THE CSB FOREFRONT

VOLUME 3
Fall 2023

"Data mining" Illustration by Ian Hsu

Prickly pears in Valencia. Taken by Cynthia Wong

Table of Contents

Illustration by Ian Hsu

Letter From Your Editor

I can barely believe it has been four years since the CSB Forefront was born. Three graduate students sat at a tiny table in the CSBGU pub. Over beers, this idea took shape. It has been massively rewarding to experience first-hand and connect with you through your phenomenal, often modestly silent, scientific and artistic talents.

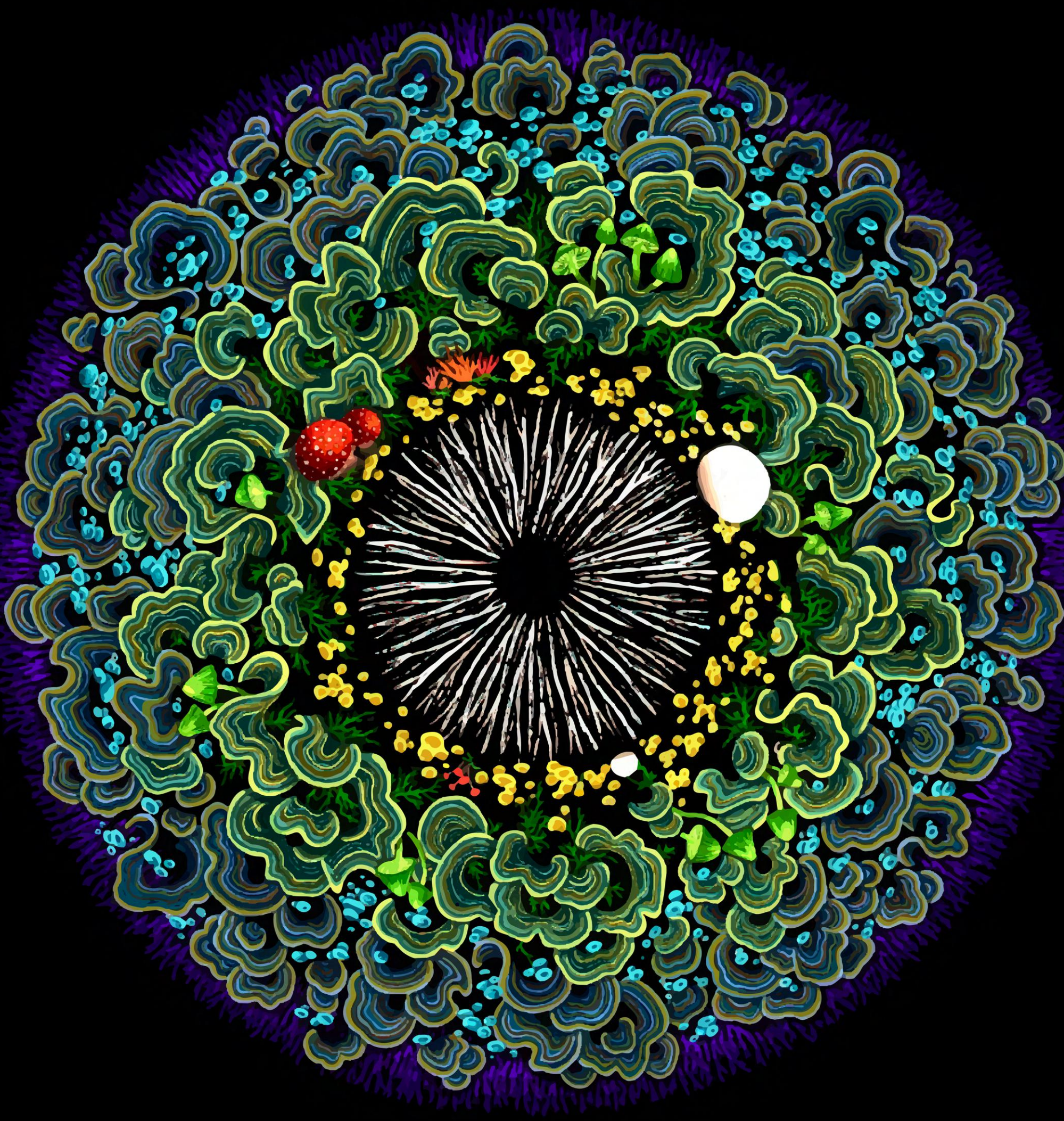
In what sometimes feel like a treadmill, life as trainees in academia can often lead us to miss the forest for the trees. This magazine was launched precisely to serve as a medium to bring the things which are important to us to the forefront of our collective perception as we walk this path. The last 4 years and 3 volumes are a clear testament to how our process of becoming scientists is guided by our discoveries just as much as it is by the larger state of the world and our community. A whole pandemic later -arguably- and here we are.

In this issue, we want to bring the conversation back to the science that unites us. As biologists, we have trained our eyes to identify patterns, make connections, and ultimately test evolutionary explanations. I like to believe that we go through graduate school to, more than anything else, naturalize the process of training our imagination with logic and data. This volume's cover was made by Ian Hsu, talented as always, on his farewell from graduate school; a surrealist lens on data mining. It reminded me of being an undergrad and wanting to draw on my window a giant geological timeline overlayed with the phylogeny of all living and extinct creatures, only to realize I lack the artistic talent for it. So many of you do not! As you read through this issue, I hope you can see the excitement our grad community has for the science we do, for the careers of those who we admire, and in the ideas we brew to help science education and communication reach further. We can all bring our two cents into making science a fair, kind, and exciting place for everyone.

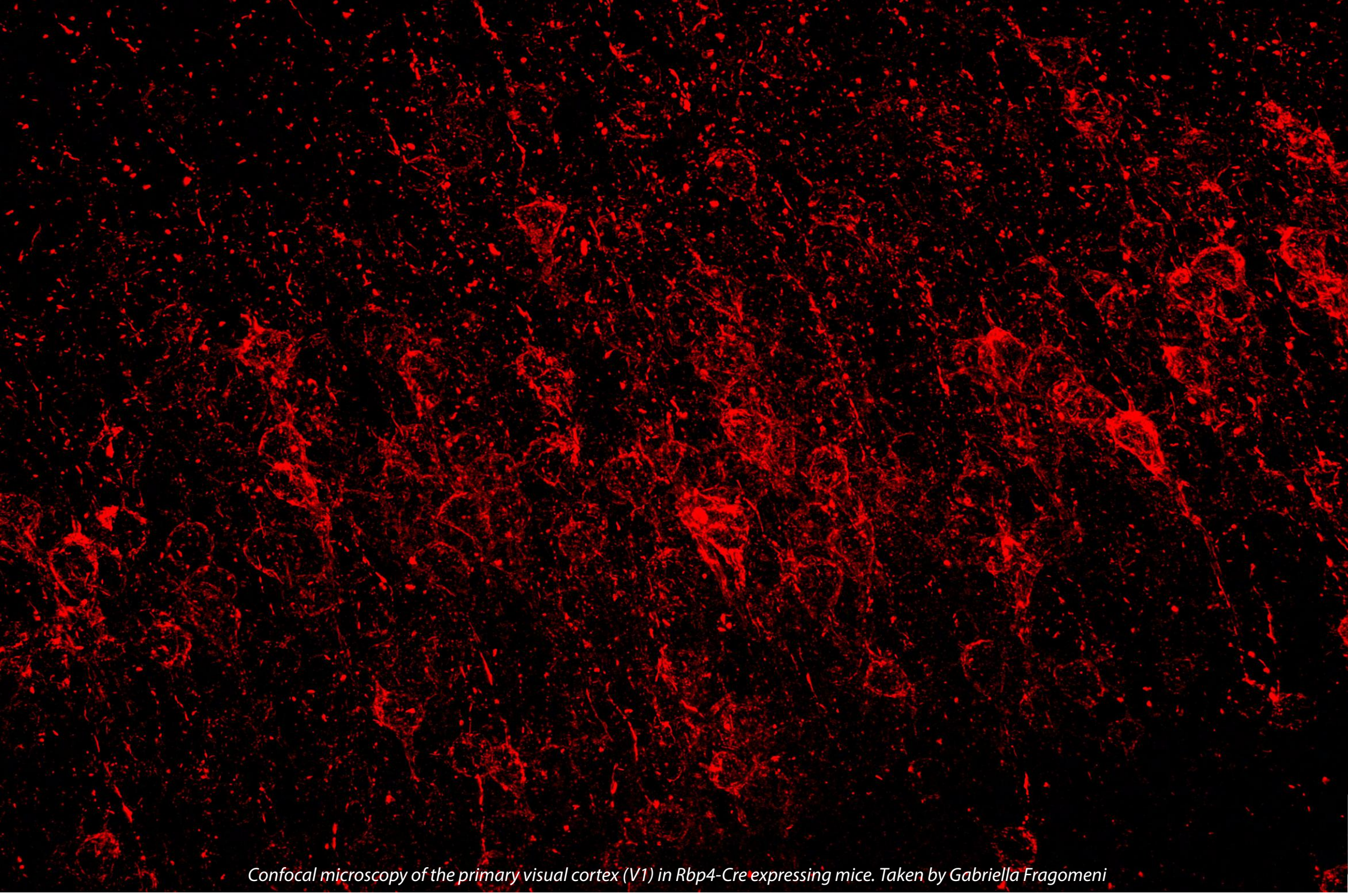
It is time for our magazine to see a renewed leadership and perspective as its first generation trickles into the world outside. To everyone who has worked to materialize their ideas here, thank you; folks who have been here from day one, **Francis Lee** and **Sonhita Chakraborty** -first and second co-pilots-, to **Amir Arellano Saab** for his consistent enthusiasm, **Michael Bunsick** for his sharp writing, to all the writers/editors, to the invaluable artistic talent of **Cynthia Wong**, **Ian Hsu**, **Luis Abatti**, and the ongoing support of **Dr. Neil Macpherson**. Special shoutout to **Ian** for designing fabulous covers and infinite art, and to **Cynthia** for putting this issue together, both from the other side of the Atlantic. This has been a labour of love. Thank you all for your patience with the release of this issue and for putting up with my pestering over the years. Helping launch and nourish this magazine has been a phenomenal experience, one of which I am deeply grateful. I hope it has and continues to bring something positive into our community.

Let's welcome our new **Editor-in-Chief, Sanjana Bhatnagar**! Her enthusiasm and commitment for science communication have already been invaluable for this release and will certainly lead this magazine forward into exciting and important conversations. Come join the team and keep an eye out for future volumes!

Sincerely,
Tatiana Ruiz-Bedoya



"Fung-Eye" Illustration by Cynthia Wong



Confocal microscopy of the primary visual cortex (V1) in Rbp4-Cre expressing mice. Taken by Gabriella Fragomeni

Special Feature PIs: Part I
Prof. Arbora Resulaj

By Avani Krishnan

For this issue, we invited Prof. Arbora Resulaj to chat with us about her career, interests, and her experience. Prof. Resulaj is an Assistant Professor at the Mississauga campus. She received a bachelor's degree in engineering from the University of Toronto and received her Ph.D. from the University of Cambridge, where she graduated from the Cambridge-Janelia Ph.D. program before returning to Canada to start her lab in January 2021.

While Prof. Resulaj's roots stem from engineering, things took a turn for the better during a third-year biomedical engineering course when she found her interest in neuroscience. She notes that there is a thrill to *"thinking about what experimental data means, what questions to ask, and ultimately having a novel discovery in your hands."* After completing her undergraduate degree, Prof. Resulaj landed a summer position in a neuroscience lab, her very first hands-on exposure to the field.

"I was fascinated by the brain, but I had no idea what neuroscience research was about other than some equations about neurons."

As Prof. Resulaj became more familiar with the field, one key moment struck out to her - *"In electrophysiology experiments, electrical activity of neurons get recorded. These recordings get hooked up to an audio monitor to hear these electrical spikes in the brain. There was this moment where I realized, 'Oh my God, there is this language of the brain'. I think many neuroscientists have that exact 'Wow!' moment and that's how they get into the field."* After receiving her Ph.D. from the University of Cambridge, she pursued her postdoctoral work with Prof. Massimo Scanziani at UCSF (University of California, San Francisco) and Prof. Joshua Trachtenberg at UCLA (University of California, Los Angeles) where she studied visual decision-making. In January 2021, Prof. Resulaj started her lab at the University of Toronto Mississauga, where she aims to investigate how neural circuits enable perception, memory, and decision-making. *"Consider you are going on a walk, and you see two paths - based on what you're seeing, do you choose path A or B? My lab is particularly interested in the neural mechanisms behind this decision - what are the circuits and what are the computations in the brain that enable our decision-making abilities."* Prof. Resulaj notes that decision-making is fundamental to our individuality and self-awareness, so it is important to understand how the brain enables this process.

Did our PIs achieve the heavily proclaimed "work-life" balance during their grad years? Find out in the PI Mini Interviews!

Setting up her lab, however, came with its fair share of challenges. Opening a lab involves being on-site very often, and this can be exceedingly difficult without access to childcare facilities. Schools were not open because of the pandemic, and taking care of her son alongside opening a new lab can be overwhelming. On the other hand, there were also some valuable lessons learned during this period. *"It made me more focused, and I learned how to better prioritize tasks, rather than trying to juggle multiple things at once. With borders always at risk of shutting down because of the pandemic, you must be on top of your orders of supplies that are needed to get experiments running."*

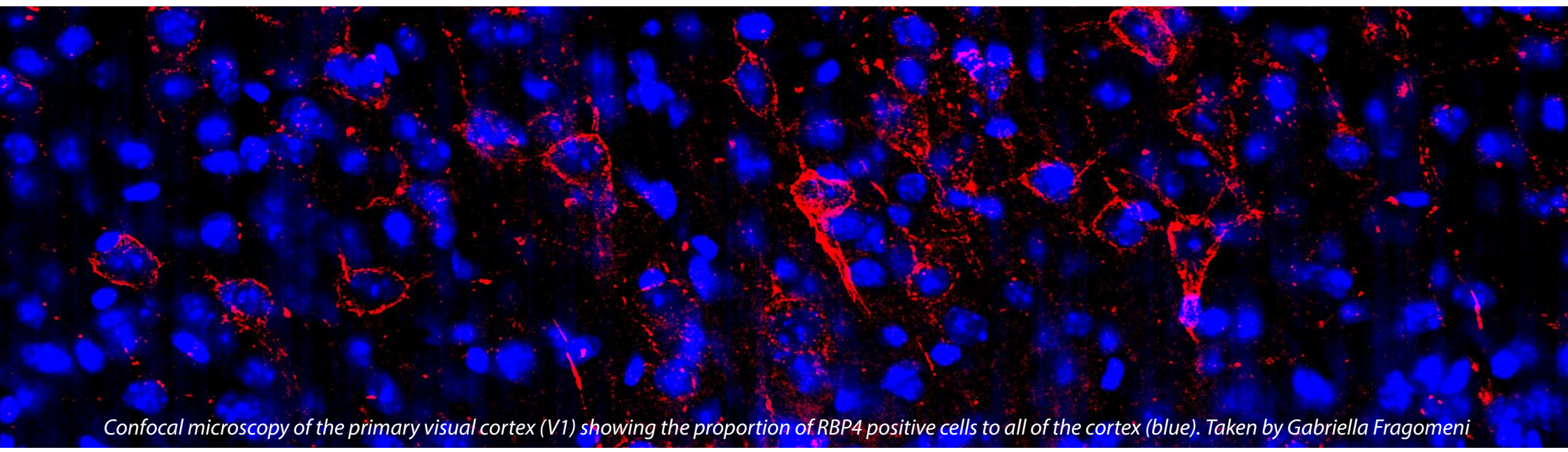
Prof. Resulaj's first course at UofT looked at computational approaches to data analysis in neurobiology. *"Technology has progressed so much over the last five years that one can gather vast datasets now and it is very important to learn how to analyze them"*, she says. To promote an enriching experience for her students, Prof. Resulaj incorporated live coding sessions and prioritized student engagement in her curriculum. She hopes to mentor her students by assisting their growth and helping them achieve their goals. *"How can I help you troubleshoot or learn a skill so you can move forward? How can I help you become independent?"* These are all questions she hopes to assist her students with. In the time she is not teaching or running her lab, she is very keen on reserving her mornings for writing grant proposals and research articles about her current projects. *"Doing that and thinking critically gives me energy throughout the day, so I think it's very important to set aside that time when you start your day."*

Aside from academics, Prof. Resulaj enjoys spending time with her five-year-old son and eight-month-old daughter, either going to parks or building Legos. However, before the birth of her children, she had a unique hobby. *"A big part of my life was performing improvised comedy, but I haven't done it in a few years."* Turns out, improvised comedy is more like science than one would think. *"The best days of science are very similar to performing improv comedy. You get up on stage and you get a suggestion from the audience - you don't know what's going to happen next, so you and your team members have to embrace discovery and build on each step - there's a thrill to that."*

Prof. Resulaj has enjoyed being a Principal Investigator thus far. She has always appreciated critical thinking and writing academic papers plus she finds it thrilling to attend seminars. However, one thing differs from her initial expectations. *"There's a lot more administrative work required to set up the the lab than I previously thought would be."* The perks that come with being a new PI in the institute can, however, outweigh that administrative burden. She notes that *"you feel closer to your data and your experiments, given that you spend so much time in the lab troubleshooting - and no one else can do that for you in the beginning stages of establishing a lab."*

I asked Prof. Resulaj for her thoughts on finding success in the field. She points out that because techniques in neuroscience can cover a very wide breadth (from techniques in molecular and viral biology to behavioural work), it can be helpful to focus on mastering just one technique rather than being a jack of all trades. Her mastery lies in behavioural training - developing behavioural paradigms *"to train a mouse to do something that nobody has ever trained a mouse to do before."* Her advice to aspiring researchers is to figure out where their interests lie early on - for example - by gaining lab experience. While imposter syndrome is an unfortunate yet common feeling amongst researchers, Prof. Resulaj notes it is important to *"approach everything as a learning opportunity."* Doing so makes you *"more aware of the progress you make every day and that gives you hope."* In fact, she admits that this is something she wishes she knew when she was a graduate student. She also notes that putting yourself out there by talking to more people can be very advantageous to up-and-coming scientists. *"You never know who will have that life-changing piece of advice!"*

As a current graduate student in Prof. Resulaj's lab, I am a lucky witness of her passion, drive, and eagerness for research. She encourages everyone to remind themselves that science is a collective effort - one person's breakthrough finding is a stepping stone for another's research. She is very excited about what the future holds in her lab and hopes to inspire people the way she was when she was a graduate student herself.

