# CELL AND MOLECULAR BIOLOGY STUDENT NEWSLETTER

Volume 2, Issue 2
May 2017


## IN THIS ISSUE



For additional articles, past publications, and information about our organization, be sure to visit our blog at **cambnewsletter.wix.com/blog**.

## RESEARCH SPOTLIGHT

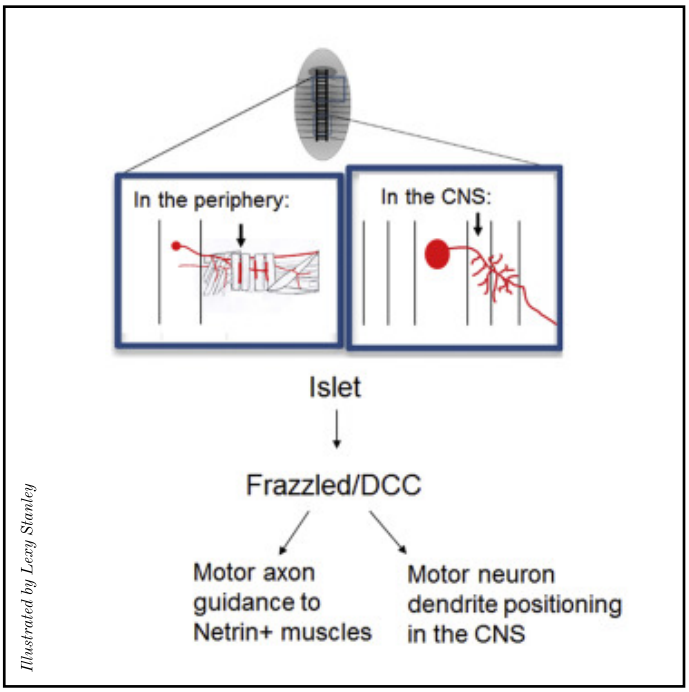
# I'm the Boss: The Role of Transcription Factors in Motor Neuron Growth and Targeting

*Lexy Stanley*

Transcription factors mediate many essential processes. The role of transcription factors in mediating neuronal growth, function, and regeneration is not well known. It is particularly poorly understood how the development, branching, and regrowth of motor neurons are regulated. There is also little known about how transcription factors regulate dendrite (projections of neurons) and how this works in conjunction with axonal outgrowth and targeting.

Regulation of dendrite and axon positioning is necessary to define a neuron's connections and is controlled by a combination of guidance receptors, adhesion molecules, and cytoskeletal regulators. The lab of Dr. Greg Bashaw studies how axons in *Drosophila* successfully navigate to their direct targets during development, with the ultimate goal of developing therapeutics for nerve regeneration and brain abnormalities. Dr. Celine Santiago, recent alumna from the Bashaw lab, took on the momentous task of elucidating how the transcription factor Islet (Isl) coordinates axon and dendrite positioning though the guidance receptor Frazzled (Fra)/DCC. Regulation of dendrite and axon positioning is necessary in defining a neuron's connections and is controlled though a combination of guidance receptors, adhesion molecules, and cytoskeletal regulators. In 2014, Celine showed that the neuronal receptor Roundabout (Robo) regulates axonal guidance in ventrally projecting RP3 motor neurons in response to the activity of the transcription factor Hb9. Celine's most recent publication describes a parallel pathway by which the transcription factor Isl regulates *fra* expression and its importance for muscle target selection.

The crux of the paper is that a single transcription factor (Isl) can control the position of both the input and output of a neuron, even when acting upon the same receptor (Fra). Celine used a plethora of complex genetic models to show that only Isl is required for *fra* expression in RP3 motor neurons, but is not required for general survival of *Drosophila* motor neurons. This suggests that Isl's effect on Fra is novel and specific. By generating separate *isl*- and *fra*- mutant flies, Celine also demonstrated that Fra is an essential downstream effector of Isl during the guidance of the RP3 axon to its target muscles. Ectopic overexpression and rescue experiments further confirm this relationship. Celine went on to show that another transcription factor, Hb9, can work in parallel with Isl to regulate different downstream targeting events in RP3 neurons, further complexing the mechanism behind some axon trajectory programs.




