Carnegie Mellon Goes to the Dark Side

A Lasting Impact
Remembering Elizabeth W. Jones

Siegals Law
Physics alumnus makes mark in legal field

It’s in our DNA
Interdisciplinary nucleic acid technologies
Fading Fast
Protecting artwork from damaging exposure to light

Priceless artwork is displayed in museums, galleries and homes around the world. Some pieces are constantly exposed to natural light while others only see the light of day on rare occasions. How do conservators determine if a piece of art is overly sensitive to light and susceptible to fading, thus requiring special care? Oftentimes conservators can’t identify which objects will fade until fading has actually happened. Paul Whitmore, director of Carnegie Mellon’s Art Conservation Research Center, had a better idea. He developed the micro-fading tester, pictured below. Using this innovative tool, Whitmore can find out in minutes whether a piece of art will fade over time under natural lighting conditions, all without harming the art in the testing process.

1. The 75-watt xenon arc lamp provides focused visible light. Each minute of lamp exposure translates to several years worth of exhibition.

2. A fiber-optic cable delivers the light to the object.

3. Light reflected from the object travels via fiber-optic cable to the photodiode array spectrophotometer.

4. The high-intensity light beam is 300 microns, or about the size of the period at the end of this sentence.

5. The photodiode array spectrophotometer measures the spectrum of light reflected from the object.

6. The computer records the spectral data and calculates the change in the measured color every second, providing a “real-time” view of the course of future fading.

The Art Conservation Research Center (ACRC) is an applied research organization dedicated to helping museums, libraries and archives improve the ways of caring for their collections. The ACRC became part of the Mellon College of Science in 2007.
Educating Global Citizens
Biotechnology
Impacting our Selves, Societies and Spheres

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Lifting As They Climb
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Russ Walker on Carnegie Mellon’s Qatar campus

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Inside MCS
Welcome to “Science Connection,” a fresh look for the Mellon College of Science News. The new magazine aims to give you a taste of the excitement of discovery, community, and innovation that happens every day at MCS. From highlights of the latest research to stories describing student-led mentoring groups, this issue is all about connections — between disciplines, within MCS, across campus, and around the world. Complex problems can’t be contained within disciplinary boxes, and MCS faculty and students reach beyond the usual boundaries to bring diverse perspectives to bear on some of the most important questions in science. This is illustrated well in our feature stories, which highlight two new centers — the Bruce and Astrid McWilliams Center for Cosmology and the Center for Nucleic Acids Science and Technology — both created within the last year. These centers, taken together, create teams of biologists, chemists, physicists, computer scientists and statisticians working together to tackle complex scientific questions. Our students have strengthened their ties to one another by creating a mentoring group and hosting the first annual MCS Ball. MCS alumni, like Charles Siegal, remember fondly how the lessons learned at MCS continue to shape their careers. Our faculty and students on the Pittsburgh campus are reaching out to places halfway around the world, including Qatar and Africa.

Ultimately, this issue of Science Connection is about celebrating some of the things that make MCS a remarkable place. Whether you are a former MCS student or are new to our community, I hope that Science Connection helps you stay connected with us in the years to come.

With best wishes for the coming year,

Fred Gilman  
Dean, Mellon College of Science  
Buhl Professor of Theoretical Physics
Carnegie Mellon chemists have solved a decade-long molecular mystery. Using intensive theoretical and computational calculations, they have modeled the initial molecular changes that occur when the neurotransmitter glutamate docks with a receptor on a neuron. The glutamate receptor’s docking site (or ligand binding domain) closes when glutamate binds to it. Tatyana Mamonova, a postdoctoral fellow in Maria Kurnikova’s lab, pinpointed the molecular mechanism — two key electrostatic interactions — responsible for switching the ligand-binding domain’s conformation from open to closed. With this knowledge in hand, the Kurnikova lab can now computationally model binding-site closure and opening. Ultimately, they could use the computer model to design a drug that either inhibits or enhances the activity of the glutamate receptor, which could eventually help scientists develop drug therapies to treat a variety of disorders, including epilepsy and Alzheimer’s disease.

Within any given human cell, hundreds, if not thousands, of proteins may interact to carry out the cell’s activities. Understanding this menagerie of proteins and their interactions in real-time is key to unraveling how cells function in health and disease. But to date there are almost no tools available to sort out all of these different interactions and activities going on in cells. Scientists at the Molecular Biosensor and Imaging Center (MBIC) are one step closer to making such tools a reality. They have developed new “fluorogen activating proteins” (FAPs) that are designed to target molecules on the surface of and inside cells. The FAPs are “activated,” or emit fluorescent light, when they bind to a fluorogen, an otherwise non-fluorescent dye added by the scientists. The new FAPs are an extension of the genetic approach made popular by the advent of fluorescent proteins, such as green fluorescent protein (GFP), more than a decade ago. GFPs, once expressed in cells, are always aglow when visualized by scientists using special light sources and microscopes. Chris Szent-Gyorgyi and the MBIC team have taken GFP technology one step further — with the novel FAPs and associated fluorogens, they can control fluorescence in space and time. The new FAP technology gives off light only when and precisely where the target biomolecule is present, enabling scientists to activate the fluorescence when needed to see exactly where in the cell the biomolecule is located. FAPs allow researchers to not only see where the target protein is within the space of the cell, but also to see color changes when it becomes fluorescent. Color changes may reflect changes in the local environment of the protein, and allow quantitative sensing in real time of the biological activity of proteins and biomolecules that are in close proximity to each other. MBIC scientists can design FAPs that have different fluorescent and binding properties, allowing them to image multiple colors inside cells, which is a step toward dynamically monitoring several proteins at once and following complex cellular functions.

Cellular Surveillance

Molecular Gatekeeper

In the Big Leagues Mass spectrometers are routinely used to determine the weight, structure and amount of small molecules or fragments of molecules but are not equipped to sensitively characterize large molecules over 150 kiloDaltons (a measure of mass) at a low-charge state. Using a novel mass spectrometer, Mark Bier has characterized large viral particles (17,700 kD) and bulky von Willebrand factors (200 to 1,100 kD). Bier anticipates that this work will help to advance research in proteomics, virology, molecular biology and nanotechnology.

Hidden Evolution Veronica Hinman has uncovered something hidden in the nuts and bolts of the genetic processes that control development. She compared a Gene Regulatory Network (GRN) — a very precise model of how genes interact, how they are interconnected and how they function in development — found in sea urchins and starfish, and she had surprising results. Although the GRN region she studied is...
More than three million people in the United States have some form of epilepsy. In a significant fraction of individuals, seizures cannot be well-controlled by medication and have debilitating consequences, and new therapies are sorely needed. Although researchers have identified a genetic component in some types of epilepsy, many seizure disorders arise because of developmental malformations or injury. Recent work by MCS neuroscientist Alison Barth established, for the first time, a shared component between different types of epilepsy. Barth and her colleagues discovered that a single seizure can alter the function of an ion channel called the BK channel, which becomes abnormally active after a seizure. Although BK channels have been linked to a rare, familial form of epilepsy, their involvement in other types of seizure disorders has never been demonstrated. The BK channel allows electrically charged potassium ions into and out of cells, an activity that starts and stops the electrical impulses by which neurons communicate with one another. Barth was specifically interested in how seizures might beget seizures — in other words, how epilepsy begins — by investigating BK channels’ function following a first seizure. Her in vitro studies revealed that, after a seizure, BK channel function was enhanced — neurons fired quicker, stronger and more spontaneously. This abnormal activity might underlie the transition between a single seizure and the emergence of epilepsy, which is characterized by recurrent seizures. Sonal Shruti and Roger Clem, the lead authors on the study, found that seizures caused cells to become more excitable, and that BK channel antagonists could normalize this aberrant firing. The most recent work out of the Barth lab shows that in vivo administration of BK channel antagonists can block seizures. These findings indicate that BK channels may be a new anticonvulsant target for a variety of seizure disorders, and offer new hope to individuals suffering from epilepsy.

