

DISCOVERIES



DEPARTMENT NEWS

New Confocal Instrument Helps Researchers See Cells in New Light

Ready for a pop quiz?

Which research instrument is commonly used to symbolize the work of biologists?

Answer...the microscope!

Even though the microscope has been with us since the 17th century, this iconic instrument has regained its preeminent place for biologists over the last decades with the discovery of fluorescent proteins that enable researchers to identify the position of individual proteins in living organisms. New technologies for modern research microscopes, combined with those that made your grandfather's microscope much more powerful, enable researchers to peer deeper into the wonderful world of cells with unprecedented clarity.

Thanks to the vision and hard work of our department head, Dan Roberts, UT now sports a Leica SP8X confocal microscope that empowers researchers in the Department of Biochemistry & Cellular and Molecular Biology to do cutting edge research.

Like all confocal microscopes, the SP8X allows optical sectioning of cells and tissues (selective imaging at different depths within the tissue) to recreate a three-dimensional representation of the original cells.

Unlike many other confocal microscopes, the SP8X also contains a resonant scanner that moves its laser at high speed over the sample. Combined with the three high-sensitivity HyD detectors, this allows for very rapid image capture to document fast processes such as cytoplasmic streaming in plant cells.

The most unusual feature of the SP8X, however, is the white light laser that allows researchers to pick any wavelength between cyan (470 nm) and red (670 nm) for excitation of fluorescent proteins within cells to tailor the incoming light perfectly to their sample and create the brightest images with the highest sensitivity.

To help offset some of the costs, we created a BCMB Microscopy gift account that will enable researchers to perform initial experiments on the SP8X in order to generate preliminary data for an external grant proposal. Despite the substantial cost per hour that users pay for the SP8X, research groups from BCMB and other departments are lining up to use this outstanding new instrument to see their favorite protein cells in a new light.

STRIVING FOR *Excellence*

“It is an exciting time to be a molecular and cellular biologist!”

One of the greatest pleasures of being BCMB department head is recruiting the very best young scientists who bring innovative approaches to address biological questions at the cutting edge of their discipline. Since becoming head, my strategic goals in hiring new faculty has been first to build bridges and synergy between areas of departmental strength; and second, to embrace emerging areas of research with an emphasis on systems biology and predictive molecular and cellular biology at the interface between the physical and biological sciences. We are fortunate to have five exceptional assistant professors that address these needs, and two additional faculty members, Keerthi Krishnan (cellular neuroscience) and Tian Hong (systems computational biologist) will be joining this strong cadre of junior faculty in 2017.

In the present issue of *Discoveries*, we highlight assistant professor Francisco Barrera, as well as a talented PhD graduate student in his group, Haden Scott. Barrera is an outstanding membrane biophysicist who was recently awarded an NIH grant to investigate peptide reagents that target membranes of cancer cells, which may provide a strategy for the potential development of therapeutic strategies.

With the hire of two additional faculty members, the BCMB faculty will expand to 27 core faculty. While we welcome our new assistant professors, we also acknowledge retirement and loss of old friends and colleagues. Professor Engin Serpersu, a longtime member of both the original biochemistry department and BCMB, announced his retirement in March 2016 and will take a permanent position as a program director and cluster leader at the National Science Foundation. We wish Engin the very best in his new position.

We also sadly report the loss of two formative figures in BCMB. Peter Mazur, a long time research professor in BCMB and a pioneer in the area of cryobiology, passed away this past January.

Ken Monty, the founding head of the UT Department of Biochemistry and a staunch supporter of graduate education in BCMB, passed away this past May. I first met Ken when I joined the biochemistry department in 1987. He was always a gentleman, very helpful in giving me advice, and a pleasure to have as a colleague. We remember and honor both Ken and Peter in the pages of this newsletter.

With this new edition of *Discoveries*, we introduce a new feature to acknowledge distinguished alumni and donors who have been instrumental in promoting and fostering faculty and student activities and initiatives. In this issue, we highlight Donald Akers, a surgeon and alum who has generously established the Dr. Donald L. Akers, Jr. Faculty Enrichment Fellowship. Motivated by his own experiences as an academic scientist and passion for research, Akers has established this fellowship that is awarded annually to recognize faculty research excellence and scholarly achievement.

