IN VIVO

Newsletter of the University of Tennessee Division of Biology

VOLUME 1, NUMBER 5 DECEMBER - JANUARY 2002

From the Director

John Koontz, Ph.D.

Friends:

Just a few days left in the semester. The students are wondering how much more material is going to be covered in their courses. Some faculty are wondering how they could get so far behind in covering the topics they had intended to cover at the start of the semester. Both students and the faculty are looking forward to the end.

As we approach the semester break, we can reflect back on the past four months. There were three major items affecting the Division during this period.

The most exciting of these is that we are now in the midst of actively recruiting eight new faculty members in the Division. The search committees in the four departments have begun to evaluate those applications already in hand while new applications continue to arrive. The goal is to invite qualified candidates for interviews early in the spring semester. It is still too early

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Using the simple to explain the complex

"I switched from worrying about who was reading my last scientific paper to thinking about how many students are impacted by my work." With that career-altering statement, **Dr. Leslie Hickok**, professor of Botany, entered the challenging world of helping students learn to "do science."

He has designed a new tool for instructors who face the problem of teaching science to 7th-12th grade and undergraduate students with short attention spans. From his 25 years of researching the tropical fern *Ceratopteris richardii* (*C-Fern*), Dr. Hickok, along with **Dr. Tom Warne**, developed an inquiry-based learning curriculum that is changing the way scientific concepts are taught. With the support of the National Science Foundation's Division of Undergraduate Education, Dr. Hickok's teaching and research system currently impacts over 55,000 students per year.

Hickok (center) in St. Louis

The *C-Fern* system has many attributes that make it perfect for studying both basic and applied aspects of plant biology. The plant starts from a single-celled haploid spore and develops into a macroscopic plant with roots and leaves within three weeks. During this time it exhibits a broad range of biological phenomena, including pheromone control of sexual types and chemotaxis with swimming sperm. Using Dr. Hickok's course materials, instructors can tailor the lab experience to focus on general biology, cell biology, genetics, or ecology. Materials and supplies are distributed by Carolina Biological Supply Company (www.carolina.com).

"Most of the materials that have been traditionally used in plant biology curricula are just not very exciting. Plants are a huge turn off for most students. I mean, they aren't warm and fuzzy and it's harder to get students interested," Dr. Hickok said. "So one of the things we are trying to develop is a plant that can elicit interest from the students. Having students grow it and do the manipulations is the main focus."

Dennis Miller, Science Department Chair at Manchester Junior High

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Botany – It's About Plants

Edward Schilling, Ph.D.

Everything that we eat comes from plants – whether we eat them directly, or feed them to an animal first. The oxygen we breathe ultimately comes from plants. So members of the Department of Botany have a tremendously important topic to study and teach!

In our electronic age, however, there is the danger that students will receive an education without ever actually coming into direct contact with their subject matter. In Botany, we are taking every opportunity to see that our own students; students in the public school system as well as the general public have chances to get up close to plants.

What strategies do we use? Most of our undergraduate classes include a laboratory. Whether it is simply cutting open a pineapple in non-majors Economic Botany, learning how to identify a species in Field Botany, or isolating and characterizing a DNA sequence in Plant Molecular Biology (taught by **Dr. von Arnim** – see, p. 4), students get their hands on plants.

The active research programs of our faculty lead to many opportunities for students to conduct research projects and become intimately familiar with plant biology. Even our freshman-level General Botany students are encouraged to conduct small research projects, which often make use of the greenhouse facility.

The Botany Teaching and Research Gardens have become a highly visible departmental resource. The Gardens, with the popular Native American Crop Plants section, have become a well-visited feature of the Hill area of campus.

Closely tied to the gardens are the Botany Greenhouses, which feature many economically important plants such as coffee, cacao, and bananas.

This is a facility that is used extensively for classes and tours, as well as for research, but over the future of which we have considerable anxiety.

Away from campus, we take advantage of our wonderful location to coordinate and participate in the annual Spring Wildflower Pilgrimage in the Great Smoky Mountain National Park. This event is a great way to educate the general public about plants in their native environments.

