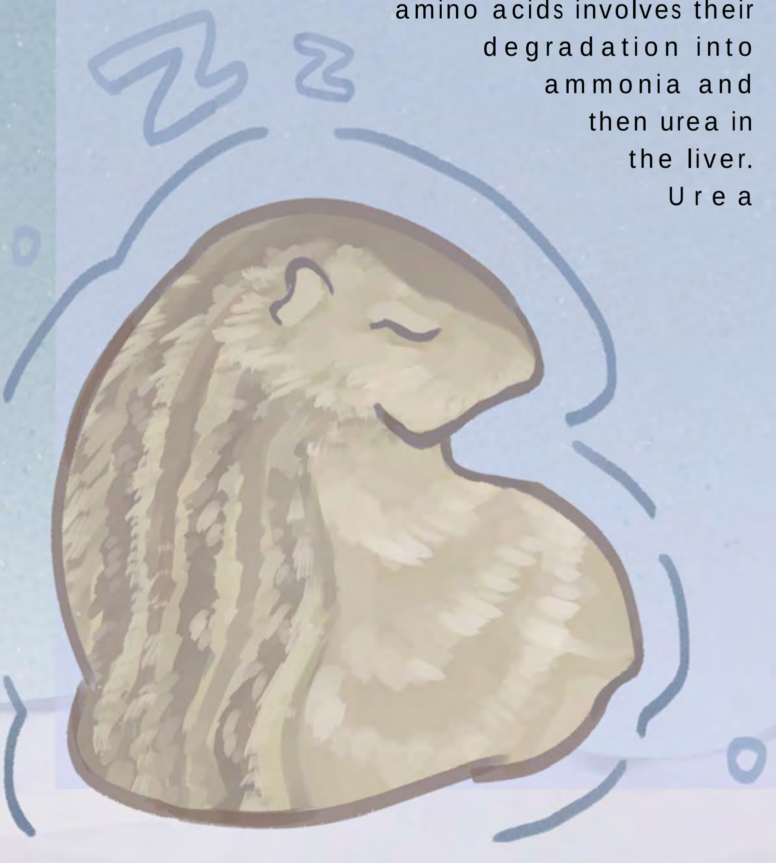
How Do Hibernating Squirrels Stay Muscular During Winter?

冬眠松鼠如何保持強壯？

By Daria Zaitseva

Have you ever wondered how animals like some squirrels, bears, and hedgehogs survive the winter months? Well, they become torpid for up to several months with a minimal demand of food and water [1]. This amazing ability is called hibernation, during which breathing, heartbeat, and most metabolic processes slow down, and body temperature significantly drops to conserve energy. Interestingly, hibernating animals are capable of maintaining their muscle mass without eating, have you ever wondered why?

To address our question, one needs to appreciate that the integrity of various tissues, including muscle, is maintained by a steady supply of amino acids, which are building blocks of proteins. When animals feed normally, the diet is the major source of amino acids. During hibernation, however, animals may turn to breaking down their own tissues in order to obtain a sufficient amount of amino acids to make new proteins for survival. An alternative, "wasteful" route for amino acids involves their degradation into ammonia and then urea in the liver. Urea eventually enters the bloodstream and is excreted in urine. How can hibernating animals minimize such "wasteful" mechanism that may reduce muscle mass?



A recent study showed the gut microbiota of hibernating squirrels may be the key. It was known that urea in the bloodstream can be transported into the gut lumen [2]. There, the gut microbiota can salvage urea by producing ureases to metabolize it back into carbon dioxide and ammonia. The latter is then used by the same microbiota to resynthesize amino acids [3]. Such a mechanism minimize the wastage of amino acids during hibernation. As a result, the squirrels end up with more muscles than before and wake up stronger for the breeding season right after the cold winter [4].

Now, let's turn to its implications for humans [3]. Muscle wasting is a common condition in the elderly suffering from age-related muscle loss and bedridden patients under prolonged inactivity. It is also prevalent in developing countries, as millions of people lack a diet with sufficient protein. Isn't this condition similar to what we saw in hibernating animals? Yes, you guessed it: We can potentially harness the gut bacteria in the hibernating squirrels to maintain muscle mass in humans.

