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LEHIGH UNIVERSITY

Biological Sciences

Greetings!

It seems as if only yesterday I was writing greetings to all of you in last year's newsletter. Yet, another year has passed with comings and goings of faculty and students, with exciting new scientific discoveries and interesting new plans for the next research project. At Lehigh, we have now witnessed the hiring of a Dean for the new College of Health. Dr. Whitney Witt who has experience in industry and academia is already on campus, and you can read about her on Lehigh's website.

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

On South Mountain, three new faculty joined Biological Sciences this year - read about David Zappulla, Santiago Herrera and Ann Fink. They have already integrated into the life of the department. It is the time of year that we are meeting first year students who will major in Biological Sciences, preparing posters for the end of the year undergraduate symposium and learning about which graduating seniors will move on to graduate school, medical school, jobs, and other exciting future endeavors. Our graduate students are looking forward to full time lab work over the summer.

Our newsletter has a great story about research in the lab of one of our assistant professors, Daniel Babcock. Read about other faculty news, student successes and alum updates including a story about three alums from 2010 who are now MDs. We hope you find items of interest through the pages.

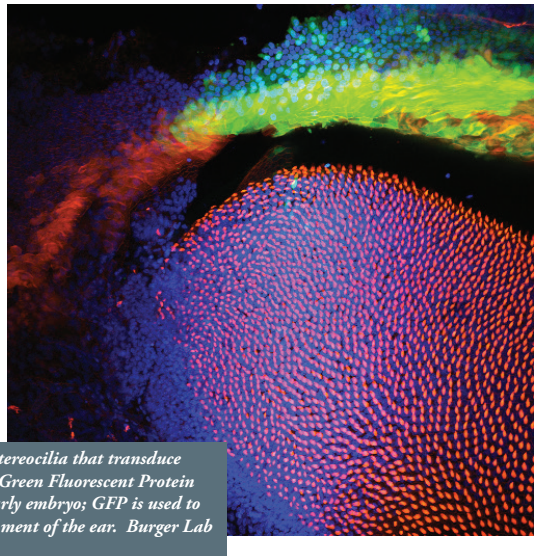
Not enough? Look for more news on our website.

Please send us your updates, stop by and visit, come to the annual poster session, and do stay in touch. We are always interested in hearing your news.

Linda Lowe-Krentz, PhD
Professor and Chair

2018 - the department at a glance ...

- 25 faculty members
- 13 post-doctoral / research scientists
- 7 technical and 3 administrative staff
- 41 Ph.D.-level graduate students
- 25 Master's-level graduate students
- 274 Undergraduate majors:
  - 142 Biology
  - 36 Biochemistry
  - 28 Molecular Biology
  - 68 Behavioral Neuroscience



The low frequency region of the inner ear. Red labels actin in the stereocilia that transduce sound into neural activity. Blue labels the cell nuclei, and green is Green Fluorescent Protein (GFP) which is expressed after GFP DNA is introduced into the early embryo; GFP is used to report the expression of genes that are manipulated during development of the ear. Burger Lab

• Daniel Babcock • Michael Behe • R. Michael Burger • Lynne Cassimeris • David Cundall • Matthias Falk • Ann Fink • Julie Haas • Santiago Herrera •
• Katie Hoffman • Wonpil Im • M. Kathryn Iovine • Murray Itzkowitz • Michael Kuchka • Gregory Lang • Michael Layden • Linda Lowe-Krentz, Chair •
• Julie Miwa • Amber Rice • Jill Schneider • Neal Simon • Robert Skibbens • Jennifer Swann • Vassie Ware • David Zappulla •

Welcome to new faculty!

The department welcomed three new faculty members in the fall of 2018

Ann Fink, Ph.D. was appointed as a Professor of Practice. She earned her bachelors degree in Psychology and her doctorate in neuroscience from UCLA. Prior to her arrival at Lehigh, Dr. Fink was a visiting assistant professor at the University of Wisconsin, Madison, specializing in feminist biology. She also served in postdoctoral research positions at New York University in the Center for Neural Science, and at the Institut Pasteur in Paris France.

In the classroom, Dr. Fink will be teaching introductory, non-majors and writing-intensive biology courses, as well as our Core III: Integrative Biology class – both lab and lecture.

Fink's research expertise is in the biological basis of memory, emotion and mental health, and includes techniques such as electrophysiology, animal behavior, confocal and two-photon microscopy, and meta-analysis. Her current research explores how basic biological models of PTSD are translated from the laboratory to human populations and includes an ethical analysis of variations in mental health by social identity.

Santiago Herrera, Ph.D. was appointed as a Professor of Practice. He earned his bachelors (Biology and Microbiology) and masters (Biological Sciences) degrees from the Universidad de los Andes, in Bogotá, Colombia. He then went on to earn his doctorate in Biological Oceanography from the Massachusetts Institute of Technology. Prior to his appointment as a professor of practice, Dr. Herrera was a visiting assistant professor at Lehigh and a postdoctoral fellow at the University of Toronto.

Dr. Herrera will be teaching Oceanography, Epigenetics, as well as a first year seminar, "Biodiversity in a Changing Planet."

Herrera's research focuses on the molecular aspects of ecological and organismal dynamics and evolution. His research has been funded by the National Oceanic and Atmospheric Administration (NOAA).