The C-Fern System created through the efforts of **Dr. Hickok** (see cover story) is bringing tens of thousands of secondary school students into close contact with plants.

Our emissaries to the local school systems, most recently **Dr. Schwarz** (see, p. 6), provide another way for the Botany Department to reach out to public school students and their teachers.

Aside from classroom teaching, most of these efforts are not, however, supported by the budget that we receive from the state.

Support for student research projects often comes from grants and contracts, and we are fortunate that almost all of our faculty have some type of research funding. Support for other activities comes from our alumni and friends, who have been generous in their contributions to our programs.

Our combined and sustained efforts in teaching, research and outreach to the public help make Botany at UT a very special program, and I hope that you will follow our progress by visiting our homepage at **http://fp.bio.utk.edu/botany/**.

Through the efforts of our talented faculty and students, and with the partnership of our supporters, we will make sure that plants continue to be a major focus of studies at the University of Tennessee.

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to draw any conclusions about the quality of the applicant pool.

The budgetary situation in the state mentioned in an earlier article remains dire. The sales tax revenue, the major source of state revenue, continues to decline. This is very likely to translate into a deficit that only an impoundment of funds can cover. The university is prepared to deal with this although it will have a significant and detrimental impact on any type of discretionary spending on campus.

One program recently abolished is a salary bonus plan that has been in existence in the College of Arts and Sciences for the past 16 years. This plan was associated with a state-supported Center of Excellence called the Science Alliance. This Center was originally established to reward the outstanding science faculty in the College of Arts and Sciences and to promote interactions between UT and Oak Ridge.

Criteria for the bonus focused on scholarly excellence in their research program and collaborative interactions with the Oak Ridge National Laboratory. This award or bonus program has proven extremely valuable as an incentive plan.

Given that the pay scale for faculty at our university is below that of our peer institutions, this incentive plan served to keep some of our best research faculty from leaving the university. The consequences of this action are obvious and efforts are underway to develop a merit pay system for all faculty members that would serve to replace this program.

As articulated in the last newsletter, the Provost convened a reallocation/reorganization task force to consider the organization of the life science units across campus. This included the departments in the Division of Biology, the department of Nutrition in the College of Human Ecology, the College of Agricultural Sciences and Natural Resources, and the College of Veterinary Medicine.

The period of study was about six weeks. The committee was unable to reach a consensus and the Provost has called for further study. In the interim, a committee is to be formed which will work to build greater communication across the various units with a goal of promoting more collaborative interactions.

Because of this initiative, I suggested to the heads of the four departments in the Division that we consider the possibility of changing the administrative structure within the Division of Biology. While our current structure has only been in existence since the 1996 academic year, I thought it might be worthwhile to consider alternate ways of doing things that might ultimately result in increased efficiency.

The goal would be to find a better way of using the resources at our discretion to support our missions of research, teaching and service. This suggestion has produced interesting responses.

The faculty members in one department were galvanized into action and proposed a two-department model. This reorganization model was proposed almost 12 years ago, but no action was taken. Another department initiated a fact finding effort, having the departmental faculty meet with the Deans of two other colleges to explore the benefits of moving the department to one or both of those colleges.

In each of these two instances, the faculty are interested in preserving the integrity of the core strengths of their departments. At the same time, they are concerned about maintaining and enhancing the environment that facilitates their research and teaching. Over the next few months there will be further opportunities for considering these and other options not only with regard to the administrative structure within the Division of Biology in Arts and Sciences but also of the life science units across campus.

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The Division will be sponsoring the **6th Annual Friends of Biology Golf Tournament**. The proceeds from the tournament go to the Division of Biology support fund and benefit undergraduate and graduate student activities in the Division.

An announcement for this tournament is on the back page of this newsletter. If you reside in the area or plan to be in the area on April 30, please participate. If you cannot play, consider sponsoring the participation of an undergraduate or graduate student. Or you might consider sponsoring an individual hole.

We would also appreciate any item(s) of value that you might donate as door prizes or awards. Weather permitting, we will guarantee a good time and the proceeds directly benefit student activities.

