IGB NEWS

Upcoming Events
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Department Announcements

Volume 14 Number 1

UPCOMING EVENTS

IGB Seminar - EIRH

Toxicoepigenetics and the Use of piRNA for Precision Environmental Health Research

February 23, 2021, 12:00 p.m.

Join via Zoom

Dana Dolinoy, PhD
University of Michigan; Professor of Environmental Health Sciences & Nutritional Sciences, Director of Michigan Lifestage Environmental Exposures and Disease (M-LEEaD) Center

Fox Family Innovation and Entrepreneurship Lecture

Dr. Hindsight's Guide to Commercializing Personal Nutrition: Lessons Learned from Launching and Selling Habit

March 3, 2021, 4:00 p.m.

Join via Zoom

Joshua C. Anthony
Founder and CEO, Nlumn, LLC

IGB Pioneers Seminar - GSP

Genomic Privacy and Identity Through a Transdisciplinary Lens: The GetPreCiSe Experience

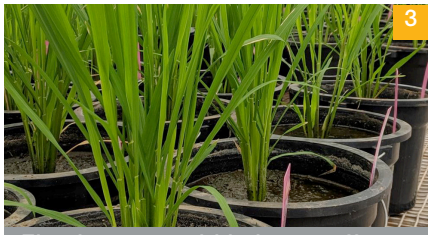
March 9, 2021, 12:00 p.m.

Join via Zoom

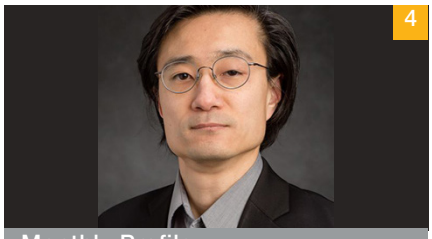
Ellen Clayton, PhD
Vanderbilt University; Craig-Weaver Professor of Pediatrics, Professor of Law, Professor of Health Policy

FEATURED NEWS

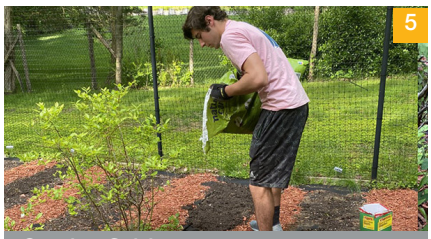
Global analysis suggests COVID-19 is seasonal



Flag leaves could help top off photosynthetic performance in rice

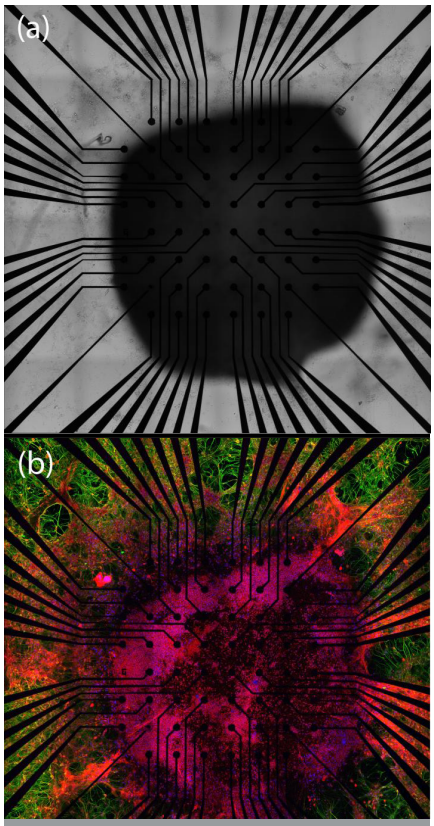


Monthly Profile: Jun Song



On the Grid: Happenings at IGB

IMAGE OF THE MONTH



This month features an image showing an engineered three-dimensional (3D) neural tissue mimics adhered on a micro-electrode array (MEA) to conduct electrophysiological recordings of neurological electrical function. The above figure shows the brightfield image (a) with its fluorescent counterpart (b) of stitched tiles across 3.25 mm by 3.25 mm taken with the Zeiss LSM 710 Confocal Microscope. Image provided by Gelson Pagan from the Bashir Lab.

