

DEPARTMENT OF CELL & DEVELOPMENTAL BIOLOGY



SCHOOL OF MOLECULAR & CELLULAR BIOLOGY

Letter from the Department Head

It gives me immense pleasure to celebrate the outstanding achievements of our faculty, students, postdocs, and staff in 2022. Pandemic notwithstanding, our department has shown extraordinary grit and resilience in pursuing research with the sole objective of 'betterment of science.' To that end, I want to thank and congratulate our spectacular members who have not just made significant strides with their research, instruction, and service mission but have made 2022 a memorable, productive, and successful year for the department and university.

Our illustrious faculty received many prestigious honors and awards. **Prof. Brian Freeman** was elected to the rank of American Association for the Advancement of Science (AAAS) fellow. Two of our faculty received awards from the College of Liberal Arts & Sciences for their outstanding contribution to the college's educational mission, including research, teaching, service, and diversity and inclusion. **Dr. Xin Li** was named a Lincoln Excellence for Assistant Professors Scholar, and **Dr. Rachel Smith-Bolton** was named the Norman P. Jones Professorial Scholar. **Dr. Kannanganattu Prasanth** was named the Horwitz Scholar after our department's founding head, **Professor Rick Horwitz**.

Another year of significant research breakthroughs! We highlight Dr. Xin Li's work on the role of transcription factor-mediated spatio-temporal regulation in generating diverse neurons in the fly brain. We also share the work from my laboratory on the discovery of a replication protein in maintaining genome stability and the importance of a gene regulator in safeguarding pluripotency. We share the Brieher and Tang laboratory's work on discovering a new organelle and its role in epithelial homeostasis. We learn about efforts in the Henry Lab to generate the first comprehensive cellular map of the cornea in a frog species at early and adult developmental stages.

I want to extend my sincere appreciation to the department's graduate students. Thanks to their efforts, we had a department retreat that showcased our scientific efforts and celebrated our research endeavors. **Mr. Tom and Dr. Cyndy Cycyota**, who generously support many of our students, graced this occasion. This newsletter features interviews with Tom Cycyota and students who have received support from the Cycyotas: **Ms. Neha Chivukula** and **Mr. Jay Sonalkar**. We spotlight our former graduate student, **Dr. Qinyu Hao**, the recipient of the 2022 Tunji Toogun award.

We continued the early career-inclusive seminar series and were excited to provide an opportunity to supremely talented postdoctoral associates to share their work with the department and the scientific community. We hope these activities will help us build and foster an environment where we make everyone feel welcome irrespective of race, color, nationality, or country of origin and gender. We are also happy to share that in 2022, we initiated a CDB alum seminar. The inaugural speaker was **Dr. Yejing Ge**, an assistant professor at MD Anderson institute. She shared the spectacular work on skin stem cells that are expected to have important implications in aging and wound repair.

I am very excited for us as a department as we embark on our journey for 2023. We hope to continue networking with our alums and facilitate their active engagement with the department to support our research, teaching, and service mission. I also look forward to continued collaboration within our department and beyond.

Supriya Prasanth



2022

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AAAS honors Brian Freeman for his work on illuminating molecular chaperones

By the Cancer Center at Illinois | Photo by L. Brian Stauffer

Congratulations to Brian Freeman, who was named a 2021 Fellow of the American Association for the Advancement of Science (AAAS) for his exceptional work in the field of molecular chaperones (MCs).

Freeman, an Alexander von Humboldt Awardee, professor of cell and developmental biology and Cancer Center at Illinois scientist, has focused his research on the study of MCs since the beginning of his career as a graduate student when chaperones were thought to have no medicinal purpose. Now, the medical research community knows that MCs play a role in most human diseases including cancer, diabetes, and neurodegeneration. However, the exact role and mechanisms of MCs remains unknown.

Proteins play critically important roles in cells and can cause fatal problems if they are not properly made, functioning, or being degraded. In these cellular processes, chaperones are present to ensure there are no mistakes.

“Everyone knows what a chaperone is – imagine a school dance – they’re there to make sure everyone behaves. With proteins, the chaperones are there to shield the polypeptides and create an environment for the nascent chains to fold properly, and correctly interact with other proteins,” Freeman said. “Then, during their lifetime, when protein complexes must be disassembled, the chaperones come along and pull them apart – just like at the end of a school dance.”

Because of their importance, chaperones are some of the most conserved proteins, meaning they can be found in many lifeforms from bacteria to humans. Many of Freeman’s students are currently studying MCs in the budding yeast cell model; the conservation of these MCs means that their findings can be easily translated to human significance, including the understanding of the transition to cancerous states.

“The MC field likes to say that cancer cells have a chaperone addiction – we mean that cancer cells show a much higher

level of MCs and rely on these high levels to be cancerous. We still don’t really know why there are these high levels, so we are still investigating and targeting them,” Freeman said.

In the past, researchers have attempted to use chaperones as a therapeutic target. A specific MC known as Hsp90 was targeted in cancer cells, and although some patients responded well to this treatment with reduced levels of Hsp90, results eventually showed a lack of improvement due to a heat shock response that raised Hsp90 back to cancerous levels.

While these Hsp90 clinical trials could not shrink tumors, they were able to stop tumor growth for several months to years in some patients. Other studies have capitalized on the large number of Hsp90 on the surface of cancer cells to improve tumor detection and visibility of tumor margins in the operating room by developing fluorescent labels that attach to Hsp90.

“My lab is also studying how Hsp90 affects normal cell pathways and how it might reorganize genomes,” Freeman said. “We know that in cancer biology, genomes are greatly manipulated in terms of position and movement, and MCs play a huge role in genome stability. So, we think this type of work will be very impactful for cancer studies in the future.”

These chaperone studies and discoveries are applicable to a wide variety of cancers and other diseases, including tropical diseases. With elevated levels across many disease states, it can be very difficult to identify the specific role that each MC plays and to develop therapeutics to target them. However, Freeman’s lab hopes to reintroduce MCs – and Hsp90 in particular – as a therapeutic target for cancer patients. Although the first clinical studies were unsuccessful, Freeman believes that the research community has a better understanding of the roles and processes of molecular chaperones, and looks forward to witnessing new studies that develop therapeutics targeting Hsp90 and other chaperones.