### Coming Soon: Cinema of the Sky

Top Cerro Pachón, a mountain in northern Chile, the world’s most powerful survey telescope will reign. It will survey the entire visible sky deeply in multiple colors each week with a three-billion pixel digital camera. It will take snapshots every 15 seconds, opening a movie-like window on objects that change or move on rapid timescales, such as exploding supernovae and potentially hazardous near-Earth asteroids. Carnegie Mellon has joined more than 23 universities, national laboratories and corporations to construct this telescope — the Large Synoptic Survey Telescope (LSST). When the 8.4-meter LSST begins operations in 2014, it will collect unprecedented volumes of data. Working with the University of Pittsburgh and the Pittsburgh Supercomputing Center, Carnegie Mellon hopes to contribute especially to the acquisition, storage and analysis of LSST data.

### research highlights

- **Changing the Channel — New Hope for Those with Epilepsy**

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### research briefs

- **Neighborhood Correlation**
  Computational biologist Dannie Durand has discovered critical flaws in the standard method used to analyze gene evolution. Standard methods fail when applied to genes that encode multi-domain proteins, an important class of proteins crucial to human health. Durand has tackled the dilemma of how to study the ancestry of multi-domain genes. She developed a novel method — “Neighborhood Correlation” — to determine whether a pair of similar genes evolved from a common ancestor, or whether they just look similar because the same domain was inserted into both genes.

- **Regenerative Medicine**
  Chemist Newell Washburn’s work was touted in the May 19 Newsweek article “War on Wounds.” Washburn, a member of a Wake Forest-led consortium in the Armed Forces Institute of Regenerative Medicine (AFIRM), is developing advanced therapies to promote scarless wound-
Special Delivery — Nanogels Carry Cancer Drugs

Many drugs have undesirable side-effects. Some cause upset stomachs, while others — like chemotherapy drugs — can cause anemia, joint pain and hair loss. Anti-cancer drugs are especially problematic because they don't just affect cancer cells; they damage healthy cells as well. MCS chemists are developing a new way to deliver chemotherapy and other types of drugs to cells that may prevent many of their adverse effects. The tiny, spherical nanogels — only 200 nanometers in diameter — can encapsulate anti-cancer drugs, and when the nanogel dissolves, the drugs encapsulated within are uniformly released. The nanogels, created using atom transfer radical polymerization (ATRP), possess many unique properties that make them ideal tools for delivering more drug directly to the target and dispensing the drug in a time-release manner. ATRP, a controlled living radical polymerization process, allows chemists to precisely regulate the composition and architecture of the polymers they are creating. Former graduate student Daniel Siegwart (S’08), under the guidance of Krzysztof Matyjaszewski and Jeffrey Hollinger, used ATRP in inverse miniemulsion to create nanogels with a uniform network of cross-linked polymer chains within a spherical nanoparticle. The uniform mesh size within the nanogels can improve control over the release of the drug inside the polymeric mesh. Siegwart and colleagues developed nanogels that encapsulate doxorubicin, an anticancer drug. After mixing the doxorubicin-loaded nanogels with HeLa cancer cells in the laboratory, the doxorubicin was released, penetrating the cancer cells and significantly inhibiting their growth. The nanogels, which are nontoxic and biodegradable, can also accommodate molecules on their surfaces. During nanogel synthesis, the ATRP process allows scientists to incorporate “targeting groups” on the nanogel surface that can interact with specific receptors, such as those on the surface of a cancer cell. In addition, the nanogels can escape the notice of the body’s immune system, prolonging circulation time within the bloodstream. The Matyjaszewski group is currently tuning the size of the nanoparticles and investigating how different sizes enter cells. By understanding how the nanogels enter cells, they hope to better target specific tissues, such as cancer cells that have a more permeable membrane.

Sharpening the Senses

Imagine walking into a room and recognizing a smell that seems to be floral. As you continue to smell the odor, you begin to recognize that the scent is indeed flowers and even more specifically that it is the scent of roses. MCS neuroscientist Nathan Urban has explained why, when we notice a scent, the brain can quickly sort through input and determine exactly what the smell is. The mechanism, called “dynamic connectivity,” explains how neuronal circuits are rewired “on the fly” allowing stimuli to be more keenly sensed. Until now, scientists thought that the connections made by the neurons in the olfactory bulb (an area of the brain responsible for processing scents) were dictated by anatomy and could only change slowly. Urban found that the connections are, in fact, not set but rather able to change dynamically in response to specific patterns of stimuli.

healing. Specifically, Washburn and his research group will make polymeric materials that regulate inflammatory responses and encourage healing. Biological Sciences and Biomedical Engineering Professor Jeffrey Hollinger will direct AFIRM’s Craniofacial Program, one of five research programs comprising the Rutgers University-led consortium. Hollinger will develop clinical treatments for U.S. troops and support personnel in Iraq and Afghanistan who incurred severe combat injuries to the face and jaw.

- Genes Inactivated in Cancer Cells Using computational biology techniques, an international team of researchers led by Ziv Bar-Joseph discovered over 480 genes that play a role in human cell division and identified more than 100 of those genes that have an abnormal pattern of activation in cancer cells. Malignant cells have lost control of the replication process, so detecting differences in cell cycle gene activation in normal and malignant cells provides important clues about how cancers develop. Unlike many cancer studies, which seek to identify “missing” genes that might cause cancer, this new research shows that genes can contribute to cancer in less obvious ways.
It’s in our DNA

At the Center for Nucleic Acids Science and Technology, interdisciplinary scientists develop tools to explore, monitor and control gene expression.

By Amy Pavlak

Since Watson and Crick unveiled the structure of DNA more than 50 years ago, the double helix has been in the limelight. But DNA is now playing co-star while another molecule stands center stage — RNA. This multi-talented molecule plays a role in nearly every aspect of gene expression, from regulating the activity of genes to fine-tuning the production of proteins.
It is here — in this new RNA world — that the intricacies of many human diseases are being uncovered. Diseases like retinitis pigmentosa, myotonic dystrophy and cancer all have defects in how one form of RNA is processed to direct the construction of proteins. Severe anemias and certain cancers result from errors in the assembly of ribosomes, complexes of another form of RNA and protein that function as the cell’s protein-producing machinery.

“The rapid influx of data from the human genome project has allowed scientists to identify more and more genes linked to disease and to explore in greater detail what happens at a molecular level. There is great optimism that genetic diseases will one day be treatable at the DNA or RNA level rather than at the traditional protein level,” said Bruce Armitage, professor of chemistry and co-director of Carnegie Mellon’s Center for Nucleic Acids Science and Technology (CNAST). Treatments at this level should be far more precise and effective.

Making advances in this area of RNA research requires two key things, according to Armitage — a deep understanding of how RNA regulates gene expression and the know-how to create new compounds that can report on RNA’s activities and ultimately help scientists regulate biological processes involving RNA.

**Genetic Cut and Paste**

Although the genes encoded in DNA provide the instructions for making proteins, a gene does not actually build the protein. The genetic information from DNA is copied, or transcribed, into one form of RNA called messenger RNA (mRNA), which carries the genetic information to ribosomes, the cell’s protein-building machinery (see schematic on page 8). But mRNA is not a simple copy of DNA. The original mRNA transcript, called pre-mRNA, is copied letter for letter from DNA, but it is then cut and pasted back together to form a mature mRNA. Depending on which RNA segments are removed and which are kept — a process called alternative splicing — the transcripts from one gene can produce many varieties of mRNA and hence yield potentially thousands of different proteins. Javier Lopez, associate professor of biological sciences and a member of CNAST, has spent more than a decade investigating alternative splicing to understand the powerful and versatile ways it regulates gene expression. Alternative splicing contributes to major developmental decisions (like wing formation in fruit flies) and fine-tunes gene function.