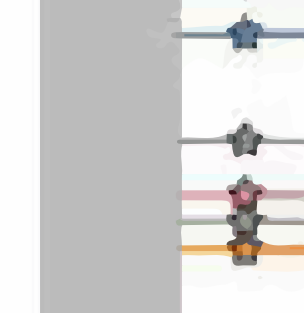


Confocal microscopy of the primary visual cortex (V1) showing the proportion of RBP4 positive cells to all of the cortex (blue). Taken by Gabriella Fragomeni

A Muller diagram from Prof. Nguyen Ba's 2019 Nature paper in which he developed a barcoding method to track evolutionary dynamics of yeast with unprecedented resolution.

Special Feature PIs: Part II
Prof. Alex N. Nguyen Ba

By Kristyna Gorospe



When Prof. Nguyen Ba was asked about his earliest memory of being excited by Science, he said - *"I was raised with science everywhere. When I was about three or four years old, I wanted to be an archeologist or a dinosaur. I collected many tools related to dinosaurs, and we had lots of scientific magazines in Montreal. One of these magazines featured young curious minds, and I happened to be on the front cover!"*

Prof. Nguyen Ba completed his BSc in Biology at UofT, obtained his PhD degree in Computational Biology in Prof. Moses' lab at UofT, and then moved on to being a postdoc in the Desai lab at Harvard University. He explained that he chose these labs because they were researching emerging topics. For instance, Prof. Alan Moses was a computational biologist when the field wasn't as big as it is now. Before, they had 30 organisms/sequences to extract as much information as possible from, but now there are hundreds of thousands of gene sequences. Prof. Nguyen Ba further added, *"I started computational biology when it was an emerging field. It was similar in the Desai lab. He started to bring automated technologies to the bench and that allowed us to ask questions that we couldn't ask before. To me, that's what was effective - automation - for the future of science. We used this aspect as our main driver for inferring patterns in the genome."*

Previous experiences in the labs of Prof. Moses and Prof. Desai propelled and greatly helped Prof. Nguyen Ba to take up the role of Professor. He exclaimed that he was extremely fortunate that Prof. Moses and Prof. Desai allowed him to supervise others during his time in their groups. During his graduate studies, he supervised undergraduate students, and as a postdoc, he very closely supervised graduate students. He added, *"Supervising means developing new projects together, teaching, writing, and preparing them for talks - being sympathetic too!"*

Young Prof. Alex Nguyen Ba featured in the cover of a magazine in Montreal, showing how vinegar and salt react to form hydrochloric acid to clean rust!

Many such interesting insights into Prof. Nguyen Ba's academic life can be gained from this interview done during 2021.

1. How would you explain your research to someone with minimal scientific background?

When individuals live and reproduce, we get mutations. The question at the core of our research is: What can we say about that mutation? This can have implications for thinking about evolution. We like to think about how the mutation can affect the population. E.g., How come the spike protein in COVID is a variant of concern? Will the mutation cause disease? In this case, we need to think about the function of a mutation.

2. You became an Assistant Professor in January 2021. What does your typical day look like?

Half of the day is trying to keep up with papers and the usual work of a professor. On slower days, I'd spend half on teaching (developing lectures, watching other professors teach to incorporate those techniques into my own courses) and the other half is spent in the lab with my students, analyzing data together.

3. How was the hiring process affected by the pandemic?

I was not hired during the pandemic; I received my offer in December 2020 before the lockdown happened. However, I'd imagine the interview process to be more annoying as the person being interviewed because you may not be able to see the lab space and peers in person. As a prof, you want to be in a community and with a zoom interview format, you can't truly gauge how well you would fit within that community.

4. What has it been like establishing your lab amidst the pandemic? What are the challenges of being a new professor during the pandemic? Are there any pros?

It has definitely been extremely challenging, and I cannot think of any pros. Everything is slowed down. For example, plastic tubes take months to ship because they're all used for COVID-19 testing. Also, help is hard to come by because professors aren't in their offices anymore. I've only met a total of three professors, and I don't have organic interactions to receive help.

5. What is your favourite part about being a PI?

My favourite part of being a PI is seeking out collaborations with great scientists, having people talk to you, and especially talking to and mentoring students. Last year, I interviewed about 60 students for positions in my lab, and it's really fun to talk to each of them and learn about their goals and how my lab can make them happen (if our goals are aligned, of course!). Mentoring people is really my calling and I really love doing it.

6. What is your favourite part about the CSB department?

I think of CSB as a home, there is a phenomenal support staff (undergrad/grad coordinators/finance) and you also get to be surrounded by so many different types of sciences that it's just inspiring to be around people. As a PI, I'm lucky that I'm basically going back home, and people that were either my professors or part of my committees already know me. While I am no longer doing the same type of science as when I did my Ph.D., I think people have been very supportive and interested in the future directions of my lab.

7. If not a professor at UofT, what other career options would you have chosen?

I would've been happy in industry, especially industries that are at the forefront of innovation. Illumina, New England Biolabs, and lots of biotech companies have pushed science forward. I would enjoy working on the optimization of techniques.

8. What were some valuable lessons you learnt throughout your academic journey?

Everyone has their own things to do and their own life to be stressed and busy about. It helps to have a good understanding and have fun conversations. Science is hard - conferences, academic Twitter, and reviewers can be mean. They sometimes can forget that there's a human behind the science. If we were nicer to each other and less personally critical of others, science could be a fun, inclusive place.

9. There is a growing demand of computational knowledge for

many fields, including biology. How can biology students who don't have a computational background get started on improving their computational literacy?

We all have our own ways. I learned on my own, and of course I had Alan to help me. I think it's really just having the time to learn, and it won't be easy at first. These days, there are many courses online to learn, and know that it will take time. It doesn't have to be that you spend 10h every day, but even a tiny bit of time every day will help a lot. I've seen people from no programming knowledge to good programmers, so it can be done!

10. How do you deal with academic pressure?

There are two types of pressure: 1) how do you keep up with your time, and any other expectations. With scientific experiments, a lot of times when supervisor tells you it needs to be done by a deadline, it's fine if you don't get it done by the deadline. There's some random barriers put onto you, that's fine. Work on your pace. 2) Expectations from supervisor or the world. These are harder to work with. Need a good support network to get through this. Find friends.

11. What do you wish you knew before you started your PhD? Does that differ from what you wish you knew before you started your post doc?

Before my PhD, I wish I knew how long things take. I now have an appreciation for time. Undergrads should be exposed to this (i.e., how long it takes for manuscripts to be published, how long experiments take). Another thing students should know is what are the resources available to you. Supervisors and other professors are not usually good at providing those resources. The biggest failing of supervisors and the university is that we don't give you all the resources available to you, like, for instance, mental health.

12. Do you have any advice for aspiring researchers or graduate students?

Find a friend that you can talk to freely about science. It's important to have an academic friend – someone in the same boat where you can exchange ideas. Hopefully not in your field so you can think about research as a whole. Science needs to be done for passion. You can't be doing a degree because you need it as a stepping stone. Doing science should be for the fun of it, including having someone else (aside from your supervisor) to share that passion with. Also, find a good supervisor! It will make or break your experience. Before joining a lab, talk to all the current graduate students and their experience with the supervisor, it could help you avoid going into toxic lab environments.

Protein representations in high dimensional space. Illustration by Denise Le

Alboraya, Valencia. Taken by Cynthia Wong

Looking Ahead: A Deep Dive into Mental Health in Our Community

By Ahmed Elbassiouny

It is with no doubt that mental health in academia is a worrisome issue, not only because it affects many members of the academic community, but also due to the stigma that prevents society from addressing it, which leaves many feeling like outcasts. Previously, The Forefront has covered the mental health issue in academia (see Volume 2). The culture of overwork, low reward, imposter syndrome and lack of honest discussions make the mental health issue in academia a real crisis.

The University of Toronto community has lost many cherished members to suicide, peaking in 2019 when the administration ramped up investment in mental health resources and accommodations to address the rise in the death toll. While many still do not believe that mental health struggles are widespread at UofT, and rather limited to some disciplines, given that many suicide incidents were largely concentrated in some departments/faculties, it is important to note, however, that for every successful suicide attempt there are many instances of suicidal deliberations which occur far and wide across all academic disciplines. It is also important to also highlight that investment in mental health resources is only the first step towards a healthier campus. But the crucial element is building an informed community that is aware of the mental health crisis and can proactively demonstrate solidarity, sympathy, and support. This community of resilience starts small: looking out for each other within the same lab, floor, building, or department is really the best way to support each other as we navigate the curveballs that academic stressors throw at us.

What are the triggers?

Academics are more likely to be affected by mental health struggles than the general population due to the nature of their work: the need to constantly deal with research failure; constant rejection from competitive grant agencies and academic journals; high workload and long work hours; and

financial struggles. While these stressors can take different forms and bear different weight, they affect academics of all career stages (graduate students, post-doctoral fellows, and faculty). Thus, addressing the mental health crisis in academia is a collective effort that every member of this "society" needs to partake in.

According to a survey of CSB members in 2020, students in the department reported that the top five sources of stress in graduate school were getting experiments to work (19%), neglecting social life (12%), financial worries (12%), the pressure to publish (11%), and their interaction with supervisors (9%). On the other hand, supervisors reported their top five stressors as securing grants (24%), interacting with students (21%), pressure to publish (14%), and administrative work (14%). Signs of overworking surfaced with some graduate students reporting feeling tired or sluggish when coming to work (46%) or even dreading coming in (5%). Similarly, faculty members reported dreading having too many non-research academic commitments (18%). During the COVID-19 pandemic, many CSB members found themselves caring for others full-time, working from their bedrooms, and getting bombarded with additional Zoom meetings – all of which added to the overwork culture.

Interaction with colleagues and lab dynamics are also important elements that directly affect the mental well-being of academics in CSB, which has been negatively impacted by social isolation due to the COVID-19 pandemic. Some faculty reported that the pandemic largely impacted their interaction with their colleagues (73%) and their own students (9%); while students reported that their interaction with colleagues/lab mates have been significantly affected by the pandemic (41%) and their communication with supervisors have become less frequent and dry (19%). Less frequent interactions leave more room for miscommunication and misinterpretation, especially when coupled with toxic interactions. Students reported a lack of interactions with their lab mates outside of lab business (30%), and in some cases, competitive lab culture (3%) that can sometimes become hostile. Some faculty members also reported that some of their interactions with colleagues have been hostile (18%).

Another important component of well-being is being able to share and "vent" when in distress, to avoid having these feelings escalate further. Most students in CSB reported that they do not feel comfortable sharing financial (57%) or mental health (76%) struggles with their supervisors. This was largely because they either worry they would be excluded from opportunities, or because they feel that their advisor would not understand or be open to helping. Similarly, 45% of faculty respondents do not feel comfortable sharing mental health struggles with their students, because they worry it would be perceived as unprofessional or that it would add an emotional burden on them.

Taken together, the high workload of academia combined with the lack of community support has been leaving many CSB members vulnerable to declining mental well-being. On top of that, the stigma around sharing struggles with their peers and lab members leaves those in distress unable to seek help and at risk of further developing poor mental health.

How do we move forward?

Building community. Now more than ever, as we rise from the social grave of the pandemic, it is important to build community within CSB. The sense of community can make members of the department have purpose, feel cared for, be motivated to do their best, and be happier. Building community does not mean "wasting time", it means investing time to build connections that can help you personally and, possibly, professionally. Academia was originally built on community, where you share your scientific ideas and results, converse with like-minded individuals and find collaborators to help you succeed. Meaningful connections with colleagues in your community have many emotional rewards, and the few minutes you invest to connect with those colleagues is a small price. It can be as simple as taking a short walk around the building or getting coffee together – things that will not consume a large portion of your day. Luckily, the department administration has been very supportive of community-building initiatives, so the only thing left is a community that is willing to participate in those efforts.

Effective and caring communication. It is important to think about the means of delivering communication in the digital world we are navigating, where intentions can be easily misinterpreted and miscommunicated. Effective communication does not need to come at the cost of added workload, it can be as simple as taking an additional 1-2 minutes after a zoom meeting to ensure the recipient understands the intentions and knows that you care for them and their well-being. Another simple tactic is to quickly dial someone on the phone to speak with them verbally if you think sending the information over email can be misinterpreted. This also allows two-way communication and saves both parties from back-and-forth emailing.

Inclusivity. Besides visible differences, workplace exclusion can arise due to non-obvious barriers such as financial circumstances and invisible disabilities. It is important to be conscious of these factors, and to accommodate for them before they become exclusionary. By inclusivity, I do not only mean admission of people of colour or those of diverse backgrounds to our community but also removing non-physical barriers in our workplace by adjusting our expectations to accommodate those with financial and disability (visible and non-visible) needs.

It is important to also highlight that investment in mental health resources is only the first step towards a healthier campus. But the crucial element is building an informed community that is aware of the mental health crisis and can proactively demonstrate solidarity, sympathy, and support.

Building a community does not mean "wasting time", it means investing time to build connections that can help you personally and, possibly, professionally. Academia was originally built on community, where you share your scientific ideas and results, converse with similar-minded individuals and find collaborators to help you succeed.

Academia is notoriously known to ignore personal needs. This is because well-known academics were wealthy individuals (e.g. Charles Darwin) who had the privilege of not worrying about finances and rather devoted their time to observing and thinking about the world around them. While some academics today share the Darwinian financial privilege and can devote 100% of their time to their research commitments, many academics come from underrepresented, underprivileged backgrounds. Measuring success and devotion to science by how much you are willing to give up for your research is largely biased towards those who can afford it. Academia largely overlooks those who have chronic illnesses that incur additional financial burdens and those who have dependents that require time and financial support. It is time we adjust our expectations to consider personal challenges like healthcare, childcare, elder care, debt, and other personal matters that really shape the day-to-day of an academic. Academics of 2023 are not necessarily rich, white, noblemen who think for a living, they are parents, caretakers, disabled, and people of colour who share the interest of advancing science to improve our lives and the desire to bring new perspectives on tackling diseases.