**Islet (isl) is required *fra* expression in RP3 motor neurons. Isl and Fra are required for axonal and dendrite targeting in RP3 motor neurons. Overexpression of *fra* rescues RP3 motor axon and dendrite targeting in *isl* mutants. A single transcription factor, Isl, is able to control both input and output of a subset of motor neurons through regulation of expression of *fra*.**

At later stages during development, RP3 neurons have reached their targeted position of an ipsilateral projection branching from the soma (cell body) and a large dendritic tree forming off the contralateral primary neurite. Celine visualized this *in vivo* by utilizing a membrane- tethered GFP transgene. With this system, Celine determined that there are severe midline crossing defects in RP3 axons when Fra is genetically ablated; however, there is little defect in midline crossing when Isl is deleted. This suggests that Isl is not required for early stages of RP3 neuronal development and axonal guidance, but is required in later stages of motor neuron differentiation and ventral target selection by controlling *fra* expression.

Deleting Isl does have its consequences, as RP3 neurons fail to form contralateral dendrite extensions into the intermediate zone of the *Drosophila* nerve cord. While the length of the dendritic projections does not change compared to *isl* controls, *isl* mutant RP3 neurons appear to have their dendrites in a laterally shifted position within the CNS. Despite this shift, the axons still appear to reach their correct target muscle groups. In contrast, *fra* mutants have a more severe lateral shift defect, although their axon projections also still reach the correct target muscle groups and there was no significant reduction in dendrite projection length. Combined, these findings demonstrate that the Isl-Fra signaling pathway is not a major controller of the outgrowth of motor neuron dendrites in the nerve cord. Using the limb3b-GAL4 construct to overexpress a UAS-HA- Fra transgene and visualize single RP3 neuronal dendrites, Celine rescued laterally shifted dendrites in *isl* mutants without affecting dendritic projection length or number of projections, which confirms that Isl directly regulates RP3 dendrite positioning though *fra* expression.

*Celine Santiago, DSRB*

The final question Celine asked was whether changes in dendrite positioning could alter axonal positioning and targeting. There appeared to be no correlation between axonal and dendrite defects in *isl* mutants, with the majority of *isl* mutants showing a defect in either axonal or dendrite positioning but not both. This was also the case with *fra* mutants. Therefore, central targeting defects (axon or dendrite positional shifting within the nerve cord) can occur separately from defects in muscle target innervation in an RP3 neuron.

In conclusion, Celine effectively demonstrates that Isl directs RP3 motor axon targeting. She shows that this is regulated through the single transcription factor Fra, and Isl is able to concomitantly regulate branching of dendrites in the CNS and axons in the periphery of *Drosophila*. Future experiments will identify other transcription factors that control motor neuron growth and development in the hopes of developing potential therapies for patients with movement and coordination disorders.

Celine is now moving on to begin a post-doctoral fellowship studying the development and homeostasis sensation of touch in David Ginty's lab at Harvard University. She's excited to be switching over to a new model organism - the mouse.

**Santiago C, Bashaw GJ. Iset Coordinately Regulates Motor Axon Guidance and Dendrite Targeting through the Frazzled/DCC Receptor. *Cell Rep*. 2017; 18(7):1646-1659.**

# Bite Me! Developing a Potent Zika Virus Vaccine at Penn

***Neha Pancholi***

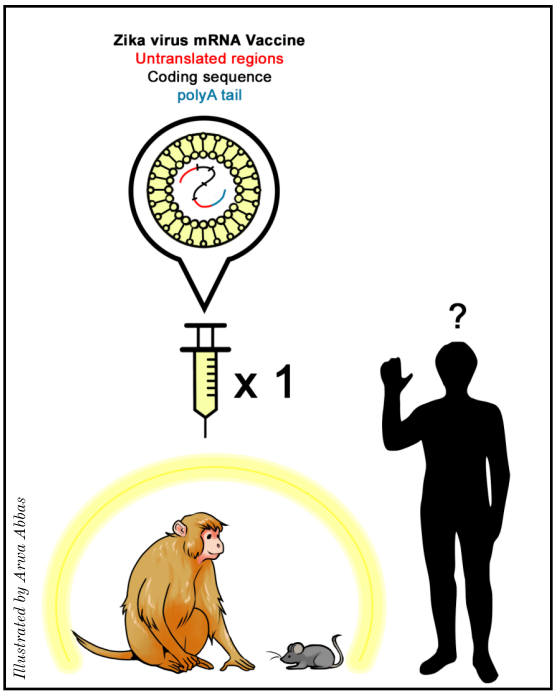
In the midst of a global health emergency, many look to researchers and health care providers to develop and administer treatments or vaccines to curtail the spread of infectious diseases. For some diseases, development of such resources prior to an outbreak is hindered due to lack of prior risk, public interest, and/or funding. The onset of an outbreak, however, can spark a sudden increase in efforts to address previously understudied pathogens, as was the case with Zika virus (ZIKV).