IGB News

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

Global analysis suggests COVID-19 is seasonal

With cities around the globe locking down yet again amid soaring COVID-19 numbers, could seasonality be partially to blame? New research from the University of Illinois says yes.

In a paper published in *Evolutionary Bioinformatics*, Illinois researchers show COVID-19 cases and mortality rates, among other epidemiological metrics, are significantly correlated with temperature and latitude across 221 countries.

"One conclusion is that the disease may be seasonal, like the flu. This is very relevant to what we should expect from now on after the vaccine controls these first waves of COVID-19," says Gustavo Caetano-Anollés (GEGC), professor in the Department of Crop Sciences and senior author on the paper.

The seasonal nature of viral diseases is so widespread that it has become part of the English vernacular. For example, we often speak of the "flu season" to describe the higher incidence of influenza during the cold winter months. Early in the pandemic, researchers and public health officials suggested SARS-CoV-2 may behave like other coronaviruses, many of which rear their heads in fall and winter. But data was lacking, especially on the global scale. The work of Caetano-Anollés and his students fills that specific knowledge gap.

First, the researchers downloaded relevant epidemiological data (disease incidence, mortality, recovery cases, active cases, testing rate, and hospitalization) from 221 countries, along with their latitude, longitude, and average temperature. They pulled the data from April 15, 2020, because that date represents the moment in a given year in which seasonal temperature variation is at its maximum across the globe. That date also coincided with a time during the early pandemic when COVID-19 infections were peaking everywhere.

The research team then used statistical methods to test if epidemiological variables were correlated with temperature, latitude, and longitude. The expectation was that warmer countries closer to the equator would be the least affected by the disease.

"Indeed, our worldwide epidemiological analysis showed a statistically significant correlation between temperature and incidence, mortality, recovery cases, and active cases. The same tendency was found with latitude, but not with longitude, as we expected," Caetano-Anollés says.

While temperature and latitude were unmistakably correlated with COVID-19 cases, the researchers are quick to point out climate is only one factor driving seasonal COVID-19 incidence worldwide.

They accounted for other factors by standardizing raw epidemiological data into disease rates per capita and by assigning each country a risk index reflecting public health preparedness and incidence of co-morbidities in the population. The idea was that if the disease was surging in countries with inadequate resources or higher-than-average rates of diabetes, obesity, or old age, the risk index would appear more important in the analysis than temperature. But that wasn't the case. The index did not correlate with the disease metrics at all.

Earlier work from Caetano-Anollés and his coworkers identified areas in the SARS-CoV-2 virus genome undergoing rapid mutation, some represented in the new virus variant out of Britain, and other genomic regions becoming more stable. Since similar viruses show seasonal upticks in mutation rates, the research team looked for connections between mutational changes in the virus and temperature, latitude, and longitude of the sites from which genomes were sampled worldwide.

"Our results suggest the virus is changing at its own pace, and mutations are affected by factors other than temperature or latitude. We don't know exactly what those factors are, but we can now say seasonal effects are independent of the genetic makeup of the virus," Caetano-Anollés says.

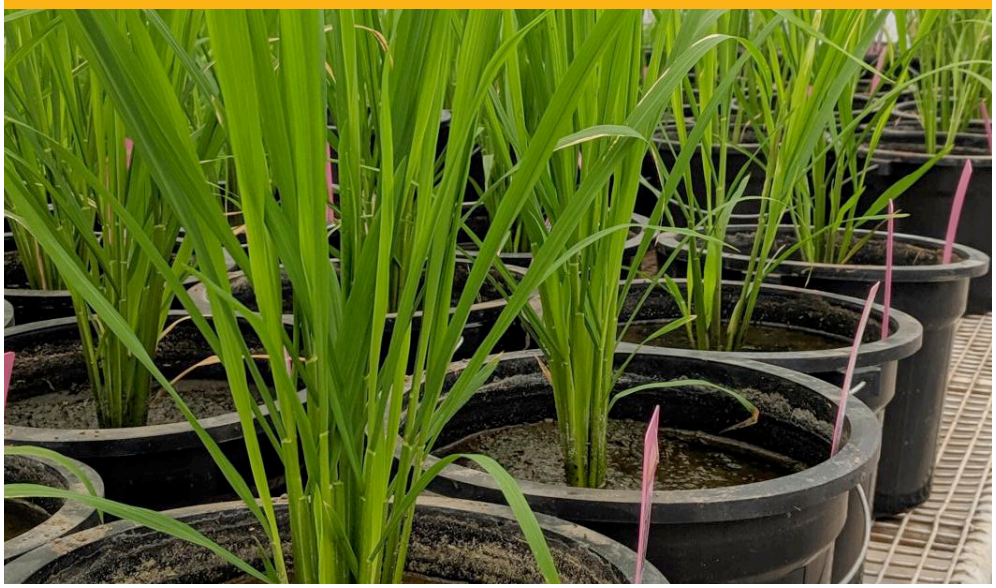
Caetano-Anollés notes more research is needed to explain the role of climate and seasonality in COVID-19 incidences, but he suggests the impact of policy, such as mask mandates, and cultural factors, such as the expectation to look out for others, are key players as well. However, he doesn't discount the importance of understanding seasonality in battling the virus.

