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SCIENCE FOR THE BENEFIT OF HUMANITY

BENCHMARKS

THE COMMUNITY NEWSLETTER OF THE ROCKEFELLER UNIVERSITY

FRIDAY, JULY 10, 2015

When The Rockefeller University held its first Convocation in 1959, there were only five graduates. Fifty-six years later, as of Convocation on June 11, 2015, there are now 1,178 recipients of the Rockefeller University doctor of philosophy degree.

The festivities began with a graduate luncheon in the Great Hall of Welch Hall, followed by Rockefeller's traditional cap-and-gown procession of students and mentors across campus to the degree-granting ceremony in Caspary Auditorium. Afterward, the campus community joined the graduates and their families at a reception on the Peggy Rockefeller Plaza.

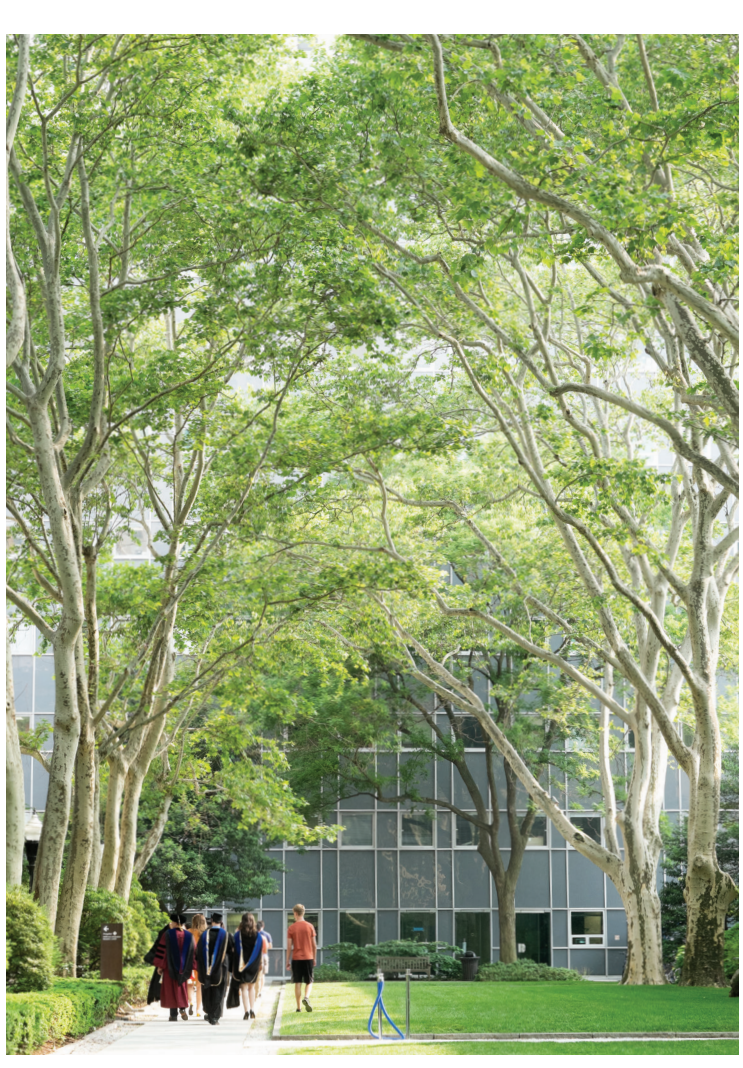
The class of 2015—17 men and 11 women—come from 12 countries: Argentina, China, Germany, Japan, Korea, Pakistan, Singapore, Taiwan, Tanzania, Ukraine, the United Kingdom, and the United States. Twenty-one Rockefeller labs were represented by the graduates, six of whom are members of the Tri-Institutional M.D.-Ph.D. Program and will continue on to medical school. Others will begin careers in academia, industry, or other fields.

This annual Convocation issue of BenchMarks *salutes the Rockefeller University class of 2015.*

To view more photos, visit www.rockefeller.edu/convocation.

CONVOCATION

FOR CONFERRING DEGREES · 2015



ALL PHOTOS: MARIO MORGADO PHOTOGRAPHY AND ZACH VEILLEUX

BENCHMARKS

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Honorary degrees awarded to three Pearl Meister Greengard laureates

by AMELIA KAHANEY

In addition to 28 students, three trailblazing women in science received degrees from Rockefeller this year. In a tradition dating back more than 50 years, the university awarded honorary doctorate of science degrees to distinguished individuals who have made notable contributions to bioscience: Nicole Le Douarin, a developmental biologist at the Collège de France; Mary Frances Lyon, a geneticist at the U.K. Medical Research Council, whose degree was awarded posthumously; and Brenda Milner, a neuropsychologist at McGill University. All three honorees are past recipients of the Pearl Meister Greengard Prize from The Rockefeller University, which recognizes the accomplishments of outstanding women in science.

Dr. Le Douarin was honored for her embryological work with the neural crest, a ridge that gives rise to most of the peripheral nervous system. Using chimeric embryos containing both chick and quail cells, Dr. Le Douarin found that precursor cells in the neural crest are, in effect, versatile stem cells, and that the migratory pathway these precursor cells take determines the type of cell they will become. Her work made essential contributions to the scientific understanding of how the brain and other structures of the nervous system form, as well as how the immune system develops. Dr. Le Douarin received her Ph.D. from the University of Paris. From 1975 to 2000, she was director of the Institute of Embryology at France's National Center for Scientific Research, and she is permanent secretary of the French Academy of Sciences.

PHOTO: MARIO MORGADO

"I wish to thank the members of the Rockefeller faculty for giving me the intense gratification of being here today in a room full of so many scientists I have worked with and admired over the years, and who I deeply respect," said Dr. Le Douarin.

"Mary was delighted to have been offered this honor by Rockefeller University," said Dr. Rastan, who accepted Dr. Lyon's degree.

"Nicole is one of the giants of embryology. She developed an ingeniously simple genetic approach and used it to solve one of the most difficult problems in development," said Mary E. Hatten, Frederick P. Rose Professor and head of the Laboratory of Developmental Neurobiology.

Dr. Lyon's honorary degree recognizes her work in genetics. Intrigued by the mottled coat patterns of female mice who had inherited different variants of a color-determining gene, Dr. Lyon inferred that the splotchy coats resulted from random silencing of one of the female mice's two X chromosomes, and thus one of two pigment genes in each cell. Her theory of X-chromosome inactivation suggested an answer to the longstanding question of how female cells can function similarly to male cells, which contain X and Y chromosomes; helped explain the inheritance of certain diseases; and shed light on the mechanisms of epigenetic regulation. Dr. Lyon received her Ph.D. from the University of Cambridge, and worked at the U.K. Medical Research Council in Harwell from the 1950s through her retirement, heading the genetics division there for many years.

"It seems that Dr. Lyon was always looking ahead to a future in which she saw great potential," said Magda Konarska, Evelyn Gruss Lipper Professor and head of the Laboratory of Molecular Biology and Biochemistry. Dr. Lyon's award was accepted by Sohaila Rastan, her second Ph.D. student and now the executive director of biomedical research at Action On Hearing Loss, a U.K. nonprofit dedicated to supporting people with hearing disorders.

Dr. Milner was recognized for her research on memory. Working with a patient who had undergone surgical removal of several sections of his brain and so lost the ability to create long-term memories from new experiences, Dr. Milner found he could learn and improve upon a challenging drawing task—even though he could not recall performing the task from day to day. Her work with him and with other patients showed that episodic and procedural memory are different processes associated with different structures in the brain. This led to the hypothesis that the brain has multiple memory systems that govern specific functions. Dr. Milner received her Ph.D. from McGill University and a D.Sc. from the University of Cambridge. She is currently professor of psychology at the Montreal Neurological Institute and McGill University's department of neurology and neurosurgery.

PHOTO: MARIO MORGADO

"It has been a wonderful day, seeing the variety of scientific enterprises in which Rockefeller students are engaged, and at such a high level," said Dr. Milner.

"The importance of Dr. Milner's work to the history of neuroscience cannot be overemphasized," said Leslie Vosshall, Robin Chemers Neustein Professor and head of the Laboratory of Neurogenetics and Behavior. "Her scientific career that has spanned over six decades and counting has been an inspiration to scientists—particularly female scientists—worldwide."

David Rockefeller Fellowship awarded to third-year Robert Heler, a bacteriologist

by AMELIA KAHANEY

Robert Heler, a graduate fellow in Luciano Marraffini's Laboratory of Bacteriology, has been awarded the 2015 David Rockefeller Fellowship, given each year to an outstanding third-year student for demonstrating exceptional promise in science and leadership.

The fellowship was established by alumni in 1995 as an expression of gratitude for Mr. Rockefeller's role in founding the university's graduate program and for his commitment to its success. Mr. Rockefeller has said that few honors have meant so much to him as the creation of this award.

Born and raised in a small town in the Transylvania region of Romania, Mr. Heler first considered pursuing a career in science in 2008, when he traveled to India to compete in the International Biology Olympiad after having won at the national level. He returned with the bronze medal, coming in third against biology students from every corner of the world. Though winning the title took years of extracurricular science study, Mr. Heler says, "I obviously loved doing it."

