Iacocca Hall, B217
111 Research Drive
Bethlehem, PA 18015

Tel: (610) 758-3680 | Fax: (610) 758-4004
Email: inbios@lehigh.edu
Web: www.lehigh.edu/~inbios

LEHIGH UNIVERSITY

Biological Sciences

Greetings!

Linda Lowe-Krentz, Ph.D.
Professor and Chair

Time got away from me, and it is a little later than I have written past newsletter messages. Already it is the second week after spring break, the daffodils on the hills at Lehigh are in full bloom, and the weather (today at least) is gorgeous. As usual around this time of year, we are looking forward to celebrating with students graduating in May, dissertation defenses, planning for new faculty hires to join us in fall and more. But for the moment, I am excited to write to all of you after a year without a newsletter.

We have had two years with lots of changes. For example, you will see two years of Epstein Scholars, one set of which has already graduated and are busy rising to meet new challenges. We will miss our retired faculty members mentioned in the newsletter, but we are very happy to introduce two years of new faculty members who are already making their marks in the department and on campus. We happily recognize a promotion. What is also new at Lehigh, but is not primarily our story, is that the new Health Science and Technology building, home to the College of Health on main campus, is now home to many faculty members from Bioengineering and Chemical and Biomolecular Engineering Departments who used to be in Iacocca Hall with Biological Sciences. That has changed the people with whom we interact regularly, and has expanded the spaces in which we work to include some offices and other rooms on the first and third floors of Iacocca. We are making good use of these spaces for our expanding research programs and student opportunities.

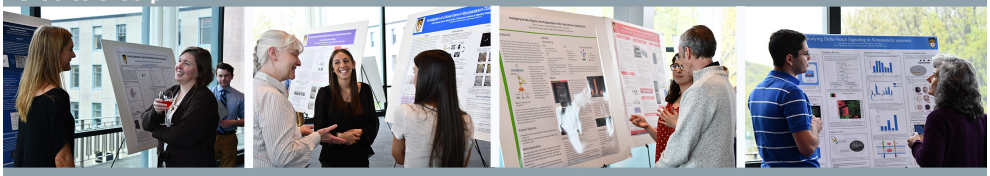
In addition to three stories about research in a faculty member's lab, by an alum and by a current graduate student, there are news updates from many of you. Take a look to see whether any of your friends wrote. As in many years, alums contributing these messages go back to the 1960s and forward to very recent years. While this newsletter provides some fun information, if you want to know more about what is going on, visit our department website and look at everything from faculty pages to program updates and more. Finally, please contact us with updates on what you are doing and we will be happy to include your information in our newsletter next year.

Please join us!

2023 Undergraduate Research Symposium

Thursday April 27th
3:00 to 5:00 p.m.

Iacocca Hall
Iacocca Conference Center



student poster presentations | meet with professors | learn about exciting research

2022 - at a glance ...

- 27 faculty members
- 16 post-doctoral / research scientists
- 12 technical and 3 administrative staff
- 51 Ph.D.-level graduate students
- 34 Master's-level graduate students
- 304 Undergraduate majors

• Daniel Babcock • Michael Behe • R. Michael Burger • Matthias Falk • Julie Haas • Santiago Herrera • Wonpil Im • M. Kathryn Iovine •
• Johanna Kowalko • Michael Kuchka • Gregory Lang • Michael Layden • Linda Lowe-Krentz, Chair • Wynn Meyer • Julie Miwa • Kayleigh O'Keeffe •
• Amber Rice • Jill Schneider • Neal Simon • Robert Skibbens • Jennifer Swann • Lawrence Tartaglia • Nathan Urban • Vassie Ware • David Zappulla •

Welcome to New Faculty


Santiago Herrera

Santiago Herrera, Ph.D. earned his bachelor's degree in Biology and Microbiology from the Universidad de los Andes in Bogotá, Columbia, as well as his master's degree in Biological Sciences. He earned his Ph.D. in Biological Oceanography from the Massachusetts Institute of Technology. He then went on to be a postdoctoral fellow at the University of Toronto. Dr. Herrera came to Lehigh as a visiting assistant professor in 2016, and was then appointed as a professor of practice in the department. He was appointed as an assistant professor in 2021. The Herrera lab seeks to understand how diversity arises in and interacts with, the ocean environment. His research focuses on deep-sea and mesophotic benthic ecosystems, populations, species, and organisms.


Johanna Kowalko

Johanna Kowalko, Ph.D. is an evolutionary biologist who joined the department as an assistant professor in the Fall of 2021. Kowalko earned her bachelor's degree in Biology from Brown University, and went on to earn her Ph.D. in Genetics from Harvard University. After being a postdoctoral researcher at Iowa State University, she joined the faculty at Florida Atlantic University in 2018. Dr. Kowalko's research program seeks to understand the genetic and neural underpinnings of behavioral diversity. The lab is examining two main questions: What are the genetic, developmental and neural mechanisms that underlie differences in behavior? Further, how do behaviors evolve? To do this, the lab uses the blind cavefish, *Astyanax mexicanus* as their research model organism.


