DROSOPHILA AND BRAIN DISORDERS

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A Message from the Department Head
Jim DiCarlo

One hundred years ago, the great Spanish pathologist and histologist Santiago Ramón y Cajal, often described as the father of neuroscience, published a collection of science fiction stories under the pseudonym “Dr. Bacteria.” In these stories, he explored the long-term implications of relatively new ideas such as germ theory, microscopy, and artificial insemination.

I was reminded of this odd fact by a comment made by Paul Newton, an MIT alumnus and key supporter of our department, in his interview for this issue of our newsletter. Paul explains that he chose to set up a fund to support BCS research in perpetuity because “A hundred years from now there will be much we don’t know.”

In discussing the work of our department, it is always tempting to focus on the newest technologies and the breakthroughs we believe to be right around the corner. Paul’s comment is a good reminder that great science often feels slow day to day, but exhilarating over years and decades, and the impact of our work will be felt across centuries, mostly in ways we cannot predict today. Many of us chose this field precisely because it contains so many open questions that will require lifetimes of work, with breakthroughs along the way that spur us along.

Viewed at this scale, the educational and research goals of our department become indistinguishable. Today’s teaching and mentoring is just the first step in tomorrow’s research progress.

This issue of our newsletter highlights several ways in which BCS looks toward the future. You’ll read a profile of our newest faculty member, Mark Harnett, who asks how the physical processes within neurons give rise to their computational power—the type of work that could potentially underlie centuries of future discoveries. We also profile Meg Krench, a fifth-year BCS graduate student at the beginning of an exciting career. And we’ll introduce you to the Gradvocates, a group working to insure that our graduate students get the most out of their time here.

Ramón y Cajal famously wrote “The brain is a world consisting of a number of unexplored continents and great stretches of unknown territory.” He began a voyage of discovery a century ago which is just a blink in human history. We are proud to be embarking on that voyage with so much to discover ahead.
BCSN: We understand that your gift supports brain science by funding some modestly sized basic research projects. You also noted that some of the research might be called adventurous. What did you mean by funding modestly sized, early stage basic research projects?

Newton: In a major research organization, there are always some novel or alternate approaches that might be rewarding but cannot be pursued due to a lack of funding. It often turns out that the road less traveled is the one that leads to great discoveries. For instance, two generations ago, renowned researchers, including Linus Pauling, posited the concept that the genetic code was built into proteins—so that’s where research funds flowed. An alternate possibility was proposed by Crick and Watson, and, with a little funding, the discovery of DNA and its structure was made and gradually went from “basic” research to thousands of applications. The purpose of the Newton Fund is not to expand existing projects but to foster this type of new or different idea.

BCSN: Much neuroscience research requires incredible financial resources. For example, the BRAIN Initiative will require billions of dollars over the next 10 years in an attempt to map and track trillions of connections in the brain. How can smaller projects compete?

Newton: Blockbuster projects, such as those sponsored by the BRAIN Initiative, serve as a foundation for many smaller research efforts that cumulatively will make huge leaps. When DNA was completely sequenced a few years back, it was just a big code book. A great many research projects used this foundation to make huge leaps in genetics. I believe that if one wants to make meaningful strides in brain research there are two main underpinnings. The first is to have a “tool kit” to work with, including technologies like powerful fMRI equipment, 2-photon microscopes, gene splicing, and optogenetics, to name a few. The second foundation is intellectual capital, or knowledgeable and motivated staff. There is probably no place on earth better than MIT to provide these two elements.

BCSN: What topics are you most excited about in neuroscience and cognitive science research?

Newton: My wife and I have supported previous work in the department by setting up a faculty chair and funding equipment for experiments. Under the Newton Neuroscience Fund, a committee comprised of BCS professors will select the specific projects to be funded. There are hundreds of potentially fruitful areas. For me, one optimistic wish is to see an interactive model of the cortex start to evolve. Today, as you have a thought, your brain arouses millions of neurons and synaptic junctions but no one has been able to provide even a simplistic diagram of what is happening at the core of this activity. I also would be interested in learning how seemingly identical brains are “wired” differently. If the wiring is understood, education methods could be customized to match the person’s thinking style.

