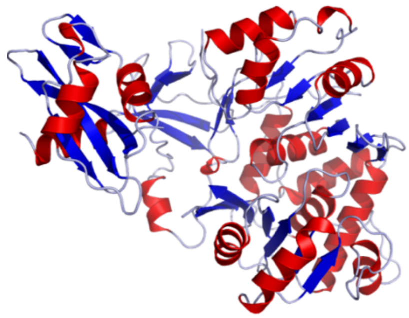
生物策略表

類別	生物策略 (Strategy)
生物策略 STRATEGY	螢火蟲會將一氧化氮送至線粒體結合，從而釋放氧氣以供點亮光源 (Fireflies send nitric oxide to bind to the mitochondria instead, freeing up the oxygen to fuel the light show)
生物系統 LIVING SYSTEM	普通東方螢火蟲 (Common eastern firefly)
功能類別 FUNCTIONS	#傳遞光訊號（可見光譜） #化學能轉型/轉換 #改變能量狀態 #Send light (visible spectrum) #Transform/convert chemical energy #Modify energy state
作用機制標題	普通東方螢火蟲透過一種化學反應產生光，該反應激發了一種分子，產生能釋放光子。 (The common eastern firefly produces light through a chemical reaction that energizes a molecule so it can release a photon.)
生物系統/作用機制示意圖 (確認版權、註明出處；畫質)	 

作用機制摘要說明 (SUMMARY OF FUNCTIONING MECHANISMS)

閃爍的功能早已知曉。最近揭示的更清晰的是對這個過程發生的確切理解。科學家已經追踪到這一特性與一組五種分子有關，這些分子位於稱為光細胞的細胞中，這些細胞位於螢火蟲的燈籠內部：熒光素、熒光酶、腺苷三磷酸（ATP）、一氧化氮（NO）和氧氣。昆蟲沒有像人類那樣的肺，而是透過稱為氣管小管的管道將氧氣運送到其體內。氧氣通過氣管小管進入光細胞，並結合到粒線體。通常情況下，線粒體會利用氧氣釋放能量進行正常的細胞過程。但當螢火蟲準備發光時，它們會發送一氧化氮來結合線粒體，從而釋放出氧氣，以供即將開始的光秀使用。氧氣進入另一個細胞結構，即過氧化物酶體。

The function of the flash has long been known. What's more recently been uncovered is a clear understanding of exactly how it happens. Scientists have tracked the trait down to a set of five molecules located in light-producing cells called photocytes that line a firefly's lantern: luciferin, luciferase, adenosine triphosphate (ATP), nitric oxide (NO), and oxygen. Insects do not have lungs like humans do, but instead transport oxygen into their bodies through tubes called tracheoles. Oxygen travels through the tracheoles and enters the photocytes, where it binds to mitochondria. Normally the mitochondria would use the oxygen to release energy for regular cellular processes. But when it's time to glow, fireflies send nitric oxide to bind to the mitochondria instead, freeing up the oxygen to fuel the light show about to begin. The oxygen enters another cellular structure, the peroxisome.

文獻引用 (REFERENCES)
在螢火蟲的生物發光反應中，一種稱為熒光酶的酵素利用腺苷三磷酸（ATP）來活化一種被稱為熒光素的分子。此反應的產物與分子氧結合，產生一種興奮態的氧化熒光素物種。當氧化熒光素回復到其基態時，能量以光的形式釋放出來。當然，這個主題存在著變化。生物發光的一個迷人之處在於它演化了許多不同的變化。不同的生物透過結構上不同的熒光素和酵素來實現生物發光。 螢火蟲熒光酶透過將基質熒光素轉換為相應的腺苷酸酯，然後氧化為生物發光的發射器氧熒光素來產生光。我們已經確認了通常認為的氧化步驟是由形成的碳負離子中間體開始，並涉及過氧化氫（陰離子）。此外，我們提供了結構證據，解釋了氧氣如何運送到基質反應位點。在這裡，我們報告了關鍵的令人信服的光譜證據，證實了超氧陰離子參與相關化學模型反應的參與，這支持了關鍵氧化過程的單電子轉移途徑。 In a firefly bioluminescence reaction, an enzyme known as a luciferase uses adenosine triphosphate (ATP) to activate a molecule called a luciferin. The product of this reaction combines with molecular oxygen to produce an excited-state oxyluciferin species. When oxyluciferin relaxes back to its ground state, energy is released in the form of light. There are variations on this theme, of course. One of the fascinating aspects of bioluminescence is how many variations have evolved. Different organisms have come up with structurally different luciferins and enzymes to attain bioluminescence. (Pepling 2006:36) Firefly luciferase produces light by converting substrate beetle luciferin into the corresponding adenylate that it subsequently oxidizes to oxyluciferin, the emitter of bioluminescence. We have confirmed the generally held notions that the oxidation step is initiated by formation of a carbanion intermediate and that a hydroperoxide (anion) is involved. Additionally, structural evidence is presented that accounts for the delivery of oxygen to the substrate reaction site. Herein, we report key convincing spectroscopic evidence of the participation of superoxide anion in a related chemical model reaction that supports a single electron-transfer pathway for the critical oxidative process. (Branchini et al. 2015:7592)
參考文獻清單與連結 (REFERENCE LIST) **Harvard 或 APA 格式**
All That Glows: Bioluminescence provides practical applications while still remaining a mystery *Chemical & Engineering News* | 2006 | R.S. Pepling **Experimental Support for a Single Electron-Transfer Oxidation Mechanism in Firefly Bioluminescence** *J. American Chemical Society* | June 9, 2015 | B.R. Branchini, C.E. Behney, T.L. Southworth, D.M. Fontaine, A.M. Gulick, D. J. Vinyard, G.W. Brudvig **Biologically inspired LED lens from cuticular nanostructures of firefly lantern** *Proceedings of the National Academy of Sciences* | October 30, 2012 | J.-J. Kim, Y. Lee, H. G. Kim, K.-J. Choi, H.-S. Kweon, S. Park, K.-H. Jeong
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