David Zappulla, Ph.D. was appointed as an assistant professor. Prior to his appointment at Lehigh, Dr. Zappulla was an assistant professor in the Departments of Biology and Molecular Biology & Genetics at Johns Hopkins University. He earned his bachelor's degree in Biology from Middlebury College, his Ph.D. in Molecular and Cellular Biology from Stony Brook University, and then he was a postdoc at the Howard Hughes Medical Institute at the Univ. of Colorado in Boulder.

Dr. Zappulla is teaching a variety of courses in the molecular biology curriculum.

The Zappulla Lab is investigating the molecules and mechanisms that maintain chromosomes in order to control cell viability and proliferation. They study the enzyme telomerase — which consists of RNA and protein components and is centrally important to human cancer and aging — and how it maintains telomeres to prevent the erosion of chromosome ends during the course of cell divisions.

Board of trustees promote two faculty members in department

Haas promoted to associate professor with tenure

Julie Haas came to Lehigh after serving as a research associate at the Center for Brain Science at Harvard University. Dr. Haas earned her doctorate in Biomedical Engineering at Boston University and her undergraduate degree in music and mathematics at Indiana University.

Dr. Haas has taught a number of neuroscience courses at Lehigh, including "Synapses, Plasticity & Learning," "Neurophysiology Laboratory," and "Central Nervous Systems." Her service to the university includes being a member of the search committee for the dean of the College of Arts and Sciences, the Health Professions Advisory Committee, and the Dean's Council on Research, Scholarship, and Creative Work.

Dr. Haas's research focuses on electrical synapses. The Haas Lab investigates how electrical synapses change in strength in response to activity in the neurons they couple, and they work to identify the molecular machinery involved in electrical synapse plasticity. In addition, they use computational models to explore how electrical synapses, and changes in their strength, contribute to information processing in neuronal circuits of the thalamus.

Dr. Haas's research has been funded by the National Science Foundation, Brain & Behavior Research Foundation, and the Whitehall Foundation.

Burger promoted to full professor

R. Michael Burger came to Lehigh after serving as a senior postdoctoral fellow at the University of Washington, and Alexander von Humboldt Foundation Fellow at the University of Munich. Dr. Burger earned his doctorate at the University of Texas at Austin and his undergraduate degree at Ithaca College.

Dr. Burger has taught a variety neuroscience courses, both at the undergraduate and graduate levels. These include "Behavioral Neuroscience," "Neuro. Of Sensory Systems," "Experimental Neuroscience Lab," "Advanced Neuro. Sensory Systems," "Advanced Auditory Phsyiology," and "CNS and Behavior." Active in varied aspects of service to the university, Dr. Burger is currently a member of the Faculty Compensation Committee, serving as its chair.

Dr. Burger is interested in how the brain processes information about its sensory environment. His research centers on the question of how cellular, synaptic, and systems level properties are integrated to allow sensory neurons to extract and represent features of the acoustic environment. The lab's specific interest has been the contributions made by inhibition in neural circuits that compute the location of sound stimuli.

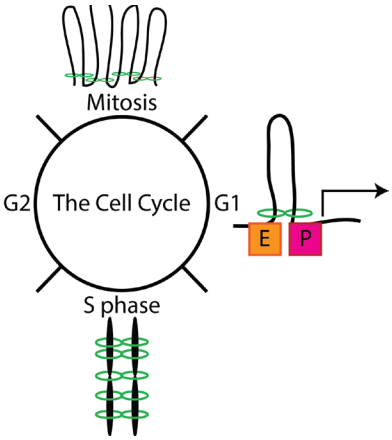
The research in the Burger Lab is been funded by the National Institutes for Health.

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

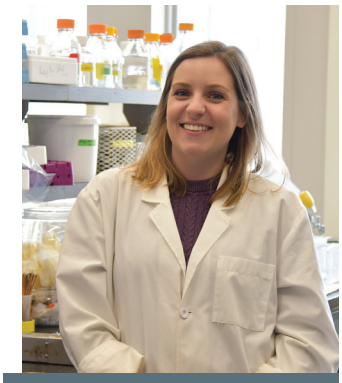
Graduate Student Spotlight

Caitlin Zuilkoski is a Ph.D. Candidate in the Cell & Molecular Concentration

Caitlin came to Lehigh University after earning a Bachelor of Science in Biochemistry, Cell and Molecular Biology at the University of Scranton. During her undergraduate career, Caitlin performed research in the laboratory of Dr. Kathleen Dwyer where she characterized protein expression patterns of receptor-like kinases in the plant Arabidopsis thaliana. In the fall of 2014, Caitlin entered Lehigh's doctoral program and joined the lab of Dr. Robert Skibbens.



Within a cell cycle, different DNA tethering reactions are required. In G1, cis tethering brings an enhancer element (E) in close proximity to a gene promoter (P) in order to stimulate gene expression. During S phase, trans tethering ensures the two identical DNA copies are held together. In Mitosis, the DNA condenses through cis tethering so that the DNA is properly inherited during cell division.



