IGB NEWS

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Image Of The Month

Research News

Department Announcements

Volume 12 Number 6

UPCOMING EVENTS

IGB Seminar - GNDP

Genetic Studies of Autism Spectrum Disorders: Family-based Approach

October 22, 2019, 12:00 p.m.

612 Carl R. Woese Institute for Genomic Biology

Maja Bucan, PhD

University of Pennsylvania Perelman School of Medicine

Professor, Department of Genetics

Special Seminar

Life Innovates, Biology Integrates: A Vision for the Biological Sciences

October 23, 2019, 4:00 p.m.

612 Carl R. Woese Institute for Genomic Biology

Dr. Joanne Tornow

Assistant Director for Biological Sciences, National Science Foundation

Reception immediately following, sponsored by the Catherine and Don Kleinmuntz Center for Genomics in Business and Society

IGB Pioneers Seminar - GNDP

Charting the Genotype-Phenotype Map: Lessons From Drosophila

October 29, 2019, 12:00 p.m.

612 Carl R. Woese Institute for Genomic Biology

Trudy Mackay, PhD

Clemson University

Professor, Department of Genetics and Biochemistry

LAS Dean's Distinguished Lecture

Earth BioGenome Project: Sequencing Life for the Future of Life

October 29, 2019, 400 p.m.

Natural History Building Auditorium (room 228), 1301 W. Green St., Urbana

Gene E. Robinson

Swanlund Chair of Entomology & Neuroscience

Department of Entomology

Director, Carl R. Woese Institute for Genomic Biology

A reception for faculty, staff, and grad students will follow in the NHB Core (room 319)

FEATURED NEWS

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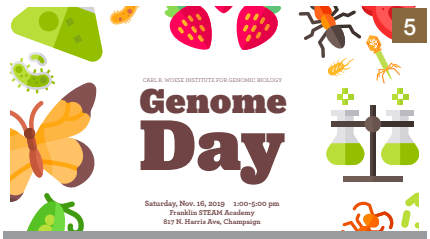
New theme takes closer look at protection of genomic data

3

Pineapple sequences hint at plant domestication in single step

4

Monthly Profile: Aleksander Ksiazkiewicz



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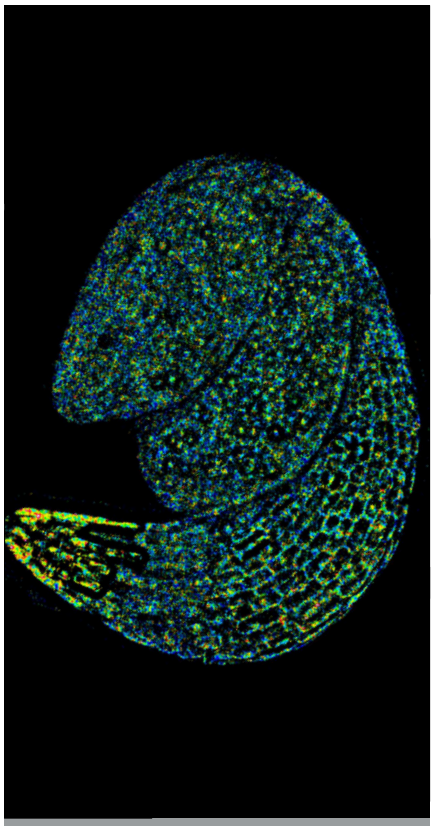
On the Grid: Happenings at IGB

IMAGE OF THE MONTH



This month features the visualization of glucose distribution within an embryo of Arabidopsis during germination, using a FRET glucose sensor. Image courtesy of Ya-Chi Yu from Li-Qing Chen Lab, Department of Plant Biology.

IGB News

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

New IGB research theme takes closer look at protection of genomic data

Genomic technologies have the power to transform individual healthcare for the better. But with that power comes responsibility—the responsibility to protect the privacy of the individual and to make ethical choices that respect the rights of communities and populations.

