

生物策略表

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| 類別 | 生物策略 (Strategy) |
| 生物策略 STRATEGY | 棕色脂肪氧化產生熱量 (Brown fat oxidation generates heat) |
| 生物系統 LIVING SYSTEM | 哥倫比亞地松鼠 <i>Uroditellus columbianus</i> (Columbian ground squirrel) |
| 功能類別 FUNCTIONS | #熱能轉型 #Transform thermal energy |
| 作用機制標題 | 地松鼠在冬眠後氧化棕色脂肪，使脂肪細胞快速產生熱量 (Fat cells in ground squirrels generate heat rapidly following hibernation by oxidizing brown fat.) |
| 生物系統/作用機制 示意圖 |  |
| 作用機制摘要說明 (SUMMARY OF FUNCTIONING MECHANISMS) | |
| 文獻引用 (REFERENCES) | |
| <p>「在冬眠期間定期補充脂肪供應的地松鼠，可以在三小時之內就從深度睡眠中醒來。在這個時候，大量脂肪被當作燃料燃燒，以提高體溫。伴隨著劇烈的顫抖和肌肉收縮，也能產生熱量。大部分熱量來自棕色脂肪的氧化，這是一種含有許多產能細胞的脂肪。地松鼠有高達 57% 的棕色脂肪在肩膀周圍，頸部有 14%，其餘大部分在胸部。這種物質就像電熱毯在作用，將熱量釋放到心臟和主要血管使其溫暖，並加速氧氣循環到大腦和其他身體前方器官 (anterior organ)，然後再到達後方區域。在甦醒期間，前方骨骼肌 (anterior skeletal muscle) 所獲得的血液量，比完全甦醒的對照個體多了 16 倍，能增強其顫抖 (shivering) 來產熱以提高體溫。」(Shuker 2001: 101)</p> <p>「棕色脂肪組織 (BAT) 是一種脂肪儲存組織，相當大量存在於小型哺乳動物及人類新生兒。BAT 是高度血管化的，富含粒線體 (mitochondria) 並以特殊方式燃燒脂肪以產熱。或許它可以提供齧齒動物 (rodent) 在冬季存活所需的溫暖，以及在甦醒時可能的作用？」</p> <p>研究團隊發現冷馴化鼠的 BAT 吸收了被氧化的脂肪酸來產生熱量。令人驚訝的是這些老鼠的轉化率比其他老鼠高 12 倍。再者，當其他老鼠放慢呼吸時，冷馴化鼠會增加呼</p> | |

吸速率，讓充氧血更能供應至 BAT，使其在寒冷時能維持體溫。

作者判斷 BAT 是非冬眠者真正的「產熱機器」…在寒冷狀態下，科學家認為非冬眠者用來維持溫暖並保持警覺的 BAT 脂肪代謝，可能是早期哺乳類演化成功的關鍵之一。」
(Rummer 2010: vi)

“Ground squirrels, which replenish their fat supplies regularly during hibernation, can awaken from their deep sleep in less than three hours. In this time, large amounts of fat are burned as fuel to raise the body temperature. This is accompanied by intense shivering and muscle contraction, which also generate heat. Much of the heat is derived from oxidation of brown fat, a kind of fat that contains many energy-producing cells. As much as 57 percent of the brown fat in ground squirrels is around their shoulders, with 14 percent in their neck, and most of the remainder in their thorax. This substance acts like an electric blanket, releasing heat to the heart and major blood vessels to warm them and speed the circulation of oxygen to the brain and other anterior organs, and then to the posterior body regions. During arousal, the anterior skeletal muscles receive over 16 times more blood than their counterparts in a fully awake animal, powering their shivering to produce heat for raising the body’s temperature.” (Shuker 2001: 101)

“...Brown adipose tissue (BAT) is a fat storage tissue especially abundant in small mammals and newborn humans. BAT is highly vascularised, full of mitochondria and burns fat to produce heat in a special way. Maybe it could provide the warmth the rodents require to survive winter in addition to its supposed role in arousal?

The team found that the BAT of cold acclimated rats took up fatty acids that were oxidised to generate heat. Amazingly, these rats were up to 12 times better at the conversion than the other rats. Additionally, while the other rats slowed their ventilation, the cold acclimated rats increased their breathing rate to better supply BAT with oxygenated blood and hence maintain their temperature while being cooled.

The authors decided that BAT is the true ‘thermogenic machinery’ for non-hibernators... Scientists think BAT fat metabolism that non-hibernators use to stay warm and remain alert during cold conditions may have been one key to the evolutionary success of early mammals.”
(Rummer 2010: vi)

參考文獻清單與連結 (REFERENCE LIST)

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contribute to the defence of core temperature in response to acute cold. *Comparative Biochemistry and Physiology Part A: Molecular & Integrative Physiology*. 154: 514-522. (<https://doi.org/10.1016/j.cbpa.2009.08.008>)

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延伸閱讀

生物系統延伸資訊連結 (LEARN MORE ABOUT THE LIVING SYSTEM/S)

<https://en.wikipedia.org/wiki/Spermophilus>

撰寫/翻譯/編修者與日期

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AskNature 原文連結

<https://asknature.org/strategy/brown-fat-oxidation-generates-heat/>