UNDERGRADUATE RESEARCH Highlights

Freeburg SH, Engelbrecht E, Powell WH. Subfunctionalization of Paralogous Aryl Hydrocarbon Receptors from the Frog *Xenopus laevis*: Distinct Target Genes and Differential Responses to Specific Agonists in a Single Cell Type. *Toxicological Sciences*. 2017; 155:5: 337–347. doi:10.1093/toxsci/kfw212. (Kenyon College)

We used TALENs to knock out individual paralogous Aryl Hydrocarbon Receptor (AHR) genes in a cell line from the frog *Xenopus laevis*. Characterization of the mutant cell lines exposed to two different agonists revealed that each receptor exhibits different transcriptional regulatory functions. Wade Powell is a professor of biology. Scott Freeburg is a PhD student at Harvard University. Eric Engelbrecht, a lab technician at Boston Children's Hospital, worked on this research as an undergraduate. This research was supported by NIH AREA Grant 2 R15 ES011130-05 (to WHP) and the Kenyon College Summer Science Scholars Program.

Deaton CD, Hein CJ, Kirwan, ML. Barrier Island Migration Dominates Ecogeomorphic Feedbacks and Drives Salt Marsh Loss along the Virginia Atlantic Coast, USA. *Geology.* 2016; 45:123–126. doi:10.1130/G38459.1. (Virginia Institute of Marine Science, College of William and Mary)

Coupling between barrier islands and their associated salt marsh and tidal flats leads to complex feedbacks that are proposed to control the response of barrier-island systems to sea-level rise. This study tested the applicability of these concepts through investigation of the Virginia barrier islands. Using historical maps and photographs from 1851 to 2010, we determine that rapid landward island migration is leading to backbarrier area reduction and large-scale salt marsh loss (19 percent). Landward barrier-island migration was responsible for 51 percent of marsh loss, with the remainder due to backbarrier processes (e.g., edge erosion). These results indicate that, for barrier island systems already undergoing migration, the primary barrier-backbarrier coupling is the loss of marsh and tidal-flat area because of barrier-island migration itself. Charles (Charlie) Deaton completed this work as part of his senior thesis at the College of William and Mary, from which he graduated in 2015. Deaton is now completing his master's degree at the University of North Carolina at Chapel Hill. Christopher Hein and Matthew Kirwan are assistant professors at the Virginia Institute of Marine Science. This work was supported by NSF LTER (1237733) and Coastal SEES (1426981 and 1325430) programs.

Smolyaninova VN, Jensen C, Zimmerman W, Prestigiacomo JC, Osofsky MS, Kim H, Bassim N, Xing Z, Qazilbash MM, Smolyaninov II. Enhanced Superconductivity in Aluminum-based Hyperbolic Metamaterials. *Scientific Reports*. 2016; 6: 34140. doi:10.1038/srep34140. (Towson University, Naval Research Laboratory, College of William and Mary, University of Maryland–College Park)

One of the most important goals of condensed matter physics is materials by design, i.e. the ability to reliably predict and design materials with a set of desired properties. A striking example is the deterministic enhancement of the superconducting properties of materials. We have engineered an aluminum/aluminum oxide hyperbolic metamaterial capable of a significant enhancement of superconducting critical temperature, while having superior transport and magnetic properties compared to the core-shell metamaterial superconductors. Vera Smolyaninova is a professor of physics and Christopher Jensen is a graduate student at Towson University. William Zimmerman, physics major at Towson, participated in the research for independent study credit. Zimmerman graduated from Towson University in May 2016 and is enrolled in the professional master's program in applied physics at Towson. Joseph C. Prestigiacomo and Michael S. Osofsky are research physicists and Heungsoo Kim and Nabil Bassim are materials engineers at the Naval Research Laboratory in Washington, DC. Zhen Xing is a graduate student and Mumtaz Qazilbash is an associate professor in the Department of Physics at the College of William and Mary. Igor Smolyaninov is a research scientist in the Department of Electrical and Computer Engineering at the University of Maryland–College Park. This research was supported in part by Fisher College of Science and Mathematics Undergraduate Research and Towson Undergraduate Research Grants, which were awarded to Zimmerman, and by NSF grant DMR-1104676 at Towson.