A newly established research theme at the Carl R. Woese Institute for Genomic Biology will address these and related issues. The new theme, Genomic Security and Privacy (GSP), will be led by Professor of Computer Science Carl Gunter. Assistant Professor of Political Science Aleksander Ksiazkiewicz will lead policy-based work within the theme.

"As the methods get cheaper to produce sequencing data . . . people are going to be a lot more concerned," Gunter said. "Going back ten years ago when it cost hundreds of millions of dollars to sequence something, it wasn't really that much of a concern, whether the data might be captured . . . but now, it seems like every time you turn around, there's some new security- or privacy-related concern."

Gunter and Ksiazkiewicz represent the two-pronged approach that the theme will take, simultaneously pursuing the identification of privacy concerns and development of strategies in the arenas of technology and policy. For example, genomic data collected in a medical setting could be vulnerable to the same cybersecurity risks that threaten other forms of personal data; however, unique formats for genomic data storage could lend themselves to unique, optimal data security solutions. Similarly, well-designed policy surrounding genomic data privacy should take into account the unique societal implications of such data, including genomic information that is shared across related individuals.

The theme's work will be strengthened by the interdisciplinarity of its research team, which already includes researchers with backgrounds in computational genomics, electrical and computer engineering, nutrition, anthropology, business, and law.

"One of the things I'm most excited about, having people from so many different disciplines, is being able to draw on the expertise that they have . . . finding interesting intersections that we wouldn't find if we were just holed up in our own offices, distributed around campus," Ksiazkiewicz said.

> *"As the methods get cheaper to produce sequencing data . . . people are going to be a lot more concerned."*

As the new theme ramps up activities, Gunter and other members have continued to play a role in related events around campus, including a recent NIH workshop on issues of equity and diversity in genomics and a TEDxUIUC talk by Gunter highlighting the urgency and everyday relevance of genomic privacy and security issues.

"The Golden State Killer is a pretty good example of what's in the wind. These direct to consumer [sequencing services] collect millions of data points, and those data points are enough that you can triangulate from them to find the name associated with anybody's DNA if they're of European descent," Gunter said. "Big attention will need to be paid to the security and privacy of genomic data."

Genomic Security and Privacy research theme membership:

Carl Gunter
(Theme Lead and Technology Lead; Department of Computer Science)

Aleksander Ksiazkiewicz
(Policy Lead; Department of Political Science)

Mikel Hernaez
(Director, Computational Genomics, Carl R. Woese Institute for Genomic Biology) (CGRH)

Zbigniew Kalbarczyk
(Department of Electrical and Computer Engineering)

Zeynep Madak-Erdogan
(Department of Food Science and Human Nutrition) (ONC-PM)

Ripan Malhi
(Department of Anthropology) (CGRH/GNDP/IGOH/RBTE)

Michael Shaw
(Gies College of Business)

Saurabh Sinha
(Department of Computer Science) (BSD/CABBI/GNDP)

Robin Wilson
(College of Law) ■

Written by Claudia Lutz.

Pineapple genome sequences hint at plant domestication in single step

As their Latin name indicates, pineapples are truly "excellent fruits"—and thanks to a freshly completed genome sequencing project, researchers have gained a new understanding of how human agriculture has shaped the evolution of this and other crops.

An international team led by University of Illinois Professor of Plant Biology Ray Ming (GEGC) published their analysis of the genome of the red pineapple, a plant grown for fiber production and as an ornamental, in Nature Genetics. They also examined new sequence data for other key cultivars of pineapple grown for fruit, leading to new insights into the genetic responses of the plant to centuries of domestication and cultivation. In particular, the work supported the hypothesis that domestication of crops that are propagated without using seeds, through cuttings or other means, can be domesticated in a single step.

"We have chosen major pineapple cultivars worldwide . . . to test our hypothesis of 'one-step operation' in domestication of clonally propagated crops," Ming said. He highlighted this aspect of the researchers' work as one of the primary goals of the study.

Pineapples are a little bit exotic yet pleasingly familiar; large, spiky fruits with sweet, juicy yellow flesh. The newly sequenced variety of this study, Ananas comosus var. bracteatus, is different from this standard grocery store variety. It produces a small fruit that is not suitable for consumption and is grown in gardens for decoration or to form a security hedge. Unlike many cultivars of pineapple, it is able to self-pollinate.

