BiOSPHERE

FALL 2004

IN THIS ISSUE:

Greetings from the Department of Biology!

As the study of life, Biology is also the study of change: changes we see in the course of a couple of seconds, hours, days or years, changes we see over the lifetime of an organism, and changes we see (or at least infer) over the millennia of geologic time. In the past year or so, Biology, the department, has also undergone a tremendous amount of change. Happily, we have added seven members to the faculty, whose research interests are featured in this year's issue of *Biosphere* and we are preparing to recruit at least 6 more faculty members this year. To accommodate this massive influx of excellent new faculty, we have embarked on a significant reorganization and renovation plan. Central to this plan is the conversion of Butler Hall into the new home for all the administrative and advising offices of the department. We will also move the microbiology teaching labs to Butler Hall and consolidate shared equipment and facilities. This move will place the departmental administration with academic advising in an attractive and historical building that is fully accessible to students and parents. The result will also free valuable research space in Biological Sciences Building West and East for research labs for the new faculty.

Biology is evolving in many other ways. New

undergraduate and graduate courses have been implemented to reflect the dynamic nature of biological inquiry. These include undergraduate and graduate classes in genomics, and graduate courses in bioinformatics and cell biology. A new initiative undertaken in collaboration with the Departments of Mathematics and Statistics will develop new curricula in quantitative biology has been funded by the National Science Foundation. This grant will allow us to develop new educational models.

There have been a number of great successes in research this year. Departmental faculty applied and received funding for 22 new research grants from state, federal and corporate agencies totaling more than $1.3 million dollars. These new grants add to the nearly $5 million in annual research funding already received by departmental faculty. This money will help faculty educate the next generation of scientists and produce new knowledge for the 21st Century.

All in all, it is an exciting time to be a part of Biology at Texas A&M. We look forward to a bright future in providing more and better research, education and service to the State of Texas.

2007 University Scholars

Two Scholars from Biology Chosen

Kaku Barkoh and Amanda Clauson were among 14 students accepted into the University Scholar program. University Scholars are selected through a rigorous and competitive application process. Eligible students are required to submit a written application to the Office of Honors Programs and Academic Scholarships and, if selected as a semi-finalist, appear for an interview with the University Scholarship Selection Committee.

This year, nearly 150 eligible freshmen applied for the University Scholar program; of that group, just 48 were selected to interview.

One Spirit, One Vision:

Campus Campaign Nears Goal of $1 Billion

Texas A&M University donors have given and pledged more than $750 million during the university's One Spirit One Vision Campaign. This puts the campaign at 75 percent of its $1 billion goal. The volunteer-led campaign encompasses all private gifts and pledges made to Texas A&M since January 1, 2000.

Texas A&M Foundation President Eddie J. Davis said the campaign is benefiting current Texas A&M students, and future students also will reap great rewards from the fund-raising effort.

"Future Aggies will benefit from this campaign as donors fulfill their pledges in the coming years and create endowments that will provide income for generations," Davis said.

"We've raised three-quarters of our campaign goal in a little more than four years," he said. "Our success thus far is due to the generosity of Texas A&M supporters and the diligence of our volunteer leaders."

Texas A&M President Robert M. Gates and a committee of volunteers lead the campaign with support from Texas A&M Foundation executives and staff. Hundreds of additional volunteers lead at college, departmental and regional levels.

Campaign Director Henry Nemcik said enthusiasm for the campaign has continued since its public launch in March of 2003. "With campaign regional events happening all over the state and nation, more people are learning about the campaign and how it will enhance educational excellence at Texas A&M," he said.

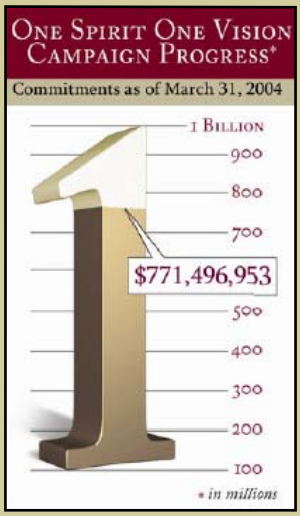

PHOTO: Courtesy of the Texas A&M Foundation.

How Can I Get Involved?