Engaging in conversations. Breaking the stigma around mental health is the most challenging aspect of improving mental health in academia, it requires a time investment from members of the community to become educated about ways to improve wellness. Open conversations about mental health and struggles are hard but also necessary for making substantial systemic changes to the work culture. It is also important to invest in learning strategies for being on the receiving end of a conversation about struggles, in order to show compassion towards those in need of help. Actively seeking and prioritizing awareness about mental health are the first steps toward building a community that nurtures the well-being of all its members.

Illustration by Ian Hsu

"Macro Mycoheterotrophs" Illustration by Cynthia Wong

Hidden Webs of Connectivity, and a Sign From Below

By James Bradley & Cynthia Wong

As systems biologists, we seek to study the interactions between components of a biological entity, often by delving into single individuals or 'model organisms.' For example, how are *Arabidopsis* stomata regulated in response to changes in soil moisture? How do *Drosophila* Hox genes regulate its body plan? These are excellent questions biologists have been asking for decades. But there is more to life than the individual. Systems exist *between* individuals, too.

There is perhaps no greater inter-individual biological system on earth than the web of plant-fungal connections within the soil of terrestrial eco-systems. To thrive, almost all plants form physiological connections with microscopic fungal filaments, called mycorrhizae, found in the soil. These

root-fungal conduits allow carbon and nutrients to flow in both directions: the plant provides the fungus with carbon in the form of sugar, and the fungus donates nutrients, such as phosphorous, to the plant. In fact, fossil evidence suggests that plant and fungal ancestors colonized land hand-in-hand (or perhaps more aptly, fungal filament-in-primordial root), and that this relationship was required to create the humus-rich soils needed to support elaborate plant forms that later evolved.

The term "the wood wide web", coined in the '90s and recently popularized in the book *Entangled Life* (Sheldrake, 2020), reflects the omnipresence and interconnectedness of these subterranean mycorrhizal connections. This hidden web of connectivity provides an excellent example of how complex multi-species systems can sustain themselves in a societal-like structure. However, the same cannot be said for the human society. As we live through the sustainability crisis of the 21st century, perhaps we have lessons to learn from the alliance between plants and fungi, which have sustained each other through the mutual provisions of resources for as long as land plants have existed.

But in any system, however sustainable, there will always be cheaters. In the case of the wood wide web, plants that cheat the system can be found in the darkest depths of the forest, where the light is too dim for photosynthesis. Sufficiently different from plants that produce their own food from raw materials (autotrophic plants), these cheaters have developed a taste for fungi and are instead referred to as mycoheterotrophic plants (*myco*: fungus, *hetero*: different, *trophic*)—i.e., plants that steal food by parasitizing fungi instead of making their own through capture of the sun's energy. One such fungal-feeding plant, *Monotropa uniflora*, is common across North America and is striking in its ghostly white stems against the forest leaf litter (**Fig. 1a**). As this plant does not harvest the sun's energy, it no longer needs to produce the green, light-harvesting pigments typical of most plants. Thus, like many mycoheterotrophs, *M. uniflora* lacks green pigments and leaves, and thus lacks the ability to photosynthesize. But in no way does it lackluster. Instead, this plant has evolved mechanisms (the likes of which are very poorly understood) to tie itself into the subterranean network of fungal filaments in order to steal resources (illustrated in **Fig. 1b**). These connections allow mycoheterotrophs to grow where no other plants can grow, namely amongst the leaf litter of a dark forest understory.

Although these plants are directly parasitic on fungi, they are ultimately stealing from the wider eco-system. To grow, mycoheterotrophs like *M. uniflora* need carbon, which in forest eco-systems mainly comes from trees whose roots are tightly connected with the forest's web of mycorrhizae. So, the carbon stolen by *M. uniflora* indirectly comes from the trees via the inter-connecting fungus. However, the parasitic part of this tale of connectivity is not a sign of system failure. On the contrary, the parasites can only survive in a highly connected, supportive network. Although mycoheterotrophs are parasitic and give nothing in return to their fungal hosts, they nonetheless shine beautifully and brightly from an otherwise dark and neglected detritus, providing a sign of forest connectivity. A few parasitic rarities are perhaps a small price to pay in a world where mutualism rules.

Mycoheterotrophs have long fascinated botanists for their unusual features as well as for their rarity. In 1866, a strange parasitic flower (*Thismia neptunis*) was discovered by Odoardo Beccari in the dense forest floor of Borneo, Malaysia.

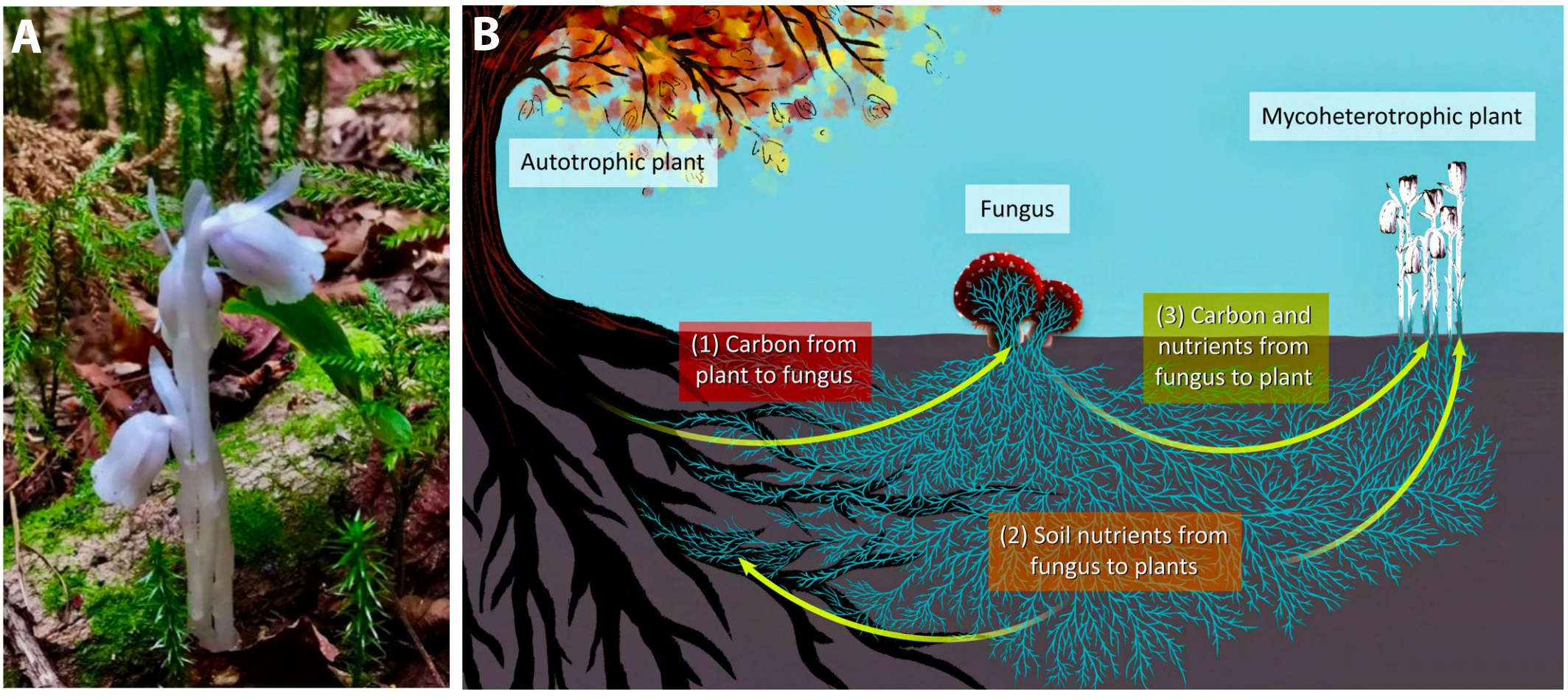


Figure 1. (A) Ghostly white inflorescence of *Monotropa uniflora* (common name: ghost pipe) a common Mycoheterotrophic plant found throughout the forests of North America. **(B)** Schematic of the hidden web of connectivity. Plants transfer carbon (sugars and fatty acids) to below-ground fungal filaments via mycorrhizal associations (1). In return, fungi supply soil nutrients to their plant partners (2). In some parasitic interactions, certain plants (mycoheterotrophic plants) steal nutrients and carbon from the network of mycorrhizae (3).

Image by James Bradley, Algonquin Provincial Park, Ontario.
Schematic by Cynthia Wong

Sitting only 3.5 inches tall, uncharacterized *T. neptunis* looked like an ethereal sea anemone (**Fig. 2a**). However, it disappeared from record for many years, thought to be extinct. Only 151 years later, Czech botanists rediscovered it blooming in the same Malaysian rainforest where it was first unearthed by Beccari. Balanced upon a translucent stem, a bulbous flower reaches up to the sky with three long antennae-like appendages (the function of which remain unclear). Their unique 'alien-like' flowers (**Fig. 2b**) appear rarely and sporadically, meaning the Czechs must have been incredibly lucky to be at the right place, at the right time! Since then, the taxonomy, and characteristics of *T. neptunis* have been described (Sochor *et al*., 2018), yet much remains unknown about its genetic diversity, ecology and distribution. It is particularly difficult to study the population size and distribution of mycoheterotrophs like *T. neptunis* due to their cryptic life histories. Nonetheless, the population is estimated to be fewer than 50 individuals, making this species critically endangered and teetering on the edge of extinction; a situation made ever more precarious by the destruction of the primary lowland rainforests that comprise its preferred habitat.

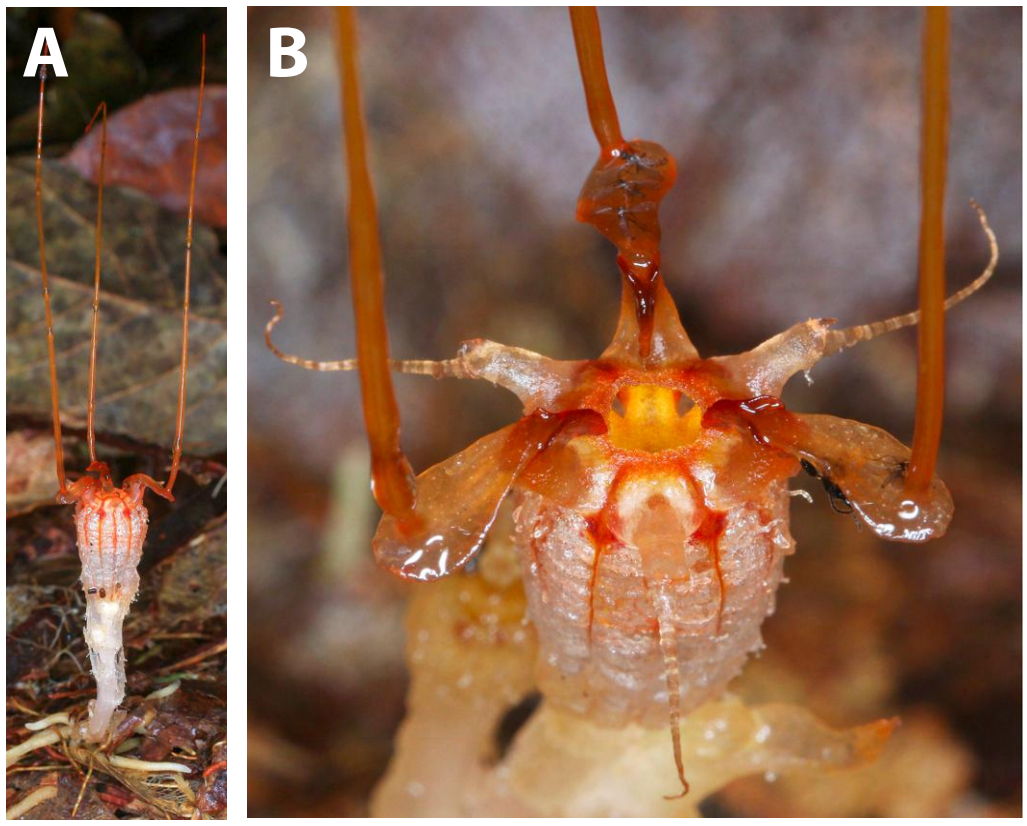
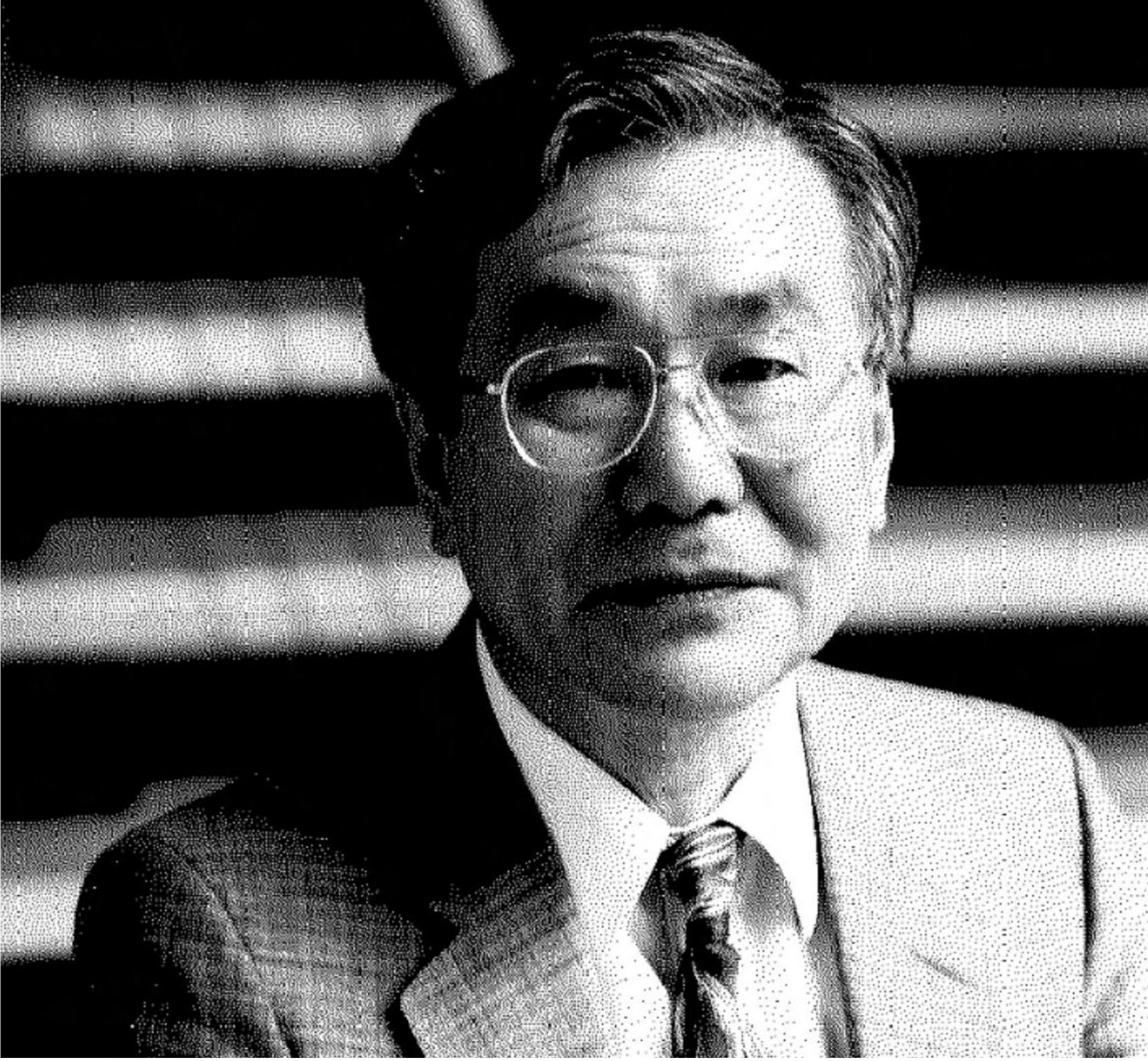


Figure 2. (A) *Thismia neptunis*. **(B)** Details of the *T. neptunis* flower (Sochor *et al*., 2017).

