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FIRST PERSON

First person – Hardeep Gumber

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. Hardeep Gumber is first author on 'Identification and characterization of genes encoding the nuclear envelope LINC complex in the monocot species *Zea mays*', published in JCS. Hardeep is a PhD Student in the lab of Dr Hank W. Bass at Florida State University, Tallahassee, USA, investigating the functions of the fast-evolving nuclear envelope LINC complex proteins in plants.

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

Maize is the third-most widely grown agricultural crop, worldwide. With the rapid increase in the human population, agricultural productivity must increase by 60% to feed the world population of 9 billion by 2050. This demands the discovery of new plant genes and their functional characterization for agricultural improvement. In this study, we have systematically identified 22 new maize genes that code for proteins connected to a multiprotein complex that resides on the nuclear envelope. This linker of nucleoskeleton to cytoskeleton (LINC) complex has been shown in other organisms to have important functions in maintaining nuclear shape, size and chromosome architecture, which influence gene expression. LINC gene mutation or mis-expression have been associated with a number of developmental, reproductive and ageing disorders. This work addresses a critical gap in our knowledge of the LINC complex in in crop plants. We have made a summary working model of the entire LINC complex in maize with implications for both basic and applied cellular research.

> **"This work addresses a critical gap in our knowledge of the LINC complex in in crop plants."**

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 identify interactors of SUN proteins using co-immunoprecipitation (co-IP) experiments. Co-IP is an unbiased approach for finding novel interactors of a protein using antibodies raised against it. This is a very powerful approach for soluble proteins but is extremely challenging for membrane- and double-membrane-associated proteins, such as those in the nuclear envelope. The detergents needed to solubilize membrane proteins often lead to disassociation of these proteins with their interactors. The most challenging step of the co-IP was to solubilize the protein complex without losing the interactions. After many trials and optimizations, I eventually used a lipophilic and membrane-permeable crosslinker called DSP, starting with co-IP experiment number 46, a key optimization that helped me co-precipitate the SUN protein interactors.

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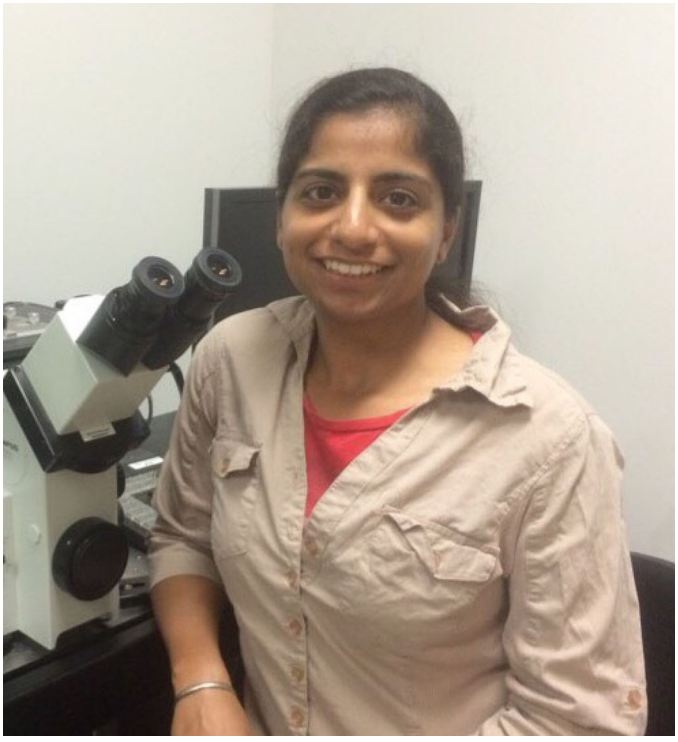

Hardeep Gumber

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

Two eureka movements happened, one when I successfully co-immunoprecipitated SUN-interacting proteins after 45 failed attempts. I clearly remember the moment when I was looking at the computer screen displaying the list of potential SUN interactors identified by mass spectrometry. The list made sense, included many of our suspects, and I felt like the experiments confirmed my understanding of the chemistry of protein complexes in the nuclear envelope. A second eureka moment was when the candidate KASH fluorescent fusion protein constructs were expressed in tobacco and were demonstrated to be localized on the nuclear envelope. It confirmed that our bioinformatic search was accurate and the predicted proteins are real KASH proteins

> **"…I successfully co-immunoprecipitated SUN-interacting proteins after 45 failed attempts."**

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

We chose Journal of Cell Science because of its prestigious international reputation and wide range of readership. It best fits our research, which is mostly cell biology of the plant nucleus. It is a great platform, especially, for plant cell biologists to present their research work in a journal read by the larger community of biologists. Journal of Cell Science increases the visibility and appreciation of the work, helping to overcome the tendencies of other journals to segregate broadly applicable and globally important research.