Ming and his colleagues sequenced and assembled the red pineapple genome, using the genome of previously sequenced fruit pineapple as a reference and comparator. They also re-sequenced the genomes of 89 pineapple accessions (samples of plant tissue) from multiple cultivars. By comparing similarities and differences in DNA sequence across different types of pineapple, they were able to trace how natural and artificial selection shaped key traits and established distinct varieties.

Pineapple plants can be grown from vegetative tissues, such as the leafy top of a fruit, a slip, or a sucker. The team hypothesized that for some cultivars, domestication might have been achieved in a single step—starting a variety with a cutting from a likely plant—rather than over years of breeding. They developed a novel bioinformatic method that looked for long strings of similar sequence at the ends of chromosomes.

"This work supported the hypothesis that domestication of crops that are propagated without using seeds, through cuttings or other means, can be domesticated in a single step."

"To our surprise and delight, extensive terminal runs of homozygosity [similarity] were detected in cultivar 'Singapore Spanish'," Ming said. He explained that this discovery was best explained by many years of exclusive clonal propagation: "One sexual recombination could interrupt terminal runs of homology formed over thousands of years. This novel method can be applied to study domestication history of other clonally propagated crops such as potato, sugarcane, cassava, banana, and many tree fruit crops."

Comparison across genomes also allowed Ming and his coauthors to identify genes that support traits distinguishing different cultivars. For example, differing activity levels of multiple genes appear to support higher leaf fiber production in the red pineapple, and the sweetness of a particular cultivar of fruit pineapple is likely related in part to selection on a particular sugar transporter gene. The study also yielded additional evidence for the involvement of certain genes in allowing or prohibiting self-pollination.

Overall, Ming said, he was most excited to find strong support for the idea that with clonal propagation, some plants were immediately and successfully domesticated.

"The co-existence of punctuated sexual reproduction and "one-step operation" in domestication of clonally propagated crops implies rapid domestication of clonally propagated crops is possible," he said. "One example is macadamia, and most macadamia cultivars in Hawaii were selected from seedlings of wild macadamia trees, just one generation away from the wild germplasm."

The work was supported by the Department of Science and Technology of Fujian Province, the National Natural Science Foundation of China, the Fuzhou Science and Technology, Fujian Agriculture and Forestry University, the Swiss National Science Foundation, and the National Science Foundation. ■

Written by Claudia Lutz. Photo by Ray Ming.

Aleksander Ksiazkiewicz is an assistant professor of political science. He leads policy-based work within the IGB's newest theme, Genomic Security and Privacy.

Aleksander Ksiazkiewicz

Tracing the heritage of the political animal

Careers in research are often grown from chance seeds of curiosity. Aleksander Ksiazkiewicz (GSP) traces his interest in the intersection of biology and political science back to the words of one of the earliest biologists.

"I did political science as an undergraduate . . . one of the things that stuck with me is this famous quote from Aristotle, that human beings are by nature political animals," Ksiazkiewicz said. "That animal component always interested me—what does it mean to be a political animal?"

Encouraged by reading and coursework, Ksiazkiewicz' curiosity about the biological side of social and political behavior developed further as he pursued first a master's degree and then a PhD in political science from Rice University. He realized that research in the area was undergoing a renaissance.

"I discovered for myself that biology and politics work, it's been going on for a long time . . . I ended up going in an empirical direction for my dissertation," Ksiazkiewicz said "My advisor guided me toward doing twin research."

As a visiting researcher with the Minnesota Center for Twin and Family Research, he worked with data from twin studies to discover a link between genetic factors, political affiliation, and cognitive style, a term that describes individual preferences for ways of engaging in thought. The results suggested that different cognitive styles are more likely to be found in those who identify as conservative or liberal, and that these differences in cognitive style and in political affiliation have a heritable component. The open question that continues to drive his research remains; what underlying mechanisms create this association?