Mr. Heler completed his undergraduate studies at the University of Richmond, in Virginia, where his job "keeping the silence" at a tiny science library on campus allowed him twenty hours a week of virtually uninterrupted study time. It paid off—he graduated first in his class of over 700 students with a dual degree in biochemistry and molecular biology, and computer science.

Rockefeller was his top choice for grad school. "I loved the flexibility of the Rockefeller program," says Mr. Heler. "At other schools, I would have had to apply to specific departments. I would never have thought I would join a bacteriology lab without sampling this topic during my rotation."

In the Marraffini lab, Mr. Heler studies the molecular basis of CRISPR-Cas immunity, a system which provides bacteria with adaptive protection against viral infections, but about which very little is known. In a series of genetic experiments, he discovered a new function for the protein Cas9, a vital agent of the CRISPR system.

"It might be the case that the novel function of Cas9 that we identified could lead to a whole new field of applications," he says. "To me, that's the most exciting part of what we're doing, and the most promising." Also exciting: His findings were published in a *Nature* article earlier this year, with Mr. Heler as a co-first author, and they were the topic of the proposal that led him to obtain a prestigious Howard Hughes Medical Institute student fellowship.

"Robert is an exceptional scientist who can conduct original research with great creativity and minor supervision," says Dr. Marraffini. "He is motivated and hard-working, and is able to postulate clear hypotheses and test them on the bench."

Outside of Rockefeller, Mr. Heler seeks volunteer projects that utilize his programming skills and computer science background. Most recently he built a database web application for a local nonprofit organization whose mission is to help secure jobs for low-income residents of Brooklyn, New York. Mr. Heler is also interested in forging partnerships between scientists and the financial industry, and is currently working with a few other students to launch the Tri-I Finance Club, which will be open to students at Rockefeller and neighboring institutions.

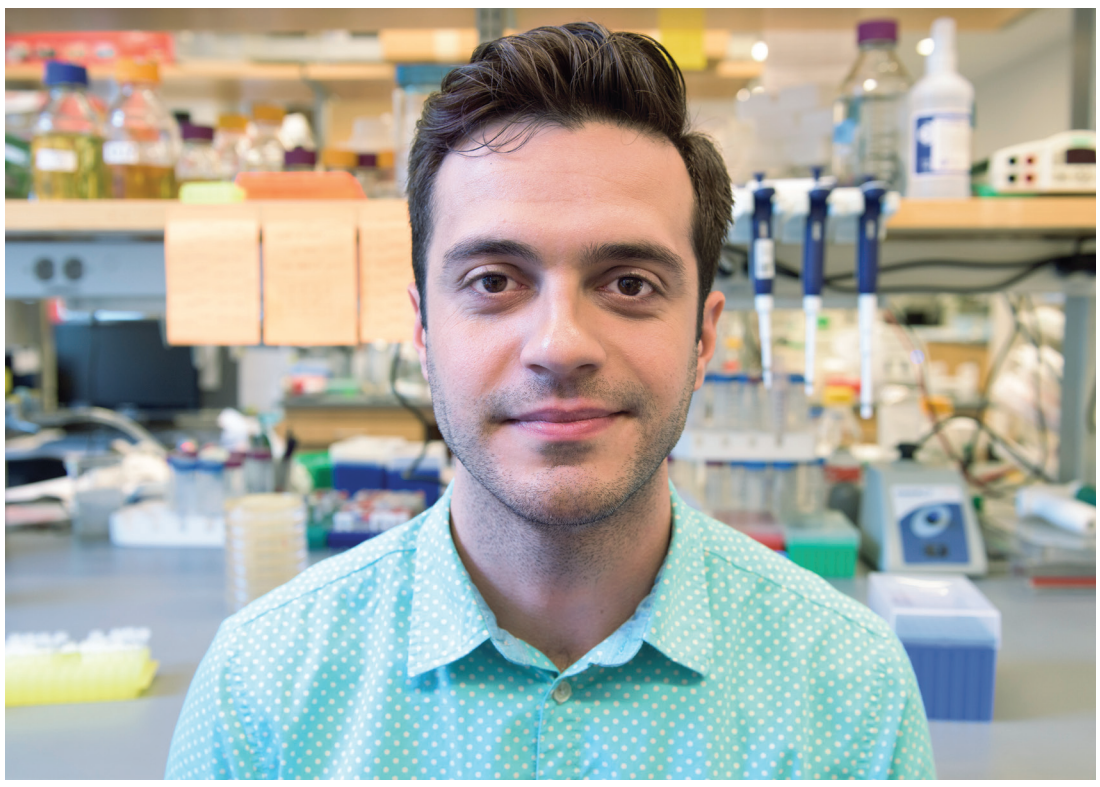


PHOTO: ZACH VEILLEUX

David Rockefeller Award for Extraordinary Service honors founding chairs of university's *Women & Science* initiative

by AMELIA KAHANEY

PHOTO: MARIO MORGADO

Sydney R. Shuman (left) and Nancy M. Kissinger accepting the David Rockefeller Award for Extraordinary Service at a dinner following this year's Convocation ceremony. Not pictured: fellow awardees Isabel P. Furlaud and Lydia A. Forbes, who were unable to attend.

Among the accolades for scholar-scientists, this year's Convocation also honored four women with a different but no less significant role in the advancement of research—Lydia A. Forbes, Isabel P. Furlaud, Nancy M. Kissinger, and Sydney Roberts Shuman, the founding chairs of Rockefeller's *Women & Science* initiative.

First given in 1995 to David Rockefeller, grandson of the university's founder and an ardent supporter of the university for more than seventy-five years, the award recognizes individuals from the Rockefeller community who have demonstrated an "unswerving enthusiasm for Rockefeller's scientists and a deep concern for the progress of their research; selfless dedication to furthering the university's mission and strengthening the institution; and an unstinting effort to enlist others to join in supporting biomedical science for the benefit of humankind."

Together with President Emeritus Torsten Wiesel, the four founding chairs played leading roles in establishing *Women & Science* as a vital outreach program at Rockefeller. Over the past 18 years, the initiative has raised crucial support for biomedical research and for the advancement of women scientists. "It was their extraordinary vision as philanthropists that enabled the four awardees to see that *Women & Science* also offered an opportunity to raise support for women, from women," said Marc Tessier-Lavigne, the university's president. "Thanks to that foresight, the university was introduced to an entirely new group of corporate, civic, and philanthropic leaders, who soon became—and remain—some of our most engaged supporters and volunteers, benefitting Rockefeller at all levels of research."

Mrs. Forbes has served on The Rockefeller University Council for more than 20 years, including 15 years on the Council's Executive Committee. A nationally renowned competitive ballroom dancer, in 2008 Mrs. Forbes published *The Year of Dancing Dangerously*, which chronicles her first year of competitive dancing. She is a director of the DanceSport Academy, which provides ballroom dance programs for children on five campuses of the Boys & Girls Clubs of Palm Beach County. She is also a board member of the Society of the Four Arts in Palm Beach.

Mrs. Furlaud has been a member of The Rockefeller University Council since 1998. In addition to her service to Rockefeller, she has served as president of the East Hampton Historical Society and as a member of the board of the managers of the East Hampton Library, an institution she was drawn to when she decided it needed better facilities for children. In 2006, Mrs. Furlaud established Aiken Equine Rescue on 90 acres of land in Aiken, South Carolina. Run mainly by volunteers, the organization rescues horses that have been abandoned or mistreated. Since its founding, Aiken Equine Rescue has saved roughly 600 horses, providing food and care until a responsible placement is found.

Mrs. Kissinger was elected to The Rockefeller University Board of Trustees in 1995, and now serves as a Trustee Emeritus. She is also a trustee of the Animal Medical Center, a director of the Queen Sofía Spanish Institute, and an honorary trustee of The Masters School. Until recently, Mrs. Kissinger was a member of the board of overseers for the Nelson A. Rockefeller Institute of Government in Albany, the public policy research arm of the State University of New York. A longtime aide to the late Nelson Rockefeller, she served as director of international studies for his Commission on Critical Choices for Americans.

Mrs. Shuman joined The Rockefeller University Council in 1995 and was elected to the university's Board of Trustees in 2001. In addition to *Women & Science*, she is an active supporter of the university's Parents & Science program. Beyond Rockefeller, Mrs. Shuman is an honorary chair of the Lenox Hill Neighborhood House. She also serves as a trustee of Second Stage Theatre and is a member of the Villa I Tatti Council of Harvard University's Center for Italian Renaissance Studies.

"The founding chairs have made transformative contributions to Rockefeller that extend far beyond *Women & Science*," Dr. Tessier-Lavigne said. "The 2015 David Rockefeller Award honors these four brilliant and visionary women as individuals—for their wise counsel, tireless advocacy, and exemplary leadership—and collectively, to signal the importance of the extraordinary program they created."

The $24 million raised to date through *Women & Science* has supported 184 graduate and postdoctoral fellows, endowed the Rebecca C. Lancefield Chair, and provided program support for many research initiatives. It has also helped to build a culture of opportunity for women at all levels of the university. The program's success financially and culturally has made it a national model for encouraging women to support scientific research.