Howdy! Let me first thank you for all you have done and continue to do for the sake of Texas A&M University. Your support of this great university is its very lifeblood.

The Biology Campaign is a vital component of the One Spirit One Vision Campaign. Funds from this source will be used to support the growth and improvement of the Department of Biology. For more details on either of these campaigns, please contact me:

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Aggie Spotlight:

Chris Janetopoulos: Seeing is Believing

Chris Janetopoulos's (Ph.D. Biology in 1999) intense interest in cell biology began when he took the BIOL 617 modules on topics in cell and molecular biology. There, he met Dr. Helmut Sauer and realized that his future graduate career lay in the Department of Biology. Dr. Sauer was not taking graduate students at the time, but he suggested that Chris's interests matched those of Dr. Karl Aufderheide, who studies pattern formation and clonal aging in the ciliated protozoan *Paramecium*. After observing the complexity in these relatively gigantic single-celled organisms, Chris decided that looking at living cells in a microscope was far more to his taste than running and scanning gels or developing immunoblots.

What began as a side project - making an optical-force trap (laser tweezers) functional - became Chris's major research tool. He also switched to a more genetically tractable ciliate, *Tetrahymena thermophila*. An additional benefit was that *Tetrahymena* is not shy about mating under the microscope. By using Dr. Aufderheide's invention, the rotocompressor, Chris found he could gently immobilize cells and examine and manipulate them for long periods of time. This tool allowed him to identify, and name, a previously undocumented organelle, the "*conjusome*," which is involved in the trafficking of nuclear materials during the sexual cycle in this organism. The conjusome, which appears only briefly during conjugation, became the topic of Chris's Ph.D. dissertation.

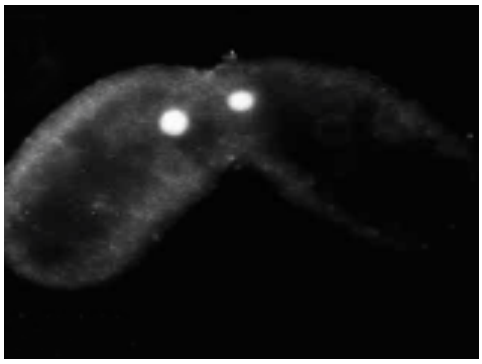

*Figure 1: Fluorescence micrograph of two mating cells (*Tetrahymena thermophila*). One brightly fluorescing conjusome can be seen in each cell.*

As a postdoc, Chris wanted to combine his skills as a microscopist with an even more powerful model system. Dr. Peter Devreotes's group at Johns Hopkins Medical School had recently published a paper in the prestigious journal *Cell* that described the dynamic events that occur within single cells of the social amoeba *Dictyostelium* that are performing amoeboid chemotaxis. Chris contacted Dr. Devreotes about a position in his laboratory and felt fortunate to get it.

Chemotaxis, the ability of cells to sense and move in response to chemical gradients, plays a central role in the development, immunity, and maintenance of tissue homeostasis in multicellular organisms. During embryogenesis, cells move along gradients of morphogenic molecules to form organs and steer growing axons in the nervous system. In the immune system, an elaborate network of attractants directs leukocytes to the correct locations and facilitates cell-cell interactions. Chemotaxis is also central to wound healing and has been implicated in disease states such as the metastasis of cancers and the spread of arteriosclerosis. The social amoeba *Dictyostelium discoideum*, in contrast, employs chemotaxis to find prey bacteria and, when starving, to form aggregates containing tens of thousands of cells that develop into a spore-generating fruiting body.

The first thing Chris did was to tag the G proteins used in intracellular signal transduction by fusing them with the green fluorescent protein. The resulting hybrid proteins can be visualized by fluorescence microscopy to determine how they move within an amoeba when it is stimulated with a chemoattractant. The same technique has subsequently been applied to other organisms, including mammalian cells. The work is of medical significance, since 50% of all drug targets are receptors that communicate with the rest of the cell using G-protein-dependent signaling pathways.