"It's trying to fill in that black box, where is this genetic influence coming from?" Ksiazkiewicz said. "It's not that people are hardwired to be one way or another, politically, because of their genes . . . but it can be the case that people are sort of nudged one way or another, that it's more likely that given this set of personality traits that are influenced by genetics, or this set of risk-taking preferences, or whatever, that that's going to nudge you to be more liberal or more conservative."

At Illinois, Ksiazkiewicz' research has developed into three related areas: examining the relationship between genetics and political attitudes and behaviors; investigating the relationship between implicit cognition, or unconscious influences on behavior, and political decision-making; and exploring associations between sleep-wake behaviors and political affiliation and participation. When communicating about his work, he tries to help people connect with the nuances of estimating heritability of political behavior.

"It's trying to fill in that black box, where is this genetic influence coming from? It's not that people are hardwired to be one way or another, politically, because of their genes … "

"People get uncomfortable when you start talking about genes influencing whether you are more liberal or more conservative—it's totally choice, or it's socialized from my parents, that's why I'm a Democrat or a Republican," he said, alluding to common reactions. "But the data seem to indicate that across many countries and lots of different samples, young people, old people, that there's a heritable component, and so it's trying to figure out how that works . . . and that the heritable component itself is contingent upon the environment that you're in."

Most of his work is fundamental, shedding light on what drives individual behaviors without seeking to modify it. Ksiazkiewicz feels this kind of research can valuably inform how we collectively understand political dynamics in modern society, especially in divisive times.

"People have these predispositions, and so the reason that someone has a different view from you might be because they experience the world in a different way," he said. "Just because one group is more threat-sensitive or higher in some personality trait or another, doesn't mean that one of those perspectives is valid and the other is invalid . . . recognizing that your experiences of the world are also being mediated through this wetwork [of our bodies] means that we should be cautious about why we believe the things we believe and recognize that other people that we disagree with, there's a reason that they believe those things."

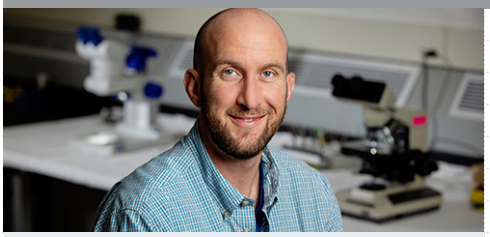
One area of Ksiazkiewicz' research that may eventually lead more directly to real-world applications comes through his new affiliation with the IGB via the establishment of a new theme, Genomic Security and Privacy. The theme has a dual focus on work in the realms of technology and policy innovation to better protect the genomic data of individuals in the era of direct-to-consumer DNA sequencing and precision medicine initiatives. Ksiazkiewicz will lead policy research for the new theme.

"I think that there's a lot of interesting intersections between what life scientists are doing and the computer scientists are doing in terms of securing data . . . the genome being relatively stable and a unique personal identifier and the privacy considerations that that raises," he said. "I'm just really excited, because I think there's a lot of potential directions that this new theme could develop in." ■

Written by Claudia Lutz. Photo by Bill Wiegand.

ON THE GRID
HAPPENINGS AT THE IGB

AWARDS



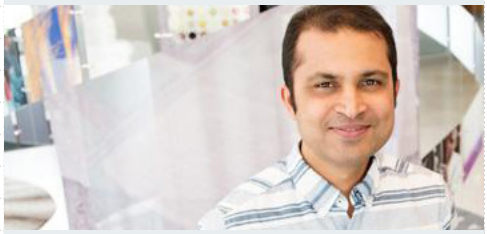
BRIAN ALLAN
Brian Allan, Associate Professor of Entomology (CGRH/IGOH), was named a University Scholar in recognition of excellence in teaching, scholarship and service.

TAYLOR CANADY
Taylor Canady, IGB Fellow (ONC-PM) received the Best Poster award at the 16th USA Korea Nanotechnology Forum, one of only three awarded.