Ph.D. Candidate, Caitlin Zuilkoski

The Skibbens lab studies the mechanisms through which different DNA architectures are promoted and maintained. DNA is comprised of nucleotide sequences and contains the genetic code that is passed down from parent to offspring. Beyond the nucleotide sequence, DNA adopts various structures that regulate cell functions. As one example, a single DNA can become looped to bring together two distant DNA sequences to promote gene expression (defining cell identity) and DNA compaction (ensuring high fidelity segregation of DNA during cell division) (figure). Looping of a single DNA molecule is referred to as cis tethering since opposing sequences at the base of the DNA loop become bound together. Alternatively, two independent DNA molecules can become tethered together through trans tethering. Trans tethering of replicated DNA molecules ensures proper chromosome segregation during cell division (figure), which is a fundamental aspect of heredity. Defects in these tethering activities lead to loss (and gain) of DNA, a hallmark of cancer cells, and severe birth defects that include Cornelia de Lange syndrome and Roberts syndrome.

In the Skibbens lab, Caitlin studies the protein complex, termed cohesin, that forms the tether in both cis and trans DNA conformations. Little is known regarding how cohesins promote and differentiate between the two forms of tethering, but what is known is that cohesin must become activated to function in these processes. Eco1 in yeast (Esco2 and Esco1 in humans) activates cohesin, a process that appears coordinated with the process of DNA duplication. Caitlin's thesis research investigates the connection between these two processes; specifically the mechanisms through which DNA replication proteins promote Eco1-dependent DNA tetherings.

Caitlin was on the administrative board for the Biological Organization of Graduate Students (BOGS) for two years. During her time in BOGS, she helped plan and volunteer at outreach events, such as "The Biology Fair" at Broughal Middle School. Caitlin enjoys attending local events in the Bethlehem area, such as comedy events at SteelStacks, and visiting local restaurants with fellow graduate students.

Introducing this year's 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. Michael Epstein was featured in the 2011 edition of the department newsletter ("The Law of Nature, pages 4-5). He and his wife, Lisa, have three children: Jesse, Emily and Eric.

We are proud to introduce the newest recipients of the Epstein Family Endowment for undergraduate research. All of this year's recipients are members of the department's honors class and will be receiving their degree at the May 2019 commencement.

2018-2019 Epstein Scholars
(l-r): Brandon Fricker, Alecia Rokes, Layna Mager

- **Brandon Fricker** (Behavioral Neuroscience) - Brandon is an undergraduate researcher in the lab of Professor Julie Haas. His research proposal is "Long-Term Potentiation of Electrical Synapses."
- **Alecia Rokes** (Biology) - Alecia's research is supervised by Professor Greg Lang. Her research proposal is "Using the Killer Virus in Yeast to Study Intracellular Competition among Viral Particles."
- **Layna Mager** (Biology) – Layna is an undergraduate researcher in the lab of Professor Kathy Iovine. Her research proposal is "Understanding localization of joint forming cells and analyzing genes implicated in the joint formation pathway in zebrafish."

Fricker, Mager and Rokes received funding for materials and supplies to complete their research. They will present their research at the department's annual undergraduate research symposium on April 25, 2019.

Success multiplied by three

Every once in a while a professor takes an extraordinary student under her wing. It might be a student with an exuberant personality, or one with an insatiable thirst for knowledge – or one who exhibits both – that will bring a smile to a professor's face years later. It is rare, however, that a professor is rewarded with three such stand-out students in her lab – all at the same time!

Since 1986, Professor Linda Lowe-Krentz has mentored over 150 undergraduate students – and, for the most part, she is able to remember them all! But three students from the Class of 2010 just happened to join the Lowe-Krentz lab at the same time. They all had that incredible energy and enthusiasm for learning, yet would bring a smile to your face when witnessing their fun-loving personalities.

Natalie Krane – Walter Joseph – Amanda Dilger

Amanda, Walter and Natalie each earned their bachelor of science degree in behavioral neuroscience in 2010 and went their separate ways. But that is not where the story ends! Amanda immediately began her studies at Harvard Medical School, and Walter journeyed to Rutgers to study at the Robert Wood Johnson Medical School. Natalie decided to take a gap year and then began her studies at Drexel University College of Medicine.

Their individual stories are different, yet remarkably similar.

In addition to the common denominator of working in the same lab, you will see that their successes were made possible because of one of the many dedicated professors who always wants her students to succeed.

Walter Joseph, Linda Lowe-Krentz, Amanda Dilger and Natalie Krane - May 2010

Natalie Krane

was recruited to play soccer for the Lehigh Women's soccer team and knew Lehigh was a great fit in terms of Division I athletics and academic opportunities, especially when considering a pre-medical sciences track.

"Dr. Lowe-Krentz was my freshman year advisor. I really gravitated towards her teaching style, support, and availability. I then begged her to continue being my advisor even though I was technically supposed to switch after freshman year. I'm sure she later thought, 'What did I get myself into?'. But, for the four years she was my advisor, she was also my mentor, and I looked to her for advice in all aspects –medical school, managing life as a student-athlete, and eventually, research and career choices. I knew I wanted to be a part of a lab at Lehigh and felt it only natural to continue working with Dr. Lowe-Krentz in her lab with its great lab personnel, principles I could understand and clinical applicability. She quite literally could not get rid of me."

