John Innes Centre

Year in Industry Proposal for 2027/28

Title of Project	How do filamentous bacteria know where to divide?
Name of Supervisor	Prof Susan Schlimpert
Email Address	Susan.schlimpert@jic.ac.uk
Telephone number	01603 450749
Weblink	www.schlimpertlab.com

Project on Offer

Cell division is essential for all cells, and precisely controlling when and where division occurs is critical for growth, development and the faithful distribution of genetic information. In bacteria, most of our understanding of cell division comes from studying unicellular model organisms such as *E. coli*, which divide by splitting into two daughter cells. In these bacteria, the protein FtsZ assembles into a ring (the Z-ring) at the future division site and coordinates the assembly of the cell division machinery (**Fig. 1**).

The antibiotic-producing *Streptomyces* bacteria have evolved a very different strategy (**Fig.1**) (1, 2). They grow as filaments and, during sporulation, must position dozens of evenly spaced Z-rings along a single filament to divide into chains of spores. Surprisingly, *Streptomyces* lack the proteins that control division-site placement in unicellular bacteria. Instead, a *Streptomyces*-specific protein called SsgB has been proposed to direct FtsZ to the sites of future cell division (3).

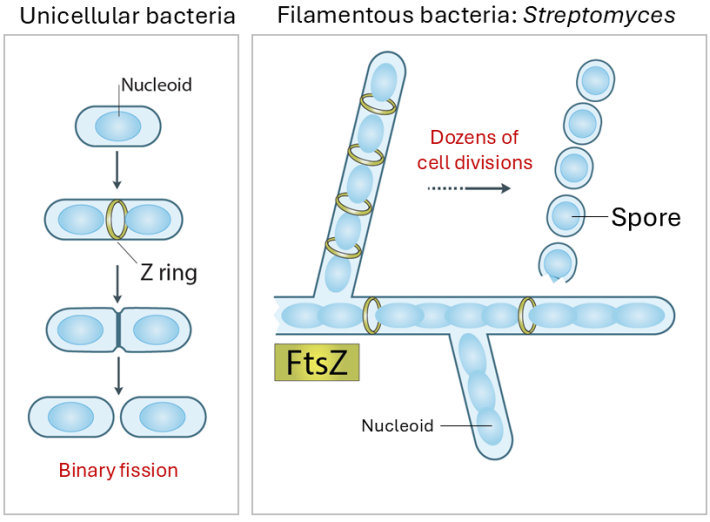

Fig. 1: Schematic illustrating the distinct mode of division in unicellular bacteria like *E. coli* compared to filamentous *Streptomyces* bacteria. FtsZ (yellow) assembly into a ring-like structure (Z ring) marks the future division site.

But how does SsgB actually influence cell division? Using a novel live-cell imaging approach (4), the Schlimpert lab recently discovered that, contrary to the current model, Z-rings are still evenly positioned in *Streptomyces venezuelae* cells lacking SsgB (unpublished). However, completion of cell division is disturbed. This unexpected finding challenges the current model of SsgB function and suggests that SsgB may not determine where Z-rings form as previously thought.

In this project, the student will combine molecular microbiology, *Streptomyces* genetics, fluorescence microscopy, and protein-protein interaction studies to systematically determine how SsgB influences cell division dynamics in *Streptomyces*.

Aim 1: Determine how SsgB influences Z-ring formation. The student will use CRISPR and other standard molecular microbiology techniques to engineer a series of *Streptomyces* mutants to assess when and where fluorescently tagged SsgB and FtsZ are localised in sporulating *Streptomyces* and how FtsZ-ring formation is affected in cells that lack SsgB. The Schlimpert lab has established a live cell-imaging approach to capture these critical steps in real time (5–7). The student will use image analysis software to interpret the results. This systematic analysis will provide a more detailed understanding of SsgB's role in cell division and help refine current models of division-site placement in *Streptomyces*.