ZIKV is a mosquito-borne flavivirus that was identified in 1947, but until recently, it was thought to be associated with only mild illness. In recent years, it has become apparent that ZIKV infection during pregnancy is associated with microcephaly in fetuses, and ZIKV has also been linked to the neurological disorder Guillian-Barre syndrome in adults. The 2015-2016 ZIKV outbreak led to a burst in research to understand its pathogenesis and to develop effective vaccines. A recent *Nature* publication co-authored by MVP student Mike Hogan from Dr. Drew Weissman's lab demonstrates the effectiveness of a nucleoside-modified mRNA vaccine in protecting against ZIKV infection.

mRNA-based vaccines are non-infectious gene vectors that produce high levels of protein and could be inexpensive and easy to manufacture, which makes mRNA an appealing vaccine platform. Unlike DNA vaccines, mRNA does not need to enter the nucleus to produce protein and poses fewer risks because it cannot integrate into the cellular genome. However, mRNA is unstable and the presence of foreign RNA can activate detrimental immune signaling. To circumvent these issues, Mike and colleagues took advantage of a vaccine platform recently developed in the Weissman lab. "One exciting thing about this project was that the timing was perfect," says Mike. "My lab had just made some breakthroughs in developing an extremely potent vaccine platform using mRNA. So, when the Zika outbreak emerged and everyone wanted a vaccine, we realized that we were in the perfect position to use mRNA to make a Zika vaccine."

Their vaccine platform has three important elements: nucleoside modification, HPLC purification of the mRNA, and delivery by lipid nanoparticles. Incorporation of 1-methylpseudouridine, a modified nucleoside, into their mRNA construct prevents detection by intracellular immune sensors. Delivery by lipid nanoparticles increases stability of the mRNA, and all three elements enhance translation. Mike and colleagues designed their vaccine to express the ZIKV pre-membrane (prM) and envelope (E) glycoproteins, which are sufficient to form subviral particles that can be secreted from cells.

Mike and colleagues delivered their mRNA construct or a control mRNA to mice by intradermal injection of the lipid nanoparticles. They observed cytokine expression from CD4+ T cells upon stimulation with the ZIKV E-glycoprotein two weeks after immunization, demonstrating




***Zika virus protection by a single low-dose nucleoside-modified mRNA vaccination.*** **A single dose of a modified mRNA vaccine delivered via lipid nanoparticles was shown by Pardi*, Hogan* *et al.* to protect mice and rhesus macaques from experimental infection of Zika virus (ZIKV). The mRNA is uniquely designed because it encodes the signal peptide from MHC class II and two viral glycoproteins from a particular strain of ZIKV. This allows the translated products to be expressed and secreted by host cells. The group also observed that neutralizing ZIKV antibodies were detectable in rhesus macaques up to twelve weeks after vaccination, suggesting that a single dose provides long-lasting protection. Ultimately, human clinical trials will determine the safety and efficacy of this vaccine for preventing ZIKV infection and disease.**

antigen-specific responses. Immunized mice also produced E-protein-specific neutralizing antibodies within two weeks of immunization at levels higher than had been observed with other ZIKV

*Mike Hogan, MVP*

vaccines. Immunized and control mice were infected with ZIKV two or twenty weeks after immunization to measure short- and long-term protection, respectively. While almost all control mice had viral RNA in their blood within three days of infection, all immunized mice were protected during both challenges, demonstrating short- and long-term protection from a single immunization. The authors also demonstrated that their vaccine provides protection against ZIKV infection in rhesus macaques. Immunized macaques produced neutralizing antibodies within two weeks after immunization, and antibodies were detectable up to twelve weeks post-immunization. Immunized and control macaques were challenged with ZIKV five weeks after immunization, and four out of five immunized macaques were protected.