Hoang NH, Kane ME, Radcliffe EN, Zettler LW, Richardson LW. Comparative Seedling Germination and Development of the Ghost Orchid, *Dendrophylax lindenii* (Orchidaceae), and Molecular Identification of Its Mycorrhizal Fungus from South Florida. *Annals of Botany.* 2017; 119: 3: 379–393. doi: 10.1093/aob/mcw220. (Illinois College; University of Florida)

The endangered, world renowned, leafless ghost orchid *Dendrophylax lindenii* is difficult to grow under artificial conditions. Critical information regarding asymbiotic and symbiotic (co-culture with a mycobiont) seed germination of this orchid is completely lacking in published sources and is nec-

essary for the development of efficient procedures for ghost orchid production for successful reintroduction. Mycorrhizal strain Dlin-394, isolated from ghost orchid roots in situ, was confirmed as a mycorrhizal associate, which significantly promoted seed germination and seedling development. Molecular ITS sequencing data identified the fungus as a previously unreported strain of Ceratobasidium. These results offer the opportunity to examine the benefits of using a fungus to enhance in vitro germination and possibly ex vitro acclimatization and sustainability following outplanting. Nguyen H. Hoang is a doctoral student at University of Florida and a research fellow in the Department of Plant Biotechnology at the University of Sciences in Vietnam. Michael Kane is a professor of environmental horticulture at the University of Florida. Lawrence Zettler is Hitchcock Professor of Biology at Illinois College. Ellen Radcliffe undertook this research project as part of a summer internship experience following her junior year at Illinois College in summer 2014. Larry W. Richardson is a biologist with the Florida Panther National Wildlife Refuge, U.S. Fish and Wildlife Service. Funding for this work was supported by the Naples Orchid Society and the Florida Panther National Wildlife Refuge, U.S. Fish and Wildlife Service.

Khan S, Klein-Banai C, Yoshida, K. Restroom Water Reduction Potential at an Urban University. *Sustainability Journal of Record*. 2016; 9: 6: 295–304. doi:10.1089/sus.2016.29073.sk. (University of Illinois at Chicago)

A water audit was conducted at University of Illinois at Chicago (UIC) campus buildings to help evaluate the potential to conserve water and save the university money. These buildings are unique in many different aspects and together are a good representation of an urban university infrastructure. Data was collected by performing a water audit on faucets, urinals, toilets, and showers and suggest it is necessary to upgrade the majority of the fixtures to meet at least the federal and EPA standards. In one scenario of an audit of a university building, the payback was found to be less than two years with a yearly savings of $72,000 and 9.4 million gallons of water per year. Cynthia Klein-Banai is associate chancellor for sustainability and adjunct assistant professor of public health. Kate Yoshida is program coordinator in the Office of Sustainability. As a junior, Khan worked from June 2015 to April 2016 on the project. He graduated in May 2017 with a BS in civil engineering. This project was supported by a UIC sustainability fee that was awarded to Khan.

Mooring, SR, Mitchell, C, Burrows, NL. Evaluation of a Flipped, Large-Enrollment Organic Chemistry Course on Student Attitude and Achievement. *Journal of Chemical Education*. 2016; 12: 93: 1972–1983. doi:10.1021/acs.jchemed.6b00367. (Georgia State University)

The study examined students' attitude and achievement in large enrollment, flipped organic chemistry courses. The results showed that there was a statistically significant improvement in A and B grades and a decrease in failure/withdrawal rates for the flipped course. The results showed a statistically significant increase in students' emotional satisfaction and intellectual accessibility for the flipped course compared to those for traditional lecture courses. This work demonstrates that the flipped course model can be adopted for challenging, large-enrollment courses. Suazette Mooring is an assistant professor of chemistry. Chloe Mitchell was a voluntary undergraduate researcher from 2014 to 2016, working on this particular study in 2016. She is currently a medical student at Mercer University. Nikita L. Burrows earned her PhD in chemistry from Georgia State University in 2017. The research was funded by the University System of Georgia, Complete College Georgia STEM Innovation Grant, which was awarded to Mooring.