Congratulations to our new faculty scholars!

College of Liberal Arts & Sciences appoints two CDB professors as named scholars

The Department of Cell & Developmental Biology is pleased to announce two professors were recently named faculty scholars by the College of Liberal Arts & Sciences for their contributions to research, education, and the academic mission of the college. Congratulations to Xin Li and Rachel Smith-Bolton!

“We’re extremely proud to recognize these exemplary faculty members,” said Venetria K. Patton, the Harry E. Preble Dean of the College of LAS. “Their creativity, hard work, and insights make them excellent teachers and researchers who deepen our understanding of the world around us.”



Smith-Bolton, an associate professor of cell and developmental biology, was named a Norman P. Jones Professorial Scholar. This recognition is for exceptional mid-career, tenured faculty members. Smith-Bolton joined the department in 2011 and researches trauma, bleeding, and tissue regeneration.

Because the process of regeneration is not well understood, her lab aims to better understand regeneration by using simple epithelial tissue and the wing imaginal disc in the model organism *Drosophila melanogaster*. She and her lab members use genetic tools to induce tissue damage and regeneration in a way that enables high-throughput experiments, forward genetic screens, and genomic approaches to identify the genes and mechanisms that regulate each step within regeneration.

Smith-Bolton is an affiliate of the Carl R. Woese Institute for Genomic Biology. She received her PhD from Stanford University, and her postdoctoral research was conducted at the University of California, Berkeley.



Xin Li was named a Lincoln Excellence for Assistant Professors (LEAP) Scholar. Li, who joined the faculty in 2014, researches development, genetics, genomics, neurobiology, and regulation of gene expression. Li and her lab members use a combination of genetic and single-cell omics

approaches to investigate how the sequential expression of transcription factors in neural progenitors generates neural diversity using the *Drosophila* visual processing center as a model. Li’s research sheds light on the neurogenesis of a complex adult neural structure, as well as on the general mechanism of temporal patterning of neural progenitors. Li teaches MCB410 Developmental Biology, Stem Cells and Regenerative Medicine course in Spring semesters.

Li is an affiliate of the Carl R. Woese Institute for Genomic Biology. She received her PhD from Northwestern University and completed her postdoctoral research at New York University.

KV Prasanth named Horwitz Scholar



Congratulations to Cell & Developmental Biology Professor Kannanganattu V. (KV) Prasanth, who was recently chosen to be the inaugural Horwitz Scholar. The named scholar recognizes mid-career faculty in the Department of Cell & Developmental Biology who conduct outstanding research programs. It honors Rick Horwitz, a former department head known for his work in cell adhesion, migration, and signaling and synapse formation. Prasanth joined the CDB faculty in 2007 and has become a leader in exploring and uncovering insights into long noncoding RNA (lncRNA) genes. The fundamental questions he and his team are asking about lncRNAs include: What are their roles in the functional compartmentalization of the cell nucleus? How does this compartmentalization regulate gene expression? And how does the regulation of gene expression by lncRNAs in turn control both normal

and abnormal cell proliferation in human health and disease?

Prasanth is an affiliate of the Cancer Center at Illinois. He received his PhD from the Cytogenetics Laboratory at Banaras Hindu University. His postdoctoral research was conducted at the Cold Spring Harbor Laboratory in New York.

Catching up with Xin Li

Xin Li, assistant professor of cell and developmental biology and recently-named a Lincoln Excellence for Assistant Professors (LEAP) Scholar



What sparked your interest in biology? Was there someone or some event that had a pivotal impact on you in pursuing science? Such as a teacher, friend, parent?

When I was young, my father, a physics teacher, taught me to look for rules underling the various natural phenomena. I then became very interested in biology starting in the middle school, wondering about how life begins and evolves, and how our brains form and function.

What brought you to UIUC? What about the School of MCB and the U of I makes this a great place to do research and teaching?

During my interview here, I found the department, school, and university to be the perfect place to set up my lab and do research and teaching, because of the highly supportive and collaborative environment, world-class cross-disciplinary research programs and cutting-edge facilities. Especially during my research seminar and chalk talk (research plan presentation) at the interview, I received a lot of inspirational questions and comments from faculty members and trainees which made me really excited about joining this community.

What do you find especially exciting about the work you and your group are doing now and have planned for the next couple years?

I feel it is especially exciting that we can combine our traditional *Drosophila* genetics with the revolutionary single-cell omics approaches to investigate the fundamental questions of neural development: how neural stem cells keep time to sequentially generate different neural types, and how these neural types connect with each other to form a complex neural structure.

In the next couple of years, we will continue to use the integrated approaches to map the transcriptional and epigenetic networks that temporally pattern neural stem cells to generate neural diversity.

What do you find fulfilling outside of the lab?

Outside of the lab, I found it fulfilling to “grow up” again together with my kids exploring the natural world and the possibilities.

RESEARCH

Decoding the molecular clock that controls neurogenesis in visual center of *Drosophila*

By Ananya Sen, Carl R. Woese Institute for Genomic Biology

The nervous system is made up of diverse cells that arise from progenitors in a specific time-dependent pattern. In a new study, published in *Nature Communications*, researchers have uncovered the molecular players involved and how the timing is controlled.

“We are interested in studying how neural diversity is created during animal development. First, the stem cells produce different types of neurons, which in turn construct the brain,” said Hailun Zhu, a graduate student in the Xin Li lab.

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The generation of neural diversity by neural progenitors, called neuroblasts, is regulated in two distinct ways: spatially, where neuroblasts at different locations make different neuron types, and temporally, by which the same neuroblasts generate different neuron types as they age.

“We are focused on the temporal patterning of neuroblasts, and we use the *Drosophila* medulla, which is a part of the visual processing center, as a model” said Xin Li, assistant professor of cell and developmental biology.