Chris Janetopoulos

Chris is now taking the analysis one step farther — to the level of single molecules. This approach is incredibly powerful because the rates of binding and release of ligands to their receptors can be measured, the diffusion coefficients of receptors within the membrane can be determined, and the interactions of individual proteins with their partners in intracellular signal transduction pathways can be visualized. This type of experimentation has already found that the "front" (up-gradient) side of an amoeboid cell responds very differently from the "back" (down-gradient) side in an attractant gradient. This information could never be obtained by looking at proteins, RNA, or DNA on a gel. "Besides," Chris adds, "why look at bands on a gel when you can look at a living cell doing its thing?"

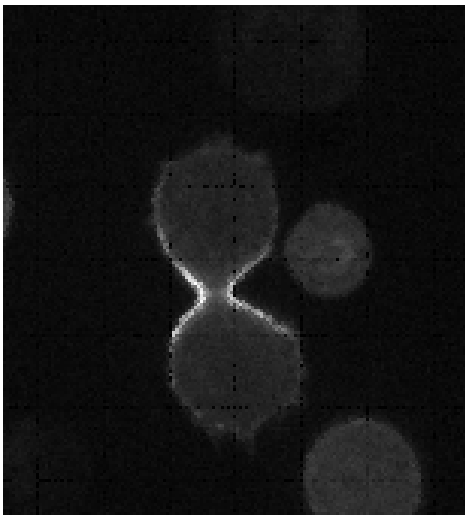

Figure 2: Fluorescence micrograph of a dividing Dictyostelium discoideum *amoeba. Fluorescence in the cell furrow is due to the fusion protein PTEN-GFP. PTEN is involved in regulation of lipid components during cell division.*

Sensory-Motor Integration

Dr. Michael Smotherman, Incoming Faculty

Dr. Michael Smotherman

One of the distinguishing features of being human is our ability to communicate complex thoughts and ideas through speech. Indeed, speech and language have played central roles in the evolution of humans as well as their culture and society. Presumably, the evolution of human speech required the reorganization of large parts of, and novel additions to, the mammalian brain. However, because human vocalizations are both unique and extraordinarily complex, research into the underlying neurophysiology has been hampered by the lack of appropriate animal models.

While many mammals vocalize, very few seem to maintain precise control over the sounds they make: other than humans, only bats and cetaceans actually need to hear themselves in order to vocalize properly. Dr. Smotherman's research takes advantage of the echolocation behavior utilized by bats to investigate just how auditory feedback is routed through the brain to control vocalization.

Human speech is generated by stringing together sequences of short sounds varying in pitch and amplitude. Producing natural-sounding human speech requires that the speaker accurately hear his own vocalizations. Any disruption in this auditory feedback can lead to speech disfluencies such as stuttering and disarthria.

Like humans, echolocating bats also require persistent auditory feedback for proper control of their echolocation calls. Bats are extraordinarily vocal animals. In flight, most echolocating bats emit at least 5 to 10 calls *per second*, and many can reach call rates exceeding 50 calls per second. This incredibly high call rate comes as no surprise when we consider that for a bat flying at night at speeds reaching 5 to 6 meters per second, its view of the world comes entirely by way of the sounds they make. Yet, despite their high call rate, bats maintain the ability to make rapid and precise changes in the spectral, temporal and intensity parameters of each individual echolocation call. For this reason, echolocation behavior provides an exceptional opportunity for studying how auditory feedback influences vocal behavior in mammals.

So why do bats change the properties of their echolocation calls? The control of echolocation calls exhibits striking variability among the many different species of echolocating bats. Indeed, each different species can be identified solely on the basis of its echolocation call. It is now known that these variations correlate strongly with a species' behavioral ecology. In particular, the spectral and temporal properties of an echolocation call greatly influence the type of information that a returning echo might contain. Bats that live in different habitats or hunt different prey tend to utilize an echolocation call with the structure best suited to provide them with the most relevant information. Furthermore, most bats appear to be able to change their calls as they move through different habitats or perform different behaviors.

Dr. Smotherman's research investigates the ways different bats adjust their calls. By using a computer to simulate echoes, Dr. Smotherman can control what a bat hears after each emitted call, and the subsequent changes in call structure and timing can be tracked and quantified. This makes it possible to describe and compare the way different bats respond to the same sequences of echoes. Using the same approach, he hopes to learn more about the how baby bats learn to echolocate as well as to determine how much of their echolocation behavior is genetically programmed.