Kayleigh O'Keeffe

Kayleigh O'Keeffe, Ph.D. earned her bachelor's degree from Amherst College and went on to receive her doctorate from the University of North Carolina, Chapel Hill. Dr. O'Keeffe joined the faculty at Lehigh as a Teaching Assistant Professor after having been a postdoctoral researcher at the University of Pennsylvania where her research focus considered questions related to the ecology and evolution of infectious diseases. In addition to her biological research, Dr. O'Keeffe is passionate about undergraduate education and communicating sciences to broad audiences. She works to create learning environments where students feel confident to participate and ultimately see themselves as a scientist.


Elizabeth Steenkiste

Elizabeth Steenkiste, Ph.D. joined the department in the Fall of 2021 as a Visiting Assistant Professor. She earned her bachelor's degree in Biology from Denison University, and her Ph.D. in Molecular and Cellular Biology from the University of Washington. While at the University of Washington, Dr. Steenkiste participated in the Science Teaching Experience Program for Upcoming PhDs (STEP-UP) which provided training in best practices of equitable, evidence-based teaching in higher education.


Lawrence Tartaglia

Lawrence Tartaglia, Ph.D. was first hired at Lehigh as a Visiting Assistant Professor and subsequently appointed as a Professor of Practice. He was then promoted to Teaching Assistant Professor. Dr. Tartaglia earned his bachelor's and master's degrees from Rutgers University, and went on to be awarded his doctorate from The University of Florida College of Medicine. Prior to his arrival at Lehigh, he was a postdoctoral fellow at Harvard Medical School, with a focus on vaccinology and vaccine research. While at Harvard, Dr. Tartaglia participated in the certificate program, "Scientists Teaching Science." At Lehigh, Tartaglia is a Health Professions Advisory Committee member and is the faculty advisor and co-founder of the Minority Association of Pre-Medical Students and the Minority Associate of the Scientific Journal Club.


Jeffrey Trimarchi

Jeffrey Trimarchi, Ph.D. was hired in August 2021 as a Visiting Assistant Professor. Previously he was an assistant professor at Iowa State University and then a research scientist at Emmune, Inc. in Florida. Dr. Trimarchi earned his bachelor's degree in Biology at Amherst College, and his Ph.D. in Biology at MIT. He served as a postdoctoral researcher at Harvard Medical School.

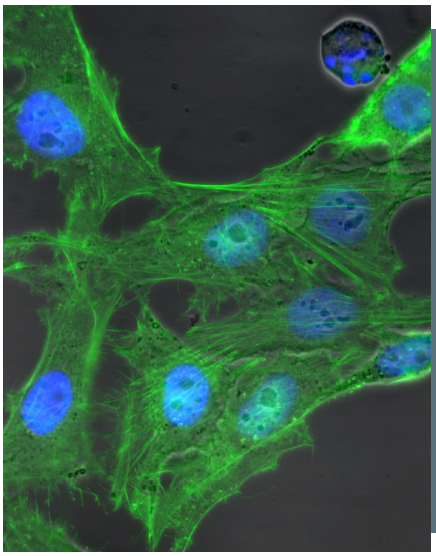
Promotion


David Zappulla

At the May, 2021 meeting of the Lehigh Board of Trustees, David Zappulla, Ph.D. was promoted to Associate Professor with Tenure.

Dr. Zappulla earned his bachelor's degree in Biology from Middlebury College and his Ph.D. in Molecular and Cellular Biology from Stony Brook University. Following his time at Stony Brook, he was appointed as a postdoctoral research associate at the University of Colorado. He later joined the faculty at Johns Hopkins University and arrived at Lehigh as an assistant professor in 2018.

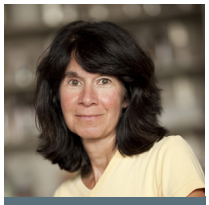
The Zappulla lab investigates the molecules and mechanisms that maintain chromosomes in order to control cell viability and proliferation.



Human epithelial cells were grown in culture, and the actin cytoskeleton was stained with Alexa488-conjugated phalloidin (green), and cell nuclei were stained with DAPI (blue). Fluorescence and white-light channels were merged. Note the rounded, apoptotic cell undergoing induced cell death in the top right corner recognizable by its fragmented nucleus, a hallmark of apoptosis. Image; Fall 2022 BioS368 Cell Bio Lab students; Instructor; Prof. Matthias M. Falk.

