

My experience at the University of Cambridge

Master's Thesis: Nutrient-dependent matrix-motility gene expression patterns in *Bacillus subtilis* biofilms

Vincent Grumbacher: 01. October 2025 – 15. April 2026

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The time I spent in the Fusco lab at the University of Cambridge was extremely fulfilling. While it was far too short, it was still a great experience, both professionally and personally.

In my master's thesis, I aimed to understand how both the morphology and the gene expression of *Bacillus subtilis* biofilms are shaped by nutrient availability. To that end, I varied either the carbon or nitrogen source in the growth medium. I then imaged the resulting biofilms using fluorescent microscopy. The *B. subtilis* strain I used for my experiments had both a matrix and a motility reporter. Matrix and motility are two of the phenotypes present in *B. subtilis* biofilms. This allowed me to study the effects of nutrient concentration on the gene expression patterns within the biofilms, as well as the fraction of the phenotypes. My results indicate that glutamate, the nitrogen source in the medium, has a significantly larger impact on gene expression than glycerol, the carbon source in the medium. We specifically observed a double-threshold behaviour in the glutamate concentration. At high nitrogen concentrations, the motility gene expression is higher compared to the matrix gene expression. For intermediate nitrogen concentrations, the opposite is true, while at very low nitrogen concentrations, we again observe more motility gene expression compared to matrix gene expression.

In addition to my wet lab work, I also developed an image-processing and data-analysis pipeline, which I used to automatically analyse all my data.

My supervision was directly performed by Prof. Diana Fusco. She allowed me to independently pursue the directions of the project that I was interested in, while simultaneously providing excellent guidance and support. Furthermore, all the members of the lab were always willing to help and support me in my endeavours.

Apart from my work in the lab, I could also immerse myself into student life in Cambridge. This was possible due to my joining of Darwin College as a visiting member. The student community in Cambridge is very lively and welcoming, as it assumes that everyone coming to the city is open to meeting new people. During my time in Cambridge, I was able to join the Darwin College Boat Club, the rowing team of the College, and was able to compete for the College in various races. Membership in Darwin College allowed me, and was necessary, to fully participate in Cambridge's student life. Furthermore, I was also able to go on trips to London to enjoy a larger city.



Rowing for Darwin College



Physics of Medicine Building,
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Darwin College, Cambridge