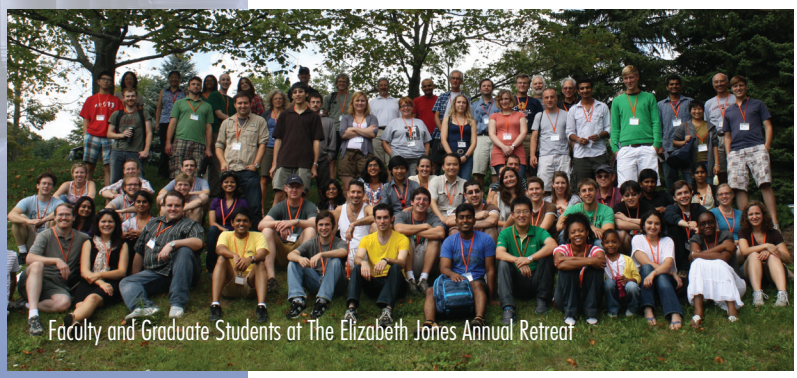
The Promoter

Spring 2012 No. 14



Faculty and Graduate Students at The Elizabeth Jones Annual Retreat

Every five years or so, the Department of Biological Sciences is reviewed by an advisory board consisting of scientists from academia and industry as well as members of the university's Board of Trustees. This board reports to the university president and administration about the state of our department. In January, the department was visited by such an advisory board, the first since 2005. Preparing for this visit gave us the opportunity to look back on our recent progress and make plans for the future.

While the board is still writing its report, one clear conclusion is that the department has grown in many ways since 2005. We teach about 20 percent more undergraduates and 80 percent more Ph.D. students. The M.S. in Computational Biology program has grown from nine to 24 students. Departmental funding through sponsored research has increased by more than 40 percent since 2007. Faculty turnover has been high, with seven faculty departing and six joining. We have had three department heads and two undergraduate advisors. Many new labs and research spaces have also been created in the Mellon Institute.

The niche of the department within CMU has also changed dramatically. Life sciences across campus have expanded, enriching the environment in which we reside. Computational biology has grown from its roots in our department to become its own department in the School of Computer Science, headed by Dr. Bob Murphy. New centers in membrane biophysics and cell mechanics have been formed, integrating faculty from biology, engineering, physics and chemistry. The Biomedical Engineering Department and the Center for the Neural Basis of Cognition are working closely with the Department of Biological Sciences to identify areas of common interest and opportunities.

Also, the undergraduate curriculum has undergone significant changes. For example, computational biology is now a requirement for all majors, in recognition of the increasing importance of approaches using large data sets in biomedical science. What hasn't changed is the emphasis that we place on having students learn to do real science through research and sophisticated lab courses. The *Phage Genomics Research* course, which introduces students to genomics, is a very successful example. This year, we are changing the course to use the Ion Torrent Personal Genome Machine gene sequencer that we recently purchased with the support of Dr. Jonathan Rothberg, CMU alumnus and founder of Ion Torrent *(see page 8)*. The importance that we attach to getting our students unique experiences like these highlights what is distinctive about a CMU education.

I invite the alumni of the department to tell us where you are now and how you think the department has changed since the "good old days" when you were here.
www.facebook.com/CMUBiologicalSciences

Biological Sciences at CMU-Qatar By Shoba Subramanian, Ph.D.

Dr. Ken Hovis (center) with the six members of the inaugural biological sciences class.

The desert gecko relies on its sense of smell for its day-to-day survival. Its vomeronasal sensory system is highly specialized to detect pheromones released by other animals via a neural circuit of only a few cell types. "This simple circuit has been implicated to underlie behaviors such as aggression, predator detection, and reproductive behaviors. This makes the desert gecko an ideal model system to study the role of particular brain circuits in directing complex stereotypical behaviors," says Dr. Ken Hovis, assistant teaching professor at Carnegie Mellon University in Qatar (CMU-Q). Hovis, a neuroscientist who is interested in understanding how brain circuits guide and direct behavior, will lead undergraduate student projects examining the role of olfaction in specific innate behaviors related to reproduction in the desert gecko. Another new teaching faculty at CMU-Q, Dr. Jonathan Finkel, is also planning student projects about his research interest, fungal pathogenicity.

Much like in Pittsburgh, an important emphasis of our new degree programs in Qatar is student research. CMU-Q started two new programs, offering B.S. degrees in biological sciences and computational biology in the fall of 2011. These degrees are the first at CMU-Q in the basic sciences, and they add to existing undergraduate degrees already offered in business administration, computer science and information systems. These degree programs mirror the established and widely successful undergraduate programs at CMU-Pittsburgh, with students taking the same chemistry, math, physics and biology core courses. Students can also select from a number of electives in biology, engineering, management, humanities, social sciences and fine arts. Armed with this broad knowledge base and research experience, the students' post-degree path will range from medical school to science policy and biotechnology management to basic research.

The biological sciences degree program is offered in collaboration with Weill Cornell Medical College in Qatar, although students will receive their degrees from CMU. This is a mutually beneficial partnership between the universities: CMU is technology-driven, employs basic science faculty and houses resources, whereas Cornell is world-renowned for medical research. CMU-Q students are uniquely positioned to derive the best from both universities. Moreover, the physical proximity of the universities in Doha's Education City is convenient for the CMU-Q students.

> *"I appreciate the opportunity to pursue this new program because it offers flexible, expansive, and research-oriented training for diverse career outcomes."*
>
> *– Member of the inaugural class*

Additionally, the CMU-Q program contains a strong community outreach component. The "Biotechnology Explorer Program" was a first-of-its-kind event held in 2011. During two sessions 50 high school students from 14 different local schools investigated a simulated disease outbreak. This is one simple and effective way that CMU-Q faculty, staff and students are getting young minds in the local community excited about biology.

In 2004, the Qatar Foundation invited Carnegie Mellon to join Education City, a groundbreaking center for scholarship and research.

Qatar Biological Sciences Administration & Faculty

Maggie Braun, Ph.D. – Assistant Department Head for Undergraduate Affairs
Amy Burkert, Ph.D. – Vice Provost for Education
April Conkey, Ph.D. – Adj. Assistant Teaching Professor
Jonathan Finkel, Ph.D. – Assistant Teaching Professor
Kenneth Hovis, Ph.D. – Assistant Teaching Professor
Gordon Rule, Ph.D. – Faculty Coordinator
Shoba Subramanian, Ph.D. – Academic Advisor
Nathan Urban, Ph.D. – Department Head

Welcoming McManus By Kristen McConnell

Dr. C. Joel McManus

The Department of Biological Sciences is proud to introduce its newest assistant professor, Dr. C. Joel McManus. McManus comes to CMU from the University of Connecticut Health Center, where he was a postdoctoral fellow in the lab of Dr. Brenton Graveley. He received his doctorate in biomolecular chemistry from the University of Wisconsin, Madison.