Herbarium News

Dr. B. Eugene Wofford, Director

The University of Tennessee Herbarium (TENN) houses over 500,000 specimens of fungi, bryophytes (mosses & liverworts), lichens, ferns, cone bearing, and flowering plants. It is a basic resource for studies in taxonomic/systematic botany and related fields and is a database containing vast information on plants from all parts of the world.

University faculty, staff, graduate students, and the scientific community use the specimens. In addition, the

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What we can learn from a common weed

From his varied background in plant genetics, **Dr. Albrecht von Arnim** brings a unique perspective to the study of botany at UT. His primary research interest, light responses in plants, was triggered at the University of Freiburg in Germany.

However, when he moved on to the doctoral level, he switched to study plant viruses at the John Innes Institute in Norwich, UK. This was a helpful move for him. He said, "at the time viruses were an excellent area to get one's feet wet in molecular biology."

Von Arnim with *Arabidopsis*

He returned to light signaling at Yale University for his postdoctoral work, better prepared to rejoin his previous research, at the cellular level. Here at UT he continues this combination of molecular genetics and whole organism research with graduate students **Tae-Houn Kim**, **Olga Ruiz Kopp**, and **Huaxia Qin**; postdocs **Byung-Hoon Kim** and **Yunzhou Dong**; and undergraduate student **Stephan Woditschka**.

Dr. von Arnim said, "We study a set of proteins that control how plants respond to shading or darkness. For example, when you germinate seeds under a layer of soil there is no light and the plants cope with that. They simply grow ten times as fast as they normally do if they had germinated on the soil surface. These kinds of developmental adaptations to variable environmental conditions are very common in plants but are rather unusual in animals. We are keen to understand how that happens. How the information from the light environments is processed to result in an appropriate response."

A rugged weed, the plant version of the laboratory mouse, aids his research. The weed's common names are Thale cress or mouse ear cress, but scientists know it as *Arabidopsis thaliana*. *Arabidopsis* lends itself well to research due to its small genome that was sequenced in 2000. It also has a rapid life cycle, is easily cultivated and grows fast under low light conditions.

Recently, Dr. von Arnim's lab became part of the NSF *Arabidopsis* 2010 Initiative, partnered with **Dr. C.H. Johnson** of Vanderbilt University. The National Science Foundation recently awarded 28 research teams with grants to collectively define the functions of *Arabidopsis'* 25,000 genes. For their part, Dr. von Arnim and Johnson are developing a new research technique called Bioluminescence Resonance Energy Transfer (BRET).

In years past it was difficult if not impossible to examine the physical interaction between two specific gene products within a plant cell. According to Dr. von Arnim, BRET gives researchers "a way of looking at interactions within the cell at the protein level." The key is that interactions are detected in vivo, i.e. within a living plant, instead of using in vitro methods or resorting to non-plant organisms.

Dr. von Arnim said, "You take a living seedling, the entire organism, place it from one light environment to a different one and watch in real time how a particular interaction develops, which may result in a specific gene being turned on or off. If it works on a genomic scale it can become very useful as a tool to identify the function of many different genes. Once we understand the interactions between individual gene products, we are a major step closer to understanding their function."

According to NSF, the implications of the *Arabidopsis* 2010 project will be profound for research in areas such as agriculture, medicine and energy. Dr. von Arnim is optimistic that, "a lot of good science will come out of it."

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School in North Manchester, Indiana uses the C-Fern curriculum in his class. He said, "The unit that I am in the process of developing is turning out to be one of the best ways of really showing the alternation of generations in organisms. The static information students read in textbooks has now come alive in the laboratory."

Dr. Hickok and his technician, **Stephenie Baxter**, travel the country explaining the *C-Fern* technique at science conventions. During a trip to St. Louis he discovered that the NASA booth was displaying brochures regarding *C-Fern* experiments on a recent shuttle mission.

Dr. Hickok's impact on students does not stop at the high school level. At UT he teaches General Genetics, Genetics and Society, and Botany 531, which is titled "Knowing and Teaching Science: Just Do It!"