We hope you enjoy reading about recent activities of our faculty and students in BCMB, as well as the myriad initiatives within our department as we continue to strive for excellence in our research and teaching mission.



DANIEL ROBERTS
Professor and
Department Head

Expanding Horizons for Deaf and Hard-of-Hearing Students

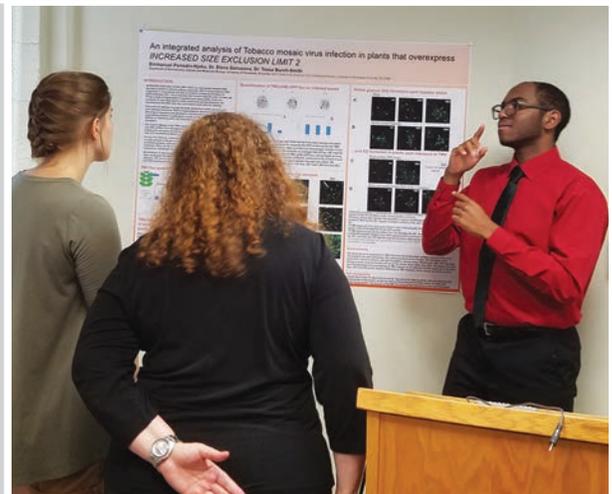
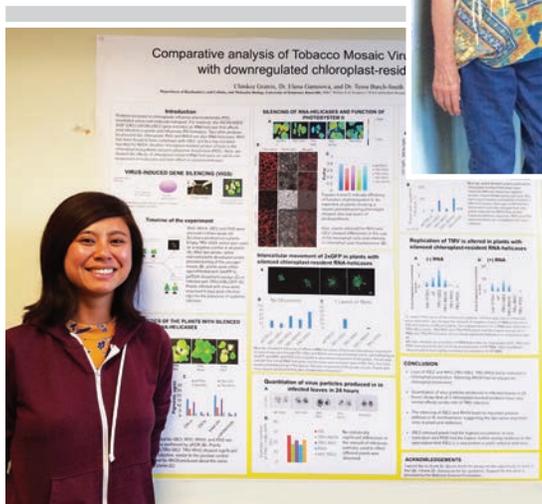
Individuals with disabilities are significantly under-represented in the scientific workforce. Among these groups, deaf and hard of hearing individuals are particularly absent from the scientific research enterprise.

BCMB faculty have partnered with the UT Center on Deafness (UT-COD) and the National Technical Institute for the Deaf at the Rochester Institute of Technology (NTID/RIT) to engage deaf and hard of hearing RIT undergraduate students in research by placing them as apprentices in the laboratories of BCMB faculty members.

The program started with a single student who worked in the laboratory of Professor Gladys Alexandre for eight weeks in the summer of 2015. In summer of 2016, five NTID/RIT students participated in research projects offered in BCMB laboratories, with funding from NSF and the BCMB department. These students spent 10 weeks working as research assistants in the laboratories of BCMB faculty members. Gladys Alexandre, Daniel Roberts, and Elizabeth Howell each mentored one student, and Tessa Burch-Smith mentored two students.

The internship was structured to include research skills, as well as professional and career development activities, and used the services of American Sign Language Interpreters from the Office of Disability Services at UT for large group meetings. Daily communications between the RIT students and the BCMB faculty and research personnel involved creative approaches including digital voice-to-text apps and a constant use of notepads, which ended up being much easier than some of the mentors had expected.

The students were very bright, worked hard, and paid close attention to subjects being discussed. The faculty in the BCMB department plans to repeat and expand the experience next summer.



From poster presentations to lab experiments, the research experiences shared between BCMB faculty mentors and their NTID/RIT students helped lay the foundation for more internship opportunities in the future.

In Search of Tumor-Targeting Peptides

Born in Greeneville, Haden Scott spent his entire life in East Tennessee. After finishing high school, Haden applied to UT where he majored in biology with concentration in BCMB. His initial plan was to attend a medical school after graduation. This was his dream since a young age influenced by many medical professionals in his family. After all, his father is a dentist and his mother is a dental assistant.

What changed his life goal was the BCMB 402 class he took with John Koontz. Haden greatly enjoyed learning about biochemistry and saw how so many discoveries were made in research labs. While an undergrad, he conducted research in the lab of Engin Serpersu and he loved it. In 2012, Haden received an Undergraduate Research Internship to work in Serpersu's lab over the summer. His plans changed and after graduating in 2013, he joined the BCMB department as a graduate student. Haden chose not to move due to his love of East Tennessee.