Can you provide support for a graduate student to travel to a professional meeting?

Retirements



Lynne Cassimeris

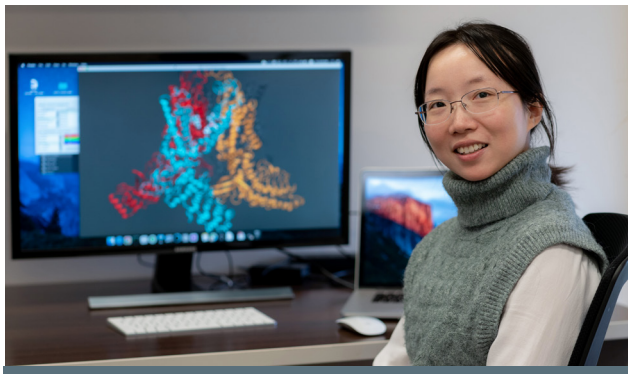
Lynne Cassimeris, Ph.D. retired from the faculty of Lehigh in Spring of 2021. Cassimeris joined Lehigh as an Assistant Professor in 1992. She was promoted to Associate Professor in 1996, and Professor in 2004. Professor Cassimeris' research focused on cell proliferation and unraveling the mechanisms responsible for cell growth and she taught a wide variety of cell biology courses. Her work zeroed in on microtubules that are responsible for separating the genome into each daughter cell at each cell division which target some of the most successful anti-cancer drugs. Later in her career, Dr. Cassimeris' love of horses motivated her to shift her research focus toward understanding equine laminitis. Lynne earned her bachelor's degree from Springfield College, and her doctoral degree from the University of North Carolina.

Margaret Kenna

In December 2022, our long-time Director of Undergraduate Labs, **Margaret Kenna, Ph.D.**, retired after serving in this position for 16 years. Dr. Kenna was the instructor of our Cell & Molecular and Genetics laboratory courses. She was instrumental in creating a smooth transition for these labs which were held for many years in Williams Hall to the STEPS building. She was also co-instructor (with Professor Vassie Ware) for the "Phage Hunting" and "Phage Genomics" classes, an instructional research program developed by the Howard Hughes Medical Institute. Meg earned her bachelor's degree from St. Joseph's College, and her doctoral degree from the University of North Carolina.

Graduate Student Spotlight

Shasha Feng is a Ph.D. Candidate in the Biochemistry program



Ph.D. Candidate, Shasha Feng

Shasha earned her Bachelor of Science in biology in the Honored Undergraduate Program in Biology (HUPB) at Peking University in Beijing, China. She conducted research on developing a neuron membrane voltage sensor. The molecular engineering and biochemistry characterization during her undergraduate studies revealed the beauty of protein dynamics. To further observe the protein dynamics in atomistic details, Shasha joined the Im Lab as a Ph.D. student in 2018 and shifted her research to utilizing computational tools for understanding biological phenomena related to lipid membranes and membrane proteins. At Lehigh, she has studied archaeal membrane and quinone localization, activation mechanism of Transient Receptor Potential (TRP) channels, as well as chemoinformatics applications powered by machine learning tecnhiques.

Her work published on J. Phys. Chem. B utilized molecular dynamics simulation to show that high concentrations of menaquinone in halo-bacteria likely increase osmotic resistance by increasing the membrane bending modulus. The localization of menaquinone in the center of archaeal membrane sheds lights into how the hydrophobicity and polarity can play a role of small molecule partition in the membrane and closely relate to drug partition and efficacy.

Her thesis work on Transient Receptor Potential (TRP) channels including a collection of TRPV/TRPC/TRPM channels shows how the lipids and ligands bind in various pockets of the ion channels and modulate conformations, which has profound meaning in ion channel drug discovery (Science 378 (6616), eadd1268; Protein Science 32 (1), e4490). The molecular dynamics simulations provide further information about protein dynamics and gating mechanism in addition to the experimental structures.

Outside research and coursework, Shasha loves to contribute and connect with the community. Her leadership experience as the president of Life Science Industry Association club at Peking University, combining with her passion for outdoor nature, channeled into the Graduate Students Outing Club (GSOC) at Lehigh. As the founder of GSOC, during her tenure as the president, Shasha expanded the club into the biggest and most active graduate student club on campus with ~400 members on the email list. GSOC was awarded Club of Year 2021 by Grad Student Senate. She continuously nurtures the club development, engages incoming new students, and brings more graduate students into the pristine nature. During her downtime, she likes visiting museums, lifting, and Zen meditation.

The research in the Im Lab is funded by grants from the National Institutes of Health and National Science Foundation.

Let us know what you're doing!

Submit your information online:

Click here to submit your information - it is fast and easy!

