IGB NEWS

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Image Of The Month
Research News
Department Announcements

Volume 12 Number 2

UPCOMING EVENTS

IGB Seminar (ACPP)

Intratumoral Immunotherapy: Occam's Pharmacokinetics

March 26, 2019, 12:00 p.m.
Charles G. Miller Auditorium Room
B102 Chemical & Life Sciences Building
601 South Goodwin Avenue

K. Dane Wittrup, PhD
MIT, Departments of Chemical Engineering and Biological Engineering

Lunch with the Core

RNA-Mediated Gene Regulation, One Molecule at a Time

March 27, 2019, 12:00 p.m.
612 Carl R. Woese Institute for Genomic Biology

Jingyi Fei
Assistant Professor, Department of Biochemistry and Molecular Biology, University of Chicago

Campus-Wide Computational Biology Brown Bag Seminar Series

More Powerful Association Testing Using Large-Scale Genomic Mediators

March 29, 2019, 12:00 p.m.
1040 NCSA

Dave Zhao, PhD
Department of Statistics, University of Illinois

Pioneers in Genomic Biology Seminar

CRISPR: From Obscure Immune Systems to Disruptive Genome Editing Technologies

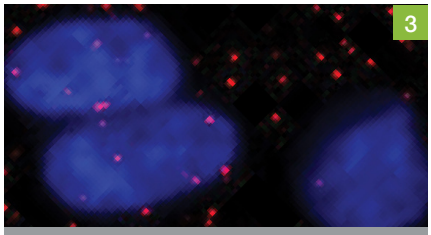
April 2, 2019, 12:00 p.m.
612 Carl R. Woese Institute for Genomic Biology

Rodolphe Barrangou, PhD
North Carolina State University, Department of Food, Bioprocessing and Nutrition Sciences

FEATURED NEWS

2

Siberian Miscanthus plants temperature performance

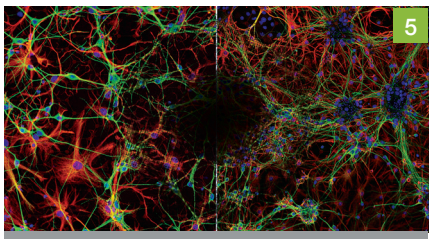


3

Illinois researchers are first to count growth factors in single cells

4

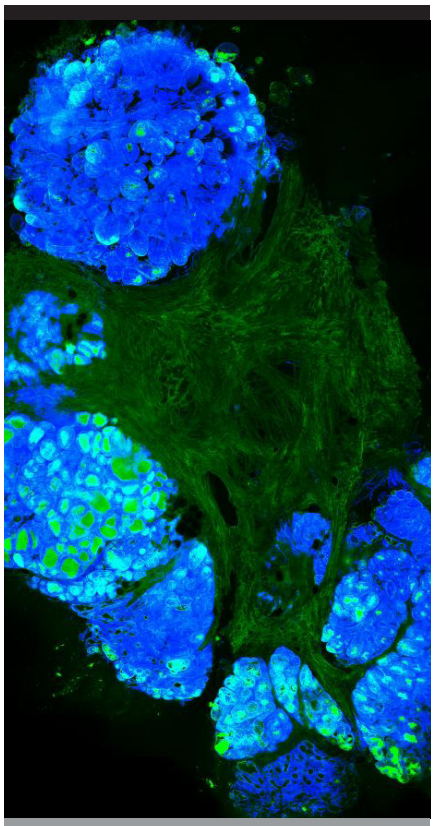
Monthly Profile: Will Montgomery



5

On the Grid: Happenings at IGB

IMAGE OF THE MONTH



This month features an image of bovine mammary gland tissue, which is cleared with the SWITCH Tissue Clearing technique and immunolabeled with a pan cytokeratin antibody that labels the entire ductal network. The image was acquired using the Tiling and Stitching Module with the Zeiss LSM 710. Image provided by Kingsley Boateng, Sr. Research Specialist, IGB Core Facilities, and Dylan Sweetman, Principal Scientist, GTR-Livestock Wellness and Performance Zoetis.