Gaby Maimon and Vanessa Ruta honored with teaching awards

Dr. Maimon (left) and Dr. Ruta.

For Rockefeller graduate students there is labwork, and there is coursework. This year, the university recognizes two teachers who have devoted substantial time, energy, and creativity to designing and leading one of the most challenging and innovative courses within the university's graduate curriculum: Gaby Maimon, assistant professor and head of the Laboratory of Integrative Brain Function, and Vanessa Ruta, Gabrielle H. Reem and Herbert J. Kayden Assistant Professor and head of the Laboratory of Neurophysiology and Behavior. They were presented with the university's Distinguished Teaching Awards at this year's Convocation luncheon.

Dr. Maimon and Dr. Ruta, both of whom joined Rockefeller in 2011, co-organize the Membrane Biophysics Course. Since its inception in 1992, the course's format requires exceptional involvement and commitment from both the instructors and the students, who participate in alternating two-hour lectures and daylong labs for its six-week duration. The course's lecture topics are biophysical aspects of the structure, function, and regulation of ion channels and transporters, and their roles in shaping electrical activity in cells. The labs involve a series of increasingly sophisticated electrophysiological experiments.

In taking over the course last spring from David Gadsby and Sandy Simon, who organized it for nearly 20 years, Dr. Ruta and Dr. Maimon saw the material from a student's perspective—Dr. Ruta passed the course with distinction in 2001 as a Rockefeller student, and Dr. Maimon took the course himself in 2011 and also helped administer the individual, two-hour oral examinations at its culmination.

"Vanessa and Gaby's willingness to organize this course is a real testament to their commitment to teaching and mentoring the next generation of young scientists," says Marc Tessier-Lavigne, the university's president. "Their dedication to teaching is an inspiration."

The 2015 Graduates

Below are the congratulatory tributes given to each of the 2015 graduates by their faculty mentors on June 11. Students in the Tri-Institutional M.D.-Ph.D. Program are denoted with an asterisk. Three students graduated in absentia: Fang-Yuan Chang, Katherine Jane Leitch, and Keith Tan.

Lindsay Bellani

presented by Leslie B. Vosshall

B.S., The University of North Carolina, Chapel Hill
Why Mosquitoes Bite Some People More than Others: Metabolic Correlates of Human Attraction in Aedes aegypti

Why do mosquitoes bite some people more than others? This question has puzzled picnickers and hikers since humans first congregated outdoors where mosquitoes waited to drink their blood. But there has been little meaningful scientific investigation into the question. Lindsay Bellani took on this important problem in her graduate work. Serving as principal investigator on two human subject protocols, Lindsay asked more than one million mosquitoes their opinion of the attractiveness of 150 volunteers. These were complicated experiments. She and her team required anaphylaxis training in case a subject suffered an allergic reaction, and spent one year sitting in a tropical room, not unlike Miami in August, chatting with volunteers whose arms served as mosquito bait. Blood was collected from each subject, with the aim of asking whether a metabolite in blood could signal quality to marauding mosquitoes. In fact, Lindsay was the first to ask this question, and has identified key biomarkers that predict how attractive a human will be to a mosquito.

This work is important because the mosquitoes we study spread yellow fever, dengue fever, and chikungunya virus to hundreds of millions of people worldwide each year. And they ruin our picnics, barbecues, and vacations. The dataset that Lindsay collected during her Ph.D. was enormously complex, comprising many hundreds of variables to be correlated with mosquito attraction.

Over the last year, Lindsay has taken her already intuitive sense of how to grapple with data and turned herself into a sophisticated data scientist. This has been an impressive transformation to watch. Inspired by her passion for big data and her great skills in analyzing it, Lindsay applied for and was accepted into a highly competitive data incubator program. This seven-week boot camp takes smart people and readies them to take on the biggest problems in data mining in the private sector. It is inspiring to see a very smart and very nice female scientist make a move into the tech sector, where I know she will again do the impossible. And leave the boys in the dust.

Jabez Bok

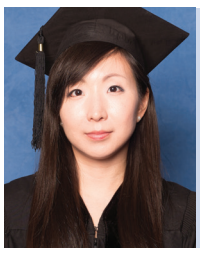
presented by Sidney Strickland on behalf of Robert G. Roeder

B.S., University of Wisconsin, Madison
Mechanism of Action of ING4 as a Transcriptional Coactivator of p53

Jabez Bok hails from Singapore, and after earning his undergraduate degree at the University of Wisconsin, he joined The Rockefeller University as part of the Singapore A*STAR program. With a longstanding interest in gene expression, Jabez joined my laboratory to learn and apply biochemical approaches to the regulation of transcription, the first step in gene expression, through chemical modifications of the histone proteins that package DNA. Notably, his focus was on histone acetylation, which was discovered here at Rockefeller in the 1960s by the late Vincent Alfrey and linked directly to transcriptional regulation through the pioneering studies of our colleague David Allis.

Relevant facts regarding histone acetylation are that there are many different modifications of the four core histones, that they are generally linked to transcriptional activation, and that they are deposited by a large number of distinct histone acetyltransferases that often occur in large multi-subunit complexes. Jabez chose to work on a particular complex, the ING4 complex, because it had been linked functionally to the action of the tumor suppressor protein p53, which is mutated in over half of human cancers, and because its mechanism of action was poorly understood and represented a challenging problem for an ambitious graduate student. After mastering critical biochemical techniques, including the assembly of recombinant chromatin templates and the purification and characterization of specific multi-protein complexes, Jabez proceeded to provide major new insights into p53 target gene activation through the ING4 complex. He showed, for example, that the ING4 "complex" actually consisted of two structurally distinct complexes with different histone acetylation specificities and that it acted in conjunction with both a different well-characterized histone acetyl-transferase (p300) and a distinct chemical modification (namely methylation) on histones. Thus, important new ING4 co-activator mechanisms for the tumor suppressor p53 were demonstrated, and have potential therapeutic implications.

With his persistent passion for a deeper understanding of the role of chromatin structure and function in gene regulation, admittedly one of the most topical areas in all of biology, Jabez has returned to A*STAR in Singapore for postdoctoral work in a prominent laboratory in this area. We are grateful for his stellar contributions to our laboratory and will remember his thoughtful and diligent attention to his studies, and especially his very gracious manner. We wish him the best of luck as he continues to explore fundamental aspects of gene regulation through chromatin modifications.



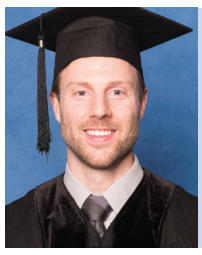
Christine E. Cho

presented by Leslie B. Vosshall on behalf of Cori Bargmann

Sc.B., Brown University
Mechanisms of Olfactory Plasticity in Caenorhabditis elegans

Although many religions warn us against fortune tellers, it's the brain's job to predict the future. What does a new stimulus presage? What should I do about it? Evolution has endowed the brain with innate predictions in the form of instinctive preferences for stimuli, especially tastes and smells. Infants love sweets and refuse bitter food because their brains innately predict that one taste will lead to growth and the other to misfortune. But the world is a complex place, full of surprises, and so the brain must build new predictions to match reality, and that we call learning.

Christine Cho is from Korea, a graduate of Brown University, and now a newly minted Ph.D. from Rockefeller University. Christine has elucidated the changes that occur in the brain of the tiny worm *C. elegans* as it learns that some food odors, sadly, are not as promising as evolution thinks they are. Christine herself is a food fanatic and a wonderful pastry chef, so she knows that this is a serious issue. To elucidate it, she studied a behavior in which an appealing food odor is paired with starvation, a most undesirable state. Even *C. elegans* can learn that this odor is leading nowhere, and first ignore and then despise it. Christine mapped a circuit for this process of olfactory adaptation, finding new genes and pinpointing neurons that are required to pair the experience of odor and starvation in the formation of the memory. She discovered how these neurons change themselves and other neurons after learning—finding the signals for mobilization of a protein kinase to the nucleus to regulate transcription, and finding long-lasting shifts in the properties of sensory neurons and their interactions with targets. These changes represent an altered prediction, an encoding of experience in connected neurons. They are a very small version—because the worm is very small—of the profound and mysterious process of memory, by which our experiences change our brains.



Eliot Dow*

presented by A. James Hudspeth

B.S., Ohio State University
Synapse Formation in the Zebrafish Lateral Line

Although our brains do not always function well, it is actually implausible that they should function at all. A human brain contains something like a hundred billion nerve cells, but the instructions for assembling that organ—not to mention the remainder of the body—reside in just twenty thousand genes. A central problem in neuroscience is therefore how development can erect an edifice as complex as the brain from such a scanty blueprint.

Eliot Dow has contributed to an understanding of this issue by conducting research on an experimental system meant to display a minimum of complexity. As you can verify from the next trout that you encounter, a fish has a prominent stripe along its side. This lateral line contains cells that detect water motion, informing the fish how fast it is moving and signaling the approach of predators or prey. The simplicity of the system resides in the fact that water moves either fore or aft along the fish, and there are separate cells that detect the two. Moreover, those cells are connected to just two classes of nerve cells, again with opposite sensitivities. An investigator can therefore ask how nerve cells connect when they have only two choices—right or wrong—rather than thousands or even millions of options. Eliot used this system to discover a novel phenomenon: the sensory receptors do not passively await contact with the appropriate nerve fibers; instead, they extend microscopic arms and essentially grab the proper nerves. This observation has sparked an entirely new line of investigation into the formation of nerve connections.