The researchers say our own immune systems could be partially responsible for the pattern of seasonality. For example, our immune response to the flu can be influenced by temperature and nutritional status, including vitamin D, a crucial player in our immune defenses. With lower sun exposure during the winter, we don't make enough of that vitamin. But it's too soon to say how seasonality and our immune systems interact in the case of COVID-19.

"We know the flu is seasonal, and that we get a break during the summer. That gives us a chance to build the flu vaccine for the following fall," Caetano-Anollés says. "When we are still in the midst of a raging pandemic, that break is nonexistent. Perhaps learning how to boost our immune system could help combat the disease as we struggle to catch up with the ever-changing coronavirus."

Authors include Prakruthi Burra, Katiria Soto-Díaz, Izan Chalen, Rafael Jaime Gonzalez-Ricon, Dave Istanto, and Gustavo Caetano-Anollés. Supported by the Office of Research and the Office of International Programs, College of ACES.

Written by Lauren Quinn. Photo by L. Brian Stauffer.



Flag leaves could help top off photosynthetic performance in rice

The flag leaf is the last to emerge, indicating the transition from crop growth to grain production. Photosynthesis in this leaf provides the majority of the carbohydrates needed for grain filling--so it is the most important leaf for yield potential. A team from the University of Illinois and the International Rice Research Institute (IRRI) found that some flag leaves of different varieties of rice transform light and carbon dioxide into carbohydrates better than others. This finding could potentially open new opportunities for breeding higher yielding rice varieties.

Published in the *Journal of Experimental Botany*, this study explores flag leaf induction - which is the process that the leaf goes through to "start up" photosynthesis again after a transition from low to high light. This is important because the wind, clouds, and movement of the sun across the sky cause frequent fluctuations in light levels. How quickly photosynthesis adjusts to these changes has a major influence on productivity.

For the first time, these researchers revealed considerable differences between rice varieties in the ability of flag leaves to adjust to fluctuating light. They also showed that the ability to adjust differs between the flag leaf and leaves formed before flowering. Six rice varieties chosen to represent the breadth of genetic variation across a diverse collection of more than 3000 were analyzed as a first step in establishing if there was variation in ability to cope with fluctuations in light.

In this study, they discovered the flag leaf of one rice variety that began photosynthesizing nearly twice (185%) as fast as the slowest. Another top-performing flag leaf fixed 152% more sugar. They also found large differences (77%) in how much water the plant's flag leaves exchanged for the carbon dioxide that fuels photosynthesis. Additionally, they found that water-use efficiency in flag leaves correlated with water-use efficiency earlier in development of these rice varieties, suggesting that water-use efficiency in dynamic conditions could be screened for at younger stages of rice development.

"What's more, we found no correlation between the flag leaf and other leaves on the plant, aside from water-use efficiency, which indicates that both kinds of leaves may need to be optimized for induction," said Stephen Long (BSD/CABBI/GEGC), Illinois' Ikenberry Endowed University Chair of Crop Sciences and Plant Biology. "While this means more work for plant scientists and breeders, it also means more opportunities to improve the plant's photosynthetic efficiency and water use. Improving water use is of increasing importance, as agriculture already accounts for over 70% of human water use, and rice is perhaps the largest single part of this."

Above: A team from the University of Illinois and the International Rice Research Institute (IRRI) found that some flag leaves of different varieties of rice transform light and carbon dioxide into carbohydrates better than others, potentially opening new opportunities for breeding higher yielding rice varieties.