After arriving at CMU in September, McManus set up his laboratory and began work on two research projects. The first is aimed at understanding how genomic differences affect gene expression. Gene expression involves transcription of DNA into mRNA, alternative splicing of mRNA, translation of mRNA into proteins, and regulation of mRNA and protein levels through degradation pathways. Differences in the networks controlling these processes lead to variation in gene expression, an important source of phenotypic diversity. Most research in this area has centered on transcription networks and mRNA abundance; however, McManus' research shifts the focus by investigating changes in splicing and translation regulatory networks using high throughput sequencing and bioinformatics.

His second project will use these same tools to investigate mRNA secondary structure genome-wide. Even though mRNA structures play a large role in gene expression, very little is known about the structures of most mRNAs.

McManus is looking forward to collaborating with the computational, gene expression and RNA communities at the university. He is pleased to be at CMU, stating "I've really been impressed by how kind and helpful everyone has been."

Departmental Highlights

Kaitlyn Dykstra (Ph.D. '13) was named the inaugural recipient of the de Vries Fellowship, a departmental award instituted to recognize the impact and quality of a recent publication.

Michael Gamalinda (Ph.D. '15) received the Outstanding Oral Presentation award at the 2011 Rustbelt RNA meeting in Dayton, Ohio. His presentation was entitled "The yeast 60S subunit is structured by ribosomal proteins in a stepwise fashion."

David Hackney (Faculty) published a study in the Aug. 12 issue of *Science* describing how molecular motor proteins fold in on themselves to save energy when their transport services are not required. The solution to this puzzle may open new avenues for the treatment of various neurodegenerative diseases such as Alzheimer's and Huntington's.

David Huang (B.S. '12) received the 2011 American Society for Microbiology Undergraduate Research Fellowship.

Tim Jarvela (Ph.D. '13) was awarded the inaugural Stupakoff Fellowship, a departmental award instituted to recognize the impact and quality of a recent publication. He also received the departmental 2011 Graduate Student Teaching Award.

Elmer Ker (Ph.D. '12) received the departmental 2011 Graduate Student Service Award.

Claire Koechlein (B.S. '11) was named the 2011 recipient of the Elizabeth W. Jones Award for Excellence in Undergraduate Research.

Kellie Kravarik (B.S. '11) received the Dr. J. Paul Fugassi and Linda E. Monteverde Award, presented to a graduating female senior with the greatest academic achievement and professional promise. Kravarik was also a Judith A. Resnik Honorable Mention recipient.

Adam Linstedt (Faculty) and **Somshuvra Mukhopadhyay (Postdoc)** were published in the Jan. 20 issue of *Science* for discovering that manganese completely protects against Shiga toxicosis in animal models.

Robert Murphy (Faculty) was appointed to the Council of Councils, National Institutes of Health.

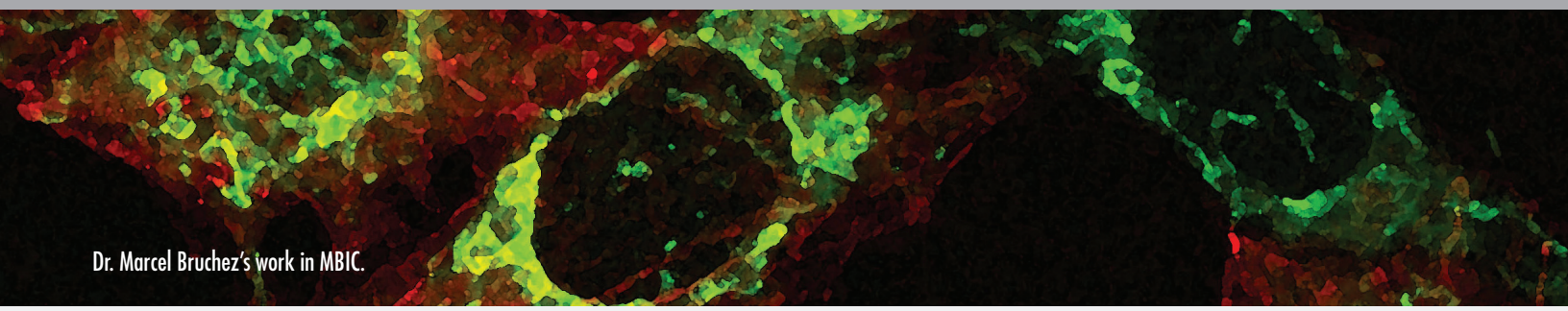
Alia Poonawala (B.S.A. '11) served as the student speaker for the university's 2011 commencement ceremony.

Suchitra Ramachandrana (Ph.D. '15) was named a Presidential Fellow in the Life Sciences by the Richard King Mellon Foundation.

Judy Savitskaya (B.S. '12) is one of 14 students nationwide to receive a 2012 Churchill Scholarship, which funds a year of postgraduate study at the University of Cambridge in England.

Rachel Vistein (Ph.D. '15) was accepted into the Multi-modal Neuroimaging Training Program.

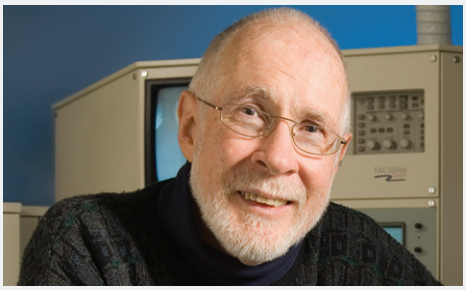
Happy Anniversary, MBIC...



Dr. Marcel Bruchez's work in MBIC.

The Molecular Biosensor and Imaging Center (MBIC), world-renowned for biomedical applications of fluorescence technologies, is celebrating its 30th anniversary. Biological Sciences Professor Alan Waggoner serves as the current director.

Dr. D. Lansing Taylor founded the center, originally named the Center for Fluorescence Research, in 1982. Center researchers pioneered automated, multi-color fluorescence-imaging technologies that were adopted by imaging microscope manufacturers. The center is also famous for its development of CyDye™ labeling technologies, which made a profound impact on biomedical research and diagnostics. Other projects include a NASA-funded collaboration with a field robotics team to detect life in extreme environments, research on imaging heart excitation to follow cardiac function, design and synthesis of quantum dot derivatives for the mesoscopic fluorescence imaging of small animals, and the development of reagents and methods in bone tissue engineering.



Dr. Alan Waggoner was recently awarded the Maxwell H. and Gloria C. Connan Professorship in the Life Sciences.

In 2002, the center was renamed MBIC. The National Institutes of Health Common Fund's Building Blocks, Biological Pathways and Networks program now supports MBIC as a National Technology Center. This research's goal is to create tools for obtaining spatial and temporal information about the structure and function of pathways in living cells.