John Innes Centre

Aim 2: Explore if SsgB interact with FtsZ and/or other cell division proteins. The student will purify SsgB and FtsZ from *E. coli* (both proteins can be produced in excess) and use established methods to assess whether SsgB binds FtsZ and affects FtsZ polymerisation (e.g., through using biolayer interferometry and co-sedimentation assays). There is also an opportunity to explore AI-guided structural modelling using AlphaFold3 to investigate potential SsgB and FtsZ interaction partners within the *Streptomyces* proteome, which could inform possible alternative models of division site placement in *Streptomyces*. This will provide hands-on experience of how complementary experimental approaches can be used to investigate an open question in bacterial cell biology.

The student will be directly supervised by Susan Schlimpert and receive training and co-supervision from Matt Bush, a senior postdoc in the lab with extensive experience in *Streptomyces* cell division. They will also have the opportunity to interact with other members of the team, including postdocs and PhD students with expertise in bioinformatics, protein biochemistry, *Streptomyces* genetics and live-cell imaging.

The Molecular Microbiology Department at the John Innes Centre provides a vibrant environment for discussing and developing scientific ideas, while the placement will provide transferable skills relevant to careers in both academic research and industry.

References

1. M. J. Bush, B. Casu, S. Schlimpert, Dividing lines: compartmentalisation and division in *Streptomyces*. *Curr Opin Microbiol* **85**, 102611 (2025).
2. S. Schlimpert, M. A. Elliot, The Best of Both Worlds-*Streptomyces coelicolor* and *Streptomyces venezuelae* as Model Species for Studying Antibiotic Production and Bacterial Multicellular Development. *J Bacteriol* e0015323 (2023).
3. J. Willemse, J. W. Borst, E. de Waal, T. Bisseling, G. P. van Wezel, Positive control of cell division: FtsZ is recruited by SsgB during sporulation of *Streptomyces*. *Genes Dev* **25**, 89–99 (2011).
4. S. Schlimpert, K. Flärdh, M. Buttner, Fluorescence Time-lapse Imaging of the Complete *S. venezuelae* Life Cycle Using a Microfluidic Device. *J Vis Exp* 53863 (2016). https://doi.org/10.3791/53863.
5. M. J. Bush, K. A. Gallagher, G. Chandra, K. C. Findlay, S. Schlimpert, Hyphal compartmentalization and sporulation in *Streptomyces* require the conserved cell division protein SepX. *Nat Commun* **13**, 71 (2022).
6. S. Schlimpert, *et al.*, Two dynamin-like proteins stabilize FtsZ rings during *Streptomyces* sporulation. *Proc Natl Acad Sci U S A* **114**, E6176–E6183 (2017).
7. F. Ramos-León, *et al.*, A conserved cell division protein directly regulates FtsZ dynamics in filamentous and unicellular actinobacteria. *eLife* **10**, e63387 (2021).

John Innes Centre

PERSON PROFILE *2 bullets max per box*	**Essential**	**Desirable**
Education *e.g. degree subject*	A level or equivalent qualification in a Science Subject Studying for a degree relevant to the project selected (e.g. microbiology, molecular biology, biochemistry)	
Specialist knowledge and skills *e.g. course module*	Basic understanding of molecular biology/microbiology; enthusiasm for learning new experimental approaches	Experience with molecular cloning, bacterial genetics, fluorescence microscopy, protein biochemistry or image analysis
Relevant experience *e.g. lab/research work*	Previous experience working in a laboratory-based research environment; ability to analyse and interpret experimental data	Experience with microbial genetics, fluorescence microscopy, protein purification/biochemistry or quantitative image analysis; evidence of experimental troubleshooting
Interpersonal and communication skills *e.g. teamwork and record-keeping*	Good communication and teamwork skills; accurate record-keeping and good organisational skills	Experience presenting scientific data; ability to discuss results and suggest next experimental steps
Additional requirements *e.g. outdoor working*	Curiosity, enthusiasm and willingness to learn; good attention to detail and time management	Persistence and creativity when troubleshooting experiments