In 2014, Haden joined the lab of Francisco Barrera and began to work with the pH low insertion peptide (pHLIP) to understand how proteins interact with cellular membranes.

The pHLIP is a cancer targeting peptide that inserts into cellular membranes at low pH, giving it the ability to deliver drug cargo specifically to the cancerous cell. The pH dependency of the insertion of pHLIP gives this peptide the ability to either be inserted into the cellular membrane or laying on the surface of the cellular membrane.

In his first publication, Haden describes how a specific component of the cellular membrane that carries a net negative charge, phosphatidylserine, hinders the insertion of pHLIP. This is critical for pHLIP's ability to target cancerous cells as this component of the membrane is found in cancer cell membranes. Understanding the effect of phosphatidylserine on the membrane insertion of pHLIP is a first step needed to refine the sequence of pHLIP to improved tumor targeting.

Recently, Haden's research has moved away from cancer to focus on obtaining a deeper understanding of how proteins and membranes interact physically using pHLIP as a model. The physical properties of the cellular membrane that interest Haden, with relation to membrane protein interactions, are membrane asymmetry and changes in membrane thickness. Haden presented his work at the 59th Annual Biophysical Society Meeting in Baltimore, Maryland. In 2016, he received the Robert and Nell Keenan Bioscience Fellowship, which recognizes an outstanding BCMB graduate student major who shows excellence in academic endeavor, productive research scholarship, and outstanding professional promise.



Haden Scott (left) works with undergraduate student Kristen Booth (right) to further his research on understanding how proteins and membranes interact.

Passion for Science and Fascination with Cells Drives Barrera's Research



Ever since he can remember, Francisco Barrera has been interested in science.

"It's a passion that grew on me slowly," says Barrera, assistant professor of biochemistry.

"To me, science is the kind of thing that the more you know about it, the deeper you want to understand it."

Barrera joined the BCMB faculty in August 2013 after a post-doctoral fellowship at Yale, where he worked with National Academy of Sciences member Donald Engelman on developing new approaches for drug delivery to cancer cells. He earned his bachelor's and PhD in Spain at the Miguel Hernández University of Elche.

In the short time he's been part of BCMB, Barrera has established an active research program, started several new collaborative projects, and published five papers. Undergraduate students have been an important part of his lab since the day he started, and Barrera considers himself lucky to currently have four very good students conducting research in his lab.

"I think UT offers young researchers a great opportunity to strongly contribute to the progress of our research program," says Barrera.

In his lab, Barrera works on taking advantage of tumor acidity to design molecules that selectively target tumors; not the healthy organs. Tumor cells undergo metabolic changes that result in the cells being surrounded by an acidic medium.

"In particular, we design small proteins that insert into the cellular membrane of tumor cells and interact with

tumor proteins that make the tumor more aggressive," says Barrera. "In the end, we hope to short circuit the activity of the tumorigenic protein."

This summer, he received two grants from the National Institutes of Health for his research, which he hopes will result in a useful delivery of therapeutic agents to cancer cells and other diseased cells. In addition to his research, Barrera teaches Biochemistry I, which he knows has a reputation for being a hard class.

"I regularly get comments from the students that this is the most challenging course they have ever taken," says Barrera. "When I think about alumni hearing me talk about this class, I imagine them thinking 'Oh, no!'"

Barrera freely admits that when he took a biochemistry course in college, he found parts of it dry and complex. But, he did love some parts of it and strives to learn from his previous experience.

"The physics and chemistry continuously occurring inside each of our cells is fascinating," says Barrera. "That is what I try to help my students understand."

When he's not in the lab, Barrera spends time with his wife and their three-year-old, as well as hiking or rafting and enjoying the outdoor experiences East Tennessee has to offer.

"We were attracted to Knoxville from day one," says Barrera. "From the outdoors to the cultural life, we think it's a really nice place to raise our son, Nicolas."

Barrera's love for science runs deep. While he considered other professions - from medicine to journalism - he knew science was his calling.

"If I could not be a scientist, I'd have to do some deep soul-searching to find an alternative career!"