Lopez carries out many studies on the fruit fly *Drosophila melanogaster*, an ideal model system for studying alternative pre-mRNA splicing. Many of the molecular mechanisms at play are the same in fruit flies and humans. Plus, certain instances of alternative splicing are stunningly obvious in fruit flies — if a specific gene is spliced one way, a male fly develops; if the gene is spliced another way, a female fly is born. Most alternative splicing events are not so easy to see in the lab, however, but their effects can be debilitating. Take, for example, a current project underway in the Lopez lab. They have uncovered genetic differences in an alternative splicing event that may influence risk for a human disease — schizophrenia. Lopez’s collaborators at the University
of Pittsburgh identified DNA sequence variations associated with schizophrenia in patients, and Lopez’s preliminary evidence suggests that these variations alter the pre-mRNA splicing pattern of a specific gene. Lopez’s first clue came when his lab found a previously undiscovered exon (a genetic region that is retained in mRNA during splicing) hidden inside an intron (a region that is removed from mRNA). Whether this exon is removed or kept during splicing is linked to the risk of having schizophrenia, Lopez discovered. When the gene sequence is the low-risk variant, the exon is removed from most pre-mRNA transcripts along with the intron. When the gene sequence is the high-risk variant, the exon is retained more frequently, resulting in disrupted protein production that could possibly explain the symptoms of schizophrenia.

“Our hypothesis right now is that some people are at higher risk for schizophrenia because their gene sequence creates stronger splicing signals, allowing the cell’s splicing machinery to recognize the exon more efficiently,” explained Lopez.

Lopez and his colleagues are working to understand exactly how splicing of this troublesome exon is regulated. Using a new method under development in collaboration with Armitage and Associate Professor of Chemistry Linda Peteanu, Lopez will soon be able to detect in real time within a cell when an individual molecule of RNA has been spliced and when it has not, something that hasn’t been possible before now. To witness this difference in splicing, Lopez will employ peptide nucleic acids (PNAs) designed by Armitage and Peteanu. These synthetic molecules possess DNA-like properties, which allow the molecule to bind to a specific DNA or RNA sequence, and protein-like properties that make PNAs long-lived within cells. Armitage’s PNAs can be tagged with a variety of fluorescent molecules whose light can be detected with a microscope. A PNA that binds to a pre-mRNA that’s being spliced one way (exon is cut out) will be labeled with one color while another, differently colored fluorescent PNA will bind to a pre-mRNA that’s being spliced the alternative way (exon is not cut out). If the exon is removed, red light is detected. If the exon is retained, orange light is detected. By analyzing the ratio of the colors in PNA-treated cells, Lopez will be able to use this new method to determine which cells have mRNAs that retained the miscreant exon.

Being able to determine the relative amounts of two alternatively spliced transcripts in a cell is critical to understanding the regulation and function of alternative splicing in specific genes, explains Lopez. Knowing how a gene’s pre-mRNA transcript is spliced in healthy individuals is key to understanding how incorrect splicing could lead to diseases like schizophrenia.

Where Biologists and Chemists Meet
Lopez and other biologists working with CNAST are in a unique position. Their CNAST chemistry colleagues are experts in PNAs, versatile molecules that can bind to specific DNA and RNA targets inside cells, such as an RNA molecule that is undergoing splicing or a ribosomal RNA molecule producing a protein. With the largest and most diverse group of PNA researchers in the world, CNAST is poised to take the lead in developing new tools and technologies that can be applied not just to the study of RNA biology but also to potential therapeutics.

“What makes PNA unique is its synthetic flexibility,” said Danith Ly, associate professor of chemistry and a member of
First reported in 1991, PNA is like DNA and RNA but it contains a protein-like backbone, instead of a sugar backbone (see image this page). PNA contains the nucleobases found in DNA and RNA, enabling PNA to bind to DNA and RNA in a complementary, highly specific manner. Additionally, PNAs have neutral, pseudo-peptide backbones — unlike DNA and RNAs negatively charged sugar-phosphate backbones — so they avoid detection and degradation within living cells.

Because PNAs have a high affinity for complementary DNA and RNA, and because they are very stable, long-lived molecules, scientists have high hopes for using PNA to study and manipulate cellular processes like gene expression. CNAST scientists have overcome a huge obstacle — the inability of PNAs to enter cells — thereby paving the way for applications of PNAs in the diagnosis and treatment of disease. With a little molecular plastic surgery, Ly developed PNAs that can be taken up by living cells.

Ly was inspired by an HIV protein called Tat, which is readily taken up by mammalian cells. He modified the PNA backbone so that it looked like the Tat protein, resulting in significantly improved delivery into human cells. Not only were the modified PNAs taken up by cells, but they also localized predominantly in the cell nucleus, the specialized compartment in the cell where mRNAs are made. Being able to localize to the nucleus is critical for using PNA to investigate, modify or block gene expression at the transcriptional or splicing stages, according to Ly.

Ly and his colleagues have already demonstrated that their modified PNAs can inhibit translation, the step in gene expression when the mature mRNA is used to build a protein. Ly treated human lung cancer cells with a PNA designed to bind to an mRNA that codes for a protein found on the cell surface. The protein, E-cadherin, usually holds cells together. In some types of cancer cells, defects in E-cadherin cause cells to detach from each other and spread, leading to metastatic cancer. In Ly’s experiment, E-cadherin is detected on the cells not treated with PNA (see image this page). But in the PNA-treated cells, very little E-cadherin is detected, indicating that the PNA suc-

cessfully stopped the mRNA from being translated into the protein.

Ly has also created PNAs with other exceptional properties, including the ability to bind to DNA and RNA much more strongly. According to Ly, this capability should make PNA an excellent tool for blocking transcription, processing or translation of RNA. The result could be a much more effective drug.

Added Armitage, “The molecular surgery Danith is doing on the structure of PNA, taking it far beyond what it was originally capable of doing, is making us excited about its biological potential.”

While PNAs show extraordinary promise for medicine, Ly and Armitage also are using them in studies with biologists to explore fundamental scientific questions, such as determining the molecular steps involved in assembling a ribosome. Ribosomes are the cellular machines that take mRNAs and translate them into all 79 different proteins and four different RNA molecules, ribosomes are critical to gene expression. Understanding how these complexes assemble to perform their protein-building duties is essential to appreciating their function, says John Woolford, professor, acting department head of biological sciences and co-director of CNAST. Woolford is working with Ly and Armitage to design PNAs that will bind to specific sites on ribosomal RNAs, tagging them with fluorescent molecules. Early stage experiments are revealing the spatial layout of RNA and protein components that comprise a ribosome. According to Woolford, these experiments will enable them to understand how functional ribosomes are formed in healthy individuals and how ribosome assembly goes awry in disease.

“RNA participates or is synthesized in different aspects of biology, and our research is represented in many of these areas. Because of the strong foundation we have here in RNA biology, we can be really intelligent in how we design our PNAs,” said Woolford. “With these tools, there are fundamental questions in biology that can be answered and there can be practical applications in treating genetic and infectious diseases — those are boundless.”
Imagine dedicating your career to studying something you can’t touch, or even see. The only way you know that it exists is by the mysterious push and pull it has on stars and planets millions of light years away.

