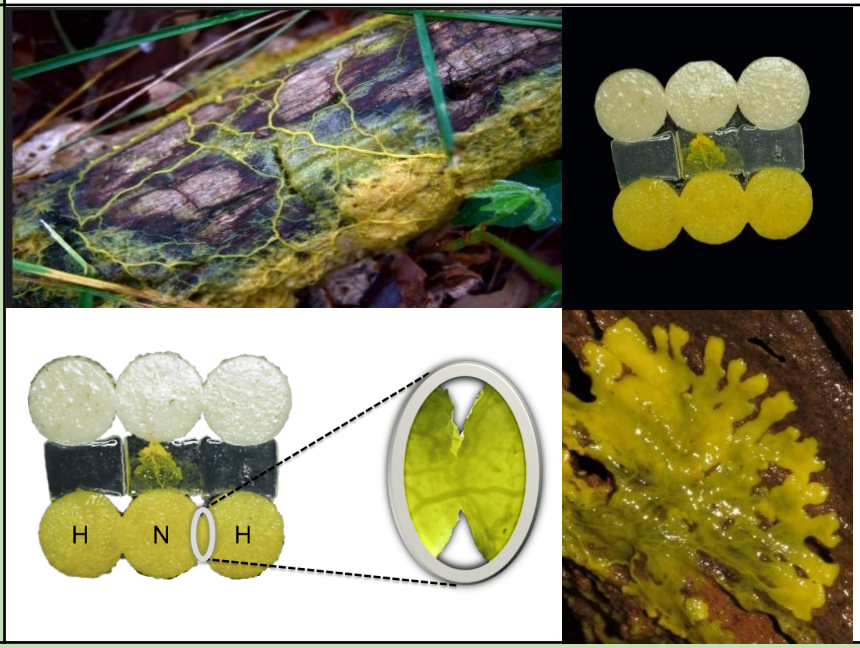
生物策略表

類別	生物策略 (Strategy)
生物策略 STRATEGY	不需大腦即可獲得、儲存與傳遞資訊 (Information Gained, Stored, and Transferred Without Brains)
生物系統 LIVING SYSTEM	多頭絨泡菌 *Physarum polycephalum* (Slime mold)
功能類別 FUNCTIONS	#學習 #相同物種之間合作 #Learn #Cooperate Within the Same Species
作用機制標題	儘管缺乏神經系統，黏菌仍然可以透過和其他黏菌連結一段時間來學習和分享其習得知識 (Despite the lack of a nervous system, slime molds can learn and share what they learn with other slime molds by joining together for a time.)
生物系統/作用機制示意圖	

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

介紹

黏菌 (slime mold) 中的多頭絨泡菌 (*Physarum polycephalum*) 既不是動物也不是植物，是生活在潮濕森林中的一種大型單細胞生物。乍看之下像是飛濺的油漆，但細心觀察下會發現它透過分泌 (oozing) 手指狀的凸出以在平面上蠕動前行。

儘管黏菌沒有大腦，它還是能根據過去的經驗來改變自身行為，從而表現出簡單的學習方式。黏菌亦可以透過與其它黏菌融合幾個小時，而將學習到的知識傳遞給對方。科學家透過給予不同黏菌機會去爬過一條由鹽製成的小橋（它們通常會避開）來獲得食物獎勵，從而發現了這一點。

策略

實驗的設置很簡單：訓練一組黏菌通過沒有鹽的橋。接下來，將這組黏菌一半曝露於有鹽的橋上。起初它們會排斥，但最終還是越過橋了。而另一半沒有曝露在鹽橋上。

待會兩組黏菌都試著跨越鹽橋，有跨越鹽橋經驗的一組比另一組更快通過討厭的鹽巴而得到美味的食物。然後，當一組已經學會了忍耐鹽巴以取得獎勵的黏菌與另一組黏菌合併，只要兩者連結的時間超過一個小時，在它們之間形成了連接結構，第二組黏菌即使與同伴分離，還是會立刻跨越鹽橋。

Introduction

Neither animal nor plant, the slime mold *Physarum polycephalum* is a large-scale single-celled organism that lives in damp forests. At a glance it may look like a splash of paint, but patient observation reveals it creeping across surfaces by oozing forward in fingerlike projections.

Even though it doesn't have a brain, the slime mold exhibits a simple form of learning by changing its behavior based on past experience. It also can pass what it learns to another slime mold simply by fusing with it for a couple of hours. Scientists discovered this by giving different slime molds a chance to creep across a tiny bridge made of salt (which they usually avoid) to reach a food reward.

The Strategy

The setup of the experiment was simple: A group of slime molds was taught to cross a bridge without salt. Next, half of those slime molds were exposed to a bridge with salt. They were repelled at first, but eventually crossed anyway. The other half were not exposed to a salt bridge.

When both groups were later given a chance to cross a salt bridge, the slime molds that had experience with a salt bridge traveled across the "yuck" to get to the "yum" more quickly than the others. Then, when a slime mold that had learned to tolerate the salt in order to reach the treat merged with another slime mold, the second slime mold also readily crossed the salt bridge—even after being separated from its partner—as long as the two had been together longer than an hour and had formed a connecting structure between them.

文獻引用 (REFERENCES)

隨著次世代網路 (next-generation network) 的規模預期變得非常大，通訊的集中化控制變得不可行。借助分散式智慧 (distributed intelligence)，多頭絨泡菌可以分散化的控制系統，提供了對於次世代、具適應性和耐用的空間基礎網路 (decentralized control system) 之設計。(Sun 2019:2)

"As the scales of the next-generation networks are expected to be extremely large, centralized control of communication becomes impractical. With the distributed intelligence, *Physarum* may inform the design of next generation, adaptive, robust spatial infrastructure networks with decentralized control systems." (Sun 2019: 2)

參考文獻清單與連結 (REFERENCE LIST)

Sun, Y. (2019). *Physarum*-inspired network optimization: a review. *arXiv*: 1712.02910v2. (https://arxiv.org/abs/1712.02910)

Vogel, D and A. Dussutour. (2016). Direct transfer of learned behaviour via cell fusion in non-neural organisms. *Proceedings of the Royal Society B* 283: 1845. (https://doi.org/10.1098/rspb.2016.2382)

延伸閱讀**: Harvard** 或 **APA** 格式（取自 **AskNature** 原文；若為翻譯者補充，請註明）

Krupin, K. (12 October, 2020). Birds Build Responsively. *AskNature*. Retrieved from: https://asknature.org/strategy/birds-build-responsively/

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

https://asknature.org/system/protists?post-type=Biological%20Strategies

撰寫/翻譯/編修者與日期

鄭聿嫻翻譯 (2021/04/07)；譚國鎏編修 (2021/07/13)；林有駿編修 (2021/11/21)；陳柏宇編修 (2022/01/02)

AskNature原文連結

https://asknature.org/strategy/brainless-slime-molds-both-learn-and-teach/