Mycoheterotrophs spend much of their life cycle below ground growing with their fungal host, only appearing above ground to flower, and even then, their flowers often emerge and blur amongst the forest leaf litter, making them difficult to spot. Thus, as the story of *T. neptunis* tells us, it is easy to falsely declare a species extinct, or perhaps for a species to go entirely unnoticed. If we continue with today's alarming rate of deforestations, we will surely lose genetic diversity and species we never knew existed. To preserve these hidden gems, we must protect the terrestrial ecosystems on which they depend. With increased urbanization, plants fade into the background of our lives, making 'plant bias' more prevalent than ever. But we can redirect our attention by trying to fit ourselves into the framework of the underground network on which we walk; to realize that we aren't so 'individualistic' and 'self-reliant' after all. Fungi nourish their plant partners, which eventually become the foods we consume, and the nutrients we gain in turn sustain the microbial communities with which we coexist and depend upon. However, our current *modus operandi* is risking system collapse. Mycoheterotrophic plants steal from a well-connected plant-mycorrhizal system. This is only sustainable if these cheaters remain rare, as the system cannot withstand rampant stealing. Yet the human species is currently stealing resources from the global ecosystem as though they were endless. We know they are not. If we continue to feed from this system, and not 'give back' to conserve and sustain the system on which we depend, then we too may become as rare as the mycoheterotrophic cheaters of the plant world. Through humble recognition of our place within the global network of ecosystems, and through creating mycorrhizal-like mutualistic alliances with nature and one another, we can begin to build a more sustainable future. Perhaps, this is one powerful lesson we can learn from these rare signs from below.

The term "the wood wide web", coined in the '90s and recently popularized in the book *Entangled Life* (Sheldrake, 2020), reflects the omnipresence and interconnectedness of these subterranean mycorrhizal connections.

Al-Wa'bah Crater, Hejazi region of Saudi Arabia. Taken by Cynthia Wong



The Greatness Within These Walls

By Fernando R. Valencia

Prof. Yoshio Masui is one of Canada's most distinguished scientists. His ground-breaking work on maturation promotion factors in the 1970s marked the start of all modern-day research on the regulation of cell division. His work has earned him many honours, including the Albert Lasker Award for Basic Medical Research, also known as the "American Nobel Prize". Prof. Masui was elected a Fellow of the Royal Society in 1998 and an officer of the Order of Canada in 2003.

I first encountered Prof. Masui in my first year of graduate studies. Every Friday, the Department invites a distinguished speaker to deliver a lecture to students. I would go every week, grab my coffee and a chocolate chip cookie, take my seat, and listen. After a couple of weeks, I noticed a man sitting in the front row. He always seemed to listen attentively, ask insightful questions, and then leave. I didn't recognize him at first – I had never seen a picture of him, only read his name: Prof. Yoshio Masui.

During the beginning of my studies at CSB as a graduate student, I often felt that my research was insignificant for the field of cell biology. I think that's a normal feeling when you're first starting out and your research revolves around questions about basic biology. It's hard to imagine or talk about your research changing the world when it's only slightly adjacent to cancer

What did you like about University of Toronto that made you stay for so many years?

Prof. Masui: Freedom for research (neither interference with nor solicitation for choices of research projects).

research or some other disease. But as I've progressed in my studies, I've learned to appreciate how research in basic cell biology is truly fundamental to all biological research and provides the foundational knowledge that allows future scientists to make new discoveries – just like how past scientists have paved the way for my own research. That's what motivated me to finally ask, "Who is that man who always comes to our departmental seminars?" and learn that he was a true powerhouse in my field – a sharp, inquisitive mind who still stayed engaged in the community, even in his late 80s, perhaps remembering the value of elders and mentors from his own student days.

Prof. Masui was a student in Kyoto University in the early 1950s. He had a strong and passionate curiosity about the effects various chemicals had on development. As such, for his doctoral research, he chose to study the effects of lithium on cell differentiation in amphibian embryos. After completing his PhD in 1961, he started his own lab at Konan University, where he compared nuclei and cytosol proteins of frog embryos at different developmental stages. Due to the complexity of the experimental system, this work led to minimally useful information. After reading a paper by Prof. Clement L. Markert from Yale University, in 1966 Prof. Masui joined the Markert lab during his sabbatical, where he was handed packs of frozen penguin embryos and got to work identifying lactic acid dehydrogenase (LDH) isoenzymes. Although this work characterized many LDH isoenzymes, he could not make any conclusive statement about of LDH patterns during development.

Prof. Masui was unconvinced that biochemical methods available at the time were sensitive enough to analyse such subtle biological processes as embryonic induction. Instead, he tried discovering a well-defined inducer of differentiation using a single-cell system, namely oocyte maturation.

In 1969, he joined what was then referred to as the Department of Zoology at the University of Toronto, which we now know as the Department of Cell and Systems Biology. It was here, in 1971, that Prof. Masui discovered the cytostatic factor in unfertilized egg cytoplasm that causes the metaphase arrest of meiosis and mitosis. Such a discovery was the first demonstration that a protein could regulate the cell cycle and laid the foundation of all work related to cyclin dependent kinases. In 1977, along with Prof. Meyerhof, he discovered Ca^{2+} sensitivity and Mg^{2+} dependency of the cytostatic factor.

These seminal findings revealed the mechanistic role of divalent cations in development and gave way to the discovery and characterization of other ion-activated kinases. Prof. Masui continued to make numerous discoveries throughout his career and had a tremendous influence in the field of developmental and cell biology. His work spanned a broad range of topics over the years, but I want to end with one quotation that speaks to his perspective on his own work:

"History tells us that learning from oocyte maturation and egg activation would help us again to gain new insight into the regulation of the cell cycle".

Prof. Masui indeed provided new insights into the cell cycle, and we continue to build on the foundation that he laid with his research. Due to the pandemic, I was not able to meet Prof. Masui in person for this article, but he was gracious enough to answer a couple of questions.

Do you have any advice for the future generation of scientists?

Prof. Masui: Choose the most fundamental problem in your field as your research project.

What advice would you have given yourself when you were just starting out in research?

Prof. Masui: Imagine a hypothesis that can explain the fundamental question and find the simplest system for testing the hypothesis.

What did you do to keep yourself motivated when you encountered frustrations, setbacks, or self-doubt about your research and its significance?

Prof. Masui: Strong curiosity to get answers to the questions.

Do you think we will ever know everything about the cell cycle?

Prof. Masui: Since one answer to a question invites another question to be answered, questions endlessly continue.

What is your favourite joke?

Prof. Masui: [Traditional Japanese joke] Even a dog can discover something when he or she is walking around.

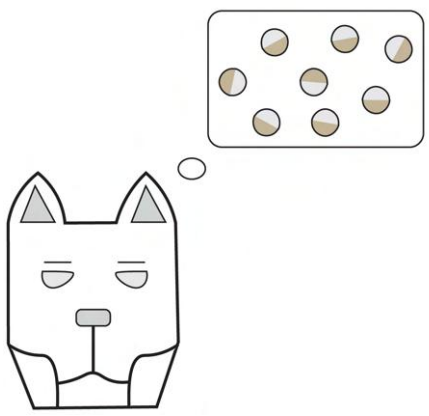


Illustration by Fernando R. Valencia

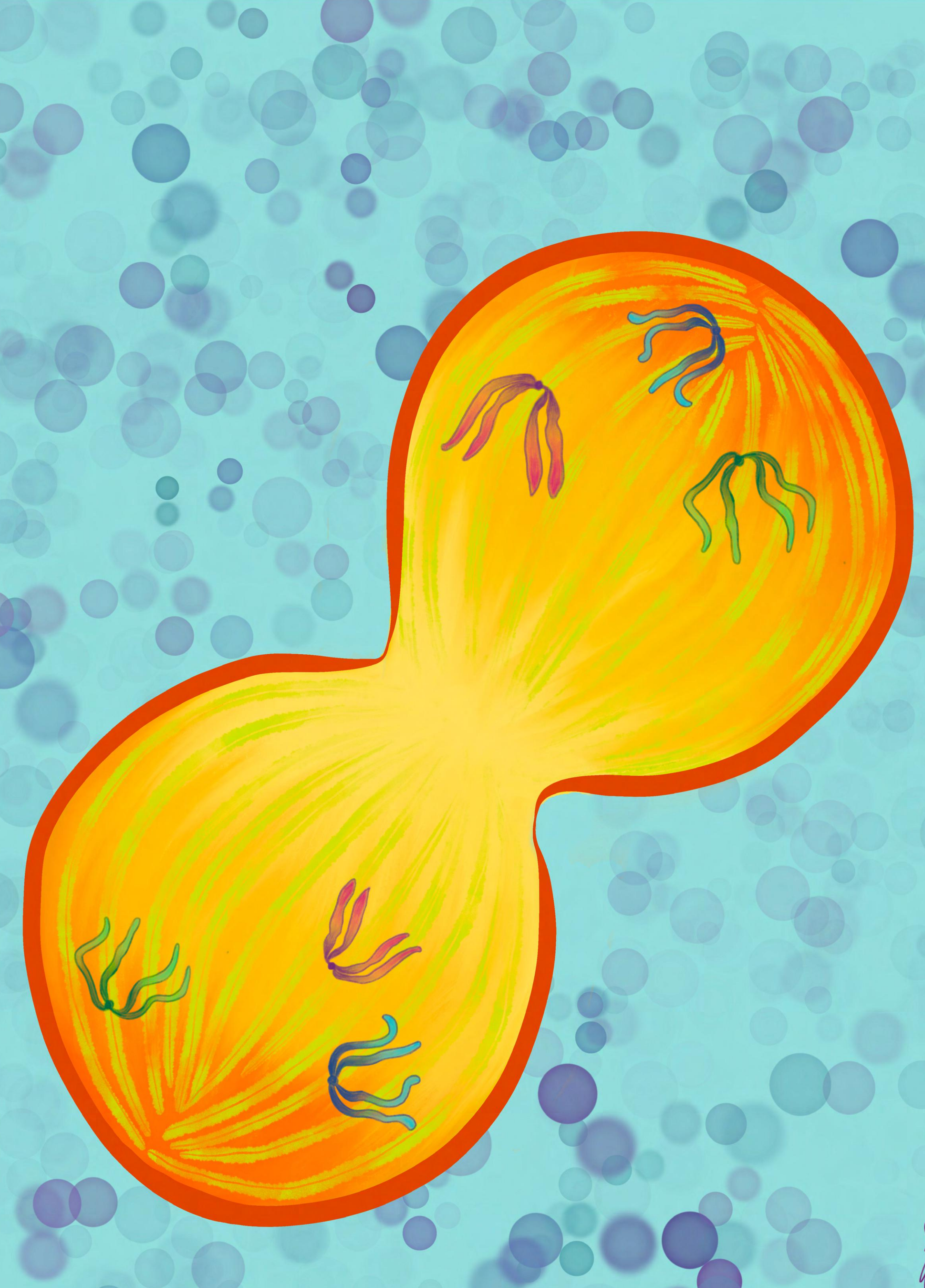


Illustration by Sonhita Chakraborty

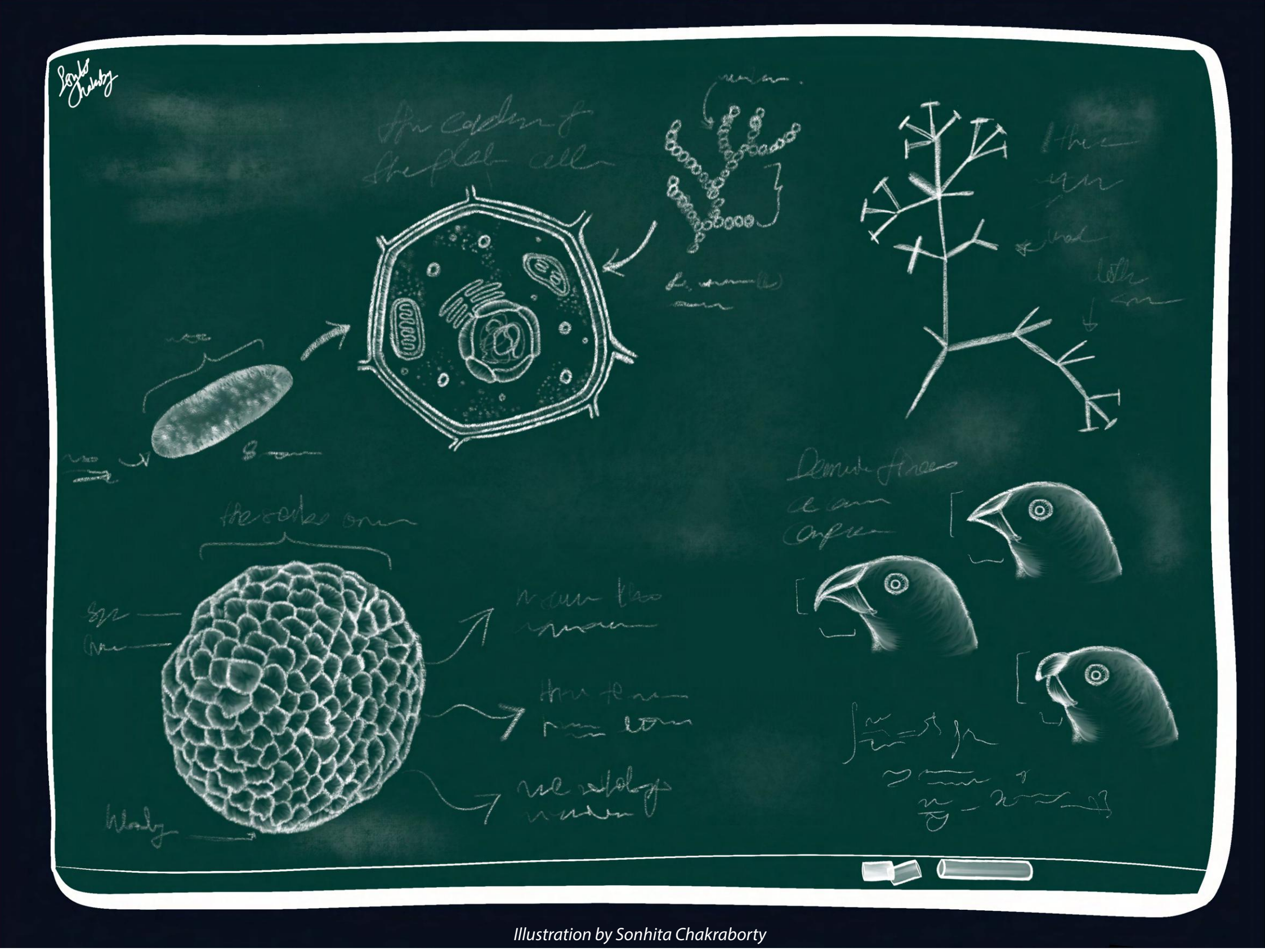


Illustration by Sonhita Chakraborty

Integrating Evolution Front-and-Center in Undergraduate Biology

By Michael Bunsick

Biology is complicated. The undergraduate biology curriculum should not be. And yet, for many students, biology is nothing more than a long list of obscure and unrelated facts. Our current course-based system forces students to compartmentalize their knowledge and this compartmentalization, in turn, could prevent them from forming a coherent view of biology. To fight against this trend, we need to show students how their courses fit together, like puzzle-pieces, into a larger picture. We can best achieve this unified view through an evolution-centric biology curriculum.

To understand the student's predicament, we need to put ourselves in their shoes. In any given semester, the average student takes five courses across a range of departments. In each course, the student gets snowed in with a blizzard of new information to learn. Because courses do not coordinate their syllabi, students can easily miss the areas of overlap. This often results in students seeing their courses, and by extension, their content, as independent of each other. Thus, a student may learn about the inherent error rate of DNA polymerase in biochemistry and not see how it provides the basis for the variation they learn about in ecology and evolutionary biology.

The fundamental problem is that students face two challenges when learning: first, they must learn many new facts; and second, they must build a framework to explain how these new facts relate to each other. These two aspects of learning re-enforce each other. A solid, factual, knowledge lets students build a strong framework. A strong framework helps students assimilate and organize new information. As biology educators, we cannot make learning facts any easier, but we can give students a solid framework on which to build.

The framework best suited to this purpose is the Darwinian one. This framework has two features that make it

ideal: (1) a broad range to take in and explain facts from different disciplines; and (2) a powerful explanatory force. These are the same features that made Darwin's work revolutionary. Indeed, Darwin's great achievement was not proposing the existence of evolution. Rather, it was his insight that populations evolve because of a struggle for existence which leads to the selection of more and more fit individuals on a given environment. But Darwin did not stop there; he also explained how his theory touched every aspect of biology. Evolution not only connects the past with the present, it also explains how natural selection shapes every aspect of an organism, from its structure and function to its external relations with the living and non-living world. Because evolution touches every aspect of life, is naturally the best framework for students to use.