Since its inception, MBIC engages in multi-disciplinary research involving scientists, engineers and medical doctors. The center also trains numerous students.

Another one of MBIC's notable strengths is the successful transfer of its innovative technologies to industry. Center scientists hold various patents. The transfer of the cyanine dye technology to Amersham PLC has led to the dyes' dissemination throughout the world. Center scientists have also started several biotechnology companies, including Biological Detection Systems Inc., Cellumen Inc., Cellomics Inc., and Sharp Edge Labs.

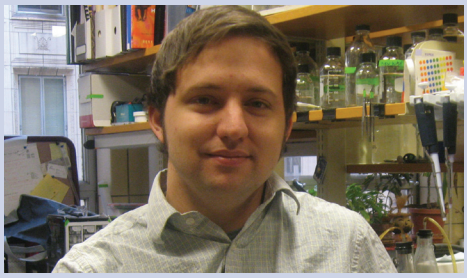
For more information about MBIC, visit: www.mbic.cmu.edu.

...and many more!

CNAST By John Woolford, Ph.D.

In 2007, Professors Bruce Armitage in Chemistry and John Woolford in Biological Sciences founded the Center for Nucleic Acids Science and Technology (CNAST). Their vision was to combine expertise in synthetic organic chemistry with strengths in RNA biology. Center members include 17 faculty from the areas of biological sciences, chemistry, physics, chemical engineering and computer science at CMU, as well as environmental and occupational health at the University of Pittsburgh. CNAST takes advantage of unique capabilities at CMU to design and synthesize a special kind of nucleic acid called PNA — a peptide nucleic acid. PNAs can bind through base-pairing with DNA or RNA with greater stability and specificity than conventional nucleic acids, and can be modified in numerous ways via their peptide moities. Derivatives of these unusual nucleic acids are being harnessed to monitor and manipulate gene expression. For example, CNAST scientists are detecting the shortening of telomeres at the ends of chromosomes with much greater sensitivity than before enabling scientists to monitor environmental damage sooner. Probes are being used to measure the editing of glutamate receptor messenger RNAs in the brain, and alternative splicing of pre-mRNAs during aging. Tags specific to ribosomes are being developed to monitor the assembly and function of these complex nanomachines. PNAs are also being designed to interfere with infectious pathogens such as malaria and viruses. In 2011, the David Scaife Family Charitable Trust awarded CNAST $3.9 million to support its research.

de Vries & Stupakoff Fellowships By Kristen McConnell



Kaitlyn Dykstra and Tim Jarvela

Two Ph.D. candidates, Kaitlyn Dykstra and Tim Jarvela, were named the inaugural recipients of departmental fellowships instituted to recognize the impact and quality of a recent publication. Dykstra received the de Vries Fellowship, made possible through the generosity of alumnus and founder of Medidata Solutions, Glen de Vries. Jarvela was awarded the Semon H. Stupakoff Fellowship, named after alumnus Semon Stupakoff.

Dykstra, a fifth-year student in the Lee lab, received the de Vries fellowship for her publication in *Molecular Biology of the Cell* entitled "Yip1A structures in endoplasmic reticulum." The site of many vital cell processes, the endoplasmic reticulum (ER) in mammalian cells is an intricate membrane network that extends from the nuclear envelope to the cell periphery in specialized cell types. The ER can undergo dramatic structural rearrangements, from an extended, latticed network into stacked, concentric whorls. The relevance of these structures and the molecular mechanisms regulating the changes are not well known.

To address these questions, Dykstra found that the protein Yip1A, previously implicated in coat protein (COP)II vesicle biogenesis, plays a role in regulating the ER structure. In HeLA cells, siRNA mediated knockdown of Yip1A resulted in a restructuring of the network into micrometer-sized concentric whorls, not unlike those seen in the specialized cells. Yip1A-depleted cells exhibited a clear delay in COPII-mediated protein export. Interestingly, this delay in COPII trafficking was also seen when ER whorling was induced by an exogenous protein, suggesting that the delay seen in the Yip1A knockdown can be attributed to the changes in ER structure. Together, these results suggest a molecular basis for regulation of ER whorling and normal maintenance through Yip1A, and suggest a functional role of ER whorls to globally regulate COPII-mediated protein secretion in specialized cell types. Dykstra's work now focuses on determining the molecular mechanism by which Yip1A regulates ER structure.

Jarvela, a Linstedt lab member in his fifth year, was awarded the Stupakoff fellowship for a publication in the *Journal of Cell Science* entitled "Irradiation-induced protein inactivation reveals Golgi enzyme cycling to cell periphery." Jarvela used high speed live cell imaging along with a powerful acute inhibition technique for protein inactivation called CALI (chromophore assisted light inactivation) to test an unresolved question in Golgi biogenesis: does the Golgi depend on continual input from the ER?

The Golgi apparatus, the organelle at the center of protein processing and secretion, processes cargo exported from the ER. The best current model to explain Golgi function is the maturation model, in which new cisternae are formed at the cis face of the Golgi from the fusion of membranes carrying cargo from the ER and recycling membrane containing cis-enzyme from the Golgi. As cisternae progress through the stack, early cis-enzymes recycle to newer cisternae. Medial and trans enzymes are then delivered in subsequent fusion of recycling vesicles. A key prediction, that the Golgi is acutely dependent on ER exit, is under study.

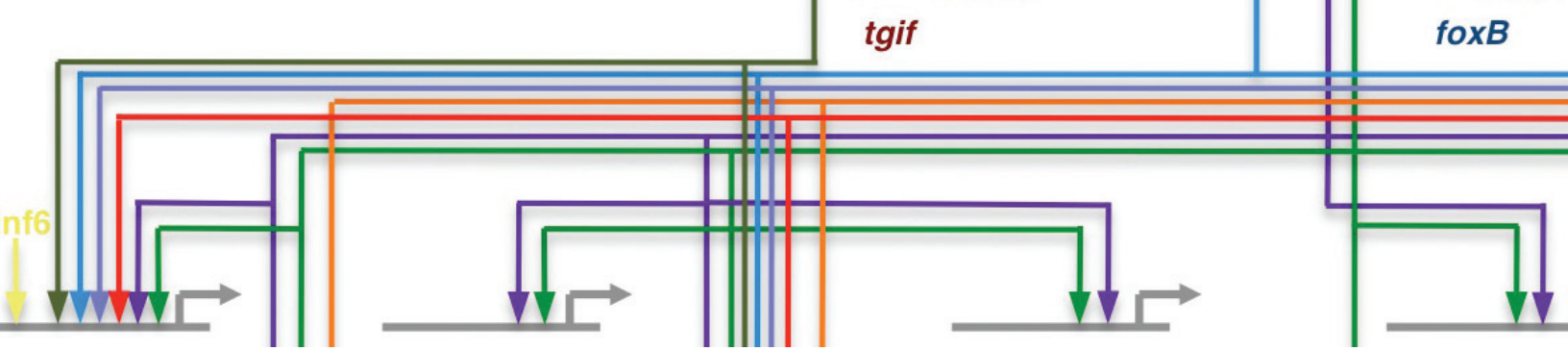
The use of a special dye, KillerRed, to block export from the ER to the Golgi was the truly novel component of this research. KillerRed-mediated inactivation allows light to specifically inhibit a component of the cells' secretory machinery. Coupled with high-speed imaging, it was shown that not only was the structure of the Golgi quickly compromised, but also early Golgi enzymes were trapped in recycling intermediates.