NIGEL GOLDENFELD
Nigel Goldenfeld, Swanlund Endowed Chair and Center for Advanced Study Professor in Physics (BCXT leader/CGRH/GNDP), was awarded the Leo P. Kadanoff Award by the American Physical Society, which recognizes a scientist whose work (theoretical, experimental or computational) has opened new vistas for statistical and/or nonlinear physics.

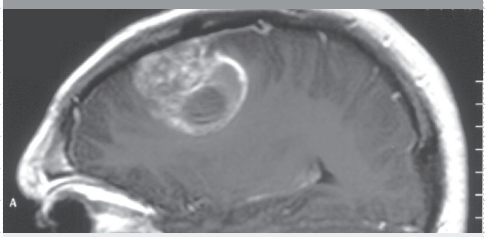
PAUL KENIS
Paul Kenis, Elio E. Tarika Endowed Chair and head of the Department of Chemical and Biomolecular Engineering (RBTE), was named Fellow of the Electrochemical Society for exceptional contributions to the invention, characterization and development of innovative processes based on microfluidic systems for diverse applications in electrochemical energy conversion, chemical synthesis, and biology.

RIPAN MALHI
Ripan Malhi, Professor of Anthropology (CGRH, GNDP, GSP, IGOH, RBTE) was named Director for Undergraduate Studies in the Department of Anthropology.



SAURABH SINHA
Saurabh Sinha, Professor and Willett Faculty Scholar of Computer Science (BSD, CABBI, GNDP, GSP) received a Maximizing Investigators' Research Award (MIRA) from the National Institutes of Health, which provides funds for the nation's most highly talented and promising investigators.

FUNDING



MULTI-THEME FUNDING FOR NEURODEGENERATIVE DISEASE RESEARCH
A testament to the collaborative nature of the IGB, additional funding has been established which stemmed from a donor's contribution to Alzheimer's research.

Friend of the IGB Scott Fisher initially donated to fund research on behalf of the Gene Networks in Neural & Developmental Plasticity and Regenerative Biology & Tissue Engineering themes. As a result of this seed funding, Professor of Cell and Developmental Biology Lisa Stubbs (GNDP theme leader) and Robert W. Schaefer Professor of Chemical and Biomolecular Engineering Brendan Harley (RBTE theme leader) were further funded by the National Cancer Institute within the National Institutes of Health. The project, titled "Biomimetic Hydrogel Niches to Study the Malignant Phenotype of Glioblastoma Multiforme," will use hydrogel systems in new ways to study neurodegenerative disease models, particularly Alzheimer's disease.

HALLOWEEN

IGB HALLOWEEN PARTY
Join us on Wednesday, October 30th from 4:00 to 6:00pm for the IGB Halloween party! IGB members and families welcome, come for great treats, fun costumes, and spooky activities on the IGB Concourse level.

ON THE GRID
HAPPENINGS AT THE IGB

RESEARCH

DRUG MAY REDUCE HEALTH BENEFITS OF EXERCISE

In a recent study published in *Aging Cell*, Assistant Professor of Kinesiology and Community Health Adam Konopka (RBTE) and colleagues at both Illinois and Oklahoma Medical Research Foundation found that a popular medication for those with Type 2 diabetes, Metformin, may prevent physical benefits during aerobic exercise that normally enhance the aging process. Their work was reported in The New York Times.

Metformin allows people with Type 2 diabetes to improve their blood-sugar control and insulin sensitivity, by reducing the amount of sugar released by the liver into the blood.

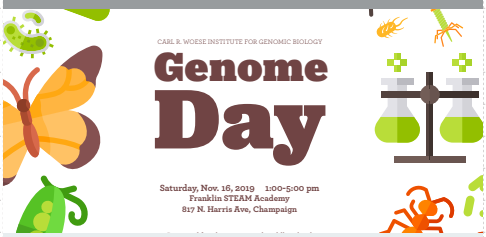
Animal subjects given metformin typically outlive those without the drug. These animal studies may suggest that the drug not only reduces blood sugar, it also reduces inflammation and produces other cellular effects that alter aging.

Researchers recruited more than 50 sedentary but otherwise healthy non-diabetic men and women in their early 60s. They measured current aerobic fitness, blood-sugar levels, insulin sensitivity and body mass, and took leg-muscle biopsies and randomly metformin or a placebo.

