Northeastern University
College of Science

The Husky Science Monitor

Volume 3, Number 1

Spotlight on the College of Science doctoral programs and its talented students

Prof. Dagmar Sternad and former post-doctoral student C.J. Hasson (Hasson is now an assistant professor in Northeastern's Department of Physical Therapy.)

contents

Message from the Dean

This edition of the *Husky Science Monitor* focuses on our Ph.D. programs, the life-blood of our research activities. Thank you for taking the time to read the *Monitor* and for staying connected with Northeastern's College of Science—alumni and friends are key enablers of our past and future success.

Why focus this issue on Ph.D.s? The growth in stature of COS undergraduate programs has been exceptional – today the average high-school GPA of our enrolled class is an exceptional 4.05, with average SAT scores of 1415. Each year these incoming metrics have gone up while Northeastern's reputation grows as the leading institution in the United States for experiential learning. Of course, what attracts today's students, and what I think has always attracted our students, is the power of co-op to illuminate and guide one's education into a rewarding career. As I tell incoming students and their parents when they make the tough choice of which school to attend – co-op helps you find your passion and guide your education before it is too late.

> While the Ph.D. student is learning, she is also the engine of the research enterprise, not only bringing more brains and hands, but also fresh approaches to scientific problems. I have graduated 15 Ph.D. students during my career, and it is gratifying to have shared in their development and to enjoy their success.

Research is intimately linked with science education. Increasingly, the vast majority of our outstanding students want undergraduate research experience. Some will become researchers, others want to learn how science works in the laboratory or on the blackboard so they can understand how science and

technology works for careers in business, government, industry, the clinic, or in education. Our outstanding faculty is key to our research enterprise – they are the scholars who advance knowledge and teach our undergraduates how it is done, and share where the excitement of the future may lie. The life-blood of the faculty research enterprise is the Ph.D. doctoral student, who learns how to be an independent researcher under the close guidance of their faculty research supervisor. While the Ph.D. student is learning, she is also the engine of the research enterprise, not only bringing more brains and hands, but also fresh approaches to scientific problems. I have graduated 15 Ph.D. students during my career, and it is gratifying to have shared in their development and to enjoy their success. Our Ph.D. students are the frontline for undergraduates in the laboratory, where both will spend much time together. To train our Ph.D. students, we hold advanced graduate courses, many of which are attractive to junior and senior undergraduates who wish to advance more rapidly in their field of interest.

In this issue, you will get a glimpse of the excitement our Ph.D. students bring to their diverse endeavors. While there are many very talented students, I don't believe that the Ph.D. program at Northeastern has received enough care and feeding in the last decade, and the time has come to change that. Our best faculty want the best students, and they can help us attract the best students to Northeastern. We must be aggressive in recruiting and in mentoring our Ph.D. students.

Fellowships to support these students are essential, and while research grants from the government and industry are important, generous philanthropic support can help jump start our quality improvements by attracting the most outstanding students.

We hope that Northeastern's upcoming capital campaign – Empower – will, with your help, provide support for undergraduate research co-ops, Ph.D. fellowships and faculty endowed chairs that will together advance our research and educational enterprise to the next level.

Thank you for your support!

Murray Gibson

Did you know . . .

There are approximately 500 active laboratory classrooms and research laboratory spaces in the service of our College of Science programs.

42 COS graduate students participated in co-op placements during the 2011–2012 academic year, earning them valuable professional experiences in their chosen fields.

In summer and fall 2013, COS will welcome 3 Distinguished Graduate Fellowship awardees as they begin their Ph.D. studies and research in the fields of biology, chemistry, and psychology.

new!

Northeastern will be offering the nation's first **interdisciplinary doctoral program in network science,** an emerging field that reaches the underlying complexity that governs all systems—be they comprised of atoms in a molecule or people using social media to communicate across the globe.

The Department of Marine and Environmental Sciences has launched a new Ph.D. program: **Ecology, Evolution, and Marine Biology.** This program is a key component of the Urban Coastal Sustainability Initiative, and will focus on approaches to environmental sustainability in the context of global change.

COS graduate programs

Ph.D. Offerings
Biology
Chemistry and Chemical Biology
Marine and Environmental Sciences
Mathematics
Physics
Psychology

M.S. Degrees Offered
Biology
Bioinformatics
Biotechnology
Marine Biology
Chemistry and Chemical Biology
Mathematics
Mathematics-Operations Research
Mathematics-Industrial and Applied
Physics

Biology

Degrees offered:
Ph.D., M.S.

The Biology Department combines a broad knowledge base with an in-depth study of specialized areas, and emphasizes close interaction between graduate students and faculty to develop the skills required for creative independent research. Faculty research includes biochemistry, cell and molecular biology, physiology, ecology and evolution.

Bioinformatics

Degree offered: M.S.

The professional science master's degree program in bioinformatics and computational molecular biology is a professional program which consists of four parts – fundamental courses, core courses, internship, and electives. All courses are available in the late afternoon or evening.

Biotechnology

Degree offered: M.S.

The professional science master's degree program in biotechnology provides students with a common core of knowledge in biotechnology, with particular emphasis on their ability to integrate knowledge across disciplinary boundaries. Specific objectives are to provide students with didactic and practical knowledge in genomics, proteomics and other bio-analytical approaches (molecular biotechnology); in drug discovery, development, and delivery (pharmaceutical biotechnology); and in bioprocess development, and optimization (process development).

Chemistry and Chemical Biology

Degrees offered: Ph.D., M.S.

The department offers thesis and non-thesis based advanced degrees with concentrations in analytical, inorganic, organic, and physical chemistry, and in interdisciplinary fields such as polymers, materials, and bio-related chemistry. Ph.D. – This program is designed for students who have earned a bachelor's or a master's degree in chemistry and who wish to earn a doctorate degree in chemistry. The program of study includes some course work, but the primary emphasis is on the completion of an original research project, its articulation in a well-written thesis, and its subsequent defense before a panel of department faculty.

Marine Biology

Degree offered: M.S.

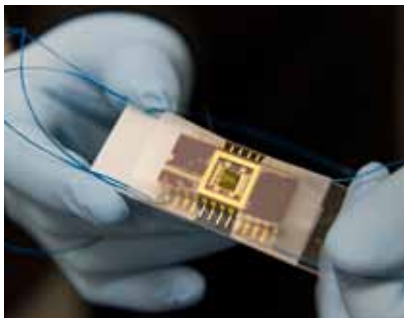
The professional science master's degree program in marine biology provides the advanced skill set needed to pursue an entry- to mid-level career in marine research, or can serve as a springboard into the nation's top Ph.D. programs in marine biology. This full-time program is offered in conjunction with Northeastern University's Three Seas Program. Now in its 25th year, the Three Seas Program has an impressive record: Alumni routinely gain admission to the top Ph.D. programs in the country, publish high quality research, and are leaders in their fields.

