IGB NEWS

Upcoming Events
Monthly Profiles
Happenings at IGB
Image Of The Month
Research News
Department Announcements

Volume 15 Number 5

UPCOMING EVENTS

IGB Pioneers Seminar
A Decade of Molecular Cell Atlases
October 18, 2022, 12:00 p.m.
612 IGB Conference Center

Steve Quake, PhD
Stanford University
Lee Otterson Professor
of Bioengineering
Co-President, Chan Zuckerberg Bio-hub; Professor of Applied Physics
Professor of Physics

Lunch with the Core
Uncovering cell biology of the intestinal parasite Cryptosporidium parvum
October 19, 2022, 12:00 p.m.
612 IGB Conference Center

Maria Guadalupe Nava
Graduate Student
College of Veterinary Medicine

Instrument: SR-SIM

Lunch will be providedd

Thriving in Graduate School
Mental Health
October 20, 2022, 5:00 p.m.
612 IGB Conference Center

Graduate school can be a stressful time; this workshop seeks to open a conversation about the importance of maintaining one's mental health. Presenters will focus on healthy coping mechanisms, dealing with impostor syndrome, and resources available to support students.

FEATURED NEWS

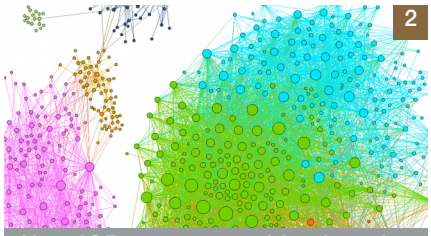
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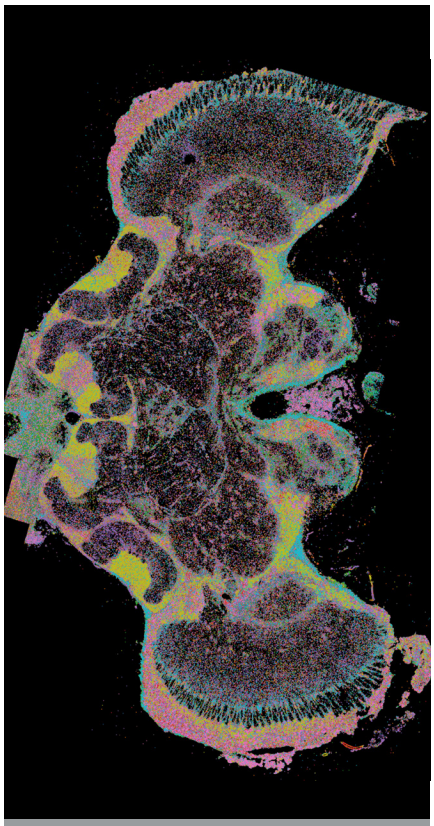
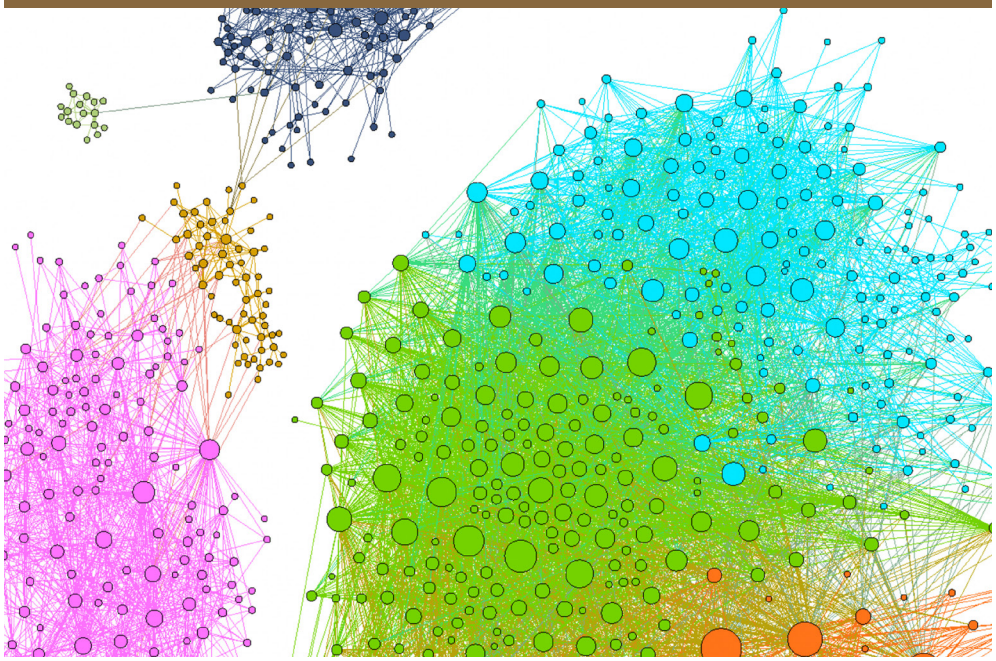
IMAGE OF THE MONTH