BCSN: Do you think we will have breakthroughs and a good understanding of most brain mechanisms in the next few years?

Newton: Breakthroughs? Yes. Having a good understanding of the brain? No. A hundred years from now there will be much we don’t know. The fund was created to be given out in perpetuity for precisely this reason.

BCSN: What would your advice be to those who might be considering a gift to MIT?

Newton: Make two! Make a donation (or donations) to something you are interested in whether it is in the research and development of a department or the graduate programs or other education. MIT can provide you with periodic news magazines or internet-based briefings that will allow you to follow the developments so that you can watch your contributions at work. A second suggestion is to leave a modest fraction of your assets to MIT in your will or family trust. It will help, and you won’t miss it.
The Brain and Cognitive Science graduate advocates, or “gradvocates,” are a new student group within BCS created with the mission of fostering a strong BCS graduate student community and advocating for their interests. The group is made up of four different committees that handle different aspects of graduate life: the social committee, the events committee, the career committee, and the education committee.

The Committees
The BCS Gradvocates began by collecting student feedback during a January 2014 ice cream social. Since then, social committee events have become a regular occurrence, with dinner and drinks catered from a different popular local restaurants at the end of each month. These events have taken on fun themes, including a larger-scale sushi social for the incoming PhD students in September, and a pumpkin-painting BBQ social on Halloween. It’s not all fun and games, however: the regular monthly social committee events also serve as a forum for student input and announcements. For the spring, the committee, headed by BCS graduate student Wilma Bainbridge, is coordinating with the annual Symposium for Boston-Area Graduate Students in Psychology to make a networking social for psychology and neuroscience students across Boston.

The events committee, headed by BCS graduate students Hilary Richardson and Galen Lynch, plan events that serve as venues for meeting alumni, hearing and giving informal talks, journal clubs, tutorials on research methods, and more. In October 2014, BCS graduate students had the opportunity to hear from a panel of BCS alumni who joined start-up businesses after leaving MIT. The panel spoke about their experience leaving academia, discussed differences between working in academia and companies, and provided advice on how to learn more about corporate career paths. In January and February, the events committee hosted two events featuring panels of senior BCS graduate students speaking about their graduate school experience at MIT to new graduate students. Moving forward, the committee has plans to host a science writing workshop and an event discussing money management.

While many students from BCS chose to pursue careers in academia, others are interested in exploring the corporate world. The career committee was formed to help create opportunities for companies to connect with brain and cognitive science students. Committee chairs Kean Jaime-Bustamante and Laura Stoppel led an initiative to bring companies to the department for the inaugural BCS Career Fair, which took place on Friday, March 13th. The fair featured informative panels, recruiting, and networking opportunities from companies representing the biotech, consulting, intellectual property law, publishing, investment, computer science, and technology industries, with a particular emphasis in targeting smaller startup companies. Prior to the fair, students had the opportunity to work with MIT Career Services to review their resumes and polish interview skills. The event was open to all undergraduates, graduate students, alumni and post docs from BCS and the Biology Department.

Gradvocates have also started attending BCS education committee meetings, joining with department faculty and administrators to become an essential part of the decisions made to the BCS graduate and undergraduate curriculum. The committee is currently considering ways to improve and expand statistics and computation coursework for BCS students. Recent changes, influenced by the Gradvocates, have included adding computational assignments to graduate systems courses, and partnering with the Biology Department to allow BCS students to enroll in biology graduate statistics courses. Additionally, BCS graduate student Emily Mackevicius, with Professors Jazayeri and Fee as faculty sponsors, is running a series of tutorials on a variety of computational topics requested from a survey of the BCS community. The tutorials will be taught by experts from BCS and the greater MIT community.