Confirming their previous study in New Phytologist, they found no correlation between data collected in fluctuating and steady-state conditions, where the rice plants were exposed to constant high light levels. This finding adds to a growing consensus that researchers should move away from research dependent on steady-state measurements.

"We're realizing the need for our experiments to more accurately reflect the reality that these plants experience out the field," said first-author Liana Acevedo-Siaca, a postdoctoral researcher at Illinois. "We need to focus our efforts on capturing the dynamic conditions so we can improve crops to be productive in the real world, not laboratories."

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This work is part of Realizing Increased Photosynthetic Efficiency (RIPE), a project that aims to improve photosynthesis to equip farmers worldwide with higher-yielding crops to ensure everyone has enough food to lead a healthy and productive life. RIPE is sponsored by the Bill & Melinda Gates Foundation, the U.S. Foundation for Food & Agriculture Research, and the U.K. Foreign, Commonwealth & Development Office who are committed to ensuring Global Access and making the project's technologies available to the farmers who need them the most.

Written by Claire Benjamin.
Photo by Liana Acevedo-Siaca.

Founder Professor of Physics Jun Song's group examines gene regulation in eukaryotes, with a focus on using integrative genomics to study the interplay among transcription factors, chromatin structure, non-coding RNAs, and gene regulation in development and diseases.

Building a platform
to recruit minority students into STEM PhD programs

Jun Song (ACPP) has followed an unorthodox research path. He completed his PhD in mathematical physics, switched to studying radiation oncology during his postdoctoral studies, and finally settled on studying cancer genomics and epigenomics using computational methods. Although his interests may seem to be variable, his innate curiosity has remained constant.

During his appointment at the University of California, Berkeley, Song learnt how mathematicians model radiation damage in cancer patients. It was the first time he learnt that mathematicians and physicists could contribute to the field of cancer research. "I was intrigued by how math and physics can help treat cancer patients," Song said. "Until that point, I didn't realize there was a direct connection between the theoretical aspect of particle physics and the practical aspect of medical physics."

Since cancer is a genetic disease, it is important to understand the chemical and physical properties of DNA and how alterations in these properties dysregulate gene expression. Unsurprisingly, Song's unconventional background has pushed him to ask mathematical and physical questions in the field of cancer research. "My approach is somewhat different because of my training in geometry. I like to think about how DNA is folded inside cells, and how that plays a role in gene regulation. Additionally, studying the interactions between particles in physics has helped me think about interactions in biological systems and about geometric data analysis," Song said.

Song is currently trying to improve strategies for cancer treatment. Although radiation is commonly used, it is an aggressive technique and does not always succeed in eliminating all the cancerous cells. "There are many processes that can malfunction in cancer cells. Unfortunately, very few of those processes can actually be targeted," Song said. "We are now looking at molecular targeted therapy and immunotherapy to target the cancer cells with increased precision."

For most researchers, switching their interests after their postdoctoral studies might seem daunting. However, Song relished the challenge. "It's important to be open-minded when you learn new concepts. Although biology is different from math and physics, I enjoy learning how to think like a biologist."

Although he was able to transition from physics to biology seamlessly, Song acknowledges that the process can be long-winded. "It takes some time to identify what you're interested in and develop your career accordingly," Song said. "Students need to identify what they're passionate about and devote all their efforts to achieve their goal. Although they may be discouraged initially, they need to push forward and continue to make progress."

"It's important to be open-minded when you learn new concepts. Although biology is different from math and physics, I enjoy learning how to think like a biologist."

Song's career trajectory has also helped him empathize with the difficulties that under-represented minority students can face. To this end, he oversees the training of such students from Fisk University, a minority-serving institution in Nashville, Tennessee. "We have an obligation to increase the diversity in science and use it as a platform to stimulate the intellectual environment in academia," Song said. "In order to accomplish this goal, we need to spark the students' interest and representation in basic science."

The Fisk collaboration was established in 2014, the same year that Song moved to the University of Illinois Urbana-Champaign. The program was initially funded by the National Institutes of Health in an effort to increase diversity in biocomputing and big data analysis. Two students are chosen every year for two consecutive summer training programs: one summer to acclimate to the campus and one to conduct research.