This sample aimed to apply a single molecule resolution spatial transcriptomics method to the Honeybee brain. 3.3 million individual transcripts that represent 130 genes in a single Honeybee section were detected. Each spot color represents a different gene. The brain section is approximately 4.5 x 3 µm in size. Sample was prepared by Prof. Hee-Sun Han's lab, and collected by Prof. Gene Robinson's lab. Images were taken using the Zeiss Axiovert 200M and analyzed using Teton at the Core Facilities.

IGB News

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



New IGB center
dedicated to machine learning and predictive modeling

A new Center for Artificial Intelligence and Modeling will be established at the Carl R. Woese Institute for Genomic Biology. It will be led by Sergei Maslov (CABBI), a professor of bioengineering and Bliss Faculty Scholar and Olgica Milenkovic (BSD/CGD/GNDP), a Donald Biggar Willett Scholar and Franklin Woeltge Professor of Electrical and Computer Engineering. The goal of CAIM is to provide biological groups with appropriate expertise in computational sciences.

"We were part of the biocomplexity theme, which historically introduced people with quantitative backgrounds, such as computer science, physics, and mathematics, with biologists so they could work on problems together," Maslov said. "We wanted to do something along those lines and decided to focus on machine learning and computational modeling."

CAIM has participants from across the campus including experts from electrical and computer engineering, bioengineering, physics, computer science, mathematics, statistics, and civil and environmental engineering. The biological projects will include members from food science and human nutrition, chemistry, physics, bioengineering, and cell and developmental biology.

"My group works in machine learning, and most of the methods are tailor-made for data sets in e-commerce or from areas that are not quite as exciting as molecular biology, for example," Milenkovic said. "I thought it would be a really good idea to have more access to interesting biological problems through datasets that could motivate new research ideas and directions in machine learning."

The goal of CAIM is to combine both modeling and learning in areas including microbiome analysis, single-cell data analysis, multiomics, spatial transcriptomics, and neural networks. Maslov and

"I thought it would be a really good idea to have more access to interesting biological problems through datasets that could motivate new research ideas and directions in machine learning."

Milenkovic hope that the center will help generate more research topics based on the collaborations that are forged.

"CAIM is different from the regular themes at the IGB. We don't have big, overarching projects. Instead, we want to use the center to provide a matchmaking service between biological groups that generate data amenable to modeling and learning with appropriate expertise," Maslov said. "We want to establish equal collaborations that are of mutual interest to the biologists generating the data and computational people who are analyzing the data."

Maslov and Milenkovic would like to invite more participants from across the campus to join CAIM. "It would be a great opportunity for people who work in modeling, statistical analysis and algorithm design and those that have specific biological problems. We can provide additional opportunities for them to meet collaborators and develop projects," Milenkovic said. ■

Written by Ananya Sen.

Olgica Milenkovic (BSD/CGD/GNDP), a Donald Biggar Willett Scholar and Franklin Woeltge Professor of Electrical and Computer Engineering (left) and Sergei Maslov (CABBI), a professor of bioengineering and Bliss Faculty Scholar will lead the new Center for Artificial Intelligence and Modeling.

