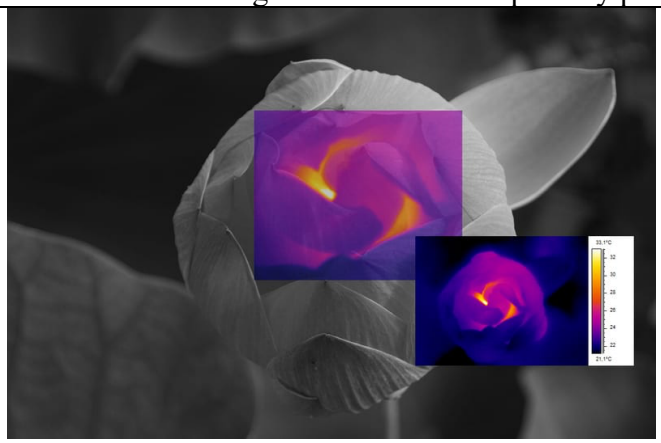
生物策略表

類別	生物策略 (Strategy)
生物策略 STRATEGY	電子流產生熱量 (Electron Flow Generates Heat)
生物系統 LIVING SYSTEM	神聖蓮花 (Sacred Lotus)
功能類別 FUNCTIONS	#轉換熱能 #在非可見光譜中傳送光訊號 #Transform Thermal Energy #Send Light Signals in the Non-visible Spectrum
作用機制標題	神聖的蓮花透過非磷酸化電子傳輸途徑產生熱量來吸引授粉者，該途徑透過替代呼吸途徑透過電子流釋放能量。 (The sacred lotus attracts pollinators by producing heat through a nonphosphorylating electron transport pathway that releases energy by electron flow through an alternative respiratory pathway.)
生物系統/作用機制示意圖 (確認版權、註明出處；畫質)	 https://asknature.org/strategy/electron-flow-generates-heat/

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

替代呼吸途徑，由替代途徑催化

氧化酶（AOX）負責神聖蓮花（*Nelumbo nucifera*）的熱量生產。“我們報告了使用氧同位素辨別技術的體內測量結果，透過熱源性植物組織（*Nelumbo nucifera*）的花貯器中的替代和細胞色素呼吸通路進行通量。 在溫度響應環境溫度的不同程度的熱生成的熱調節花卉中，測量了透過兩種途徑的通量。 在溫度高於環境溫度 16 攝氏度至 20 攝氏度的蓮花容器中，替代通路通量顯著增加，但在加熱量較少的蓮花容器中卻沒有。 最熱的貯器中的替代通路通量佔總呼吸通量的 75%。 相比之下，在熱生成期間，透過細胞色素通路的通量沒有顯著變化。 這些資料支援了這樣的假設，即透過替代途徑增加的通量是蓮花加熱的原因，並且透過細胞色素途徑產生增加通量的解耦合蛋白質不太可能對這種組織的加熱有重大貢獻。 使用抑制劑確定的實際通量與容量的比較表明，替代途徑在蓮花加熱組織中以接近最大容量執行。 然而，在非加熱組織中，抑制劑資料大大高估了替代通路通量。 這證實了同位素測量對於準確確定透過兩種途徑的通量是必要的。” (Watling 等人。 2006:1367)

The alternative pathway of respiration, catalyzed by the Alternative Oxidase (AOX), is responsible for heat production in the sacred lotus (*Nelumbo nucifera).*"We report results from in vivo measurements, using oxygen isotope discrimination techniques, of fluxes through the alternative and cytochrome respiratory pathways in thermogenic plant tissue, the floral receptacle of the sacred lotus (*Nelumbo nucifera*). Fluxes through both pathways were measured in thermoregulating flowers undergoing varying degrees of thermogenesis in response to ambient temperature. Significant increases in alternative pathway flux were found in lotus receptacles with temperatures 16$_{o}$C to 20$_{o}$C above ambient, but not in those with lesser amounts of heating. Alternative pathway flux in the hottest receptacles was 75% of the total respiratory flux. In contrast, fluxes through the cytochrome pathway did not change significantly during thermogenesis. These data support the hypothesis that increased flux through the alternative pathway is responsible for heating in the lotus and that it is unlikely that uncoupling proteins, which would have produced increased fluxes through the cytochrome pathway, contribute significantly to heating in this tissue. Comparisons of actual flux, with capacity determined using inhibitors, suggested that the alternative pathway was operating at close to maximum capacity in heating tissues of lotus. However, in nonheating tissues the inhibitor data significantly overestimated the alternative pathway flux. This confirms that isotopic measurements are necessary for accurate determination of fluxes through the two pathways." (Watling et al. 2006:1367)

文獻引用 (REFERENCES)

神聖蓮花的花朵，Nelumbo nucifera Gaertn。（蓮科）具有產熱及生理溫度調節作用。儘管環境溫度在約 10-45°C 之間波動，但 42 克花朵在 2-4 天內仍保持在 30-36°C 之間。(Roger S. Seymour and Paul Schultze-Motel)

環境溫度下降，花朵產熱量成比例增加。溫度調節顯然發生在細胞層面上，透過在花溫度高於 30°C 時對呼吸的急劇、可逆的熱抑制進行。(Roger S. Seymour and Paul Schultze-Motel)

溫度調節可能為昆蟲傳粉者帶來溫暖、平穩的環境，或它可能促進和協調花卉的發育。(Roger S. Seymour and Paul Schultze-Motel)

Flowers of the sacred lotus, Nelumbo nucifera Gaertn. (Nelumbonaceae) are thermogenic and physiologically thermoregulatory. The 42 g flowers remain between 30-36 °C during a 2-4-day period despite fluctuations in environmental temperatures between about 10-45°C. (Roger S. Seymour and Paul Schultze-Motel)

the ambient temperature drops, the flowers increase heat production in proportion. temperature regulation apparently occurs at a cellular level, by a steep, reversible thermal inhibition of respiration at lower temperatures above 30 °C. (Roger S. Seymour and Paul Schultze-Motel)

Temperature regulation may reward insect pollinators with a warm, equable environment, or it possibly enhances and coordinates flower development. (Roger S. Seymour and Paul Schultze-Motel)

參考文獻清單與連結 (REFERENCE LIST) **Harvard 或 APA 格式**
Seymour, R. S., & Schultze-Motel, P. (1998). Physiological Temperature Regulation by Flowers of the Sacred Lotus. *Philosophical Transactions: Biological Sciences*, *353*(1371), 935–943. (http://www.jstor.org/stable/56822)
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