Mathematics

Degrees offered: Ph.D., M.S., PlusOne

The graduate programs in the Department of Mathematics provide students with the opportunity to gain a strong general foundation and proficiency in specializations, such as algebra, geometry, geometric analysis, and combinatorics. Graduate students work with internationally-recognized faculty in a range of research programs in both pure and applied mathematics. Students also have the option to pursue an M.S. in operations research mathematics and industrial and applied mathematics.

Physics



Degrees offered: Ph.D., M.S.

Students in the Ph.D. program perform advanced research in condensed matter, fundamental particles and fields, biophysics, and complexity. The master's of science program gives you an understanding of the basic theoretical structures of physics as preparation for conducting cutting-edge research.

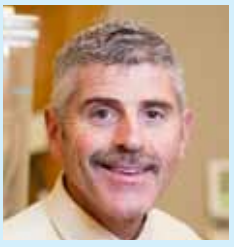
Psychology

Degree offered: Ph.D.

The Ph.D. program in the Psychology Department covers a wide spectrum of contemporary behavioral science within a close-knit community of faculty and students. The program offers four distinct areas of experimental emphasis: behavioral neuroscience, cognition, perception, and social/personality. The objective of the Ph.D. program is to prepare students to become colleagues in research and teaching in psychology.

Heather Brenhouse
Psychology

Win Chai
Biology



Raymond Booth
Chemistry

New Faculty (as of July 2013)

Welcome to Northeastern!

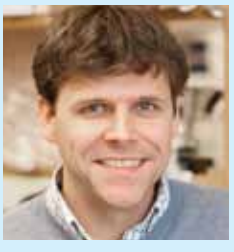
Adrian Feiguin
Physics

Tarik Gouhier
Marine and
Environmental Sciences

Brian Helmuth
Marine and
Environmental Sciences

Randall Hughes
Marine and
Environmental Sciences

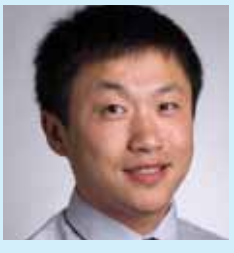
David Kimbro
Marine and
Environmental Sciences



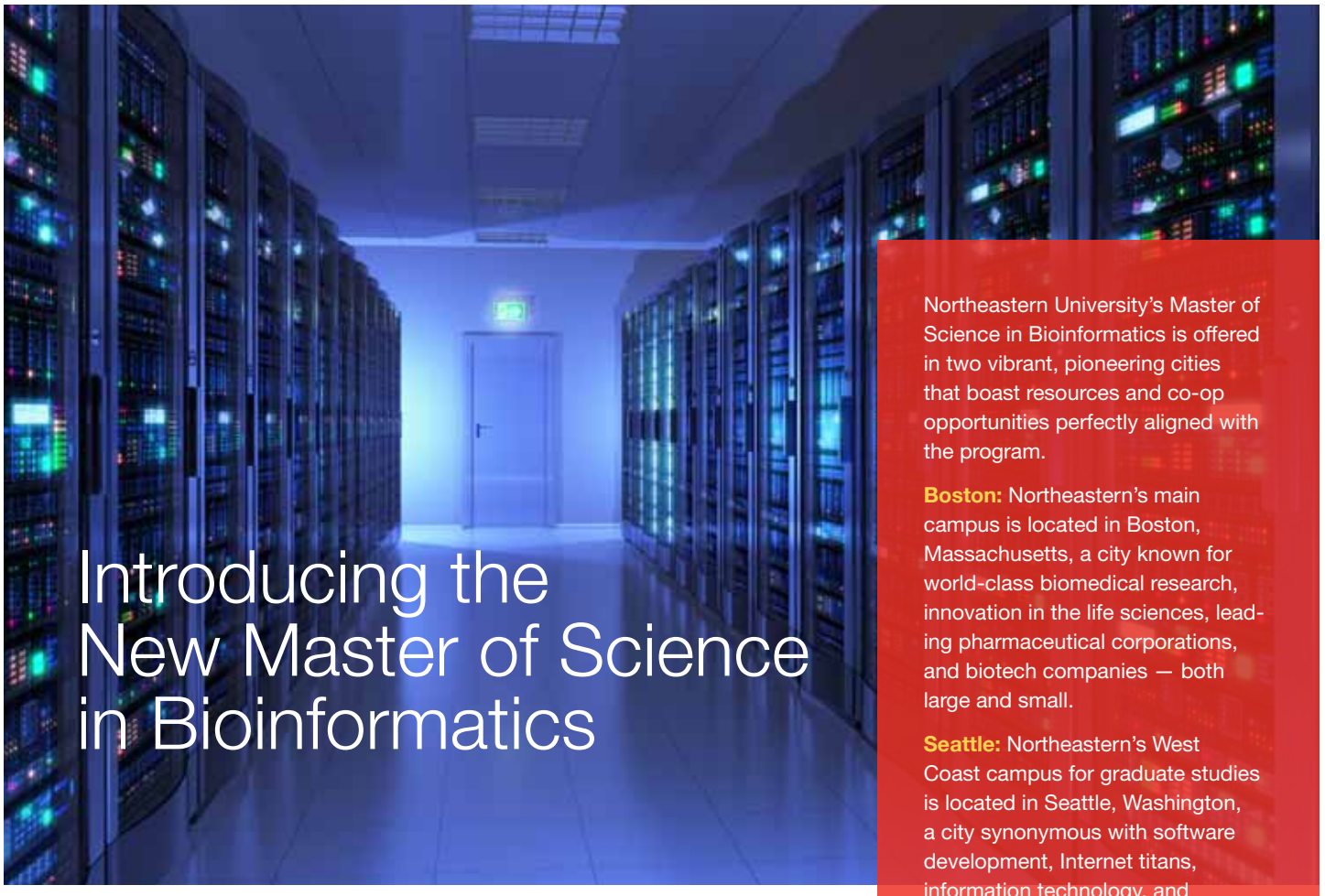
James Monaghan
Biology

Toyoko Orimoto
Physics

Paul Whitford
Physics



Ke Zhang
Chemistry



Introducing the New Master of Science in Bioinformatics

Northeastern University's Master of Science in Bioinformatics is offered in two vibrant, pioneering cities that boast resources and co-op opportunities perfectly aligned with the program.