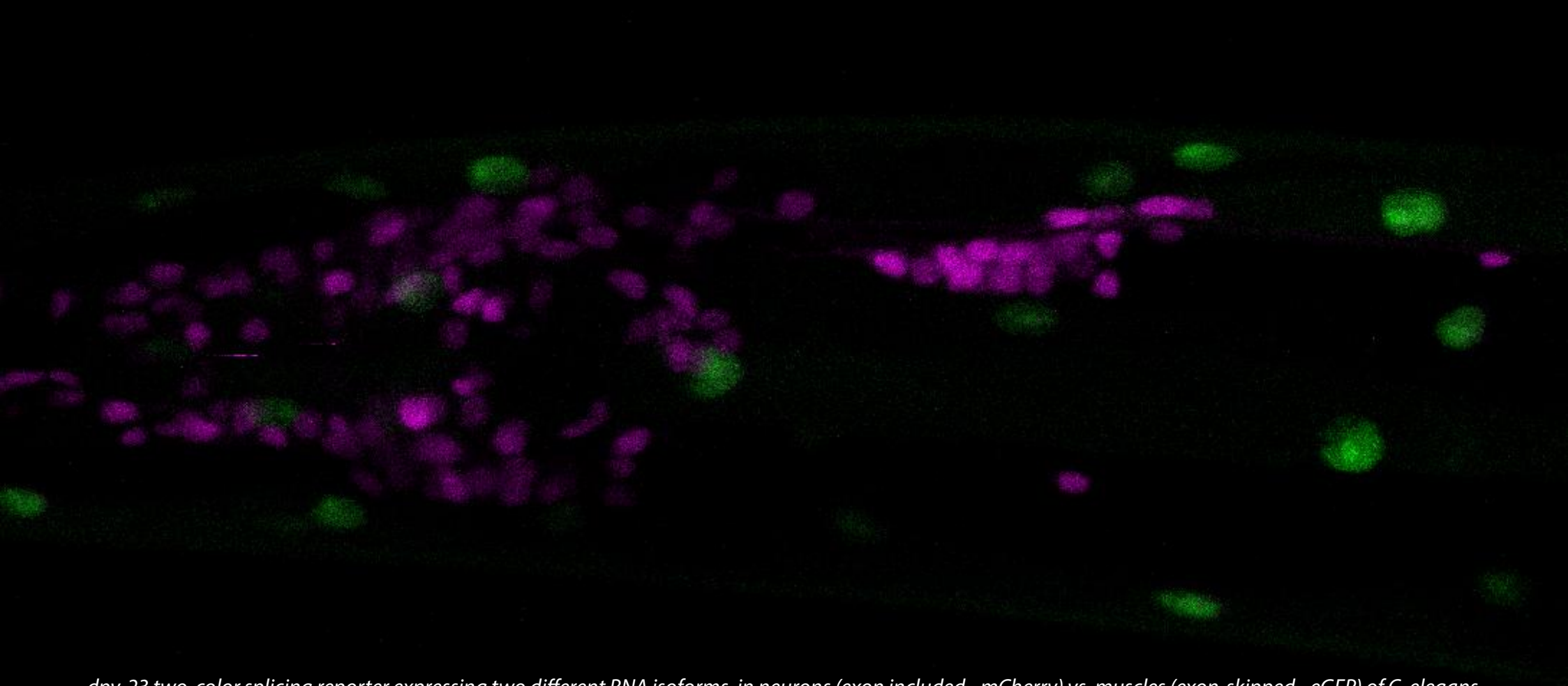
What would an evolution-centric curriculum look like in practice? Perhaps the simplest way would be to organize the undergraduate curriculum around a set of important themes such as mutation, selection, nutrient and energy extraction, and environmental interactions. Individual courses would then coordinate with each other to ensure that they cover the same theme at the same time. Take, for instance, the theme of mutation. In biochemistry perhaps, the students would learn about how DNA damage and replication errors lead to mutations and how these mutations affect protein structure. Meanwhile, in genetics, they would learn how these mutations are transmitted from generation to generation and how they lead to new phenotypes. In ecology, they would see how new phenotypes interact with the environment. And finally, in evolutionary biology, they would see how these environmental interactions affect an organism's fitness and how these changes cause evolution at the population level.

The major advantage of this approach is that it makes the connections between courses explicit. By coordinating the syllabi, courses would allow students to get a coherent picture of biology. They would get the opportunity to see the same topic from many different perspectives and at different levels of biological organization. This would enhance their learning, reduce the burden on the student when trying to understand how different subjects fit together, and sharpen their view of the breadth of causes and consequences of biological phenomena.

Biology without evolution is like a book without a plot. Evolution ties together every aspect of life: from an organism's evolutionary history to its relations with the environment. Biology educators should take advantage of this readily available framework to help students make sense of biology. In doing so, they will not only help their students learn biology but also instill in them a sense of awe at the living world.

Biology without evolution is like a book without a plot.

A pond at the Todmorden Mills Park, Toronto. Taken by Cynthia Wong



dpy-23 two-color splicing reporter expressing two different RNA isoforms, in neurons (exon included - mCherry) vs. muscles (exon-skipped - eGFP) of C. elegans. Taken by Michael Zoberman

Science Communication - Path Forward in Modern Pedagogy

By Tammy Lee

The art of delivering science accurately has been brought to the forefront, thanks to the many global issues we've been facing over the recent years. From understanding what may have caused the Amazon rainforest fires, to whether booster shots are going to provide protection against the emerging COVID-19 variants, we can all agree that words and associated imagery can dictate the narrative and frame completely different stories. Many have become more aware of the topic of science communication and are more conscious about the way they communicate science when they enter graduate studies. Not only does explaining and discussing your research become an integral part of your studies, teaching science as a Teaching Assistant (TA) is also a sci-comm experience shared by most CSB grads.

Communicating science to the public often consists of phrasing a relatable story without unnecessary details and jargon. However, being held responsible for how students learn and engage with the material adds a layer of complexity in communicating science in pedagogy. Knowing that, positive interactions between TAs may affect undergraduate students' decision to pursue STEM (Science, Technology, Engineering, and Mathematics) graduate degrees adds a bit more pressure. Course coordinators and Professors are usually flexible and give TAs enough space to develop personal teaching styles. If you are a TA assigned to a first- or second-year course, you might notice that all twenty or thirty TAs have different levels of experience in teaching and are probably equipped with variable skillsets depending on what research they do. As TAs, we are responsible for educating undergraduate students about new concepts and engaging students in learning while raising awareness about STEM topics. In most cases, it's assumed that graduate students are knowledgeable and capable of teaching and running a class. That leads to the question of whether we are well equipped with science communication skills to not just deliver the material but deliver it well to students.

What are some science communication skills that are also applicable in teaching? Of course, the basics are being aware of your target audience, framing what you're teaching into a relatable and interesting story, providing examples, and being inclusive for example by using colour-blind friendly palettes for visualizing data. Perhaps one of the quintessential multi-media and visuals tools is PowerPoint slides, which are an integral component of teaching. Many TAs actively attempt to improve the quality of science communication and teaching by making modifications to the slides. Just before the pandemic hit, I initiated a project with a few members of the Science Communication Club at U of T, where we redesigned the whole set of slides used in the laboratory component of BIO230, a second-year introductory course focused on molecular biology. While BIO230 is a required course taken by all biology programs, to our surprise, the slides were quite outdated despite being taught biannually. We considered many visual and design principles: are the colors and compositions used accurately defining the relationship between elements? Is the information flow appropriate? Does the layout of the slide make sense to students given the instructions on the protocols? The positive feedback we have received from both the students and TAs reflects the importance of visual communication of science in teaching. Nevertheless, visual literacy is not a part of our training, which underlines the potential absence of effective

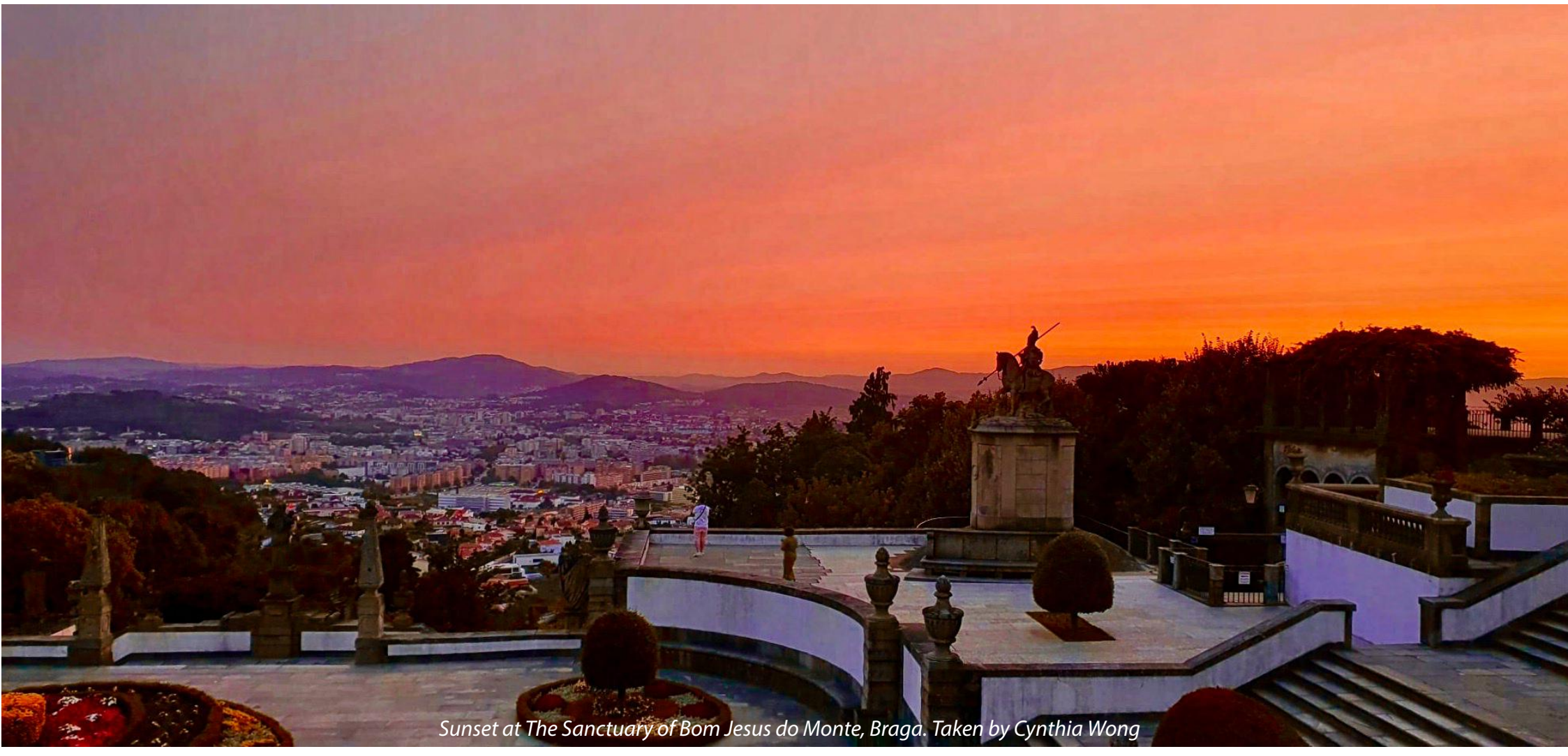
Communicating science to the public often consists of phrasing a relatable story without unnecessary details and jargon. However, being held responsible of how students learn and engage with the material adds a layer of complexity in communicating science in pedagogy.

science communication methods being incorporated into designing course materials and assignments.

If TAs are aware of how they communicate science, are there resources available for us to improve and how are we being supported by the university? Not to mention that the mandatory TA-ships implemented in our funding packages might also affect the quality of education students receive. When I took on a role as an online laboratory development TA to design assignments and coursework for the virtual lab components for BIO230, I was somehow frustrated by how constrained we are in incorporating new ways of communicating science, such as cloud-based virtual labs and simulations in courses (this idea was turned down). To this end, I think we need a bit more support from the pedagogical infrastructure in both training and opportunities for skill-development. Even though science communication skills are essential to earning career benefits such as funding opportunities, it is unfortunately not a part of our training in graduate school and resources are insufficient. We need programs and workshops that can help and provide graduate students with the chance to practice effective science communication. Graduate units should also encourage graduate students to participate in professional development programs such as ComSciCon where students can network with science communication experts and develop science outreach collaborations.

We need programs and workshops that can help to provide graduate students with the chance to practice effective science communication.

The Department of Cell & Systems Biology at UofT stands on the traditional territory of many nations including the Mississuagas of the Credit, the Anishnabeg, the Chippewa, the Haudenosaunee and the Wendat peoples, in the land that is now home to many diverse First Nations, Inuit, and Métis people.



Sunset at The Sanctuary of Bom Jesus do Monte, Braga. Taken by Cynthia Wong

A Tribute to Tamar Mamourian

Illustration by Ceda Bundalovic-Torma

"I always thought of Tamar as CSB's Yoda. She was the kindest and wisest person in the department. She knew everything and everyone. She was part sage, part advisor, and part confessor. But never underestimate her. She could move immovable obstacles with just the powers in her fingers and voice. The force was strong with her."

-Prof. David Guttman

"We will all miss her and take to heart her last message to the Department: "Sign Up! Show Up! Never Give Up!""

-Dr. Neil Macpherson

"I had the privilege of being supported by Tamar's remarkable administrative support for 20 years in Botany and CSB. Among her many talents, Tamar would never leave a question unanswered and would always look for solutions to the issues that we brought to her. In our respective roles as the first CSB Chair and CAO, I relied heavily on Tamar for help and advice, and I was very grateful to be working with such a talented individual as we sorted through all the decisions that had to be made in setting up CSB. Beyond work, Tamar was always there with a friendly ear to chat about work, life, and family. I always enjoyed our conversations."

-Prof. Daphne Goring

"I experienced Tamar's warmth and kindness when I first met her during my job interview. I knew right away that she was a special person, not only suited for administrative work, but also in building genuine relationships with people. After this initial encounter, there were many more fun conversations in Tamar's office about family, life, and many other topics. Her influence has without a doubt shaped the culture of the department, and I will always appreciate her selflessness when helping others, including the many times she looked out for me!"

-Prof. John Calarco

"Tamar Mamourian is a powerhouse of knowledge in designing and implementing policy to benefit the University of Toronto community."

"In any office, the right thing is hard to plan and execute, but Tamar had an insightful mind and deep experience."

"In March 2020, we were all told to stay home. With courage and honour, Tamar stubbornly took it upon herself to be the only one in Ramsay Wright every day. She felt she had to be there for perishable scientific samples still arriving through delayed supply chains, and to support care for the plants, animals, and stored samples in the building."

Snippets from Dr. Neil Macpherson's piece in the CSB website

Melaleuca viminalis is a tree in the Myrtaceae family, native to Australia. Flowers are showy with prominent red stamens for attracting butterflies and birds. Flowers produce nectar as a reward for pollinators, transferring pollen to and from bird heads or insect bodies when they access nectaries. *Taken by Thomas Gludovacz*

From the Greenhouse

By Thomas Gludovacz

I've always been interested in plants. In fact, my father came from a family of farmers south of Vienna and my grandma even had her own vineyard. My dad got me into landscaping, gardening, and growing vegetables. I soon found myself watering gardens, pruning hedges, and mowing lawns for my neighbors. My interest in plants prompted me to study them in the classroom. I went on to take a wide variety of plant science courses (CSB, EEB, and Forestry) during my BSc (U of T). During the second year of my undergraduate program, I started working in a casual position as an assistant in the Earth Science greenhouse. During my MSc (U of Guelph), I researched host resistance and environmental factors on clubroot disease (*Plasmodiophora brassicae*) in Brassica food crops. I eventually went on to work in the medical cannabis sector, first as a production grower in Canada, then as a Technology Transfer Project Manager in the Netherlands, organizing the construction of new medical cannabis facilities in co-operation with government agencies in the Netherlands, Germany, Australia, and Israel. I was involved in every step of cannabis production from propagation to harvest, seeing over a hundred crops to completion.

