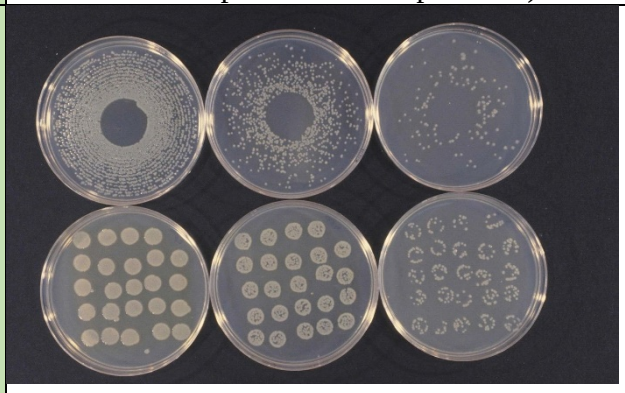
生物策略表

類別	生物策略 (Strategy)
生物策略 STRATEGY	蛋白質形成冰核 (Proteins cause ice nucleation)
生物系統 LIVING SYSTEM	假單胞菌屬細菌 *Pseudomonas* (Bacteria, Pseudomonas)
功能類別 FUNCTIONS	#改變相性 #Modify phase
作用機制標題	植物病原菌的丁香假單胞菌細胞，可以藉由特殊的表面蛋白形成冰核 (The cells of *Pseudomonas syringae*, a plant pathogen, can cause ice nucleation via specific surface proteins.)
生物系統/作用機制示意圖	  菌落及受感染的番茄葉 (維基百科，許秋容加入)

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

文獻引用 (REFERENCES)

「丁香假單胞菌是少數被發現可以傳播至雲層中的植物病原菌 (Jayaweera and Flanagan, 1982; Sands et al., 1982) 。它還能隨著降雨而從空氣中被沖刷出來 (Constantinidou et al., 1990) 。在此細菌中有許多菌株具有冰核形成活性 (Lindow, 1983)，被發現能存活在冰凍的環境中，以及擁有引導結冰的能力，甚至被認為它們可能因為透過形成冰核的作用而在引起降雨的過程中扮演著重要的角色。(Morris et al., 2004)」 (Morris et al. 2007: 85)

「抗凍蛋白 (Antifreeze proteins, AFPs) 能抑制冰的生成，而冰核蛋白 (ice-nucleation proteins, INPs) 可以促進冰的形成…雖然有一些生物也被認為擁有形成冰核的活性，但在生物化學的方法中，最有特色的還是細菌的冰核蛋白。在這些 INPs 中，丁香假單胞菌的 INPs 通常被當作最具代表性的蛋白。」 (Graether and Jia 2001: 1169)

"*P. syringae* is one of the few plant pathogens known to be disseminated up into clouds (Jayaweera and Flanagan, 1982; Sands et al., 1982). It is also scrubbed from the air during rain (Constantinidou et al., 1990). Many strains of this bacterium are ice nucleation-active (Lindow, 1983), are known to survive freezing as well as induce freezing, and it has been suggested that

they might even have a role in inciting rainfall via their ice nucleation activity (Morris et al., 2004).” (Morris et al. 2007: 85)

“Antifreeze proteins (AFPs) inhibit the growth of ice, whereas ice-nucleation proteins (INPs) promote its formation…Although several organisms have been identified as having ice-nucleation activity, the best characterized by biochemical methods are the bacterial INPs. Of these INPs, that of *Pseudomonas syringae* is often used as a representative protein.” (Graether and Jia 2001: 1169)

參考文獻清單與連結 (REFERENCE LIST)

Morris, C. E., L. L. Kinkel, K. Xiao, P. Prior, and D. C. Sands. (2007). Surprising niche for the plant pathogen *Pseudomonas syringae*. *Infection, Genetics and Evolution* 7: 84-92. (https://www.sciencedirect.com/science/article/abs/pii/S1567134806000736)

Graether, S. P. and Jia, Z. (2001). Modeling *Pseudomonas syringae* ice-nucleation protein as aβ-helical protein. *Biophysical journal* 80: 1169-1173. (https://www.sciencedirect.com/science/article/pii/S0006349501760936)

延伸閱讀: Harvard 或 APA 格式

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

https://en.wikipedia.org/wiki/Bacteria

https://en.wikipedia.org/wiki/Pseudomonas

撰寫/翻譯/編修者與日期

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AskNature 原文連結

https://asknature.org/strategy/proteins-cause-ice-nucleation/