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FIRST PERSON

First person – Neha Khetan

First Person is a series of interviews with the first authors of a selection of papers published in Journal of Cell Science, helping early-career researchers promote themselves alongside their papers. Neha Khetan is first author on 'Self-organized optimal packing of kinesin-5-driven microtubule asters scales with cell size', published in JCS. Neha is a CEFIPRA postdoctoral research fellow in the lab of Chaitanya A. Athale at the Indian Institute of Science Education and Research, Pune, India, investigating the interplay of self-organization and evolutionary forces in cytoskeletal patterns and collective behaviour.

Neha Khetan

How would you explain the main findings of your paper in lay terms?

The most beautiful natural patterns have hexagonal ordering – for instance, the shape of honeybee combs, snowflakes, soap foam bubbles, pineapples and epithelial cells in the wings of the fruit fly. A similar hexagonal order emerges under the surface of the egg cell of a marine organism, *Phallusia*, when perturbed with chemical agents. These patterns are formed by arrays of microtubules, known as asters, in the presence of kinesin-5 motor proteins. The cellular space is divided into small sub-domains using Voronoi tessellations, such that each polygon contains a single aster at its centre. In experiments, these polygon distributions exhibit hexagon dominance. Computer simulations of multi-asters with kinesin-5 in confinement result in similar hexagon-dominated distributions. In addition, higher motor numbers and specific densities of asters result in the formation of mini-spindles along with the hexagonal lattice. Such patterns are observed in cells treated with Bi-D, a potential anticancer drug. Thus, our study identifies a mechanical basis for aster segregation and provides a framework for the emergence of spatial patterns in cells. Furthermore, it suggests that such a mechanism could have evolved to maintain the bipolar spindle structure, which may have implications for the process of cell division.

Were there any specific challenges associated with this project? If so, how did you overcome them?

The most challenging part of the project was to quantify the qualitative match that is visible between the experiments and simulations, and the differences across the experimental conditions. There were several open parameters where an error could change the results. In spite of the automated analysis, I went back-and-forth several times over hundreds of images to be confident of the correctness of the match.

When doing the research, did you have a particular result or 'eureka' moment that has stuck with you?

I had a few 'eureka' moments. I had been exploring the effects of antagonistic motors in a multi-aster system across cell sizes in simulations. The very first time I saw the emergence of the spatial order in the asters was simply beautiful! Another moment was when I found polygonal order while analysing the images in *Phallusia* oocytes. The overlays of polygon tessellations on the images were a treat for the eyes. This further deepened the quest to find out how and why the patterns arise in the single-cell oocytes.

Why did you choose Journal of Cell Science for your paper?

The study has implications that are of general relevance, especially to the wider community of cell biologists. By combining biochemical perturbations, image analysis and computer simulations, we have found a mechanical basis for the patterns induced by the microtubule asters in a single-celled oocyte. We believe the interdisciplinary nature of the work and the role of the cytoskeleton in pattern formation has relevance for other systems too. Journal of Cell Science covers a vast area of cell biology, and many papers are at the interface of experiment and theory. My supervisor Dr Chaitanya Athale and co-author Dr Janet Chenevert also felt that this journal was a good choice to publish our results in order to reach a wide cell biology audience.

Have you had any significant mentors who have helped you beyond supervision in the lab? How was their guidance special?

I have been fortunate to have wonderful mentors in my scientific journey so far. My PhD supervisor Dr Chaitanya Athale has been a