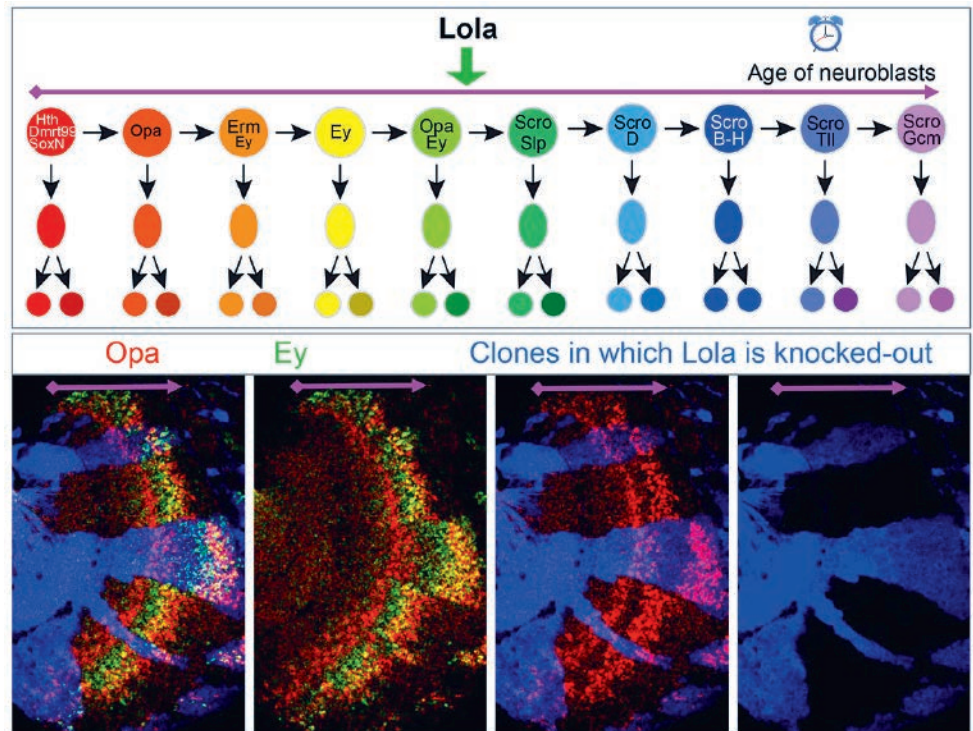
Li’s postdoctoral work had revealed that there is a cascade of Temporal Transcription Factors in *Drosophila* medulla neuroblasts where some factors are expressed early on and they successively activate others. However, gaps were observed in this original cascade, and it was also not known how the temporal cascade progression was regulated. To solve these problems, the Li group, in collaboration with Sihai Dave Zhao, an associate professor of statistics, used single-cell RNA sequencing technology to examine how gene expression changes as medulla neuroblasts age.

“We used two markers to label the cells. One was expressed in all the neuroblasts and the other was expressed specifically in the medulla part of the optic center,” Zhu said. “We then sorted the cells and sequenced the RNA in single medulla neuroblasts.”

Single cell RNA sequencing adds specific barcodes to the transcripts that are formed when the information in the DNA is converted to RNA. As a result, each cell has a different barcode and at the end the researchers can identify the transcripts in every single cell. The sequenced cells were then grouped based on the similarity in their gene expression.

The researchers found that the TTFs that had previously been identified by Li’s postdoctoral work were expressed in specific cell clusters. These results demonstrated that medulla neuroblasts were indeed clustered according to their age, from the youngest to the oldest. Furthermore, the researchers identified nine more transcription factors that are expressed in temporal patterns in medulla neuroblasts.

The group confirmed their findings using mutant



The top figure shows the sequential expression of a series of TTFs which instruct the *Drosophila* medulla neuroblasts to generate different neural types. The bottom panel shows the immunostaining of two TTFs: Opa in red and Ey in green. As medulla neuroblasts age, they transition from expressing Opa, then Ey, and then both Opa and Ey (yellow). In the clones where Lola is knocked out, the transitions slow down.

Drosophila. They found that early transcription factors are required to activate late transcription factors, while late transcription factors repress early ones, forming a temporal cascade. “We used mutants that lacked these transcription factors to test whether they’re required in the cascade. We were able to find some TTFs that were missing in the previous studies, allowing us to develop a more complete temporal patterning gene network,” Zhu said.

They also discovered that the speed of the cascade progression is regulated by transcription factors that are not TTFs. “We found that although the transcription factor Lola is not expressed in a specific stage, without it the cascade slows down,” Zhu said. “It’s very interesting and it’s different from what we’ve seen before.”

The researchers are interested in further examining the transcriptional mechanisms regulating the TTF network. “The interactions between the transcription factors inferred from the mutant analysis are not necessarily direct. The next step is to see whether they act directly,” Li said. “We also want to examine how these TTFs control the downstream specification of different neuron types.”

The work was funded by NSF-Simons Center for Quantitative Biology at Northwestern University and the National Eye Institute.

RESEARCH

Researchers investigate neuron differentiation in fruit fly brains

By Shelby Lawson, Carl R. Woese Institute for Genomic Biology

The brains of all higher order animals are filled with a diverse array of neuron types, with specific shapes and functions. Yet, when these brains form during embryonic development, there is initially only a small pool of cell types to work with. So how do neurons diversify over the embryo's development? Researchers know that neural stem cells called neuroblasts divide multiple times to sequentially produce neurons of specialized function, but the mechanisms of this process, and how the timing varies for different genes and neuron types, is still not fully understood.

In a new paper published in *eLife*, Alokandanda Ray, a cell and developmental PhD candidate during the time of the study and now graduated, and Xin Li, an assistant professor of cell and developmental, shed light on the process in the optic medulla of *Drosophila melanogaster*, the fruit fly.

As neuroblasts divide and differentiate, they express transcription factors which ultimately direct the daughter cells on what kind of neuron to be. Because they are expressed in a particular way depending on when they split, these transcription factors, called temporal transcription factors, act as a marker that tells researchers what stage the neuroblast is at, and allows them to piece together the order of events in this neurogenesis cascade. The researchers focused on two different TTFs in the fruit fly brain, called eyeless and sloppy-paired, to better understand how differences in the expression of TTFs that lead to different neuron fates.