Congratulations to both awardees.

Left to right: MCS Dean Fred Gilman, Dr. Peter Berget and Dr. Nathan Urban at Berget's retirement party.

Berget Retires

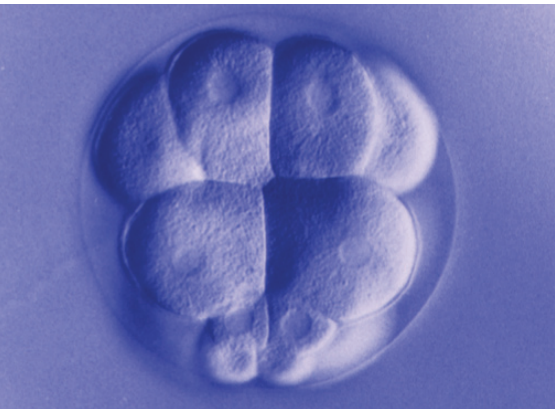
Associate Professor Peter Berget joined the department in 1986. As a member of the Molecular Biosensor and Imaging Center, Berget used single chain antibody molecules that bind and release fluorescent haptens as a platform for biosensors. Berget also served as the director of the Pennsylvania Governor's School for the Sciences from 1993 until 2000. A favorite of students, his excellence in teaching earned him the Richard Moore Education Award in 2005 and the Julius Ashkin Teaching Award in 2009. After retiring from the department, Berget began as chair and professor of biological sciences at the University of the Sciences in Philadelphia, Pa.



The Evolution of Development

By Veronica Hinman, Ph.D., and Alys Cheatle, Ph.D. Candidate

It's hard to look down a microscope at the early events of embryonic development and not be awestruck by the extraordinary spectacle: the organized program of cell cleavage indicating a new life in progress. Combine this spectacle with what you might already know about cell biology and genetics and the complexity of what is unfolding is all the more extraordinary. Housed within the fertilized egg is all of the information needed to instruct cells on how to divide, how to produce exactly the right combinations and amounts of proteins in the right cells at the right time and in the place, and how to change shape and move into precise positions. And all of these steps must be done perfectly by every egg. Sometimes, of course, there are errors in the process. The importance of these errors cannot be overstated – a baby is born with a congenital birth defect every four and a half minutes in the United States.



A living sea urchin embryo, three hours after fertilization (16-cell stage). *Ettensohn Lab.*

To understand how development works, it is important to know how the genome regulates cell fates, how the cyto-architecture and mechanics of cells affect movements. Ideally there needs to be a way to visualize these processes in what is a remarkably dynamic system. The science of developmental biology requires the expertise of genomics, cell biology, biomechanics, imaging, computational genomics, and biochemistry, among other disciplines. CMU's biology department has established strengths in these areas and are bringing new and innovative approaches to bear on important problems in developmental biology.

One of the most significant breakthroughs has been in the area of technology associated with high throughput nucleotide sequencing and the bioinformatics tools used to interpret these data. Along with the Lane Center for Computational Biology, the department has established a genome-sequencing suite that includes an Ion Torrent personal genome machine. Now with this machine, scientists can examine whole genomes, transcriptomes and proteomes in a matter of a few days instead of having to look at subsets of likely candidates of genes and proteins, systematically probing through the sequences of DNA.

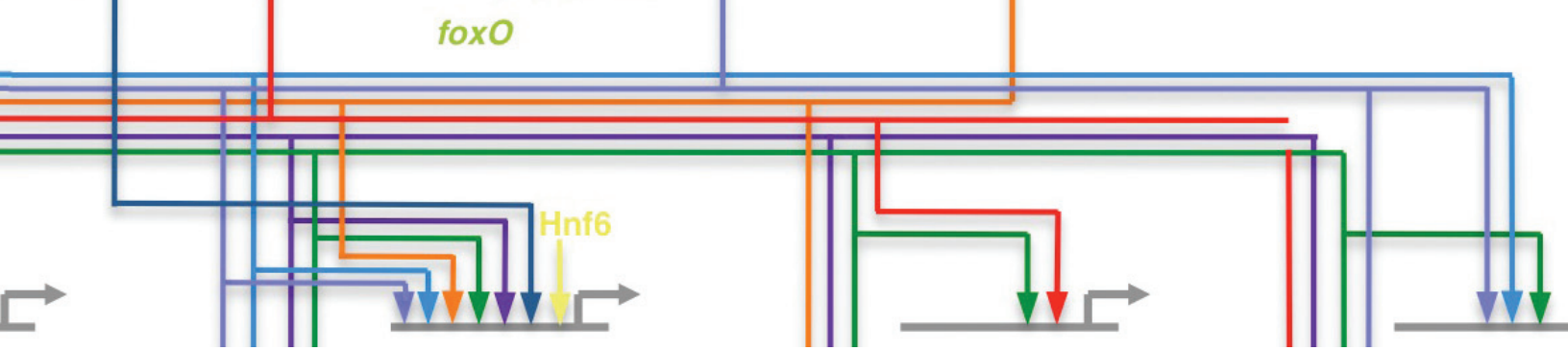
Many groups in the department demonstrate how this multifaceted approach to developmental biology is leading to important advances.

Ettensohn Laboratory

Development is characterized by dynamic changes in the morphology of the embryo, which are driven by cell behaviors such as cell division, movement and differentiation. Understanding how these programs of cell behavior are encoded in the genomic DNA sequence, and how they produce the anatomy that we actually see, requires an integration of information from multiple levels of biological organization. Much of the work in the Ettensohn lab uses as an experimental model, the developing sea urchin embryo, which has the significant advantage that it can be studied using many different experimental approaches, from genomics to light optical imaging. Current work is focused on the formation of the sea urchin's elaborate skeletal system. Recent studies by the Ettensohn lab have revealed how the development of this major anatomical structure is driven by specific cell behaviors, how these cell behaviors are controlled by a complex and dynamic network of genes, and how this genetic circuitry is activated in the correct time and place in the embryo. Their work is providing an exciting view of how the one dimensional information in DNA sequences is "translated" into three dimensional anatomy.