New grant awarded to study
the importance of salmon to the Kenaitze Indian Tribe

A community-based project, conducted by researchers at the University of Illinois Urbana-Champaign in collaboration with the Kenaitze Indian Tribe and Kenai Peninsula College, has been awarded a $1,017,215 grant by the National Science Foundation. The project will map the use of salmon as a cultural keystone species of Dena'ina peoples.

Since before written history, perhaps for thousands of years, the Kenaitze people harvested salmon from Cook Inlet, once called Tikahtnu – Big Water River, and the Kenai River – Kahtnu. The Kenai River traditional place names include many designations, each for a section of the river or place such as *Qughuzdlent* (current flows around its place) – for the sand bar in the mouth of the Kenai River. People lived along the beach and river, and harvested salmon, drying, smoking and preserving the fish to provide enough food for families to survive the long winters. For thousands of years, it was also a means of natural resource management – harvesting large quantities of fish in small, unobtrusive fish camps. The Kenaitze people lived by a true Leave-No-Trace sustainable economy.

The project will focus on the genomes of three salmon species: *Oncorhynchus gorbuscha* (Pink salmon), *Oncorhynchus kisutch* (Coho salmon), and *Oncorhynchus nerka* (Sockeye salmon) from the Kenai region in Alaska. Using DNA extracted from ancient salmon bones, found at an archaeological site, along with present-day salmon samples collected by members of the Kenaitze Indian Tribe from the same historic location, the researchers will examine salmon diversity to identify changes in the genomes over the past 2000 years, especially in the midst of the rapidly changing environment.

"This unique data set will provide us with a great opportunity to understand how the salmon genome has evolved and changed over the past two millennia," said Julian Catchen (GNDP), an associate professor of evolution, ecology, and behavior.

"Our first collaboration started in 2013, when the tribe got in touch with me to use paleogenomics for a project," said Ripan Singh Malhi (GNDP/GSP/IGOH), a professor of anthropology. "As we began working together, the scope of our partnership expanded. I learned about their interests and it made sense to take an interest in salmon, not just the ones living today, but also back in time."

The Kenaitze community has traditionally been characterized as a "salmon culture" and have been operating an educational fishery on Tribal land since 1989. The fishery still serves as a center of learning and tradition, bringing the community members together. Therefore, the second major aim of the project will use interviews, focus groups, surveys, and archival work to supplement historical and legal documents that demonstrate how salmon have been used from pre-European contact to present times.

The third aspect of the project aims at integrating the genomic information and community-based knowledge to understand Indigenous people's stewardship practices with salmon over time. "This project is important because it can serve as an example of how to integrate scientific results with traditional knowledge," Malhi said. "It is relevant to look at Indigenous knowledge for guidance, especially in the face of climate change."

The research team will work closely with the Kenaitze community members throughout the project, including study design, data generation, analysis, interpretation, and dissemination of the findings. The team will also conduct workshops, as a part of the Summer Internship for Indigenous Peoples in Genomics (SING) program, to discuss data sovereignty and develop procedures for responsible data dissemination while safeguarding Indigenous interests.

"One of the aspects of my theme is to study whether your genomic data is being treated the way you want it to be. Although this is a unique project, it is connected to the question of what practices can be used for the management of genomic data," said Carl Gunter (GSP leader), a professor of computer science. The other topics in the SING program will include genomic theory, techniques, analyses and perspectives on genomic research.

Additional principal investigators on the grant include Adam Dunstan at Kenai Peninsula College and Norma Johnson at the Kenaitze Indian Tribe. ■

Written by Ananya Sen. Photo by Alan Boraas.

Named after Illinois professor of microbiology Carl R. Woese, who discovered the third domain of life, the mission of the IGB is to advance life science research at the University of Illinois Urbana-Champaign, meaningfully engage with the public to understand the impact of genomic research, and to stimulate bio-economic development in the state of Illinois.

15 Years of IGB
Centers of the Institute

The Carl R. Woese Institute for Genomic Biology has hosted numerous research centers over the years, fostering collaboration between researchers at the IGB and external partners, including those of academic, governmental, and industrial nature. The IGB's centers often work together with multiple institutions and companies, producing interdisciplinary research that is then translated into real-world solutions. Here, we discuss the centers both past and current that the IGB has hosted over the last 15 years.

