Army Research Laboratory Technical Assessment Board: 2024 Panel on Assessment of Biological and Biotechnology Sciences

Committee

Samuel I. Stupp

Chair

SAMUEL STUPP (NAE/NAS) is Board of Trustees Professor of Materials Science and Engineering, Chemistry, Medicine, and Biomedical Engineering at Northwestern University. He also directs Northwestern's Simpson Querrey Institute for BioNanotechnology and the Center for Bio-Inspired Energy Science, an Energy Frontiers Research Center funded by the U.S. Department of Energy. Work in his laboratory focuses on supramolecular self-assembly aimed at creating materials and nanostructures with functions ranging from biological activity and photocatalysis to electronic properties and actuation that emulates living organisms. His laboratory designs and synthesizes organic molecules programmed to spontaneously form nanostructures and superstructures with hierarchical organization across scales. The laboratory has also developed strategies to template inorganic structures within supramolecular assemblies inspired by biomineralization in nature. An important area of interest in his laboratory has been the supramolecular self-assembly of peptide amphiphiles in water, which led to a broad platform of bioactive materials for use in regenerative medicine. These materials form hydrogels based on supramolecular filaments that display signals to cells and activate receptors to regenerate tissues such as bone, cartilage, muscle, blood vessels, and axons in the spinal cord. In the area of renewable energy the laboratory has developed materials for the synthesis of solar fuels in which the supramolecular assemblies support formation and motion of excitons to photosensitize catalysts. Other work has focused on supramolecular dynamics and its role in actuation to create robotic soft matter and optimize bioactivity. Dr. Stupp is a member of the U.S. National Academy of Sciences, the U.S. National Academy of Engineering, the American Academy of Arts and Sciences, the Royal Spanish Academy, the National Academy of Sciences of Latin America, the National Academy of Sciences of Costa Rica, and the U.S. National Academy of Inventors. Dr. Stupp has won numerous awards over the course of his career, including three American Chemical Society national awards: the Award in Polymer Chemistry, the Ronald Breslow Award for Achievement in Biomimetic Chemistry, and the Ralph F. Hirschmann Award in Peptide Chemistry. He recently received the 2022 Materials Research Society Von Hippel Award, the highest honor awarded by this society. Other awards include the Department of Energy Prize for Outstanding Scientific Accomplishment in Materials Chemistry, the Materials Research Society Medal Award, the Royal Society of Chemistry Award in Soft Matter and Biophysical Chemistry, and the Nanoscience Prize from the International Society for Nanoscale Science, Computation, and Engineering, which recognizes lifelong achievement in the field. Dr. Stupp earned a B.S. in chemistry from the University of California, Los Angeles and a Ph.D. in materials science and engineering from Northwestern University.

Katherine Borkovich

Member

KATHERINE A. BORKOVICH is a Professor in the Department of Microbiology and Plant Pathology and Divisional Dean for Life Sciences in the College of Natural and Agricultural Sciences at the University of California – Riverside and was previously an associate professor at the University of Texas-Houston Medical School. Dr. Borkovich has worked with microorganisms during her entire career. Her current research focuses on how multicellular (filamentous) fungi sense their environment and then fine-tune their gene expression to allow exploitation of different nutritional sources or to infect plant hosts. Her group pioneered study of heterotrimeric GTP-binding proteins (G proteins) in filamentous fungi, using the model system Neurospora crassa. Dr. Borkovich has contributed to whole-genome information for filamentous fungi, including predictions of gene functions in N. crassa and plant-pathogenic species in the genus Fusarium, and creation of a genome-wide mutant library for N. crassa. Her group's landmark publications have led to the discovery that G proteins regulate pathogenesis, toxin production and secondary metabolism in numerous animal and plant fungal pathogens. Dr. Borkovich has received funding for her research from the National Institutes of Health and the National Science Foundation. She has served as editor or lead author for major books and papers focused on the genomics and cell biology of filamentous fungi. Dr. Borkovich was instrumental in establishment of the Microbiology undergraduate major and reinstatement of the Microbiology graduate program at UCR. She was recognized with the 2016 UCR Campus Distinguished Teaching Award for her teaching of a research-based course for the Microbiology major, Experimental Microbiology. Dr. Borkovich is a Fellow of the American Association for the Advancement of Science and of the American Academy of Microbiology. Dr. Borkovich earned a B.S. and Ph.D. in biochemistry from the University of California, Los Angeles and performed postdoctoral training at the University of Chicago and the California Institute of Technology.