Send us an e-mail:

Send your information to inbios@lehigh.edu. Please include your name, year of graduation, degree, and the information you would like to share.

Call us:

Call the department office (610-758-3680) and give your information to Melissa.

Send us a note:

Biological Sciences
attn: Alumni Updates
111 Research Dr., B217
Bethlehem, PA 18015

2022 Selected Research Publications

Bold = Faculty | ***Bold+Italic*s** = Graduate Student | *Italics* = Undergraduate Student | *= Former Student

Davis, J. Kolaski, E. **Babcock, D.** 2022. Vexed mutations promote degeneration of dopaminergic neurons through excessive activation of the innate immune response. Npj Parkinson's Disease, 147. DOI: https://doi.org/10.1038/s41531-022-00417-5

Burger, R.M. and Kopp-Scheinpflug, C. 2022. Editorial: Neuromodulatory Function in Auditory Processing. Frontiers in Neural Circuits. 16: DOI=10.3389/fncir.2022.898646 ISBN 978-2-88976-315-3

Levin, M., Spiro, R.C., **Jain, H.**, and **Falk, M.M.** 2022. Effects of Titanium implant surface topology on bone cell attachment and proliferation in vitro. Med. Devices (Aukl.) April 26; 15:103-119. doi: 10.2147/MDER.S360297.

Vaughn, M., **Haas, J.** 2022. On the diverse functions of electrical synapses. Fronteirs in Cellular Neuroscience, 16:910015. DOI: https://doi.org/10.3389%2Ffncel.2022.910015

Suh, D., ***Feng, S.***, ***Lee, H.***, ***Zhang, H.,*** Park, SJ., ***Kim, S.***, Lee, J., Choi, S., **Im., W.** 2022. CHARMM-GUI Enhanced Samper for various collective variables and enhanced sampling methods. Protein Science. 2022; 31:34416. DOI: 10.1002/pro.4446

McCartin, L., Vohsen, S., Ambrose, S., **Layden, M.**, McFadden, C., Cordes, E., **McDermott, J.**, **Herrera, S.** 2022. Temperature controls eDNA persistence across physicochemical conditions in seawater. Environmental Science & Technology. 56, 12, 8629-8639. DOI: https://doi.org/10.1021/acs.est.2c01672

*Vignogna, R., Allocca, M., Monticelli, M. Norris, J. Steet, R., Perstein, E. Andreotti, **G., Lang**, G. 2022. Evolutionary rescue of phosphomannomutase deficiency in yeast models of human disease. eLife, 11:e79346. DOI: https://doi.org/10.7554/eLife.79346

Field*, CJ, ***Perez*, *AM***, Samet*, T., Ricles*, V., **Iovine, MK**, and **Lowe-Krentz, LJ**. 2022. Involvement of transmembrane protein 184a during angiogenesis in zebrafish embryos. *Front. Physiol.*, doi.org/10.3389/fphys.2022.845407

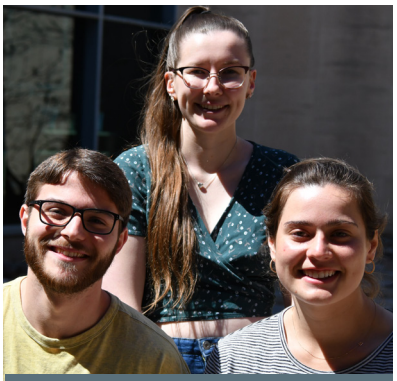
Sanchez, A., Thren, E., **Iovine, M.K., Skibbens, R.** 2022. Esco2 and cohesion regulate CRL4 ubiquitin ligase ddb1 expression and thalidomide teratogenicity. Cell Cycle Mar;21(5):501-513. DOI: https://doi.org/10.7554/eLife.79346.

Swann, J. 2022. Academic bullying and diversity: challenges and solutions. FEBS Letters, 596: 2855-2858. https://doi.org/10.1002/1873-3468.14504

Introducing recent years' Epstein Scholars ...

Through a generous gift, Michael Epstein, Esq. ('75, B.A. Bio) established the Epstein Family Endowment for the purpose of supporting undergraduate research. All received funding for materials and supplies to complete their research.

The 2021-2022 recipients of the Epstein Family Endowment received their degree in May, 2022. They spent the year in the department's Honors Class, under the guidance of Professor Michael Kuchka.



front: Thomas Dressler, Isabella Papov
Rear: Kaya Harper

• **Thomas Dressler** (B.S., Biochemistry) - Thomas's research advisor was Professor Linda Lowe-Krentz. His research was on the underlying signaling schemes behind angiogenesis.

• **Kaya Harper** (B.S., Molecular Biology) - Kaya's research proposal was, "Studying the efficacy of CRISPR/Cas9 with highly homologues genes from *S. paradoxus* and *S. cerevisiae*." Dr. Greg Lang was Kaya's research advisor.