"In an effort to further increase the general awareness in high-performance computing, we also developed online teaching modules that can be reused every year by the students," Song said. The modules include games about genomics as well as tutorial websites that teach students about sequencing technology.

After the initial NIH funding ended, the collaboration received financial support from the Office of the Executive Associate Chancellor for Administration and University Relations and the Office of the Vice Chancellor for Research. In 2020 the effort had to handle the challenges associated with virtual learning. "It was the first time we had to manage the program virtually. However, we are hoping to eventually bring the students to the campus so that we can meet them in person and get to know them better," Song said.

Song believes that education plays an important role in building a fair and just society. "Although it has been said that education is a great equalizer, it needs to be made equally available. Therefore, we need to compensate for the lack of education that minority communities suffer early on," Song said.

There are several new programs that Song is now interested in launching, including establishing bridge programs that will enable Fisk students to transition into PhD programs at the University of Illinois. "It is not enough to just recruit them; we need to make them feel at home, build their self-confidence, and provide them with career opportunities. They need to recognize that they have infinite possibilities ahead of them. Here at UIUC, we are very fortunate to have strong support from our University administrators, staff, faculty, and students in making these changes possible," Song said. ■

Written by Ananya Sen. Photo courtesy of Physics.

ON THE GRID
HAPPENINGS AT THE IGB

AWARDS

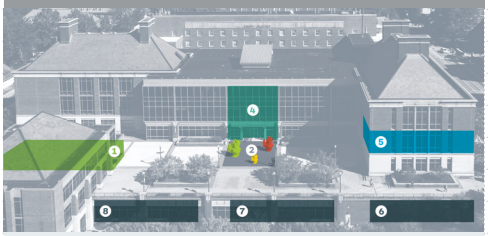
MARK HAUBER

Mark Hauber (GNDP), Harley Jones Van Cleave Professor of Host-Parasite Interactions, Evolution, Ecology, and Behavior, was appointed a Center for Advanced Study (CAS) Associate.

PAUL HERGENROTHER

Paul J. Hergenrother, Kenneth L. Rinehart Endowed Chair in Natural Products Chemistry and Professor of Chemistry (ACPP theme leader/MMG), has been named a 2020 National Academy of Inventors (NAI) Fellow, recognized for groundbreaking innovations that have made tangible, positive impacts on society and the economy.

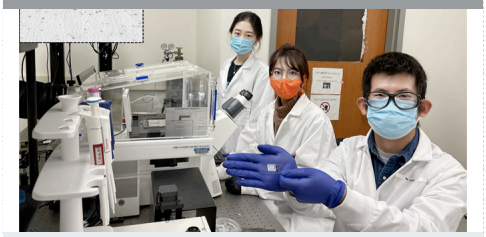
TOUR



SEE THE IGB

Visit the IGB virtually and stop by some of our key locations such as Darwin's Playground, the Walk of Life, and the Gatehouse Atrium on our new virtual tour page. Visit See The IGB to get started.

RESEARCH



LAB TEAM CREATES FAST, CHEAP, AND ACCESSIBLE COVID-19 ANTIBODY TEST

As the numbers of those infected with COVID-19 has continued to climb, the desperate need for a vaccine was apparent. Even now with the invention and administration of several COVID-19 vaccinations, the question remains: How effective are these vaccines? HMNTL students Congnyu Che, Weijing Wang, and Nantao Li, also members of the ECE Nanosensors Group, along with IGB Fellow Bin Zhao and Professor Brian Cunningham (CGD Director/MMG) have recently been published in the journal Talanta for the development of a cost efficient COVID-19 antibody test.

"Compared with other detection methods, our method is a simple, 15-minute sample-to-answer test," says Zhao, a postdoctoral research associate and IGB Fellow. "It costs less than $2 per test and is used with a desktop detection system that is suitable for point-of-care situations like clinics and physician offices."

When COVID-19 began developing into a global crisis in early 2020, this research group was already working on an NIH-funded project to develop a "flu chip" that would rapidly determine the most likely cause of a fever by measuring several proteins within a droplet of blood. They decided to pivot their efforts to detect COVID-19 antibodies instead.