The latter is a class designed to show pre-service teachers how to teach science by conducting their own scientific experiments. Dr. Hickok said, "We give them the *C-Fern* as an unknown and basically ask them to find out something about the organism. We hope by the end of the semester that they have gotten over their fear of asking questions. It's as far away from a 'cookbook' laboratory type experience as you can get."

http://cfern.bio.utk.edu

Answering century's old questions with a new model

It would be difficult enough to study the lone Golgi apparatus in an animal cell, but to study a plant cell, which could contain hundreds of these structures is another matter.

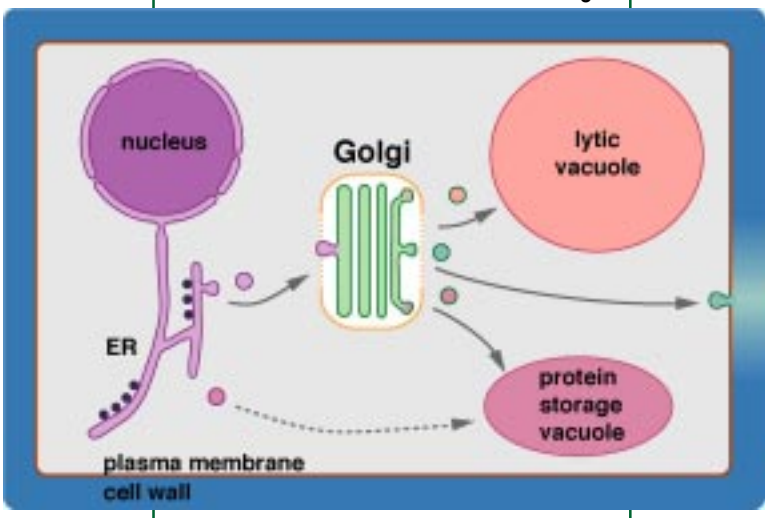
The newest member of the Botany faculty, **Dr. Andreas Nebenführ**, relishes this challenge. Even though science has known of the existence of the Golgi for over 100 years, it was only when electron microscopy became widely used that this protein processor could be adequately studied.

Proteins destined for insertion into membranes or secretions from the cell are synthesized in the endoplasmic reticulum (ER) and routed through the Golgi, which is a flattened stack of membrane sacks.

Dr. Nebenführ likens the Golgi's structure to a stack of pancakes. Each protein makes its way through all the layers, being chemically modified by the addition of sugars. The proteins are then sorted in the Golgi before they go to one of three destinations.

One of these destinations is the lytic vacuole, which is a hydrolytic compartment where proteins can be degraded. Another is a protein storage sack where energy is stored for activities such as germination. The final route is the one studied by Dr. Nebenführ and that is the cell wall.

He said, "The Golgi is an important organelle for setting up the cell wall, and of course the wall is what keeps the plant upright, like a skeleton."



He has many questions to answer as he studies the Golgi. For example, why does the Golgi move around the cell? Is the Golgi moving toward the transport vesicles or vice versa? And ultimately, what role does this secretory system play in setting up plant structure? Finding the answers to these questions will take time, but Dr. Nebenführ feels he is in the right place to further his search.

He began his work in botany at the Albert-Ludwigs-Unitversität in Freiburg, Germany, which is not far from his home in Stuttgart. His attraction to cell biology came from his study of plant hormones at Oregon State University.

There he realized he needed to go to a smaller scale in his studies to better understand the workings of plant development, while still keeping an eye on the whole organism. His postdoctoral work at the University of Colorado prepared him for the research that he will do here.

He was attracted to UT by the infrastructure and the other cell biologists. He plans to make frequent use of the Electron Microscopy Facility and the Molecular Biology Resource Facility, or sequencing lab. He is also encouraged by the camaraderie he has with the other cell biologists within the Division.

He will begin teaching next fall in the genetics core courses and wants to add a plant cell biology class as well. He chose the academic environment over industry because he "likes the challenge of teaching people and sharing knowledge with younger colleagues."

"Now we can ask questions that were unthinkable ten years ago."