Hinman Laboratory

All animal life is built using the same basic genetic toolkit, which raises the puzzling question of how so much diversity can be produced using the same sets of genes. The answer to this may lie in the part of the genome that doesn't encode for genes (greater than 95 percent) but instead may control how these genes are deployed: when and where they are turned on, for how long, and to what levels. For the first time, the increasing availability of genome sequences is making it possible to really look into the function of these regions of the genome. The Hinman lab is especially interested in understanding how these regulatory DNA regions evolve and what this means for development. The lab focuses on genes not as individual units, but instead as sets of various numbers of genes that work together in inter-regulated networks. For instance, the lab has shown that sub-circuits of these regulatory gene



networks can evolve as complete modules. Evolutionary variation can come from changing the context of these modules, and the linkages between them are the sites of important evolutionary change.

Lanni Laboratory

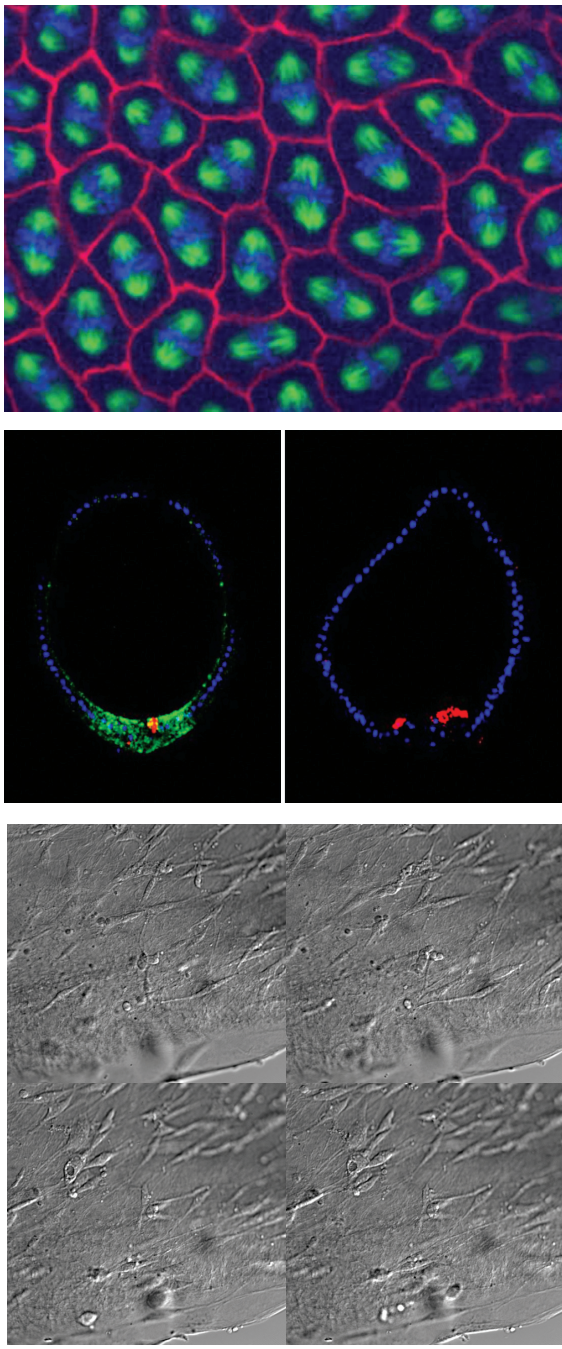
Wound healing and tissue maintenance require processes that overlap greatly with development. In animals, these processes are carried out by fibroblasts, which migrate and generate contractile forces in order to shape and repair connective tissue. Locomotion, extension, and contractility involve cell shape changes and regulatory small GTPases that are also integral to developmental processes. Much of what is known about fibroblast cell mechanics is known from studies done with cells on glass or plastic slides and dishes. However, fibroblasts move and behave differently in a collagen matrix, which resembles more closely the environment that these cells normally encounter *in vivo*. By combining a variety of imaging techniques, the Lanni lab has been able to assess fibroblast activity in a way that captures visual and mechanical information to gain a better understanding of how these cells exert forces.

McCartney Laboratory

Actin cytoskeleton rearrangement underlies many of the morphogenic processes that drive development. However, little is understood about how actin filaments are assembled at the molecular level. The McCartney lab, in collaboration with Bruce Goode's lab at Brandeis University, is developing a four-color TIRF (Total Internal Reflection Fluorescence) system that will allow each key player in actin assembly to be labeled and visualized. A new technology, "SNAP-tag coupling," has allowed the addition of fluorophores to purified samples corresponding to proteins of interest in actin assembly. This allows the actin assembly process to be examined at the molecular level with such precision that even monomers and dimers can be differentiated from each other. Observations made using this *in vitro* system can then be tested using the powerful genetic and *in vivo* imaging techniques frequently used by the McCartney lab.

Minden Laboratory

Cell shape changes and cell death are both integral processes in development but they remain poorly understood. This is partly because the rapidity of these processes makes microscopic analysis challenging. Moreover, all cells express both the major structural proteins required to establish cell shape and the proteins required to keep the cells poised for apoptosis. Both of these scenarios make genetic analysis of the developmental inputs for specific cell shape changes and cell death events difficult. The Minden lab has developed technologies aimed at solving these problems by creating new tools for time-lapse microscopy and proteomics. In collaboration with Dr. Alan Waggoner, the lab has developed fluorescent reagents to create new reporters for monitoring cell shape change and cell death in live embryos and to identify proteome changes that drive these rapid processes. These methods have had an important impact in the field by allowing for quick identification and testing of proteins implicated in these developmental processes. They also invented a method called Difference Gel Electrophoresis (DIGE), which can be used to compare any two sets of proteins. Because of this capability, DIGE has found applications in studying a wide variety of normal and abnormal developmental processes.