Looking Ahead
While the Gradvocates have only just finished their first year, their impact to graduate life at the department is undeniable. Boasting large event turnouts, a successful career fair and changes to the academic curriculum, the committee hopes to become a fixture in BCS graduate student life. Ideas for the future include collaborating with other MIT organizations and the Boston community to organize larger-scale events, community outreach, and undergraduate mentorship.
BCS Community News

Come celebrate with us as we highlight the past, present, and future of brain and cognitive sciences at MIT. For more information and to relate a favorite story of your time in the department, visit our anniversary website at bcs50.mit.edu. Submissions may be featured in a display on June 3, 2015.

1. BCS community members enjoying the holiday party
2. Asst Professor Josh McDermott and his daughter at the holiday party
3. BCS graduate students Lea Hachigian, Caitlin Vander Weele, Pedro Tsividis, Hilary Richardson, Joshua Manning, Emily Mackevicis (Missing from photo: Kimberly Scott, Laura Stoppel, Yang Wu, Idan Blank) receive teaching awards
4. BCS faculty members Nancy Kanwisher, Josh Tenenbaum, Michale Fee and Kay Tye receive teaching and mentoring awards (pictured with Dept head Jim DiCarlo)
BCS Welcomes New Assistant Professor

Mark Harnett sits down with BCS News during Interview Day 2015

BCSN: Tell us a bit about your research interests.

Harnett: I really want to know how the biophysical processes in neurons, things like ion channels and membranes, endow neural circuits with computational power. Where do computations come from in a neural circuit? My focus is primarily on how dendritic integration, or the process by which a single neuron produces useful output from the ten thousand synaptic outputs it receives, works. I focus on dendritic integration because I think it’s where the nascent forms or building blocks of computations start to arise, at the level of single neurons. What are the rules that govern this process? What biological mechanisms are utilized? And ultimately what perspective does it give us for understanding neural processing in the brain?

I’m particularly curious about asking these kinds of questions within the framework of intellectual disability models, including autism spectrum disorder. My approach to this starts at functional analysis of what’s wrong at the level of single synapses and then how that affects the interaction between small groups of synapses, neurons, and neural circuits.

BCSN: Are there any potential faculty collaborations at MIT that excite you?

Harnett: Most of my work thus far has used rodent models, so I’m looking forward to extending that by collaborating with BCS faculty who are developing disease model in rodents, and I’m also very excited about complimenting our rodent work by collaborating with faculty using monkey models. I am as well very interested in the physiological and genetic technology being developed on campus by Ed Boyden, Michale Fee, and Yingxi Lin.

BCSN: Why did you come to MIT?

Harnett: So many reasons! Over the course of my career I’ve followed and been influenced by the work of many of the people in this building, so coming here to start my own laboratory is tremendously exciting. It’s an incredibly inspirational place. The quality of the students is phenomenal. So many of them have the quantitative or computational backgrounds that are essential to the questions my lab will be asking.

Drosophila and Brain Disorders

By Rachel Traughber, BCS

BCS Graduate student Meg Krench studies Huntington’s disease-like 2 in the Littleton Lab

“During my last year of high school I made a big decision about whether to focus on science or art in college. I never imagined this is how I would be using my paintbrush,” says BCS graduate student Meg Krench as she delicately brushes the fruit flies she plans to examine under a microscope. A student in Professor Troy Littleton’s laboratory, Krench uses the flies as a model to study a variation on Huntington’s disease.

“When we see human patients afflicted with Huntington’s disease-like 2, they have the same neuropathology, defects, and symptoms as those with Huntington’s disease. We thought that when we looked at models of this disease in flies, they would have the same patterns. It turns out that they have completely different defects.”

While comparing the simple neurons of flies to the complicated human nervous system might seem like a stretch, fruit flies are a natural fit for this type of research. Many of the basic mechanisms of biology are conserved from flies to humans. “When you’re looking at things like how connections are formed in glutamatergic neurons, which are the same in humans and flies, there are probably many similarities. When you’re looking at higher level functions like cognition in neural circuits and systems, then you have to be more careful with your questions. But for very basic neurobiology questions, the overall system might not be the same but basic things about how cells communicate might be very similar,” explains Krench.