A group of researchers at MCS’s newly formed Bruce and Astrid McWilliams Center for Cosmology (see side bar page 13) chose to do just that when they decided to devote their life’s work to the study of dark matter and dark energy.

Dark matter and dark energy make up more than 95 percent of the universe, yet scientists have no clue what it is. But they have some guesses about what the dark part of the universe does. It is thought that dark matter plays a role in the formation and clustering of galaxies while dark energy is responsible for the expansion of the universe. The idea of dark matter and dark energy is relatively new in the world of science. Dark matter was first proposed in the 1930s, but wasn’t widely accepted until the early 1970s; dark energy was proposed in the 1970s, but wasn’t named until 1998. Prior to this development of the theories of dark matter and dark energy, many thought that the universe was made up of the same elements as those found on the periodic table, the same elements that make up everything we see around us.

While physicists can successfully explain the nature of ordinary matter using the Standard Model of Particle Physics, they came to realize this theory didn’t apply to the majority of matter in our galaxy and beyond. The stars were simply moving too fast to be explained by the amount of matter that existed in space, and the universe was expanding too quickly — some other unknown force had to be at play. Researchers came to believe that it was dark matter and dark energy. To find out what exactly these elusive dark elements are, researchers need to understand how the universe began and how it has evolved over time to become what it is today.

“We are in the most revolutionary time in physics since the development of the Standard Model of Particle Physics in the 1960s and early 1970s,” said Fred Gilman, dean of the Mellon College of Science and Buhl Professor of Theoretical Physics. “The questions we want answers to are just as revolutionary. At the same time, the tools that we have give us the power to answer them. Using machine learning to help us analyze huge data sets, supercomputing and programs to simulate the universe, and possibly directly observing dark matter in the laboratory,
give us the ability to do things that were previously impossible.” Gilman hopes that cosmology researchers will be able to pull from the data a fundamental understanding of the nature of dark matter and how it shaped the universe.

Tiziana Di Matteo and Rupert Croft, associate professors of physics, are harnessing the power of supercomputers to recreate how galaxies are born and how they develop over time. They work with machines within the physics department and at the Pittsburgh Supercomputing Center. A computer cluster nicknamed “Ferrari” is dedicated solely for the use of McWilliams Center researchers, and a supercomputer cluster funded through a donation from the Moore Foundation is shared with the School of Computer Science.

Croft crafts computer simulations that start with the conditions thought to be present at the beginning of the universe — the so-called Big Bang — and then enters in the laws of physics as well as proposed algorithms to simulate the gravitational pull of dark matter and other cosmological phenomena including cooling gas and exploding stars. Di Matteo uses simulations to better understand the physics of black holes. She was the first to incorporate black hole physics into simulations, the result of which was the most detailed and accurate recreation of the evolution of the universe to date.

Simulations such as Croft and Di Matteo’s provide snapshots of the development of the galaxy in frames of a half a million years each. Strung together, the frames create a movie of cosmic evolution over the past 14 billion years. At the beginning of the simulations, matter is evenly dispersed, but over time it begins to clump, with superclusters aggregating at intersections, becoming what is known as the “cosmic web.” It is thought that this clumping is caused by dark matter and dark energy.

“Knowing why there is structure in the universe and not just empty space is key in understanding dark matter. Without dark matter, our galaxy wouldn’t have formed and we wouldn’t be here,” said Croft. “Without dark energy, we might still be here, but things would look a whole lot different.”

Thanks to the power of the supercomputers available to the Carnegie Mellon researchers, the images created in the simula-
tion are at such a high resolution and are so precise and detailed, they can zoom in to a particular event, like the formation of a black hole, to see what happens during the formation as well as the aftermath.

"While a biologist can recreate an environment in a Petri dish, or a chemist in a test tube, cosmologists can’t make another universe in the lab," said Croft. "Computer simulations give us the opportunity to test our theories that otherwise couldn’t be tested." In fact, Croft believes that the Carnegie Mellon simulations could be used to invent new tests for dark matter and dark energy.

Furthermore, the computer simulations can help experimental astrophysicists plan their telescopic observing strategies to best see the types of phenomena important to the history of the universe.

Indeed, it is a great big sky, billions of light years deep. Physics Professor Jeff Peterson hopes to see as far back as possible — into the “Dark Ages” of the universe, a time where there were no stars and no light. He hopes to be able to see “The Enlightenment,” when the first stars were turned on. This event has been simulated, but never measured.

To do this, Peterson is gathering data from the 21 cm (centimeter) band of radiation given off by neutral hydrogen using a prototype radio telescope he built on the old LTV Coke Works site along the Monongahela River. Radio telescopes use antennae to gather information from the dark radiofrequency part of the electromagnetic spectrum as opposed to optical telescopes, which gather information from light in the visible part of the electromagnetic spectrum. Kevin Bandura, a doctoral student and McWilliams Fellow working with Peterson, has developed a prototype interferometer that detects these radio emissions.

At 21 cm, you can see the glow of neutral gas from the Dark Ages. When stars begin to glow, they ionize neutral hydrogen, turning off its glow. The telescope, which according to Peterson looks like a "hammock for giants," focuses radio waves from the universe into a line of antennas that then wire the data to computers.

Peterson hopes to build a much larger version of this telescope that will allow him to look at radio waves from across the universe, an essential next step because there is little neutral hydrogen left in the universe.

Carnegie Mellon will also use data from optical telescopes to find evidence of dark energy and dark matter. Carnegie Mellon has joined more than 23 universities, national laboratories and
corporations in constructing the world’s most powerful survey telescope called the Large Synoptic Survey Telescope (LSST). Images from the LSST will be used to trace billions of remote galaxies and measure the distortions in their shapes produced by concentrations of dark matter, providing multiple tests of dark energy.

Telescopes like the one Peterson hopes to build and the LSST accumulate large sets of astrophysical data. To attempt to define dark matter and energy, researchers need to be able to detect subtle non-linear signals out of these noisy masses of information. Carnegie Mellon has assembled a team of astrostatisticians focused on developing statistical techniques for analyzing this data. The researchers from the College of Humanities and Social Sciences have used standard traditional statistical methods to analyze cosmic microwave background radiation, estimate the dark energy equation of state, analyze galaxy spectra and detect galaxy clusters.

To study and understand dark matter and dark energy, researchers must sift through billions of years and a universe worth of data. While the McWilliams Center is housed in MCS’s Physics Department, it depends on the contributions from across the university, including from researchers in computer science and statistics, as well as those from international collaborations.

Complementing the work of the statisticians, researchers in the School of Computer Science will develop scalable algorithms, data mining, and machine learning techniques for analyzing and gaining knowledge from massive amounts of cosmological data and create tools for completing cutting-edge numerical simulations relevant to cosmology.

With these tools, and this large multi-disciplinary team, the McWilliams Center hopes to shed light on the dark part of the universe, making this elusive matter to which they have dedicated their careers definable and real.
A Lasting Impact
Remembering Elizabeth W. Jones

By Amy Pavlak and Kristen Boise

When Jared Wenger (S’06) walked into Beth Jones’s lab the summer after his freshman year, he wasn’t sure what he had gotten himself into. He had given up ten weeks of his summer, and he was really worried that he wasn’t going to get to do “real” research. But after ten weeks, Wenger got a taste of what it’s like to conduct scientific research, and he hasn’t stopped since. Now pursuing a Ph.D. in genetics at Stanford University, Wenger remembers that summer working with Beth Jones: “Watching her in the lab was like watching a kid in a candy store,” he said.

Wenger is just one of more than 130 students who have felt the thrill of scientific research in Jones’s lab, and it represents just one example of the many ways Beth Jones has left her mark on the Department of Biological Sciences, MCS, the university and the field of genetics. Jones, who died June 11, is remembered as a superb teacher, mentor, colleague and friend.