“Nervous systems diversify from a small pool of neural stem cells to the great diversity of neurons we see in adult brains of higher ordered animals,” said Ray. “We really wanted to understand the molecular mechanisms that drive the transition of these neuroblasts from expressing one temporal transcription factor to the next transcription factor, which ultimately determines what type of neurons these progenies will become.” The researchers used genetics and a number of



Alokandanda Ray, PhD candidate during the time of the study and now graduated, and Xin Li, assistant professor of cell and developmental biology.

techniques including reporter assays, antibody staining and microscopy to measure the expression pattern of genes within the optic medulla of fruit fly brains during development. Typically, the regions of the DNA that are considered to be “important” are the sequences that contain genes. However, through these experiments, the researchers discovered that two non-coding regions near the sloppy-paired genes were essential to making sure the sloppy-paired TTFs expressed at the right time and amount. Researchers then removed these non-coding DNA regions, called enhancers, using the gene-editing technique CRISPR to see how the brain of the flies were affected, and found that flies with deleted enhancers showed a complete absence of expression of the sloppy-paired TTF in medulla neuroblasts.

“On the outside, we don’t see morphological changes from removing sloppy-paired enhancers, but neurons generated in the sloppy-paired stage will be missing from the brain, and I think the neurons generated in later stages will also be lost,” said Li.

The second major finding in the paper was that a mechanism called Notch-signaling works together with the preceding TTFs to activate the expression of the next TTFs in question. The researchers determined that not only is Notch-signaling important for regulating TTF expression, but the way it regulates is dependent on where in the neurogenesis cascade the cells are at. In other words, once a certain number of a specific neuron type have been made, Notch-signaling regulates the transition such that the neuroblasts start differentiating into a different neuron type.

“One TTF is required to activate the next TTF, but that alone is not sufficient to cause the transition,” explained Li. “After each cell cycle, Notch-signaling will further activate the next TTF until a certain level is reached, at which point it will repress the previous TTF, then the

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FRUIT FLY, continued

transition to the next TTF stage will happen. Basically, this mechanism couples the temporal patterning in these neural stem cells with the generation of the appropriate number of neurons at each temporal stage.”

Though TTFs vary between animals, Notch-signaling is highly conserved, meaning that understanding the molecular mechanisms that regulate neuron differentiation in the fly can potentially translate across other higher-order animals. The findings in this study illuminate some of the mechanisms underlying neuron diversity in the brain, but the researchers said there is more to be explored.

“Identifying the molecular determinants, or enhancers, that are required for the transition to take place from eyeless to sloppy-paired gives us ideas for how other transitions may also be regulated,” Ray explained. “We’re going to try to identify other enhancers that previous TTFs bind to activate the expression of subsequent factors.”

The paper, titled “A Notch-dependent transcriptional mechanism controls expression of temporal patterning factors in *Drosophila medulla*” is published in *eLife* (<https://doi.org/10.7554/eLife.75879>), and was supported by the National Eye Institute.

Study identifies key regulator of cell differentiation

By Diana Yates, U of I News Bureau

Embryonic stem cells and other pluripotent cells divide rapidly and have the capacity to become nearly any cell type in the body. Scientists have long sought to understand the signals that prompt stem cells to switch off pluripotency and adopt their final functional state.

In the study, “BEND3 safeguards pluripotency by repressing differentiation-associated genes,” published in the *Proceedings of the National Academy of Sciences (PNAS)*, researchers report that they have identified a key regulator of this process. They discovered that a molecule known as BEND3 shuts down expression of hundreds of genes associated with differentiation, maintaining the cell’s stem cell-like status. Only when BEND3 is downregulated can cells adopt their final form and function. Once they differentiate, they usually stop actively proliferating.

The findings are relevant to understanding normal development and also may be useful in cancer research, said Supriya Prasanth, professor of cell and developmental biology and department head.

“In most cancers, cells are going through this rampant proliferation because cell-cycle regulators are not functioning properly,” she said. “The prognosis of how cancer cells will respond to treatment often relates to its status of differentiation. The more differentiated a tumor is, the better the prognosis.”

Stem cells have the capacity to repopulate a cancer tumor after it has shrunk during treatment, Prasanth said.



The research team included, from left, undergraduate student Darya Asoudegi; graduate students Neha Chetlangia and Fredy Kurniawan; and Supriya Prasanth, a professor of cell and developmental biology at the U. of I. Photo by L. Brian Stauffer.

Finding a molecular switch that will shift cancer cells away from proliferation and toward differentiation could aid in cancer treatment.

Prasanth’s laboratory focuses on cell cycle regulators. Her early studies identified BEND3 as a potentially important player in the system. Her team found that when BEND3 bound to strategic locales along the chromosome, it reduced or blocked the expression of dozens of genes. When BEND3 was removed, gene expression rebounded.

“When you do these gene-expression studies, you can see hundreds of genes go up, hundreds down,” Prasanth said. “But what does it really mean?”

In the new work, she and her colleagues found that many of the genes repressed by BEND3 promote cell differentiation. Illinois graduate students Fredy Kurniawan and Neha Chetlangia spearheaded the work with postdoctoral researcher Mohammad Kamran, in collaboration with the laboratory of cell and developmental

RESEARCH

KEY REGULATOR, continued

biology professor Kannanganattu Prasanth and Mirit Aladjem, a senior investigator at the National Institutes of Health's National Cancer Institute.

"The binding of BEND3 to these genes blocks their expression, preventing the cells from entering a differentiated state," Supriya Prasanth said. "And the moment you remove that control, the cells are now moving toward the differentiation pathway."