Luttamaguzi J, Eslami A, Brooks DM, Sheybani E, Javidi G, Gabriel PM. Using Simulations and Computational Analyses to Study a Frequency-Modulated Continuous-Wave Radar. *International Journal of Interdisciplinary Telecommunications and Networking*. 2017; 9:1: 38–51. doi: 10.4018/ijitn.2017010104. (NASA Goddard Space Center)

This paper describes a method for simulating Frequency-Modulated Continuous-Wave (FMCW) radar. FMCW radar system simulations are an example of a real-world application, invested in rich mathematical/physical content that exercise these competencies. Unlike conventional radars that operate in the time domain, FMCW radars operate in the frequency domain. Spectral and phase analyses are required to infer range and the range resolved velocity of meteorological targets such as rain or drizzle. Jamiiru Luttamaguzi is a faculty member in the Department of Mathematics and General Sciences at Prince Sultan University in Riyadh, Saudi Arabia. Akbar Eslami is a professor in the Department of Technology at Elizabeth City State University. Dwayne Brooks was a mathematics student at Elizabeth City State University and a 2012 NASA intern at NASA Goddard Space Center during this project. Currently he works for a company in Hampton, VA. Ehsan Sheybani is assistant professor of information systems and decision science and Giti Javidi is assistant professor of information technology at the University of South Florida Sarasota-Manatee. Philip M. Gabriel works at General Ana-

lytics in Wolfville, Nova Scotia, Canada. This research was supported by a NASA–Science and Technology Institute for Minority Institutions grant.

Walters LA, Webber JA, Jones BA, Volker CL. Taking a Break: The Relationship between Ambient Temperature and Nest Attendance Patterns of Incubating Carolina Chickadees (Poecile carolinensis). *Wilson Journal of Ornithology*. 2016; 128: 4: 719–726. doi: 10.1676/15-115.1. (Northern Kentucky University)

We investigated the incubation behavior of female Carolina Chickadees using remote temperature data loggers to obtain an extensive, continuous sample of incubation recesses, or off-bouts. We found that as ambient temperature increased, off-bout duration increased while off-bout frequency decreased. This study provides new information about the incubation behavior of this species and helps clarify the complex influence of temperature on the tradeoff between investment in offspring versus self-maintenance for intermittently incubating birds. Lindsey Walters is an associate professor of biological sciences. Three undergraduate students participated in this research during summers 2012–2014: Cassie Volker, Brittany Jones, and Jackie Webber. Volker earned a M.S. from Florida Atlantic University and is now employed at Northern Kentucky University. Jones is a veterinary student at Lincoln Memorial University. Webber is a senior biology major. This study was funded by Northern Kentucky University's Center for Integrative Natural Science and Mathematics (Walters, Jones), a Greaves Undergraduate Summer Fellowship (Volker), and the National Science Foundation (Webber).

Hines JM, Eason JJ, Siebert MR. One Lump or Two? A Plurality of Pathways in Gold(III)-Catalyzed Cyclization Transforming Propargyl Acetates to a Carene-like Bicyclo[4.1.0]heptane. *Organometallics*. 2017; 36: 4: 920–926. doi: 10.1021/acs.organomet.6b00946. (Missouri State University)

The bicyclo[4.1.0]heptane substructure, featured in a number of natural products, is economically formed via gold(III)-mediated cycloisomerization. We used quantum chemical calculations to evaluate multiple pathways that gold(III) could take in the creation of the final product. We found that two pathways are very close in energy, which, in terms of the conventional undergraduate curriculum, would make them difficult to differentiate between. However, relative turnover frequency calculations indicate that a single (cyclization first) pathway dominates. Matthew R. Siebert is an assistant professor in the Department of Chemistry. Jeremy Hines is nearing completion of a master's degree and is seeking admission to a PhD program. Jesse Eason received her bachelor's degree from Missouri State University in spring 2014 and works as a technical writer. This work was supported by XSEDE (grant number TG-CHE150070) as well as Missouri State University's Graduate College, College of Natural and Applied Sciences, and the Department of Chemistry.