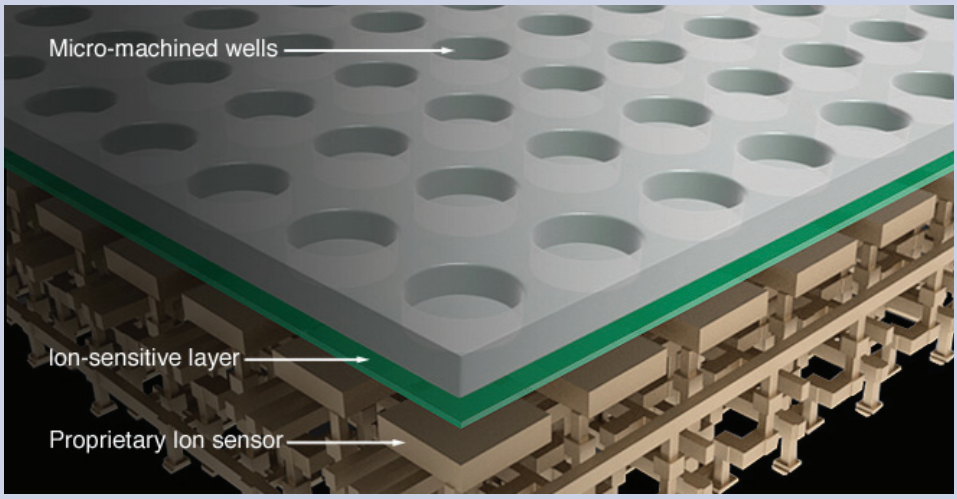
Top: Actin furrows (red) in an early Drosophila embryo undergoing mitosis. The spindle is shown in green and chromosomes in blue. *McCartney Lab.* Middle: A red fluorophore is used to label a gene expressed in a cell migrating into the embryonic cavity of a sea cucumber. *Hinman Lab.* Bottom: Fibroblasts migrating in a collagen gel. *Lanni Lab.*

Have You Met your Personal Genome Machine?

By Maggie Braun, Ph.D., and
A. Javier López, Ph.D.

The ability to read the entire genome sequence of an organism has revolutionized many fields within biology, allowing gene function, expression, variation and evolution to be assessed on a large scale and opening the door to new kinds of questions. However, even the technologies that led to the first human genome sequence were too slow or too costly for routine use or clinical applications. As the power of whole-genome analyses became evident, the push was on to develop more efficient "next-generation" sequencing technologies. The recently released Ion Torrent semiconductor sequencing technology is salient among these for its unique concept, speed and economy. It brings high-throughput sequencing within the reach of the small laboratory and teaching environment through its Personal Genome Machine (PGM) implementation. A second implementation with even higher throughput, the Ion Proton, is designed for rapid sequencing of the large human genome to analyze gene-disease associations.

In the fall of 2011, the Department of Biological Sciences became an early adopter by purchasing an Ion Torrent PGM system from Life Technologies. This cutting edge sequencing technology is different from other, more traditional approaches, which have relied on fluorescently modified nucleotides and expensive photo-detectors to record nucleotide incorporation as the new DNA strand is synthesized during sequencing. Instead, the Ion Torrent system uses natural chemistry to detect nucleotide incorporation.



Magnified illustration of the proprietary Ion Torrent chip technology. Each well contains a different DNA template. The Ion Sensing Layer transmits pH changes to the Proprietary Ion Sensor. pH changes are then converted to nucleotide inclusion by the computer server.

Pyrophosphate and hydrogen molecules are released as natural byproducts when a nucleotide is incorporated into a newly synthesized DNA strand by a polymerase. In the Ion Torrent instrument, the released hydrogen molecules result in localized pH changes that are detected by highly sensitive semiconductor chips, each of which contains millions of individual sequencing wells in an area of less than one square inch. The small yet powerful scale at which this is accomplished is impressive: the chips can distinguish even minor

Alumni Updates

Eda Akyar (B.S. '11) received a 2011 Fulbright Scholarship to travel to Indonesia, where she will serve as an English teaching assistant.

Tom Anfuso (B.S. '91) is now vice president of business applications support at USAA in San Antonio, Texas. He also led multiple science fair teams aimed at encouraging girls to pursue STEM careers through Girls Inc.

Margarida Anjos (M.S. '08) now works in ribosome biogenesis in the Department of Molecular Genetics and Microbiology at the University of Texas at Austin as a researcher.

Erik Boczko (Ph.D. '95) is an associate professor at Vanderbilt University in the Department of Biomedical Informatics.

Barbara Bralver (B.A. '70) is enjoying retirement as a member of the Collegiate Chorale. This summer the Chorale will travel to Israel and Austria to sing with the Israel Philharmonic.

Elena Chartoff (B.S. '92) is an assistant professor in the Department of Psychiatry at Harvard Medical School where she studies the neurobiological mechanisms of drug addiction.

Roger Clem (Ph.D. '07) is completing a postdoctoral fellowship in the laboratory of Rick Huganir at Johns Hopkins University School of Medicine and will begin as assistant professor in the Neuroscience Department at the Mount Sinai School of Medicine in New York City, N.Y.

pH changes that result in each of these wells as nucleotides are incorporated into the newly generated DNA strand, and current PGM chips can analyze up to one billion base pairs in just two hours (compared with the more than ten years that it took to sequence the first human genome in the 1990s). In sum, the Ion Torrent technology allows for inexpensive sequencing of nucleic acid sequences with extremely quick turnaround times. More information can be found at www.iontorrent.com/technology-how-does-it-work-more.

This year, the undergraduate *Phage Genomics Research* course piloted the PGM technology for use in an educational setting for Ion Torrent. The 16 students processed their newly isolated phage from genomic library preparation through sequence analysis. The students digested their phage genomic DNA into short, 100-200 base pair fragments by random enzymatic digestion. "Barcode" and "adapter" sequences were ligated to the ends of the fragments, so that the 16 genomic libraries could be pooled for analysis. These fragments were then gel purified and conjugated to microscopic beads via the adapter sequence and clonally amplified by emulsion PCR using a microfluidic system (set up so that each emulsion bubble contains one template fragment and one bead), resulting in millions of beads that are each conjugated to hundreds of thousands of separate but clonal copies of the genomic fragments. A specialized robot was used to purify the template-conjugated beads, which were then loaded onto a sequencing chip, placing a single bead into each well on the chip prior to processing by the PGM.

During a sequencing reaction, the template-containing chip is exposed sequentially to individual nucleotides. If the system knows to which nucleotide the wells are exposed at a given time, then a pH change can be interpreted to represent incorporation of that particular nucleotide, thereby translating this chemical signal into a computer-generated nucleotide sequence of the template. If the template in a given well is exposed to a given nucleotide that doesn't match, no pH change is detected and no base is called. The PGM computer server processes the millions of data points for each nucleotide exposure and generates sequence files for each 200 base pair template on the chip, and organizes the templates by barcode. Further software analysis assembles the original genomes from the short reads that the PGM has generated.

Undergraduate Rene Francolini loads the student Phage samples onto an Ion Torrent chip for sequencing, while other students and Dr. Braun (left) observe.

This technology is currently used primarily for educational purposes in our undergraduate laboratories. This spring semester, the students in the *Phage Genomics Research* course have truly been pioneers with this technology in the classroom. Using the sequencing data obtained from the PGM, the students plan to annotate their genomes to predict the genes and their protein products prior to submission of genomic data to GenBank at the end of the semester. The department plans to incorporate this technology into the junior level biology laboratory courses, with the hope that all students will gain first-hand experience with cutting edge nucleic acid sequencing, making them more prepared for the ever-advancing technologies that they will encounter in their careers.