IGB News

Share your news with the IGB. Send ideas on stories, articles, and features to *nvasi@illinois.edu*.

FEATURE

When temp drops, Siberian Miscanthus plants surpass main bioenergy variety

Photosynthesis drives yields, but in cold conditions, this process that turns sunlight into biomass takes a hit. *Miscanthus* is a popular, sustainable, perennial feedstock for bioenergy production that thrives on marginal land in temperate regions. A new study in GCB Bioenergy from the University of Illinois and Aarhus University assessed *Miscanthus* collected on a Siberian expedition to identify three new accessions (a term for plants collected from a particular area) with exceptional photosynthetic performance in chilling temperatures that outstrip the industry favorite.

"When an arctic vortex hits, we have the luxury to bundle up and stay indoors," said Stephen Long (BSD/CABBI/GEGC), the Ikenberry Endowed University Chair of Crop Sciences and Plant Biology at IGB. "*Miscanthus* stays in the ground year-round, and in the spring, regrows from belowground stems to produce biomass that can be turned into a sustainable source for bioenergy and bioproducts —but to survive, it has to withstand and remain productive in a wide range of weather conditions including chilling temperatures between 15 – 0 °C [59 - 32 °F]."

Today, a sterile clone of the hybrid of *Miscanthus sacchariflorus* and *Miscanthus sinensis* called *Miscanthus x giganteus* 'Illinois' is considered one of the best bioenergy feedstocks available due to its ability to thrive on marginal land, withstand chilling temperatures, and produce 59 percent more biomass than corn. Its sterility prevents it from producing viable seed and becoming invasive but also means it cannot be used to breed new lines. This requires new hybridizations of the parent lines, which provides the opportunity to add more chilling tolerance.

Scientists from Illinois, the U.S. Department of Agriculture, and Russia's N.I. Vavilov Research Institute of Plant Industry (VIR) led an expedition to Eastern Siberia, the coldest region where *Miscanthus* grows, to find wild populations of *M. sacchariflorus* that could be used to breed improved *M. x giganteus* hybrids. In this study, the team winnowed down 181 Siberian *Miscanthus* accessions to the top three that photosynthesized better than *M. x giganteus* during chilling.

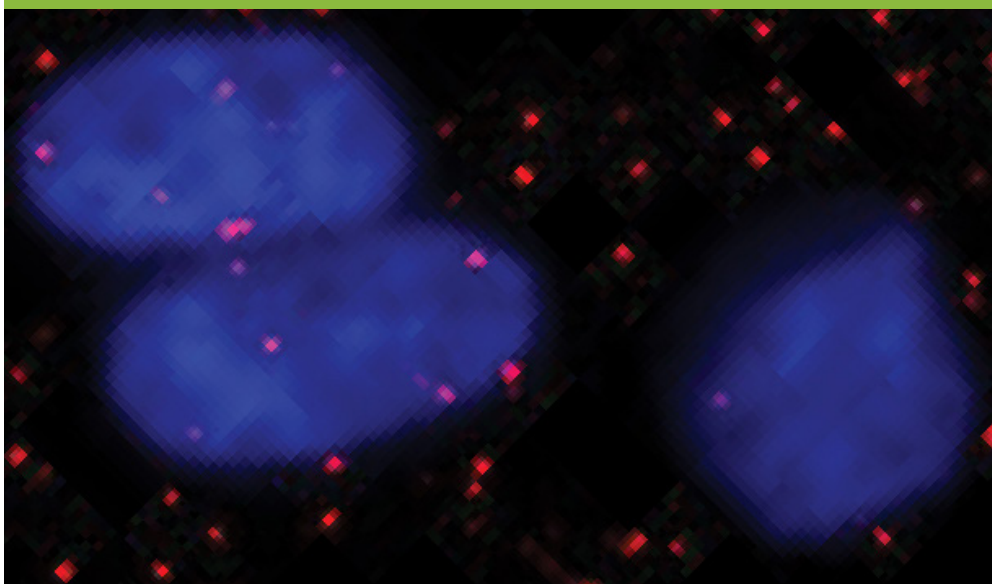
(above) In Eastern Siberia, Professor Erik Sacks collected cultivars of Miscanthus—a popular, low-input, perennial bioenergy feedstock. A new study from the University of Illinois found three Miscanthus plants that have exceptional photosynthetic performance in chilling temperatures, which will be used to breed improved varieties.