Human gut microbiota is plastic such that it can be shaped by diet. A classic example is the transfer of beneficial gut bacteria such as *Bifidobacterium* from mother to infant through breastfeeding [5]. Breast milk also contains human milk oligosaccharides, a prebiotic (or food) for *Bifidobacterium*, to facilitate the colonization of the bacteria to provide health benefits to infants [6]. In another case to promote healthy growth in undernourished children, scientists have developed microbiota-directed foods to repair their immature gut microbiota by increasing the representation of growth-promoting bacterial taxa [7]. In light of these stories, researchers are now exploring the possibilities of developing oral probiotic supplements to introduce the bacteria that produce ureases such as the genus *Alistipes* in hibernating squirrels, or genetically designed bacteria to the human gut to promote the breakdown of urea and muscle replenishment [3]. These approaches could be promising in combating muscle wasting by manipulating our gut microbiota.

Hibernation is a fascinating animal behavior that involves many unusual physiological and microbial processes. By studying hibernating animals and the mechanisms of related processes, we may be able to develop new therapies for treating human disease and promoting patients' quality of life. It might also come in handy in the future for space travel where prolonged inactivity is involved [3]. Who knows?

你曾經想過像松鼠、熊和刺蝟這些動物如何渡過寒冬嗎？牠們當中一些物種會在長達數個月的日子裡進入一種不活躍的狀態，只需要極少食物和水就能生存 [1]。這種驚人的能力叫冬眠，期間呼吸、心跳和大部分代謝過程都會減慢，體溫會顯著下降以節省能量。有趣的是冬眠動物在停止進食期間也能維持肌肉質量，你有想過這是怎樣做到的嗎？

要回答這個問題，我們先要明白包括肌肉在內，身體組織需要穩定氨基酸供應才能保持完整，而氨基酸是構成蛋白質的基本單位。當動物正常攝食時，氨基酸的主要來源是膳食；但在冬眠期間，動物會轉為分解身體組織以獲取足夠氨基酸製造新蛋白質維持生命。然而身體亦存在另一個途徑會在肝臟先把氨基酸分解成氨，再分解成尿素，使氨基酸白白被浪費掉。尿素隨後會進入血液，最終隨尿排出。那冬眠動物如何對抗這種會導致肌肉質量減少的生化途徑呢？

最近一項研究發現冬眠松鼠的腸道微生物群可能就是關鍵。我們知道血流中的尿素能被運輸至腸腔 [2]，那裡的腸道微生物群可以透過製造尿素酶將尿素代謝回二氧化碳和氨，後者可被同一個微生物群用於重新合成氨基酸 [3]。這個回收途徑能減少動物在冬眠時消耗的氨基酸，使松鼠甚至可以擁有比冬眠前更發達的肌肉，從而更強壯地迎接緊隨在冬季後的繁殖季節 [4]。

也讓我們談談這個發現對人類的啟示 [3]。肌肉萎縮常見於因年齡增長而流失肌肉的長者，和長期臥床缺乏運動的病人；由於在發展中國家數以百萬計的人膳食中缺乏足夠蛋白質，這種情況亦非常普遍。這不就是與我們在冬眠動物中看到的情況相似嗎？是的，你猜對了：我們也許可以利用冬眠松鼠的腸道細菌來維持人類的肌肉質量。