Although Eliot worked with extraordinary vigor and perseverance on his doctoral research, he also found a potent means of amplifying his effort. Defining the elaborate connections between nerve cells requires laboriously tracking each cell through hundreds of tissue slices; a view of the cell then emerges as in an old-fashioned flip book. Reasoning that New York City is full of starving artists, Eliot advertised on Craigslist for individuals with appropriate graphical skills and computer facilities. The response was gratifying: there are a lot of people hereabouts who are interested in science, but not fortunate enough to have academic careers. Knowing that they could make a genuine contribution to human knowledge—and get paid for it—these individuals were eager to participate in research and did an outstanding job of identifying the various cells in Eliot's preparations.

As a student in the M.D.-Ph.D. program, Eliot recently returned for his final two years of clinical education. It remains to be seen what will transpire thereafter, but I must admit a prejudice: Eliot has an exceptional gift for research, and I hope that he will use it to learn more about how the brain is assembled.

Akinori F. Ebihara

presented by Winrich Freiwald on behalf of himself and Marcelo O. Magnasco

B.S., The University of Tokyo
Normalization Among Heterogeneous Population Confers Stimulus Discriminability on the Macaque Face Patch Neurons

As I introduce Akinori Ebihara to you, I find myself in an eerie situation in that I am, at this very moment, redoing his main experiment.

Let me explain. Akinori studied how the brain processes information it receives from the eyes. He focused on a tiny region in the brain that specializes in faces. Cells in this region measure facial features like the distance between the two eyes. But how do these cells do their measurements, when they are confronted not with one, but many faces all at once? To get an answer to this question, Akinori designed stimuli that looked very much like what I see now: many faces packed close together. Before Akinori's experiment, we thought cells would get confused or at best muddle through, trying to ignore as many stimuli as possible. What Akinori found was the exact opposite and truly beautiful. Face cells embrace the challenge of a complex scene, and they do so by constructing a code that counts how many stimuli there are, where they are, and what kind they are. Akinori even elegantly identified the circuit mechanism that generates this code, providing deep new insights into how our brains make sense of the world.

Akinori is a man of many talents. He studied biophysics and biochemistry at Tokyo University, where he performed his thesis work on odorant receptor genes. A molecular biologist by training, Akinori is a mathematician by inner calling. He still makes a point of getting up early in the morning to study math. After spending endless hours in the lab, he even found the time to acquire new experimental skills at night and turned himself into an outstanding jazz guitarist—Akinori really rocks! His many talents, and his unique mix of easygoing joyfulness paired with a calm confidence, seriousness, and determination will serve him well as he moves on as a postdoc to tackle new problems in the neurosciences at the interface of experiment and theory.

Akinori was the first student to join my lab at Rockefeller. As his sensei, I am proud and happy today, but I am also sad to see our time together come to an end. His co-advisor Marcelo Magnasco and I join Akinori's mother Yoko and his wife Yuka on congratulating him on this special day.

Clark Fisher*

presented by Winrich Freiwald

A.B., Princeton University
Effect of Temporal and Spatial Context within the Macaque Face-Processing System

Social life relies on faces. A day like today—when lots of people come together all wearing pretty much the same outfit—would be unthinkable if we could not tell one face from another.

To most of us, face recognition comes easily. But that experience belies the daunting computational challenges our brains must solve to make that happen. To do so, evolution has equipped us with a network of areas devoted to the task of face recognition and face recognition only, each area solving a different computational problem.

When Clark Fisher joined my lab, he came with a background in biochemistry and neuroscience from Princeton and experience with the retina, the part of the brain in the back of our eyes that implements the very first steps of vision. To make his transition easier, I thought it would be best for him to work on the earliest parts of the face-processing network. But Clark had other, better ideas and set out on a scientific journey that took him to uncharted territory.

You see, there are faces out there that are actually not really faces. Take the faces of dolls—they look real, but you know they are not alive, they don't belong to a real person. Clark discovered a new brain region that is exquisitely sensitive to the natural motion of faces, a quality like no other to give away the reality of another person. Clark also discovered where and how face-representations are enhanced when the face is seen on top of a body—and why the converse is not the case. Both discoveries mark a critical transition from the analysis of a face as a shape to the recognition of a face as that of a real person.

There are lots of things I admire about Clark. He is an excellent scientist. He is also a natural teacher—most avidly, he has been teaching at our student and faculty club, where his infinite knowledge of matters big and small earned my lab the title "super nerds," something I am immensely proud of. And Clark is a physician in the making. When he told me that after his Ph.D. he saw his future in medicine, it was one of those moments when everything makes sense. The doctor I would want at my bedside—that would be him.

Ariel Halper-Stromberg*

presented by Michel C. Nussenzweig

B.S., University of Maryland, College Park
Therapeutic Uses of Broadly Neutralizing Anti-HIV-1 Antibodies in Humanized Mice

Ari Halper-Stromberg grew up in Maryland and went to college at the University of Maryland, College Park. Because of his interest in science, Ari spent two of his college summers doing research on HIV-1 in Sriram Subramaniam's lab at the National Institutes of Health. Sriram's laboratory focuses on understanding the structure of the HIV-1 spike, a problem that is directly related to vaccine development. Ari's work at NIH inspired him to pursue science and join the M.D.-Ph.D. program after college, and eventually to join my laboratory to continue to work on HIV-1.

HIV-1 is currently a lifelong chronic disease that cannot be cured because drugs cannot eliminate the virus from a so-called latent reservoir. For his thesis, Ari decided to try to explore the possibility that the immune system might be used to try to cure HIV-1, using humanized mice as a model. This is in some ways akin to the latest immune-based cancer therapies that use the immune system to attack cancer cells. His approach required the use of newly available monoclonal antibodies against HIV-1 combined with a shock to induce the virus in latent cells. Although this was only effective 60 percent of the time, it was the first experiment ever to show that the immune system might be used to eliminate HIV-1. His experiment was published in *Cell*, and a clinical trial is planned to attempt the same experiment in humans.

Ari is a fabulous individual who, in addition to his interest in science, has incredibly diverse hobbies and skills: he brews his own beer, roasts his own coffee beans, and is an exceptional baker and an athlete. He is an avid cyclist, a tough mudder, and a spartan racer. For those of you like me that did not know what a tough mudder or spartan racer is, those are marathons that include a very serious obstacle course.

Ari will now be returning to Cornell to finish up medical school. His colleagues and I will deeply miss his insightful analytical and quantitative approach to science.

Jeffrey G. Johnson

presented by Sidney Strickland on behalf of Tom Muir

B.A., Knox College
Studies on the Maturation of Secreted Quorum Sensing Peptides That Regulate S. aureus *Virulence*

Jeffrey Johnson received his undergraduate degree in chemistry from Knox College in Illinois before joining the Tri-Institutional Program in Chemical Biology in the fall of 2009. For his thesis work, Jeff studied how virulence is regulated in pathogenic staph bacteria through something called quorum sensing. For the non-specialists, staph in many ways act like soccer hooligans. When they are on their own they are relatively docile and harmless, but get them in a crowd, particularly in the presence of a chemical stimulant, and you'd better watch out. Indeed, staph turn on their virulence response (the ability of the infection to spread) only when their numbers have reached a certain threshold, hence the term quorum sensing—they use chemistry to count how many of their buddies are nearby before undergoing this Jekyll and Hyde transformation. During his time in my lab, Jeff focused on the biosynthesis and secretion mechanisms of the peptide-based "words" that bugs use to talk to each other. Using a combination of chemical and genetic tools, Jeff was able to make incisive contributions to our understanding of the multiple-step process that releases a cyclic peptide pheromone from the middle of a ribosomal polypeptide precursor. As part of this work, he developed an ingenious genetic method that allowed him to manufacture the mature peptide pheromone in staph in a manner that was totally orthogonal to the normal biosynthetic pathway and that, as a consequence, unveiled novel aspects of the secretion pathway. Indeed, Jeff's insights have unleashed a whole new area of research in my lab related to peptide secretion and how this might be harnessed for the purposes of the development of novel therapeutic modalities.

In addition to his contributions at the bench, Jeff acted as a key social hub in the lab. He grew up pretty close to Las Vegas, and this clearly had an impact on his tastes in recreation. For instance, barely a sporting event went by without Jeff eagerly organizing a laboratory gambling pool. His honest and warm demeanor naturally drew people into these schemes. For my part, I never really understood how any of these worked since I consistently lost even when I picked the winner. Still, I will really miss listening to Jeff trying to explain the nuances of the bracket system (or was it racket system?) and will alas now have to find new ways of giving my money to the group. Jeff, I will really miss you in the lab, but I know that it is a good "bet" that you will go on to great success in your future as a science journalist.