"*M. x giganteus* has been touted as having exceptional photosynthetic cold tolerance compared to other species such as corn," said first-author Charles Pignon, a postdoctoral researcher at Illinois, who led this work. "We were excited to find other accessions that did so much better at low temperatures."

In fact, one cultivar photosynthesized 100 percent more efficiently, or double the rate of *M. x giganteus*. Over a two-week period of chilling temperatures, *M. x giganteus'* photosynthetic rates dropped precipitously, but a second cultivar maintained stable photosynthesis, which could make it better adapted to long cold spells. When temperatures were increased after two weeks of chilling, a third cultivar could quickly recover photosynthesis—a trait that could maximize photosynthesis during the early spring when temperatures fluctuate.

"Now I am working on breeding these highly cold-tolerant accessions with other forms of *Miscanthus* in order to form new hybrid cultivars that hopefully will be more effective, productive, and resilient in the field," said co-author Erik Sacks, an associate professor of crop sciences in the College of Agricultural, Consumer and Environmental Sciences at Illinois. "But the ultimate goal of our work is to provide consumers with a sustainable, plant-derived source of energy."

Written by Claire Benjamin. Photo by Erik Sacks.



Illinois researchers are first to count growth factors in single cells

Whether healthy or diseased, human cells exhibit behaviors and processes that are largely dictated by growth factor molecules, which bind to receptors on the cells. For example, growth factors tell the cells to divide, move, and when to die—a process known as apoptosis.

When growth factor levels are too high or too low, or when cells respond irregularly to their directions, many diseases can result, including cancer. "It is believed that cells respond to growth factors at extreme levels of sensitivity," said University of Illinois Bioengineering Associate Professor Andrew Smith (ONCPM). "For example, a single molecule will result in a major change in cell behavior."

In a recent paper published in *Nature Communications*, Smith reported the invention of a new technology platform that digitally counts, for the first time ever, the amount of growth factor entering an individual cell. Prior to this, researchers inferred growth factor binding based on how the receiving cells responded when the growth factor molecules were introduced.

"We showed the first direct cause-and-effect relationships of growth factors in single cells," he said. "We expect the outcomes to lead to a new understanding of cell signaling, how cells respond to drugs, and why cell populations become resistant to drugs, particularly toward improved treatments for cancer."

Smith's technology platform tags each growth factor with a single engineered (10 nanometer) infrared fluorescent quantum dot, which can then be viewed using a three-dimensional microscope. In their study, they counted how many epidermal growth factor (EGF) molecules bound to human triple-negative breast cancer cells that were pre-patterned on island-like surfaces.

EGF molecules typically signal cell division and lead to tissue growth. Numerous cancers have mutations in their EGF receptors.

"This finding is significant as it means that signaling molecules present in the cancer cells' tumor—a place where signaling molecules are often misregulated—can enhance the cancer cells' resistance to pharmaceutical agents."

"We used quantum dots as the fluorescent probe because they emit a lot more light compared to other conventional fluorescent probes such as organic dyes, and we can tune their wavelengths by changing their chemical composition," said Bioengineering doctoral student Phuong Le, the lead author of the paper. "In our study, we demonstrated that quantum dots emitting light in the near-infrared wavelength allowed the most accurate counting of growth factors binding to cells."

According to Le, the team also treated the breast cancer cells with quantum dot-tagged EGF in the absence and presence of pharmaceutical drugs that inhibit EGF signaling in cells. "We found that the amount of EGF binding is inversely proportional to drug efficacy," Le said. "This finding is significant as it means that signaling molecules present in the cancer cells' tumor—a place where signaling molecules are often misregulated—can enhance the cancer cells' resistance to pharmaceutical agents."