Boston: Northeastern's main campus is located in Boston, Massachusetts, a city known for world-class biomedical research, innovation in the life sciences, leading pharmaceutical corporations, and biotech companies — both large and small.

Seattle: Northeastern's West Coast campus for graduate studies is located in Seattle, Washington, a city synonymous with software development, Internet titans, information technology, and biotechnology.

East Coast or West, Northeastern University delivers the same rigorous academics, cutting-edge research opportunities, innovative faculty, and supportive global alumni network for an unparalleled educational experience and solid foundation for an exciting and fulfilling career.

Big Data. It's today's buzzword. It's also a driving force behind the explosive demand for trained professionals in the field of bioinformatics. With high-throughput genomic assays generating significantly more data, research within the life sciences is increasingly data-intensive. As a result, the need for individuals with the broad, interdisciplinary knowledge and skills to plan, mine, analyze, and interpret large-scale data sets continues to grow.

Northeastern University's Master of Science degree in Bioinformatics and Computational Biology provides the cross-disciplinary training in biology, computer science, and information technology — along with real-world experience — that prepares graduates to play pivotal roles in today's cutting-edge life science, biotechnology, and pharmaceutical industries, including: genomics, proteomics, personalized medicine, drug discovery, and cancer therapy. "Today, bioinformatics professionals are playing critical leadership roles throughout the life sciences and pharmaceutical industries," said Prof. Steven Vollmer, director of the Bioinformatics Program. "Northeastern's multi-disciplinary bioinformatics program is opening up new and exciting career opportunities for recent undergraduates and professionals alike — helping biologists become computer savvy, and retraining computer and IT specialists for the biotech industry."

The College of Science at Northeastern University is committed to delivering cutting-edge programs that foster interdisciplinary thinking, research, and the pursuit of innovation-driven discoveries that have an impact on lives. That commitment and vision are at the very core of the Master of Science in Bioinformatics. Combining challenging academics in biology, computer science, and information technology with real-world experience, the program helps students integrate the knowledge, skills, experience, and confidence they need to achieve their goals and make a difference in our world.

Students in the bioinformatics program gain real-world knowledge, awareness, perspective, and confidence during a three- or six-month graduate co-op in industry or academia. As the recognized leader in experiential learning and a trusted source of high caliber students, Northeastern enjoys relationships with more than 2500 public and private sector employers on seven continents. Recent bioinformatic co-op placements have included the Broad Institute, Harvard Medical School, Brigham and Women's Hospital, the Dana-Farber Cancer Institute, and pharmaceutical giants including Genzyme, Millennium, and Novartis. "Northeastern University's Bioinformatics program gave me the solid foundation in molecular biology and bioinformatic computational methods needed to apply my systems development skills to biological questions," said Charles Roesel, Bioinformatics 2013. "Northeastern's established ties with co-op employers provided a number of choices, including the Perrimon Lab at Harvard Medical School, where I had the opportunity to co-author my first scientific paper and develop a web-based application for proteomic analysis of high-throughput data sets."

cos doctoral students

Studying the Origins of the Universe

Gregory Peim

Ph.D. candidate, Physics
Advisor: Prof. Pran Nath

"I applied to the graduate program at Northeastern to work with Prof. Pran Nath for his reputation as a researcher. I was interested in working on supergravity and the ability to detect such models experimentally."

Peim says during the initial data taking stage of the Large Hadron Collider (LHC), his research focused on the potential to discover new physics in the early runs.

"Such studies included the crucial understanding and proper simulation of background processes. In the same work, these Standard Model processes were then used to investigate the LHC's reach potential in supergravity parameter space," he says.

Peim says that in the beginning of 2011, the LHC started to release early 7 TeV analysis beyond the Standard Model physics.

"The limits they found surpassed those from the Tevatron," he says. "My colleagues and I began to study how their results could be extended to other regions of the parameter space."

Additionally, Peim said, his group explored the implications that these results had on direct detection dark matter experiments.

"It was found that within supergravity models the LHC had excluded a large region of the signature space at direct detection experiments. The analysis was then extended to supergravity models with non-universal soft breaking in the gaugino sector. In this case, we found that a part of the dark matter-excluded region became repopulated and thus a signature to observe nonuniversality."

Peim said the majority of current studies only consider the case where one fundamental particle contributes to cold dark matter, but there is no overriding principle that requires such a restriction.

"Dark matter may in fact be composed of several components," he says. "A branch of my research has been to investigate such a possibility. In one paper, my collaborators and I proposed extending the Minimal Supersymmetric Standard Model by a hidden sector field that includes both fermionic and baryonic stable particles as dark matter candidates, which was the first in literature to do so."

Peim says he has also investigated whether there is some underlying principle behind the ratio of the dark matter relic density to baryonic relic density being about 5, i.e. the cosmic coincidence.

"We extended the Standard Model as well as the Minimal Supersymmetric Standard Model using the Stueckelberg mechanism to explain the cosmic coincidence," says Peim. "We discussed several candidate models for asymmetric dark matter using a variety of operators constructed from Standard Model fields, which transfers the asymmetry to the dark matter sector at thermal equilibrium in the early universe. The Stueckelberg extension provides us with a mechanism to deplete the symmetric component of dark matter produced by thermal processes. In the Minimal Supersymmetric Standard Model extension, the model has two dark matter candidates with the additional one being the stable neutralino."

"Gregg has worked on two very different areas of fundamental physics — the search for new physics at the LHC and the physics of the early universe," says Prof. Nath. "In each area, he has made outstanding contributions. He has published 13 papers, has over 350 citations and a Hirsch index of 11, which are significantly more than any other theory graduate student in recent memory."

Gregory Peim

Daniel Blustein

Building Robo-Animals

Daniel Blustein

Ph.D. candidate, Biology
Advisor: Prof. Joseph Ayers
Dan was awarded the AAAS Science Media Fellowship for Summer 2013

Dan Blustein uses robot animals to study biological principles related to animal behavior and neuroscience, and expects to graduate in May 2014.

"I got involved in this research because it combines my two passions — biology and engineering — which is what I was looking for in graduate school," says Blustein. "We build biomimetic (mimicking natural systems) robots that can be manipulated in order to test biological hypotheses. For example, we can experimentally change the nervous system on a robot to observe effects on its behavior. From these experiments, we can make inferences about animal behavior and neuroscience."

Blustein says, in addition to what his group learns about animals, they are also trying to build robots that can behave more like animals.

"Traditional robots have been known to get stuck or lost, two outcomes we don't see very often in animals in the natural world," he says. "We hope that by mimicking the ways that animals move about in their environments, we can build more capable robots."

