Take AIM

Smith institute
for industrial mathematics and system engineering

Frozen - the Mathematical Modelling of Cryopreservation

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A biological cell is often compared to a city as it makes use of many 'amenities' in order to run smoothly and function effectively. A cell's counterparts to city amenities are called 'organelles' and they each have a unique function. For example, the town hall governing a city is comparable to the cell's nucleus; a power station, mitochondria; infrastructure and transportation systems are the endoplasmic reticulum. The metaphor can even be stretched to include a post office as the golgi apparatus!

Given the many vital roles performed by organelles, it should be of no surprise that cryopreservation - preserving a cell by freezing - is problematic. Imagine freezing a city and expecting it to operate as normal when thawed. Infrastructure would be destroyed as metals sustain stress fractures; electric circuitry would be irrevocably damaged and many crops would die. Similarly, there are phenomena that occur during cryopreservation that cause damage to the cell. Sharp ice crystals form, puncturing the delicate cell membrane, while improper water distribution causes cellular dehydration.

My research involves constructing a mathematical model for cryopreservation by unifying theories from fluid dynamics and mathematical geoscience. An accurate mathematical model will shed light on the problems with cryopreservation and offer pointers to their solution. Contrary to the case of actual cities, there are many reasons to want to freeze cells. Preserving organs for transplantation, restoring ovarian tissue destroyed by cancer treatments, and conserving tissue samples for research are just a few ways that cryopreservation promises to enhance modern medicine.

The use of mathematics has profound consequences in all walks of life, but the opportunities that it opens up often go unrecognised or underexploited. The Smith Institute, enabled by the generous sponsorship of our leading corporate partners, ran the fourth annual TakeAIM competition in 2014 to make visible the crucial role that mathematics will increasingly play in all aspects of our lives. The competition was open to all undergraduate and postgraduate students working in the mathematical sciences. The author of the best entry received £1,000 of Apple vouchers as his prize, with £500 of Apple vouchers being awarded to authors of the four entries that tied for second place.