


生物策略表

類別	生物策略 (Strategy)
生物策略 STRATEGY	高效率的纖維排列 (Fiber Arrangement Is Highly Efficient)
生物系統 LIVING SYSTEM	羅漢竹 <i>Phyllostachys aurea</i> (Fish-pole bamboo)
功能類別 FUNCTIONS	#應付張力 #應付擠壓 #Manage Tension #Manage Compression
作用機制標題	竹子莖部纖維由於排列而能有效率地使用材料 (Fibers in stems of bamboo use materials efficiently because of their arrangement)
生物系統/作用機制 示意圖	 <p>The image block contains three photographs. The top left shows several green bamboo stalks. The top right shows a bamboo plant with leaves. The bottom left shows a cross-section of a bamboo stem, which is hollow. The bottom right is a scanning electron micrograph (SEM) of the bamboo stem's internal structure, showing a dense arrangement of vascular bundles. A scale bar in the SEM image indicates 1 mm and 15 kV.</p>
作用機制摘要說明 (SUMMARY OF FUNCTIONING MECHANISMS)	
<p>竹子是一種堅固而柔韌的複合材料 (composite)。像木頭一樣，它的強度來自呈垂直排列且嵌入無定形 (amorphous) 排列的纖維素 (cellulose) 包裹的維管束 (vascular bundle)。維管束有著作為運輸管道和加固莖桿的雙重作用。樹木和其它木本植物是實心的圓柱體，整體均勻分佈著強韌的維管束，但是，竹子會形成空心的管狀莖。管壁的橫截面顯示維管束隨著密度梯度 (density gradient) 排列。在管壁的內表面，竹子組織主要是矩陣排列，而強韌的維管束之比例則隨著往管壁外緣而增加。管壁外緣是應力最強的地方，因此竹子透過將最堅硬的材料放在最需要的地方來使材料的使用最佳化。</p> <p>Bamboo is a strong and flexible composite. Like wood, it gets much of its strength from cellulose fiber-wrapped vascular bundles arranged vertically and embedded in an amorphous matrix. The bundles serve dual functions as transport vessels and reinforcement for the stem. Trees and other woody plants are solid cylinders with the strong vascular bundles evenly</p>	

arranged throughout. Bamboo, however, forms hollow tubes. Cross-sections through the tube walls show that the vascular bundles are arranged in a density gradient. At the inner surface of the tube wall, the bamboo tissue is predominantly matrix, while the proportion of strong vascular bundles increases towards the outer edge. The outside edge is where the stresses are strongest and so the plant optimizes material use by placing the toughest materials where they are most needed.

文獻引用 (REFERENCES)

參考文獻清單與連結 (REFERENCE LIST)

Sato, M., A. Inoue, and H. Shima. (2017). Bamboo-inspired optimal design for functionally graded hollow cylinders. *PLoS ONE* 12: e0175029.
(<https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0175029>)

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

<https://asknature.org/system/flowering-plants?post-type=Biological%20Strategies>

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AskNature原文連結

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