Currently, Mike and colleagues are examining whether their vaccine can protect against fetal ZIKV transmission in a susceptible mouse model. They are also investigating whether the antibodies produced in response to their vaccine enhance infection by the closely related Dengue virus due to antibody-dependent enhancement. The ultimate question, of course, is whether the vaccine would protect humans from ZIKV infection. A similar ZIKV mRNA vaccine was developed by Moderna Therapeutics and is moving into human clinical trials, demonstrating the potential of an mRNA vaccine platform for ZIKV protection.

The 2015-2016 ZIKV outbreak turned a relatively unheard of virus into a household name and sparked a flurry of research. Not surprisingly, Mike describes his ZIKV vaccine project as much more fast-paced than his other projects. “It was very interesting to follow how the basic and vaccine research developed for Zika in real time,” says Mike. “There was a big movement for labs to post their data online in real time, or to publish results in pre-peer-review journals before they later came out in peer-reviewed ones.”

Mike is co-mentored by Drs. Drew Weissman and Jim Hoxie and will defend his thesis on July 10, 2017. To learn more about ongoing ZIKV research at Penn, check out this article from August 2016 on our blog.

**Pardi, N.*, Hogan M.J.* et al. Weissman, D. Zika virus protection by a single low-dose nucleoside-modified mRNA vaccination. *Nature* 2017; 543:248-251.**

## SPECIAL INTEREST

# Graduate Student Unionization and CAMB: Perspectives on the Collective Bargaining Movement

*Gleb Bazilevsky*

Since March of this year graduate students at the University of Pennsylvania have come to hear the truth about the state of their work and support. Two truths, really. The first - graduate students can have everything they need. The second - nothing they need is theirs to have. This Dickensian dichotomy becomes apparent as discussion swirls around the question, should “[I] hereby join Graduate Employees Together at the University of Pennsylvania (GET-UP) and authorize GET-UP to represent me for the purposes of collective bargaining with the University of Pennsylvania?”[1]

The ambitious renewal of the Penn graduate student collective bargaining movement officially went public two months ago.[2] It has since engendered often-heated discussion of its merits and risks. GET-UP has forced graduate students to examine their level of satisfaction with their compensation and accommodation by the University. Veteran GET- UP member Joe Jordan (BMB) frames the movement as a push on a graduate population that has not dared imagine that it can and should receive significantly more in return for its work. “CAMB is good but could be better; Penn is good but could be better,” he presents as the philosophical basis for his involvement. The central pillar of GET-UP is, “We know we are worth more. Without us, Penn would not run…But without a contract and a platform to negotiate with the administration, we have no voice. GET-UP can provide that voice.”[3] In opposition, the counterarguments against collective bargaining have forced students to examine the uncertainties posed by such a restructuring to their representation, negotiation over benefits, and new obligations to the American Federation of Teachers network that supports the initiative. The other-minded student group GETDN-UPenn summarizes the contra argument as, “We don’t believe a decision to form a union when no complete examples exist where the university recognizes and works with unionized graduate students, and all financial and other issues across all involved departments have been resolved to adequate satisfaction to all parties involved.”[4] Furthermore, the No Penn Union student group argues that “A pan- graduate school union can not accurately represent the needs of all 12 graduate schools. The current proposed union model at Penn could have significant drawbacks with few added benefits.”[5]

Each group has presented a raft of statements in support of their arguments, in addition to town hall meetings with BGSA and GAPSA and even podcast interviews with the Penn Science Policy Group.[6] So significant a proposal has also garnered comments from the other interested parties in this discussion. Memoranda from former University Provost Vincent Price emphasize that “we continue to believe that we can better support our graduate students and their educational experience without the intervention of a union.”[7] Faculty members have also voiced their opinions, with some professors in support of collective bargaining penning a letter to the *Daily Pennsylvanian*. “We believe that unions are a good way to allow any organization, including a university, to best represent itself,” writes Professor Suvir Kaul of the English Department.[8] That is not to claim that professors are unanimous in their support. Strong opinions dominate faculty discussions, and ultimately PIs, like their students, predicate their stances on the fundamental uncertainties unleashed: what is to be changed, how is it to happen, and who is to be covered?