• **Isabella Papov** (B.S., Biochemistry) – Isabella did her research in the Lowe-Krentz lab. Her research proposal title was "Eluciating the Role of Transmembrane Protein 184A in Recycling of Vascular Endothelial Cadherin Specific to Endothelial Remodeling."

The 2022-2023 recipients of the Epstein Family Endowment are members of the department's honors class and will be receiving their degree in 2023. They have been busy presenting their research in the Honors Class, led by Professor Kathy Iovine.

l-r: Alex Winters, Mary Grace Allen, Michael Chavez

• **Mary Grace Allen** (B.S., Biology) - Grace's research advisor is Professor Greg Lang. The focus of her research is studying recessive mutations that lead to sterility in haploid yeast.

• **Michael Chavez** (B.S., Biology) - Michael's research proposal is titled, "Examining a feedback loop betweed Cx43 and β-catenin during skeletal patterning." Dr. Kathy Iovine is his research advisor.

• **Alex Winters** (B.S., Biology) – Alex is doing research in the Babcock Lab. His focuses on how synapses fall apart in Amyotrophic Lateral Sclerosis (ALS), using the model organism *Drosophila melanogaster*.

Interested in supporting undergraduate research? Visit giving.lehigh.edu to make your gift.

The pursuit of perfectly targeted cancer drugs

Written by Seth Augenstein
Hackensack Meridian Health

Picture this: a cancer patient has their tumor tissue sampled, collected, and sent to a laboratory. The tissue is grown in a dish, and can be cloned into organoids. The scientists analyze the entire genetic sequence – then tactically aim drugs at the cancer's molecular vulnerabilities. Whatever works in the organoid should work on the patient, giving doctors the edge back in the hospital. It could soon be regularly happening at Hackensack Meridian Health, thanks to Kevin Tong, Ph.D ('2015).

"Can I test in real-time, a drug screen in an organoid and know as soon as possible exactly what combination of drugs is going to work for that patient's unique cancer?" said Kevin Tong, Ph.D., the assistant member of the Hackensack Meridian Center for Discovery and Innovation (CDI), from his lab. "It's the definition of 'personalized medicine.' It's a dream. But I think we can make it come true."

This may be the future of cancer treatment at Hackensack Meridian Health, via the science of the CDI and particularly the mission of Tong, a recent arrival to the CDI whose lab has focused on molecular profiling of cancers, particularly colorectal cancer. But while he continues to use his expertise to study mutations and tactics of cancer, he is also looking toward these organoids under a microscope which could provide a key strategy to defeating tumors on an individualized basis.

Kevin Tong, Ph.D. '15

"Kevin Tong is a scientist who has had a terrific start to his career," said David Perlin, Ph.D., the chief scientific officer and executive vice president of the CDI. "We're thrilled he brought his work to the CDI, where it will complement so much of the other fundamental investigations of cancer here."

Colorectal Cancer

Colorectal cancer is a mercurial, heterogeneous beast to tackle. It is a disease which has a variety of root causes in genetic mutations and environmental factors, and has always been a puzzle for clinicians and scientists. Key breakthroughs were made in the 1980s by Burt Vogelstein, M.D., now of Johns Hopkins, who developed a "Vogelgram" showing the genesis of colorectal cancer based on genetic mutations, and their progression through human biology. It was the first model of its kind done for any kind of cancer, by most accounts.

Of course, the picture has become increasingly complex in the ensuing 30-plus years of cancer biology. Tong is one of investigators seeking to find new details within the Vogelgram, accurate though it may largely be, in a large cross-section of cases.

One particular pathway that Tong has focused on is the "serrated" form of colorectal cancer. One aspect of this more-difficult variety of the tumor is the BRAF-mutation-driven variety – and particularly the loss of a critical tumor suppressor known as SMAD4.

Several projects revolve around a novel mouse model, a Tong creation, which aggressively generates serrated tumors that emulate human varieties of the cancer.

Tong and his laboratory have found that SMAD4 might actually play a greater role earlier in serrated colorectal cancer – that SMAD4 is critical to prevent serrated tumors from even starting.

Organoids

Tong did his postdoctoral work at Rutgers University. But when the opportunity arose at the CDI to further accelerate his work, he seized it.

"What sold me on the CDI was the translational aspect of the work," said Tong. "Here you have a network supporting you – and you get to move the work as close to the clinic as you possibly can. That's what it's all about."

Just a few weeks ago, Tong received the first patient samples from clinical settings in Hackensack Meridian Health and has successfully established organoids from them. But it's just the beginning.

Coupled with the access to the rapidly-growing Bio-Repository at HMH, the ambitious project has just become that much closer to a "personalized medicine" reality, he mentioned.