Robert Egbert

Member

ROBERT EGBERT is a staff scientist in the Biological Sciences Division at Pacific Northwest National Laboratory (PNNL). Dr. Egbert is an expert in bacterial genetic circuit design and genome engineering. He currently leads a DOE program in Secure Biosystems Design on novel genome remodeling approaches to control the persistence of engineered functions in the environment, is Integration Lead for a PNNL-led team for the DARPA Friend or Foe program, and is Co-PI for data-driven synthetic biology within the DARPA Synergistic Discovery and Design program. Dr. Egbert is also the Science Lead for an PNNL internal investment in synthetic biology and biosecurity. One of his recent projects focused on expanding the interdisciplinary visual analytical toolkit on plastic degradation through microbial metabolis by investigating the use of helium ion microscopy (HIM) as an alternative to SEM for documenting the plastic-microbe interface and biofilm development on three of the most abundant plastic polymer types: high-density polyethylene (HDPE), low-density polyethylene (LDPE) and polypropylene (PP). This research elucidated insights into the development of microbial populations on polyolefins and details about microbial attachment phenotypes. He received dual-BS degrees in electrical engineering and Korean at Brigham Young University, a Ph.D. in electrical engineering from the University of Washington working with Eric Klavins, and a joint appointment as a postdoctoral researcher at the University of California Berkeley and Lawrence Berkeley National Laboratory.

Courtney Ellison

Member

COURTNEY ELLISON is an assistant professor in the department of microbiology at the University of Georgia, where she runs the Ellison Lab. Her research interests include microbe-host interactions, which includes studying the roles of microbes in disease, beneficial symbiosis, pathogenesis, parasitology, and immunology; microbial ecology, which includes studying the interactions of microorganisms with the environment, and their roles in natural communities and molecular microbiology, which includes studying molecular approaches to studying microbial structures, cell biology, gene regulation, genomic stability, development. As part of her research, she has investigated how single bacterial cells join together to form complex biofilms and on bacterial appendages called type IV pili that play a crucial role in biofilm formation. Dr. Ellison obtained a B.S. in microbiology from the University of Georgia and a Ph.D. in microbiology from Indiana University. She completed her postdoctoral training at Princeton University.

Katrina Forest

Member

KATRINA FOREST is a Professor and Chair in the Bacteriology Department at UW-Madison. Her laboratory's area of research are in structural microbiology—studying biological interactions at the molecular level with a focus on the structures, functions, and mechanisms of bacterial proteins with consequences to prokaryotic physiology and symbiosis with eukaryotes. She is, in particular, known for her work on the knotted red-light photoreceptor phytochrome and on the intricacies of the bacterial Type IV pilus. She is a Fellow of the American Society for Microbiology, has served as chairperson of the NIH Prokaryotic Cellular and Molecular Biology study section, was Chair of the 2018 Photosensory Receptors Gordon Conference, is on the Steering Committee of the Advanced Photon Source Life Sciences Collaborative Access Team, and is on the Board of Directors of Advantigen Biosciences. Dr. Forest received her bachelor's degree in applied biology from MIT followed by a Ph.D. in molecular biology at Princeton University under the research mentorship of Clarence Schutt.