Natalie Krane, M.D. , Class of 2010

Natalie studied and wrote her honors thesis on the effects of heparin on p38 MPAK in vascular smooth muscle cells. "Bench research gave me a real-life application of the biochemical principles I was learning about in class which had clinical implications. It also introduced me to the collaborative nature both within the lab and within the biological sciences department. I felt extremely well-supported and the relationships I had with the instructors both gave me extra motivation to excel in my courses and helped me get into medical school through letters of recommendation."

Working towards acceptance into medical school was always something Natalie knew she wanted to do. Becoming a doctor was always her goal. When asked if her undergraduate research experience in the Lowe-Krentz lab helped with her medical school studies, Natalie emphatically replied, "Of course, it did! Dr. Lowe-Krentz was my de facto mentor, and it was the combination of having her as my advisor both in and outside of the lab that augmented by medical school application and supplied me with the knowledge base to continue to find success while in medical school and beyond."

Natalie believes that it was a benefit to take time off prior to entering medical school. "This is a great time to travel, work and gain professional skills before cramming the books for years onward. I worked for Genentech, a biotechnology company in the Bay Area (a job I got because of the Lehigh alumni network!). I interned there first between the summer of my junior and senior year and then took a position after college with the intent of going to medical school. I was an associate within the Commercial Regulatory Department and reviewed promotional materials for drug promotion to ensure alignment with FDA regulations. I continued to work within pharma while in medical school at Shire Pharmaceuticals. What I learned while in industry was invaluable and it gives me an advantage while navigating the medical profession. "

Dr. Krane is currently a fourth year resident in Otolaryngology Head & Neck Surgery at Oregon Health & Science University. "Head and neck anatomy is intricate and fascinating to learn about and the pathology encountered within it is extensive. The surgeries are amazing and vary widely in anatomical location and pathology: ear surgery, sinus surgery, facial plastic surgery, laryngology (voice box surgery), pediatric surgery, head and neck cancer surgery and more. There is so much to do just within one specialty."

Planning for her future, Natalie is looking to do a fellowship in facial plastic and reconstructive surgery. This includes facial trauma, facial reconstruction in the setting of cancer (e.g. skin cancer reconstruction), cosmetic/aesthetic facial surgery, facial nerve reanimation, congenital malformations (including cleft palate, cleft lip, and microtia repair), microvascular surgery ("free flap" surgery) and rhinoplasty (both cosmetic and functional).

What advice would you give to a current Lehigh student who intends on attending medical school?

Find things you are passionate about that give you joy – those are the things that will make you a well-rounded, balanced applicant. Try to spread ideas and be involved in your community. **- Natalie Krane, M.D.**

Walter Joseph

had a high school teacher who one day made college predictions for everyone in the class. When it was his turn she said, "Walter, I could see you going to Lehigh University." Walter didn't know much about Lehigh at that point, but after doing some research, visiting the campus, and weighing all his options, he decided that Lehigh was the perfect combination of strong academics, prestige, beautiful campus, and an active social life.

When asked about his favorite class in biological sciences, Walter said it was a toss up. "Dr. Lowe-Krentz's Honors Seminar was my first real gateway into critically reviewing scientific literature and has been integral in my development as a physician scientist. Dr. Lowe-Krentz didn't treat us like college students; she treated us as her peers and pushed us to be better and better each time we all met."

"Dr. Burger's course was one of the most challenging courses of my tenure at Lehigh, but it was absolutely one of my favorites. I was enthralled with the complex neural pathways we studied and their clinical applications. This course made me realize that I was on the right path toward medicine."

Walter Joseph, M.D., Class of 2010

Pathogenesis of atherosclerosis was the focus of his research. Walter, too, was drawn to the Lowe-Krentz lab because of the clinical relevance of her work and her impressive scientific productivity. "Once I expressed interest in doing work in her lab, Dr. Lowe-Krentz took the time out of her busy schedule to meet with me. I was greeted by a warm, caring woman who was incredibly invested in my goals and my success. I knew immediately that Dr. Lowe-Krentz would be an invaluable mentor."

Even though no one in his family was even remotely connected to the medical field, Walter had an interest in medicine since high school. While at Lehigh, Walter shadowed physicians and, during the winter break of his junior year, had the opportunity to travel abroad to Nairobi, Kenya, where he volunteered at a medical clinic for three weeks and even helped deliver his first baby. "At that point, I knew there wasn't another option besides medical school," Walter noted.

He also noted that doing basic science at the bench instilled in him an early sense of maturity and an ownership over his own work. "In college, it's easy to just get caught up in the books and the papers, the studying, and even the social life. But things like culturing your own cell lines and executing your own experiments — even if it meant coming into the lab on the weekends! — not only allows you to grow as a scientific thinker, but it allows you to be passionate about something that's bigger than you."

While a student at RWJ Medical School, Walter took an extra year to pursue basic science research in Plastic Surgery at Memorial Sloan-Kettering Cancer Center in New York City. He was able to publish several scientific manuscripts, which he believes he couldn't have done without the strong research background that the Lowe-Krentz lab afforded him.