In comparing the groups, among other trends they noticed metformin had decreased the normal exercise-related gains in muscle-cell mitochondrial respiration.

Read the publication here. Text and photo from The New York Times.

EVENT



GENOME DAY

Join us for Genome Day! Designed for elementary and middle school children, all members of the community are welcome. Exhibits and activities will cover topics including the environment, energy use & production, health, and fundamental research at the IGB in an approachable manner for all ages. Free and open to the public.

Saturday, Nov. 16, 2019
1:00-5:00 pm Franklin STEAM Academy
817 N. Harris Ave, Champaign
Questions? Contact outreach@igb.illinois.edu

DEPARTMENT ANNOUNCEMENTS

COMMUNICATIONS

AUTHOR BYLINES

As the new semester we remind everyone the importance of including within the author byline both the home department and "Carl R. Woese Institute for Genomic Biology" whenever appropriate. We have a number of automated systems that track and archive publications by IGB faculty and affiliates, which are unable to do so if no reference to the IGB is made. We use these metrics when we present to campus, in our annual report and other important documents, and to track media coverage. Our aim is to be as accurate as possible and we appreciate your assistance.

SKETCH TALKS

For IGB faculty presenting at networking events or other relationship-building opportunities with alumni, donors, or industry leaders, we have prepared the following guidelines designed to maximize your impact with these audiences. We have developed an approach called a "sketch talk," a one slide presentation aimed at individuals who have no scientific training or background, that will deliver a clear takeaway through the use of a compelling image and a narrative content structure. Visit our Sketch Talk page for a step-by-step guide. ■

CNRG

NETWORK UPGRADE FOR BIOCLUSTER

On October 18 we will have an all day outage of Biocluster so that we can do an upgrade of it's connection to the campus research network as well as do some maintenance of the system. When this work is completed, we could in theory transfer data at 100Gbps through Biocluster to/from outside networks. ■

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.

McFaul, L. W., Wright, W. J., Sickle, J., & Dahmen, K. A. (2019). Force oscillations distort avalanche shapes. *Materials Research Letters*, 7(12), 496-502. https://doi.org/10.1080/21663831.2019.1659437

Wu, X., Tang, A., Bi, X., Nguyen, T. H., & Yuan, B. (2019). Influence of algal organic matter of *Microcystis aeruginosa* on ferrate decay and MS2 bacteriophage inactivation. *Chemosphere*, 236, [124727]. https://doi.org/10.1016/j.chemosphere.2019.124727

Mand, T. D., & Metcalf, W. W. (2019). Energy Conservation and Hydrogenase Function in Methanogenic Archaea, in Particular the Genus *Methanosarcina*. *Microbiology and molecular biology reviews : MMBR*, 83(4). https://doi.org/10.1128/MMBR.00020-19

Huang, E., Zhang, X., Rodriguez, L. F., Khanna, M., de Jong, S., Ting, K. C., ... Lin, T. (2019). Multi-objective optimization for sustainable renewable jet fuel production: A case study of corn stover based supply chain system in Midwestern U.S. *Renewable and Sustainable Energy Reviews*, 115, [109403]. https://doi.org/10.1016/j.rser.2019.109403

Zambuto, S. G., Clancy, K. B. H., & Harley, B. A. (2019). A gelatin hydrogel to study endometrial angiogenesis and trophoblast invasion. *Interface Focus*, 9(5), [20190016]. https://doi.org/10.1098/rsfs.2019.0016

Bianco, C. M., Fröhlich, K. S., & Vanderpool, C. (2019). Bacterial Cyclopropane Fatty Acid Synthase mRNA Is Targeted by Activating and Repressing Small RNAs. *Journal of bacteriology*, 201(19). https://doi.org/10.1128/JB.00461-19

Boppart, M., & Mahmassani, Z. S. (2019). Integrin signaling: linking mechanical stimulation to skeletal muscle hypertrophy. *American journal of physiology. Cell physiology*, 317(4), C629-C641. https://doi.org/10.1152/ajpcell.00009.2019