“To me, science is the kind of thing that the more you know about it, the deeper you want to understand it.

The physics and chemistry continuously occurring inside each of our cells is fascinating,” says Barrera. “That is what I try to help my students understand.”

Fellowship Provides Opportunities to Create New Knowledge at UT

Since 2012, Don Akers Jr. has sponsored a Faculty Enrichment Fellowship to outstanding BCMB faculty for research efforts. The priority is given to funding pilot projects to generate preliminary data for extramural grants.



Akers grew up in East Tennessee. After graduating from UT in the Department of Biochemistry, which was one of the forerunners of BCMB, he received his MD from the UT Health Science Center in Memphis. From 1991-2007 he was a

professor of surgery at Tulane University before returning to Knoxville as a practicing vascular and general surgeon.

“The University of Tennessee is where I got my start,” says Akers. “I grew up in Knoxville. I started from very modest beginnings, and through the University, I have done very well.”

In conjunction with his wife Judy, Akers endowed the fellowship to be given to the department every year.

“I looked to see where I had gotten the most benefit from, and what I’m trying to do is give back to the community that gave me that opportunity,” says Akers. “BCMB is where I got a great deal of help with developing many of the skills that I used later.” Akers’ own experiences with research in medical school led him to establishing the Fellowship.

“You have the opportunity every day to create new knowledge,” says Akers. You are discovering something that nobody else before you ever knew. You created something new. That was always the exciting part.”

According to Akers, the biggest issue researchers or people who work in academics have is funding. He established the fellowship in order to help start the process of research that provides enough data to eventually write a grant. To Akers, the start is the hardest part.

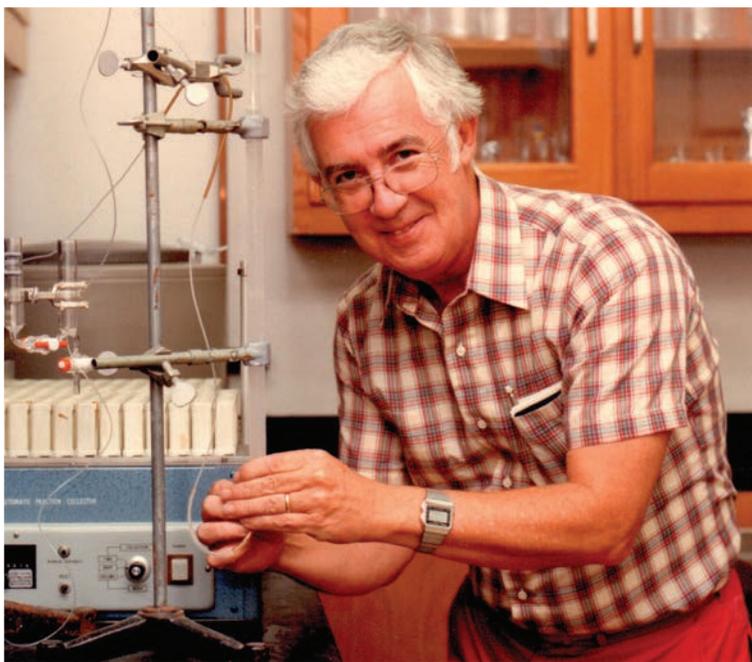
“I wanted to support something that advances science, that advances medicine,” says Akers. “If you give money today, that’s great, but that’s a one-year promise. If you can establish an endowment, then every year, in perpetuity, there is money that can be given to someone to do research with. It’s a returning gift and something that goes to what I consider the ultimate goal of being an academic institution – do research. That’s big to me.”

Recipients of the Dr. Donald L. Akers Jr. Faculty Enrichment Fellowship include Brad Binder (2016), Mariano Labrador (2015), Elias Fernandez (2014), Engin Serpersu (2013), and Rebecca Prosser (2012).

“At a time when all other financial resources had dried up, my laboratory received the Akers award,” says Labrador about his 2015 Fellowship. “To us, this award meant continuity for our research program and made it possible to generate enough preliminary data for a NIH proposal, which was ultimately funded.”

REMEMBERING AN ICON

KEN MONTY, the founding head of the biochemistry department, which later became BCMB, passed away May 23 at age 85. When Ken came to the University of Tennessee to establish and head the new UT Department of Biochemistry in 1963, there were five faculty members and the emphasis was on graduate education. There was no undergraduate program in biochemistry.