The Big Data to Knowledge Center of Excellence

The human genome is massive, totaling about 3 billion nucleotides long. Though our sequencing technology has advanced considerably in recent years, it still falls short in its capability to analyze such large quantities of genomic data quickly and accurately. The need for an advanced platform that could generate, interpret, and apply genomic data spawned the creation of BD2K, established in 2016 with funding from NIH. The focus of this center was to get computer software up to the scale of genomic data, and create a platform with an intuitive user interface, integrated analytical methods involving data mining and machine learning, and an open access design such that it be a "knowledge network" of community genomic data sets. The platform, called The Knowledge Engine for Genomics, contained data for not just human genomics, but animals and plants as well, which were used to create patient-specific treatments for disease, modify microbes for agriculture and human health, and improve efficiency of plant and animal agriculture.

Center of Advanced Bioenergy and Bioproducts Innovation

The human population is expected to reach 8 billion by 2023, and with this population growth comes the need for more efficient agriculture to grow enough food, and more sustainable sources of fuel to power the world. To help with this problem, CABBI was established in 2017 with funding from the U.S. Department of Energy as part of a widescale collaboration with multiple universities across the county. CABBI seeks to create a new generation of bioenergy crops, biofuels, and bioproducts, that are sustainable, resilient, and cost-effective. The crops that are developed by researchers at CABBI can produce valuable chemicals such as biodiesel, organic acids, and alcohol, that work to reduce use of fossil fuels and dependence on non-sustainable sources for these chemicals. The crops are also engineering to produce higher yields, helping to sustainably feed both people and livestock.

The Center for Nutrition, Learning, and Memory

Diets vary tremendously across the human population and throughout our lives, yet the effects that nutrition has on our brain function and development are still unclear. This was the inspiration for CNLM, established in 2011 in partnership with Abbott Nutrition, as the first interdisciplinary center for studying the impact of nutrition on brain cognition. Using leading-edge brain imaging and supercomputing technologies, CNLM researchers explored the mechanisms underlying nutritional enhancement of learning and memory, and used this data to create reliable tests for measuring how learning and memory changed depending on nutrition and age. CNLM also hosted an annual research competition that awarded novel multi-disciplinary research on the intersection between nutrition and cognition.

Center for Genomic Diagnostics

Methods for testing for some diseases in humans can be invasive, expensive, and time consuming. Furthermore, treatments for certain diseases, like cancer, often only work for some patients. Ideally, there would be a way to reliably test for biomarkers of disease and create patient-specific treatments based on the results. This is where the CGD comes in. Originally the Omics Nanotechnology for Cancer Precision Medicine theme, the CGD grew out of this theme through a partnership with the Grainer College of Engineering in 2020. This center is currently developing non-invasive genomic "liquid biopsies" which measure micro-RNAs in the blood of patients, allowing for quick, easy, and reliable testing for certain diseases. Their goal is to make this test easy to take at home, such that a patient can use a finger stick to collect a drop of blood, put it in a cartridge, and send it in the mail to be analyzed by a lab. The CGD also hopes to use blood-based diagnostics of biomarkers to create more individualized treatments for patients based on their needs. Recently CGD has developed a technique called Photonic Resonator Interferometric Scattering Microscopy, which can be used to count virus loads in real time at a low cost. The center is working to integrate PRISM technology with other virus testing, like that for COVID-19, to create rapid diagnostic tests to monitor viral load in patients with these diseases.

Genome Scale Engineering Center

In recent years, metabolic engineering involving microorganisms has been used to produce much of the biofuels and chemicals that we use. Usually, these efforts focus on baker's yeast or other model organisms. Increasing the diversity of microorganisms we use can offer advantages for biomanufacturing and may even lead to discovery of new compounds. However, the time and effort needed to explore and manipulate the genes of new models microorganisms is extensive. The goal of GSE, created in 2018 with funding from the Department of Energy, is to develop genome scale engineering tools that allow for rapid testing of microorganisms for new industrial compounds. By integrating genomic engineering tools with metabolic analyses and computational modeling, the center will accelerate the "design-build-test" cycle of microorganism testing, and engineer emerging yeast models to produce valuable fuels and chemicals as part of DOE's renewable energy mission.