Blustein has published several papers on his team's research. "Some of them have shown how we build biomimetic robots to use for scientific discovery. A video publication came out in May which shows others how to use the biorobotic approach using Lego robots."

His most recent research has been focused on extending the robotic approach from underwater robots to flying and wheeled robots. Right now, he says they are working to develop an electronic nervous system to control a robotic bee.

Blustein has given many presentations over the years at conferences, at Northeastern, and in local classrooms.

"Last year, I spoke to middle schoolers about robotic bees, to teachers about underwater robots, to colleagues at a conference about my research, and to graduate students at a science communication workshop," he says.

Blustein is also one of several graduate students at Northeastern University's Marine Science Center who writes for a blog supported by the College of Science. "We share information about our research, life as a grad student, and science in general," he says. "It's a great way to connect with those interested in the work, both colleagues and science enthusiasts. I also recently began serving as a Twitter ambassador for the College of Science. It's been a fun challenge trying to make science interesting and concise on the Twitter platform."

Post-graduation, Blustein says he'd really like to work "at the intersection of research, education, and policy."

"I enjoy satisfying my curiosity by making scientific discoveries, but I love bringing this information to the general public through educational and policy avenues."

Professor Ayers says Blustein's research is important because these nervous system hypotheses can't be tested on living creatures, but robots can be studied extensively to determine the principles that control adaptive behavior. He is also impressed by Blustein's outreach initiative.

"It's really unique, he can use LabVIEW instruments to build networks in Lego Mindstorms, and he's developed a K-12 curriculum to teach high school students using these robots. It's very impressive."

Cracking Casmir Equations

Andrea Appel

Ph.D. candidate, Mathematics
Advisor: Prof. Valerio Toledano Laredo

Appel met his advisor during his first year at Northeastern after attending one of his reading courses.

"I was deeply impressed by his ability to explain the interactions between many areas of mathematics in an extremely elegant and transparent way," says Appel. "I really loved the aesthetics of the mathematics describing the deep connection between certain systems of differential equations and quantum groups. This connection is a fundamental ingredient in Prof. Toledano Laredo's research, and I found it very hard and terribly beautiful."

"My dissertation, titled 'Monodromy Theorems in the Affine Setting,' is aimed at proving a variant of the famous Kohno-Drinfeld theorem for a certain class of infinite dimensional algebras. This is part of a bigger project of Prof. Toledano Laredo — and all his students — aimed at the complete description of the properties of the 'Casimir equations,' a particular system of differential equations that was discovered by Prof. Toledano Laredo himself."

Appel's current project consists of three papers.

"The goal is to establish an equivalence between two different incarnations of the generalized braid group representations of affine type. This can be achieved in three steps and each paper is describing one of the steps," he says.

Appel has also taught Calculus I in spring 2009 and Mathematical Thinking in spring 2011.

He has also served as a teaching assistant several times for Group Theory, Linear Algebra, and Calculus III. Appel also founded and served as president of the Mathematics Graduate Student Association. The main goal of the group is to improve and maintain communication between graduate students and faculty.

Based on his research proposal, Appel has been accepted as a Postdoctoral Fellow at the Einstein Institute at the Hebrew University in Jerusalem for 2013–2014.

"And, beginning January 2014, I will be a (non-tenure-track) assistant professor at the University of Southern California," he says.

Prof. Toledano Laredo says Appel's time at Northeastern has been well spent. "In his thesis, Andrea solved a very important problem which lies at the crossroads of several areas of mathematics and mathematical physics — representation theory, algebraic geometry, and string theory, to name a few. He did so by using a fascinating blend of algebra, logic, and number theory, which Andrea manipulates with great virtuosity."

Andrea Appel

Paul Condon

Compassion Through Meditation

Paul Condon

Ph.D. candidate, Social/Personal Psychology
Advisor: Prof. David DeSteno

For his doctoral research, Condon is examining the impact of sustained contemplative practice — i.e. meditation —on interpersonal behavior.

"I entered graduate school in 2009 with an interest in compassion and pro-social behavior — stemming in part from books written by the Dalai Lama, which I read in college — and subsequently began my master's research on compassion and its ability to counter-veil aggressive behavior," Condon says. "My attendance at the 2010 Mind & Life Summer Research Institute in Garrison, New York, however, invigorated my interest and ability to examine the inter-personal benefits of meditation practice. This conference exposed me to a deep body of knowledge in science and contemplative scholarship (like Buddhism) that could serve as a precedent for research on the social impact of meditation. Attendance at the conference allowed me to apply for grant funding through the Francisco Varela Research Awards at Mind & Life, which was ultimately awarded. We used the grant to conduct a study examining whether participation in an eight-week mindfulness — or compassion-based — meditation course increases compassionate responses to another's suffering, relative to those who did not complete a meditation course. It turned out that those in the meditation groups exhibited higher amounts of compassionate behavior toward a stranger relative to those who did not complete the course."

Condon said, in clinical psychology and neuroscience, there have been numerous documented cases of intra-personal benefits emanating from mindfulness and compassion-style meditation practice. These include increases in gray matter density, positive affect, and improvements in various cognitive abilities and mental health outcomes.

The wealth of findings demonstrating the health and emotional benefits of meditation motivated my doctoral research, which is looking at those very questions.

Condon says although several researchers have begun to examine the benefits of meditation, his research is the first to examine behavior in a real world setting.

Currently, Condon is working on two projects that directly expand upon his previous work.

"Based on the findings from my master's work, we are continuing to study the impact of compassion on aggressive behavior directed at a transgressor and the extent to which this effect might transcend group boundaries," he says. "My master's work indicated that a temporary experience of compassion for one individual can carry over and result in reduced aggression directed at a separate, transgressing individual. Yet, it's unclear if that experience of compassion will reduce aggression for a member of a threatening out-group. We are studying this very question, and the results will have clear implications for 'compassion interventions' that might be geared toward reducing inter-group conflict."

Also, based on the findings from Condon and his group's first meditation study, they applied for a second grant — through the 1440 Award for Real-World Contemplative Research at Mind & Life — which was recently awarded.

"In this study, we will further examine whether sustained contemplative practice increases compassionate behavior," he says. "This study, however, will integrate measures of peripheral psychophysiology — like heart rate and skin conductance as measures of sympathetic arousal — and measures of daily subjective experience. This will allow us to examine whether increases in compassionate behavior can be predicted by meditation-induced changes in autonomic functioning and subjective experience."