In addition to Smith and Le, other research contributors to this study include Illinois Molecular and Integrative Physiology Professor Hee Jung Chung and graduate student Brian Baculis, who conducted molecular biology confirmation studies; former Illinois Postdoctoral Researcher Sung Jun Lim, who performed quantum dot synthesis; and University of New South Wales Professor Kristopher Kilian, who designed the micro contact printing process for the cell islands.

This work was funded by the National Institutes of Health and the University of Illinois at Urbana-Champaign.

Recently, Smith and Bioengineering Assistant Professor Pablo Perez-Pinera (ACPP) received more than $1 million in funding from the National Institutes of Health to further expand Smith's novel technology with new cell engineering tools and image analysis software. The goal of their R01 grant will be to develop a quantitative analysis platform for single-cell signaling through growth factors and cytokines. ■

Written by Laura Schmitt. Photo by Andrew Smith.

MONTHLY PROFILE

Will Montgomery is an IGB Postdoctoral Fellow and a member of the Anticancer Discovery from Pets to People research theme. His research aims to develop novel chemotherapeutics for the treatment of cancer in companion animals, with the future goal of translating successful treatments to human clinical trials.

Will Montgomery

A chemist ventures into new fields in the fight against cancer

Will Montgomery (ACPP) does not have a neat and tidy story about the development of his research interests. The progression of research that led him away from his colleagues and chemistry and into the world of cancer biology was governed by curiosity and talent rather than a preconceived plan.

"I kept doing what I was good at and I ended up here," Montgomery said. "It's kind of this roundabout way ... it was this bob and weave."

Montgomery discovered his love and facility for chemistry in high school, but did not consider a career in scientific research until near the end of his undergraduate stint at Dartmouth College. As a collegiate football player, Montgomery was enthusiastic about staying on campus over the summer and decided to take care of some course credit requirements by conducting an independent research project in the laboratory of organic chemist Gordon Gribble, for whom he had been working.

"[I thought] I kind of enjoy it, it comes naturally," Montgomery said, describing his first impression of independent research. "My advisor said, you should consider writing an honors thesis ... you should also look at grad school, and I said yeah, that's a great idea."

He matriculated to the University of Texas at Austin for his graduate degree, embarking on a medicinal chemistry project to synthesize and characterize anticancer compounds. His thesis advisor, Stephen Martin, connected Montgomery with a former lab member, present University of Illinois Professor of Chemistry Paul Hergenrother (ACPP Theme Leader/MMG). Montgomery began a collaboration with Hergenrother that drew him further into the development of new pharmaceuticals for cancer treatment.

As Montgomery grew more intrigued by the biological side of cancer pharmacology, he found himself venturing further from the traditional boundaries of his laboratory's work and into the life sciences.

"I got interested in cancer research in chemical biology in the last year of my PhD when Paul's student was working on the project graduated ... which meant I had to learn how to do cell culture," Montgomery said. "I just started learning the biology."

During that time, he began taking cancer biology classes and attending conferences through his fund-

> *"This is the future of science, this is the future of cancer therapy, so how can we as chemists work with this? Ever since then, that's something that I've been fascinated by, is how can you, with a chemist's background, work with the immune system to treat cancer."*

ing organization, the Cancer Prevention and Research Institute of Texas. He was inspired by a guest lecture by James Allison, a renowned immunologist who has since been awarded the Nobel Prize in Medicine for his ground-breaking work in cancer immunotherapy.

"This is how I became interested in immunology," Montgomery said. "This is the future of science, this is the future of cancer therapy, so how can we as chemists work with this? Ever since then, that's something that I've been fascinated by, is how can you, with a chemist's background, work with the immune system to treat cancer."

Moving to Illinois to join Hergenrother's laboratory and the Anticancer Discovery from Pets to People research theme landed Montgomery in a fruitful environment for weaving together the skills and concepts from each stage of his academic career: his grounding in chemistry, his investment in cancer drug discovery, and the inspiration provided by the early successes of immunotherapies. As an IGB Fellow, he has enjoyed the opportunity to connect with experts in different areas and gain new perspective on his work. Applying a systems biology approach to cancer drug discovery has also broadened his view.