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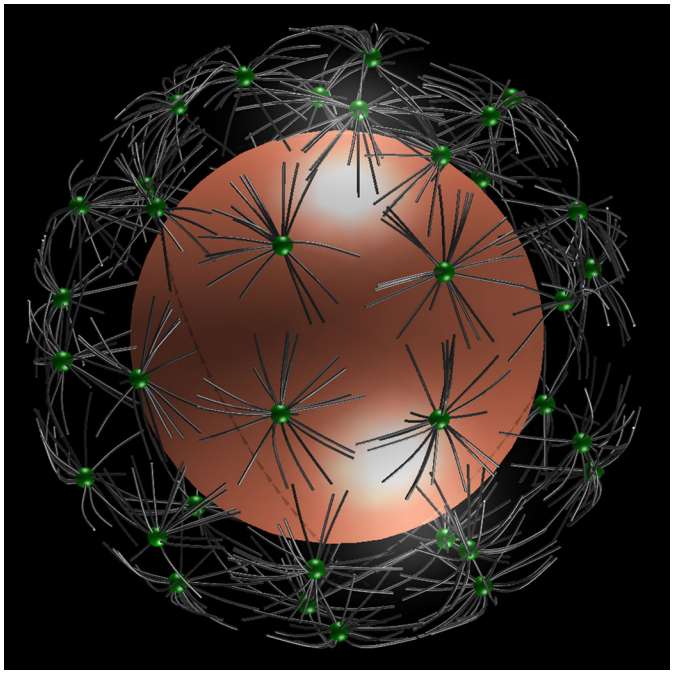

A representative snapshot of the 3D geometry of multi-asters in a *Phallusia* oocyte during Cytosim simulation. The egg yolk (brown) is modelled as a steric object at the centre of the cell, and asters are initialized randomly beneath the cell surface in the presence of kinesin-5 motors.

great mentor who always encourages scientific discussions, including on topics that can extend beyond the scope of the projects. Under his mentorship, I have enjoyed my scientific freedom to explore and experiment with ideas. His zeal for science has taught me to aim higher and work towards my goals irrespective of any odds. Prior to the start of my PhD, I worked with Professor Vidyanand Nanjundiah during my undergraduate years. As my first mentor, he has had a profound impact on my scientific path, and his teachings continue to guide me. Dr Santosh Sathe was a mentor from whom I learnt experimental techniques from scratch. Working with Dr Richa Rikhy was also an extremely stimulating and enriching experience, during which I enjoyed performing quantitative microscopy experiments. My other mentors, Professor Sanjeev Galande and Dr M. S. Madhusudhan, have played a significant role in my journey at IISER.

What motivated you to pursue a career in science, and what have been the most interesting moments on the path that led you to where you are now?

I always enjoyed reading scientific articles in the newspapers; over the years, this convinced me to pursue a career in science. In the second year of my engineering degree, I was amazed and intrigued by seeing the life cycle of social amoebae at an open science day event. This led me to work with Professor Vidyanand Nanjundiah during my summer vacations. The experiments with *Dictyostelium* amoebae were great fun, and the experience introduced me to fascinating aspects of biology. By the end of my engineering degree, a PhD was the next natural step in pursuit of a scientific career. I joined IISER for a dual degree programme (master's and PhD), during which I worked with many wonderful scientists, collaborators and colleagues who continue to shape my interests.

Who are your role models in science? Why?

Many people, starting with my schoolteachers, and then my mentors and other scientists, have been my role models at different phases. Their struggles, their attitude and their passion towards science, or the ease with which they delivered a concept or an idea, have been inspiring. Scientifically, I admire simple questions addressed in a systematic and rigorous manner, which thereby advance the fundamental understanding of nature. I like the style of John Bonner, Uri Alon and Rob Philips, and the writings of D'Arcy Thompson and Richard Dawkins interest me.

What's next for you?

I would like to continue in academia and explore areas that have implications for human health. I will be looking for a postdoctoral or early-career independent position.

Tell us something interesting about yourself that wouldn't be on your CV

I like writing, and my poems are inspired by biology and the work I do.

Reference

Khetan, N., Pruliere, G., Hebras, C., Chenevert, J. and Athale, C. A. (2021). Self-organized optimal packing of kinesin-5-driven microtubule asters scales with cell size. *J. Cell Sci.* **134**, jcs257543. doi:10.1242/jcs.257543