

Fall 2024 Meeting of the Board on Life Sciences



TUESDAY, OCTOBER 29, 2024

OPEN SESSION

12:30pm–2:30pm ET

Genetically Engineered Microbes: Future Challenges and Opportunities

Speakers will discuss trends in research and development at the frontier of engineering biology to create microbes and microbial communities that may benefit a diversity of fields including health, energy, the environment, agriculture, and more. Speakers will consider biotechnologies and research driving innovation of these microbes and their products, challenges for safe and effective deployment of these genetically engineered microbes, opportunities for using advanced computation and experimentation to solve long-standing technical challenges, and policy and data needs for addressing future research and development. This discussion is intended to be forward-leaning looking at edge cases and the unique challenges and opportunities they create.

Moderator

India Hook-Barnard, Engineering Biology Research Consortium

Speakers

Richard Murray, California Institute of Technology

John Marken, California Institute of Technology

Alexa Schmitz, REEgen

Zachary Abbott, Zbiotics

Vincent Sewalt, International Flavors & Fragrances

2:30pm–3:00pm ET

Break

3:00pm–5:00pm ET

Exploring The Intersection of Art and the Life Sciences

During this session, board members and interested members of the public will be able to speak with artists who use various mediums to capture biological phenomena, systems, and concepts in creative and accessible ways.

Facilitator

Louis Muglia, Borrough Wellcome Fund

3:00pm–4:15pm ET

Featured Artists

Beata Mierzwa

Frederic Bertley, Center for Science and Industry (COSI)

4:15pm–4:45pm ET

END OF DAY 1

WEDNESDAY, OCTOBER 30, 2024

OPEN SESSION

1:30pm–3:00pm ET

Education and Training to Meet Future Needs of the Life Sciences and Biotechnology Enterprise within an Increasing Contract Research and Manufacturing Context

Speakers will discuss the integration and use of contract research and manufacturing organizations within the life sciences and biotechnology research enterprise, the availability of a trained workforce, and needs for education and training of individuals to meet the needs for contract research and manufacturing within the research enterprise. Speakers will be asked to describe: a) the skills, expertise, and skill or knowledge level needed to support contract research and manufacturing organizations and contract research services at universities, which also has emerged during the past several years; b) sufficiency of existing education and training programs at various levels (e.g., high school, vocational school, community college, 4-year undergraduate, post-graduate training) for meeting these needs; and c) opportunities for building education and training to address these needs.

Moderator

Patrick Boyle, Ginkgo Bioworks

Speakers

Emily Aurand, Engineering Biology Research Consortium

Linnea Fletcher, Austin Community College and InnovATEBIO

Natalie Kuldell, Massachusetts Institute of Technology

Tamara Goetz, Utah STEM Action Center

Tyson Schank, KCAS Bio

END OF MEETING

SPEAKER BIOGRAPHIES

Genetically Engineered Microbes: Future Challenges and Opportunities

Zachary Abbott is the CEO and Co-founder of ZBiotics, and the inventor of ZBiotics' proprietary technology. ZBiotics genetically engineers probiotic bacteria to perform specific functions, and then uses those engineered probiotics as ingredients in food products that they brand and sell directly to consumers. They launched their first product containing a genetically engineered probiotic to the market in 2019 and their second product in 2024. All of ZBiotics's products are labeled "proudly GMO", and the company's mission is to elevate the conversation around genetic engineering and GMOs. Zack has a PhD in microbiology & immunology from the University of Michigan where he studied bacterial gene regulation in *Legionella pneumophila*, and prior to starting ZBiotics, he worked in clinical trial design as well as researching HIV vaccines and pursuing novel antibiotics in both academia and industry.

India Hook-Barnard is Executive Director of the Engineering Biology Research Consortium (EBRC). Her primary interests are in the areas of synthetic biology, precision medicine, responsible innovation, and biosecurity. India enjoys building multidisciplinary collaborations and developing a vision and strategy to address complex challenges. She works with experts and leaders from across academia, industry, and government sectors to identify and shape scientific opportunities, technical feasibility, and policy issues. Her goal is to advance and accelerate engineering biology solutions across all application areas, drive innovation, and grow the bioeconomy for all.

Prior to joining EBRC, India was Senior Advisor to the Beyond 2020: A Vision and Pathway for NIH Working Group, and Senior Vice President for Patient Outcomes and Experience at the National Marrow Donor Program. She was the Director of Research Strategy and Associate Director, Precision Medicine at the University of California, San Francisco; she helped launch and was the Executive Director for the California Initiative to Advance Precision Medicine. Earlier in her career, India worked at the National Academies of Sciences, Engineering, and Medicine (NASEM), focusing on areas of emerging science and technology, including policy issues of data governance, regulation, bioethics, biodefense, and workforce development. At NASEM, she directed standing committees, workshops, and six consensus reports, including *Toward Precision Medicine: Building a Knowledge Network for Biomedical Research and a New Taxonomy of Disease* (2011).