Nancy Keller

Member

NANCY KELLER is a Professor of Medical Microbiology and Immunology and Plant Pathology at the University of Wisconsin-Madison. She is internationally preeminent fungal biologist, with particular expertise on toxigenic fungi and the mycotoxins they produce. Her research focus lies in genetically dissecting those aspects fungi that render them potent pathogens and superb natural product (also called secondary metabolite) machines. Her laboratory's research is focused on: Biosynthetic gene clusters and synthetic expression of these clusters which includes: characterizing regulation, genes and entire gene clusters in a range of fungi including several clusters involved in virulence in the human pathogen A. fumigatus and developing tools for heterologous expression of secondary metabolite gene clusters. Her laboratory is also looking at epigenetic control of BGC and initiated the concept of epigenetic regulation of secondary metabolism not only through LaeA studies but also through the finding that deletion or overexpression of histone modifying enzymes and feeding of chemical epigenetic modifiers can induce the production of 'silent' gene clusters. Histone modifying proteins affecting secondary metabolism include HdaA a histone deacetylase, EsaA a H4 acetyl transferase and CclA a member of the histone H3K4 methylation complex. Since their first description of this phenomenon, many other labs have published on the epigenetic regulation of secondary metabolites and addition of chemical epigenome modifiers is now a popular method to enrich natural product production. She is also focused on elucidating fungal metabolic pathways (e.g. copper, mitochondrial, aromatic amino acid metabolomes, etc.) as tangible drug development targets. To expand the limitations imposed by insect and murine models of IA, her laboratory has also developed the A. fumigatus/host toolset through development of microscale platforms and a visual zebrafish larval model of IA. Her laboratory is also elucidating identification of cross-kingdom small molecule communication. Dr. Kellery received both her M.S. and Ph.D. degrees in plant pathology from Cornell University. Following postdoctoral work in genetics, she became a faculty member at Texas A&M University and, subsequently (since 2001), at the University of Wisconsin.

Minkyu Kim

Member

MINKYU KIM is an Associate Professor at the University of Arizona, holding appointments in the Departments of Materials Science and Engineering and Biomedical Engineering, and is affiliated with the BIO5 Institute. Dr. Kim’s expertise encompasses the design, synthesis, materials processing, and multiscale characterization of biopolymer-based functional materials, aimed at advancing human health, defense, and environmental safety. His research integrates biopolymer nanomechanics, polymer physics, biomolecular engineering, and soft materials, significantly contributing to the fields of biomaterials and biotechnologies. He has been recognized with the NSF CAREER Award in 2022 and is an active member of the Materials Research Society. Dr. Kim earned his Ph.D. in Mechanical Engineering and Materials Science from Duke University, focusing on developing protein-based building blocks for nanostructured molecular networks and materials. He further expanded his expertise during his postdoctoral training at MIT, where he contributed to the development of innovative polymer- and biopolymer-based materials for defense applications.

Lynn Rothschild

Member

LYNN ROTHSCHILD is Senior Research Scientist, Bio and Bio-Inspired Technologies, Research and Technology Lead for NASA HQ STMD Dr. Rothschild is passionate about the origin and evolution of life on Earth or elsewhere, while at the same time pioneering the use of synthetic biology to enable space exploration. With a foundation in protistology and evolution, research interests include the early evolution of life, life in extreme environments and the search for life in the universe. As an evolutionary biologist and astrobiologist and wears several hats as a senior scientist NASA’s Ames Research Center and Bio and Bio-Inspired Technologies, Research and Technology Lead for NASA Headquarters Space Technology Mission Directorate, as well as Adjunct Professor at Brown University, and the University of California Santa Cruz. Her research has focused on how life, particularly microbes, has evolved in the context of the physical environment, both here and potentially elsewhere. She founded and ran the first three Astrobiology Science Conferences (AbSciCon), was the founding co-editor of the International Journal of Astrobiology, and is the former director of the Astrobiology Strategic Analysis and Support Office for NASA. Astrobiology research includes examining a protein-based scenario for the origin of life, hunting for the most radiation-resistant organisms, and determining signatures for life on extrasolar planets. More recently Dr. Rothschild has brought her creativity to the burgeoning field of synthetic biology, articulating a vision for the future of synthetic biology as an enabling technology for NASA’s missions, including human space exploration and astrobiology. Since 2011 she has been the faculty advisor of the award-winning Stanford-Brown iGEM team, which has pioneered the use of synthetic biology to accomplish NASA’s missions, particularly focusing on the human settlement of Mars, astrobiology and such innovative technologies as BioWires and making a biodegradable UAS (drone) and a bioballoon. Her laboratory will be move these plans into space in the form of the PowerCell synthetic biology secondary payload on a DLR satellite, EuCROPIS, scheduled to launch in July 2017. She is a fellow of the Linnean Society of London, The California Academy of Sciences and the Explorer’s Club. In 2015, she was awarded the Isaac Asimov Award from the American Humanist Association, and was the recipient of the Horace Mann Award from Brown University, and has been a NASA Innovative Advanced Concepts (NIAC) fellow three times, most recently in 2018.