Shaheen Kabir

presented by Titia de Lange

B.S., Haverford College
Investigating Mechanisms of Telomere End-protection

Despite being young, Shaheen Kabir's life has already involved five continents. Born to Pakistani parents, Shaheen grew up in beautiful Tanzania. She went to Australia to study biology, theater, and dance in Melbourne, and then came to the U.S. to go to Haverford College, where she graduated with a major in biology and a minor in theater arts.

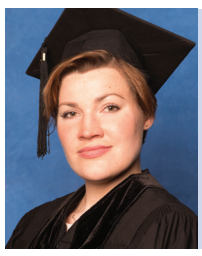
Before Shaheen joined our graduate program, she worked as a technician with Jay Chaudhuri, who had then just joined the faculty of Memorial Sloan Kettering Cancer Center. After helping him set up the lab and getting the first results published, she joined The David Rockefeller Graduate Program in 2008.

When Shaheen started in our lab, she joined postdoc Agnel Sfeir and former graduate student Megan van Overbeek in their quest to understand the role of Rap1 in shelterin, the complex that protects our chromosome ends. Agnel and Megan had been working on various approaches, including gene knockouts, to figure out what Rap1 was doing at telomeres. Disappointingly, they had found that Rap1 was not doing anything at telomeres at all. Shaheen, however, within a few months of joining the lab, showed that Rap1 is required to prevent telomeres from exchanging DNA sequences with each other.

Having established the function of mouse Rap1 at telomeres, Shaheen wanted to address two major questions. She wanted to understand why Rap1 was a highly conserved telomeric protein even though its role at telomeres did not seem to be critical for survival since mice without Rap1 are alive and well. She also wanted to know what the function is of human Rap1, because there were several papers that argued that human and mouse Rap1 were quite different.

Shaheen decided to address these questions by knocking out human Rap1 with TALENs. Since the CRISPR explosion, TALEN gene knockouts are now to genome editing what the iPhone 4 is to the Apple Watch. But the TALENs worked, and Shaheen found that human Rap1, like mouse Rap1, is not essential. Furthermore, the work provided her with the fascinating insight that we have a protein hanging onto our telomeres that is mostly conserved because it is moonlighting as a transcriptional regulator.

Shaheen has now joined the lab of Jennifer Doudna at the University of California, Berkeley. This choice possibly reflects her enthusiasm for the ease of genome editing with CRISPR compared to TALENs. But I suspect that her move to the Bay Area may also have to do with the location of her husband, Alex Bolze, whom she met when he was a student here at Rockefeller. Since Alex is French, their wedding in Paris brought the fifth continent into Shaheen's life.



Anna Katherine Kruyer

presented by Erin Norris on behalf of herself and Sidney Strickland

B.A., Fordham College at Lincoln Center
The Effect of Chronic Hypertension on Neuropathology in the TgSwDI Mouse Model of Alzheimer's Disease

When Anna Kruyer moved to New York City from a small town in western Ohio, she set out to study communications at Fordham University, following in her mother's footsteps. Lucky for us, her plans changed. Anna found herself immersed in science courses and independent projects using *Drosophila*, *C. elegans*, and zebrafish in labs at Fordham, Columbia, and University of Cincinnati, and soon realized she was really meant to be a neuroscientist. Her undergraduate mentors felt the same way. She was referred to as "a true catch," while another advisor stated, "I've never had a better student. Poise, drive, maturity, intelligence, curiosity—she has it all."

When Anna joined the Strickland lab, she started studying the GluK4 receptors, which are involved in diseases such as schizophrenia, depression, and bipolar disorder, and also took part in studies on our lab's novel mouse model of hemorrhagic stroke. After these works were published—coauthored by Anna—her focus shifted to Alzheimer's disease. She began characterizing the pathology of an Alzheimer's disease mouse line that produces high levels of β-amyloid deposits along the brain's microvessels. Anna and I attended an Alzheimer's disease conference together in the summer of 2012, where we heard numerous clinicians present epidemiological evidence that untreated midlife hypertension drastically increases one's risk for Alzheimer's disease. It was during this insanely fun yet intensely scientific time in Vancouver that we created her thesis project.

By treating her Alzheimer's disease mouse model, which our lab affectionately calls the TgSwDI line, with a chemical vasodilator, Anna induced chronic hypertension prior to the onset of Alzheimer's disease pathologies. Her findings were remarkable. Not only did hypertension exacerbate the Alzheimer's disease pathology and cognitive impairment that were already known to occur in these mice, but it also induced significant degeneration of neurons and pericytes that had not been found previously. Most notable, though, was the impact of hypertension on the ultrastructure of the brain's microvessels surrounded by β-amyloid and the apparent dysfunction of the nearby cellular components. Anna is currently continuing her work on this project in the hopes that we can nail down the cellular and molecular mechanisms that make untreated midlife hypertension so damaging to the brain.

In addition to Anna's scientific abilities, she's one of the most likeable people I've ever met. She is funny, sweet, helpful, supportive, happy, mature, and kind. I can't think of a time I asked her to help me with something or carry out an experiment where she didn't genuinely smile and say, "Of course!"

I couldn't have gotten luckier having Anna as my first official graduate student. She has set the bar incredibly high for the next student who comes along. Something tells me no one will ever really fill her shoes.

Johannes Larsch

presented by Leslie B. Vosshall on behalf of Cori Bargmann

M.Sc., University of Konstanz
A Mechanism for Spatial Orientation Based on Sensory Adaptation in Caenorhabditis elegans

In his work on the unity of opposites, *hodos ano kato*, the pre-Socratic philosopher Heraclitus said that "the path up and down are one and the same." Johannes Larsch, in his thesis work, has described that path on a level of detail that Heraclitus could not have imagined, and proved, 2500 years later, that Heraclitus was incorrect. Thus, science makes progress.

Johannes came from Konstanz to Rockefeller in 2007 to do his Diploma Arbeit with Leslie Vosshall, in whose laboratory he studied how the nervous system encodes an unpleasant odor. Echoing Heraclitus, from the outset of his career Johannes has shown himself to be a scientist who cared passionately about the path and not just the goal. Science is about the path, and the details of the path. Johannes's attention to detail was apparent in his development of precise microfluidic methods for presenting odor stimuli to many living *C. elegans* animals while recording the activity of their neurons. Studying these neurons, he could see the path up and the path down, the *hodos ano kato*, as animals experienced first increases and then decreases in odors. On the path up, even small odor increases were always detected by olfactory neurons. But the path down was very different. As odors decreased, neurons were silent, completely indifferent to stimuli that had excited them only a few seconds earlier. Johannes learned how the sensory neurons adjust to maintain sensitivity over a thousand-fold range of odor increases. He followed the signal to the brain, and then found that behaving animals followed the same logic, yearning toward the upward odor path and disregarding the downward as they reached the pinnacle of their desire, the odor of chardonnay.

Johannes is now following his own path back to Germany as a postdoc with Herwig Baier at the Max Planck Institute in Martinsried. There he will study the behavior of zebrafish, perhaps to disprove another famous assertion of Heraclitus: "You cannot step into the same river twice."

Hyeseung Lee

presented by Sohail Tavazoie

B.S., Ewha Womans University
Identification of Tmem2 *as a SOX4 Transcriptional Target Involved in Breast Cancer Metastasis*

Hyeseung studied chemistry and life sciences in South Korea. In my lab, she studied how a gene called *SOX4* endows cancer cells with the ability to form deadly metastases. SOX4 is what we call a transcription factor. It encodes a protein that turns on other genes. Hyeseung used a systematic approach to identify which genes SOX4 turns on. She then tested each of these genes to determine which one(s) are responsible for the effects of SOX4 on metastasis. This led her to discover one gene not previously linked to cancer as being the culprit that mediates the effects of *SOX4* on metastasis. This gene is a protein that sits in the membrane and whose function was poorly understood. Hyeseung found that this gene enhances the ability of breast cancer cells to spread and form metastases. Moreover, breast cancers from patients that express higher levels of SOX4, and consequently Hyeseung's newly found gene, tend to metastasize more frequently. In addition to this work, Hyeseung collaborated with Claudio Alarcon in the lab to study how marks on RNA, in the form of methyl groups on adenosines, can impact the expression of genes in our genomes.

Hyeseung came to my lab with very limited experience in molecular biology and cancer. I'm incredibly proud of how much she has learned and how far she has come. She is an incredibly hard worker and absolutely loves doing science. She has convinced me that she loves science more than she loves karaoke, and you've never seen anyone love karaoke more than Hyeseung. Hyseung is currently choosing her postdoc lab. Hyeseung, keep up the great work and congratulations!

Joseph M. Luna

presented by Robert B. Darnell on behalf of himself and Charles M. Rice

B.S., Yale University
A Genomic Portrait of Hepatitis C Virus and MicroRNA-122

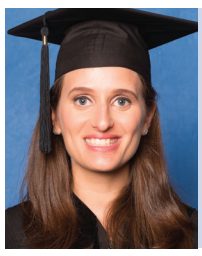
"The crowded hall was brimming with excitement as a room full of scientists took their seats." These prescient words were written by Joe in his application to Rockefeller University. They capture his excitement at and investment in science and the scientific community, and happily, they presaged Joe's spectacular thesis talk given here this spring. Before I tell you about what he has accomplished at Rockefeller, it is worth noting how his own background lay the groundwork for his success here.