As a postdoctoral research fellow at the National Institutes of Health, India studied the regulation of gene expression in bacteria and phage. She earned her PhD in Microbiology-Medicine from the Department of Molecular Microbiology and Immunology at the University of Missouri.

John Marken is a postdoctoral scholar in the Division of Biology and Bioengineering at Caltech. John works with Caltech's Linde Center for Science, Society, and Policy to analyze the challenges associated with regulating engineered microbes intended for environmental release. He has spoken on this topic at the SynBioBeta conference and is on the steering committee for the upcoming Spirit of Asilomar conference, organizing programming for the broader theme of the environmental release of biotechnology.

John's academic research focuses on developing engineering principles and mathematical frameworks to enable the design of genetic circuits with predictable performance in variable environmental conditions. John received his Ph.D. in Bioengineering under the supervision of Richard Murray at Caltech, and received his B.S. in Applied Mathematics from the College of William and Mary.

Richard M. Murray received the B.S. degree in Electrical Engineering from California Institute of Technology in 1985 and the M.S. and Ph.D. degrees in Electrical Engineering and Computer Sciences from the University of California, Berkeley, in 1988 and 1991, respectively. He is currently the Thomas E. and Doris Everhart Professor of Control & Dynamical Systems and Bioengineering at Caltech. Murray's research is in the application of feedback and control to networked systems, with applications in synthetic biology and autonomy. Current projects include design and implementation of synthetic cells and design, verification, and test synthesis for discrete decision-making protocols for safety-critical, reactive control systems.

Alexa Schmitz is the CEO and Co-founder of REEgen, a rare earth biomanufacturing start-up based in Ithaca, NY. Alexa developed the technology for efficient recovery of rare earth elements using engineered microbes as a postdoc in the Barstow Lab in Biological and Environmental Engineering at Cornell University, where she also received her PhD in Plant Pathology and Plant-Microbe Biology. Shortly after co-founding REEgen in 2022, Alexa was awarded an Activate Fellowship, which has helped support the early development of the start-up through non-dilutive funding and intensive

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entrepreneurial training. When not answering endless emails and talking to investors, Alexa enjoys playing violin with the Cayuga Chamber Orchestra, paddleboarding on Cayuga Lake, and renovating her historic NY home.

Vincent Sewalt leads the Scientific & Public Affairs function of IFF, a business that develops nutritional and bioscience products aimed at improving sustainability of the food chain and the bio-based economy at large. Vince has an Ir. degree from Wageningen Agricultural University in the Netherlands, a Ph.D. in Nutrition from Virginia Tech in the US, and was a biotech post-doc with Agriculture & Agri-Foods Canada and with the Noble Foundation in Oklahoma, US. His early career research publications and patents made Dr. Sewalt a recognized expert in plant cell wall chemistry, plant lignin biosynthesis, maize seed physiology, and genetic manipulation interventions to enhance the conversion of both grain and biomass for animal nutrition and biofuels.

With over 25 years' experience managing innovation and market access of agricultural & bioscience products in four US companies, Vince is passionate about biotech capacity building with regulators and other stakeholders. Vince has shared his insights in Microbial Biotech risk assessment and risk communication in multiple conferences and with regulatory agencies around the globe. Vince is a prolific author with over thirty peer-reviewed publications and patents in the areas of food & agricultural science, biotechnology, and safety/regulatory of microbial products (for example, "GEMs and their regulatory oversight" <https://doi.org/10.1080/10408398.2020.1749026>). He has served as reviewer of scientific publications on biotechnology and food safety, as associate editor of the journal *Industrial Biotechnology*, and board member of multiple trade associations and NGOs.