"Our developed method is not only rapid and simple, but also highly sensitive and quantitative. It also requires only a fingerstick quantity of blood (~ 4 μL)," says Nantao Li, an ECE and Holonyak Lab graduate student. "The method that we used to detect COVID-19 antibody can also be adapted to detect other molecules, such as antibodies to other viral pathogens, biomarkers for cardiac disease, and biomarkers for cancer."

Read the full article here.

PODCAST

SHINING A LIGHT ON COVID-19 VIRUS DETECTION

Brian Cunningham (CGD Director/MMG), a professor in the Department of Electrical and Computer Engineering, was recently featured on the Finding Genius Podcast discussing his group's recent work on COVID diagnosis, his research at the IGB with the new PRISM microscope, and collaborations in the Center for Genomic Diagnostics as well as the Center for Pathogen Diagnostics.

Listen to the podcast here.

COLLABORATION

REGENERON SCIENCE TALENT SEARCH SCHOLAR CONDUCTS AT-HOME STUDY ON CROP IMPROVEMENT

Byram Hills High School student Bailey Goldstein conducted research from his home due to travel restrictions under the pandemic, with remote training from plant biology faculty Stephen Long (BSD/CABBI/GEGC) and Justin McGrath, using his backyard and bedroom as testing sites.

"I had to achieve a high light stress within a specific range, which was very hard to achieve, and so I constantly had to experiment with the light and see what worked best," said Goldstein.

Read the full article here.

DEPARTMENT ANNOUNCEMENTS

BIOECONOMY

Part of IGB's mission is to stimulate the bioeconomy of the state of Illinois. Here, we feature innovation from IGB researchers.

- The new Bioeconomy homepage is live on the IGB website! Explore innovation resources, startups associated with IGB faculty, and more at www.igb.illinois.edu/bioeconomy

- The Office of Technology Management (OTM) is seeking MBA, JD, and PhD candidates to join its paid commercialization analyst internship program, starting Summer 2021 and lasting through Spring 2022. In this position you will develop an understanding of intellectual property law, market and industry analysis, and licensing strategies. You will assess new innovations for patentability, commercial readiness and next steps. OTM staff will mentor you to ensure your professional development.

  Application deadline is February 26, 2021. Handshake #4289908 or Simplicity #33078. For more information click here.

- Join us on March 3rd at 4 pm (CST) for this semester's Fox Family Innovation and Entrepreneurship Lecture co-hosted by the Division of Nutritional Sciences. Joshua Anthony, Founder and CEO of Nlumn (MS '97), will be discussing "Dr. Hindsight's Guide to Commercializing Personal Nutrition: Lessons Learned from Launching and Selling Habit." Find more information visit the IGB Events page. ■

BUSINESS

ON-LINE FORM W2 & FORM 1042-S AVAILABLE NOW

If you have consented to receive your Form W-2 and/or Form 1042-S electronically, it is now available. Below are the instructions to retrieve your form(s).

- Go to the System HR Services website at https://www.hr.uillinois.edu/
- Select the 'Pay' tab.
- Click the link 'W-2/1042-S/1095-C Tax Statement' from the dropdown list
- Click the 'Access Tax Forms' green button.
- Log in using your NetID and password. (Remember, you will be prompted to use 2-Factor Authentication)
- Log into 2FA
  - Authenticate using one of the four methods
    - Send me a push
    - Call me
    - Text me
    - Use a passcode
  - Click 'Continue'.
  - On the Online Tax Forms page, click on the link of the 2020 tax form you want to retrieve.
- Click on the 'Continue to View/Print' button.
- Select the link of the tax form you want to retrieve (i.e. 2020 W-2 Form or 2020 1042-S Form).
- Select Log Out to exit.

Your Form W-2 or Form 1042-S will display on the screen. You may print the form (the form is 2 pages so if your printer has duplex printing you may want to turn it on) or save your form to a hard drive or disk. If you need an additional copy later please use the same process via the Systems HR website.

If you have questions, you may contact University Payroll & Benefits Customer Service Center: payinq@uillinois.edu or (217) 265-6363. ■

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.

