



# Know your enemy: Using mathematics to understand the movement of bacteria

## TakeAIM Runner-up 2020:

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Bacteria have caused some of the worst pandemics in human history – from the bubonic plagues of the Middle Ages, to the cholera pandemics of the 19th and 20th century. Even in modern societies, with improved sanitation and antibiotic treatments, bacteria continue to cause diseases such as tuberculosis and typhoid fever, and regularly make the news in relation to food poisoning outbreaks. What is less known is that the ability of bacteria to spread inside the host body, by moving in response to chemical signals, may also be harnessed for good. To this end, ongoing pre-clinical studies are exploring the possibility of using attenuated or “ghost” bacteria to deliver drugs directly to cancerous tissues, which bacteria could recognise based on their chemical signature.

My research explores fundamental questions about the movement of bacteria with multiple flagella, such as *Escherichia coli* and *Salmonella*, which are notorious for causing food poisoning from leafy greens and raw meat. We have developed new mathematical models to investigate the swimming behaviour of these bacteria, and to predict how quickly they move and spread out in a fluid environment such as the human gut. These new and valuable insights could become useful in optimising ghost bacteria for targeted drug delivery. Furthermore, our models are not limited to the study of bacterial flagella – they are also relevant to the understanding of cilia, hairlike structures which play a crucial role in clearing mucus from our lungs and circulating cerebrospinal fluid in the brain.

### Sponsors







The Smith Institute, enabled by the generous sponsorship of our leading corporate partners, ran the TakeAIM competition in 2020 to make visible the crucial role that mathematics will increasingly play in all aspects of our lives. The competition, also celebrating its 10th anniversary in 2020, was open to undergraduate and postgraduate students working in the mathematical sciences. First prize was £1,000, with three second prize winners receiving £400.