After graduating from Rutgers, Walter moved to the University of Pittsburgh and is doing his residency in plastic surgery. "I chose plastic surgery because it combines a deep understanding of the human anatomy with precise manipulation of nearly all types of tissue to deliver the ultimate service of improving the quality of life of the patient. While most surgical fields are based on cutting away or 'removing' parts of the body, plastic surgery rebuilds what was no longer there, remolds what was once deformed, and reshapes to beautify. There is nothing better!" Dr. Joseph is considering a fellowship in reconstructive microsurgery when he has completed his residency.

What advice would you give to a current Lehigh student who intends on attending medical school?

Create your own opportunities to make your dreams come true. Find amazing mentors, stay focused, and keep pushing. But most of all, make sure you love what you're doing while you're doing it. **- Walter Joseph, M.D.**

Amanda Dilger

didn't know a lot about Lehigh but did hear that it was a great school and thought the campus was really nice when she came for a tour. "I'm so glad I ended up there, though – the biological sciences department is amazing and I felt that I got a really unique and comprehensive educational experience."

Accepted to Lehigh into the Eckardt Scholars program, Amanda was in the audience when a senior was presenting their research on signal pathways in atherosclerosis. That's when she decided to pursue a similar project in the Lowe-Krentz Lab since she liked the clinical implications of the project and knowing that she was planning on a career in medicine.

Amanda spent the next few years studying the effects of heparin on JNK signal transduction pathways in vascular smooth muscle cells and the implications of these effects on the treatment of atherosclerosis. "Performing bench research was a good way to learn about biochemistry and signal pathways from a different perspective."

Amanda Dilger, M.D., Class of 2010

When asked about her favorite class in the department, Amanda noted that it is hard to choose. "Obviously Dr. Lowe-Krentz was an incredible teacher and research mentor. I also really enjoyed Dr. Burger's class on neural pathways in the auditory system – it's what first got me interested in otolaryngology as a specialty." While at Lehigh, Amanda was a volunteer EMT and had the opportunity to shadow doctors at St. Luke's Hospital. "I discovered how much I valued the patient-doctor relationship and the opportunity to help others."

Being active in an undergraduate research experience helped Dilger learn about how much time and effort goes into bench research. "It helped me make educated choices about which research projects to get involved with as a medical student and resident."

After earning her bachelor's degree from Lehigh, Amanda spent the next four years at Harvard Medical School and then moved to Northwestern University to begin her residency in Otolaryngology – Head and Neck Surgery. She will be graduating in June and will be moving to Los Angeles for a private practice fellowship in facial plastics and reconstructive surgery.

"I've always loved aesthetics and I think it's amazing how much of an impact someone's appearance can have on their self-confidence, the way one carries oneself and their overall quality of life. I broke my jaw when I was younger and had to have several reconstructive surgeries; the results truly changed my life and made me so much more comfortable with myself. I wanted to be able to give my patients that same experience of becoming the best version of themselves and gaining confidence."

What advice would you give to a current Lehigh student who intends on attending medical school?

While it is important to get involved in research and medicine-related activities, it's an absolute must that you continue doing the things you love outside of medicine. **- Amanda Dilger, M.D.**

Unpacking the secrets of neurodegenerative diseases

Mary Ellen Alu
University Communications

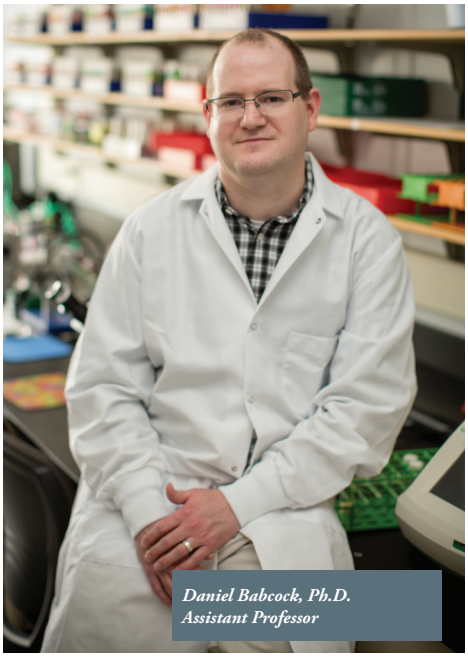
Babcock is using fruit fly research to pave the way to treatments for Parkinson's and other diseases.

Vials of fruit flies line the shelves of neuroscientist Daniel Babcock's lab on the second floor of Iacocca Hall. Here, where fruit flies number into the tens of thousands, if not millions, Babcock and his students are creating models of neurodegenerative diseases such as Alzheimer's and Parkinson's in the flies to unpick the diseases' secrets and potentially pave the way to treatments.

"One of the most common questions I get is, why would you look at fruit flies to study something as complex as neurodegenerative disease?" says Babcock, assistant professor of biological sciences.

But the tiny fruit flies—only a few millimeters long—remarkably share some 70 percent of the same genes as humans, which puts them in what Babcock considers a "sweet spot" of model organisms.

"They are simple enough, where we can study thousands and thousands and thousands of fly brains," he says. "But they are complex enough, where there is enough similarity between fly biology and human biology that if we model these human diseases...hopefully, whatever we find in how these diseases work in the flies will then somehow be relevant to human health and disease."