Ghaffari, S., Hanson, C., Schmidt, R. E., Bouchonville, K. J., Offer, S. M., & Sinha, S. (2021). An integrated multi-omics approach to identify regulatory mechanisms in cancer metastatic processes. *Genome biology*, 22(1), [19]. https://doi.org/10.1186/s13059-020-02213-x

Li, Z., Tofangchi, A., Stavins, R. A., Emon, B., McKinney, R. D., Grippo, P. J., & Saif, M. T. A. (2021). A portable pen-sized instrumentation to measure stiffness of soft tissues *in vivo*. *Scientific reports*, 11(1), [378]. https://doi.org/10.1038/s41598-020-79735-8

Mahajan, T., & Dar, R. D. (2021). Internetwork connectivity of molecular networks across species of life. *Scientific reports*, 11(1), [1168]. https://doi.org/10.1038/s41598-020-80745-9

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Bhatia, S. K., Jagtap, S. S., Bedekar, A. A., Bhatia, R. K., Rajendran, K., Pugazhendhi, A., Rao, C. V., Atabani, A. E., Kumar, G., & Yang, Y. H. (2021). Renewable biohydrogen production from lignocellulosic biomass using fermentation and integration of systems with other energy generation technologies. *Science of the Total Environment*, 765, [144429]. https://doi.org/10.1016/j.scitotenv.2020.144429

Zhao, B., Che, C., Wang, W., Li, N., & Cunningham, B. T. (2021). Single-step, wash-free digital immunoassay for rapid quantitative analysis of serological antibody against SARS-CoV-2 by photonic resonator absorption microscopy. *Talanta*, 225, [122004]. https://doi.org/10.1016/j.talanta.2020.122004

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Haggerty, D. K., Flaws, J. A., Li, Z., & Strakovsky, R. S. (2021). Phthalate exposures and one-year change in body mass index across the menopausal transition. *Environmental Research*, 194, [110598]. https://doi.org/10.1016/j.envres.2020.110598

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Somavat, P., Liu, W., & Singh, V. (2021). Wet milling characteristics of corn mutants using modified processes and improving starch yields from high amylose corn. *Food and Bioproducts Processing*, 126, 104-112. https://doi.org/10.1016/j.fbp.2020.12.015

Liman, M. S., Franco, V., Cardoso, C. L., Longobardi, V., Gasparrini, B., Wheeler, M. B., Rubessa, M., & Esposito, G. (2021). Effects of Dietary Supplementation of Conjugated Linoleic Acids and Their Inclusion in Semen Extenders on Bovine Sperm Quality. *Animals*, 11(2). https://doi.org/10.3390/ani11020483

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Dong, F., Lin, Z., Lin, J., Ming, R., & Zhang, W. (2021). Chloroplast Genome of Rambutan and Comparative Analyses in Sapindaceae. Plants, 10(2). https://doi.org/10.3390/plants10020283

Tkachenko, A. V., Maslov, S., Wang, T., Elbanna, A., Wong, G. N., & Goldenfeld, N. (2021). How dynamic social activity shapes COVID-19 epidemic: waves, plateaus, and endemic state. (medRxiv). Cold Spring Harbor Laboratory Press. https://doi.org/10.1101/2021.01.28.21250701

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Lim, S. J., Aguilar-Lopez, M., Wetzel, C., Dutra, S. V. O., Bray, V., Groer, M. W., Donovan, S. M., & Ho, T. (2021). The Effects of Genetic Relatedness on the Preterm Infant Gut Microbiota. *Microorganisms*, 9(2). https://doi.org/10.3390/microorganisms9020278

Tan, T. J. C., Yuan, M., Kuzelka, K., Padron, G. C., Beal, J. R., Chen, X., Wang, Y., Rivera-Cardona, J., Zhu, X., Stadtmueller, B. M., Brooke, C. B., Wilson, I. A., & Wu, N. C. (2021). Sequence signatures of two IGHV3-53/3-66 public clonotypes to SARS-CoV-2 receptor binding domain. *(bioRxiv)*. https://doi.org/10.1101/2021.01.26.428356

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Burra, P., Soto-Díaz, K., Chalen, I., Gonzalez-Ricon, R. J., Istanto, D., & Caetano-Anollés, G. (2021). Temperature and Latitude Correlate with SARS-CoV-2 Epidemiological Variables but not with Genomic Change Worldwide. *Evolutionary Bioinformatics*, 17, [1176934321989695]. https://doi.org/10.1177/1176934321989695

ILLINOIS

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