BEND3 is not the only regulator of the cell-differentiation pathway; it binds to and interacts with many other

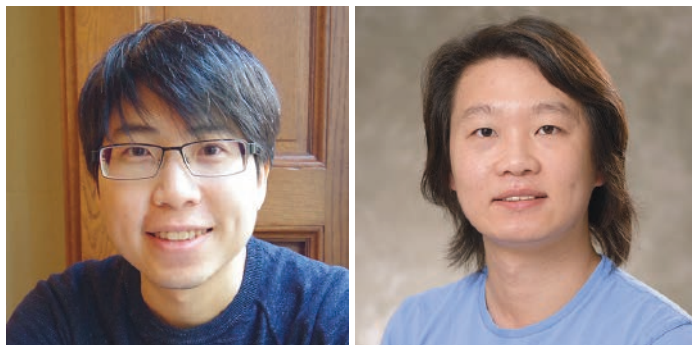
molecular regulators of this process, she said. But its presence or absence appears critical to determining a cell's fate, making it an attractive target for potential medical interventions when the process goes awry.

In an accompanying paper published in the journal *Genes and Development*, the Supriya Prasanth lab and collaborators at the Memorial Sloan Kettering Cancer Center provided structural insights into BEND3-mediated gene regulation.

The National Institutes of Health, the National Science Foundation, and the Cancer Center at Illinois supported this research.

Prasanth lab uncovers new insights into the role of Orc6 in the maintenance of genome integrity

By Eman Zwawi, MCB Communications intern



The research team included, in addition to Prasanth, Yo-Chuen Lin, PhD, '20 cell and developmental biology; and current PhD student Dazhen Liu.

Initiation of DNA duplication requires a six-subunit complex, the Origin Recognition Complex (ORC) that binds to the origins of DNA replication. The individual components of ORC also have many roles in other parts of the cell cycle, including heterochromatin organization and cytokinesis.

New research from Supriya Prasanth's lab at the University of Illinois provides tremendous insight into the role of the smallest subunit of the human ORC, Orc6. Although the ORC is conserved in all eukaryotes, Orc6 is the most evolutionarily diverged. In a recent study published in *PNAS*, the Prasanth lab identified a novel role for Orc6 in the maintenance of genome integrity.

Dr. Prasanth, professor and head of the Department of Cell & Developmental Biology in the School of Molecular & Cellular Biology, explores the cell cycle in cancer cells, with a specific emphasis on how cells avoid cancer through intracellular genetic repair systems, like MMR (mismatched repair). MMR functions by detecting "bulges" that indicate insertion/deletion mutations in recently replicated DNA and works to correct the mismatched bases.

To Dr. Prasanth, the most exciting finding of this paper is that hOrc6 has a role during replication progression and is an accessory factor of the mismatch repair complex, and it plays a critical role in DNA repair.

The results of this project have "opened up many newer areas of exploration," she said. Next steps include studying how mutations in Orc6 impact genome stability. Errors in the MMR genes are linked to Lynch syndrome, a hereditary cancer syndrome. Further, researching the role that hOrc6 plays in tumorigenicity and as a protein of MMR will provide insight into the larger regulatory mechanism of DNA replication and repair in human cells, she said.

The National Science Foundation, National Institutes of Health, Cancer Center at Illinois, and Prairie Dragon Paddlers supported this research.

RESEARCH

‘New player in town:’ Researchers uncover new organelle and its role in epithelial homeostasis

By Bianca Savant, BS MCB 2022

Epithelial cells, which cover our body and line our organs, have several functions which make them critical for certain bodily processes. To carry out their various physiological functions, these cells rely on apical junctions, specialized cell-cell junctions which exert a force that will carry out dynamic processes such as wound migration and morphogenesis through their interactions with actomyosin.

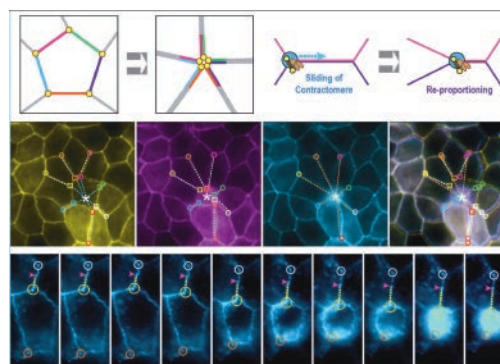
Researchers from the University of Illinois School of Molecular & Cellular Biology have discovered that functions of a new motorized organelle challenge the existing model of epithelial homeostasis. The project, six years in the making, was led by Vivian Tang, Research Assistant Professor in the Department of Cell & Developmental Biology, and three students who were undergraduate researchers in her lab: Timothy Morris, BS, '19, Molecular & Cellular Biology (MCB); Eva Sue, BS, '21, MCB; and Caleb Geniesse, BS, '14, MCB. Their findings were published in “Synaptopodin stress fiber and contractomere at the epithelial junction” in the *Journal of Cell Biology*.

“The undergraduate researchers really contributed to the project, and each did so in a different way. I am impressed by their dedication and continual interests in the project even after they graduated,” Tang said.

“I came into the Tang lab with the goals of being able to perform research with a higher level of interaction with the principal investigator,” said Morris, who is now a medical student at the University of Iowa. “After my time with the lab members, I learned not only about research, but I learned life lessons and advice for my future career. Dr. Tang was always supportive of me going into medicine while being in her lab. The research I performed helped me get more research published while in medical school and learn how to read papers and create my own analysis of the data.”

For this endeavor, Morris zeroed in on molecular biology research. Caleb Geniesse, currently a PhD candidate at Stanford University, focused on the biochemistry work behind the project. Eva Sue, who is now studying bioinformatics at the University of Chicago, generated cell lines and conducted multicell analysis.

The new organelle, which they named contractomere, possesses the ability to alter the proportions of the apical



Contractomere movement reorganizes epithelial cell boundaries. Image courtesy of the Brieher-Tang Lab.

junction and the cell-packing geometry of an epithelial monolayer. These novel functions alter the current dogma of junction dynamics.

For a mechanical force to be transmitted from one cell to another, a physical linkage is necessary, Tang said. However, details of these linkages are relatively unknown in the field. Scientists have established that adhesion receptors allow for the linkage between two cells. There is a direct connection between the adhesion receptors and the actomyosin cytoskeleton, where the forces are generated. When considering the role of contractomeres in these linkages, “there is a new player in town,” she said.