Joe came from El Paso, Texas, where he was raised by a wonderful, energetic, and forward-thinking family that I have had the privilege of coming to know. This led him on a path of intellectual curiosity—he took on the very challenging molecular biophysics and biochemistry major as an undergraduate at Yale, while at the same time becoming literally a master printer—he was the chief printer to Jonathan Edwards College. This may seem like a stretch, but I believe Joe saw this as a physical incarnation of the very concept of scholarship—how does one make books (knowledge) from lead and brass? He has since applied this analogy to the experiments and advancement of science.

At Rockefeller, Joe became fascinated by the relationship of microbial-host interactions, and how it leads to the "accident" of disease. This attracted him to a number of microbiology projects at Rockefeller, and he eventually settled on studying hepatitis C with Charles Rice's Laboratory of Virology and Infectious Disease. At the same time, Joe was interested in the "lead and brass" of molecular biology, and decided on developing a joint program with dual thesis advisors, Charlie and me.

As I noted early in his Rockefeller career, when Joe received the David Rockefeller Fellowship, Joe was "as fully engaged as one could possibly hope for from a young scientist." Joe took a technique that our lab had developed, termed HITS-CLIP, in which one can very precisely lock RNA molecules inside living cells to the proteins that regulate them, and applied it for the first time to understand host-viral interactions. Joe's work, reviewed by a panel of virologists at his thesis defense, was stunning in its careful execution and precision, confirming and extending our understanding of the basic molecular biology of how hepatitis works, focusing on how regulation of the viral RNA at one end is addicted to a single small host microRNA, termed miR-122.

Joe took this understanding to a new level, reasoning that the virus, in its addiction to the liver cell's own miR-122, exposes a potentially very important Achilles' heel. That is, by "sponging up" all of the host liver cells' miR-122, it leaves the normal mRNAs that are normally controlled by miR-122 freed from their normal regulatory constraints. This observation has potentially great relevance for understanding hepatitis C. Nearly 200 million people are infected with the virus, with outcomes ranging from "no problem" to chronic infection with its complications, including, in a not insignificant number, the development of liver cancer. While the virus appears the same in each patient cohort, Joe's discovery of a new set of virus-host interactions has great importance for understanding why some get so sick from this virus. Joe's work has impressed many beyond those who have worked so happily and so closely with him—it was published last month in *Cell* with Joe as the first author, a major work attracting interest from virologists, cancer biologists, and molecular biologists. Charlie and I both feel privileged to have worked with Joe, and will support him as strongly as we can as he goes forth into the world of science.



Jennifer Zuckerman Malin

presented by Shai Shaham

B.A., University of Pennsylvania
Components of the Ubiquitin Proteasome System are Required for the Nonapoptotic Death of the Caenorhabditis elegans *Linker Cell*

It is a distinct pleasure for me to be here today to participate in Jennifer's graduation. Jennifer is a persistent and motivated scientist and it has been exciting to watch her grow to become a seasoned investigator. She entered the lab the proverbial naïve, bright-eyed, and bushy-tailed graduate student, and will leave with a strong understanding of what makes a good experiment. This is what graduate school is all about.

From the beginning, it was clear that Jennifer was driven. She joined my lab with a keen interest in understanding a novel and mysterious form of cell death we had uncovered that plays an important role in the development of the nematode *C. elegans*, and which may be conserved across animals. She chose to work on a difficult project—we had found that a protein regulating the degradation of other proteins was important for cell death; however, it was also important for other essential functions. Studying the effects of removing this protein from the animal was therefore challenging, as animals did not survive.

Undeterred, Jennifer carved out a path using creative strategies to understand what this protein does. Although we still have much to learn, Jennifer's work has generated a framework for thinking about this new cell death process. This framework guides much of our current modeling. Jennifer's exciting work has been recognized by invitations to speak at international meetings.

Besides becoming an experienced scientist, Jennifer contributed to the lab in many other ways. She routinely helped to organize our lab's contribution to a joint group meeting we run with several labs on campus, and has been a source of support and advice for new lab members. She is a generous and thoughtful person, and has contributed greatly to the open and friendly character of the lab.

Jennifer will remain at Rockefeller for a few more months as she completes work for her paper, and she plans to continue her scientific career as a postdoc. I have no doubt that she will choose her future lab with great care and that she will be a strong contribution to that lab.

Alexander R. Nectow

presented by Jeffrey M. Friedman

B.S.E.S., M.S., Tufts University
Functional Dissection of Brainstem Circuitry

Some of you may be familiar with the phrase "all heat and no light." This describes a person who generates lots of energy but who illuminates very little. This phrase does not describe Alex Nectow, for whom the phrase "all heat and lots of light" is more apt, so long as there are some lightning bolts, electrical fires, and solar flares added in. Alex is a dynamo. To give you an example, I asked Alex to send me some information about his background and received an email with 18 bullet points.

Alex graduated from Tufts University in four years with both a B.S. and a master's degree while also exploring many side interests, including playing the drums and performing stand-up comedy at clubs where he will forever be associated with his legendary cheese sandwich joke.

His application to The David Rockefeller Graduate Program was also somewhat legendary, in that he crafted and submitted an independent research proposal on circadian or biologic rhythms despite having no prior background in this area. The proposal was viewed by the Dean's Office and by our provost who works in this area as interesting, novel, and of considerable merit. Dean Strickland told me that he had never seen another application like it.

In my laboratory, Alex has probed the neural basis of several basic behaviors, including feeding and movement. He has found that activating a small population of neurons in the midbrain leads animals to spontaneously run four times more than a normal animal. This was in addition to developing two new methods for better characterizing specific neural populations, starting a journal club, critiquing the quality of the beer all around the city, commuting regularly to Boston to see the Patriots, Bruins, and Red Sox play, networking with the great and the good and everyone in between, and applying for independent positions while taking the MCATs and applying to medical school. It wouldn't surprise me if he ended up doing both at the same time.

My favorite moment with Alex, however, was in the aftermath of Super Bowl XLVI, when he had to wear a New York Giants T-shirt and hat while listening to me recite a poem I wrote.

Alex is the complete package. He is bright, ambitious, hard working, and passionate. In recognition of his many talents, Alex received a David Rockefeller Fellowship from the Rockefeller Graduate Program. You will be hearing more about him, most probably in many different areas.

Zeeshan Ozair

presented by Ali H. Brivanlou

B.S., M.B., The Aga Khan University Medical College
A Reductionist Approach to Modeling Human Corticogenesis

Where does the mind come from? What is the origin of our brain?

Zeeshan Ozair came to me in 2009 via Abu-Dhabi and Pakistan, with a medical degree and after extensive training at Harvard Medical School. Already by then, he had developed

a true passion for the way the brain works. He quickly realized that one of the best ways to answer this question is to understand how the brain is made. And because I share the same passion, he decided to join my lab.

Previous work performed on frogs had established that during early embryogenesis, every single cell of the embryo wants to become a brain cell, unless she is told otherwise by her neighbors. To what extent this was true in humans is what ignited Zeeshan's drive during his graduate work. He demonstrated that the molecular basis of brain development has remained surprisingly unchanged between frogs and humans despite millions of years of evolutionary distance. Zeeshan then pushed his work forward and made several seminal discoveries on the development of the human neocortex. This is the part of the brain that makes us human, and encodes our precious cognitive functions such as language, dreams, and love.

His work opens for the first time a window into the molecular basis of our consciousness. I am lucky to have Zeeshan stay in the lab for a little longer as a postdoctoral fellow, before he moves on to complete his medical residency. There is something magical about humans wanting to understand their brain. When you think about it, this is really the brain trying to understand itself. It is as if the brain is reflecting its own image in a mirror. As Rumi, my favorite Persian poet, says: "Between the mirror and the mind there is a single difference: The mind conceals secrets, while the mirror does not."

Zeeshan has always been and will continue to be a mirror in which I can find the reflection of myself.

Pablo Polosecki

presented by Winrich Freiwald

Licenciado, University of Buenos Aires
Specialized Signals for Spatial Attention in the Ventral and Dorsal Visual Streams

Pablo Polosecki once founded a club on campus with the purpose of discussing the foundations of science and philosophy. This was not by coincidence. Pablo had come to Rockefeller after undergraduate studies in philosophy and theoretical physics in Buenos Aires, and thesis work on human cognition. Pablo is interested in fundamentals.

In his thesis, Pablo worked on how the brain controls the focus of attention. As I am sure you are aware, we are not just passive recipients of the pieces of information that happen to impinge on our senses, but active selectors of that information. Some of you might even take pride in your ability simply not to listen to what you don't want to hear. This is attention at work! Pablo put a fundamental theory of attention to the test. The theory states that there has to be a master map in the brain that controls the focus of attention. For several decades, a particular brain area had been thought to serve that function. But through a clever new behavioral paradigm and recordings of brain activity, Pablo could show that that area is actually doing something fundamentally different. However, Pablo discovered that the proposed master map actually does exist, and that it has, in fact, exactly the properties that had been postulated. Yet he found that map in a part of the brain where no one had expected it to be—a finding with profound implications for neurology.