“No matter what she was doing, Beth was in the thick of things, participating with all of her energy,” said Professor Aaron Mitchell, a former student and undergraduate researcher in Jones’s lab. “Working in her lab, I had the impression that she was having the time of her life with us and making sure we did too.”

Jones joined the Carnegie Mellon community in 1974 as an associate professor of biological sciences. She arrived with a passion for genetics that never diminished.

“She was truly a force in our field,” wrote the Genetics Society of America (GSA) in an announcement of Jones’s death. “Her pioneering work in yeast genetics, most notably on vacuole biogenesis, was recognized this year with GSA’s Lifetime Achievement Award.”

But Jones’s passion for genetics extended beyond her own research — She was an enthusiastic and dedicated teacher who took great joy in guiding her students through the logic of genetics. She taught introductory genetics courses to thousands of undergraduates and reached countless more who studied either of the two textbooks she co-authored. “Essential Genetics” is now in its 4th edition, and “Genetics: Analysis of Genes and Genomes” is in its 7th edition.

Early in her teaching career, Jones recognized that involving undergraduates in research was a great way to elicit enthusiasm and facilitate learning. Her lab was always teeming with inquisitive undergraduates, and Jones was often at the bench with her students, actively engaged in sharing results, discussing next steps and truly listening to what they had to say.

“She was more involved with students at every level than anyone else I know,” said Professor John Woolford, acting department head of biological sciences. Jones was a partner and ardent supporter of the Biological Sciences Student Advisory Council.
(BioSAC), overseeing booth construction during Carnival or gamely participating in BioSAC’s annual murder mystery dinner. Students clamored for a spot at Jones’s table since it was likely she would help the table triumphantly solve the case.

Jones’s commitment and enthusiasm inspired other faculty members within the Department of Biological Sciences so that undergraduate research became an integral part of undergraduate education and the departmental culture. It also spread across the university.

“Beth Jones is the person who really started undergraduate research here,” said Indira Nair, vice provost for education. “Carnegie Mellon was recognized as one of the pioneers in undergraduate research solely because of Beth having started really early when it wasn’t fashionable.”

The Howard Hughes Medical Institute (HHMI) has recognized Jones’s and the department’s commitment to and experience in facilitating undergraduate research, awarding six consecutive grants totaling $9.3 million dollars in support of bioscience education. With HHMI support, Jones developed highly interdisciplinary undergraduate programs and a Summer Research Institute that introduced students to scientific research at an early stage in their college experience.

Jones’s impact on the Department of Biological Sciences stretched beyond undergraduate education. As department head she was a leader in expanding the department into diverse new areas, including computational biology and neurobiology, by aggressively recruiting high-quality faculty. She also extended the department’s growth in the more traditional areas of cell and developmental biology.

Jones had a vision for leading the Department of Biological Sciences into the future and for educating budding biologists, like Jared Wenger.

“Many students were first turned on to science in her lab,” said Woolford. “There is a legacy of these students — hundreds in the lab and thousands in the classroom — who have gone on to become inspired scientists and teachers. It’s an infinitely progressive legacy — a living legacy.”

To honor Jones’s passion for and dedication to undergraduate education, the university has established the “Elizabeth W. Jones Memorial Fund.” Contributions to this scholarship fund may be made in Jones’s memory to Carnegie Mellon University, P.O. Box 371525, Pittsburgh, Pa., 15251-7525.
Called BIOS^3 for short, the class is the brainchild of Assistant Dean Amy Burkert and her MCS colleagues Associate Dean Eric Grotzinger and Biological Sciences Professor William Brown, who died last year. The course, which currently focuses on HIV/AIDS, was designed with some basic principles in mind: Teach students the core science, help them make sense of their new knowledge using a global perspective and encourage them to take personal action. But the BIOS^3 class isn’t just about HIV/AIDS. Students are trained to apply this framework to tackle other global biotechnology issues, including stem cells, genetically modified foods and the emerging tuberculosis epidemic.

For many students in the class, this approach was very rewarding but unlike anything they had learned in a class before. “I’m used to doing abstract math and working with computers,” said Thorpe, a computer science major. “But this class expands the things you are aware of and how you see issues.”

A tenet of BIOS^3, which is funded by President Cohon’s Global Education Initiative, is to help students gain an appreciation of the social and cultural contexts that are involved in HIV/AIDS and other international health issues and the impact they can have at individual, societal and global levels. Burkert and Grotzinger not only brought in guest speakers from local volunteer organizations, like Prevention Point Pittsburgh and the Pittsburgh AIDS Task Force, but they also organized an effort to assemble “caregiver kits” for family members and volunteers who are caring for people living with AIDS in Africa. Distributed via Global Links, the caregiver kits include simple items like antibacterial soap, cotton balls and latex gloves and provide caregivers with the supplies they need to help tend to their patients and to protect themselves from infection.

“The service learning component really enhanced student engagement,” Burkert said. “By providing students with a level of scientific literacy necessary to understand and respond to personal, societal and global challenges like HIV/AIDS, we can help them realize that they can make an impact.”

Students’ global awareness was enhanced by having a firm grasp of the science of HIV. On the first day of class, students from various backgrounds — art, computer science, biology, business — jumped right in with a thorough study of HIV. Students learned how the virus operates, adding new terms like reverse transcriptase and CD4 to their vocabulary. Once they mastered this new knowledge, they applied it to understanding how HIV infection is diagnosed and treated. They even went to the lab to perform an Enzyme-Linked ImmunoSorbent Assay (ELISA), the first test used to screen blood for HIV. For many students, including Thorpe and art major Brenda Battad, this marked their first experience working in a biology lab.

Because they had a grasp of the biological processes surrounding HIV/AIDS, students could appreciate why the disease is so difficult to fight or why sticking to the
“Seeing statistics in an article isn’t anything compared with someone telling you about their experiences. It reminds you of why you are studying what you’re studying,” said Akshay Goel, a computer science major and premed student.

“I hope I will always be able to conjure those particular feelings within myself to approach problems; there is no better motivation than believing in the reality of a situation,” wrote a student in a course reflection paper assignment. “I think this course is quite an encouragement in the fight against daunting challenges like HIV/AIDS because it models the winning approach, the approach from all angles.”

The BIOS³ course is a true model of teaching a course for science literacy with integrity to the scientific principles and concepts, but also framing these in the context of societal and global issues so that students learn deeply and develop appreciation for the implications of science in society.

Indira Nair, Vice Provost for Education.

Resources:
Prevention Point Pittsburgh, www.pppgh.org
Pittsburgh AIDS Taskforce, www.patf.org
Global Links, www.globallinks.org

antiretroviral drug schedule is imperative to stopping HIV from becoming drug resistant. But having this solid scientific foundation is only the beginning. The next critical step, which is quite challenging in science classrooms, is to translate the science to the real world and to real people. Gathering for class at 7:30 a.m. one morning, students spoke via Skype, an internet-based phone service, with doctors working with HIV+ patients in Zambia and Kenya. Interacting with doctors working in Africa and in Pittsburgh and with patients living with HIV was a profound and eye-opening experience for many students.
When Charles Siegal (S1967, 1972) drives to work each morning, he’s reminded every quarter of a mile that choosing to practice law was a good idea.

It’s not that the Pittsburgh-born Los Angeles resident and Stanford Law grad holds anything against physics — in fact, he’s still a member of the American Physical Society — but his work as a lawyer has left a direct impact on the daily lives of people that further research on nuclear physics may not have.