人類腸道微生物群是可塑的，它受膳食影響。經典例子是透過母乳哺育將有益的腸道細菌，例如雙歧桿菌（*Bifidobacterium*），從母親轉移到嬰兒體內 [5]。母乳還含有人乳寡糖，作為雙歧桿菌的益生元（即是雙歧桿菌的食物），它能有助細菌佔據並居住在嬰兒的腸道中，促進嬰兒健康 [6]。在另一個促進營養不良兒童健康成長的案例中，科學家研發了能促進微生物生長的食品，透過增加腸道中能幫助兒童成長益菌的比例，科學家嘗試修復兒童早年因營養不良而未能發展成熟的腸道微生物群 [7]，藉以幫助兒童健康成長。鑑於這些故事，研究人員現正探索研發口服益生菌的可能性，將能製造尿素酶的細菌，例如冬眠松鼠中發現的阿里斯氏屬（*Alistipes*）細菌，或經基因改造的細菌引入人類腸道，促進尿素分解和肌肉補充 [3]。這些方法都有望藉改造腸道微生物群對抗肌肉萎縮。

冬眠是一種神秘得讓人想探索更多的動物行為，當中涉及許多不尋常的生理和微生物過程。透過研究冬眠動物和相關過程的原理，我們或許能從中得到啟發，研究出治療人類疾病和改善患者生活質素的新療法；未來太空旅行的航程亦可能涉及身體長時間靜止等待，這些研究那時也許就能大派用場 [3]。誰知道呢？

References 參考資料：

[1] Geiser, F. (2013). Hibernation. *Current Biology, 23*(5), R188–R193. *https://doi.org/10.1016/j.cub.2013.01.062*

[2] Walpole, M. E., Schurmann, B. L., Górka, P., Penner, G. B., Loewen, M. E., & Mutsvangwa, T. (2015). Serosal-to-mucosal urea flux across the isolated ruminal epithelium is mediated via urea transporter-B and aquaporins when Holstein calves are abruptly changed to a moderately fermentable diet. *Journal of Dairy Science, 98*(2), 1204–1213. *https://doi.org/10.3168/jds.2014-8757*

[3] Sommer, F., & Bäckhed, F. (2022). Staying strong during hibernation. *Science, 375*(6579), 376–377. *https://doi.org/10.1126/science.abn6187*

[4] Regan, M. D., Chiang, E., Liu, Y., Tonelli, M., Verdoorn, K. M., Gugel, S. R., Suen, G., Carey, H. V., & Assadi-Porter, F. M. (2022). Nitrogen recycling via gut symbionts increases in ground squirrels over the hibernation season. *Science, 375*(6579), 460–463. *https://doi.org/10.1126/science.abh2950*

[5] Soto, A., Martín, V., Jiménez, E., Mader, I., Rodríguez, J. M., & Fernández, L. (2014). Lactobacilli and bifidobacteria in human breast milk: influence of antibiotherapy and other host and clinical factors. *Journal of Pediatric Gastroenterology and Nutrition, 59*(1), 78–88. *https://doi.org/10.1097/MPG.0000000000000347*

[6] Taft, D. H., Lewis, Z. T., Nguyen, N., Ho, S., Masarweh, C., Dunne-Castagna, V., Tancredi, D. J., Huda, M. N., Stephensen, C. B., Hinde, K., von Mutius, E., Kirjavainen, P. V., Dalphin, J. C., Lauener, R., Riedler, J., Smilowitz, J. T., German, J. B., Morrow, A. L., & Mills, D. A. (2022). *Bifidobacterium* Species Colonization in Infancy: A Global Cross-Sectional Comparison by Population History of Breastfeeding. *Nutrients, 14*(7), 1423. *https://doi.org/10.3390/nu14071423*

[7] Gehrig, J. L., Venkatesh, S., Chang, H. W., Hibberd, M. C., Kung, V. L., Cheng, J., Chen, R. Y., Subramanian, S., Cowardin, C. A., Meier, M. F., O'Donnell, D., Talcott, M., Spears, L. D., Semenkovich, C. F., Henrissat, B., Giannone, R. J., Hettich, R. L., Ilkayeva, O., Muehlbauer, M., . . . Gordon, J. I. (2019). Effects of microbiota-directed foods in gnotobiotic animals and undernourished children. *Science, 365*(6449). *https://doi.org/10.1126/science.aau4732*

The Modern Bronze Age: *Fake Tan*

摩登青銅時代 美黑霜

By Aastha Shreeharsh

"Sun-kissed skin", "radiant", "bronze", and a "healthy glow" – these are just a few of the many descriptors trending on social media and in the beauty industry worldwide, especially in Western countries. While this look could possibly be achieved by a few sun-drenched days at the beach, many people are now opting for sunless alternatives to tanning.