Dr. Nebenführ is still unpacking his lab, but is already making plans to secure funding. He will make proposals to NIH and NSF and possibly to the NRC. He hopes to soon attract a lab technician as well as graduate students.

He feels that studying the Golgi is a perfect fit for him. He said, "In recent years, major progress has been made because of the genetic sequencing of yeast and other organisms and because of advances in technology. Now we can ask questions that were unthinkable ten years ago."

He also feels that studying plant cells is beneficial because most of the research is being done in animal and yeast systems. Dr. Nebenführ's work currently focuses on tobacco cell cultures, but he hopes to move on to *Arabidopsis thaliana*.

For various reasons, plants are harder to study than animal cells, therefore, funding and recognition has been slow to come. However, Dr. Nebenführ feels confident that will soon change as the uniqueness of plants among living organisms and their fundamental importance for mankind are better understood and appreciated.

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"It's a blast"

Some UT faculty members are so concerned about the education of their students that they are willing to invest time in improving the pre-college preparation that is offered in Tennessee public schools. **Dr. Otto Schwarz**, professor of Botany, is such a person.

Schwarz (center)

Dr.Schwarz, and other faculty from the Colleges of Arts and Sciences and Education, presented a "Seeds for Success" workshop in July to 40 middle school science and math teachers. This endeavor was supported by the UT Collaborative for the Enhancement of Education and Science and Mathematics (CEEMS).

The workshop is a joint program of the Colleges of Arts and Sciences and Education that was established by a grant from UT-Battelle. **Keith Bowman,** a Botany graduate teaching assistant, aided Dr.Schwarz in preparation for the workshops by providing backup greenhouse research and lab set-ups.

Several goals of the workshop were to illustrate the scientific method using botanical experiments; to provide the teachers with hands-on, discovery-based experiments; and to demonstrate the interdependency of science and mathematics.

In a follow-up meeting in November held to discuss the workshop, Dr. Schwarz said, "The teachers indicated that they were able to apply what they learned in many creative ways in both their science and math classes." Because of its success, the workshop will be repeated in the summer of 2002.

However, Dr. Schwarz's influence on the community does not stop with this one particular program. He was selected, through a competitive process, to represent the life sciences division as a James T. Chappell "Scholar in the Schools," administered by the College of Arts and Sciences Office of Academic Outreach.

This program allows him to spend 8 to 12 hours each week at West Valley Middle School for this school year. He does not teach classes, but observes the classroom environment and curriculum and provides enrichment support for **Charlotte Jennings**, Chair of Science for the school as well as the other science teachers at the school.

Dr. Schwarz is learning a great deal about the local public school system during his tenure at West Valley. He said, "This is a wonderful opportunity as a professional to enrich the material given to K through 12 students. In the long run, everyone will benefit. What I provide as an outside source is advantageous to overworked teachers, who are grateful for the help and attention, but more importantly it expands the learning horizons for the students. It is personally gratifying, and I plan to continue my efforts in this area after I retire from UT."

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www.artsci.utk.edu/ceems.htm

www.artsci.utk.edu/outreach/

Herbarium, *Cont. from page 3*

general public, numerous state and federal agencies, conservation groups, environmental consulting firms, etc. rely frequently on specimen records for data critical to biodiversity, habitat management, and conservation decisions.

TENN maintains active loan, exchange, and gift programs. Based on the total number of specimens deposited, TENN ranks in or close to the top 10 public supported herbaria in the United States even though the original collection, beginning in 1888, was destroyed by fire in 1934.

A collections improvement grant from NSF made it possible for TENN to move to new/temporary quarters in Hoskins Library (room 190). It was a daunting task moving over 500,000 specimens but they are all now consolidated and provided with expansion space for the near future.

Dr. Victor Ma, collections manager, examines a specimen of American ginseng

The additional expansion space made it possible to accept orphaned collections of over 200,000 specimens and over 50 herbarium cabinets from Union College, Vanderbilt University, Appalachian State, and The University of Memphis.