Prof. DeSteno says he's been impressed with Condon's graduate work. "Even at this early point in his career, Paul has been recognized internationally for his work on pro-social behavior," says DeSteno. "Using an interdisciplinary perspective, Paul has begun to illuminate the mental mechanisms that underlie humans' capacity for compassion — work that already has earned publications in prestigious journals and attracted external funding."

Stretching DNA to the Limit

Kathy Chaurasiya

MRC Career Development Fellow, Imperial College London
Ph.D., Physics, Northeastern University
Ph.D. Advisor: Prof. Mark Williams

"DNA is a double-stranded helix of complementary base pairs, and many proteins are required to organize cellular DNA and read the genetic code," says Chaurasiya. "I use optical tweezers to capture and stretch a single molecule of DNA in the presence of these proteins. They bind the DNA molecule and alter its structure, and measurements of these effects provide insight into the function of these proteins inside complex living systems."

Chaurasiya says she chose Northeastern University for her Ph.D. specifically to do this particular kind of research.

"Mark has been an amazing advisor, one of those rare physicists who understands both the world and the people in it," she says. "His explanations on seemingly intractable topics crystallize in a concise and elegant way, and I knew that joining his group would allow me to explore the biology questions I find important and interesting."

Chaurasiya's thesis research has focused on replication of retroviruses and retrotransposons, which reproduce by copying their RNA genome into cellular DNA.

"In the paper I just submitted, I used optical tweezers to demonstrate and quantify the two biophysical mechanisms by which the human protein APOBEC3G (A3G) inhibits HIV replication. Retroviruses and retrotransposons encode proteins called nucleic acid chaperones, which rearrange the viral genome and are therefore required for successful replication."

Chaurasiya explains that A3G is a protein present in the type of human cells susceptible to HIV, and it inhibits HIV replication in the absence of the viral infectivity factor, which is protein the virus evolved to counteract A3G.

"It has been well-established that A3G mutates viral DNA, which impairs viral replication. However, there is also strong evidence for an additional, unknown mechanism by which A3G inhibits HIV replication. Our collaborators have proposed the roadblock model as a hypothesis, in which A3G binds the HIV genome and blocks the HIV DNA polymerase, called reverse transcriptase, from making the virus' DNA. However, because only about seven A3G molecules are inside the virus, the roadblock mechanism requires A3G to unbind from single-stranded nucleic acids very slowly. However, A3G is an enzyme that mutates the viral genome very quickly, which requires rapid on-off rates from single-stranded nucleic acids."

Chaurasiya says she resolved these seemingly contradictory biophysical mechanisms by demonstrating that oligomerization transforms A3G from a fast enzyme to a slow nucleic acid binding protein.

"This paper answered a very specific question: how does A3G work against HIV? But the biophysical mechanism we demonstrated could also be how other proteins similar to A3G regulate their enzymatic activity in order to inhibit retroviral replication in multiple ways. The relative strength of these two redundant mechanisms is probably optimized by the cell's immune system for different responses to retroviruses and other threats to human health."

Prof. Williams says he has no doubt that Chaurasiya's accomplishments at Northeastern will have a very strong impact on the field of retrovirus replication, as well as in single molecule biophysics.

"Her work on A3G could only be done by someone with great experimental skills as well as the ability to work independently with several researchers from different fields, from theoretical biophysicists to virologists," he says. "Kathy's incredible work ethic, intelligence, instinct for research, and great communication skills have all combined to make her a stellar and accomplished researcher."

Kathy Chaurasiya

Characterizing Proteins

Han Zhou

Ph.D. candidate, Chemistry
Advisor: Prof. Alex Makriyannis

"This project requires very solid molecular biology and bench work abilities to generate healthy cell lines and reliable results," Zhou says. "We've identified the precise binding sites for several ligands on CB1 and CB2 (two G-protein coupled receptors) through site-directed mutagenesis and covalent labeling assays to develop and design novel drug candidates."

Zhou says the method applied in her project is called Ligand-Assisted Protein Structure (LAPS), which was discovered and developed within the Center for Drug Discovery (CDD).

"It contains molecular biology," she says. "The target CB receptors are too large for NMR or X-ray to test, so we have LAPS to look into the motifs inside to get structural information. Ligands with covalent probes are designed and assayed. For a certain compound, we have several binding site candidates, so we mutate the sites one by one and assay again, to find the key residue(s) responsible for the attachment. Another way to localize the site is using mass spectrometry. Combining motifs with functions, we're building a relationship between binding sites and signaling pathways, which will help understand the receptor and future drug design."

Zhou says her most recent work centers on protein purification and mass spectrometry-based characterization of the human CB2 receptor.

Zhou has given several talks about her work for meetings, conferences, seminars, and retreats, including presentations at the 21st Annual Symposium on the Cannabinoids for the International Cannabinoid Research Society and the Current Trends in Drug Abuse Research 9th Annual Symposium.

Zhou says her post-graduation goal is to find a job in her field.

Prof. Makriyannis says Zhou is an excellent researcher, always ready to exchange ideas and accept suggestions.

"She brings a positive outlook and dedication to her research and a considerable degree of intellectual independence," Makriyannis says. "In her work on LAPS, a central portion of her thesis, she has collaborated with several other scientists here at the Center for Drug Discovery and outside Northeastern. She has shown herself to be a good scientist and collaborator."

Han Zhou

Using Physics to Understand the Heart

Zhen Song

Ph.D. candidate, Physics
Advisor: Prof. Alain Karma
Song was the recipient of a prestigious American Heart Association pre-doctoral fellowship

"The American Heart/Stroke Association is committed to identifying and supporting specific science areas deemed vital to achieving their mission and strategic objectives," says Song. "The Association has established partnerships with various organizations to fund critical-need, high-impact, and focused research programs. I currently hold an American Heart Association (AHA) pre-doctoral fellowship, which aims at helping students initiate careers in cardiovascular and stroke research by providing research assistance and training."

Song received the AHA pre-doctoral fellowship in July 2011.

"Under the guidance of Professor Karma, I proposed a project using computer models to study arrhythmogenic effects of calsequestrin mutations," he says. "Triggered activity often causes life-threatening reentrant cardiac arrhythmias. Various forms of triggered activity have been linked with mutations of one or several cardiac membrane ion channels in the setting of the inherited Long QT (LQT) syndrome, or with mutations of calcium cycling proteins as in the setting of Catecholaminergic Polymorphic Ventricular Tachycardia (CPVT), which is an inherited life-threatening electrical disturbance of the heart. Carriers of LQT mutations are at risk for polymoriphic ventricular tachycardias such as torsade de pointes (TdP) and/or sudden cardiac arrest."