"We know everybody wants to do this in healthcare," he said. "But we want to be ahead of it. We want to help drive it forward."

"My dream is to translate my research to help patients," said Tong. "What's better than that?"

Kevin Tong earned his bachelor's degree in biotechnology from Rutger's University and then his doctorate from Lehigh University in 2015 in Cell and Molecular Biology. He met his future wife, Caitlin Zuilkoski, Ph.D. ('20) when both were graduate students in the lab of Professor Robert Skibbens. Dr. Zuilkoski works at Modern Meadow, a biotech company which is in the same building as the CDI.

Remaking the Nervous System

Kelly Hochbein
University Communications

Michael Layden Studies the Starlet Sea Anemone, Nematostella, to Understand Neural Development, Evolution and Regeneration

Michael Layden turns to the starlet sea anemone to better understand neural development and how the human brain evolved, and potentially improve treatments of the central nervous system.

Researchers originally targeted *Nematostella vectensis*, the starlet sea anemone, in the search for an organism that could help them understand the evolution of complex bilaterian animals. Bilaterians, which include insects, worms and vertebrates, have body plans built on bilateral symmetry, with sensory organs at the anterior and centralized nervous systems. However, *Nematostella* is also capable of extensive regeneration, and the 2007 publication of its genome opened the door for the anemone to inform our understanding of animal evolution and regeneration.

Michael Layden, Ph.D.

"Some people describe sea anemones as these primitive animals," says Michael Layden. "But you can use them to ask modern questions."

Layden, an associate professor of biological sciences, uses *Nematostella* to try to answer questions related to nervous system evolution and to understand how neuronal regeneration differs from development, which has implications in how researchers think about regenerative therapy design.

"When I started [my career] … there were lots of good regeneration models," he says. "Hydras had been around for almost 300 years, and planarians are these little crazy worms that you can cut into 211 pieces and get 211 worms. But the problem with those systems is that you cannot really get embryos, so you cannot study development effectively. The animals are incredible for learning about regeneration, but you cannot ask the specific question of how similar and dissimilar regeneration and development are. So that's what attracted me to *Nematostella*."

Layden began his career studying nervous system development in *Drosophila*—the fruit fly, which he calls "the poster child for genetics"—at the University of Oregon. There, he encountered researchers interested in linking evolution and development—and discovered *Nematostella*, an organism more genetically similar to humans than *Drosophila*.

"I saw a talk on *Nematostella*, two in a row, actually, that came out of the lab that I ended up doing my postdoc in [at the University of Hawaii at Manoa]," he says. "What I realized was, first of all, this is a weird animal, but they're doing cutting-edge research on it. They are taking advantage of the new era in genomics and are able to ask pretty sophisticated questions. At that time, if it wasn't a mouse, a fly, a zebrafish or a frog, you couldn't do anything in it. But they were doing it in this sea anemone—they were knocking down genes and trying to look at function. And it just kind of hit me that I could still work on the nervous system, I could look at evolution and I could study regeneration, all in this one system."

Layden, who first glimpsed research in action when he was a laboratory dishwasher as an undergraduate at the University of Rochester, has never looked back. He now helms the Layden Lab, which studies neural development in the starlet sea anemone.

"Even to this day, I'm still excited to come to work and see what we're going to learn," he says.

Two Big Questions

Layden and his team aim to answer two questions: First, how was the ancestral nervous system that gave rise to the human brain patterned? And second, how can an organism remake neurons and rewire the nervous system during regeneration?

The answers to these questions may help in developing a better understanding of neurogenesis—the formation of neurons in the brain—and potentially aid in improved treatments of central nervous system disorders.

To answer the first question, Layden and his team are trying to determine how different neurons first were made: "How did cells go from naive to neural? And then how do all the different types of neurons that an organism needs to sense its environment and determine the appropriate response get patterned?"

The mechanisms that patterned the ancestral nervous system can help researchers understand whether complex brains evolved once or multiple times, which has significant implications about our understanding of animal evolution, he explains.

"What we think is that by understanding how *Nematostella* patterns its nervous system [and how its relatives pattern theirs] … we can build a theoretical model of what the ancestral system looks like," Layden explains. "That allows us to understand what might have occurred during nervous system evolution. What we're seeing is that patterning we thought was specific to c omplex brains is actually patterning *Nematostella*, too."

Complex brains, including the human brain, are patterned from the anterior to posterior axis using a gradient of a Wingless-Int (WNT) protein. That gradient then makes the specific domains

of the nervous system, which give rise to the forebrain, midbrain, hindbrain and spinal cord. That entire program is already present in *Nematostella*, says Layden.