Let’s begin with the question of *whom*. There is a frustrating lack of clarity about the kind of graduate work and benefits that the union would have the authority to negotiate over. The NLRB ruling in 2016 in *Trustees of Columbia University vs. Graduate Workers of Columbia-UAW* expanded the definition of employment to any member of the graduate community that receives payment to advance the ranking, performance, and profit of the institution.[9,10] From this redefinition, graduate students at a handful of private universities, such as Harvard and Columbia, have progressed to holding votes to form unions – with partial success.[11] However, those nascent unions have barely entered the negotiation stage. The strongest precedent-holder for collective bargaining at private universities is the Union for Graduate Employees at New York University (GSOC-UAW Local 2110).[12] This agreement, alongside the collective bargaining agreements at public institutions such as the University of Michigan and the UC system, are all being explored by GET-UP as the model for the Penn union. Of note, the public university collective bargaining agreements and the agreement between NYU and GSOC-UAW only explicitly cover the work and rights of teaching assistants, adjunct instructors, social science research assistants, and

graduate assistants, with uneven application to graduate student researchers.[13,14,15] It would fall to negotiation between GET-UP and the University to define the bargaining unit and determine if students' stipends for their dissertation work would be covered by contract.

To answer *what* is to be changed, GET-UP has released a list of issues that would be on the bargaining table should their efforts succeed. The group raises legitimate concerns about healthcare coverage, family support, and international student rights, and the disparities in benefits from department to department.[16] Student organizations, such as BGSA and GAPSA, also recognize these and other issues and have themselves tried to address them. It must be noted that the question of what issues the union would negotiate over is far from decided. Whereas each student organization has proscribed roles and functions, initial negotiations upon approval and recognition of the union will determine the bounds of which student benefits will be covered by collective bargaining.

This leads to the *how* of change. Central to the discussion over unionization is the question over the most effective means of achieving these goals. Importantly, neither a group like GAPSA nor a union could ever guarantee or force a policy change. Either would, through contrasting mechanisms, merely communicate students' needs and desires to the University. "[Unions] make us better able to communicate. I don't see this as an adversarial relationship as much as a better line of communication, one in which we can all have our give-and-take," outlines former GAPSA and SASGOV member and current GET-UP organizer Yakov Feygin (SAS).[17] There is, however, no obvious dearth of communication between students and the various echelons of the University administration. "There is no precedent for the University refusing to hear the reasonable requests of the students. [GET-UP] needs to demonstrate that we have a need for a union, and I haven't seen that," posits former Student Health Insurance Advisory Committee (SHIAC) member and current No Penn Union organizer Laura Bryant (NGG). It is true that the University has been very open to hearing requests. It has in many cases also acted on those requests, such as the School of Medicine's most recent stipend increase and the one-time moving credit for incoming BGS students. Yet, hearing a request is no guarantee of its acceptance, with outcomes varying widely across the different graduate schools. Recently, the GAPSA Research Council could not come to an agreement with the University to guarantee funding up to the 75th percentile of each school's average completion time, an accepted practice at Columbia and Yale.[18] (BGS is an exception, with guaranteed support up to graduation in the event of the loss of a lab's funding.) How would unionization alter the mechanisms of student advocacy?

Both student government and GET-UP aim to address graduates' concerns, through different means. Currently, each graduate group, school, or department has students that present and negotiate over issues with the directors of the programs all the way up to the dean of that school. In the union, the bargaining unit of all students from all graduate schools would collectively reach a consensus and vote on a negotiated contract between the University and the elective bargaining committee, of which any GET-UP member from any graduate program may be a part. In this way, there are two competing models of representation. Whereas each graduate group currently has its own student organization with different levels of efficacy, transparency, and accessibility, union negotiations would proceed with a negotiating committee of volunteers and be approved by simple majority of participating members irrespective of the disparities in size and current benefits of the graduate groups under the union umbrella. The broader AFT network supporting GET-UP would also be present during negotiations,[19] although GET-UP is adamant that the union local would remain autonomous from the AFT national. Significantly, every member of GET-UP would have the right to be heard, although no member would have the right to remove themselves from union agreements or obligations. Ultimately, both the current system and the union will rely upon individuals to champion their causes of interest within the framework of these systems. Moreover, the negotiated contracts between the union and the University would not be all-encompassing. These contracts would likely leave open the possibility for questions not explicitly covered by the contract to be answered through existing channels of communication between students and administrators. "We need a union *in addition to* organizations like GAPSA, BGSA, and SASGOV. Student organizations are funded by the university, and though their members often sit on bodies like the University Council and SHIAC, they simply do not have the tools or leverage to create change there… I view GET-UP as a supplement, not a competitor to, the student government organizations that uses our position as a financially independent body with support from the larger pooled resources of our national," insists Feygin. Nonetheless, many of the benefits that have been laboriously negotiated by student organizations like BGSA would likely enter under the purview of GET-UP, greatly diminishing the import of existing student groups. "What is very clear is the following. Should the students vote to unionize, GAPSA and BGSA would no longer be allowed to represent the students in any discussions with faculty leadership or administration about matters subject to negotiation, including stipend, benefits, or other conditions of their graduate work," states Daniel Kessler, CAMB Graduate Group Chair.