Catherine and Don Kleinmuntz Center for Genomics in Business and Society

The Kleinmuntz Center was established in 2019 by Catherine and Don Kleinmuntz as an intersection between business and science. The center provides opportunities for scientists to engage with businesses and develop their research into something both innovative and commercial. The Kleinmuntz center hosts the Young Innovator Program yearly, through which a cohort of graduate students learn about professional development, and design a project to create something to provide economic and social impact, such as new healthcare or industrial products. The center also offers the Mikashi Awards, which provides funding for projects at the IGB that are innovative and marketable. ■

Written by Shelby Lawson.

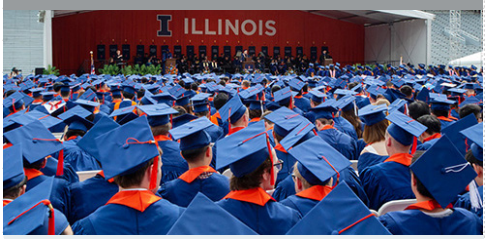
ON THE GRID
HAPPENINGS AT THE IGB

AWARDS

ELIZABETH MURPHY

Elizabeth Murphy, Managing Director of the Institute for Sustainability, Energy, and Environment (iSEE), received the 2022 SPaRC Outstanding Service Award from the campus Sponsored Programs Administration in recognition of outstanding service in support of research administration at Illinois.

SEMINAR SERIES

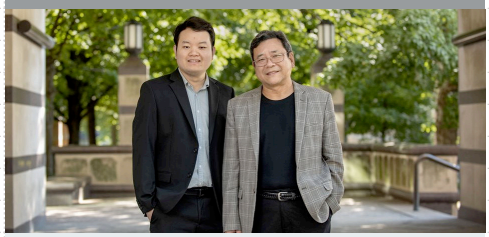


THRIVING IN GRADUATE SCHOOL SEMINAR SERIES

Funded by a grant from the IGB Diversity, Equity, and Inclusion initiative, the student-run Thriving in Graduate School seminar series will provide a workshop for the first year of graduate school, how to troubleshoot your mentor relationship, an international student panel, and coping mechanisms to support mental health.

Sign up for the mailing list at https://forms.illinois.edu/sec/398930130

GRANT



RESEARCHERS RECEIVE NCI GRANT TO DEVELOP TARGETED CANCER IMMUNOTHERAPIES

Hua Wang (RBTE), a Materials Science and Engineering assistant professor, was recently awarded a 2.26M Research Project grant from the National Cancer Institute, which will support the development of type 1 conventional dendritic cells (cDC1) targeted cancer vaccines and cytokine therapies through the integration of immune cell homing materials and metabolic glycan labeling.

Wang, the grant's principal investigator, said his team will design macroporous materials with independently tunable pore size, mechanics, and chemokine release kinetics; and decipher the role of each parameter on the immune cell homing profile to rationally design materials, which can program immune cells of interest, like cDC1s.

The five-year grant, which comes on the heels of Wang's lab research receiving a Bridge Grant from the Cancer Center at Illinois, supports his partnership with Shuming Nie, a Grainger Distinguished Chair and Bioengineering professor who is a co-investigator of the NCI grant. Nie is also a professor of Chemistry, Materials Science and Engineering and Electrical and Computer Engineering.

For Wang and Nie, the funding will further their ongoing collaboration to advance cancer research with CCIL, led by Director Rohit Bhargava (CGD).

Read the full story here.

DIRECTOR

IGB WELCOMES NEW DIRECTOR OF COMPUTATIONAL GENOMICS

Sihai Dave Zhao, a professor in the department of statistics at the University of Illinois Urbana-Champaign, is the new IGB Director of Computational Genomics.

Dave has been an IGB member for over 8 years, serving in both the Gene Networks in Neural Development and Plasticity theme and the former theme Computing Genomes for Reproductive Health. Through statistical approaches to genomics he looks to develop analysis patterns for genomic data, innovate statistical applications to biology, and investigate spatial transcriptomics and behavioral genomics.