Pablo has many outstanding qualities as a human being and as a scientist, but the one that's most unique is his ability to distill a problem to its essence and to provide a new and often surprising perspective. His witty remarks and poignant comments have been frequent highlights at our group meetings, and I, for one, would often turn to him to try out an idea, and have enjoyed many insightful and stimulating discussions with him over the years. I will greatly miss them.

As you might guess, Pablo is now seeking a new challenge and a new level of abstraction—from philosophy, theoretical physics, and cognitive brain science, Pablo is now setting out to the field of data science, where he is destined to make deeply meaningful discoveries.

Kavita Rangan

presented by Howard C. Hang

B.S., University of California, Berkeley
Characterization of Bacterial Metabolites Involved in Host Pathogen Resistance

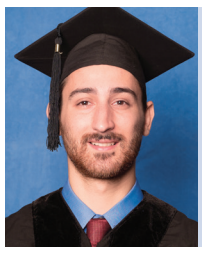
It has been a pleasure to have Kavita Rangan do her graduate thesis studies in my laboratory. Kavita is a remarkable individual who is kind, creative, and scientifically fearless.

In our quest for new approaches to fight infectious diseases, my laboratory has been interested in how bacteria that are part of our microflora protect us from pathogenic bacteria and viruses. By figuring out how these beneficial bacteria protect us from infections and identifying specific molecules they use, we hope to develop these factors into new anti-infective agents. This is a daunting task since the tissues in our body are colonized by hundreds to thousands of different bacterial species, each of which may have complex interactions with our cells and other microbes.

Kavita was undeterred by this challenge and realized that we needed more efficient animal models to investigate the protective mechanisms of these bacteria. Inspired by our colleagues in development biology, neuroscience, and microbial pathogenesis, Kavita showed that the roundworm *Caenorhabditis elegans* could also be used as an efficient model organism to dissect how individual bacteria species protect animals from bacterial pathogens. Using *C. elegans*, Kavita discovered that *Enterococcus faecium*, a gut bacterium found in many animals including humans, secretes a specific protein that activates host immune pathways to prevent Salmonella infection. This was an original discovery by Kavita, and required her to overcome many intellectual and experimental challenges since she was the first to work with *C. elegans* and *Enterococcus faecium* in my lab.

Remarkably, the secreted *Enterococcus faecium* protein Kavita discovered is not only active in worms but also protects laboratory strains of mice from Salmonella infection, which suggests that it also works in mammals. As intestinal bacterial pathogens such as Salmonella are still major challenges to human health and agriculture, the secreted *Enterococcus faecium* protein Kavita discovered is an interesting candidate for antimicrobial drug development and an exciting future direction in my lab.

I want to thank Kavita for taking me along on this incredible adventure and opening up a whole new area of research in my laboratory. I wish her all the best in her future endeavors and am excited to see what discoveries lay ahead of her.



Jason Barzel Ross*

presented by Sohail Tavazoie

B.S., Stanford University
Molecular Determinants of Tumor Re-initiation in Breast Cancer

Jason received his undergraduate training in biology at Stanford University, where he was actively involved in stem cell research. Upon joining my lab, he chose to pursue a very challenging project centered on the biology of cancer metastasis. Many scientists would correctly refer to this project as a fishing expedition, but this did not deter Jason.

Cancer cells start off in an organ such as the breast by growing on a scaffold called extracellular matrix that forms a sort of carpet that cancer cells depend on. This scaffold provides signals to cancer cells that enable their growth and survival. Jason sought to answer the question of how cancer cells that leave the growth factor-rich scaffolding of the breast survive and grow in the blood or distant organs, which can lack these signals cancer cells require for growth. By purifying rare cancer cells that were professionals at surviving in the blood and in distant organs, and identifying the genes they turn up, Jason made some surprising findings. He found that these cells create their own scaffold of extracellular matrix, which provides them with signals that drive their growth and expansion. These cells can thus continue to proliferate in hostile environments without being anchored to a surface. By reducing the level of one such gene, Jason found that he could reduce the ability of breast cancer cells to spread. Jason showed that by blocking the ability of cancer cells to make or to interact with their self-made scaffolding, he could suppress breast cancer metastasis. His findings reveal yet another clever trick that cancer cells utilize to overcome biological barriers that keep most cancers in check.

Jason is currently completing his clinical training and plans to pursue radiation oncology and a postdoctoral fellowship in cancer research in the future. It was a tough expedition, Jason, but you certainly caught the fish you were searching for.

Joshua Salvi*

presented by A. James Hudspeth

B.S., The Pennsylvania State University
Mechanical Control of Sensory Hair-bundle Function

Human hearing is truly remarkable: we can detect frequencies a thousandfold as great as those measured by our other senses; we can capture sounds down to a level set by the clattering of air molecules against the eardrum; and we can analyze sounds from that threshold to a millionfold as loud. All these features suggest that something extraordinary is happening, and that has proven to be the case: each of our ears is equipped with a so-called "active process," a sort of built-in hearing aid that amplifies and otherwise enhances the sounds that we hear, resulting in the qualities that I have mentioned.

Josh Salvi has devoted his doctoral research to understanding how this active process operates. Using single receptor cells from the ears of frogs, he has developed a unique experimental apparatus that can coerce the cells into the full range of behaviors that have been observed across a variety of sensory organs and species. By this means, he has clarified the conditions under which the receptor cells can operate most effectively and demonstrated how they achieve the technical specifications to which I have alluded.

In addition to his elegant research and his support of others in our group, Josh has also contributed a great deal to the local community during his period of research. As a student in the M.D.-Ph.D. program, he served for two years as executive director of the Weill Cornell Community Clinic, a voluntary organization that provides medical services to the indigent. He mentored high school students in the university's Summer Neuroscience Program and Science Outreach Program and played an important role in the Neurodome project, which fosters neuroscience education through lurid but nicely produced projections in various planetaria. Finally, during the past year he organized and cotaught a statistics course that was highly successful and attracted more than two dozen participants.

Josh's research has gone so well that he has elected to remain with our group for an additional year as a postdoctoral fellow before resuming his clinical education. My colleagues and I look forward to his continued presence and—in view of the variety of experimental questions that he can now approach—to his ongoing success.

Johannes F. Scheid

presented by Michel C. Nussenzweig
member of the graduating class of 2014

Diploma, University of Arts, Berlin
M.D., Humboldt University – Charite, Berlin
The Antibody Response against HIV

This is the second Rockefeller graduation for Johannes Scheid, the first being from the Rockefeller Children's School. Johannes' father was a professor in the Tamm and Choppin laboratory, and his mother was a faculty member at Memorial Sloan Kettering.

Shortly after his first graduation, Johannes's family returned to their home in Germany, where Johannes went to school and eventually entered the music conservatory with the idea of becoming a concert cellist. But he hedged his bets by attending medical school as well. He became fascinated with experimental medicine, and decided to take a year off to come back to New York City and Rockefeller for a one-year rotation to try his hand at science. Although I was initially reluctant to take Johannes because he had so little laboratory experience, I eventually did because he agreed to spend three months at the Max Planck Institute to train before coming here.

I am very happy that he did, because his rotation turned into a Weintraub Award-winning Ph.D. with multiple first author publications in journals like *Science* and *Nature*. When Johannes arrived, I gave him the task of developing a technique to clone antibodies from the blood cells of patients infected with HIV-1, something that had never been done before. We chose very rare patients that had developed broad and potent neutralizing activity in their serum, and Johannes was able to fish out their antibodies with his new technique. This led to the isolation and molecular characterization of a whole new class of antibodies by us and by a number of other laboratories that adopted Johannes's technique. The new antibodies have yielded insights into how to neutralize HIV-1, uncovered new sites of vulnerability in the virus, and provided an important explanation for why it has been so difficult to produce a vaccine.

Moreover, Johannes' experiments showed that these antibodies were sufficiently potent that they might be used in therapies or even as a passive vaccine to prevent the disease.

These ideas were tested first in pre-clinical models, and now Johannes' antibodies are being tested in humans right here at The Rockefeller University Hospital.

Johannes' work has had a major impact on my laboratory and more importantly on the entire HIV-1 community, which has turned its attention to immunotherapy. This is an unusual accomplishment for a graduate student, but Johannes is an exceptionally gifted individual. It's been a true pleasure and a privilege to have had Johannes as a colleague.

In addition to his Ph.D., Johannes has managed to finish medical school. In the next phase of his career, he will be following in the footsteps of Zanvil Cohn, Ralph Steinman, and yours truly as an intern in medicine at Massachusetts General Hospital.

Roman Subbotin

presented by Brian T. Chait

B.S., M.S., Taras Shevchenko Kiev State University
M.S., University of Minnesota
Chemical Stabilization—A Path Towards Deciphering Protein-Protein Interactions in the Cellular Milieu

Roman Subbotin was born in Stryi in the Soviet Ukraine. He studied chemistry at Kiev State University and inorganic chemistry at the University of Minnesota before joining our Tri-Institutional Program in Chemical Biology.