Q: That seems recent – so what's up with the title?

While it is true that the original Bronze Age lasted for many centuries and fake tanning is a relatively recent phenomenon, the "Modern Bronze Age" is just a term used by popular media to describe the era of the fake-tan – playing on the word "bronze" to describe the generally desired outcome of a fake tan. From celebrities to the former US president Donald Trump (footnote 1) [1], it seems that sunless tanning products, such as tanning beds, lotions, and sprays, are in extensive use. Many people from countries where a sunny day is a rarity turn to fake tanning as a solution, and they have the scientist Eva Wittgenstein to thank for her discovery.

Q: How did one stumble upon a fake tan?

As with many scientific discoveries, one did not set out to find or develop a fake tan. While investigating the oral application of a chemical compound known as DHA (dihydroxyacetone; not to confuse with the omega-3 fatty acid (docosahexaenoic acid) in fish oil) for children with glycogen defects, she observed the noticeable coloration of skin where the DHA spilled. This was not the first time this skin-browning effect was noticed by scientists – German scientists in the 1920s had already done so – but it was the first time for DHA to be considered for cosmetic purposes [2]. Wittgenstein researched this further and published a paper in 1960 to explain how DHA produced an "artificial tan" [3].

Q: Wow! So, you're telling me, I can just use a lotion at home and get a tan without having to suffer outside during the summer. How does that work? Could it also offer me sun protection?

This may come as a surprise, but this process of skin-browning follows the same reaction responsible for the browning of bread and roast meat, known as the Maillard reaction. Our skin is composed of a few layers, and the outer surface comprises a layer of dead skin cells. The Maillard reaction between the amino acids in this outer layer and the colorless DHA produces the brown pigment melanoidins [2].

Nevertheless, the process is not instantaneous. After two to three hours, the skin begins to acquire a tan and the reaction carries on for another one to three days [2, 4]. Once formed, melanoidins can't be washed off by water, soap, or moisturizer until the skin cells are shed. [2, 4]. The browning effect can last for one week [2, 4].

However, unlike the pigment melanin in natural tanning, melanoidins don't offer much ultraviolet (UV) protection on their own (Figure 1). It's estimated that most of these sunless tanners can offer only a meager SPF of 3, which is not nearly enough sun protection [2]. Therefore, it's extremely important to wear sunscreen with adequate SPF when going outdoors, with or without a sunless tan.

Q: That story does not fill me with a whole lot of confidence about fake tanning, and the cosmetic industry has a history of being misleading to sell us products. What do scientists have to say about its safety?

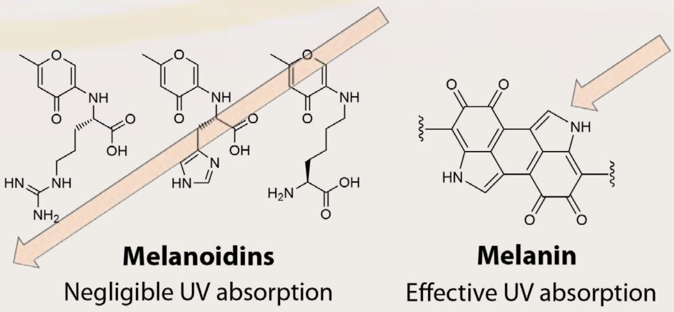


Figure 1 Chemical structures of the three major types of melanoidin resulted from the Maillard reaction between DHA and assorted amino acids (left) [5], and the stoichiometric structure of melanin (right). The highly conjugated π-bonding (alternating single and double bonds) ring system of melanin enables the molecule to absorb UV effectively.

