Project title: Next-gen biological crop protection using antifungal proteins and peptides from natural yeast isolates

Lead Supervisor and Department: Dr Sonja Billerbeck, Department of Bioengineering

Co-Supervisor(s) and Department(s): Prof Jason Micklefield, Department of Chemistry

Project Description:

Crop diseases pose a significant threat to global food security eith Fungi are responsible for 80% of crop diseases, leading to over 20% loss in crop productivity annually. Although chemical fungicides have long been effective, their overuse along with crop monoculturing, climate change, and global trade has accelerated disease spread and resistance development. Moreover, broad-spectrum fungicides harm biodiversity. There is an urgent need for new, targeted, and functionally diverse biocontrol strategies to sustainably protect crops from fungal pathogens.

Environmental yeasts offer a diverse, yet underexplored potential for fungal biocontrol. They naturally inhibit pathogens through secreted antifungal molecules such as siderophores, antifungal proteins and peptides (ribosomal and non-ribosomal), volatiles, and biosurfactants. Many act selectively against a narrow pathogen range, enabling targeted control that preserves beneficial microbiota. Their safety, scalability, and genetic tractability make them promising candidates for biological plant protection. **Informal co-funding from Syngenta, a leading crop-control company and Imperial partner, underscores growing industrial interest in yeast-based biocontrol.**

Challenges and aim: The molecular mechanisms and genes that are responsible for the antagonistic activities of yeast remain largely unknown [ref], complicating efforts to optimize and customize their biocontrol capacities. **This proposal will integrate functional genomics with synthetic biology,** to verify the genetic basis of the biocontrol traits of three in-house yeast belonging to the genus *Aureobasidium* spec [DOI:10.1016/j.nbt.2025.01.008] – focussing on antifungal proteins and peptides targeting the plant pathogen *Botrytis cinerea* – and how they individually and in combination contribute to their antifungal capacity and targeting specificity. This will involve the following steps:

1. Genome sequencing (*3 months).*
2. Proteomics and metabolomics of the secretome (*3 months, in parallel with step 1).*
3. Development of a bioinformatic pipeline to identify secreted candidate genes and gene clusters encoding the secreted peptides and proteins (*10 months).*
4. Verification of candidate genes by combinatorial cloning and heterologues expression in *Saccaromyces cerevisiae (12 months)*
5. Molecular characterization of identified proteins and peptides (*12 months*).

The team: Sonja Billerbeck has an in-house collection of > 700 biocontrol yeast, including the three *Aureobasidium* isolates [DOI:10.1016/j.nbt.2025.01.008] and expertise in synthetic biology and

yeast genetics. Jason Micklefield has complementary experience in identifying and characterizing natural product gene clusters in microbial genomes.

By uncovering the molecular basis of yeast-mediated biocontrol, in the future we aim to optimize natural strains, design targeted yeast cocktails and apply synthetic biology to create engineered yeasts for large-scale production of non-living biocontrol formulations.

To apply:
Please email s.billerbeck@imperial.ac.uk with the following documentation:
- Statement of Purpose
- Your CV
- At least two references must be emailed to *Sonja Billerbeck* (by the referees)