"You have to look at things in a holistic manner, in the way that a drug interacts with a complex system," Montgomery said. "Some of the drugs that look best in the clinic are the drugs that work with the immune system. And so there's this unrealized component of drug efficacy, that twenty years ago people weren't paying any attention to, and we just serendipitously empirically selected the drugs that worked. It's the key takeaway I've gotten from this, is that things are always more complicated than we appreciate, and that there's a lot of things that contribute to an effective drug that you could never fully appreciate."

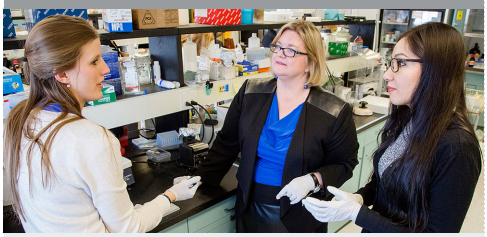
Montgomery's work at Illinois has focused in part on examining the immune system activity of an anticancer agent discovered in the Hergenrother laboratory, PAC-1, which was successfully used to treat malignant brain cancers in pet animals and is now in human clinical safety trials. He believes that efforts like this one are part of a major turning point in the development of more effective cancer therapies.

"If you understand why something works, you can better understand why it doesn't work, or in what situations it will work better," he said. "Cancer is a fascinating and complex disease that we're only really just even now just scratching the surface of ... on the treatment side, we've definitely reached an inflection point; we've been developing new chemotherapies and targeted therapies, and we've gotten to a certain level, and now that we've gotten into the realm of immunotherapy and effective immunopathology, it's a breakaway." ■

Written by Claudia Lutz. Photo by Kathryn Faith.

ON THE GRID
HAPPENINGS AT THE IGB

AWARD



SHARON DONOVAN NAMED TO 2020 DIETARY GUIDELINES ADVISORY COMMITTEE

Sharon Donovan (MME, above middle), a professor of nutrition and the Melissa M. Noel Endowed Chair in Nutrition and Health at the University of Illinois, has been appointed to the USDA's 2020 Dietary Guidelines Advisory Committee. The appointments include 20 nationally recognized scientists to serve on the committee to ensure America's dietary guidance reflects the latest science.

"Sharon Donovan's contribution to pediatric nutrition research is advancing our understanding of some of the most pressing health issues for children and families," said Kim Kidwell, dean of the College of Agricultural, Consumer and Environmental Sciences at Illinois. "I am thrilled that she has been appointed to this committee and I know that her participation in informing dietary guidelines for Americans will help to improve lives."

FACILITIES & SERVICES

PERSONAL PACKAGES

Please note the following policy from our Facilities & Services department: Shipping and receiving of personal packages to the Carl R. Woese Institute for Genomic Biology is prohibited, only items associated with University projects or research may be shipped or received.

NEW ARRIVAL

UWE RUDOLPH

Professor Uwe Rudolph has joined the IGB as an affiliate member in the Gene Networks in Neural and Developmental Plasticity (GNDP) Research Theme. Dr. Rudolph recently became the Head of the Department of Comparative Biosciences in the College of Veterinary Medicine. He previously served as the Director of the Laboratory of Genetic Neuropharmacology at McLean Hospital in Belmont, Massachusetts and as a Professor at Harvard Medical School.

BLOOD DRIVE

BLOOD DRIVE

DONATE BLOOD

Community Blood Services of Illinois will be holding another blood drive at IGB. Please consider a donation by stopping by or contacting Erin Johnson at eejohns@illinois.edu.