Daniel Babcock, Ph.D.
Assistant Professor

For more than a century, the fruit fly—*Drosophila melanogaster*—has proven to be a tremendous resource in understanding many fundamental and important questions in human development. Six Nobel Prizes have been awarded for groundbreaking research using fruit flies, including the 2017 Nobel Prize in physiology or medicine that went to three scientists who used fruit flies in their discoveries about the molecular mechanisms controlling the body's circadian rhythm.

"Our brains have somewhere around 100 billion neurons, the flies have about 250,000," Babcock explains. "So that's much less than ours, but it's still a large group of neurons. Their neurons work the same way as ours do. They use the same chemicals to communicate with each other."

Babcock and his team are focusing their research on three major areas of inquiry: Why are certain populations of neurons vulnerable to a particular disease? How do accumulations of protein aggregates spread throughout the brain? What is happening at the synapses of neurons in different neurodegenerative diseases?

In trying to answer the first question, Babcock and his team are focusing on why dopamine-producing neurons selectively die in patients with Parkinson's disease, a progressive disorder of the central nervous system that affects movement. He says another set of neurons tends to be "ground zero" for Alzheimer's, a progressive disorder that affects memory and other mental functions.

"So people who have a mutation that might render them vulnerable to Parkinson's disease tend to lose dopaminergic neurons," Babcock says. "But why are dopaminergic neurons the ones that are lost and not the ones that affect learning and memory, like it is with Alzheimer's disease? ... We don't have an answer for why that is."

When the scientists manipulate the dopaminergic neurons in the flies' brains or examine flies with mutations for PINK1 or Parkin—two genes closely linked to Parkinson's—they find that the flies exhibit similar motor problems to humans, such as difficulty walking and climbing, Babcock says. By dissecting the flies' brains and staining them with antibodies to make them "light up" in different colors, the scientists are able to analyze the flies' brains under a microscope.

"One of the nice things about flies is they have such a short life span," Babcock says. "They can live 60 to 70 days normally, but a 20- or 30-day-old fly is already pretty old," so scientists don't have to wait decades to be able to study the progression of a disease.

How Do Protein Aggregates Spread?

In another key area of research, Babcock and his team are looking at how protein aggregates spread throughout the brain.

Scientists have known for quite some time that neurodegenerative diseases are associated with aggregates forming in the affected neurons, he says. The protein alpha-synuclein can cause clumps known as Lewy bodies, the hallmark of Parkinson's, for example. The plaques and tangles of Alzheimer's that build up in the brain are accumulations of proteins called beta-amyloid and tau, respectively. Huntington's and amyotrophic lateral sclerosis (ALS) are also associated with aggregates.

"Different parts of the brain and different proteins are involved, and yet, time and time again, these different diseases all share this feature of aggregate accumulation," says Babcock. "We've thought for a while now that this clearly has some implication in disease progression."

About a decade or so ago, when people started looking more carefully at where the aggregates started to accumulate, he says, they found that the aggregates seemed to follow neuronal circuits throughout the brain. That meant aggregates seen in one set of neurons would next be seen in a part of the brain that the neurons connected to.

"People thought, 'Well, this seems to be a bit more than a coincidence. These aggregates are not just building up independently, they're spreading throughout the brain, so they can actually travel from one cell to another,'" he says, "And that's been a kind of scary prospect, that these aggregates can actually move and spread throughout the brain. We think that might be why, as these diseases progress, symptoms get worse and worse, because the pathology is literally spreading from one part of the brain to another."

While at the University of Wisconsin, Babcock and genetics professor Barry Ganetzky used fruit flies to demonstrate that protein aggregates accumulated at synaptic terminals and progressively spread through the brain. Their study was published in 2015 in the PNAS (Proceedings of the National Academy of Sciences).

At Lehigh, Babcock and his team are further investigating how those aggregates are getting out of those neurons, and also, just as importantly, how they're getting into other neurons. They are working on a model of Huntington's disease, but they are building flies in which they can investigate other disease models, such as Parkinson's, Alzheimer's and ALS. Do those aggregates spread the same way as the Huntington aggregates do?

"It's my favorite kind of experiment," Babcock says, "because no

matter what happens, it's interesting. If they all end up spreading the same way, then anything we find with our Huntington aggregates could now be applicable to all these other diseases as well. If they don't all spread the same way, that's interesting for its own reason. Ok, why do these aggregates behave this way and these do not?"

What Happens at the Synapses?

In a third area of inquiry, Babcock and his team are trying to understand what happens at the synapses of neurons in neurodegenerative diseases. That's important, he says, because of evidence that synaptic dysfunction and other problems at the distal ends of cells begin long before the neurons actually die.

"We think that losing neurons is actually a very late stage of the disease progression," Babcock says. "It's possible that by the time you're actually losing neurons, it might be too late to really fix anything."

With currently no cures for any of the major neurodegenerative diseases, Babcock is testing the hypothesis that what is taking place at the tips of the neurons is setting off a cascade of events that ultimately cause the neurons to die. "If we can understand what takes place much earlier, can we intervene at that point?" he asks. "Can we fix it and stop the neurons from dying?"

Important Research for an Aging Population

Babcock's work in fruit fly research began "almost on a whim" while choosing rotations as part of his graduate study. He had already done several rotations with different researchers to get a better feel for their work—"because it's a major commitment, spending five, six, seven years of your life" in a particular field. He decided on a final rotation with Michael Galko, of The University of Texas, MD Anderson Cancer Center, who used fruit flies to conduct pain research.

