UNDERGRADUATE RESEARCH Highlights

Reinhold H, Soyk S, Šimková K, Hostettler C, Marafino J, Mainiero S, Vaughan CK, Monroe JD, and **Zeeman SC**. β-Amylase–like proteins function as transcription factors in Arabidopsis, controlling shoot growth and development. *Plant Cell*. 2011;23:4:1391-1403. (James Madison University, and ETH Zurich)

The authors describe two novel β-amylases in the model plant Arabidopsis thaliana that are located in nuclei and function as transcription factors. The DNA-binding domain within these proteins binds to DNA sequences found in genes regulated by the growth hormone brassinosteroid revealing how hormones and carbohydrate status may coordinately control a plant's growth. β-amylases were thought to only function in plastidic starch degradation so this discovery was unexpected and opens an entirely new avenue of research on the regulation of plant growth. Jonathan Monroe is a professor of biology at James Madison University. During his junior and senior years, John Marafino used transgenic plants expressing GFP-tagged β-amylases to make the discovery that these proteins were located in nuclei. Samantha Mainiero's honors thesis included using site-directed mutagenesis to define the nuclear localization signal in one of the β-amylases. John is currently applying to graduate programs and Samantha is a first-year doctoral student in plant biology at Cornell University. Both students received academic credit for their work. The Jeffress Memorial Trust supported the research.

Zhu J, Canter RC, Keten G, Vedantam P, Tzeng T, Xuan X. Continuous flow separation of particles and cells in a serpentine microchannel via curvature-induced dielectrophoresis. *Microfluid Nanofluid*. 2011;11:6. Published online. DOI: 10.1007/s10404-011-0839-9. (Clemson University)

This study demonstrates a continuous-flow electrokinetic separation of polymer particles and biological cells in a serpentine microchannel through curvature-induced dielectrophoresis. The separation arises from the particle size-dependent cross-stream dielectrophoretic deflection that is generated by the inherent electric field gradients within channel turns. Through the use of a sheath flow for focusing, we implement a continuous separation of 1 and 5 um particles and a continuous separation of yeasts and 3 um particles in a serpentine microchannel under small DC electric fields. Xiangchun Xuan is an assistant professor of mechanical engineering. Cameron Canter worked in Dr. Xuan's lab first as an honor undergraduate student in Jan.-Dec. 2010 and then as an Creative Inquiry undergradaute student in Jan.-May 2011. He is currently a graduate student at GA Tech.Gyunay Keten worked in Dr. Xuan's lab as a Creative Inquiry undergradaute student in 2009-2010. He is a co-author of two journal papers from Dr. Xuan's group. This research was supported by NSF and Clemson University (Creative Inquiry Program and Calhoun Honors Program).

Glumac B, Curran HA, Motti SA, Weigner MM, Pruss SB. Polygonal sandcracks: Unique sedimentary desiccation structures in Bahamian ooid grainstone. *Geology*. 2011;39:7:615-618. (Smith College)

This article describes an unusual sedimentary structure—polygonal cracks in sand—from less than 6,000 years old dune and beach carbonate rocks on Cat Island, Bahamas. These structures resemble mudcracks—features formed by the drying of mud and commonly used to identify ancient sediments that were initially exposed to the air—but on Cat Island such cracks formed in sand without any mud. In experiments with modern Cat Island beach sand (made almost entirely of tiny spherical grains called ooids), cracks formed during the collapse of large irregular pore spaces when the ooid sand dried at ambient temperature. Sandcracks have been documented rarely because they are not easily preserved and their formation requires well-rounded spherical grains of relatively uniform size and shape. Bosiljka Glumac is an associate professor, H. Allen Curran is a professor emeritus, and Sara B. Pruss is an assistant professor in the Department of Geosciences. Sarah Motti and Madeline Weigner conducted this research as part of their Spring 2009 Carbonate Sedimentology coursework. Sarah is now working for a non-profit youth center in Fairfield County, Connecticut. She developed a new 'science in the field' program that involves children in studying Long Island Sound geology and marine science. Madeline

is currently a graduate student at the University of Idaho. Her research focuses on Late Devonian shelly fossils from the Jefferson Formation in central Idaho. The research on polygonal sandcracks was funded by small research grants administered through Smith College.

Patel E, Lynch C, Ruff V, Reynolds M. Co-exposure to nickel and cobalt chloride enhances cytotoxicity and oxidative stress in human lung epithelial cells. *Toxicol. Appl. Pharmacol*. 2012;258. (Washington College)

In this study, we investigated the effect of exposure of H460 human lung epithelial cells to nickel and cobalt, both alone and in combination. We demonstrated that cells exposed simultaneously to cobalt and nickel exhibit a dose-dependent decrease in survival compared to the cells exposed to a single metal. The decrease in survival was the result of enhanced caspase activation and cleavage of PARP. Co-exposure increased the production of ROS and the formation of DSB. Mindy Reynolds is an assistant professor of Biology Eshan Patel '13 is a dual major in biology and psychology. He contributed to this project during the summer of 2011.Christine Lynch '11 is currently a research assistant at the US Army Research Institute of Environmental Medicine, Military Performance Division, Natick, MA. He contributed to this project during the summers of 2009 and 2010.Victoria Ruff '14 is a psychology major at Washington College. She contributed to this project during the summer of 2011. This project was supported by the Hodson Trust and Middendorf Foundation at Washington College.