However, I missed Toronto, so I returned to work remotely. My desk job, which consisted of writing reports and conference calls to Australia and Europe, wasn't satisfying. I also knew that I didn't want to go back to being a full-time cannabis grower. When I heard that my now predecessor Andrew Petrie was retiring in the summer of 2018, I applied for the position. I feel privileged to work in a space that most people could only dream about. It probably benefits my mental health to be in a green space every day. In the winter, I have humid and tropical rooms to work in, almost like a daily sauna. When it's cloudy and the days are short, I have warm grow lights that are the next best thing to the actual Sun. What I like the most about work is that every day is different. Typically, I start with watering the collection and checking on the actual operation of the greenhouses and growth chambers.

My favourite part of the job is working with researchers. We routinely field questions and requests from researchers for anything from pest management to finding suppliers for seeds to formulating custom soil mixes. I also like collaborating with professors on how to incorporate the greenhouse collection into their teaching. Depending on the time of year, we provide a lot of support to undergraduate and graduate courses. In the summer we visit the Koffler Scientific Reserve to provide support for student research

Tom and bonsai *Cryptomeria japonica*. *C. japonica* is a species of conifer in the Cupressaceae family. They are endemic to Japan where they're called Sugi. Branches and leaves are very soft. They like growing in well-draining soil and work well as bonsai.

Tom and *Stanhopea tigrina*. *S. tigrina* is an epiphytic orchid with an inflorescence that emerges and hangs below its pseudobulbs. Flowers are short lived, one to three days, and are very fragrant, smelling like perfume. Male orchid bees bathe in the fragrance and use it as a pheromone attractant for females. In the process, pollinia, masses of pollen grains, are dislodged and transferred to the bees.

projects or collect material for courses. I get a lot of satisfaction out of helping students troubleshoot their research and seeing the results. I like seeing new students come in with fresh ideas and then see the culmination of their hard work when they defend their thesis. Although there is quite a bit of bookkeeping, administrative desk work, and planning, I feel privileged that I can split up my desk work with hands-on work in a greenhouse.

We have a very wide diversity of plants in the teaching collection. One of my favorite smelling flowers is our Tiger-like Stanhopeas (*Stanhopea tigrina*), which has delicate perfume, almost lemon-like. The stinkiest plants we have are carrion flowers (*Stapelia spp.*), that mimic the aroma of rotting meat to attract blowflies, tricking them to act as pollinators. The climbing onion (*Bowiea volbubilis*) is an example I like to use to talk about how plants can be both medicinal and poisonous depending on the dosing and how it's used. The plant extracts have traditional use In Africa for treating skin infections and inflammation, however the presence of cardiac glycosides means an overdose can cause vomiting and irregular heart palpitations. The oldest plants we have are probably the *Welwitschia mirabilis* and golden barrel cactus (*Echinocactus grusonii*) that we estimate to be at least 75 years old. We also have Queen Victoria agave (*Agave victoriae-reginae*) in the collection, which is also known as the century plant because it was believed it took close to one hundred years to bloom. The actual age required for flowering is closer to 20 or 30 years.

When I'm not working with plants at work, I take a lot of pictures, like the ones decorating these pages. I worked with Brassica vegetables and Cannabis for a very long time, so they'll always be the favourites for me. I like plants with strong fragrances like orchids, roses, Plumeria, and the citrus family. At home I mostly have plants in the Aloe, Arum, and Bromeliad families, as well as a few bonsais. I also like to keep a few favorite botany books within arm's reach: *The ROM Field Guide to Wildflowers of Ontario*, *Mabberley's Plant-Book*, Ronse De Craene's *Floral Diagrams*, David Gledhill's *The Name of Plants*, and Michael Simpson's *Plant Systematics*. My favorite botany YouTubers are guerilla ecologist 'Crime Pays But Botany Doesn't' and fruit enthusiast 'Weird Explorer'. Lately, my interest in plants has shifted towards ethnobotany, the cultural uses of plants. The ceremonial use of tobacco for smudging is becoming more understood and accepted in the university and in society. I like learning about the history of traditional indigo dying in Japan, essential oil extraction for incense and perfume production, how post-harvest processing changes the aroma of tea and coffee beans, looking back to old traditional food as functional foods, like the fermentation of rice for wine and cabbage for kimchi. Nixtamalization, the process of cooking maize in an alkaline solution to remove the kernel covers so that the starch can be extracted and milled into flour for tortillas, is an example of a traditional practice that increases the nutritional quality of maize by increasing the bioavailability of vitamin B3, iron, and fortification with calcium.

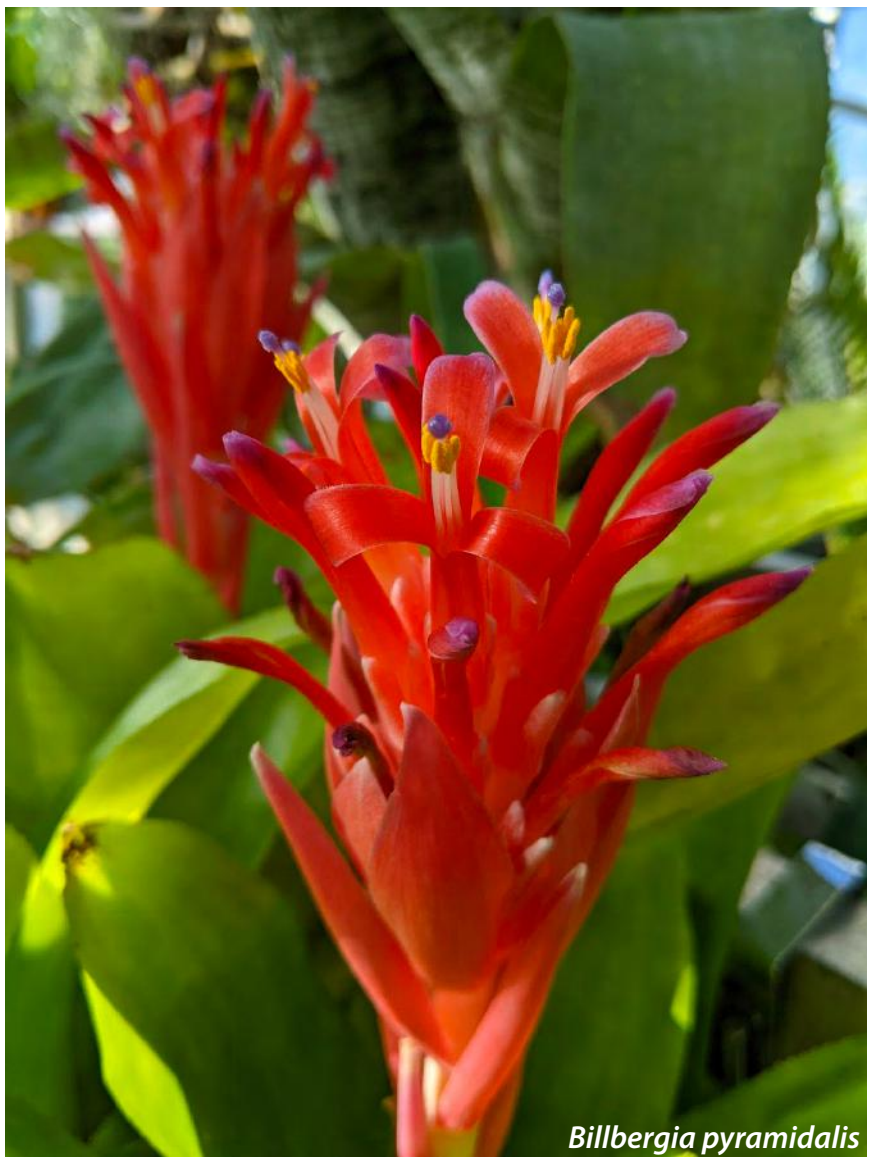
"Our lives are entwined with plants, and I wouldn't have it any other way."


Oncidium sphacelatum

O. sphacelatum is an epiphytic orchid that grows on trees and on rock faces. They have pseudobulbs that are used for storing water and energy. Species in the genus *Oncidium* have highly varied labellum, modified petals that attract pollinators and act as landing pads.


Nelumbo nucifera

N. nucifera is an aquatic agricultural crop. Its rhizomes and seeds are edible, and its leaves are fragrant and can be used to wrap rice for steaming.


Billbergia pyramidalis

B. pyramidalis grows terrestrially and epiphytically attached to trees. Leaves grow in cup-shaped rosettes for capturing and storing water. They like high humidity but well drained soil. Its root system is primarily for anchoring to tree bark. Flowers emerge from a central stalk and the whole rosette dies back after flowering. New offshoots emerge from the roots.


Euphorbia obesa

E. obesa is a slow growing species in the Euphorbiaceae family. Its growth habit is similar to cacti. Stems are round and succulent, with a low surface area to volume ratio to minimize water loss. *Euphorbias* have unique inflorescences called cyathia. Within a cyathium are a floral envelope, bracts, nectar glands, and unisexual flowers. Plants in the genus *Euphorbia* have milky latex that can act as a chemical defense against herbivory and aid in sealing wounds.


Nepenthes mirabilis

N. mirabilis is an epiphytic carnivorous plant. The pitchers are modified leaves that emerge with a solution of enzymes for attracting and digesting insects. The pitcher lip and inside surface are slippery, making escape difficult for prey. Nutrients are absorbed through the leaf. The cup shape of the pitcher helps to capture rain for a plant that typically grows like a vine on trees.


Drosera sp.

Drosera is a carnivorous genus that attracts and captures insects with sticky trichomes on its leaves. Leaves secrete enzymes which aid in the digestion of the prey, and the nutrients that are released, including nitrogen, are absorbed by the leaf.


Agapanthus praecox subsp. minimus

A. praecox subsp. minimus is an ornamental bulb plant native to South Africa. Its growth habit is similar to ornamental Alliums, both plants being in the Amaryllidaceae family. Its soil should be allowed to dry between watering. This is the smallest of the subspecies.


Brassica rapa

B. rapa growing under LED lights. This is the first project performed under newly installed LED lights in the greenhouse. This undergrad project was conducted by Alice DesRoches in the Weis Lab.


Coleus scutellarioides

C. scutellarioides is an ornamental plant in the Lamiaceae (mint) family. The square cross-section of their stems have distinctive corner vascular bundles, which are utilized in teaching labs on auxin mobility and xylem regeneration.

Images by Thomas Gludovacz

CSBGU: Not Just (A Line) for Your CV

By Jenny Jiahui Huang & Eduardo A. Ramirez Rodriguez

Who we are

Starting grad school in the post-COVID era is a daunting experience. After four years of an undergraduate degree, coming into a space where there are less stringent deadlines, a very different social dynamic and a more unstructured workplace is not easy. This is where the **Cell and Systems Biology Graduate Union (CSBGU)** comes into play.

We are a diverse group of students committed to **organizing engaging activities and advocating for grad students at the department of Cell and Systems Biology**. We come from different labs across the department and across all three campuses. Our research interests might be diverse (ranging from plant pathogen enthusiasts to mouse surgeons), but our hearts are in the same place.

We work as a liaison between the department and the students. By taking part in different committees at the university, we represent and advocate for the diverse voices of students at CSB. One such committee is the **University of Toronto Annual General Meeting** where improvements to student equity, bursaries and awards, and representation by the Canadian Union of Public Employees (CUPE) are discussed.

What we do

As your graduate union, we are here to promote both student entertainment and tackle students' concerns. Over the past years, our dedicated members have organized **student activities** including pumpkin carving contests, trivia nights, and playing intramural sports such as volleyball, ultimate frisbee, and badminton. In 2021, we started a breakfast club as an opportunity for students to meet one another while following COVID safety guidelines. Additionally, we fundraise for charities by hosting a holiday raffle, which gives CSB members the chance to win prizes during our annual CSB holiday party while also donating to charity – win-win!

Monthly graduate seminars enable students to practice their public speaking skills, share their research with their peers, promote discussion within the research community, all while developing key academic skills. To help you with your first steps in grad school, we also provide first year information sessions and seminars (with data to back it up) on what students wish they had known when picking a thesis supervisor. These are just some of the few events we organize.

We also invite speakers to present their research and share thoughts on their academic journey at our Friday Departmental seminars. In the year of 2022, we had distinguished lectures from Dr. Sara Wickström [University of Helsinki/Max Planck Institute for Molecular Biomedicine], Abigail Gerhold [McGill University], and Dr. Jeremy Purvis [University of North Carolina]. A meet-and-greet virtual 'lunch' with the speakers is a great opportunity for grad students to network with these researchers and discuss science outside the lab.

We also hold monthly coffee breaks, urban hikes, game nights, trivia, pub nights and a myriad of other events. We are open to new ideas and welcome all suggestions. If you have an idea that you think we should be working on, please contact us!

Remember to follow us on our social media platforms to stay up-to-date with our latest events. (Facebook, Twitter, and Instagram)

Join us!

Every September, new grad students are elected to the CSBGU for the opportunity to add their own special touch to the activities we run for students and faculty. We would like to take this opportunity to invite you to join our CSBGU family. We can't wait to hear from you!

Monthly CSBGU Meeting. January 19, 2022. From left to right, top to bottom: Cindy Hong, Clare Breit-McNally, Tamar Av-Shalom, Gerard Kim, Racquel Singh, Tammy Lee, PJ Gameuda, Andrew Duncan, Steven Chen, Jenny Huang, Kathryn McTavish, Tristan Phillip, Rebecca Tam, Kristyna Gorospe, Elina Kadriu, Ernest Lu. Screenshot by Clare Breit-McNally

Halloween Trivia Night hosted by Kailynn Macgillivray (Social representative) and Eduardo Ramirez (GSU representative) in October 2022. Halloween celebrations have been a staple in the CSBGU events calendar and is a fun 'teambuilding' event for grads outside of the lab.

Cooking hot dogs at the annual CSBGU camping trip in August 2022.

The CSBGU intramurals Volleyball team for fall 2022.

CSBGU Committee at the Annual CSB Holiday Party, December 10, 2021. From left (back): Jenny Huang, Tammy Lee, Tristan Phillip, Carlo Perolo. From left (front): Tamar Av-Shalom, Racquel Singh, Eduardo Ramirez, Elina Kadriu, Kathryn McTavish, PJ Gamueda, Ernest Lu, Steven Chen. Photo by: Leo Xu

Coffee break held by Rebecca (Ombudsperson 2021-2022). Coffee breaks are a great place to relax, meet new people, and catch up with your fellow grads!

Trivia Night hosted by Kailynn Macgillivray (Social Representative 2022-2023) and Eduardo Ramirez (GSU Representative 2022-2023) at the Ramsay Wright Basement.

Winners of the annual CSBGU gingerbread house decorating contest (Mitchell lab and Moses lab members). The gingerbread house decoration contest held in December is a place where scientists unleash their creativity and fine motor skills!

PJ (Co-president 2022-2023) at the Brunch Club station. On the menu, we have ramen noodle cups, roasted seaweed, and boiled eggs.

Graduate students from the Saltzman, Tepass, and Calarco labs enjoying hot dogs and iced tea on a sunny day in May 2023.

"Galaxy" Illustration by Janis Cheng

Plantentuin Meise, Brussels. Taken by Cynthia Wong

PI Mini Interviews: Meet Our Faculty

By Amir A. Arellano Saab & Kristyna Gorospe, edited by Sanjana Bhatnagar

Penney Gilbert

Rodrigo Fernandez-Gonzalez

John H. Peever

Maithe Arruda-Carvalho

Alan M. Moses

Marcus Dillon

Brandon Walters

Academia is undoubtedly an intimidating yet thrilling environment. Feelings of stress and anxiety, difficulties in achieving work-like balance, and self-doubt can feel like constant companions throughout the long years of graduate studies. But have our principal investigators (PIs), who appear so driven to push the limits of science, experienced graduate studies in a esimilar way? Did they overcome the same challenges as we do?

When **Kristyna Gorospe** and **Amir A. Arellano Saab** set out to explore these questions, they discovered many parallels between our experiences as graduate students and those of our PIs in academia. They interviewed PIs from three campuses (UTSG, UTM, and UTSC), and we are grateful to all of them for giving us a peek into their academic journeys as well as their wise counsel on important matters in graduate school.

1. Can you describe in one sentence the work that excites you the most about your lab?

Maithe Arruda-Carvalho: I really like that we are now finally able to get to the fundamental, long-standing question: Understanding how circuits form and brain regions are wired together to support behavior.

Marcus Dillon: I would say the entire process of dissecting evolution and how it can drive disease emergence through diversification and bacterial factors. I really like that my group takes computational group biology approaches to derive hypothesis and further guide wet lab experiments.