Perhaps the idea that the same reaction governing the fake tanning process also takes place during the roasting of meat may have been a bit off-putting. According to scientists, there is no significant cause for concern – with some caveats. One study from 2008 suggested that our skin may become more susceptible to UV radiation after the application of tanning products, as a UV exposure after the application of 20% DHA solution on porcine skin resulted in the formation of 180% more harmful free radicals, which are generally believed to cause premature skin aging and wrinkling [6]. Fortunately, most over-the-counter tanning lotions contain only 3-5% of DHA, and precautions can always be taken by using sunscreen and avoiding the sun after applying a self-tanner [2]. Another point to note is that, the US Food and Drug Administration (FDA) has approved DHA only for external application, meaning that a self-tanning lotion may be a safer choice than a spray because DHA is not likely inhaled or ingested into the body [7]. Overall, self-tanning is considered as a safer alternative to tanning naturally.

Q: Awesome! Can I give my pet a spray tan?

Okay, it's unlikely many readers were thinking about this, but apparently, someone was. In 2008, one study found that using 5% DHA on Mexican hairless dogs can result in severe contact dermatitis, causing blisters and epidermal necrosis [8]. So, if you love your pet, it's possibly best to forego the spray tan! (An obvious but necessary disclaimer on animal cruelty: It's not a good idea to use this on animals you do not love either.)

Q: Well, that's a bit scary. Can it hurt us humans?

Apart from the caveats above, with any cosmetic product, there is a chance it does not react well to your skin – which is why you should always test a product on a small patch of skin.

In another way, the whole concept of fake tanning may have hurt us. Historically, "sun-kissed" skin was associated with labor in the scorching heat – not considered very attractive. The idea that a tan is undesirable is one that is still bandied about in many Asian households, but amongst countries with colder climes, tans came to be associated with luxury as it meant you could afford to enjoy more tropical vacation spots [9]. The invention of the fake tan has perhaps made unattainable, short-lived beauty standards and trends more attainable for some; or, perhaps, it helps instead of hurts in some regions – making darker, tanner skin more the norm as we see those with fairer complexions seek tanner complexions that were once frowned upon.

1. Trump has been the star of frenzied media coverage for many reasons aside from his distinct appearance and mannerisms; in this context, it is referring to his vibrant, orange complexion. He claims that accusations of him using fake tanning products are fake news, yet there is much debate surrounding the validity of such claims [1].

The Science of Sunscreen

Check out our Instagram posts for more information about UV radiation and SPF!

#1 #2

「Sun-kissed skin（被陽光親吻過的肌膚）」、「radiant（明艷照人）」、「bronze（古銅色）」和「healthy glow（健康色澤）」— 這些都是社交媒體和全球美容行業經常使用的形容詞，特別是在西方國家。儘管我們可以透過在沙灘曬上幾天來得到一身古銅色肌膚，但現在許多人都選擇不用曬太陽的替代方案來「美黑」。

問：這現象近年才出現！標題為甚麼說是「青銅時代」？

雖然歷史上的青銅時代（Bronze Age）持續了好多個世紀，而美黑只是近年才出現的潮流，但西方媒體常用「Modern Bronze Age（現代青銅時代）」一詞形容現今美黑風潮當道的世代，以「Bronze（銅）」一字帶出美黑者所追求的效果。從明星到前美國總統特朗普（註一）[1]，似乎許多人都追捧包括曬燈機、美黑霜和美黑噴霧等的美黑產品。有些人居於陽光罕至的國家，他們就只能藉這些產品獲得小麥色的肌膚。無論如何，他們要感謝科學家 Eva Wittgenstein 的發現。