Justin Siegel

Member

JUSTIN SIEGEL is a Professor at the University of California, Davis (UC Davis), holding concurrent appointments in the School of Medicine, Business School, Genome Center, and the Department of Chemistry within the College of Letters and Science. His scientific efforts are focused on combining computational and experimental tools to develop a fundamental knowledge of enzyme catalysis, and applying those principles to design novel proteins of therapeutic or commercial interest. He has been working with an international community on the development of Rosetta computational methodology for predicting and designing macromolecular structures, interactions, and functions. Using this methodology He has completed the de novo design of enzymes capable of catalyzing chemical reactions not found in nature, such as the Diels-Alder reaction. This was followed up by working with an online community, Foldit, to further engineer these proteins for enhanced activity. More recently, he has worked on the redesign of naturally occurring enzymes for the degradation of immunogenic gluten proteins, to develop a novel CO2 fixation pathways, and design of a novel anthrax therapeutic. His research is also focused on the design of novel biofuel and commodity chemical biosynthetic pathways, the development of novel therapeutics, and the general understanding of the relationship between protein sequence, structure, and function. He currently serves as the Director of the Innovation Institute for Food and Health at UC Davis. An expert in protein engineering, molecular modeling, artificial intelligence, synthetic biology, and research commercialization, Dr. Siegel has authored over 50 publications and holds more than 100 patents. These contributions have led to over a dozen commercial ventures, producing innovative products across the research tools, food, wine, and healthcare industries. In 2023, he was elected to the National Academy of Inventors. Dr. Siegel earned his B.S. in biochemistry from UC Davis in 2005 and his Ph.D. in molecular biophysics and structure design in 2011 from the University of Washington.

Kevin Solomon

Member

KEVIN SOLOMON is an Associate Professor of Chemical & Biomolecular Engineering at the University of Delaware (UD). Prior to his position at UD, Prof. Solomon was an Assistant Professor of Agricultural & Biological Engineering at Purdue University. He has expertise in systems and synthetic biology, applied microbiology, metabolic engineering, and protein engineering. His research centers on the development of environmental microbes for applications in sustainability, materials research, and health. Examples include the creation of tools to engineer lignocellulolytic anaerobic fungi native to large herbivores for renewable biofuel production and ongoing discovery of plastics-degrading enzymes from the microbiome of yellow mealworms. He has coauthored several technology roadmaps for engineering biology and provided expert testimony before the 116th US House of Representatives on the convergence of engineering and biology. He has been recognized with multiple awards for research, teaching, and service including a US Department of Energy Early Career Award (2019), an NSF CAREER Award (2022), the Society for Industrial Microbiology & Biotechnology (SIMB) Early Career Award (2022), the Lloyd N. Ferguson Young Scientist Award from NOBCChE (2023), the American Chemical Society (ACS) Biochemical Technology (BIOT) Division Early Career Award (2023) and the AIChE Division 15 Early Career Award (2023). Dr. Solomon received his B. Eng in chemical engineering and bioengineering from McMaster University, and M.S. and Ph.D. in chemical engineering from the Massachusetts Institute of Technology (MIT) in 2012.