Exploring The Intersection of Art and the Life Sciences

Frederic Bertley, President and CEO of The Center of Science and Industry (COSI), affectionately known as "Dr. B", is a scientist, scholar, immunologist and educator. His research in infectious diseases and vaccine development, as well as his commitment and innovation in STEM education have led him to programs and partnerships throughout the United States, Caribbean, South America, Africa, Europe, and Asia. His innovation has led to the development of award-winning programs including the The Color of Science™, EiPITM, Science Meets Society™, and hands-on STEM education kits. Under his leadership, COSI received the prestigious 2023 IMLS National Medal. Specifically, Bertley's work on the importance of science communication has led to several awards, including six Emmys™ for the PBS television show he hosts, "QED with Dr. B", and the animated series "Dr. B in 3". Dr. B has presented at distinguished institutions nationally and internationally including The United Nations, The White House, the National Academy of Sciences, NASA, US DOE, as well as at conferences and institutions of higher education in Europe, Asia, Africa, South America and the Caribbean. Bertley graduated from McGill University where he earned a B.Sc. studying Physiology, Mathematics, the History of Science, and a Ph.D. in Immunology. He completed a postdoctoral 3 fellowship at Harvard Medical School and MIT in DNA vaccine development.

Beata Mierzwa is a molecular biologist working on cell division of animal cells. She combine her two passions – science and art – to create unique and unconventional illustrations.

During Beata's research, she realized that these two have a great deal in common and that combining these passions creates a unique way to communicate science. She wanted to add some creativity to the conventional forms of scientific communication, with the aim to spark interest inside and outside the scientific community.

Her drawings are designed to illustrate scientific themes with an artistic twist and aim to highlight fundamental scientific aspects in an unconventional way. Beata creates her drawings for everyone to enjoy – for scientists to appreciate biological findings in a refreshing way, and for non-scientists to discover the beauty in fundamental biological principles. Every drawing is an experiment!

To create each scientific illustration, Beata collaborates with her partner, Matthew Cooney, who specializes in conservation and science communication. They begin by considering a scientific concept or recent discovery, discussing how to communicate it both inside and outside the scientific community. She then makes a detailed pencil drawing – sketching by hand allows me the greatest level of detail. For Beata, nothing can replicate the texture and feel of a real pencil on paper. After taking a high-resolution scan, Matthew digitally outlines the drawing for post-processing, and finally, Beata adds the colors and scientific data to create the finished piece. For her microscopy fashion, she spends many hours in a dark microscope room and captures the most beautiful images she can find and compiles them into aesthetic patterns.

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Louis Muglia is President and CEO of the Burroughs Wellcome Fund, an independent nonprofit research foundation accelerating discovery in the biomedical sciences. Previously, he served as Vice Chair for Research, Director of the Division of Human Genetics, Co-Director of the Perinatal Institute, and Professor of Pediatrics at Cincinnati Children's Hospital Medical Center. The goal of the Muglia laboratory has been to understand the molecular machinery comprising the biological clock that determines the timing for birth, and how this is shaped by the environment, to prevent or better treat human preterm labor and delivery utilizing genetic and comparative genomic approaches. Among Dr. Muglia's achievements are more than 280 publications and election to the American Society for Clinical Investigation and Association of American Physicians. In 2010, Dr. Muglia was elected to Fellow in the American Association for the Advancement of Science. In 2013, Dr. Muglia was elected to membership in the National Academy of Medicine and in 2020, to the Finnish Academy of Science and Letters. Dr. Muglia has served as Chair of the Board of Scientific Counselors of the NICHD at the NIH and standing member of the NIH Pregnancy and Neonatology Study Section. Currently he is a member of the Climate Change and Human Health Planning Committee, National Academy of Medicine, on the Board of Directors, Science Philanthropy Alliance, and a member of the Steering Committee for the Pediatric Scientist Development Program. Dr. Muglia earned his Doctor of Medicine (1988) and Doctor of Philosophy (1986) degrees from the University of Chicago. He received a Bachelor of Science degree in biophysics from the University of Michigan in 1981.

Education and Training to Meet Future Needs of the Life Sciences and Biotechnology Enterprise within an Increasing Contract Research and Manufacturing Context

Emily Aurand has served as the Director of Roadmapping and Education at EBRC since 2018. Dr. Aurand is the Executive Editor of EBRC's technical research roadmaps (available at <https://roadmap.ebrc.org/>). Dr. Aurand created and led the EBRC Industry Internship Program and leads the EBRCsee outreach and education project, including the collaboration with the Tumble Science Podcast for Kids to create "Life Lab" a five episode podcast series about engineering biology for school-aged kids and their families. She mentors and oversees the activities of EBRC's 200+ member Student and Postdoc Association. She also serves as a community expert on strategies and policy for engineering biology training and workforce development. Prior to EBRC, Emily was an American Association for the Advancement of Science (AAAS) Science & Technology Policy Fellow at the National Science Foundation, in the Division of Chemical, Bioengineering, Environmental, and Transport Systems (CBET). Emily received a B.S. in Biomedical Sciences from Colorado State University and a Ph.D. in Neuroscience from the University of Colorado.