問：科學家怎樣意外發現美黑霜？

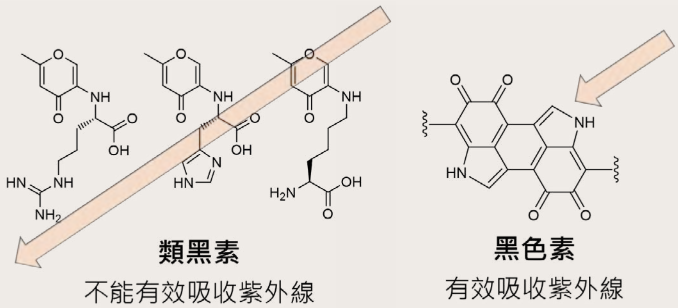
與許多科學發現一樣，美黑霜並不是有人特意去尋找或開發的。當時 Wittgenstein 正研究處方一種名為 DHA（dihydroxyacetone，二羥丙酮；並不是魚油中名為二十二碳六烯酸的奧米加-3 脂肪酸）的化學物質以口服方式治療患上糖原貯積病的兒童，她觀察到與 DHA 接觸的皮膚部分明顯變色，然而這並不是科學家第一次注意到這種使皮膚變棕的現象，因為德國科學家早於上世紀 20 年代注意到這一點，但這是人們首次想到可以將 DHA 用於美容用途 [2]。Wittgenstein 於是對此作進一步研究，並在 1960 年發表了一篇論文，解釋 DHA 如何造成「人工曬黑」[3]。

問：嘩！你在告訴我：只要乖乖待在家裡塗美黑霜，不用在外承受夏天暑熱，就能得到一身小麥色的肌膚。這是怎麼做到的？產品有防曬功能嗎？

這可能會讓你驚訝：皮膚變棕的過程正是焗麵包和烤肉中的褐變反應，也就是梅納反應（Maillard reaction）。我們的皮膚結構上可以分為幾層，外層是一層死皮細胞。外層的氨基酸與不帶顏色的 DHA 發生梅納反應，就會產生名為類黑素（melanoidins）的褐色色素 [2]。

然而，這過程並不是瞬間完成的，只有在兩至三個小時後皮膚才會開始變黑，反應會持續一至三天 [2, 4]，產生的染色效果不能被水、肥皂或保濕霜洗掉，直至外層細胞脫落為止 [2, 4]，使棕色效果能持續一週 [2, 4]。

然而，與天然曬黑產生的黑色素（melanin）不同，類黑素本身並不能提供足夠的紫外線保護（圖一）。據估計美黑產品僅能提供相等於 SPF 3 的微弱保護，遠遠不足以提供防曬效果 [2]。因此，無論我們有否使用美黑產品，到戶外時都必須緊記塗上 SPF 數值足夠的防曬霜。



圖一 DHA 與不同氨基酸發生梅納反應產生的三種主要類黑素的化學結構（左）[5]，以及黑色素的計量結構（右）。黑色素高度共軛的 π 鍵（意指當中含有交替的單鍵和雙鍵）環系統使分子能夠有效吸收紫外線。

問：這聽起來不能使我對美黑產品有太大信心，而且美容業界不時會以誤導方式慫恿我們購買產品。科學家本身怎樣看美黑產品的安全性？

可能美黑和烤肉兩者原理都能歸因於同一個化學反應這點令人有點不安，但科學家還是覺得沒有太大值得擔憂的原因，雖然也有一些值得注意的地方。2008 年的一項研究曾在豬的皮膚上塗抹 20% DHA 溶液，再把其暴露於紫外線下，然後發現皮膚產生比正常多 180% 的有害自由基。這些自由基普遍被認為導致皮膚老化和皺紋的元兇，科學家由此推斷美黑產品可能會使我們皮膚更容易受紫外線侵害 [6]。然而，市面上大多數美黑霜都只含 3–5% 的 DHA，我們亦大可以在使用美黑產品後再塗防曬或留

在室內預防紫外線侵害 [2]。另一點需要注意的是，美國食品和藥物管理局僅批准以外用方式使用 DHA，意味著美黑乳液應比噴霧安全，因為這樣 DHA 就不會被吸入體內或意外吞食 [7]。總的來說，美黑產品被認為是比天然曬黑更安全的替代品。

問：太棒了！我可以給寵物噴灑美黑產品嗎？

好吧，相信不會有太多讀者想到這個問題，但顯然地有人這樣考慮過。2008 年另一項研究發現，在墨西哥無毛犬上使用5% DHA 會導致犬隻出現嚴重接觸性皮膚炎、水泡和表皮壞死 [8]。因此，如果你愛你的寵物，最好還是打消噴灑美黑產品的念頭！(《科言》編採部有必要作出一段聲明：殘酷對待動物是不對的，所以也請不要給你討厭的動物塗美黑霜。)