Neurodegenerative diseases and how they affect the human nervous system hold a special fascination for her. “The brain is incredibly complex – the fact that it wires correctly in the first place is a huge biological feat. To think that you could accomplish that only to have it unravel later in life is a very interesting question.”

Next Steps

As a fifth year graduate student, Krench is preparing for the next chapter in her scientific career. Chief among her interests is bridging communication gaps between the scientific and nonscientific communities. “My eyes were opened to industry as a summer student in the Amgen program. A career in something like science communications, where I could write literature for patients and doctors to explain a disease and its potential continued on back cover
Noteworthy News

Six teams from MIT were selected to receive awards from NIH as part of President Obama’s BRAIN Initiative.

The PIs and titles include:

Edward Boyden, Mark Bathe and Yin Peng: Ultra-Multiplexed Nanoscale In Situ Proteomics for Understanding Synapse Types; Ian Wickersham: Novel technologies for nontoxic trans-synaptic tracing; Robert Desimone: Vascular Interfaces for Brain Imaging and Stimulation; Alan Jasanoff: Calcium sensors for molecular fMRI; Elly Nedivi and Peter So: Next generation high-throughout random access imaging, in vivo; and Mriganka Sur: Cortical circuits and information flow during memory-guided perceptual decisions

Professor Emery Brown was elected to the National Academy of Engineering. Brown is one of fewer than 20 people to be elected to the National Academy of Science, the Institute of Medicine and the National Academy of engineering.

Chung lab postdoc Sung-Yon Kim received the Donald B. Lindsley Prize in Behavioral Neuroscience from the Society for Neuroscience, which recognizes an outstanding PhD thesis in the area of general behavioral neuroscience.

Professor Tomaso Poggio received the Swartz Prize for Theoretical and Computational Neuroscience from the Society for Neuroscience, which recognizes an individual who has produced a significant cumulative contribution to theoretical models or computational methods in neuroscience.

Postdoc Xu Liu and grad student Steve Ramirez received a Smithsonian American Ingenuity Award in Natural Sciences and were featured in Smithsonian Magazine. These awards salute extraordinary achievements in innovation across nine diverse categories, including performing arts, education, and social progress. Ramirez was also named among Forbes Magazine’s “30 Under 30”, which lists the top scientists and healthcare entrepreneurs under age thirty.

Professor Pawan Sinha was selected to receive the Pisart Vision Award by the Lighthouse Guild. The award recognizes “individuals who have made extraordinary contributions to the prevention, treatment, or cure of severe vision impairment or blindness.” He was also named an “Asia Game Changer” by the Asia Society for Project Prakash.

Assistant Professor Kay Tye was chosen by Technology Review as one of their “Innovators under 35”.

Professor Feng Zhang received a Young Investigator Award from the Society for Neuroscience, which recognizes the outstanding achievements and contributions by a young neuroscientist who has recently received his or her advanced professional degree.

Both BCS and the Picower Institute were granted the Environment, Health and Safety Excellence Award by Provost Schmidt for superior performance in achieving the standards of MIT’s Environment, Health and Safety Management System.
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treatment options would be very rewarding. Additionally, I’ve had a few great opportunities to work as a consultant helping startup biotech companies design their scientific materials to appeal to nonscientific investors.”

She is also interested in teaching. Last year, she co-taught a class at Tufts University’s experimental college with her husband, a lawyer. The challenge of working with students who might not consider themselves scientists and exposing them to the benefits of understanding applied science was provocative.

“Our class was on criminal justice and neuroscience. Half of the class were scientists, half were prelaw, so finding a balance between the science and law was fascinating. A major focus was teaching them the value of having an informed opinion on science and technology by studying primary scientific literature. For example, if you don’t have a fundamental understanding of how fMRI detection works, how can you advocate for or against using it as a lie detector in court?”

Find out more about Meg Krench and the Littleton laboratory on the BCS website bcs.mit.edu

BCS graduate student Meg Krench