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Choquette, N. E., Ogut, F., Wertin, T. M., Montes, C. M., Sorgini, C. A., Morse, A. M., ... Ainsworth, E. A. (Accepted/In press). Uncovering hidden genetic variation in photosynthesis of field-grown maize under ozone pollution. *Global change biology*. https://doi.org/10.1111/gcb.14794

Adil, M. T., Simons, C. M., Sonam, S., & Henry, J. J. (2019). Understanding cornea homeostasis and wound healing using a novel model of stem cell deficiency in *Xenopus*. *Experimental Eye Research*, 187, [107767]. https://doi.org/10.1016/j.exer.2019.107767

Wang, W., Yu, S., Huang, S., Bi, S., Han, H., Zhang, J. R., ... Zhu, J. J. (2019). Bioapplications of DNA nanotechnology at the solid-liquid interface. *Chemical Society Reviews*, 48(18), 4892-4920. https://doi.org/10.1039/c8cs00402a

Cheng, M-H., Wang, Z., Dien, B. S., Slininger, P. J. W., & Singh, V. (2019). Economic Analysis of Cellulosic Ethanol Production from Sugarcane Bagasse Using a Sequential Deacetylation, Hot Water and Disk-Refining Pretreatment. *Processes*, 7(10), [642]. https://doi.org/10.3390/pr7100642

Precord, T. W., Mahanta, N., & Mitchell, D. A. (2019). Reconstitution and Substrate Specificity of the Thioether-Forming Radical S-Adenosylmethionine Enzyme in Freyrasin Biosynthesis. *ACS chemical biology*, 14(9), 1981-1989. https://doi.org/10.1021/acschembio.9b00457

Lutz, J. P., Davydovich, O., Hannigan, M. D., Moore, J. S., Zimmerman, P. M., & McNeil, A. J. (2019). Functionalized and Degradable Polyphthalaldehyde Derivatives. Journal of the American Chemical Society, 141(37), 14544-14548. https://doi.org/10.1021/jacs.9b07508

Bernardi, R. C., Durner, E., Schoeler, C., Malinowska, K. H., Carvalho, B. G., Bayer, E. A., ... Nash, M. A. (2019). Mechanisms of Nanonewton Mechanostability in a Protein Complex Revealed by Molecular Dynamics Simulations and Single-Molecule Force Spectroscopy. *Journal of the American Chemical Society*, 141(37), 14752-14763. https://doi.org/10.1021/jacs.9b06776

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Yuan, Y., Zallot, R., Grove, T. L., Payan, D. J., Martin-Verstraete, I., Šepić, S., ... de Crécy-Lagard, V. (2019). Discovery of novel bacterial queuine salvage enzymes and pathways in human pathogens. *Proceedings of the National Academy of Sciences of the United States of America*, 116(38), 19126-19135. https://doi.org/10.1073/pnas.1909604116

Yamamoto, K., Hackley, K. C., Kelly, W. R., Panno, S. V., Sekiguchi, Y., Sanford, R. A., ... Tamaki, H. (2019). Diversity and geochemical community assembly processes of the living rare biosphere in a sand-and-gravel aquifer ecosystem in the Midwestern United States. *Scientific reports*, 9(1). https://doi.org/10.1038/s41598-019-49996-z

Darolti, I., Wright, A. E., Sandkam, B. A., Morris, J., Bloch, N. I., Farré, M., ... Mank, J. E. (2019). Extreme heterogeneity in sex chromosome differentiation and dosage compensation in livebearers. *Proceedings of the National Academy of Sciences of the United States of America*, 116(38), 19031-19036. https://doi.org/10.1073/pnas.1905298116

Aydin, O., Zhang, X., Nuethong, S., Pagan-diaz, G. J., Bashir, R., Gazzola, M., & Saif, M. T. A. (2019). Neuromuscular actuation of biohybrid motile bots. *Proceedings of the National Academy of Sciences of the United States of America*, [201907051]. https://doi.org/10.1073/pnas.1907051116 ■

ILLINOIS

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