問：好吧，有點可怕。它會對人類造成傷害嗎？

除了上述提過的告誡外，任何化妝品都有可能使皮膚產生不良反應 — 這就是為甚麼在使用任何美容產品前，都應該先在一小塊皮膚上進行過敏測試。

從另一個角度看，美黑這個概念才可能是有害的。歷史上，「被陽光親吻過」的肌膚與在炎熱天氣下從事體力勞動的工作扣上關係，因此在傳統上不被認為是個具吸引力的特徵。儘管現今許多亞洲家庭裡還是繼續流傳這種根深蒂固的觀念，但是在氣候較冷的國家裡，曬黑反而是奢華的象徵，因為這代表具有能到熱帶旅遊勝地渡假的經濟能力 [9]。美黑產品的出現也許使一些遙不可及、短暫的審美標準和潮流對部分人來說變得觸手可及。它對世界某些地方帶來的又或者不是傷害，而是祝福，因為它使一度不被接納的深色肌膚變得深受愛戴，現在白皙膚色的人也開始追求更黝黑的肌膚。

1 除了獨特的外貌和舉止之外，特朗普亦因許多其他原因成為傳媒瘋狂追訪的對象。文中指的是他被拍到膚色呈鮮橙色的風波，他聲稱指控他使用美黑產品的傳言是「假新聞」，而傳言的真確性仍存有很大爭議 [1]。

防曬霜的科學

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#1 **#2**

References 參考資料：

[1] Rogers, K. (2019, February 2). In the Pale of Winter, Trump's Tan Remains a State Secret. *The New York Times*. *https://www.nytimes.com/2019/02/02/us/politics/trump-tan.html*

[2] Brunning, A. (2014, August 7). *How Do Tanning Lotions Work? – The Chemistry of Fake Tan*. Compound Interest. *https://www.compoundchem.com/2014/08/07/faketan/*

[3] Wittgenstein, E., & Berry, H. K. (1960). Staining of skin with dihydroxyacetone. *Science, 132*(3431), 894–895. *https://doi.org/10.1126/science.132.3431.894*

[4] Wong, M. (2015, November 3). The Science of How Fake Tan Works. *Lab Muffin Beauty Science*. *https://labmuffin.com/the-science-of-how-fake-tan-works/*

[5] Sun, Y., Zhang, P., Wang, X., Al-Zahrani, F. A. M., de Leeuw, N. H., & Lin, L. (2022). Deciphering key coloured compounds from sunless tanning reactions. *Dyes and Pigments, 204*, 110448. *https://doi.org/10.1016/j.dyepig.2022.110448*

[6] Jung, K., Seifert, M., Herrling, Th., & Fuchs, J. (2008). UV-generated free radicals (FR) in skin: Their prevention by sunscreens and their induction by self-tanning agents. *Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy, 69*(5), 1423–1428. *https://doi.org/10.1016/j.saa.2007.09.029*

[7] U.S. Food and Drug Administration. (2022, March 15). *Sunless Tanners & Bronzers*. *https://www.fda.gov/cosmetics/cosmetic-products/sunless-tanners-bronzers*

[8] Kimura, T. (2008). Contact dermatitis caused by sunless tanning treatment with dihydroxyacetone in hairless descendants of Mexican hairless dogs. *Environmental Toxicology, 24*(5), 506–512. *https://doi.org/10.1002/tox.20456*

[9] Edwards, A. (2017, March 23). The Bronze Age: Shedding light (and throwing shade) on our tanning infatuation. *Vox Magazine*. *https://www.voxmagazine.com/news/features/the-bronze-age-shedding-light-and-throwing-shade-on-our-tanning-infatuation/article_db0b63f0-04b2-53a1-8878-5d85c62402ca.html*

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