Penny Gilbert: I am super excited about expanding fundamental knowledge of muscle stem cell regulation by

using our predictive 3D culture assays to evaluate molecular targets uncovered by omics data analysis.

John H. Peever: It is the understanding of how the brain controls us.

Rodrigo Fernandez-Gonzalez: I am most excited by experiments that investigate the mechanisms by which cells behave collectively, particularly the experiments involving biophysical tools and manipulations that allow us to address questions beyond the realm of traditional genetic approaches.

Alan M. Moses: When we reach the edge of knowledge, we get to do something that's never been done before.

Brandon Walters: We are trying to understand how synapses make their own proteins, locally, and how this influences memory formation.

"Last Christmas, my lab gave me a CD called "A Very Peever Christmas" of Christmas songs during the year. Never been more touched by a gift because it showed what wonderful people I work with. It touches my heart to this very day." – Prof. John Peever

2) How did you achieve work-life balance as a graduate student and what advice would you give to the current and forthcoming generation of graduate students?

Penney Gilbert: it is important to acknowledge that work-life balance means different things to different people. For me, long days at the bench broken up by a midday exercise session with my lab mates and followed by evenings spent with friends was my ideal rhythm.

Rodrigo Fernandez-Gonzalez: As a graduate student, I had a clear schedule that distinguished work hours and non-work hours, and I stuck to it rigidly. Also using a calendar and making sure to schedule any task longer than 30 minutes, so that we know to say 'No' when our schedule is full, is a tremendous help.

Alan M. Moses: I got the advice: "you'll never look back and wish you had spent an extra day or week in the lab or office. So, enjoy your time doing the special things." Balance is especially important in life. For me, work vs. life doesn't really make sense.

Brandon Walters: The key is maintaining productivity. Professors should not care about your time; they should care about what you produce. Make sure your projects are well thought out and make sure you are making progress on them. Then, and only then, can a work-life balance really start to occur.

3) How did you deal with the overwhelming academic pressure to publish and stay on top of your field during your graduate studies? Do you have any advice for current graduate students?

John H. Peever: It is common to feel such pressure, especially early in your career because you feel the need to prove yourself to yourself and to your peers. Organizational skills are important, and scheduling when you will work and when to stop.

Brandon Walters: The first step is to figure out why? Are you burned out because you are uninterested in the topic? It may cost you time but changing mentors / fields at this stage is simple. Are you burned out because your experiments kept failing? I get it. It happens to all of us. Take some time, decompress, and re-think your experiments.

Penney Gilbert: I refocus myself and start with introspection and the recognition that these are self-imposed feelings. It is me feeling overwhelmed by the pressure. That 'Aha!' moment usually allows me to shake the perceived pressure and redirect my focus back to my own goals. Of course, this is a constant struggle, but has become easier for me over the years of practice.

Maithe Arruda-Carvalho: The pandemic added stress to everyone's lives, at every level, and made it much harder. The one thing that helps me is physical exercise. It relieves my anxiety and stress. And we got a pandemic cat. Not everyone may have the privilege, but it really helped my family amidst all the challenges.

If Prof. Maithe Arruda-Carvalho could bring only one CD to a deserted island, it would be 'Kid A' by Radiohead!

4) If you could change one thing about the scientific culture right now, what would it be?

Alan M. Moses: I wish there was less emphasis on superficial measures of productivity like retweets and citation counts, and more deep thinking about what has actually been done.

John H. Peever: I would change the pressure to publish no matter what. Early on as a grad student, publishing is everything to you. Pressure is enormous, and the gauge we determine the success as scientists. The number and journals in which they are published. I want to refocus away from the journal and number of publications to the sheer impact of the publication.

Maithe Arruda-Carvalho: There is a lot of solid data pointing out all these inequalities in terms of gender, race, socio-economic background. For me, we need more equity and fairness. I think listening is a big part of it, there is so much to learn, when everyone comes from diverse backgrounds and experiences.

Brandon Walters: It would be the publishing model i.e., the myopic focus on "good" journals and the free labor model of scientific review. We became lazy and instead of trying to understand if a scientist is good, we just look at where they published and then assume the good part. Additionally, publishing negative results or redoing other lab's experiments should be acceptable and an important part of your life in science. Unfortunately, it is not.

5) If you could start your career over, what would you do differently and what do you wish you had known before you started in academia? Did you ever think about following a different career?

Penney Gilbert: I'm not sure I would change anything, except that I wish I had elected to take coding classes early on in my career. I urge all students to take the leap if you've not done so already; it's a skill that will increase your marketability. I really loved benchwork and I hadn't appreciated that my days at the bench would be more or less over when I started a position as a professor. With so few academic positions available, I most definitely considered following other career paths. I lived in the Bay Area as a postdoc where the biotech scene is so prominent, so I had my eyes on those positions as a career option.

Marcus Dillon: I really wish I knew how long of a grind it was going to be. My friends outside academia settled into full time jobs, were buying houses, starting families, and if that is still during your post-doc period it can make you feel like you are getting left behind. Even though you've been in training positions, and are getting close to the end, it wears on you because other careers don't have such long-term training. As a grad student, I thought more about transitioning to industry. As a postdoc, I thought more about looking at exclusive teaching-focused positions. I always knew ultimately; I could try to find a faculty position to teach and do research because that's what I love doing. Happy that I stuck it out!

John H. Peever: I've had an enjoyable career. Largely because I found myself in institutions where my peers and colleagues are supportive from a scientific and personal perspective. It's through those interactions that I've landed in a great department, institution, and can't really think of a better opportunity to be in than UofT. What I didn't know then, is that science doesn't exist when there is a dogma. Don't always believe the general trends. It's the people who make drastic change in how we view science, who win Nobel prizes. We often go into our careers in a perceived way... If you think you know the answers to the question you are asking, you are asking the wrong question. I get no more joy than discovering something new.

What would you do if you won the lottery for $10 million?

"Buy a single house in the GTA!!! Seriously, give away $90, 000 to $100, 000 scientific grants and 1-million-dollar grant to my lab." – Prof. Brandon Walters

6) What advice do you have for students running into research difficulties (i.e., not being able to obtain expected results, struggling to write a manuscript, etc.)?

Penney Gilbert: Generally, one should try to convert big tasks or challenges into as many sub-tasks or steps as you can. 'Write a manuscript' is not a feasible goal in a single day, but drafting the methods section or one of the figures is! Be realistic in your self-imposed expectations

Marcus Dillon: Switch it up. Change what you're working on then come back later on to the experiment you're struggling with. Put project on back burner, and work on something else, whether it's a manuscript, maybe a new experiment, work on another project and push that forward.

John H. Peever: Difference between generating, collecting, and interpreting data. There's a prediction, but it's just that. Let the data guide you. Never guide your data. That is inappropriate. Predictions are better than "expected results."

Rodrigo Fernandez-Gonzalez: Constantly talk to your supervisor. Supervisors have one thing over grad students (and possibly only one thing), and that is experience. So, they should be able to help with professional issues, or, sometimes, recognize when it is time to pivot and change the research question, focus on a different aspect of the project, or modify the scope of the paper.

Alan M Moses: Remember that there are always things we must do that are not fun. People succeed not because they don't have struggles, but because they don't give up.

What would you do if you won the lottery for $10 million?

"Same thing I am doing now for another few years. Then retiring to the Caribbean and writing poetry." – Prof. Alan Moses

Alan M Moses: Remember that there are always things we must do that are not fun. People succeed not because they don't have struggles, but because they don't give up.

Brandon Walters: Keep your head down and keep trying. Manuscripts are hard, but you must get used to 1) writing garbage and then promptly 2) editing it. The hardest part is getting words on the page, once you can start editing it and refining what you were thinking, it gets much easier.

Maithe Arruda-Carvalho: Talk to as many people as possible! Although it's not easy, we can normalize our challenges and share our experiences to know that we're not alone. If it's a technical issue, talk to someone to give insight on that. Also, from an emotional point of view, community support is important!

7) What should a graduate student do if they have trouble communicating effectively with their supervisor?

Brandon Walters: Figure out why. There is nothing more important to your future career than the relationship between you and your mentor. To this day my PhD mentor still writes me letters and still collaborates with me. Start with yourself. What are you doing to contribute to these issues? Be hard on yourself. Then move on to doing the same with your mentor, realizing you will be biased in your view.

John H. Peever: There is an enormous amount of support from UofT and SGS. In fact, SGS created a new center that focuses on scientific communication called center for graduate mentorship and supervision. This center recognizes that there are times when students face difficulties with their supervisor. This is a resource for students and supervisors to use to help increase their ability to navigate challenges.

Marcus Dillon: If you have done your best to have productive conversations with your advisor and are feeling unsupported, the next step is to seek outside help. Your thesis committee is a great place to start.

8) To finish off, what general advice would you give to all the new graduate students in the department?

John H. Peever: From the 'if I knew then what I know now' files and as a former procrastinator, I have seen things from both sides and would advise getting things done ahead of schedule whenever possible. Anything that is finished a day or two or three ahead of schedule is a euphoric feeling and significantly reduces stress.

Alan M Moses: Do what is interesting for you and do not take it too seriously: you are here to learn.

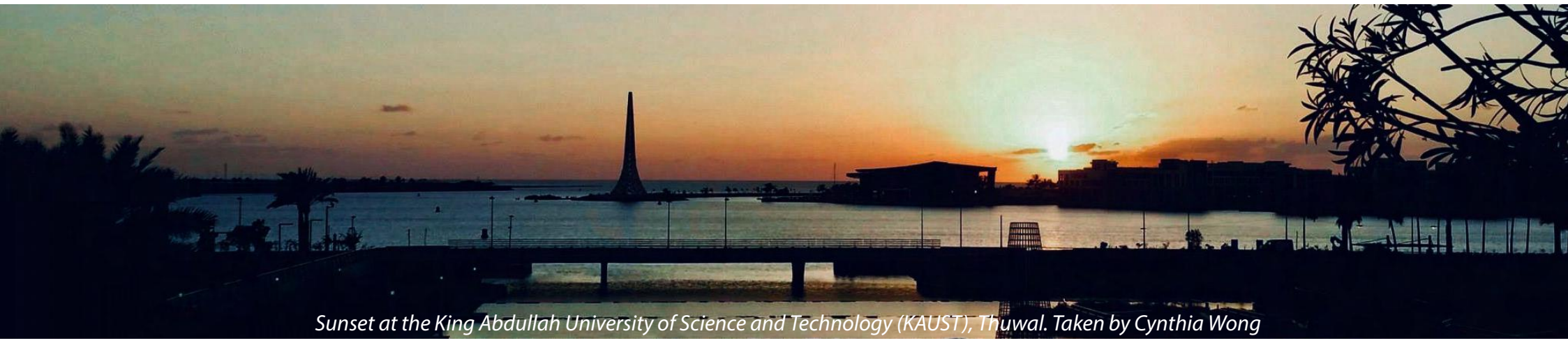
Words of Wisdom

Want to be a tough competitor in industry after graduation? Prof. Penney Gilbert advises adopting coding skills early on in your career.

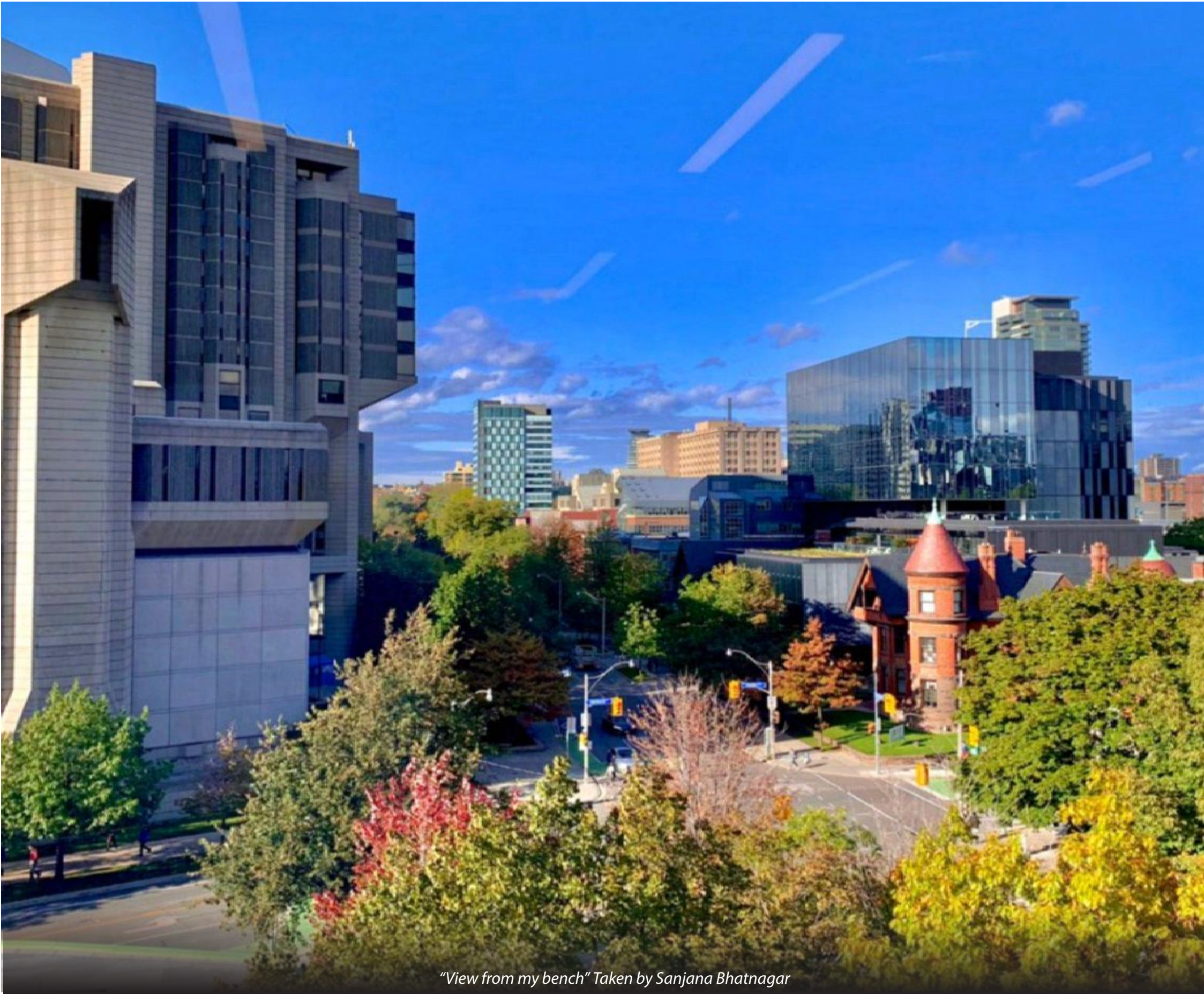
Fighting overwhelming academic pressure with some introspection and scheduling, according to Prof. Maithe Arruda-Carvalho, maybe a work-out that might work out!

When academic life becomes overbearing, Prof. Alan Moses asks himself - "Are you getting inspired by the reasons you came into science?"

Prof. John Peever's mantra to survive the pressure to publish - "I would much prefer to be remembered for one glorious publication than for many invisible ones. - Nobel Laureate."



Sunset at the King Abdullah University of Science and Technology (KAUST), Thuwal. Taken by Cynthia Wong



"View from my bench" Taken by Sanjana Bhatnagar

Review of "Science Writing Internship 2021"

By Sonhita Chakraborty

While writing my thesis, I saw a call for the first online 'Science Writing Internship', funded by Canada's Natural Sciences and Engineering Research Council (NSERC) and Laurier Centre for Women in Science (WinS). I applied on a whim and was pleasantly surprised when I received a letter informing me that I had been accepted.