Take, for example, what he sees each morning on the L.A. freeway. A few years ago, his firm Munger, Tolles & Olson LLP took on a pro bono case representing clients with disabilities in a suit against the Los Angeles Metropolitan Transportation Authority, the California Department of Transportation and the California Highway Patrol seeking to make freeway call boxes accessible. The boxes, located every quarter of a mile, allow people involved in accidents or having car trouble to call the Highway Patrol. But the boxes weren’t accessible to everyone, and one of the clients Siegal represented literally had to crawl over a curb to get to the call box, only to find that she couldn’t reach it. The case ended in a settlement, mandating that all the call boxes in Los Angeles County had to be updated to be accessible, which included installing ramps and equipping phones with telephone typewriters for those with hearing or speech difficulties.

“You drive down the freeways in L.A. County now, and there’s a sign on every call box that says ’This is accessible,’” Siegal said. “It’s very rare that you see something on your way to work and think ’I did that and it’s helpful.’”

Throughout his career, he has made strides for people with disabilities, including a term as president of the Disability Rights Legal Center. But disability law hasn’t been Siegal’s only pro bono focus. He’s also committed to international human rights law, and is president of the American Branch of the International Law Association. In addition to his pro bono work, Siegal’s successful career of more than three decades has focused on commercial litigation, ranging from electric industry regulation to insurance coverage disputes and, more recently, patents.

Siegal’s interests are varied, but they have their roots in his physics studies at Carnegie Mellon.

“Physics and math are very good training if you want to be analytical, and the law is analytical,” he said. “I think that training sets the mind in the right direction.”

He also says that his professors at Carnegie Mellon shaped him. “All the faculty in the Physics Department influenced me. I still have huge admiration for them — the way they understood physics, the way they saw the world, their politics. Their moral base was grounded in the hunt for the truth. If you follow that, you cannot go too far astray.”

Even today, Siegal recalls specific conversations with Physics Department faculty members that have shaped the way he still works. Once, he discussed leaving

alumni briefs

- **Ray H. Baughman** (S1964) has been elected into the National Academy of Engineering, which promotes the technological welfare of the nation through eminent engineers. Baughman designs innovative devices in the field of nanotechnology and has 58 U.S. patents. He is the Director of the NanoTech Institute of the University of Texas at Dallas.
- **John Polles** (S1967) is running for a seat in the House of Representatives. Polles, a Vietnam War Veteran who served in the Army for twenty-five years and taught chemistry at the United States Military Academy, West Point for four years, recently won the primary election in Indiana.
- China-based pharmaceutical company WuXi PharmaTech has promoted **Edward Hu** (S1993) from Executive Vice President to Chief Operating Officer. Hu received both his MBA and M.S. in Chemistry from Carnegie Mellon. Prior to his promotion at WuXi PharmaTech, Hu worked for many companies where he utilized both of his Carnegie Mellon degrees.
- **Nicolay Tsarevsky** (S’95) received the 2008 National Starch and Chemical...
the Ph.D. program and moving on to law school with Emeritus Professor Leonard Kisslinger. Kisslinger’s advice — to complete the degree because of the satisfaction derived from finishing what you start — is something Siegal has passed along many times.

Siegal also recalls debating the search for truth in science with the late Simeon Friedberg, who pointed out that scientists get to the truth by publishing research results and exposing them to scrutiny. Siegal hopes that, though judicial review, the law can follow that same model.

The political upheaval and social unrest of the early 1970s also helped shape Siegal’s career. He chose law, in part, to have an impact on the world. Since his time as a student at Stanford, Siegal has found himself involved in politically charged matters. His first “real” job was in the U.S. State Department, drafting Agreements for Cooperation covering U.S. sales of nuclear materials to other countries. Later, he wrote amicus briefs for Supreme Court cases dealing with the Alien Tort Statute, which gives victims of human rights violations abroad the right to sue their abusers in federal court.

Siegal is currently working on the second edition of a casebook, “Disability Civil Rights Law,” which he co-authored. One of his sections — on international disability rights law — weaves together his experience in both areas. He’s revamping the section in light of the United Nations Convention on the Rights of Persons with Disabilities, which entered into force this past May and has been signed by 127 countries — and not by the United States, he notes ruefully. The convention aims to ensure that nations promote the rights of people with disabilities and make the world accessible to them. Not only is Siegal rethinking the casebook, he’s also looking for ways to promote the convention.

He says that 31 years ago, he made two great decisions. He married Sandra Tate (they have a daughter Anne, who just passed her CPA exam, he says proudly) and he joined Munger Tolles — recently named the number one law firm on the American Lawyer “A list.” Three decades later, between his work representing industry and individuals — from regulatory matters and litigation to disability rights — Siegal has little time to be bored. But that’s the way he likes it.

“I always like tackling something new,” says Siegal. “Every case is a new challenge, a new set of facts. All that makes for a varied life. …It keeps your mind young, which is useful when you’re married to Sandra and your daughter is Anne.”
Lifting As They Climb
COMPASS provides minority student mentoring

Denise Asafu-Adjei (S’08), Alana Cheeks-Lomax (S’08) and Betty Mbom (S’08) shared many of the same classes throughout their four years as biological sciences majors. But, for these young women, it went beyond being mere classmates. They had each other to turn to for support, which was very important to them especially since they did not see many other students of color in their courses. Recognizing that others were not so lucky, they enlisted fellow upper-level students Tamara Hamilton and Mariela Zeledón and together reached out to first-year underrepresented minority students, and COMPASS (COaching Minority Progress and Academic Success in Science) was born.

Spearheaded by Betty Mbom in 2007, COMPASS aims to build a supportive community for first-year minority students. During her first year at Carnegie Mellon, Betty struggled as she adjusted to the rigor of the work. “Sometimes I felt like I was hanging on by my fingertips, but every time I felt like I was going to slip, there was always someone there pulling me up and encouraging me to keep climbing,” she said during her student commencement speech. Betty’s insight that first-year minority students in MCS may also find themselves struggling and “questioning [their] abilities as a student and whether [they] really belonged here,” as she did, prompted her to work with MCS and the Carnegie Mellon Advising Resource Center to create COMPASS.

“Like every first year student at the Mellon College of Science, you tend to get lost in the work. Your GPA is the first thing on your mind, and your tests are the next…,” said Kamal Ibrahim, former mentee and now a sophomore mathematical sciences major and COMPASS mentor. “Having someone there really took the pressure off. My mentor didn’t teach me physics or math; she taught me that for a freshman I was in good standing, and she informed me not to worry about the GPA yet, ‘just get adjusted.’” By phone, email, texting, informal study sessions and a few meals together, the upper-class mentors maintained contact with their mentees to share their experiences, perspectives, and guidance when needed. COMPASS mentors also wanted to help

and Mariela Zeledón and together reached out to first-year underrepresented minority students, and COMPASS (COaching Minority Progress and Academic Success in Science) was born.

Pursuing careers in the natural sciences is made easier through Goldwater scholarships, and this year MCS is proud to have two students as recipients. Andrew DeYoung, a chemistry major who conducts research in theoretical chemistry, and Samuel M. Kim, who works with faculty to develop novel molecular biosensor technology, are two of 321 undergraduates chosen from more than 1,000 scholarship nominees nationwide.

The National Institutes of Health presented the National Research Service Award to Ken Hovis, a third year graduate student pursuing a Ph.D. in the Department of Biological Sciences. The award provides Hovis with travel allowance and tuition for three years as he investigates how cells communicate within the olfactory bulb in the brain.

Rhiannon Low, a junior majoring in chemistry, won the National Security Education Program Scholarship to study abroad. Low is one of 150


student honors

- Arbob Ahmad (CS, S’08) and Mariela Zeledón (S’08) both received a National Science Foundation Graduate Research Fellowship. The fellowship will enable Ahmad, a fifth year senior in mathematical sciences, and Zeledón, a 2008 Science and Humanities Scholar graduate, to continue their outstanding research.