Both genetically predetermined and learned aspects of echolocation reflect specific features of the underlying neural circuits that control echolocation. Once a specific component of the behavior is thoroughly characterized, Dr. Smotherman works to identify which regions of the brain are essential for the behavior. In so doing, he can trace out the neural circuits that control vocal behavior.

While working with Dr. Walter Metzner at UCLA, Dr. Smotherman helped uncover at least part of the pathway that allows horseshoe bats to make rapid and precise changes in the frequency of their echolocation calls. A brain structure known as the parabrachial nucleus was previously suspected to be peripherally involved in the control of vocal behavior. However, they were able to demonstrate that this brain region plays a central role

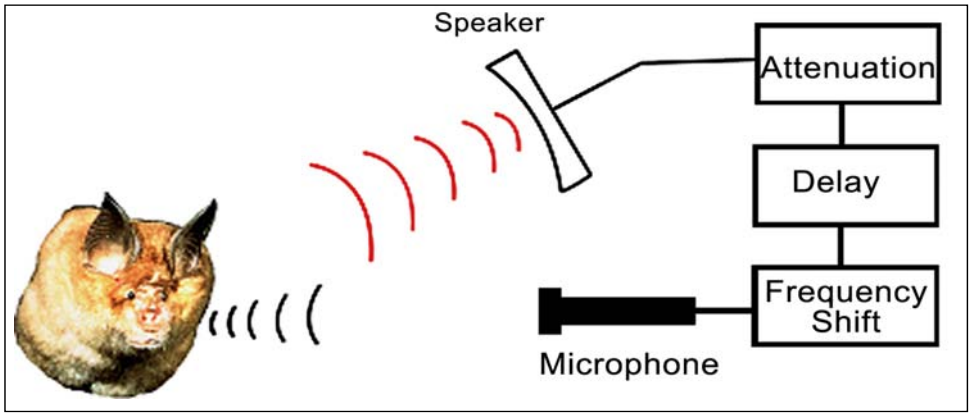

Figure 1. Computers are used to create artificial echos for the bat

*Figure 2: Dr. Smotherman holding a horseshoe bat (*Rhinolophus ferrumequinum*)*

in the control of vocal pitch.

Dr. Smotherman is anxious to study the physiology of the parabrachial nucleus in Texas species, the Mexican Free-tailed Bat, because it controls its call frequency differently than horseshoe bats, raising the possibility that activity within this brain region varies among different species of bats. By studying many different bat species, Dr. Smotherman eventually hopes to elucidate both generalized and specialized adaptations of the neural circuitry underlying the control of vocal behavior in mammals.

Behavioral studies suggest that many separate neural pathways mediate auditory feedback-control over different parameters of call emission. However, a major limitation of this research is the limited information about the organization and physiology of the vocal motor pathways that generate species-specific sounds. Therefore, Dr. Smotherman focuses on identifying and describing the physiology of the midbrain and brainstem neurons involved in call emission. The goal is to identify neurons that are active during vocalization and how their activity varies as the bat emits different types of sounds. Ultimately, Dr. Smotherman wants to understand how all the parameters of a single vocalization are represented and coordinated in the brain. Only then can the significance of each component of the sensory-feedback pathways that contribute to the precise control of vocalization be understood.

For more information about Dr. Smotherman's work, contact him at (979) 845-7747 or msmotherman@mail.bio.tamu.edu.

Undergraduate Research:

Ashli Moore *written by Julie Hayes*

Ashli Moore

Every year, the College of Science of Texas A&M University chooses an outstanding student to receive the John B. Beckham Award. This year, they selected Ashli Moore, a fifth-year Biology and Psychology double major who has had extensive undergraduate research experience. At the end of her junior year, Moore applied for the University Undergraduate Research Fellows program and conducted her own research project with the guidance of Dr. Ira Greenbaum. Her research focused on determining the genetic similarity between populations of deer mice (genus *Peromyscus*) from Baja California in order to establish their taxonomic relationships. "Research has enriched and broadened my university educational experience more than I can accurately describe," Moore states. "Working in a real lab every day, focusing on the same ongoing project, has given me a much more accurate idea of how concepts and information are applied in the real world." Undergraduate research is a popular way for students to get hands-on experience in their field of study, and those who choose to participate gain invaluable knowledge of the "real world" of science.