"And I absolutely fell in love with it, stuck with it, continued to do that," Babcock says. His post-doctoral work in fruit fly research into neurodegenerative diseases was at the University of Wisconsin. At Lehigh, his active research team includes graduate and undergraduate students and a post-doctoral fellow.

Hopefully, he says, the team will be able to find "something new" in how the proteins that are known to be involved with [neurodegenerative diseases] actually work, in trying to figure out a way to stop cell death, and specifically, how aggregates move from cell to cell throughout the brain, "which is fascinating and terrifying at the same time, that these toxic proteins can actually travel throughout the nervous system and spread throughout the brain," he says.

"If we could find a condition either using a genetic manipulation or some type of tool where we can figure out how that spreading is happening mechanistically and then find a way to stop it, could we potentially identify some potential therapeutic target or drug target?" he asks. That, he says, would allow researchers who design drugs to treat patients "to have something they could try and aim for, instead of just designing compounds in the dark."

Babcock notes that with people living longer, the potential of more and more people developing neurodegenerative diseases looms larger.

"This is not only a fascinating area of research," he says of his team's work, "but something where we can hopefully make a real difference that will matter to people."

Fruit Fly Dining

The skills of the members of the Babcock Lab extend to the "kitchen" as well. Because keeping massive amounts of overripe fruit in the lab would not be cost-effective, Babcock and his team whip up vats of special food to keep their fruit flies happy and healthy. They fill thousands of vials with the food, which solidifies and provides sustenance and a place for the flies to lay eggs.

Their recipe includes:

- Corn meal
- Corn syrup
- Soy flour
- Inactivated dry yeast
- Agar
- Propionic acid (an antifungal agent)

2018 Selected Research Publications

Bold = Faculty
Bold+Italics = Graduate Student
Italics = Undergraduate Student
*= Former Student

Cassimeris, L., Engiles, J. B. and Galantino-Homer, H. 2019. Detection of endoplasmic reticulum stress and the unfolded protein response in naturally-occurring endocrinopathic equine laminitis. BMC Veterinary Research. 15:24.

Cunningham, P.C., Waldeck, K., Ganetzky, B., **Babcock, D.T.** 2018. Neurodegeneration and locomotor dysfunction in Drosophila scarlet mutants. J. Cell Science. Sept. 17;131(18). pii: jcs216697. doi: 10.1242/jcs.216697.

Fink, A.E., LeDoux, J.E. (2018). Beta-adrenergic enhancement of neuronal excitability in the lateral amygdala is developmentally gated. Journal of Neurophysiology 119(5): 1658-1664.

Sigwart J.D., M.K. Wicksten, M. Jackson & **S. Herrera** (2018) Deep sea video technology tracks a monoplacophoran to the end of its trail (Mollusca, Tryblidia). Marine Biodiversity. Doi:10.1007/s12526-018-0860-2

Park, S. and **Im, W.** 2018 Quantitative Characterization of Cholesterol Partitioning between Binary Bilayers. J. Chem. Theory and Comput. 14 (6), pp 2829-2833. Doi: 10.102/acs.jctc.8b00140.

Draud, M. and **Itzkowitz, M.** 2018. Have the Algae-Grazing Fish in the Back Reefs of Jamaica and Grand Cayman Changed in Size? A View across 36 Years. Open Journal of Marine Science, 8:300-313. Doi:10.4236/ojms.2018.82016

Fisher, K.J., Buskirk, S.W., ***Vignogna, R.C.***, ***Marad, D.A.***, **Lang, G.I.** 2018. Adaptive genome duplication affects patterns of molecular evolution in Saccharomyces cerevisiae. PLoS Genet. 2018 May 25;14(5:31007396. doi:10.1371/journal.pgen.1007396. eCollection 2018 May.

McQuillan, M. A., Roth, T. C., ***Huynh, A. V.***, and **Rice, A. M.** 2018. Hybrid chickadees are deficient in learning and memory. Evolution 72: 1155-1164.

Chen, H., Xie, J., Churikov, D., Hass, E.P., Lemon, L.D., Luciano, P., Bertuch, A.A., **Zappulla, D.C.**, Geli, V., Wu, J. and Lei, M. 2018. Structural insights into yeast telomerase recruitment to telomeres. Cell. 172(1-2): 331-343.

Publications that include undergraduate students

***Kells-Andrews, R.M.**, *Margraf, R.A.*, **Fisher, C.G.**, **Falk, M.M.** 2018 Connexin-43 K63-polybiquitylation on lysines 264 and 303 regulates gap junction internalization. J. Cell Sci. 2018 Aug 9;131(15). pii: jcs204321. doi: 10.1242/jcs.204321.

Pham, T. and **Haas, J.** 2018. Electrical synapses between inhibitory neurons shape the responses of principal neurons to transient inputs in the thalamus: a modeling study. Nature. 8:7763. DOI:10.1038/s41598-018-25956-x

Bragué JC, Lenchur CN, Hayden JM, Davidson RH, Corrigan K, *Santini GT*, **Swann JM**. (2018) BDNF infusion into the MPN mag is sufficient to restore copulatory behavior in the castrated Syrian hamster. Horm Behav. pii: S0018-506X(18)30016-3. doi: 10.1016/j.yhbeh.2018.05.006.