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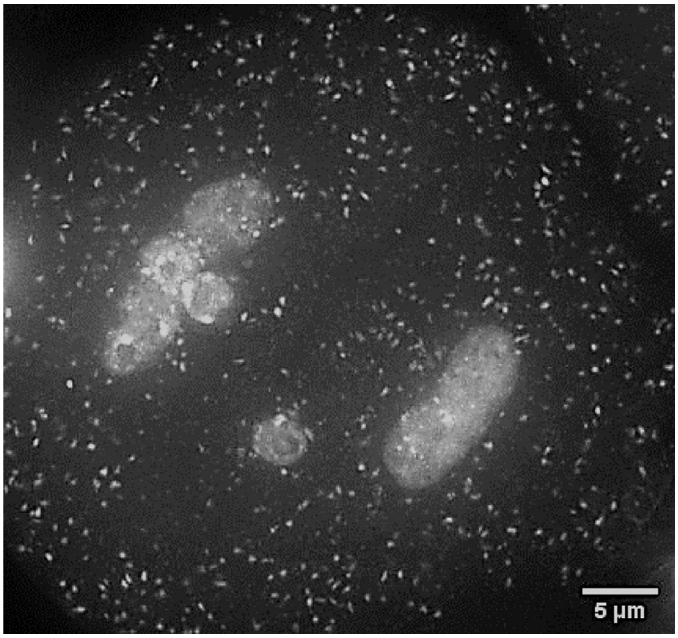

Maize *mlks2* mutant meiocyte showing irregular chromosome segregation by the formation of micronuclei during telophase I.

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

When I started as a graduate student at Florida State University, a couple of advanced-year PhD students mentored me. They gave me insights into how to approach research and coursework. They shared the challenges that they had to face during their graduate school years and advised me to start writing papers early on. They taught me to be patient and persevere during long periods of failed experiments.

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 am a very curious person, by nature. Since childhood, I have been very observant of the night sky and nature around me. In grade school, when formal science education began, I got really interested in biology. As we were taught cell biology in middle school, I immediately fell in love with chromosome movement and cytoskeletal dynamics. I used to hand draw structures of plant and animal cells undergoing cell division and decorate them with beautiful craft pieces to make posters for my classroom. Another thing I enjoyed was looking at small insects and plant tissues under the microscope. My parents ended up buying me a personal microscope which set me off on scientific explorations into cells. Later, I majored in biology as an undergraduate and did a master's in biotechnology with specialization in molecular biology. It was during my master's research that I realised that scientists can manipulate the DNA and do wonders with it like generating better varieties of agronomically important plants. So, I decided to pursue a PhD to learn molecular biology in even greater detail to be able to apply it to solve real-world problems.

Who are your role models in science? Why?

I have several role models in science. My historical role model is Barbara McClintock, a maize cytogeneticist, a Nobel Laureate and most importantly, a female scientist. When I started my PhD and used maize as the organism to study, I came across great findings from McClintock's research. She did a lot of foundational work for maize cytogenetics which involved visualization of maize chromosomes under the microscope, the relationship between chromosomal cross-over and recombination of genetic traits, and the finding that the ends of chromosomes are capped by 'telomeres'. She also led research in the breakage-fusion-bridge cycles, discovery of transposable elements and their role in gene regulation. Her work was visionary, with much of it not recognized or found in other species for years or decades to come. She always trusted her data, no matter how much scepticism she received from other scientists. Her incredible discovery of transposable elements made her the unshared recipient of the Nobel Prize in Physiology and Medicine.

My active role model, with whom I had the opportunity to directly work with and learn from, is my PhD major professor, Hank W. Bass. He is a modern plant cytogeneticist who has made significant contributions to the understanding of the role of telomeres in chromosome dynamics during meiosis. He is a great role model for young scientists, and is collaborative and easy to approach. His friendly approach with lab members keeps the lab environment happy and productive. He inspires us to do good quality science with open minds. He knows the art of presenting complex data in an easy-to-understand format. This has made him a good outreach scientist. Every year he hosts workshops to educate young students from minority groups about genetics in a fun and engaging way. This inspires me not only to be a good researcher but to also care about the community.

What's next for you?

I am currently looking for jobs in the biotechnology industry. The ideal scenario for me will be to work for a company with good ethics and service to humanity as their mission. High-profile companies have great resources to help their scientists to develop and execute projects. It involves team work, where many people are working on small tasks to achieve a bigger goal. So, the goals are achieved at a faster pace than in a typical academic setting. I find the life of academics to be harder and less rewarding compared with those working in industry. The demand of continuous grant writing is quite challenging and is greatly impacted by the availability of federal funds.

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

I have a strong passion for providing free and quality basic education to every household in developing and under-developed countries. I started it by teaching our domestic worker back home in India, when I was in middle school. Since moving to the US, I have not had many opportunities, however, so I would like to resume this very soon. Education gives power.

Reference

Gumber, H. K., McKenna, J. F., Estrada, A. L., Tolmie, A. F., Graumann, K. and Bass, H. W. (2018). Identification and characterization of genes encoding the nuclear envelope LINC complex in the monocot species *Zea mays*. *J. Cell Sci.* **132**, jcs221390.