Patrick Boyle is the Head of Codebase at Ginkgo Bioworks, a Boston-based synthetic biology company that makes and sells engineered organisms. The Codebase team leads Ginkgo's customer facing programs and develops the company's "Codebase" portfolio of reusable biological assets. Ginkgo's Codebase includes thousands of novel strains, enzymes, genetic parts, and diverse genetic repositories, including millions of engineered DNA sequences. During the COVID-19 pandemic, Patrick has been responsible for coordinating Ginkgo's COVID response programs in the area of therapeutics and vaccines. Much of this work has focused on optimizing the production of raw materials for nucleic acid vaccines, including Moderna's mRNA-1273 COVID-19 vaccine. Patrick also participates in a number of efforts related to the broader development of synthetic biology and biosecurity. This includes a fellowship at the Johns Hopkins University Center for Health Security, as well as two consensus studies for the National Academies of Sciences, Engineering, and Medicine: "Biodefense in the Age of Synthetic Biology" (2018) and "Safeguarding the Bioeconomy" (2020). Prior to Ginkgo, Patrick received his PhD from Harvard Medical School in 2012, developing synthetic biology applications in bacteria, yeast, and plants in the lab of Dr. Pamela Silver. He received an SB in biology from the Massachusetts Institute of Technology in 2006.

Linnea Fletcher received her Ph.D. in microbiology from the University of Texas at Austin, did two postdocs one at the Southwestern Medical Center and another in the Biochemistry Department at the University of Texas. She joined Austin Community College as a Department Chair in Biology and started the Biotechnology Program in 1999. At the same time, she joined the first NSF Funded National Biotechnology Education Center, Bio-Link and received her first NSF funded ATE grant to start Biotechnology high school programs in Texas. She worked as an NSF Program Officer from 2008 to 2010 and was involved in setting up the first Vision and Change Meeting. In 2015, she received an Emerging Technology Fund Grant to build a Bioscience Incubator at ACC and several Wagner Peyser Grants to equip it. Today the incubator is full of start-up companies and students interning or working for these companies. She was PI of the AC2 Bio-Link Regional Center, the PI of InnovATEBIO 1.0, and now InnovATEBIO 2.0 the NSF funded National Biotechnology Center. Combining economic development with educational opportunities is her passion.

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Tamara Goetz served as the Governor's State Science Advisor and during her tenure led in the creation of the Utah STEM Action Center in 2013, with the support of the Utah Legislature. Tami has over 20 years of creating STEM education and workforce development programs in partnerships across K-12 and higher education, industry and business, state agencies and cultural and community partners. She led the Center in the creation of the Utah STEM Foundation and works with numerous partners in collaborative research efforts to support promising and best practices in STEM program design and implementation. Dr. Goetz received the "40 Under 40 Rising Stars" and "30 Women to Watch" by Utah Business magazine, the Award of Merit by the National Association for Career and Technical Education, the Women Technology Council's "Community Builder" and "Decade of Impact" award and the Governor's Medal for Science and Technology.

Natalie Kuldell is a molecular biologist and educator who has combined these two parts of her career into the BioBuilder Educational Foundation, a nonprofit she founded in 2011. BioBuilder provides exposure to real-world STEM applications and industry-relevant skills to ready the largest and most diverse group of students for college and careers in science. Over the last 13 years, BioBuilder has provided content and programs in 49 states and over 66 countries, impacting approximately 63,000 students, teachers, and industry professionals. This year, BioBuilder launched a second curricular offering to complement its problem-based learning modules. This new curriculum, BioTechBuilder, is more directly connected to skills-based training, enabling students to earn a recognizable certification that speaks to their mastery of some fundamental lab techniques. The curriculum won the 2024 Educator's Choice "Best of STEM" award for Career and Technical Education curriculum.

BioBuilder's laboratory kits are distributed by Carolina Biological Supply Company and are used by 1000s of students each year. BioBuilder's textbook was published by O'Reilly Media in 2015 and has since been translated into multiple languages including Russian and Japanese. BioBuilder opened a community lab in Kendall Square's LabCentral in 2017, and a second in 2021 inside Ginkgo Bioworks. A third is scheduled to open in Allston, MA in January 2025.

Dr. Kuldell studied Chemistry as an undergraduate at Cornell, completed her doctoral and postdoctoral work at Harvard Medical School, and taught at Wellesley College before joining the Department of Biological Engineering faculty at MIT in 2003. She is the 2020 recipient of the Margret and H.A. Rey Curiosity Award and the Million Women Mentors STEM Trailblazer Award.

Tyson Schank