In the lab, Roman's task became in essence the development of a generalized molecular microscope for mapping the macromolecular components of cells in space and time. As you are no doubt aware, living cells are amazingly complex collections of microscopic molecular structures and machines with tens of thousands of different molecular players taking part in a beautifully orchestrated choreography of almost unimaginable complexity. Think of something like all of New York City compressed into an object that is perhaps a thousandth of an inch across! To gain insight into this orchestration, it is imperative to have available tools that can tell us which of the tens of thousands of different molecular players are interacting in space and time, and how they are organized into dynamic structures and machines to allow cells to accomplish their myriad tasks.

Although tools certainly exist to do part of this job, they are mostly specialized to look at just a few macromolecules at a time. And the more general tools are currently beset with problems of differentiating the real interactions from those that occur non-specifically, as well as their inability to catch the myriad important interactions that occur only transiently. Roman took on the task of developing such a much-needed tool with determination, courage, and imagination. While his broad chemistry skills were certainly important to the task, I believe that even more important were his keen powers of observation, his open-mindedness, and his extraordinary stubbornness—outstanding characteristics that ultimately allowed him to succeed spectacularly in a task that had eluded so many fine scientists for so many years. In the process, Roman has developed an extraordinarily useful tool that I believe will be widely used by biologists for uncovering the secrets of the cell.

He Tian

presented by Thomas P. Sakmar

B.S., Peking University
Development of Novel Chemical Biology Tools for Probing Structure-Function Relationships in G Protein Coupled Receptors

It is a challenge to describe chemistry in narrative form. Chemistry is a way of thinking. Chemistry is intellectually challenging—it has a practice and formality that dates back hundreds of years. Physiological chemistry and chemical biology are more recent formulations of the field—perhaps only about 60 years old. Chemical biology really began when it became possible to synthesize in the laboratory molecules that have activity in living systems. And now chemical biology has paved the way for synthetic biology; not just making molecules that function in living systems, but building up the molecules that *define* living systems.

For the past five years, He Tian has been at the forefront of a revolution of protein engineering. Her thesis work involved expanding the genetic code to produce complex signaling proteins in cells with unique and useful chemical properties. She advanced a methodology to introduce fluorescent tags at defined sites in specific protein receptors on cells. When the receptors are lit up, it's possible to see where they are, what drugs they bind to, and for how long. Working with my faculty colleague, Thomas Huber, Tian dramatically advanced a field called site-specific bioorthogonal labeling, and their approach is already being used by perhaps 50 labs and pharmaceutical companies around the world to discover new therapeutic drugs. Last week she had a cover article in a leading chemical biology journal, just in time for Convocation, and in time to be able to celebrate here today with her parents from China.

Tian worked hard to make it to Beijing University on a scholarship, and then to compete in an MIT-sponsored international biotechnology competition, and then during her time here at Rockefeller to make so many brilliant experimental advances and innovations. In her spare time she is an avid photographer, and her online photo album has received nearly half a million views. As she decides between Boston and San Francisco for the next phase in her career, I can say that as much as I respect the chemistry, I also respect the chemist, the thoughtful innovator, the student apprentice turned master chemical biologist.

Yifan Xu*

presented by Jeremy Dittman on behalf of Cori Bargmann

B.S., Duke University
Neural Circuit Dependence of Acute and Subacute Nociception in Caenorhabditis elegans

Most grad students experience some type of pain during their thesis work. For Yifan's thesis, she decided to work on pain. Yifan Xu is an M.D.-Ph.D. student who conducted her thesis work in the laboratory of Cori Bargmann. Yifan's project tackles a formidable challenge: bridging the cellular properties of pain-sensing neurons with the circuit and behavioral dynamics of *C. elegans* as a model nervous system.

Yifan used the major nociceptive pain receptor neuron in the worm together with quantitative imaging approaches in behaving animals as tools to analyze how different patterns of sensory input into the pain receptors drive distinct behaviors. She developed a simple logic using the known circuitry of the worm to describe how pain sensing has both deterministic and malleable components, allowing an animal to respond reliably to dangerous inputs while maintaining the flexibility to ignore less painful cues when outweighed by competing attractive cues. These studies highlight the contributions of simple cellular properties to the complex decision-making capacity of the nervous system.

John Z. Xue

presented by Hironori Funabiki

B.A., University of Cambridge
Xenopus *Dppa2 is a Direct Inhibitor of Microtubule Polymerization Required for Nuclear Assembly*

From John Xue's eloquent British accent, it may be hard to imagine his origin. John was born and raised in Jingbian, a rural town in the Shaanxi province of China, before he moved to London with his parents when he was seven. There, and later at Cambridge University, John cultivated his dry sense of humor, his affection for tennis, and his curiosity about broad aspects of culture and nature before joining the graduate program here.

John's thesis project was related to one of the first events in human life. All of our lives start when an egg from our mother fuses to the chromosomes of our father. During this process of fertilization, paternal chromosomes are tightly compacted and clustered to facilitate their fusion with the egg. After fertilization, these chromosomes must be decompacted and recruit a nuclear membrane, so that chromosomes can be replicated within a nucleus. In addition, the two parental nuclei must move on microtubule fibers to meet. Through his thesis project, John demonstrated that a novel chromosome-binding protein, Dppa2, plays a critical role in assembling a functional paternal nucleus through destabilizing microtubules. This was the first demonstration that nuclear formation is not simply a process of recruiting nuclear envelope components, but requires active clearing of microtubules around chromosomes.

John, a man of curiosity, always delivered a variety of intriguing information to the lab, from the latest articles I should read to important gossip I should know. John always encouraged lively debates, and regardless of the topic, he knew how to finish heated discussions with a genuine smile we are all going to miss.

Daria A. Zamolodchikov

presented by Sidney Strickland

A.B., Princeton University
A New Role for β-Amyloid in Alzheimer's Disease: Initiation of Thrombotic and Inflammatory Processes via Coagulation Factor XII and Fibrinogen

Let's consider American Pharoah. It takes intelligence, speed, endurance, and heart to become a Triple Crown winner. How is that relevant to my remarks? These are attributes that Dasha Zamolodchikov has in abundance.

Dasha has a thoroughbred lineage—three of four grandparents and both parents were scientists. Born in Moscow, she came to the U.S. when she was six. Her precollege education was in New Jersey, France, and back in Russia, making her trilingual at an early age. She was fast out of the gate at Princeton, and had an extraordinary college career.

In our lab, Dasha worked on the relationship between Alzheimer's disease and the blood circulation. She wondered if the reason that some Alzheimer's disease patients show increased blood clotting was activation of a coagulation system. Using previous knowledge coupled with her creative ideas, she demonstrated this system is indeed activated in Alzheimer's disease patient plasma. Its activation by restricting blood flow in the brain and causing inflammation could help explain the cognitive decline seen in Alzheimer's disease. The work has possibilities for a new diagnostic test and new therapeutic approaches. Since Alzheimer's is a looming medical crisis, novel insights such as these provided by Dasha are desperately needed.

Like winning a horse race, pursuit of this work required intelligence, endurance, and heart. Nothing new is easily accepted, and Dasha had to persevere in the face of entrenched skepticism. But persevere she did, and the work had a happy landing as an outstanding publication, capping off a stunning graduate career. As one tribute to her abilities, the Regeneron company awarded her second prize in a worldwide contest for the most creative graduate students. The company was so impressed, they issued her a standing invitation for a job, and she will take them up on their offer in the fall.

Dasha is multidimensional to an amazing degree. She is a superb pianist, rock climber, ski racer, and in keeping with the theme of this talk, horseback rider. It was while rock climbing that she met an impressive Italian man who shared her enthusiasms and now shares her life. She of course then needed to add Italian to her language repertoire, which has made her quadrilingual. And she'll soon have to learn yet another language—baby talk—since she and Andrea have great expectations for a new addition in July.

Dasha has been a remarkable student. Her desk is close to my office, and many mornings my first conversation was with her. Incredibly knowledgeable, creative, lively, interactive, and fun, these conversations have been a joy to me. She and her dear friend seated on the stage, Anna Kruyer, with their boundless enthusiasm and energy, have helped create a wonderful atmosphere in our lab.

There are great things ahead for Dasha. My prediction? That she'll be the equivalent of the first winner of the quadruple crown.

Coming soon, to The David Rockefeller Graduate Program

As the graduating class of 2015 moves on to the next stages of life and career, the Rockefeller community welcomes the incoming group of graduate fellows. There were 689 applications received this year, and after careful consideration by the admissions committee, 81 applicants were offered admission to the university. Twenty-seven students will enroll, the university's second best yield since 2000 (two additional students deferred admission to next year). The 14 men and 13 women are from 11 countries: Austria, Belgium, Canada, China, Cuba, India, Peru, Singapore, Switzerland, Thailand, and the United States. Their alma maters include: Beihang University/Beijing Normal University; Cornell University; Georgetown University; Georgia Southern University; Grinnell College; Haverford College; Hunter College, CUNY; Kenyon College; McGill University; McMaster University; Medical University of Zurich; Massachusetts Institute of Technology; National University of Singapore; Peking University; Rutgers University; Smith College; Technical University Munich; Cayetano Heredia University; University of North Carolina, Chapel Hill; University of San Diego; University of California, Los Angeles; University of Havana; University of Pittsburgh; and Wellesley College.