"For basically 100 years or so, people have said that all brains look like they're patterned the same, so they evolved once. But really, of course they would look like they are patterned the same way, because they are just co-opting something that was already there. It wasn't specific to the brain. So that means that that information cannot be used to say that brains only evolved once.

"We're hoping that by looking at *Nematostella*, we can start to get a better sense of what we can look at in brain development that would be informative to tell us if evolution happened once or multiple times, and potentially how many times. … It's really simple at its core, but it took time for the technology of science to get to the point where people could think about it this way. We are part of that group of newer biologists trying to look at these older questions with new technology," he explains.

Development & Regeneration

The second question—How do you remake the nervous system through regeneration?—requires a focus on how the neurons in a regenerated animal were made relative to the mechanisms that made those same neurons during embryonic development. Layden and his team use *Nematostella* to compare the processes of development and regeneration. "It's becoming more apparent that during regeneration, the nervous system—or probably all tissues—is actually not being built with the exact same programs used to construct them during development," Layden says. "It kind of makes sense because the way that animals are patterned is sort of context-specific, and regeneration is different from development. In hindsight it's obvious, but this is a question that researchers struggled with for a long time."

This difference makes a comparison between development and regeneration even more necessary. "We need to know that difference because if you're trying to use regenerative therapies for biomedical intervention and you just force animals down this developmental pathway, it's sort of doomed to fail," Layden explains. "And so, we are now rethinking our approach to regeneration research and regenerative medicine."

During development and regeneration, each neuron undergoes a process that determines its job. This process requires turning parts of the organism's genome on and off in specific ways, which is defined as a gene regulatory network, says Layden. Layden and his team build gene regulatory networks to determine the order that the genes in the *Nematostella* genome are turned on during development and regeneration of different types of neurons. They then compare the two processes.

The team has identified 20 neural genes—known as transcription factors—that act right after a cell switches from naive to neural to start each neuron down its own path during development. They then work to put these genes in order by reducing or taking away the function of one of them and observing what happens to the remaining genes. "So if you take something away and five of the other genes are now all of a sudden at higher levels, then you know that the function of the one you took away was to block the activity of those other five. And, conversely, if you take it away and you see these other 10 genes all are no longer expressed, then you know that the job of the particular gene you took away is to turn those other 10 genes on. Using that logic, we build a preliminary gene regulatory network describing the order in which the genes function," says Layden.

Next, using biochemistry, molecular biology and genomics, the team tries to refine the regulatory networks that govern neuronal patterning.

Nematostella vectensis, the startlet sea anemone, helps Layden understand animal evolution and regeneration

Regeneration is more challenging to examine than development, says Layden.

"It's not like you have a separate subset of your genome that functions during regeneration and during development. They both are acting in both processes, but they are used in different ways. So if you get rid of a gene, development never happens and you can't study regeneration. Thus, to study regeneration, we need to design approaches that allow us to control whether a gene is disrupted during development or regeneration.

"The first thing we are doing is just making a map of where all our developmental genes are during regeneration. When we do that, we see some very simple patterns. Sometimes, where the gene is turned on during regeneration is different from where it's turned on during development. We know that it can't be functioning exactly the same, just based on that simple observation. We don't know how it's different yet, but we know that it's not the same.

"Other times it appears, based on the expression pattern, that a particular gene probably does something similar in both processes. So we are building that information first, and simultaneously trying to come up with new technologies to take away gene activity during regeneration. To do that, we are adapting tricks that have been used in traditional model systems," he explains.

The complete answers to these big questions, Layden says, will be found beyond *Nematostella*.

"The answer isn't going to come from only using *Nematostella*. Development and regeneration should be compared in multiple species to identify the patterns in how these processes differ across the tree of life," he says. "When we look broadly enough, patterns always emerge that shape our understanding of all biology and advance our ability to positively impact human health."

Layden received a National Institutes of Health (NIH) R03 in 2016, an R01 award in 2019 and a National Science Foundation (NSF) CAREER Award in 2020 to support this work.

Alumni Updates

Visit our website:
www.lehigh.edu/~inbios

Jon Green (1970, B.A. Biology) I graduated from New Jersey Medical School (now Rutgers) in 1974 and after residency in internal medicine and fellowship in gastroenterology at NJMS began a private practice in gastroenterology spanning 42 years.

George Hoskin (1972, Ph.D. Biology) Now retired in Maryland after serving as Director, Science and Applied Technology, Office of Seafood, FDA (and other previous careers; Lafayette College; Downstate Medical Center)

Alan Harrison (1989, M.S. Biology) - Just hit two years as the College Administrative Officer for the College of Design at the Georgia Institute of Technology.

Cailin Pachter (1990, B.A. Biology) - Currently the Director of Health Professions Advising at Muhlenberg College. Received MA in Counseling from Eastern Kentucky University in 1993.