Song says considerable progress has been made in the molecular characterization of various cardiac gene mutations in several congenital diseases, but arrhythmogenic mechanisms of triggered activity are varied and complex and remain not completely understood, even at a cellular level.

"A main reason is that triggered activity at this level results from the complex interaction of a very large number of cardiac membrane ion channels and calcium cycling proteins," he says. "Thus, it is generally extremely difficult, if not impossible, to predict the effect of one defective gene-coded functional protein, taken in isolation, without considering its interaction with all the other normally-functioning cardiac proteins. From this standpoint, in-silico electrophysiological computer models of cardiac activity provide a powerful tool to study this complex interaction in order to gain basic mechanisms of triggered activity and arrhythmias. The overarching goal of my proposed doctoral research is to further develop and use a new physiologically detailed in-silico electrophysiology model of the ventricular myocyte to gain basic insights into calcium-mediated cellular mechanisms of triggered activity."

Overall, Song says his research goal is to understand the basic arrhythmogenic mechanisms of CPVT. CPVT occurs in genetically-predisposed individuals without structural cardiac abnormalities.

"It is typically manifested as syncope in the setting of physical activity or acute emotion," Song says. "Even though CPVT is a rare disorder, it is estimated to account for roughly 15 percent of all sudden cardiac deaths in young people. Even though we focus specifically on a rare genetic disorder, the insights derived from this study are also expected to be relevant for other diseases such as the LQT syndrome and heart failure. Also, while this investigation is limited to a cellular level, we expect the insights to provide a basis to understand mechanisms of triggered activity at the organ level where they become even more complex. Lastly, ventricular fibrillation remains a major cause of sudden death in the US and worldwide. The novel insights into mechanisms of triggered activity from the study should provide an improved basis for risk stratification in a broad population and the development of reliable antifibrillatory drug therapies."

Post-graduation, Song will begin a postdoctoral fellowship this spring at Cardiovascular Research Laboratories, David Geffen School of Medicine, at UCLA.

Dashun Wang

Breaking Down Big Data & Human Behavior

Dashun Wang
Ph.D. candidate, Physics
Advisor: Prof. Albert Laszlo Barabasi

"When I started graduate school, we were witnessing a fundamental shift in the area of social systems — availability of large-scale datasets," says Wang. "Indeed, just about everything we do leaves digital traces constantly being recorded in some database. Our whereabouts are saved by mobile phone companies for billing and routing purposes, and also by various mobile apps we installed on our smart phones. Whenever we make a purchase, what we shop for and our taste is indexed by credit card providers and the vendors we shop with. These large-scale datasets, capturing — in unprecedented detail — human activities, are expected to fundamentally alter our understanding of human behavior."

Wang says his research has three main focus areas:

"The first one is about the interplay between human mobility patterns and social networks," he says. "How do an individual's whereabouts affect who he interacts with, and vice versa. The goal is to develop a mathematical and analytical understanding of the spatiotemporal aspects of human behavior."

The second focus, Wang says, is to understand human behavior in the face of emergencies and other extreme events. He says much progress has been made studying human dynamics during regular activities, but there is an exceptional need to also study human activity in times of great duress.

"Lastly, and also more recently, we have been wondering whether there are any reproducible patterns behind success and future impact and if can we predict them," he says.

Wang says, in one published paper, he and his fellow researchers asked if it is possible to predict social contacts by looking at where people have been — their mobility patterns.

"We find mobility patterns reveal just as much, if not more, than state-of-the-art metrics about your friendships," he says. "Most importantly, we demonstrate that when combining mobility and social network information, we have shockingly high confidence in predicting your next social contact, which also raises new privacy implications."

In the case of emergencies, Wang says they've found that human behavior exhibits rather reproducible patterns.

"We identified several patterns from three aspects: temporal (when do you call after an emergency and how long does it last), spatial (how far are you from the epicenter of the event), and social (whom do you contact during emergencies)."

Wang's most recent research centers on understanding the laws that govern success.

"We just finished a paper that quantifies 'success' in science — scientific papers," he says. "The paper is currently in submission to *Science*."

Wang says he feels fortunate to have presented his, and his group's, research in many international conferences and at some of the world's leading institutes.

"I found it a rather fascinating experience — to share with others my research and also to learn about others' work," he says.

Post-graduation, Wang says he hopes to continue research on the topic of success and to extend its understanding beyond the scientific setting, "looking at other domains like product adoption, popularity in social media like YouTube or Twitter, and so on."

Wang's advisor, Prof. Barabási, says he's been very impressed with Wang's graduate work.

"It is hard to be interdisciplinary, without compromising depth and quality," Barabási says. "Dashun, as a student, has managed to find that middle ground. His research is far-reaching, impacting many disciplines — from network science to computer and social sciences — without giving up the rigor of the physics perspective."

From Three-Seas to Ph.D.

Catherine Matassa

Ph.D. candidate, Marine Biology
Advisor: Prof. Geoffrey Trussell

"I am an alumna of Northeastern's Three Seas Marine Biology Program, and I met Geoff through that program. He taught the experimental design/statistics course in the fall semester, which I now teach. In the class, we conducted an experiment that examined how intertidal snails behaved when they smelled their crab predators."

Matassa became interested in the anti-predator behaviors of prey, and she completed her master's research examining these types of predator-prey interactions in California kelp and, during an internship with Trussell, in New England rocky intertidal communities.

"The internship with Geoff allowed me to further explore the 'nonconsumptive' effects of predators — predators scaring prey — in contrast to 'consumptive' predator effects — or predators consuming prey/reducing prey density — in a very tractable system. Our collaborations during this time led to several publications."

After she earned a master's degree through the Three Seas Program, Matassa decided to stay on as a Ph.D. student in Trussell's lab and continued to use the model rocky intertidal system they developed.

"I use a combination of laboratory and field experiments to understand how prey manage their risk of predation and the ecological consequences of their behavior," she says. "One example would be trophic cascades. Trophic cascades, in the classic sense, occur when carnivores — predators — eat herbivores — prey — and have a positive indirect effect on plants — the resource. However, ecologists are beginning to appreciate that trophic cascades can arise without the consumption of prey by predators."

Matassa explains that when prey detect their predators, they will often reduce their foraging activity so that they can hide or be more vigilant.

Catherine Matassa

"This behavioral response has a positive effect on the prey's resources and lead to a trophic cascade," she says. "Trophic cascades are important for the stability and functioning of healthy ecosystems and are often used in conservation or ecological management."

For example, she says, wolves were reintroduced into Yellowstone National Park to cull the booming elk population and restore the heavily consumed plant community.