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mentees get to know faculty and advisors outside of classrooms and offices in relaxed social settings. According to Associate Dean Eric Grotzinger, “COMPASS has added an extra, casual way for us as advisors to get to know this group of students — and to keep the lines of communication open and foster connections, such as for undergraduate research with faculty and for academic advising.”

After its first year, COMPASS can boast many successes — all of the participating mentees are continuing in their chosen MCS majors this fall, some have begun research experiences, and the majority are also now COMPASS mentors. According to Dami Phillips, “Last year, everybody made great friendships and loved having an experienced student mentor to turn to, and as this year’s student coordinator, I hope we continue to provide a sense of community that minority students can enjoy.”

The Proof is in the Proof

Team Carnegie Mellon places 7th in prestigious mathematics competition

For some, pre-game preparation doesn’t include gearing up in shoulder pads and a helmet. Instead, strapping on thinking caps and sharpening some pencils is what it takes to represent Carnegie Mellon in the Annual William Lowell Putnam Mathematical Competition. And the 2007 team represented us well, together placing 7th out of 516 teams and over 3750 contestants.

“The Putnam Competition is like a math Olympics,” explains Roy Nicolaides, head of the Department of Mathematical Sciences. “It is extremely competitive and highly regarded. A 7th place finish is truly exceptional.”

The Putnam Competition, which tests math knowledge and stimulates a healthy rivalry in students from universities across the United States and Canada, was founded in 1938 in honor of Mr. William Lowell Putnam. The proctored test has two, three-hour sessions where competitors are given a set of six questions in each session. All of the problems are proof problems, and grading is based on how well students have explained their proofs. Prizes and scholarships are awarded to the top teams.

The Carnegie Mellon students who participated in the 67th annual competition include Emily Allen, Evan Danaher, Richard Biggs, Jie Qi, Mark Spindler, and Pawat Techapongtada. On an individual level, the Carnegie Mellon students ranked among the top 500 contestants, with Biggs ranked 10th, Qi 103rd, Spindler 126th, Techapongtada 149th, and Allen and Danaher 367th.

“I like competing because there are interesting problems. It’s very fun,” says Spindler, who has been participating in math competitions since the fourth grade.

Team Carnegie Mellon was mentored by Assistant Professor Oleg Pikhurko and looks forward to competing again this year.

— Jill Perkins

For more stories about COMPASS students

Dynamo Walking
Science, May 16, 2008
sciencecareers.sciencemag.org/career_development/previous_issues/articles/2008_05_16/caredit_a0800071

A guiding COMPASS
Nature 452, 1030 April 23, 2008
www.nature.com/naturejobs/2008/080424/full/nj7190-1030b.html

Mariela Zeledón received the Dr. J. Paul Fugassi and Linda E. Monteverde Award

Biological Sciences Senior Awarded a National Science Foundation Graduate Research Fellowship

students awarded this competitive and prestigious scholarship that funded her 8-week study in Beijing during summer 2008.

• Kathleen McCann, Gregory Newby, Steven Reilly and Natalie Weir were named Beckman Scholars this year. Because of The Beckman Scholar Program, which encourages and supports undergraduate research, these four MCS students were able to spend their summers conducting research in the biological sciences.

• Senior chemistry major Natalie Weir won the top poster prize at the 16th annual American Heart Association Fellows Research Day. Weir, who conducts research in Biological Sciences Professor Chien Ho’s laboratory, also presented her poster at the joint meeting of the Biophysical Society and the International Biophysics Congress.

• Michael Williams, (’08) a graduate student in the Department of Physics, won the 2008 CEBAF Thesis Prize for his Ph.D. thesis on the expected number of excited states of the proton and neutron. Williams is now a postdoctoral researcher at Carnegie Mellon and is working as a part of the Physics at the Information Frontier Grant from the National Science Foundation.
As the moon lights the sky, Russ Walker walks across a quiet Carnegie Mellon campus with paint and brushes in hand. Walker and a few students are about to give the Fence a new face. Their mission is to spice up the campus with a taste of the Middle East. Once finished, the Fence has been transformed into a giant Qatari flag, and Walker is on the go. With barely enough time to clean the paint from his hands, Walker hops a plane to Doha, Qatar where he will spend three weeks teaching Essential Elementary Functions for the Summer College Preview Program on Carnegie Mellon’s Qatar campus.

Walker, teaching professor, former associate department head and undergraduate advisor for the Department of Mathematical Sciences, made his maiden voyage to Doha in 2004 to help launch the new Carnegie Mellon campus. Walker developed the math assessment that determined math competency for Qatari students who hadn’t taken the SAT or ACT. He returns to Doha occasionally to teach, and encourages students from the Pittsburgh campus to seize the opportunity to study in Qatar and also to be teaching assistants there.

With a 14-hour plane ride separating Pittsburgh from Doha, visiting students might expect a major culture shock. Despite the change of scenery and climate, Walker finds Qatar surprisingly comfortable. The campus is like “a big extended family,” says Walker, whose experiences in Qatar suggest that students there are similar to those here. For many students, regardless of what country they’re in, grasping complex mathematical concepts isn’t easy. Walker’s active approach to teaching makes math classes enjoyable and engaging. In his classroom, students participate in interactive experiments, like recording the position of a falling basketball to recreate Galileo’s experiment.

“Before taking Professor Walker’s Graph Theory class, I liked math but I wasn’t very interested in it,” says senior computer science major Hatem Alismail, a student at the Qatar campus. “After taking his class, I’ve decided to minor in math. He certainly changed the way I think about mathematics and how we can use it and apply it in the real world, which is very influential.”

When he’s not in the classroom, Walker soaks up the local culture. Whether it’s blazing through the desert in a car at 87 miles per hour in pursuit of ancient ruins, or riding camels in Jordan, Walker enjoys the opportunities he can’t get in the States, especially relishing the chance to share them with his family. Walker shared a real-life Indiana Jones experience with his son as they explored the Siq in Petra on a pair of camels.

Recently, Carnegie Mellon graduated its first class in Qatar, and Walker was there to witness it. “Standing while the ‘Star Spangled Banner’ was played at commencement, I had the feeling that I was a part of something that reached beyond the university, beyond my discipline of mathematics — an endeavor that allowed me to contribute positively as an American in a very tricky part of the world.”
New Faculty

Kasper Larsen
Assistant Professor, Mathematical Sciences
Specialty: Interested in how mathematical tools can be applied to solve financial problems, including the portfolio delegation problem, derivative pricing in incomplete markets using risk management tools and growth optimality of portfolios.
Education: Ph.D. Mathematical Finance, University of Southern Denmark

Maumita Mandal
Assistant Professor, Chemistry
Specialty: Investigates the conformations in RNA molecules that function as “molecular switches” and cellular sensors. By applying mechanical forces in single-molecules of RNA, she plans to study their structural rearrangements in response to cellular factors.
Education: Postdoctoral research, University of California, Berkeley and Yale University; Ph.D., Center for Cellular and Molecular Biology, India

Aaron Mitchell
Professor, Biological Sciences
Specialty: Investigates the mechanism by which fungi respond to their environment. Focuses on Candida albicans, the major invasive fungal pathogen of humans, with a goal of understanding and ultimately combating its mechanism of infection.
Background: Ph.D. Biology, Massachusetts Institute of Technology; postdoctoral research, University of California at San Francisco