Her group’s discovery of the contractomere, which walks around the perimeter of a cell while simultaneously rearranging it, highlights an entirely new mechanism of organizing cell boundaries. The contractomere is also force-generating but in a very different way than what was known prior to this study.

The contractomere “requires a local compressive force to propel itself. This is very different from other models that imagine the cytoplasm generating force and pulling on the adhesions,” Tang said.

Investigating the distinctive functions of this novel organelle may provide insight into the mechanisms of maintaining epithelial homeostasis. Epithelial cells have a high turnover rate. Their regeneration requires a sheath of cells to close the area where cells are extruded. Inefficient closing of this area will result in a leaky epithelium where toxins can enter. Previous scientific models rely on the membrane recycling mechanism, which is not an efficient method to maintain epithelial homeostasis.

RESEARCH

Researchers generate first comprehensive cellular map of frog cornea

By Jennifer Lask, MCB Communications

University of Illinois researchers have generated the first comprehensive cellular map of the cornea in a frog species at early and adult developmental stages. Their findings could lead to the improvement of therapeutic treatments for diseases and dystrophies that effect human corneal tissue integrity.

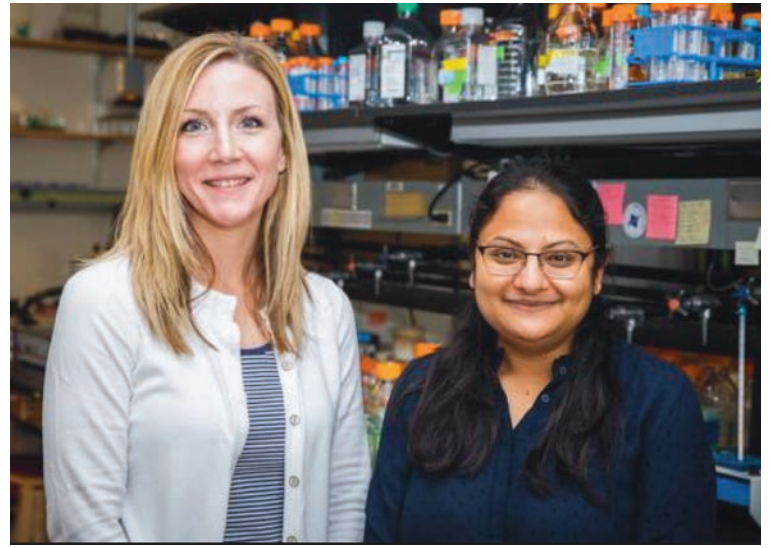
In this study, Jonathan Henry's lab characterized more than 22,000 single-cell transcriptomes to generate an atlas of the cornea in *Xenopus* (South African clawed frog) larvae and adults. First author Surabhi Sonam (PhD '21, cell and developmental biology), says the goal of their research was to understand the gene profile dynamics, differentiation program, and transcription factor regulatory networks for in vivo corneal development and maturation. Henry is now an emeritus professor of cell and developmental biology in the School of Molecular & Cellular Biology. Throughout her time in the Henry Lab, Sonam had observed corneal studies focused on humans and mice, but had not seen significant research into frog corneas, she says.

"The structure of the frog cornea is very similar to human cornea," Sonam explains. "It's kind of amazing because the frog is a four-legged species that has a tetraploid genome, meaning each chromosome has four copies whereas we have a diploid genome. Things are different genetically, but in this case, the beauty is that the structure and the anatomy is very similar to one another's cornea."

Sonam first published research in 2019 in the journal *Experimental Eye Research*, where she identified biomarkers that differentiated two distinct layers of cell types in the frog cornea.

"I wanted to look at the markers which identify corneal epithelial stem cells," Sonam recalls. "People have studied mice, humans, horses, and pigs... I wanted to try those markers and see whether they have similar expression pattern in frogs or not, because each species is so unique."

Her research of the molecular characterization of corneal tissue of adult and larval frogs revealed that stem cell markers were expressed at different stages in



Drs. Kimberly Perry and Surabhi Sonam, members of the Henry Lab and fellow authors on the Developmental Biology research paper

different epithelial layers. After publishing her findings, Sonam was determined to move the project forward. She collaborated with Sushant Bangru, a biochemistry PhD student in Professor Auinash Kalsotra's lab, to conduct computational bioinformatics analysis. Through single-cell RNA sequencing, the co-authors were able to expand their view of the vertebrate corneal epithelium in the clawed frog model at two distinct stages of development.

During this phase of research, Sonam and her fellow researchers examined 22,481 cells and identified eight distinct cell clusters in larvae and 13 clusters in adult frog corneas. They also identified unique gene regulatory networks within the tissue that are developmentally conserved and examined cell-cell communication dynamics at both the larval and adult stages of development. Sonam hopes the data may be extrapolated to understand the biology of cornea development in other amphibians, mammals, reptiles, and birds. Her findings could advance the development of therapeutic treatments for various genetic eye disorder that leads to progressive vision loss.

UNDERGRADUATE STUDENT FEATURE

Meet Jay Sonalkar



MCB major Jay Sonalkar was the 2022 recipient of the Tom and Cynthia Cycyota Research Scholarship

What made you want to pursue a degree in molecular and cellular biology at UIUC?

The reason I wanted to pursue a degree in MCB was because I enjoyed a lot of my science classes in high school, but specifically biology was what held my interest the most. I feel like biology is a discipline that attempts to tell stories

about the way things work. There are many stories out there that still need to be told which is also a major reason I became a student researcher.

Tell us about the research projects you have been involved with as a student researcher. How does being a student researcher have an impact on your education?

The research project I was working on this past summer as well as this semester deals with Orc6, a protein that is part of DNA replication initiation and its role in DNA damage response. Being a student researcher has helped me to be able to apply everything I have learned in the classroom. I have also learned a lot about different experimental methods and experimental design which I may not have specifically learned in the classroom.

What was your proudest moment while a student at UIUC? What moment stands out to you that you will not be able to forget?