The bold broad strokes may resonate, but it is in the fine details that we must seek out our answers and be convinced of how we can proceed. Regardless of which arguments ring most true, one thing at least is reassuring. Dr. Kessler emphasizes, "Should the students choose to unionize, we will find a way in accordance with the rules imposed by the collective bargaining process to maintain the quality of the educational programs, the quality of our research, and the quality of life for our students. There is nothing introduced through the process of unionization that will dramatically change the goals and the intentions of the faculty and I believe our students are committed and ambitious to do the best work they can." And that, we hope, will hold however the vote goes.

For more in-depth discussion, readers are encouraged to continue to ask questions. They are especially recommended to listen to the Penn Science Policy Group podcast, call the local NLRB chapter at 215-597-4310, talk to their BGSA reps about graduate student government advocacy, and attend GET-UP planning committee meetings Thursdays at 6 pm at the GET-UP office at 4305 Locust St. **A full list of references for this article can be found on our blog.**

## WHERE ARE THEY NOW?

# Karla Leavens

***Kate Palozola***

Traditionally, the format of the Medical Scientist Training Program (MSTP) consists of two years of medical school, approximately four years of graduate school, and another two years of medical school. However, Karla Leavens, M.D., Ph.D. is proof that the traditional path is not the only route to achieve a dual degree.

Although Karla always liked research, she did not consider pursuing a career in medicine until her senior year of college when she became interested in endocrinology. However, she did not apply to medical school at the time because she had already committed to attend graduate school the upcoming fall. Karla joined the CPM program in CAMB where she rotated in the labs of Drs. Hah, Ahema, and Birnbaum, all of whom are supportive of clinician scientists. She ultimately joined the Birnbaum lab, and after two years in the CAMB program, switched to the MSTP program. Karla then completed the first two years of medical school before returning to the Birnbaum lab to resume her thesis work. Upon the defense of her thesis in 2010, she returned

to medical school and earned her M.D. in 2012.

Karla then completed a pediatric residency in Pittsburgh. Karla was drawn to pediatric, rather than adult, endocrinology because the symptoms in children are genetically and/or physiologically influenced, rather than the result of breakdown as is usually the case in adults. Plus, as Karla said, "Kids are fun!" While she conducted a bit of research during her three-year residency, Karla ultimately chose to focus on her clinical training during her residency. She felt confident in her research training at this point and wanted to be sure that she had the medical training necessary to be a good physician.

*Karla Leavens, CPM*

After residency, Karla returned to Philadelphia for a pediatric endocrinology fellowship at CHOP. She chose CHOP not only because of its merits, but also because her partner, Dr. Robert Lee (CAMB/CPM alumnus – Fosket lab), landed a faculty position at CHOP as well! Though the first year of the fellowship was solely clinical, Karla is finally back at the bench. She joined Dr. Paul Gadue's lab in July 2016 where she is using stem cells as a model of pancreatic beta cell physiology. Fellowships often only last for two years, but Karla is hoping for a third year of funding so that she can make as much progress as possible before establishing an independent lab.

Throughout our conversation, it was clear that clinician scientists like Karla face several key decisions during training. For example, residency allowed Karla to treat patients and now her fellowship permits Karla to do research and specialize in endocrinology. Now, Karla faces yet another important decision – how to balance her time between the clinic and the lab. Karla isn't exactly sure how she'll split her time, but she does know that she wants to play both roles.