Up until this internship, my involvement in science communication or "SciComm" mostly took place in classrooms and science outreach fairs. Seeing young minds fascinated by science experiments showed me the importance of engaging people of all ages. Through my recent experiences in grad school, I came to realize that my strengths and comforts lie in conveying science through writing. If you feel similarly and want to explore careers in science writing, keep reading. Prof. McDonald and Prof. Borowiec, researchers at the Wilfrid Laurier University's Dept. of Biology, ran the program from May through August of 2021. As an intern, I had exclusive access to many workshops, and networked with renowned SciCommers and interns like myself from around the country (and abroad). We were incrementally exposed to a range of topics: the basics of SciComm, how to write science blogs, make considerations on EDI, the importance of science communication (and miscommunication), how to pitch stories as a science journalist, and explore careers in SciComm. My favourite session was meeting and talking with Dr. Siri Carpenter, the creator of an amazing initiative called the The Open Notebook, which provides science journalists resources and advice on conducting interviews with scientists and pitching science stories to different media outlets. As an intern, I also transcribed notes from some of these workshops, which helped me develop this valuable skill. Equipped with some newfound expertise, I wrote a blog post about my research and paired the piece with original digital illustrations. My blog post

inaugurated the internship website and received much attention in part because it was widely shared on Twitter. Encouraged by the positive feedback, I wrote a second blog post that I am planning to pitch it for publication in the near future. This internship experience provided me with a platform to communicate science, explore new opportunities I was previously unfamiliar with, and network with like-minded budding SciCommers. The experience and skills gained over the course of this internship have been invaluable and I look forward to applying them for years to come. In fact, I already find myself drawing from Dr. Cylita Guy's teachings on storytelling, even in the more technical role I later took as a Scientific Managing Editor. You can learn more on the internship website. Be sure to keep your eyes peeled for the next call!

If Prof. Moses could bring only one CD to a deserted island, it would be 'Life on Planet Groove' by Maceo Parker!

"Busy bee" Taken by Cynthia Wong

Taken by Sanjana Bhatnagar

CiteMe!

Congradulations to all the graduate students who had their first author publication come out! Papers from the last two years (August 2021 - August 2023) are presented in chronological order.

1) Darvish-Ghane S, Baumbach J, Martin LJ. Influence of Inflammatory Pain and Dopamine on Synaptic Transmission in the Mouse ACC. Int J Mol Sci. 2023 Jul 5;24(13):11113.

2) Liu J, Liu BH. Quantification of Visual Feature Selectivity of the Optokinetic Reflex in Mice. J Vis Exp. 2023 Jun 23;(196).

3) Phung T, Ramzan F, Monks DA. Hormone-dependent sexual responses of female mice in response to manual genital stimulation. Horm Behav. 2023 May;151:105338.

4) Ruiz-Bedoya T, Wang PW, Desveaux D, *et al*. Cooperative virulence via the collective action of secreted pathogen effectors. Nat Microbiol. 2023 Apr;8(4):640-650.

5) Shishis S, Tsang B, Ren GJ, *et al*. Effects of different handling methods on the behavior of adult zebrafish. Physiol Behav. 2023 Apr 1;262:114106.

6) Sheppard L, Green DG, Lerchbaumer G, *et al*. The α-Catenin mechanosensing M region is required for cell adhesion during tissue morphogenesis. J Cell Biol. 2023 Feb 6;222(2):e202108091.

7) Chakraborty S, Kopitchinski N, Zuo Z, *et al*. Enhancer-promoter interactions can bypass CTCF-mediated boundaries and contribute to phenotypic robustness. Nat Genet. 2023 Feb;55(2):280-290.

8) He Y, Tan X, Li H, *et al*. Phosphoproteomic analysis identifies differentially expressed phosphorylation sites that affect muscle fiber type in pigs. Front Nutr. 2022 Dec 22;9:1006739.

9) Levinsky AJ, McEdwards G, Sethna N, *et al*. Targets of histone H3 lysine 9 methyltransferases. Front Cell Dev Biol. 2022 Dec 6;10:1026406.

10) Chadee A, Mohammad M, Vanlerberghe GC. Evidence that mitochondrial alternative oxidase respiration supports carbon balance in source leaves of *Nicotiana tabacum*. J Plant Physiol. 2022 Dec;279:153840.

11) Eisha S, Joarder I, Wijenayake S, et al. Non-nutritive bioactive components in maternal milk and offspring development: a scoping review. J Dev Orig Health Dis. 2022 Dec;13(6):665-673.

12) Valentino P, Erclik T. Spalt and disco define the dorsal-ventral neuroepithelial compartments of the developing Drosophila medulla. Genetics. 2022 Nov 1;222(3):iyac145.

13) Shishis S, Tsang B, Gerlai R. The effect of fish density and tank size on the behavior of adult zebrafish: A systematic analysis. Front Behav Neurosci. 2022 Oct 5;16:934809.

14) Zhu Y, McFarlane HE. Regulation of cellulose synthesis via exocytosis and endocytosis. Curr Opin Plant Biol. 2022 Oct; 69:102273.

15) Barua D, Winklbauer R. Eph/ephrin signaling controls cell contacts and formation of a structurally asymmetrical tissue boundary in the *Xenopus gastrula*. Dev Biol. 2022 Oct;490:73-85.

16) Breit-McNally C, Laflamme B, Singh RA, *et al*. ZAR1: Guardian of plant kinases. Front Plant Sci. 2022 Sep 23;13:981684.

17) Faykoo-Martinez M, Collins T, Peragine D, *et al*. Protracted neuronal maturation in a long-lived, highly social rodent. PLoS One. 2022 Sep 15;17(9):e0273098.

18) Darvish-Ghane S, Lyver B, Facciol A, *et al*. Inflammatory Pain Alters Dopaminergic Modulation of Excitatory Synapses in the Anterior Cingulate Cortex of Mice. Neuroscience. 2022 Aug 21;498:249-259.

19) Huang Y, Winklbauer R. Cell cortex regulation by the planar cell polarity protein Prickle1. J Cell Biol. 2022 Jul 4;221(7):e202008116.

20) Taylor T, Sikorska N, Shchuka VM, *et al*. Transcriptional regulation and chromatin architecture maintenance are decoupled functions at the *Sox2* locus. Genes Dev. 2022 Jun 1;36(11-12):699-717.

21) Singh G, Stefanelli G, Narkaj K, *et al*. Author Correction: Histone macroH2A1 is a stronger regulator of hippocampal transcription and memory than macroH2A2 in mice. Commun Biol. 2022 May 27;5(1):531.

22) Burnie J, Persaud AT, Thaya L, *et al*. P-selectin glycoprotein ligand-1 (PSGL-1/CD162) is incorporated into clinical HIV-1 isolates and can mediate virus capture and subsequent transfer to permissive cells. Retrovirology. 2022 May 21;19(1):9.

23) Singh G, Stefanelli G, Narkaj K, *et al*. Histone macroH2A1 is a stronger regulator of hippocampal transcription and memory than macroH2A2 in mice. Commun Biol. 2022 May 19;5(1):482.

24) Martel A, Laflamme B, Breit-McNally C, *et al*. Metaeffector interactions modulate the type III effector-triggered immunity load of Pseudomonas syringae. PLoS Pathog. 2022 May 16;18(5):e1010541.

25) Vonapartis E, Mohamed D, Li J, *et al*. CBF4/DREB1D represses XERICO to attenuate ABA, osmotic and drought stress responses in Arabidopsis. Plant J. 2022 May;110(4):961-977.

26) Breit-McNally C, Desveaux D, Guttman DS. The Arabidopsis effector-triggered immunity landscape is conserved in oilseed crops. Sci Rep. 2022 Apr 20;12(1):6534.

27) Gauberg J, Elkhatib W, Smith CL, *et al*. Divergent Ca^{2+}/calmodulin feedback regulation of Ca_V1 and Ca_V2 voltage-gated calcium channels evolved in the common ancestor of Placozoa and Bilateria. J Biol Chem. 2022 Apr;298(4):101741.

28) Yalnizyan-Carson A, Richards BA. Forgetting Enhances Episodic Control With Structured Memories. Front Comput Neurosci. 2022 Mar 25;16:757244.

29) Hegazi S, Cheng AH, Krupp JJ, *et al*. UBR4/POE facilitates secretory trafficking to maintain circadian clock synchrony. Nat Commun. 2022 Mar 24;13(1):1594.

30) Facciol A, Marawi T, Syed E, *et al*. Age-dependent effects of embryonic ethanol exposure on anxiety-like behaviours in young zebrafish: A genotype comparison study. Pharmacol Biochem Behav. 2022 Mar;214:173342.

31) Persaud AT, Bennett SA, Thaya L, *et al*. Human monocytes store and secrete preformed CCL5, independent of de novo protein synthesis. J Leukoc Biol. 2022 Mar;111(3):573-583.

32) Persaud AT, Burnie J, Thaya L, *et al*. A UV-LED module that is highly effective at inactivating human coronaviruses and HIV-1. Virol J. 2022 Feb 10;19(1):29.

33) Kanaris M, Poulin J, Shahinas D, *et al*. Elevated tyrosine results in the cytosolic retention of 3-deoxy- d-arabino-heptulosonate 7-phosphate synthase in *Arabidopsis thaliana*. Plant J. 2022 Feb;109(4):789-803.

34) Abozaid A, Hung J, Tsang B, *et al*. Behavioral effects of acute ethanol in larval zebrafish (*D. rerio*) depend on genotype and volume of experimental well. Prog Neuropsychopharmacol Biol Psychiatry. 2022 Jan 10;112:110411.

35) Abozaid A, Gerlai R. Behavioral Effects of Buspirone in Juvenile Zebrafish of Two Different Genetic Backgrounds. Toxics. 2022 Jan 7;10(1):22.

36) Stulberg J, Tropepe V. In Situ Quantification and Isolation of Müller Glial Cells by Fluorescence-Activated Cell Sorting from the Regenerating Larval Zebrafish Retina. Methods Mol Biol. 2022;2429:345-356.

37) Miles A, Blair C, Emili A, *et al*. Usher syndrome type 1-associated gene, pcdh15b, is required for photoreceptor structural integrity in zebrafish. Dis Model Mech. 2021 Dec 1;14(12):dmm048965.

38) Seto D, Khan M, Bastedo DP, *et al*. The small molecule Zaractin activates ZAR1-mediated immunity in Arabidopsis. Proc Natl Acad Sci U S A. 2021 Nov 23;118(47):e2116570118.

39) Chakraborty S, Toyota M, Moeder W, *et al*. CYCLIC NUCLEOTIDE-GATED ION CHANNEL 2 modulates auxin homeostasis and signaling. Plant Physiol. 2021 Nov 3;187(3):1690-1703.

40) Karia P, Yoshioka K, Moeder W. Multiple phosphorylation events of the mitochondrial membrane protein TTM1 regulate cell death during senescence. Plant J. 2021 Nov;108(3):766-780.

41) Bunsick M, McCullough R, McCourt P, *et al*. Plant hormone signaling: Is upside down right side up? Curr Opin Plant Biol. 2021 Oct;63:102070.

42) Chadee A, Alber NA, Dahal K, *et al*. The Complementary Roles of Chloroplast Cyclic Electron Transport and Mitochondrial Alternative Oxidase to Ensure Photosynthetic Performance. Front Plant Sci. 2021 Sep 28;12:748204.

43) Barua D, Nagel M, Winklbauer R. Cell-cell contact landscapes in *Xenopus* gastrula tissues. Proc Natl Acad Sci U S A. 2021 Sep 28;118(39):e2107953118.

44) Alwash N, Allen AM, B Sokolowski M, *et al*. The *Drosophila melanogaster foraging* gene affects social networks. J Neurogenet. 2021 Sep;35(3):249-261.

45) Sharma M, Jiang T, Jiang ZC, *et al*. Emergence of a smooth interface from growth of a dendritic network against a mechanosensitive contractile material. Elife. 2021 Aug 23;10:e66929.

46) Faykoo-Martinez M, Kalinowski LM, Holmes MM. Neuroendocrine regulation of pubertal suppression in the naked mole-rat: What we know and what comes next. Mol Cell Endocrinol. 2021 Aug 20;534:111360.

47) Mattocks M, Tropepe V. Know thy neighbor: Modeling spatiotemporal cell-fate patterns in a neural stem cell niche. Cell Stem Cell. 2021 Aug 5;28(8):1339-1340.

48) Martel A, Ruiz-Bedoya T, Breit-McNally C, *et al*. The ETS-ETI cycle: evolutionary processes and metapopulation dynamics driving the diversification of pathogen effectors and host immune factors. Curr Opin Plant Biol. 2021 Aug;62:102011.

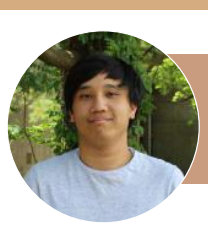
49) Tsang B. Six ways to grab your principal investigators' attention by e-mail. Nature. 2023 Feb 28. doi: 10.1038/d41586-023-00592-2.

50) Krimberg JS, Lumertz FS, Orso R, *et al*. Impact of social isolation on the oxytocinergic system: A systematic review and meta-analysis of rodent data. Neurosci Biobehav Rev. 2022 Mar;134:104549. doi: 10.1016/j.neubiorev.2022.104549.

51) Tsang B, Gerlai RT. Common Aquarium Plants as an Enrichment Strategy in Zebrafish Facilities. Zebrafish. 2022 Dec; 19(6):218-223. doi: 10.1089/zeb.2022.0036.

52) Evans SE, Duggan P, Bergman ME, *et al*. Design and fabrication of an improved dynamic flow cuvette for $^{13}CO_2$ labeling in Arabidopsis plants. Plant Methods. 2022 Mar 27;18(1):40. doi: 10.1186/s13007-022-00873-3.

53) Duggan A, McMillen D. Methods for Electroporation and Transformation Confirmation in *Limosilactobacillus reuteri* DSM20016. J Vis Exp. 2023 Jun 23;(196). doi: 10.3791/65463.



54) Trinh D, Nash J, Goertz D, *et al*. Microbubble drug conjugate and focused ultrasound blood brain barrier delivery of AAV-2 SIRT-3. Drug Deliv. 2022 Dec;29(1):1176-1183. doi: 10.1080/10717544.2022.2035855.

A view of La Mujer Muerta from the city of Segovia. Taken by Cynthia Wong

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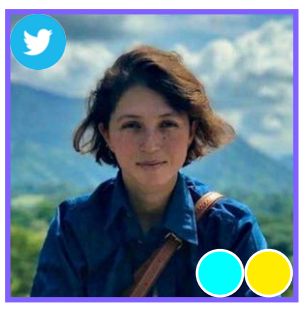

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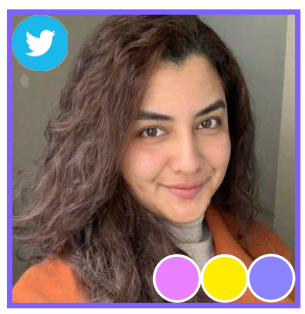

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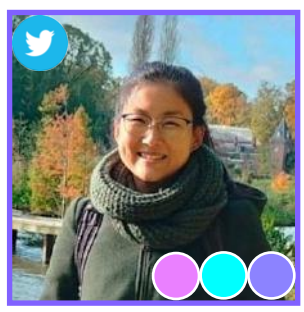

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Join the team! We are always looking for new enthusiastic members to join this project as one-time contributors or as part of the core editorial or graphic team. If you are interested in being a part of The CSB Forefront 2024, please contact Sanjana. (sanjana.bhatnagar@mail.utoronto.ca)

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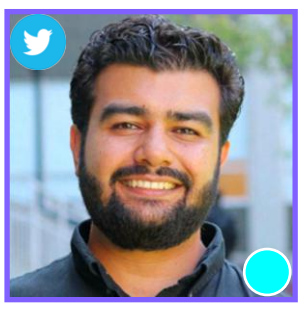

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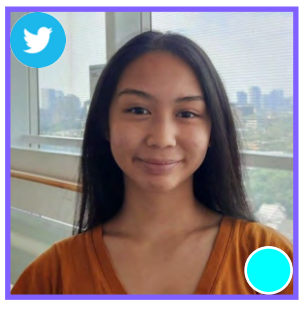

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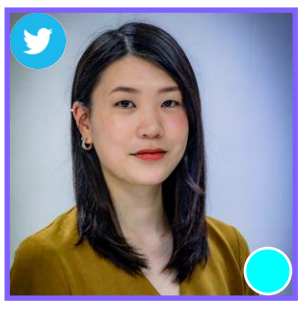

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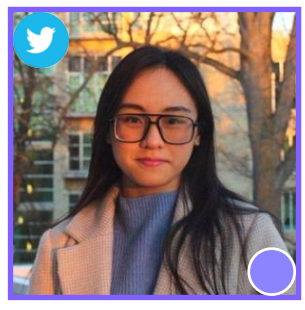

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"Wisterias in Mallorca". Taken by Cynthia Wong