"However, the wolves did not have to consume the elk to make a big impact on the plants," Matassa says. "The scared elk retreated into the safety of the forest — a refuge habitat — and this allowed for the plant communities around the open riverbeds — a risky habitat —to be restored."

Matassa's research examines how different environmental contexts — like how much food is available, quality of hiding places, etc. — can shape the way prey respond to their predators and determine the strength of these fear-driven trophic cascades.

"You can imagine that it would be hard to do experiments on such large and wide-ranging animals, so I use a model food chain of small intertidal invertebrates — a predatory crab, an intermediate consumer snail, the prey, and mussels or barnacles as the bottom of the food chain. The overarching goal of my research is to understand when, where and how the fear of predators will have cascading consequences on ecological communities."

Matassa also says she's had wonderful teaching opportunities at Northeastern, as a teaching assistant and an instructor.

"For the last several years, I've been teaching the Three Seas class my advisor taught when I was in the program," she says. "It's a hands-on, field-based experimental design/statistics course for upper undergrads and beginning grad students. The field-based part might seem a strange component for a statistics-type course. But what it means is that I actually take the students through the process of an experiment, from developing hypotheses, designing the experiment and conducting the experiment — and these are typically large-scale field experiments based in my research area of predator-prey interactions — to analyzing the data and writing up a manuscript that could be submitted to a journal. We even go through the peer review process."

Matassa says she's grateful for the opportunity to teach this kind of class as a graduate student and, especially, to teach it multiple times.

"I've been able to develop my own material and structure for the course, as well as my own teaching style," she says. "My ultimate goal is to be a professor, and the skills I've developed at Northeastern as a researcher and a teacher have been invaluable."

Prof. Trussell says what really distinguishes Matassa from her peers is that "her work and insights on the ecological effects of predation risk began to influence scientific thinking well before she was ready to defend her dissertation this year."

"This influence, coupled with many other successes such as a Dissertation Improvement Award from the National Science Foundation, is why Catherine will be a hot commodity on the academic job market this fall."

Supporting the College of Science

Rob Esmond is a new Barnett Advisory Boardmember. His gift supports the Barnett Institute for Chemical & Biological Analysis. Dr. Esmond is a director in the Biotechnology/Chemical Group of the Washington, D.C. based intellectual property firm Sterne, Kessler, Goldstein & Fox P.L.L.C. His intellectual property law experience has principally been in the biotechnology and chemical areas.

Len McNally ’72, MS ’78 Biology supports young people who might not otherwise have the opportunity to discover marine sciences. He believes that it is critical to expose socio-economically disadvantaged youth to the sciences to open their minds to knowledge and career opportunities that they previously would not envision as a possibility. Therefore, he annually provides financial need-based scholarships for the Coastal Ocean Summer Academy at the Marine Science Center; a unique two-week program for high school students enabling them to explore ocean habitats and resources along the coast from Ipswich to Boston.

Dr. Stanley Burba ’61 Biology established the Burba Family Lectureship to bring world-class marine scientists to Northeastern, serving as an interdisciplinary catalyst for discussion among our faculty, students, and the surrounding community. Sylvia Earle was granted the honorarium of Burba Family Keynote Lecturer at Northeastern’s Sustaining Coastal Cities conference on May 22, 2013.

THE NERD ALERT

Honors and Awards

Faculty Awards and Honors

Prof. Thomas Gilbert Elected to ACS Board of Directors

Northeastern University's Prof. Thomas R. Gilbert, an associate professor of chemistry and chemical biology, was recently elected to the American Chemical Society Board of Directors. He will serve as the director for District I, which includes New England, New York, and parts of Pennsylvania. Read more of the story here: http://goo.gl/VSEhM

Prof. Alessandro Vespignani Elected as President of the Complex Systems Society

The science of complex systems was born in the mid-20th century, but it has only recently begun to mature into a research field with real-world relevance. The development of new technologies that stamp data points on nearly all of our activities is allowing us to quantifiably study society — the ultimate complex system.

"Complex systems is really now getting into a different stage of its life in which it can start to have an impact through practical applications," said Alessandro Vespignani, the Sternberg Family Distinguished University Professor of physics, computer science and health sciences.

It is for this reason that the European Union sought, in 2006, to support the first-ever academic society devoted to complex systems science, which comprises 600 members worldwide. This year, in the first renewal of the society's leadership, Vespignani was elected as its president. Read more of the story here: http://goo.gl/TMm7L

Alessandro Vespignani

Lisa Feldman Barrett

Prof. Lisa Feldman Barrett Elected to the Royal Society of Canada

The College of Science would like to congratulation Prof. Lisa Feldman Barrett who was recently elected to the Royal Society of Canada. The Society is made up of Canadian citizens or residents who have made outstanding contributions to the arts, humanities, sciences, and Canadian public life. Read more of the story here: http://goo.gl/AIXnv

Jerzy Weyman

Prof. Weyman Elected Humboldt Fellow

Prof. Jerzy Weyman was elected a Humboldt Fellow. The prestigious award is sponsored by the German government and the Alexander van Humboldt Foundation to bring talented foreign scholars to the country's top universities and research institutions. Read more of the story here: http://goo.gl/RLVej

Student Awards

Two COS Ph.D. Students Receive Outstanding Graduate Student Research Awards

Gregory Peim (Ph.D. candidate in Physics; nominated by Dr. Pran Nath) and Catherine Matassa (Ph.D. candidate in Biology; nominated by Dr. Geoffrey Trussell) received this year's Outstanding Graduate Student Research Award from Northeastern University!

The College of Science took two of the three top research awards this year.

Congratulations Gregory and Catherine!

Catherine Matassa

Psychology Students Receive Compass Award

Congratulations to Dalal and Alaa Alhomaizi for winning the 2013 Compass Award. The Compass Award is given to students who have demonstrated a true commitment to a core set of values: leadership, volunteerism, academic integrity, and commitment to Northeastern.

Dalal and Alaa Alhomaizi

College of Science Graduate Student Fellowships

The National Science Foundation is funding fellowships for two of our graduate students in the Department of Marine and Environmental Sciences: Dan Blustein and Kate McClur.

Two students in the Department of Chemistry and Chemical Biology have received funding from the Army: Kinh Luan Dao and Patrick Weiser.

Zhen Song in the Department of Physics has received fellowship funding from the American Heart Association.

Julia Ebert

Julia Ebert Awarded Goldwater Fellowship

Undergraduate Behavioral Neuroscience major Julia Ebert has been awarded the Goldwater Fellowship. In addition to being a behavioral neuroscience major, Julia serves as a mentor to the PRISM program at Northeastern, and is a research volunteer in Prof. Dagmar Sternad's lab since her first year on campus. She completed a research co-op in Prof. Sternad's lab last year.