It was at this point in our conversation that Karla offered advice to doctoral students, particularly current MSTP students: "You can plan, but you have to make decisions when you reach the forks in the road. Have some idea of what you may want to do, but be open about what you can do with your degree and accept that your interests will likely change over time." Karla has been on the same trajectory for the past five years, but now it is time for her to decide the next step. Based on her experience thus far, Karla recommends worrying less about the balance between the clinic and the lab at earlier stages in training because there will be plenty of time to decide. Instead, focus on what excites you and makes you happy, especially since you can't make any of the big decisions until it's time. MSTP student or not, I think that's advice that we can all consider.

# Jamie Lemon and Alexandra Bryson

***Annie Chen***

Clinical microbiology is the application of research for the prevention, direct diagnosis, and treatment of infectious diseases. Clinical microbiology may be a viable career option for those who want to apply their knowledge of infectious disease in clinical settings to promote public health. Two recent CAMB graduates, Jamie Lemon and Alexandra Bryson, pursued this path after leaving Penn. Jamie Lemon was an MVP student in Dr. Jeffrey Weiser's lab, where she studied the immune response to *Streptococcus pneumoniae* colonization using a mouse model. She defended her thesis in March 2015 and is currently a second-year Clinical Microbiology Fellow at the NIH. Alexandra Bryson, MVP, is currently a first-year Clinical Microbiology Fellow at the Mayo Clinic. She completed her graduate work in Dr. Rick Bushman's lab, where she investigated the effect of covalent DNA modifications in bacteriophage on the CRISPR-Cas9 system and evolution of the human gut virome.

Clinical Microbiology Fellowships are two-year postdoctoral training programs that prepare microbiologists and immunologists for director-level positions in several settings, including hospital and public health laboratories. Jamie describes the program as "having to do parts of a postdoc, medical school, and residency all at once." The fellowship encompasses three main areas: training in diagnostic labs, clinical service, and research. To learn the various diagnostic tools used to detect pathogens, fellows rotate through different clinical labs, including bacteriology, mycology, and virology. Fellows also go on clinical service, answering physicians' questions about culture results and consulting on available tests. Research is the third component of the fellowship, and Alexandra's research project will include a metagenomic analysis of cerebral spinal fluid samples. She is focused on using deep sequencing to detect organisms in cases of meningitis and encephalitis, whose microbial etiologies remain largely unknown. There is also an emphasis on developing management and budgeting skills to prepare Fellows to become lab directors. Alexandra says, "I like that we are doing something that is beneficial to a lot of people. The Mayo Clinic in particular is extremely collaborative, and every day is something new and exciting."

Jamie and Alexandra cited their experiences at Penn and CAMB as good preparation for their fellowships. Jamie began graduate school with an interest in pursuing public health as a career. She specifically chose Penn because of the opportunity to participate in the Public Health Certificate Program, and her courses through the program gave her a good foundation in public health. Both gained exposure to the field by attending plate rounds at the Hospital of the University of Pennsylvania (HUP), in which directors and trainees reviewed culture plates of infectious disease cases to learn about diagnostic procedures, examine microbial morphology, and determine appropriate interventions. Alexandra also attended Infectious Diseases Rounds at HUP, which are more clinically focused. She conducted a research project in the Infectious Disease Diagnostic Laboratory at the Children's Hospital of Philadelphia and presented her work at the Clinical Virology Symposium, where she was able to meet lab directors and others in the field. Some of the most important skills from graduate school that they use include critical thinking, troubleshooting, and communication skills. As Jamie says, "Things don't always work as expected (or as they should) and being able to systematically figure out why something isn't performing as expected is a skill that I honed in grad school." Alexandra added, "Communication and leadership skills are essential. I give presentations to a big community of physicians and researchers, so you have to be comfortable speaking on diverse topics." For students who are interested in clinical microbiology, they suggest talking to current fellows or lab directors and gaining as much exposure to the field as possible, either by going to plate rounds, doing a small project, or learning about the direction of the field. Some of Jamie's favorite memories at CAMB include spending time with friends, daily coffee time with her lab, and finishing the Philadelphia Half Marathon. For Alexandra, a combination of having great friends and an exercise community were key to helping her get through grad school.

*Alexandra Bryson, MVP*

Regarding future plans, Jamie's fellowship ends in June, and she is currently interviewing for director-level positions at city and state public health labs. Alexandra is interested in becoming a director or assistant director of a clinical microbiology lab at a hospital or research university, preferably at a medical school where she can also teach.