



Using Mathematics to Optimise Stem Cell Experiments

TakeAIM 2nd place 2019:

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Stem cell research is revolutionising regenerative and transplant medicine. Pluripotent stem cells can turn into any specialised adult cell (the 'pluripotency' property) and self-renew indefinitely through repeated divisions, offering a renewable source of replacement cells and tissues. They are also used as a direct treatment in ground-breaking 'stem cell therapies', in which an injection of stem cells encourages surrounding injured tissues to self-repair. However, these clinical applications require improved control over the growth and pluripotency of laboratory stem cells to improve production efficiency if the demands of the emerging industry are to be met.

My research uses mathematics to advance our understanding of stem cell behaviour, investigating key problems such as "how do colonies rearrange to make space for new cells?", "can we mathematically describe how a stem cell turns into a specialised cell?" and based on these results, "how can we optimise laboratory stem cell production?". The unique combination of experimental and mathematical approaches gives us the best of both worlds, allowing experimental data to inform mathematical models and modelling results to direct experimental protocol.

The research has already characterised the memory properties of cell movements and found pairs of cells move together which has been useful in developing a mathematical framework for modelling colony growth. The model will inform experimental protocols to maximise cell yield while minimising unwanted colony merges. This mathematical insight into stem cell biology is essential to biologists and their industrial partners in advancing the efficiency of stem cell production for pioneering clinical applications.

The Smith Institute, enabled by the generous sponsorship of our leading corporate partners, ran the TakeAIM competition in 2019 to make visible the crucial role that mathematics will increasingly play in all aspects of our lives. The competition was open to undergraduate and postgraduate students working in the mathematical sciences. First prize was £1,000 of Apple or Amazon vouchers, with second prize winners receiving £200 and 8 runners-up receiving £25 in their choice vouchers.

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