Katie D'Aco (M.S. '09) is working as a bioinformatics scientist at the human genomics company, Knome, in Cambridge, Mass.

Parth Dalal (B.S. '10) is in his first year of medical school at The Commonwealth Medical College in Scranton, Pa.

James Dang (M.S. '10) is an AVP and software developer at Barclays Capital in Singapore, working on pricing and risk systems for exotic commodity derivatives.

Amanda Deming (SHS '06) is a medical student at Jefferson Medical College in Philadelphia, Pa. She will start her residency in Obstetrics and Gynecology next year.

Emily Drill (B.S. '03) is a special lecturer in the Department of Biological Sciences at CMU, teaching *Experimental Cell and Developmental Biology* and *Experimental Genetics*.

Kimberly Dy (B.S. '11) works in the Department of Anesthesiology at Cooper University Hospital in Camden, N.J. studying the effects of anesthesia and drug interactions on cognition and the body.

Michael L. Epstein (B.A. '82) is president and CEO of Lightening Energy (LE) based in Dover, N.J.

Nicholas Fleming (B.S. '03), who is serving in the Navy, married Lara (Thomas) Fleming (B.S. MechE '03) on August 20, 2011.

Corey Flynn (Ph.D. '11) is a bioinformatics scientist in the Connectivity Map group and Cancer Program in the laboratory of Todd Golub at the Broad Institute.

Jennifer Forbes (B.S. '94) is the chief law clerk for the Honorable David N. Wecht in the Superior Court of Pennsylvania.

Joy (Meli) Fuchs (M.A. '70) is in her 25th year as the originator/teacher of Science Excitement, Inc., which offers hands-on science programs to preschoolers in the metro Atlanta area.

Amy Fuller (B.S. '11) is a research assistant at St. Luke's Roosevelt Hospital in Manhattan, investigating psychosocial factors and wound healing.

Laura Gabby (B.S. '06) began an apprenticeship in carpentry in the NYC Carpenters Union.

Sara Gaffen (B.S. '88) was promoted to professor in the Department of Medicine, Division of Rheumatology and Clinical Immunology at the University of Pittsburgh.

Shantanu Ganguly (Ph.D. '11) joined Medidata Solutions Worldwide as an associate product manager.

Katie Griswold (B.S. '11) is a research assistant at UPMC Western Psychiatric Institute and Clinic, where she works with PET and MRI imaging to examine the functioning of dopamine receptors in mental illnesses.

Elena Balestreire Hawryluk (B.S. '01) will be a chief resident at Harvard's Dermatology Residency program for 2012–2013.

Karen Hoffmann (SHS '04) was a science writer at the University of Pittsburgh from 2004-2008, then began freelance reporting for magazines like *The Ecologist* and *Earth Island Journal*. She plans to attend law school in the fall with a focus on environmental and human rights law.

Paul Karmin (B.S. '83) is an assistant professor of Radiology, medical director of Ultrasound, and the Body Imaging Medical Student Radiology Rotation liaison at the Georgia Health Sciences University in Augusta, Ga.

Benny Kil (B.S. '03) graduated from Johns Hopkins University in May 2010 with an MBA and M.S. in Biotechnology. He works as a business analyst/consultant at Data Networks Corporation in Reston, Va.

Wladimir Labeikovsky (B.S. '98) is a postdoctoral associate with David Gadsby in the Laboratory of Cardiac and Membrane Physiology at the Rockefeller University.

Akshay Lalla (M.S. '05) works as a senior analyst in the Business Analytics and Research wing of Fidelity Investments.

Robert Last (Ph.D., '86) is Barnett Rosenberg Professor of Biochemistry and Molecular Biology at Michigan State University, where he recently received the University Distinguished Faculty Award.

Bryan LeBude (B.S. '06) married **Jessica O'Hara (B.S. '07)** in October 2011. He is in his second-year of Internal Medicine residency at Thomas Jefferson University Hospital. She is completing a Ph.D. in Molecular Biology at Princeton University.

Donghun Lee (M.S. '09) is a Ph.D. student in computer science at Princeton University, researching algorithms in reinforcement learning and decision making under uncertainty to construct artificial intelligence driven controllers for electricity storage devices on smart power grids.

Melissa Lee (B.S. '09) is working at Johnson & Johnson as an IT analyst.

Elyse Maiorini (B.S. '08) is a third-year dental student at the Harvard School of Dental Medicine.

Bradley Malin (B.S. '00) was promoted to associate professor of biomedical informatics in the School of Medicine and associate professor of computer science in the School of Engineering at Vanderbilt University.

Parker Mills (Ph.D. '11) is a freelance programmer and editor at Transform Technology Consulting.

Susan Montenegro (B.S. '06) is a Clinical Pharmacy Specialist I at Union Memorial Hospital.

Marc Newman (B.S. '71) started a position with the Department of Veterans Affairs, Office of Information and Technology. He was also recently named a life member and fellow of the Health Information Management Systems Society.

Theresa Nguyen (B.S. '03) finished her residency in Emergency Medicine last June and is now an attending physician at Christiana Care Health System in Newark, Del. She also will be joining the Himalayan Health Exchange on a medical mission trip in July.

Max Oran (B.S. '07) is in his second year of medical school at Drexel University.

Narayanan Perumal (Ph.D. '85) is a senior research scientist at Eli Lilly and Company.

Vamsee Pillalamarri (B.S. '08, M.S. '09) joined the Center for Human Genetic Research at Massachusetts General Hospital / Harvard Medical School in the lab of Dr. James Gusella. Their research is in neurodevelopmental disorders, especially autism.

Julie (Jadlowiec) Phillippi (Ph.D. '05) was promoted to assistant professor (tenure-track) in the Department of Cardiothoracic Surgery at the University of Pittsburgh. She and her husband welcomed their daughter named London Elizabeth Phillippi on Nov. 2, 2011.

Huaguang David Qu (B.S. '03) will complete his Physical Medicine and Rehabilitation Residency at Harvard Medical School in June 2012, then start a clinical fellowship in Pain Medicine in the Department of Anesthesiology and Critical Care at the University of Pennsylvania.

Shannon Quinn (M.S. '10) is a doctoral student in the Joint CMU-University of Pittsburgh Computational Biology program.

Mohammad Haroon Qureshi (M.S. '09) is a Ph.D. student in the Department of Biological Sciences and Physics at Kent State University, working in the laboratory of Dr. Hamza Balci studying protein-DNA interactions.

Marni Bregman Reinhardt (B.S. '01) recently became a licensed marriage and family therapist. Her family also welcomed a son, Logan Kyle, on March 22, 2011, joining three-year old daughter, Alana Brooke.