Paul Whitmore
Research Professor, Chemistry (newly appointed);
Director, Art Conservation Research Center (since 1988)
Specialty: Explores the origins of aging problems that threaten cultural property, and develops practical and effective strategies to inhibit or avoid deterioration.
Education: Ph.D. Physical Chemistry, University of California at Berkeley

Retiring: Morton Kaplan
Chemistry Professor Morton Kaplan has retired after 37 years at Carnegie Mellon. Kaplan’s research, which has ranged from the chemical aspects of Mössbauer spectroscopy to the primordial chemistry of the early universe, has been funded for 43 consecutive years by the Department of Energy. Since the early ’90s, Kaplan focused his research efforts on the STAR experiment based at Brookhaven National Laboratory. STAR (Solenoidal Tracker at RHIC) is one of two large detectors in the Relativistic Heavy Ion Collider (RHIC) that tracks the profusion of particles liberated from nuclei when heavy ions smash into each other at near light speed. Kaplan is a founding member of the STAR collaboration, an international consortium of more than 400 researchers from 45 institutions worldwide, and in 2002 was elected STAR’s Deputy Council Chairperson.

faculty awards and honors

- Terrence Collins received the Charles E. Kaufman Award “for substantial contributions to science for both the betterment and understanding of human life.” Charles Kaufman, who established the award, said of Collins: “I believe his research is going to make a big difference to our world…”
- Tiziana Di Matteo received the 2008 Award for Excellence in the Emerging Female Scientist category from the Carnegie Science Center, which stated in a press release: “Di Matteo has proven herself to be a revolutionary female in the field of physics.”
- Sara Majetich was elected a fellow of the American Physical Society for her innovative research on magnetic nanoparticles and the design of plasmonic magnetic nanoparticles for biomedicine.
- Robert Murphy is conducting computational biology research in Germany under the auspices of a Humboldt Research Award, which are given to eminent foreign researchers at the peak of their academic careers and in leading positions.
- Steven Shreve has been elected president of the Bachelier Finance Society, the world’s leading professional society for quantitative finance. Shreve is universally considered a pioneer in the quantitative finance field, both in conducting research and in educating students.

PSC Appoints Alumnus
David Moses as Director

David Moses (S’86) has returned to Carnegie Mellon as the new executive director of the Pittsburgh Supercomputing Center (PSC). As executive director, Moses will manage the day-to-day internal operations of PSC, overseeing a scientific and technological staff of about 75 people. The PSC provides university, government, and industrial researchers with access to the most powerful systems for high-performance computing, communications and data-handling available to scientists and engineers nationwide. Moses received his Ph.D. in nuclear chemistry from Carnegie Mellon in 1986, and while serving as director of computing facilities in the Chemistry Department, helped co-found Gaussian, Inc., a worldwide leader in computational chemistry software.
Excellence in Education and Research Recognized
Curtis Meyer wins Carnegie Mellon’s Ryan Award for Meritorious Teaching

Each year Carnegie Mellon bestows its most prestigious teaching honor, the Ryan Award, to a professor who shows unusual devotion and effectiveness in teaching. Curtis Meyer is this year’s recipient. Letters supporting Meyer’s nomination explain that he is “a special teacher at all levels” with thorough knowledge of the subject and enthusiasm for teaching and communicating what he knows to the students.” Meyer has taught the introductory physics courses for all student groups, including engineering, math and science students. The classes are not easy, but Meyer has earned the reputation of putting students at ease by explaining course material in terms they can understand, and he even wrote the textbook for his electronics course. A leader in medium energy physics research, Meyer has successfully integrated his experiences into the classroom, guiding undergraduates in research and helping them to make significant contributions.

“Teaching in itself is very rewarding, so to get feedback like this makes it all the more worthwhile,” said Meyer. “It is a big honor for me to receive the Ryan Award.”

Richard Moore Education Award: Paul Karol
At the forefront in exploring the most effective means to use technology to enhance learning and improve the impact of technology on education, it’s not surprising that Paul Karol, professor of chemistry, received the Richard Moore Education Award, which recognizes MCS faculty who make substantial and sustained contributions to the educational mission of the college. Karol has developed many new courses for the Department of Chemistry and has also received the Julius Ashkin Award, where he was recognized for his excellence in teaching.

Julius Ashkin Teaching Award: Amy Burkert
Amy Burkert is more than a professor and academic advisor. “She was my surrogate mother, sincere teacher, and a role model for women in science,” wrote a former student in a letter supporting Burkert’s nomination for the 2008 Julius Ashkin Teaching Award. Burkert, who is the assistant dean for the Health Professions Program and Educational Initiatives, academic advisor and professor, is this year’s recipient of the award. “Amy’s influence has a positive impact on many facets of the undergraduate experience,” according to a faculty nomination.

Hugh D. Young Graduate Student Teaching Award: Robert Aguirre
Patience, support and a personable style are just a few qualities that make Robert Aguirre’s interactive method of teaching stand out to his students, according to letters in support of his nomination for the Hugh D. Young Graduate Student Teaching Award. Aguirre, a graduate student in Mathematical Sciences and a teaching assistant, received the award that recognizes graduate students for effective teaching.

Guy C. Berry Graduate Research Award: Haifeng Gao
Haifeng Gao already has a remarkable list of accomplishments. Co-authoring more than 20 papers in peer-reviewed journals, including the Journal of the American Chemical Society and Macromolecules, Gao’s publication output is quite impressive. Now Gao can add the Guy C. Berry Graduate Research Award for excellence in graduate research to his list of achievements. A Ph.D. candidate in the Department of Chemistry, Gao has made extensive contributions to the field of star and brush polymer synthesis and has invented a new method for synthesizing miktoarm star copolymers.

Dr. J. Paul Fugassi and Linda Monteverde Award: Mariela Zeledón
When Mariela Zeledón is not in Costa Rica researching the genetics of alcoholism and bipolar disorder, you might find her here, focusing on her interest in genetics and molecular biology. Zeledón, a Science and Humanities Scholar and biology major, received the Dr. J. Paul Fugassi and Linda E. Monteverde Award, which recognizes a graduating female who exhibits the most outstanding academic achievement and professional promise.
With their noses usually buried in textbooks and their hands encased in latex gloves in the lab, MCS students deserve a night out. What better way to gather everyone together than to host the first annual MCS Ball? On April 12th, students, faculty, and alumni arrived at Phipps Conservatory for a night of food, dancing, and raising money for MCS and for Carnegie Mellon. Donations received that night increased the overall student giving rate by 70%. “It was great getting everyone together and having a good time while at the same time benefiting MCS and Carnegie Mellon,” said Ben Williams (S’08), who initiated and coordinated the event with Elyse Maiorini (S’08). Be on the lookout for your invitation to the next MCS Ball!

Sponsored by: Mellon College of Science, Office of the Dean of Student Affairs, Alumni Relations, Student Development

Student planning committee: Dan Carmody, Jae Choi, Guangzu Gao, John Hannon, Hyun Kim, Elyse Maiorini, Gregg Peim, and Benjamin Williams
Following Bill Brown’s Path

Early on a Saturday morning in March, cyclists of all ages and abilities gathered in Doha, Qatar to take part in the inaugural Bill Brown Ride. Held in honor of the beloved biological sciences professor who died last year, the ride helped raise money for the Bill Brown Scholarship Fund. Beginning at 8 a.m., cyclists headed out on one of three looped routes, which ranged from 16 miles to the 42 mile loop Brown frequently biked while he was in Doha. “The fact that we can remember him and at the same time raise money for scholarships is exactly the kind of thing Bill spent his own life doing. The ride was the type of event Bill would have loved,” said Chuck Thorpe, Dean of Carnegie Mellon Qatar. A barbecue held after the ride was the perfect way to end the day of fun, friendship, and exercise for a good cause.