EVENT

IGB HOLIDAY PARTY

Join us for the IGB Holiday Party as it returns this year with a celebration on all three floors of the lab building. The party will take place from 4:00pm to 6:00pm on Monday, December 5th. Mark your calendars!

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.

Winogradoff, D., Chou, H. Y., Maffeo, C., & Aksimentiev, A. (2022). Percolation transition prescribes protein size-specific barrier to passive transport through the nuclear pore complex. *Nature communications*, 13(1), [5138]. https://doi.org/10.1038/s41467-022-32857-1

Zaharias, P., & Warnow, T. (2022). Recent progress on methods for estimating and updating large phylogenies. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 377(1861), [20210244]. https://doi.org/10.1098/rstb.2021.0244

Lazarus, B. S., Luu, R. K., Ruiz-Pérez, S., Bezerra, W. B. A., Becerra-Santamaria, K., Leung, V., Durazo, V. H. L., Jasiuk, I., Barbosa, J. D. V., & Meyers, M. A. (2022). Equine hoof wall: Structure, properties, and bioinspired designs. *Acta Biomaterialia*, 151, 426-445. https://doi.org/10.1016/j.actbio.2022.08.028

Banerjee, S., Singh, R., Eilts, K., Sacks, E. J., & Singh, V. (2022). Valorization of *Miscanthus x giganteus* for sustainable recovery of anthocyanins and enhanced production of sugars. *Journal of Cleaner Production*, 369, [133508]. https://doi.org/10.1016/j.jclepro.2022.133508

Fan, T. M., Garrett, L. D., Selting, K. A., & Constable, P. D. (2022). Novel immunotherapy offers promising weapon against canine melanoma. *American journal of veterinary research*, 83(10). https://doi.org/10.2460/ajvr.22.08.0133

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Ma, Q., Beal, J. R., Bhurke, A., Kannan, A., Yu, J., Taylor, R. N., Bagchi, I. C., & Bagchi, M. K. (2022). Extracellular vesicles secreted by human uterine stromal cells regulate decidualization, angiogenesis, and trophoblast differentiation. *Proceedings of the National Academy of Sciences of the United States of America*, 119(38), e2200252119. https://doi.org/10.1073/pnas.2200252119

Li, L., Kohler, F., Dziadkowiec, J., Røyne, A., Espinosa Marzal, R. M., Bresme, F., Jettestuen, E., & Dysthe, D. K. (2022). Limits to Crystallization Pressure. *Langmuir*, 38(37), 11265-11273. https://doi.org/10.1021/acs.langmuir.2c01325

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Wang, Y., Stutz, S. S., Bernacchi, C. J., Boyd, R. A., Ort, D. R., & Long, S. P. (Accepted/In press). Increased bundle sheath leakiness of CO2 during photosynthetic induction shows a lack of coordination between the C4 and C3 cycles. *New Phytologist*. https://doi.org/10.1111/nph.18485

Dong, H., & Cronan, J. E. (2022). Unsaturated fatty acid synthesis in *Enterococcus faecalis* requires a specific enoyl-ACP reductase. *Molecular Microbiology*. https://doi.org/10.1111/mmi.14981

Zambuto, S. G., Jain, I., Clancy, K. B. H., Underhill, G. H., & Harley, B. A. C. (2022). Role of Extracellular Matrix Biomolecules on Endometrial Epithelial Cell Attachment and Cytokeratin 18 Expression on Gelatin Hydrogels. *ACS Biomaterials Science and Engineering*, 8(9), 3819-3830. https://doi.org/10.1021/acsbiomaterials.2c00247

Parthasarathy, T., Bhosale, Y., & Gazzola, M. (2022). Elastic solid dynamics in a coupled oscillatory Couette flow system. *Journal of Fluid Mechanics*, 946, [A15]. https://doi.org/10.1017/jfm.2022.542

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Lloyd, C. T., Iwig, D. F., Wang, B., Cossu, M., Metcalf, W. W., Boal, A. K., & Booker, S. J. (2022). Discovery, structure and mechanism of a tetraether lipid synthase. *Nature*, 609(7925), 197-203. https://doi.org/10.1038/s41586-022-05120-2.

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