Shannon Rice (B.S. '07) graduated as a physician assistant from the Philadelphia College of Osteopathic Medicine in July 2011, then attended the Navy's Officer Development School in Rhode Island. She is now serving as a Lieutenant Junior Grade within the Family Medicine department at the Marine Air Station base in Iwakuni, Japan.

Ashraf Saleemuddin (B.S. '03) completed her residency in July 2011 and is now board certified in Internal Medicine. She is currently a gastroenterology fellow at Boston University Medical Center.

Erica Schleifman (B.S. '05) graduated from Yale in May 2011 with a Ph.D. in Genetics and is now working as a Senior Research Associate at Genentech in San Francisco.

Tara Sharma (Ph.D. '11) is a postdoctoral fellow at Sloan-Kettering Cancer Center in the laboratory of Dr. Hadjantonakis, studying cell fate specification and morphogenesis in the early mouse embryo.

Sonal Shruti (Ph.D. '10) is a postdoctoral researcher in the laboratory of Dr. Eve Marder at Brandeis University.

Jessica Stensrud (B.A. '71) began a position as a software interface engineer with Optum Insight in Providence, R.I., in October 2011. She also continues as a professional violinist with the Eastern Connecticut Symphony in New London, Conn.

Arpit Tandon (M.S. '09) just joined SRA Int. in Raleigh-Durham, N.C., as a bioinformatician.

Glenn Telling (Ph.D. '90) directs the Prion Research Program at Colorado State University where he is also a professor in the Department of Microbiology, Immunology and Pathology. His lab studies the mechanism of prion replication, prion species barriers and strain diversity, and the molecular basis of inherited human prion diseases.

Peter Ward (B.S. '96) was tenured and promoted to associate professor of anatomy at the West Virginia School of Osteopathic Medicine. He also has an adjunct faculty position at Purdue University and was elected to the council of the American Association of Clinical Anatomists.

Quinn Weisman (B.S. '11) was awarded the Rancic-O'Neill Fellowship from the National Institutes of Health.

Jared Wenger (B.S. '06) and his wife, Jesse, welcomed a son, Frederick Lee, on April 25, 2011. In August 2011, he completed his doctorate in genetics at Stanford University and is now a scientist in microbial physiology at Amyris, Inc., in Emeryville, Calif.

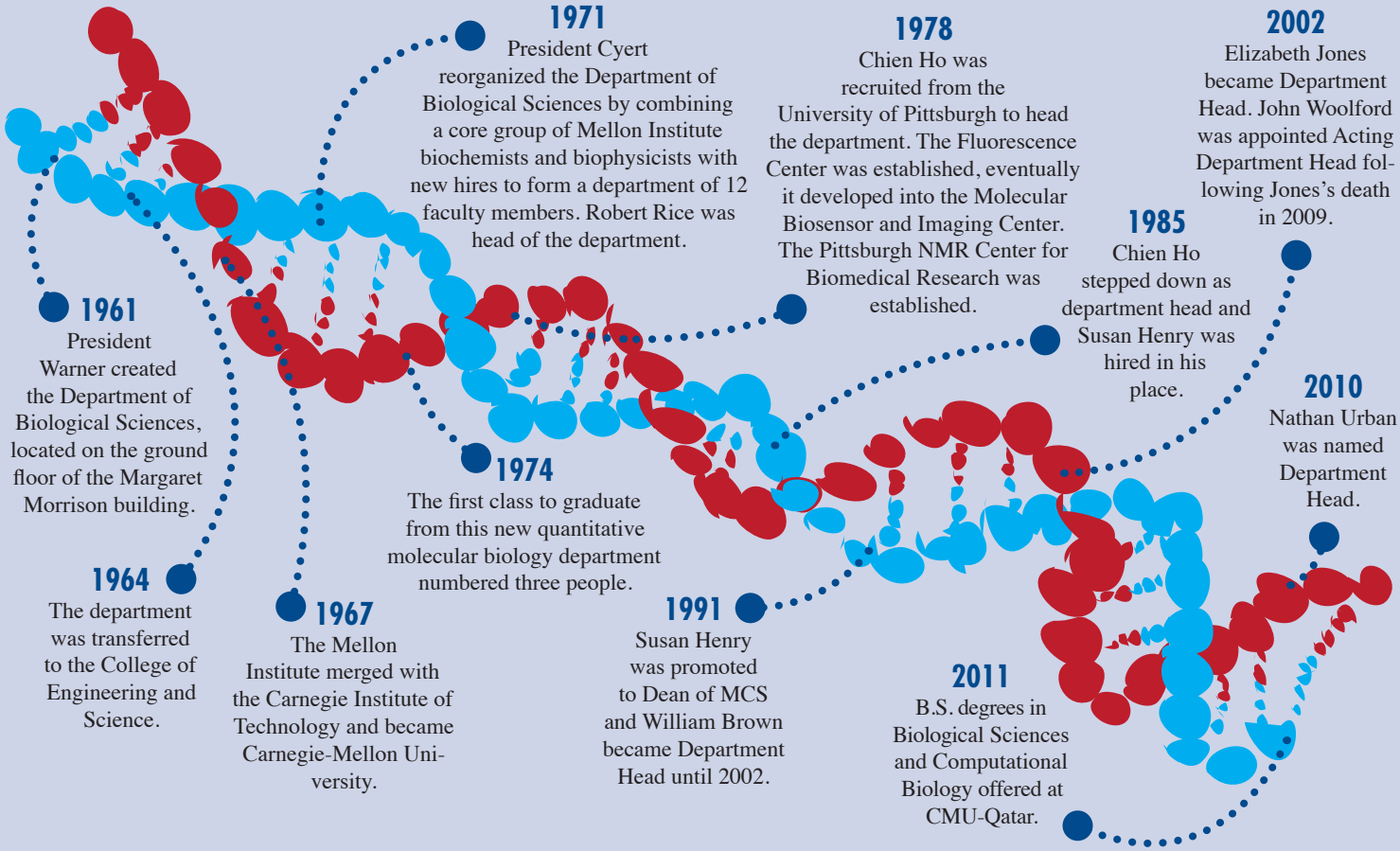
Benjamin Williams (B.S. '08) started at the University of Michigan Medical School in fall 2011. Previously, he spent three years in orthopaedic clinical research at the Hospital for Special Surgery in New York City.

Jessica Williams (B.S. '10) is a student at the University of Pennsylvania and works as a research assistant at Penn Presbyterian Medical Center.

Sandra Zimmerman (Ph.D. '09) is a postdoctoral fellow with Dr. Celeste Berg in the Department of Genome Sciences at the University of Washington. The focus of her work is the regulation of tubulogenesis using a *Drosophila* model.

Departmental Timeline

Adapted from a timeline by Eric Grotzinger, Ph.D.



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www.cmu.edu/bio/alumni

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