Tanya (Butensky) Smarglassi (1992, B.A. Behavioral Neuroscience) graduated from Temple University School of Podiatric Medicine in 1997.

Kristin (Gunzel) Reph (1992, B.S. Biochemistry) "After doing some graduate work in biochemistry and working in research for many great companies like Roche, Chesapeake Biological, and Dupont, I got my certification and then my MS in Professional and Secondary Education to teach high school chemistry. "

Karen Flam (1992, B.A. Pre-Dental Sciences) – working as a technology leader in Southeastern PA.

Jeremy Gill (2001, B.S. Behavioral Neuroscience) Graduate from UMD Medical School in 2005. Residency/Fellowship at UMass in Neurology until 2010.

Paramjeet Randhawa (2001, B.S. Molecular Biology) PhD, Biology - University of North Carolina - "After obtaining my PhD, I worked at Impact Pharmaceutical Services as a medical writer. I started their first Medical Writing Fellowship Program, among other initiatives, and worked as a Senior Manager. As of Sep 2019, I now work as the Director of Clinical Studies at Sapere Bio, a diagnostics start-up. "

Andrea Adimando (2003, B.A. Behavioral Neuroscience) received her RN and MSN in psychiatric nursing from Yale in 2006. "While practicing as a psychiatric nurse practitioner I went back to school to earn an MS in human nutrition from UB as well as a Doctor of Nursing Practice degree from Chatham University in 2014. I have been teaching full time in the nursing program at SCSU and recently received tenure and promotion to associate professor."

Sean Keck (2003, B.S. Molecular Biology) continued learning after Lehigh, while working, at the University of Medicine and Dentistry of NJ - Masters in Biomedical Science, with a concentration in Pharmacological Sciences. I have been at Novartis Pharmaceuticals since I graduated in 2003.

Kristen (Merlo) Buttrick (2009, B.A. Biology) is working as clinical dietitian in ICU in Massachusetts ... lots of nutrition support challenges with covid

Natalie Krane (2010, B.S. Behavioral Neuroscience) "I'm an Otolaryngologist - Head & Neck Surgeon and finished fellowship training in Facial Plastic and Reconstructive Surgery summer of 2021 with plans to head back west to be an Assistant Professor at Oregon Health & Science University in Portland, OR. "

Rebecca Graziano (2011, B.S. Biochemistry) Graduated from Rutgers-RWJ Medical School and is at NYU for residency in pathology.

Souma Rudra (2013, Ph.D. Molecular Biology) Currently work as Senior Scientist, Analytical lead, Gene and Cell Therapy, Johnson and Johnson Pharmaceuticals

Monika Martin (2015, B.A. Biology) Working as the marketing manager for Neurosurgery at Aesculap, a medical device manufacturer.

Michelle Juarez (2016, B.S. Behavioral Neuroscience) Graduated with an MD from the Johns Hopkins School of Medicine in 2020, completed an intern year in internal medicine at the University of Maryland, and is now completing her residency in dermatology at NYU.

Suraj Pursnani (2017, B.S. Molecular Biology) -Completed MD at Montefiore Albert Einstein College of Medicine and now in residency in Urologic Surgery at Penn State Milton Hershey Medical Center

Garrett Santini (2018, B.S. Behavioral Neuroscience) "I took a year out of medical school to do a Master's degree in Translational Research (MTR) in a cardiology-focused lab that studies the 3D structure of the genome. My project is focused on Lamin B mutations that result in inherited dilated cardiomyopathy."

Aizelmarie Magsino (2019, B.A. Biology) is a data analyst at Cigna.

Dixie Miller (2019, B.A. Biology) is a medical student at Penn State College of Medicine at Hershey Medical Center.

Not a stellar academic record as a Biology major, I so enjoyed my professors in the department. Dr Trembly, Malsberger, and of course Dr Owen were inspirational thru out my years at Lehigh. My dream of pursuing a career in Medicine never wavered. I went on to graduate school at Seton Hall University and completed courses in Immunology with excellent grades. No luck getting into an American medical school on a second go around. The opportunity to attend a foreign medical school arose and I headed off to Guadalajara Mexico to the Universidad Autonoma de Guadalajara where I spent the first two years of medical school. I was accepted to the Rutgers Medical School (formerly the New Jersey College of Medicine) where I graduated from in 1972. I went on to specialize in Emergency Medicine and practiced at various hospitals in the Chicago and for the next 30 years. My wife and I returned to our roots and moved back to the East coast where we both grew up. We settled in Westchester County in 2008 and I changed my practice to Urgent Care medicine. When Covid arrived I dropped out of the front lines because of health issues. I transitioned into Telemedicine which has flourished during the pandemic. Thank you for listening to a 76 year old alumnus. **Steven Ross (1967, B.A. Biology)**