Hinsa-Leasure SM, Nartey Q, Vaverka J, Schmidt MG.Copper Alloy Surfaces Sustain Terminal Cleaning Levels in a Rural Hospital. *American Journal of Infection Control*. 2016; 44: 11: 195–203. doi: 10.1016/j.ajic.2016.06.033. (Grinnell College)

This study demonstrated that patients in rooms with high touch copper alloy surfaces are exposed to substantially fewer bacteria than patients in rooms with standard surfaces. It also highlighted the ability of copper alloy surfaces to maintain bacterial loads at or near cleanliness standards following terminal cleaning of the hospital room. In other words, copper is key to protecting newly admitted patients from contracting infections and is an integral part of an effective infection-control strategy. Shannon Hinsa-Leasure is an associate professor of biology at Grinnell College, and Michael G. Schmidt is professor and vice chairman of microbiology and immunology at Medical University of South Carolina. Queenster Nartey received her BA in biological chemistry from Grinnell College in 2016; she is working in a government lab and is in the process of applying to medical and graduate programs. Justin Vaverka is a medical student at the University of Iowa. Funding for this work was provided by a Grinnell College competitive grant awarded to Hinsa-Leasure.

Bilger D, Sarkar A, Danesh C, Gopinadhan M, Braggin G, Figueroa J, Pham TV, Chun D, Rao Y, Osuji CO, Stefik M, Zhang SJ. Multi-Scale Assembly of Polythiophene-Surfactant Supramolecular Complexes for Charge Transport Anisotropy. *Macromolecules*. 2017; 50: 1047–1055. doi: 10.1021/acs.macromol.6b02416. (California Polytechnic State University–San Luis Obispo)

The present study examined multiscale assembly of poly(3-alkylthiophene)s complexed with various alkyl-chain surfactant architectures in dilute and concentrated solutions. In dilute solutions, the complexes undergo a coil-to-rod transition with an intramolecular mechanism. In concentration solutions, the complexes exhibit an isotropic-to-liquid crystal transition yielding hexagonally ordered microstructures. The sheared films from liquid crystalline phases display a four times faster charge transport along the backbone alignment direction than the perpendicular direction. Shanju Zhang is an assistant professor of chemistry, David Bilger is a senior, Jose Figueroa is a junior, Danielle Chun is a senior, and Thanh Vy Pham is a visiting student in the Department

of Chemistry and Biochemistry at California Polytechnic State University–San Luis Obispo. Morgan Stefik is an assistant professor and Amrita Sarkar is a graduate student in the Department of Chemistry and Biochemistry at the University of South Carolina. Cameron Danesh is pursuing doctoral study at the University of California at Los Angeles, Gregory Braggin is working at LAM Research Corp., and Yashas Rao is a research assistant at the SLAC National Accelerator Laboratory. Chinedum O. Osuji is associate professor of chemical and environmental engineering and Manesh Gopinadhan is an associate research scientist at Yale University.

Dozier H, Perry, J. Androids Armed with Poisoned Chocolate Squares: Ideal Nim and Its Relatives. *Mathematics Magazine*. 89: 4: 235–250. doi: 10.4169/math.mag.89.4.235. (University of Southern Mississippi)

The authors describe two new combinatorial games. The first, Ideal Nim, both generalizes the well-known game Nim and its relative Chomp, and provides a recreational perspective on some important ideas of commutative algebra; for instance, the fact that the game is guaranteed to end is equivalent to Dickson's lemma, a well-known fact of commutative algebra. This relationship leads to a game-based proof of Dickson's lemma. The second game, Gröbner Nim, is really a variant of Ideal Nim that illustrates Buchberger's algorithm to compute a Gröbner basis. The authors conclude by describing the relationship between Gröbner Nim and polynomial rings. John Perry is an associate professor of mathematics. Haley Dozier worked on the project from 2013 to 2014 and presented her work at the annual meeting of the LA/MS Section of the Mathematical Association of America. She graduated from University of Southern Mississippi in 2015 with a major in mathematics, completed a master's degree in mathematics at the university, and is pursuing doctoral-level study in computational science at Southern Miss. The work was supported by an Eagle SPUR grant from the Drapeau Center for Undergraduate Research at the University of Southern Mississippi.