Tso R, Bailey QG. Light-bending tests of Lorentz invariance. *Phys. Rev. D.* 2011;84:8:085025. (Embry-Riddle Aeronautical University)

Recently, there has been growing interest among physicists in high-precision tests of Einstein's Special and General Theories of Relativity. This is motivated by the possibility of finding miniscule relativity violations as a signal of new physics from an, as yet unknown, unified theory of gravity and quantum physics. One classic test of General Relativity is the bending of distant starlight around the sun. In this paper, we use an established general framework for relativity tests, called the Standard-Model Extension, to derive a modified deflection angle formula for light passing near the sun. We describe how this formula can be used by future dedicated light-bending tests, such as ESA's Gaia mission, to measure new types of hypothetical relativity violations. Dr. Quentin G. Bailey is an assistant professor in the physics department at Embry-Riddle Aeronautical University, Prescott. Undergraduate Rhondale Tso is a senior physics major who participated in the research project during the 2009-10 and 2010-11 academic years as part of an independent study and undergraduate research project. The research was supported by the Arizona NASA Space Grant and the Ronald McNair Scholars program.

Bertram SM, Thomson IR, Auguste B, Dawson JW, Darveau C-A. Variation in cricket acoustic mate attraction signaling explained by body morphology and metabolic differences. *Anim. Behav*. 2011;82:1255-1261. (Carleton University and the University of Ottawa)

To address the proximate causes underlying variation in male cricket signaling effort, we quantified the morphological, physiological, and biochemical variation among male European house crickets (Acheta domesticus) and assessed whether it correlated with variation in male acoustic mate attraction signalling. Surprisingly, variation in acoustic signaling did not appear to be influenced by lipid metabolism. Instead, some of the variation in acoustic signaling was driven by differences in overall body size and differences in the activity of the glycolytic enzyme pyruvate kinase. These correlations suggest that the capacity for carbohydrate catabolism is important to male cricket acoustic signalling. Sue Bertram and Jeff Dawson are associate professors at Carleton University, and Charles Darveau is an assistant professor at the University of Ottawa Ian and Bourne undertook this research as NSERC Undergraduate Student Research Assistants. Bourne is currently studying medicine at McMaster University, while Ian is currently pursuing an MSc at Carleton University. The research was supported by NSERC discovery grants awarded to Sue, Charles, and Jeff and for NSERC USRA grants to Ian Thomson and Bourne Auguste.

Wammer KH, Slattery MT, Stemig AM, Ditty JL. Tetracycline photolysis in natural waters: Loss of antibacterial activity. *Chemosphere.* 2011;85:1505-1510. (University of St. Thomas)

The antibiotic tetracycline, commonly detected in natural waters, undergoes direct photolysis by natural sunlight. This study examined tetracycline photoproducts generated under a wide range of water hardness and pH conditions and found that none retained significant antibacterial activity. This suggests that these photoproducts will not contribute to the selection of antibiotic-resistant bacteria in environmental systems. Kris Wammer is an assistant professor of chemistry and Jayna Ditty is an associate professor of biology. Amanda Stemig and Matthew Slattery, both chemistry majors, were supported by the University of St. Thomas Undergraduate Research and Collaborative Scholarship program to perform the work over the course of several summers and academic years. Amanda is currently in a doctoral program at the University of Minnesota, and Matthew is currently employed.

Steiner AL, Pressley SN, Botros A, Jones E, Chung SH, Edburg SL. Analysis of coherent structures and atmosphere-canopy coupling strength during the CABINEX field campaign. *Atmos. Chem. Phys*. 2011;11:11921-11936. (University of Michigan and Washington State University)

This study analyzed transport processes between a forest and the atmosphere, showing that intermittent coherent structures are responsible for a large fraction of the total air mass exchange. These coherent structures need to be considered when studying the mixing and chemical reactions of trace gases and aerosols between a forest canopy and the atmosphere. The percent contribution of mass and energy transport in and out of the canopy is quantified using two methods, the quadrant-hole analysis and the wavelet analysis. The methods predicted that coherent structures are responsible for 40-65% of the energy exchange between the forest canopy and the atmosphere. Allison Steiner is an assistant professor in the Department of Atmospheric, Oceanic and Space Sciences at University of Michigan. Shelley Pressley and Serena Chung are assistant research professors in the Laboratory for Atmospheric Research, Department of Civil and Environmental Engineering at Washington State University. Steven Edburg is a research associate in the Geography department at University of Idaho. Eric Jones participated in a REU program at Washington State University during the summer of 2010 after his freshman year. He is currently a junior enrolled at Olin College and expects to graduate in May 2013. Abraham Botros participated in a REU program at the University of Michigan during the summer of 2010 after his sophomore year. He is currently pursuing a neuroscience degree at University of California, Los Angeles and expects to graduate in June 2012. Jones was supported by a NSF-REU grant at WSU, Botros was supported by a NSF-REU grant at UM, and Steiner, Pressley, Chung and Edburg were all supported by NSF grants.