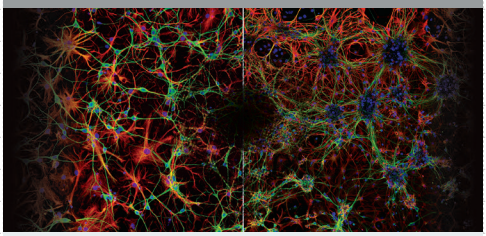
Monday, April 22
9:00a.m. to 12:00p.m.
612 IGB Conference Center

SEMINAR

LESLIE VOSSHALL TO SPEAK AT IGB DISTINGUISHED PUBLIC LECTURE

Dr. Leslie B. Vosshall, Robin Chemers Neustein Professor at The Rockefeller University and Howard Hughes Medical Institute Investigator will give her lecture "Thirst for Blood: Mosquito Neurobiology and Behavior" at Alice Campbell Alumni Center on April 9th, 2019. Reception will begin at 4:00 p.m., with the lecture commencing at 5:00 p.m.

OPENING



ART OF SCIENCE 9.0 OPENING RECEPTION

The Carl R. Woese Institute for Genomic Biology's Art of Science program is a celebration of common ground between science and art. This year's exhibit centers around a theme of comparisons. To compare is to take the time to observe, consider, read, and even measure similarities and differences. By building comparisons into this year's show we hope to invite you into a mode of perception that can reveal the beautiful work of science at the IGB.

Opening Reception
April 25th 5:00–8:00pm
Springer Cultural Center
301 N Randolph St, Champaign, IL 61820
Refreshments Provided

RECENT PUBLICATIONS

Please include your connection to the IGB in your author byline when submitting publications, as it will greatly help track potential newsworthy items and increase the possibility of coverage.

Ding, J., Johnson, J., Chu, Y. F., & Feng, H. (2019). Enhancement of γ-aminobutyric acid, avenanthramides, and other health-promoting metabolites in germinating oats (*Avena sativa L.*) treated with and without power ultrasound. *Food Chemistry*, 283, 239-247. https://doi.org/10.1016/j.foodchem.2018.12.136

Lichiheb, N., Myles, L. T., Personne, E., Heuer, M., Buban, M., Nelson, A. J., ... Bernacchi, C. (2019). Implementation of the effect of urease inhibitor on ammonia emissions following urea-based fertilizer application at a Zea mays field in central Illinois: A study with SURFATM-NH 3 model. *Agricultural and Forest Meteorology*, 269-270, 78-87. https://doi.org/10.1016/j.agrformet.2019.02.005

Phadera, L., Michelson, H. C., Winter-Nelson, A. E., & Goldsmith, P. D. (2019). Do asset transfers build household resilience? *Journal of Development Economics*, 138, 205-227. https://doi.org/10.1016/j.jdeveco.2019.01.003

Tannous, P. J., Peddada, S. R. T., Allison, J., Foulkes, T., Pilawa-Podgurski, R. C. N., & Alleyne, A. G. (2019). Model-based temperature estimation of power electronics systems. *Control Engineering Practice*, 85, 206-215. https://doi.org/10.1016/j.conengprac.2019.01.006

Roch, S., Nute, M., & Warnow, T. (2019). Long-Branch Attraction in Species Tree Estimation: Inconsistency of Partitioned Likelihood and Topology-Based Summary Methods. *Systematic biology*, 68(2), 281-297. https://doi.org/10.1093/sysbio/syy061

Krichels, A., Delucia, E. H., Sanford, R. A., Chee-Sanford, J., & Yang, W. (2019). Historical soil drainage mediates the response of soil greenhouse gas emissions to intense precipitation events. *Biogeochemistry*, 142(3), 425-442. https://doi.org/10.1007/s10533-019-00544-x

Goldsmith, P., Andrade, J., Cornelius, M., Asigbee, M., Atim, P., & Tamimie, C. (2019). National School Lunch Nutrition and Cost Profile: A Case Study of the Ghana School Feeding Programme. *Food and Nutrition Bulletin*, 379572119825960. https://doi.org/10.1177/0379572119825960

Masonbrink, R., Maier, T. R., Muppirala, U., Seetharam, A. S., Lord, E., Juvale, P. S., ... Baum, T. J. (2019). The genome of the soybean cyst nematode (*Heterodera glycines*) reveals complex patterns of duplications involved in the evolution of parasitism genes. *BMC genomics*, 20(1), [119]. https://doi.org/10.1186/s12864-019-5485-8

