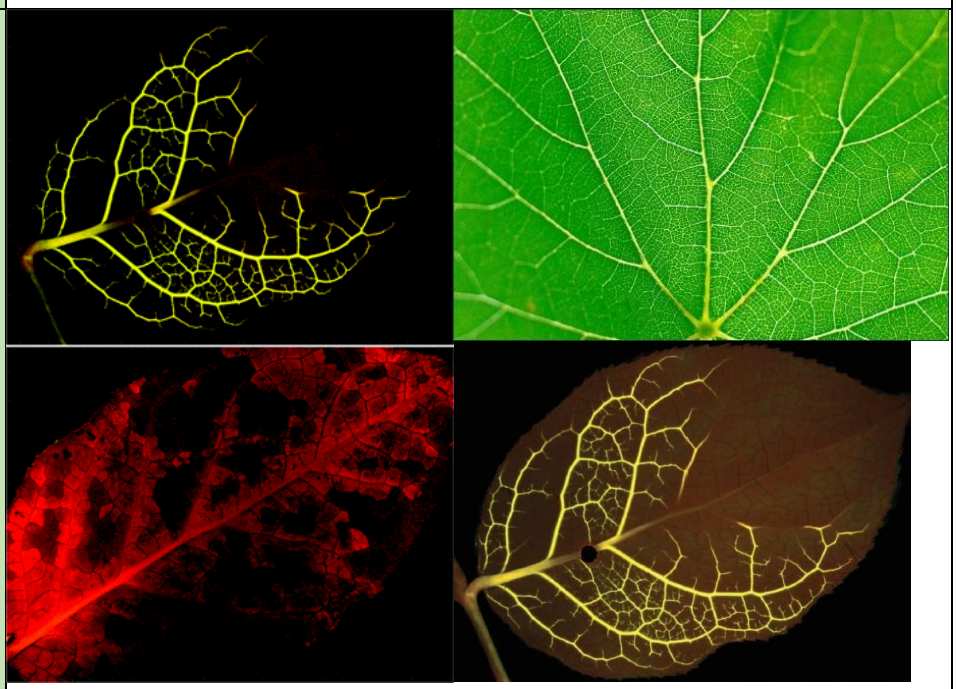
生物策略表

類別	生物策略 (Strategy)
生物策略 STRATEGY	迴圈網路使水分及養分的流動最佳化 (Looped Network Optimizes Water and Nutrient Flow)
生物系統 LIVING SYSTEM	檸檬 (Lemon)
功能類別 FUNCTIONS	#分配液體 #形狀/材料最佳化 #Distribute Liquids #Optimize Shape/Materials
作用機制標題	葉子中的葉脈系統因為是嵌套式、互相連結的緊密迴圈，能最佳化液體的流動及面對傷害時的回復性 (Vein systems in leaves allow for optimal flow and resilience to damage due to a dense network of nested, interconnected loops.)
生物系統/作用機制示意圖	

作用機制摘要說明 (Summary of functioning mechanisms)

在自然或人造系統中，網路 (network) 都能把物質從中央源頭輸送到廣為分散的目的地。分支的、樹狀的網路包含重複地分叉的節點 (node)，常常可以在河川網路或污水系統 (sewage system) 中發現，是一種常見的網路設計。雖然這種設計容許系統頻繁且有效率地輸送資源，但只有在持續且不間斷流動的狀態下才會有最佳效果。在其它系統中，例如大腦的血管和葉片的葉脈 (vein) 網路必須為最佳狀態，以快速地對負載的波動 (fluctuation) 進行反應，或快速地改變流動路徑以應付損害。這些運輸網路都有共同的模式：互相連結 (interconnected)、嵌套式 (nested) 的迴圈 (loop)。迴圈對於這些運輸網路非常重要，因為它們容許物質隨著條件改變而跟隨不同的路徑流動。

舉例來說，檸檬樹的葉片中有一條主脈從中間貫穿，運送水分到行光合作用的細胞，並將醣類 (sugars) 運離。而次級葉脈 (secondary vein) 會從主葉脈分岔，類似樹狀網路。然而，所有葉脈會額外地以嵌套式迴圈的方式互相連接，較大的迴圈中還有許多更小的迴圈。這些在葉片上遍佈、互相連接且嵌套式的迴圈，能使物質流在葉片受傷或是需要改變流動方向的情況下，快速地重新導向到其他葉脈。這種設計使葉片能快速且有效率地回應物質流中的波動，並能在受傷害時保持回復力 (resilient)。

In both natural and man-made systems, networks transport materials from a central source to widely distributed destinations. Branched, tree-like networks that contain repeatedly forking nodes, as are often found in river networks and sewage systems, are one of the most common network designs. Although this design allows for rapid and efficient transport through a system, it is only optimal if the flow is constant across time and space. In other systems, such as the blood vessels of the brain and the veins of leaves, networks must be optimized to quickly respond to fluctuations in load, or rapidly re-route flow in response to damage. These networks all have a common pattern of interconnected, nested loops. Loops are essential for these networks, because they allow material to follow different paths as conditions change.

For example, in leaves of the lemon tree, a main vein runs through the center, transporting water to the photosynthetic cells, and sugars away from them. Secondary veins branch off the main vein, similar to a tree-like network. However, all the veins are additionally connected to each other through a pattern of nested loops, with several smaller loops inside larger ones. This pattern of interconnected, nested loops throughout the leaf allows for flow to be quickly re-routed to any other vein in the event of injury, or when a change in flow is required. This allows the leaf to rapidly and efficiently respond to fluctuations in flow, while remaining resilient to damage.

文獻引用 (REFERENCES)

參考文獻清單與連結 (REFERENCE LIST)

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撰寫/翻譯/編修者與日期

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