One of my proudest moments as a

student at UIUC was getting my first summer fellowship, the Jenner Family Summer Undergraduate Research Fellowship (SURF). I was proud of this moment specifically because it showed that all my hard work in class and in my lab cultivated me receiving that award.

Any post-graduation/career plans you would like to pursue?

After graduation I plan to attend medical school to become a physician.

How do you find fulfillment or joy outside of the classroom or lab?

Outside of class I like to play basketball as well as volunteer whenever I can.

What volunteer activities have you been involved in?

I volunteer at Carle Health once a week and then try to find philanthropic events around campus. One recent activity I did was a pumpkin carving event to raise money for military heroes.

Early Career Seminars Continue

Launched in Fall 2021, the department's Early Career Inclusive Excellence Seminar Series has welcomed several outstanding speakers.

Lydia Grmai, postdoctoral researcher with the Vasudevan Lab in the Department of Cell Biology at Johns Hopkins University, spoke on "Sex-specific ecdysone signaling is established by Doublesex to control gonad development."

Jessica Butts, postdoctoral fellow with the Department of Molecular and Human Genetics in the Baylor College of Medicine delivered a talk on "Investigating Caudal CNS Development From Dish to Embryo."

We also hosted **Piere Rodriguez-Aliaga**, a postdoctoral research scholar in Judith Frydman's Laboratory at Stanford University. His lecture was entitled, "Dissecting the structural basis of Huntingtin pathogenesis one molecule at a time."

With this seminar series we aim to provide talented postdocs from diverse backgrounds the opportunity to present their research and engage with our scientific community. Postdoctoral fellows studying any aspect of cell and developmental biology are welcome to apply; applications from members of historically underrepresented groups are particularly encouraged. Selected applicants will be contacted to schedule a visit.

For additional questions, please contact Laura Martin, departmental office administrator, at lmartin@illinois.edu, or Xin Li, CDB seminar committee chair and assistant professor, at lixin@illinois.edu.

STUDENT FEATURE

Neha Chivukula Venkata



Graduate student Neha Chivukula Venkata is a recipient of the Tom and Cynthia Cycyota Research Scholarship.

Tell us where you grew up and about any people or events that had an influence on your life or education.

I grew up in India. During my undergraduate at Delhi University, I had excellent teachers who sparked my interest in cell and molecular biology and genetics. Fortunately, I got selected for a summer undergraduate research fellowship at Jawaharlal Nehru Centre for Advanced

Scientific Research, one of the premier research institutes in India. This exposure to research convinced me that I wanted to pursue a PhD.

What made you want to pursue a PhD in CDB?

During my master's degree, I was fascinated by how cellular identity is established through the regulation of gene expression during development and wanted to understand this process better. So, a PhD in cell and developmental biology seemed like a natural fit.

What lab are you in and what research projects are you pursuing?

I am in Dr. Andrew Belmont's lab, and we are broadly interested in the effect of spatial positioning of genes within the nucleus on gene expression regulation. Regulatory factors within the nucleus can be enriched locally in different membrane less bodies, for example, nuclear speckles. Previously, our lab discovered that in the association of the heat shock gene HSPA1B with nuclear speckles enhanced the amount of RNA produced from the

gene as compared to when it was not associated. This phenomenon has been found to occur for several genes.

I am interested in understanding where speckle non-associated genes are located within the nucleus and whether the local environment, where these genes are present, influences their RNA production. In addition, the nuclear bodies themselves are dynamic structures that get altered upon different cues. I am also interested in how these bodies change over time and the effect it has on genes that interact with these bodies.

What is your favorite place on campus or in Champaign-Urbana and why?

I like all the tree-lined alleys on campus and in Urbana, where I often take walks to relax.

How do you find fulfillment or joy outside of the lab and classroom?

I am fond of cooking, gardening, and reading. I also love being outdoors whenever I can. Hiking and kayaking are some of my favorite things to do!



Congratulations to Professors Rachel Smith-Bolton and Brian Freeman! Smith-Bolton was awarded the school's Teaching Excellence Award and Freeman was presented with a Research Excellence Award.

CDB PhD students Madhura Duttgupta, Jesus Moreno-Castillo, and Pradeep Kumar celebrate at the School of MCB holiday party in December 2022.

ALUMNI FEATURE | Qinyu Hao, '21



Recent PhD graduate Qinyu Hao was a recipient of the Tunji Toogun Research Excellence Award. The award recognizes CDB graduate students for their outstanding research accomplishments.

Tell us where you grew up and about any people or events that had an influence on your education.

I grew up in Beijing. My dad is a professor of Toxicology at Peking University. I grew up watching him do experiments. This had a significant impact on me choosing biology as my major.

What lab were you a member of and what research projects did you pursue while here?

I was in Dr. KV Prasanth lab. My primary project during my PhD was about a novel nucleolus-associated RNA species. It was a challenging project because everything was new. Any small progress made me feel like my efforts were not in vain. I am happy with what I got during those years.

Tell us what you are doing now, and any future career plans you have.

I am now a scientist at a startup company. It is quite a different

experience than doing research in institutions.

How do you find fulfillment or joy outside of work and/or the lab?

Doing sports is a great way to release stress and feel good. I ran a lot when I was at UIUC and now I play tennis. It is important to have some hobbies that can distract you from work and/or research.

What is one piece of advice someone gave you that you have found valuable as you navigated your PhD and now your life afterward?