Two COS students receive Fullbright Scholarship

Congratulations to Hollis Thomann '13 and Lauren Byrnes '13 — both women were awarded Fulbright Scholarships! The Fulbright Scholarship is one of the most prestigious nationally competitive fellowships. This merit-based award provides funds for U.S. citizens to study, conduct research, or teach overseas for a year in order to increase mutual understanding between the people of the United States and other countries. Byrnes and Thomann were awarded Fulbright U.S. Student awards for 2013–2014 to Germany.

Byrnes, a native of Perry, Ohio, earned a Fulbright for Study and Research at a German university. With her Fulbright, Byrnes will pursue a master's degree in molecular biosciences at Universität Heidelberg. A biology major with a minor in chemistry, Byrnes has been on the Dean's List throughout her career at Northeastern, boasting a near perfect academic record in a challenging and pointed curriculum. While Byrnes' in-class accomplishments are impressive, she is also an enormously gifted researcher. During her time at Northeastern, she has worked in Prof. Erin Cram's lab, studying the signaling pathway involved in regulating cell migration by utilizing the translucent worm, C. elegans. She presented her findings at Northeastern University's Research Expo, as well as at the 18th International C. elegans conference in Los Angeles. In addition to this research, Byrnes has earned prestigious co-op positions, performing research at Adnexus Therapeutics, a biotechnology company, and in Dr. Chenghua Gu's lab at Harvard Medical School. Byrnes' current research focuses on the regulation of vascular cell growth through various molecular interactions. Byrnes earned an Honorable Mention in the 2012 Barry M. Goldwater Scholarship Competition.

Thomann of Chicago, Illinois, earned a Fulbright English Teaching Assistantship in Germany. Thomann, who majors in linguistics, with minors in international affairs and psychology, will provide assistance to teachers of English while in Germany.

Thomann's interest in languages and bilingualism was born of the time she spent with her Swiss grandfather, who spoke Swiss, German, French, Italian, and a smattering of Spanish. His joy in learning languages and communicating across cultures made an enormous impression on her. At Northeastern, Thomann has dedicated herself to understanding how language works. In her studies, Thomann has analyzed the morphology of Zulu and Nahuatl, studied pronoun processing in 4-to-6-year-old children as a Research Assistant in Dr. Jesse Snedeker's lab at Harvard University, conducted research on language acquisition during an international co-op in Germany, and will be completing an Honors Thesis entitled "Reaching Up and Reaching Out: A Look at Preposition Processing." Both building upon and adding to this theoretical framework, Thomann has taught English as a Second Language to newly arrived immigrants with Boston's Educational Development Group, volunteered with NUTELLS on campus, and most recently, served as Advocacy and Public Policy Intern at the Massachusetts Bilingual Education Association. Thomann hopes her time in Germany will help her in advocating for Bilingual Education in the United States.

Lauren Byrnes

Hollis Thomann

COS Has Strong Representation for Conduit Award

We are so proud to announce that 26 College of Science seniors received the Condit Award from Northeastern University. This award goes to the 100 graduating seniors with the highest QPA.

Congratulations to

Imelda Muller	Elise Funke
Sara Al Mughairy	Lisa Martinek
Tamara Samardzic	Katherine Wilson
Dimira Tambunan	Ezekiel Landes
Denise D'Auria	Kristen Cook
Alexandra Wallace	Allison Del Plato
Lauren Byrnes	Brittany Lange
Catherine Dussault	Alaa Alhomaizi
Joby Jacob	Dalal Alhomaizi
Liana Shahinian	Caroline Stinehart
Cristin Juda	Jessica Katz
Anthony Varca	Michelle DuBow
Victoria Ronga	Brianna Hertford

Seven COS Students Receive President's Award

Seven College of Science students have received the President's Award, which goes to the top 10 students in the graduating classes of 2013, 2014, and 2015. Congratulations to Cristin Juda, Imelda Muller, Matthew Eaton, Thomas Hirsch, John McKenna, Lauren Byrnes, and Catherine Dussault!

Three Chemistry Students Awarded Viola Award

Caitlin Feeney, Samantha Guido, and Rebecca Lewis—all in the Department of Chemistry and Chemical Biology—were selected for the Viola student award.

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In Memoriam: Andrei Zelevinsky

The College of Science would like to honor the life and legacy of Andrei Zelevinsky, University Distinguished Professor of Mathematics. Zelevinsky passed away in April. He was 59 years old.

Andrei spent 22 years of an incredibly productive career here at Northeastern.

Andrei demonstrated his mathematical prowess at an early age, winning the Silver Medal of the International Mathematics Olympiad when he was a 16-year-old freshman at Moscow State University. He made major contributions to several areas of mathematics, including representation theory, algebraic geometry, and

algebraic and polyhedral combinatorics. Andrei's book "Discriminants, Resultants, and Multidimensional Determinants" with I. M. Gelfand and M. M. Kapranov is a classic text. In addition to its applications to mathematics, the results of this book were used by several groups of researchers to create new algorithms in robotics.

Most recently, he created the theory of cluster algebras with Sergey Fomin. The theory of cluster algebras has undergone an absolutely explosive growth, and in 2010 was added to the American Mathematical Society's subject classification list, reflecting its judgment that Zelevinsky and Fomin had created a new field of mathematics. Cluster algebras have applications in a wide range of areas of mathematics and were the theme of a semester-long series of conferences and symposia at the Mathematical Sciences Research Institute in the Fall of 2012.

In addition to Andrei's scientific work, he was a key figure in mathematics education. With local mathematics teachers and other mathematicians, he helped organize the Math Circle, which aims to bring research-level mathematicians into contact with K-12 students.

Andrei received a Humboldt Research Award in 2004 and was selected as a Fellow of the American Mathematical Society in 2012. Andrei was posthumously honored at this year's university convocation with Northeastern's highest academic honor—the title of University Distinguished Professor. The college honored Andrei's life and his work at a major workshop funded by the National Science Foundation in April. His loss is deeply felt by his many friends and colleagues at Northeastern and beyond.

Andrei is survived by his parents Vladlen and Natalia, his brother Dimitri, his wife, Galina, his children Katya and Leo, a daughter-in-law, Karen, and grandchildren.

northeastern.edu/cos

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- 2,527 pounds of solid waste were not generated,
- 22,837 gallons of wastewater flow were saved,
- 4,975 pounds net greenhouse gasses were prevented from forming.

Read the *Husky Science Monitor* online!