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How soil health-promoting *Streptomyces* adapt to soil stresses

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Actinobacteria of the genus *Streptomyces* play a crucial role in supporting a fertile and biologically active soil ecosystem due to their unique biological and ecological functions¹. They secrete a broad array of hydrolases which break down complex organic compounds like cellulose and chitin needed for recycling of nutrients and enrichment of the soil. They also produce many different antibiotics that suppress soil-borne pathogens, promoting a healthier microbial balance. However, in their natural habitat soil, streptomycetes and other microorganisms are often exposed to rapid changes in their environment such as variations in osmolality due to rainfall or drought. How they adapt to different types of stresses they face in soil is not well understood.

Many strategies that bacteria evolved for the adaptation to stress involve complex second messenger signalling cascades². Nucleotide-based second messengers are small, diffusible molecules which can be monomeric, such as 3',5'-cyclic adenosine monophosphate (cAMP) or dimeric for example bis-(3'-5')-cyclic dimeric adenosine monophosphate (c-di-AMP). *Streptomyces* use five different nucleotide-based second messengers for signal transduction with dedicated and to some extent overlapping functions³. c-di-AMP is produced out of two molecules of ATP by the deadenylate cyclase DisA and is hydrolysed to the linear pApA and further to AMP by the phosphodiesterase AtaC. Increased levels of the signalling molecule interfere with the formation of stress-resistant spores, while deletion of the deadenylate cyclase makes *Streptomyces* highly susceptible to osmotic stress⁴. The molecular mechanisms causing failures in cell functioning upon modulation of c-di-AMP are not yet fully understood. In our recent studies, we found that c-di-AMP affects a range of physiological functions at the cell-environment interface, such as transport and cell wall architecture, and thus fulfils a crucial role for stress adaptation in streptomycetes.

[1] Chater K.F., Biro S., Lee K.J., Palmer T., Schrempf H. The complex extracellular biology of *Streptomyces*. FEMS Microbiology Reviews, Volume 34, Issue 2, March 2010, Pages 171–198

[2] Bhowmick, S., Shenouda, M.L., and Tschowri, N. (2023). Osmotic stress responses and the biology of the second messenger c-di-AMP in *Streptomyces*. *MicroLife* 4, uqad020

[3] Latoscha, A., Wörmann, M.E., and Tschowri, N. (2019). Nucleotide second messengers in *Streptomyces*. *Microbiology* 165, 1153–1165.

[4] Latoscha, A., Drexler, D.J., Al-Bassam, M.M., Bandera, A.M., Kaefer, V., Findlay, K.C., Witte, G., and Tschowri, N. (2020). c-di-AMP hydrolysis by the phosphodiesterase AtaC promotes differentiation of multicellular bacteria. *Proc Natl Acad Sci U S A* 117, 7392–7400.

Keywords

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Professional Status of the Speaker

Professor

Junior Scientist Status

No, I am not a Junior Scientist.

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