iCase Project / AY 2024 -2025

# Spore mimetics: Bioengineering Gram-negative biological control products for enhanced desiccation tolerance

**Project Reference:** ICS-CEB-GC

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**Department/Institute:** Chemical Engineering and Biotechnology

**Website:** https://www.ceb.cam.ac.uk/research/groups/mm

**Industrial Partner:** Syngenta

**Research area:** Technologies for Enabling the Formulation of Sensitive Microbials

**BBSRC DTP main strategic theme:** Bioscience for sustainable agriculture and food

**BBSRC DTP secondary strategic theme:** Transformative technologies

**Project outline:**

The problem: Thermotolerant bacterial spores have found widespread application as 'biologicals' in the agri-tech and related sectors. However, other microorganisms with potentially useful attributes, including certain gram negative bacteria, remain a challenge to develop into biological control products due to their sensitivity to processing conditions and their instability (e.g., to desiccation) in the final product. Syngenta are looking for techniques to improve the production of ambient stored, long-term stable sensitive microbials.

Proposed solution: The aforementioned spores – more specifically endospores formed by certain members of the phylum Bacillota – are additionally resistant to desiccation, UV and ionising radiation, various chemicals including oxidising and alkylating agents, and enzymes. The spore adopts a combinatorial approach to such challenges. Desiccation, for example, is countered by the presence of a unique class of DNA binding proteins and associated DNA repair systems. These are coupled with the presence of a highly mineralised protoplast, which collectively minimises the mutations and DNA breaks associated with desiccation-induced cell death. Recent insights to the molecular mechanisms that underpin spore resistance are such that we can now feasibly use synthetic biology approaches to introduce defined elements of spore resistance pathways to gram negative bacterial bio-control agents i.e., in effect 'ruggedizing' them for bioprocessing, storage and subsequent field application. Accordingly, the current project will focus on enhancing the desiccation tolerance of select *Pseudomonas* and/or *Rhizobium* species by developing systems that permit the generation of a new class of spore mimetic bacterial bio-control strains.