Recent initiatives and news include assuming the mycology collection (**Dr. Ron Petersen**, Curator), which houses approximately

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Alumni News

1970's

James Sykes completed his undergraduate degree in Organismal and Systems Biology in 1978. He later received his M.P.H. at UT in 1980. He is currently the Director of Community Health Services for the Tampa AIDS Network, which is the oldest AIDS Service Organization in central Florida. Their mission is to provide mental and physical support and prevention education.

Dr. Anthony Vitto graduated from the GST program in 1978 and went on to medical school at Temple University. He is now in private practice with offices in Gilroy and Monterey, Calif. He practices general adult and child neurology with a special interest in Alzheimer's disease and headaches/migraines.

1980's

W. Thomas Carter III received his undergraduate degree in Biology in 1987. He then attended law school at the University of Pennsylvania and is now a partner with Alston & Bird in Atlanta. He chairs the firms Venture Capital Group and co-chairs the Life Sciences Group.

Dr. Joseph Mitchell graduated in 1982 with a Ph.D. in Ecology. He is currently a research biologist with the University of Richmond and owns an ecological consulting firm in Virginia. He studies the ecology and conservation biology of amphibians, reptiles, and small mammals, often on military bases and other public lands.

1990's

Dr. Amy Harbage completed her degree in general biology in 1995. She then received her Master of Public Health degree at UT in 1997 and went on to medical school at the University of Health Sciences, College of Osteopathic Medicine in Kansas City. She now works in pediatrics and public health issues in Tampa, Fla.

Gene Connelly received his degree from Zoology in 1994 and is now the Fan Relations Manager for the Nashville Predators NHL hockey club in Nashville, Tenn.

Tyler Ogle graduated with a Biology degree in 1992. He now works in sales for Willmette Industries out of Newton, N.C. (www.wii.com).

Dr. Nicole Sheffield graduated from Microbiology in 1992. She attended medical school at the University of Louisville and trained in pediatrics at Childrens Medical Center in Dayton, Ohio. Her practice is located in Memphis, Tenn.

2000's

Brenda Warrick completed her Biology degree in 2000. She is now an Assistant Scientist with the company Paradigm Genetics, which is based in the Research Triangle in North Carolina. She works with the plant *Arabidopsis* as a model to help improve the quality of crops and crop production.

Dr. Lisa Webb graduated from the GST program this year and has accepted a postdoctoral position at Jackson Lab in Bar Harbor, Maine.

http://web.bio.utk.edu/division/alumni/alumnimain.htm

IN VIVO
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Herbarium, *Cont. from page 6*

60,000 specimens. Fieldwork in 2001 to northern Argentina, Mexico, and central Europe resulted in collecting almost 500 additional specimens for ongoing research. Four foreign visitors used the mycology collection in the past two years and all types of fungi specimens and approximately 15,000 specimens from the general collection have been data based.

The bryophyte collection (**Dr. D. K. Smith**, Curator) comprises nearly 200,000 specimens of global representation. This impressive collection is an international resource containing examples of about 85% of the generic bryophyte flora of the world.

Dr. Smith is also project coordinator of the botany portion of the All Taxa Biodiversity Inventory being conducted in the Great Smoky Mountains National Park. The overall life inventory of the Smokies is expected to document more than 100,000 species of organisms.

The vascular plant collection (Dr. Wofford, Curator) houses about 300,000 specimens, has added approximately 10,000 this year and provided at least this many on exchange or as gifts. The vascular plant distribution atlas website is in the early phases of reconstruction: adding digital images of all of the vascular plants in Tennessee including a common name link.

This website currently receives about 9,000 visitors each year. This should double or triple with completion of this new initiative. Most of these projects have been supported with extramural funding of approximately 500,000 dollars over the past five years.

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www.bio.utk.edu/botany/herbarium/index.html

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6th Annual Friends of Biology Golf Tournament

Date: April 30, 2002
Time: Shotgun start at 9:00 am
Location: Centennial Golf Course
Cost: $60 entry fee that includes greens fee, cart and lunch
Hole Sponsorship: Individual $50
Corporate $100
For more information, contact:
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