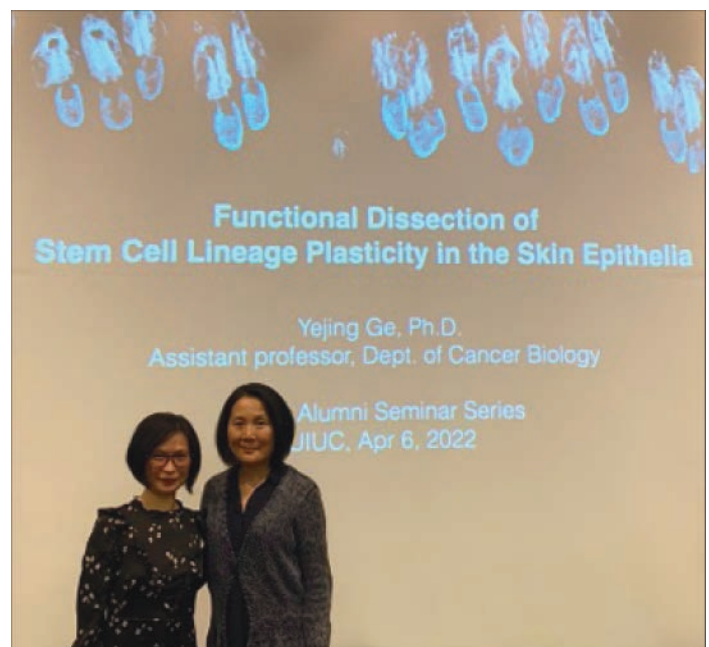
My master thesis supervisor once told me that it is important to remember the three “C”s when doing research in biology: clear mind, clever hand, and clean bench. I found this advice valuable, especially the clear mind, in all kinds of work.

Alumni Seminar: Dr. Yejing Ge, '12

The department was thrilled to welcome back to campus Dr. Yejing Ge for its first Alumni Seminar.

Ge received her PhD in cell and development biology in 2012 under the mentorship of Professor Jie Chen. She is currently Assistant Professor in the Department of Cancer Biology, Division of Basic Science Research at the University of Texas MD Anderson Cancer Center in Houston. At MD Anderson, Ge studies the molecular mechanisms underlying stem cell plasticity in skin wound repair, cancer, and aging. Her talk was entitled, “Functional dissection of stem cell lineage plasticity in the skin epithelia.”

G’s visit was in April 2022. We are looking forward to hosting another successful alumni seminar in 2023!



2022 CDB Annual Retreat



Professor and former department head Jie Chen, guest speaker Tom Cycyota and wife Cyndy Cycyota; and CDB professor and department head Supriya Prasanth.

The department held its annual retreat in October 2022. Many thanks to keynote speaker Tom Cycyota. Tom Cycyota (BS, '80, biology), is president and CEO of AlloSource, which preserves human tissue from generous donors to create transplantable allografts (human-to-human transplants). Under his leadership, AlloSource has become one of the largest and most respected tissue banks in the country.

In addition to his Illinois degree, he has an MBA from Loyola University. In 2015, the College of LAS presented him with its Alumni Humanitarian Award. Cyndy Cycyota is a professor of management at the U.S. Air Force Academy and holds three degrees in business: a BS, MBA, and PhD. Prior to academia, she was a manager for two international accounting firms and a bank.



Above: Attendees gather for a group photo.

Right: Thank you to our fantastic graduate students who organized the retreat. Left to right: Temirlan Shilikbay (co-chair), Andrew Riley, Shrunali Amin, Laureen Daniels, Snigdha Mathure (co-chair), Allison Boss-Kennedy, Neethu Babu, Humayra Oishi.





Meet Tom Cycyota, keynote speaker at the 2022 department retreat

Where did you grow up and what sparked your interest in biology?

Mrs. Sheila Emmitt was my high school biology teacher at Proviso West in Hillside, Illinois during my junior year. Mrs. Emmitt and her husband were personal friends of my parents so I knew her outside of school as well. She took me to see Dr. Michael DeBakey, an esteemed heart surgeon at a special event at Northwestern Medical Center. Mrs. Emmitt's passion and energy in teaching me biology, along with the Dr. DeBakey event, changed my life and inspired me to become completely enthralled with biology and with the idea of becoming a surgeon when I went to college.

What brought you to the U of I? Do you have a favorite class or event or professor that stands out in your memory?

The U of I was the only university I applied to and could afford. Remember, this was in 1975—long before the Common App or anything like that! If I hadn't gotten into Illinois, I would have gone to a community college. My siblings and I were the first people in our extended family to go to a four-year school. I loved all my biology courses even though I got mediocre grades. I especially loved an embryology course I took when I was a junior. It was the only D I ever got in all my education, primarily because I was such a bad test taker. But I learned so much and was and still am amazed by the growth of human embryos. I loved and am still awestruck by the complexity of bio-

logical systems. My grades didn't allow me to go to med school, but I was fortunate to have a career that used my biology education in the companies for which I worked.

Regarding your career, what are you most proud of?

After graduating from Illinois, I sold medical devices for the Kendall Company, earned my MBA from Loyola University, then transitioned to wound care management at New Dimensions in Medicine, followed by Johnson & Johnson. I was hired as President and CEO of AlloSource in 2000. AlloSource is gifted with donated human tissues (e.g. bones, tendons, skin) from deceased donors and transforms those gifts into allografts (human to human transplants) that can be used in various surgical and medical procedures. I am incredibly proud of the work we have done at AlloSource in taking the gift of donated human tissue and turning that gift into solutions for surgeons and now medical doctors who are treating hard to heal ailments. I have been touched by countless people who have been impacted by tissue donation. It has been a great honor to serve as AlloSource's President and CEO.

Regarding your career, what are you most proud of?

I am now in the process of retiring so the future is up in the air! Living in Colorado has afforded us the opportunity to do so many things outside—including backcountry hiking and downhill skiing. My wife Cyndy and I are recent grandparents, and the grandkids live in Seattle, so I have no doubt we'll be spending a great deal of time there as we enter the next phase of our lives.

Congratulations to the graduate students who won research presentation awards at the 2022 retreat!

Research Poster Award Recipients

Natalie Biel (Sokac Lab) | Neha Chivukula (Belmont Lab) | Pradeep Kumar (Belmont Lab)

Tejas Mahadevan Padmanabhan (Sokac Lab) | Hailun Zhu (Li Lab)

Research Talk Award Recipients

First Place: Tejas Mahadevan Padmanabhan (Sokac Lab)

Second Place: Pradeep Kumar (Belmont Lab)

Third Place: Anish Bose (Smith-Bolton Lab)

Fourth Place: Sihang Zhou (Van Bortle Lab)



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