*Figure 1: A deer mouse (*Peromyscus maniculatus*).*
Photo courtesy of Dr. Ira Greenbaum

Freshman Biology Association

All new Biology majors who enter as freshmen in September 2004 are invited to join the Freshman Biology Association (FBA). The FBA was created to build camaraderie and increase retention of students in the degree programs offered by the Department of Biology. The meetings will be held beginning in September and run throughout the year. In addition to representatives from different departments across campus (Financial Aid, Study Abroad, Career Center Services), former students will also be invited to talk with incoming students about careers in the sciences. Faculty members will be available to provide guidance and mentoring relationships to the incoming students, and exposure to research and science in other countries will be explored.

The monthly meetings of the FBA will present interesting and useful topics, such as opportunities for independent research, resources available to help students, and professional organizations available to students. Refreshments will be provided at each meeting.

The Undergraduate Advising Office looks forward to an exciting year. Increasing interactions between faculty and students should significantly enhance the educational experience. All first-year students are encouraged to participate actively in this forum for networking with classmates who share common interests and goals.

New Faculty 04-05

Ginger Carney
Assistant Professor

Dr. Carney received her B.S. and Ph.D. degrees in Genetics from the University of Georgia. From Georgia she traveled to Corvallis, Oregon for postdoctoral work with Dr. Barbara Taylor at Oregon State University. As a postdoc, she used behavioral genetic screens to identify mutations that affect *Drosophila* reproductive behavior. Dr. Carney returned to Georgia for two years as a Faculty Research Scientist at Georgia Institute of Technology in Atlanta before coming to Texas A&M in August 2004 as an Assistant Professor of Biology.

Currently, little is known about how individual genes regulate central nervous system function and behavior. Dr. Carney uses a tractable genetic and developmental model, the fruit fly *Drosophila melanogaster*, to identify and characterize genes that regulate reproductive behaviors in the fly. There are sex-specific behaviors associated with reproductive success, and Dr. Carney is characterizing mutations that affect these behaviors in male or female flies. Their goals are to identify mutations in genes that regulate reproductive behaviors, determine if the gene products function in known regulatory cascades that control reproduction, and understand the molecular function of these gene products in behavior.

Adam Jones
Assistant Professor

Dr. Adam G. Jones is an Assistant Professor in the Department of Biology. He received a Bachelor of Arts Degree in Environmental, Population and Organismic Biology from the University of Colorado at Boulder in 1992. He then moved to the University of Georgia and earned his Ph.D. in Genetics under the mentorship of Dr. John C. Avise in 1998. Jones then took a position as a postdoctoral fellow in the laboratory of Dr. Stevan Arnold in the Department of Zoology at Oregon State University. From 2002 to 2004, Jones was an Assistant Professor in the School of Biology at Georgia Institute of Technology. In the summer of 2004, he moved to his current position at Texas A&M. His research involves the use of molecular and quantitative techniques to understand phenotypic evolution in natural populations, with a major focus on the evolution of morphology and male pregnancy in seahorses and their relatives

Research in the Jones Lab is concerned with the mechanisms of phenotypic change in evolutionary lineages. Most of the research effort in the lab is directed at the use of molecular techniques to resolve unanswered questions in sexual selection, theoretical studies of quantitative genetics and behavior, and the evolution of major morphological innovations.

Keith Maggert
Assistant Professor

Dr. Keith Maggert received his undergraduate degree in Biochemistry and Molecular Biology from the University of California-Santa Cruz, which he attended from 1988-1992. After graduation, he entered the University of California San Diego as a graduate student. Initially, worked on mesoderm determination and gastrulation in the fruit fly, *Drosophila melanogaster* in the laboratory of Dr. Michael Levine. After a few years, his attention turned toward chromosome biology and cytogenetics. He moved to the Salk Institute to work with Dr. Gary Karpen on the structure of the centromere – the region of the chromosome responsible for proper segregation of the genetic material driving cell division. His research helped establish that identical DNA sequences may behave differently depending on context and condition, a branch of genetics called "epigenetics." This work earned him his Ph.D. in 2000. Keith continued investigating epigenetics in Kent Golic's laboratory at the University of Utah as a postdoctoral fellow. There (and during a brief stay as a visiting researcher position with John Tamkun at the University of California-Santa Cruz) he began his work on genomic imprinting, asymmetric gene regulation, and DNA modification.