***Mageeney, C.**, **Kearse, M.**, **Gershman, B.**, *Pritchard, C.*, *Colquhoun, J.*, **Ware, V**. 2018. Functional interplay between ribosomal protein paralogues in the eRpL22 family in *Drosophila melanogaster*. Fly. Doi: 10.1080/19336934.2018.1549419

Alumni Updates

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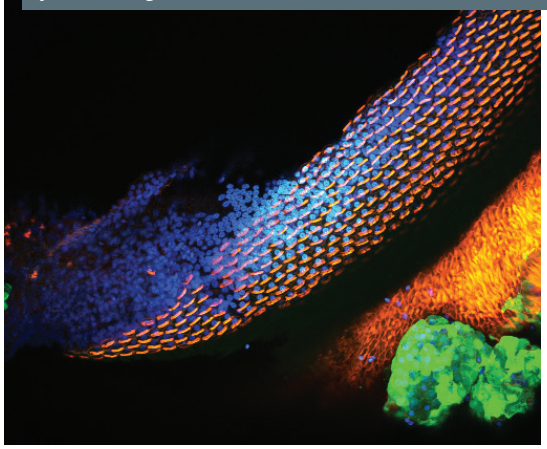
Marvin Segel '60 (M.S. Biology) "After teaching at a small college I took further graduate work at U. Cincinnati in gross anatomy. Left the academic world and spent my time selling custom high technology informational systems to hospitals in 50 states. At Lehigh I worked with Saul Barber in neurotransmission and just up the hall from an elaborate ear lab which visited I periodically, Dr. Burger would probably be there then now. I have never lost interest in neurotransmission perhaps because of the development of the digital world. All was analog at Lehigh. I also remember Dr. Trembly. I am 83 now and just reviewed an MRI of an ear for a friend who was worried about a tumor on the auditory nerve. Results seem to be negative. Read over what Dr, Burger is doing and wish I were just applying to Lehigh."

Hayden Pritchard '63 (Ph.D., Biology) retired in 1995 and lives in PenArgyl, PA. "I am enjoying my retirement from the biology department. I recently turned 85 years old, and I remain in reasonably good health. I remain in touch with Steve Krawiec and Dave Cundall. I believe that I am the oldest living member of the biology department faculty. I began as a graduate student at Lehigh in 1958 (after graduating from Princeton University in 1955 and then serving for two years in the US Army at the Walter Reed Army Inst. for Research). I was inducted into the Lehigh faculty biology department in 1964 and served the university until retirement in 1995. My wife, Kathleen, and I remain active in local activities."

Edward Feinberg '66 (B.A. Biology) is Professor and Emeritus Chair of Ophthalmology at Boston University School of Medicine. "I continue to be active in clinical care and medical education. Four years ago I was awarded at graduation the annual Clinical Educator of the Year Award, and last year I received at graduation the Leonard Tow Gold Humanism Award."

John Gilly '90 (Ph.D., Mol. Bio) was designated a National Distinguished Expert as part of the Thousand Foreign Talents Program by the Peoples Republic of China (May 2017). This is an award for a three year term made to experts selected to take a lead in urgent areas of science, technology and industrial development.

High frequency region of chicken inner ear. Red labels actin in the stereocilia that transduce sound into neural activity. Blue labels the cell nuclei, and green is Green Fluorescent Protein (GFP) which is expressed after GFP DNA is introduced into the early embryo; GFP is used to report the expression of genes that are manipulated during development of the ear. Burger Lab.



Amanda Fraser '99 (B.S. Biology) went on to get her Masters in Physician Assistant Studies from the Univ. of Nebraska Medical Center and through the military's Inter-service Physician Assistant program. "I graduated in 2007 and have been working as a physician assistant. I have deployed twice with the Army. I spent about a year in Iraq and one year in Egypt. I am currently working in the specialty of allergy, asthma and immunology."

Sharon Wright '03 (B.S. Mol. Bio.) is working as a general surgeon in Reno Nevada. "I love to read your updates and hope all is well on the hill!"

Brittany Yerkes '08 (B.S. Biology) has been working as a Physician Assistant specializing in Infectious Diseases in Maryland. "I provide direct services to patients infected with HIV, Hepatitis B and Hepatitis C. I also provide public health education in regards to the spread, prevention, and treatment of infectious diseases. My experiences in Dr. Sands' Virology course set me on this path early on and helped to cultivate my interest in viruses, most specifically HIV. I have found healthcare to be a fitting application of this knowledge to the real world, and I have dedicated my career to treating patients living with these conditions."

Theresa Collins '12 (B.S. BNS) received her M.S. in Physician Assistant Studies at Hofstra University in 2014 and has been working as a PA in Malignant Hematology since graduation. "Most recently, I have been employed at Memorial Sloan Kettering Cancer Center in New York as a Physician Assistant in inpatient adult bone marrow transplant since February 2017."

Anne Smolko '13 (B.S. Mol. Bio.) is currently a graduate student at Case Western University and hopes to complete her Ph.D. degree this year. "My graduate research has been with Dr. Helen Salz working on determining how sex identity in the Drosophila female germline is maintained through H3K9me3."

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