Zhang, Q., Rao, S., & Warnow, T. (2019). Constrained incremental tree building: New absolute fast converging phylogeny estimation methods with improved scalability and accuracy. *Algorithms for Molecular Biology*, 14(1), [2]. https://doi.org/10.1186/s13015-019-0136-9

Kosuge, T., Zhu, X., Lau, V. M., Aoki, D., Martinez, T. J., Moore, J. S., & Otsuka, H. (2019). Multicolor Mechanochromism of a Polymer/Silica Composite with Dual Distinct Mechanophores. *Journal of the American Chemical Society*, 141(5), 1898-1902. https://doi.org/10.1021/jacs.8b13310

Rivera, M., Cealie, M. K., Hauber, M. E., Kleindorfer, S., & Liu, W. C. (2019). Neural activation in response to conspecific songs in zebra finch (*Taeniopygia guttata*) embryos and nestlings. *NeuroReport*, 30(3), 217-221. https://doi.org/10.1097/WNR.0000000000001187

Sweedler, J. V. (2019). The Evolving World of Scientific Publications: From Unethical Behaviors to New Mandates from Funding Agencies. *Analytical Chemistry*, 91(3), 1673-1674. https://doi.org/10.1021/acs.analchem.9b00332

Kosik, I., Angeletti, D., Gibbs, J. S., Angel, M., Takeda, K., Kosikova, M., ... Yewdell, J. W. (2019). Neuraminidase inhibition contributes to influenza A virus neutralization by anti-hemagglutinin stem antibodies. *The Journal of experimental medicine*, 216(2), 304-316. https://doi.org/10.1084/jem.20181624

Weber, L. A., & Phillips, H. (2019). Congenital cleft sternum with diaphragmatic hernia and radial hemimelia in a kitten. *Veterinary Record Case Reports*, 7(1), [e000472]. https://doi.org/10.1136/vetreccr-2017-000472

Robertson, H. M., Robertson, E. C. N., Walden, K. K. O., Enders, L. S., & Miller, N. J. (2019). The chemoreceptors and odorant binding proteins of the soybean and pea aphids. *Insect Biochemistry and Molecular Biology*, 105, 69-78. https://doi.org/10.1016/j.ibmb.2019.01.005

Liu, W., Cui, Y., Ren, W., & Irudayaraj, J. M. K. (2019). Epigenetic biomarker screening by FLIM-FRET for combination therapy in ER+ breast cancer. *Clinical Epigenetics*, 11(1), [16]. https://doi.org/10.1186/s13148-019-0620-6

King, A. M., Vanderpool, C., & Degnan, P. H. (2019). sRNA Target Prediction Organizing Tool (SPOT) Integrates Computational and Experimental Data To Facilitate Functional Characterization of Bacterial Small RNAs. *mSphere*, 4(1). https://doi.org/10.1128/mSphere.00561-18

Li, Z., Seo, Y., Aydin, O., Elhebeary, M., Kamm, R. D., Kong, H. J., & Taher Saif, M. A. (2019). Biohybrid valveless pump-bot powered by engineered skeletal muscle. *Proceedings of the National Academy of Sciences of the United States of America*, 116(5), 1543-1548. https://doi.org/10.1073/pnas.1817682116

Wang, Y., Hua, X., Xu, J., Chen, Z., Fan, T., Zeng, Z., ... Zhang, J. (2019). Comparative genomics revealed the gene evolution and functional divergence of magnesium transporter families in *Saccharum*. *BMC Genomics*, 20(1), [5437]. https://doi.org/10.1186/s12864-019-5437-3

Bobeica, S. C., Dong, S. H., Huo, L., Mazo, N., McLaughlin, M. I., Jiménez-Osés, G., ... van der Donk, W. A. (2019). Insights into AMS/PCAT transporters from biochemical and structural characterization of a double Glycine motif protease. *eLife*, 8. https://doi.org/10.7554/eLife.42305

ILLINOIS

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