From this modest beginning, and under Ken's early guidance, biochemistry became a central component of the UT experience. The department has evolved over the years into a robust enterprise consisting of 27 faculty members, 54 graduate students, and over 400 undergraduates, which is a clear example of Ken's influence and legacy at UT. Without his early vision this would not have been possible.

Ken served as the coordinator of the Division of Biology departments (1973-84), the interim head of biochemistry (1973-75), and oversaw the design and construction of the Walters Life Science Building on the UT campus. In 1991, Lamar Alexander appointed Ken to head the Governor's School at UT and to serve as the founder and head of the Academy for Teachers of Science and Mathematics (1991-2003). Over 600 administrators and teachers attended the Academy during his tenure as director. During the 1990s he was also the director of the Tennessee Science Olympiad. More recently, we are indebted to Ken for organizing the early biochemistry alumni and offering the Biochemistry Alumni Graduate Assistant Award, which is given to a BCMB graduate student that shows combined excellence in teaching and research.

Throughout his tenure at UT, Ken was a passionate advisor to undergraduate and graduate students and a champion for excellence in education.

PETER MAZUR, CRYOBIOLOGY PIONEER

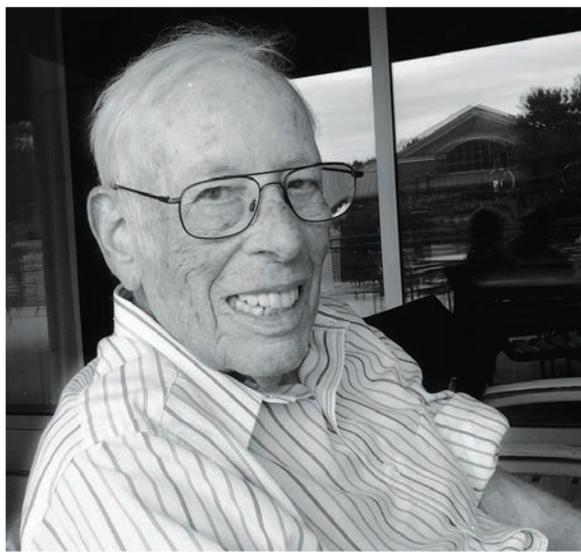
It is with great sadness that we report the passing of Professor **PETER MAZUR** on December 31, 2015.

Peter was an outstanding scientist with a remarkable career and is considered a giant and pioneer in the area of cryobiology, a science that studies the physical and biological behaviors of cells and tissues at low temperatures. Methods of cryobiology allowing the freezing and eventual thawing of living materials without damaging them are essential for fertility treatments allowing long term storage of eggs, sperm, and embryos.

Peter Mazur earned his BA *magna cum laude* and PhD in biology from Harvard University. In 1959, Peter came to East Tennessee to take a position in the Division of Biology at ORNL, and in 1998 he moved his lab from ORNL to the BCMB department at UT. During his tenure at ORNL and UT, he published over 120 scientific papers on cryopreservation and the biophysics of freezing damage to cells and tissues.

He also developed the "Two Factor Theory," which is a central tenant of cryobiology and cryopreservation of biological systems. This theory explained why both too-high and too-low cooling rates can kill cells, predicted that an optimal cooling rate for cell survival should exist between high and low rates, and described its dependence on the rate of water transport across a cell membrane. In recent years, Peter studied the importance of the warming rate for the cell survival.

Peter's passion for excellence in research and scholarship continued up to the time of his death at age 87. Over the past five years, he published 20 scientific papers, including two posthumously.



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Your gifts make a difference!

Over the years, we have been fortunate to receive generous donations from a variety of supporters, including former graduates. These gifts have made it possible for us to offer undergraduate and graduate scholarships. Other donations have been used for Research Incentive Awards to faculty who propose pilot projects that promise to lead to extramural grant funding from national agencies. Our generous donors have made all of these things possible.



To contribute online, please visit: bcmb.utk.edu/support-the-department and click on “Give to UT.”



COVER STORY:

Cutting Edge Research

UT students experience the department's new Leica SP8X confocal microscope.

DISCOVERIES

The *DISCOVERIES* newsletter is published annually by the UT Department of Biochemistry & Cellular and Molecular Biology.

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