New Faculty, Continued

Brian Perkins
Assistant Professor

Dr. Perkins was born in Abilene, Texas, and received his B.S. degree in Biochemistry from Abilene Christian University in 1995. He earned his Ph.D. in Biochemistry and Molecular Biology from Baylor College of Medicine in 2000. His dissertation research in the laboratories of John Wilson and Ted Wensel focused on the use of oligonucleotide-based technologies for genetic modification of the human rhodopsin gene. He then did postdoctoral work with John Dowling at Harvard University from 2000-2004. While at Harvard, he began to explore the genetics of photoreceptor development and degeneration, using zebrafish as a model organism. By utilizing existing zebrafish mutants and performing a genetic screen for cell-specific mutations in the retina of transgenic zebrafish, Dr. Perkins's laboratory hopes to understand the regulation of genes required for photoreceptor development and maintenance. The retina is very similar to that of humans both in structure and function, so the genes required to make a zebrafish retina should resemble those needed to make a human retina. Future work in this area will help identify genes required for normal retinal development and will likely have relevance to human blindness disorders such as macular degeneration and retinitis pigmentosa

Michael Smotherman
Assistant Professor

Dr. Smotherman received his bachelor's degree in Biology from Occidental College in 1989. He began his graduate studies in neurobiology at the University of Maine, where, with Dr. Leonard Kass, he studied circadian rhythms in photoreceptor function in horseshoe crabs. He received his M.S. in Zoology in 1992. That year, he moved to UCLA to work on the evolution and physiology of the vertebrate auditory system with Dr. Peter Narins. Dr. Smotherman's dissertation research was on the biophysical properties of sound-transducing cells (hair cells) in the vertebrate ear. Following completion of his Ph.D. in 1998, Dr. Smotherman joined Dr. Walter Metzner's lab at U.C.-Riverside (currently at UCLA), where he began investigating the neurophysiology of echolocation by bats.

His primary line of research is the neurophysiology of those parts of the mammalian brain involved in the reception and production of acoustic communication signals. He is particularly interested in identifying connections between the central auditory system and the vocal motor pathways. Dr. Perkins believes that by studying both bats and cephalopods, one may eventually uncover basic principles of multi-modal sensory-motor integration in animal nervous systems.

Thomas Stidham
Assistant Professor

Dr. Thomas Stidham joins the department as an Assistant Professor of Biology and will also serve as Director of Lower Division Instruction, a new position that integrates our Introductory Biology program with our sophomore level majors courses, BIOL 213, Cell and Molecular Biology, and BIOL 214, Genes, Ecology and Evolution. He received a BS in Geology with a minor in Biology from the University of Texas at Austin and a PhD in Integrative Biology from the University of California, Berkeley. Dr. Stidham is the department's first paleontologist, bridging Geology with our growing strength in Evolutionary Biology. His research interests span evolutionary biology, with a focus on organismal and ecological evolution, concentrating on the evolution of birds and insects. He also has broad interests in paleoecology. His international exploits collecting fossils in Africa, Asia and North America have resulted in discoveries of new species of fossil birds and grasshoppers, which have altered our views of the evolution of these diverse groups of animals. As an educator, Dr. Stidham integrates his interests in evolution and field research into the classroom in many innovative ways, and he will work with the NSF Information Technology in Science (ITS) Center for Teaching and Learning.

www.bio.tamu.edu

Biology is Life: *Keep in Touch*

We hope that you enjoy this second issue of BioSphere, the newsletter of the Department of Biology at Texas A&M University. We aim to inform and entertain. If we generate a bit of nostalgia, too, we have succeeded. We need your feedback to help us improve. In addition, if you know of someone who would be interested in receiving BioSphere, please send their contact information to the address or e-mail below.

Please send contributions or suggestions to:

BioSphere, 3258 TAMU, Department of Biology, Texas A&M University, College Station, TX 77843-3258 or via e-mail to biosphere@mail.bio.tamu.edu or by phone 979-845-7747.

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