BIOSCIENCES AREA
FY22 LDRD PRIORITIES

Biomaterials *[POCs: Nigel Mouncey & Blake Simmons]*

Discovery, development and application of novel host organisms, biosynthesis pathways, biocatalysts and computational approaches for the design, synthesis, characterization and testing of genetically encoded systems for the production, modification and/or recycling of advanced biomaterials that are fit-for-purpose or bioadvantaged for targeted industry sector(s).

Biodefense/Biodetection *[POCs: Susannah Tringe & Blake Simmons]*

Development of novel and validated approaches and experimental or computational technologies that can detect engineered or naturally occurring pathogenic organisms (bacteria, fungi, animals) or viruses and/or their associated biomarkers (biosignatures, viruses, proteins, etc.) relevant to biodefense applications. This includes understanding the fate of engineered organisms in targeted ecosystems, and the role of abiotic and biotic stressors that play a role in determining their viability and pathogenicity (e.g., ecosystem surveillance). Development of novel mitigation, decontamination and countermeasure strategies to combat the release, by malevolent intent or by error, of such pathogenic organisms or viruses into the environment. Development of novel design for and construction of resilient biosystems (e.g. cell-free systems) for stable and on-demand production of molecules and sensors relevant to biodefense applications are also desired.

C1 Biomanufacturing *[POC: Blake Simmons]*

Discovery, development and demonstration of novel biological approaches to the capture, purification and conversion of carbon dioxide into biofuels and bioproducts. Specific technical challenges and barriers to be addressed should include efficient coupling of CO2 capture, conversion, and separation chemistries; development of efficient bioprocesses for separations; working with low pressure, dilute carbon dioxide streams; efficient utilization of reductants for deoxygenation; selective C-C bond formation (carbon-carbon homologation); incorporation of heteroatoms (e.g., N or S) using biochemical or synthetic biology strategies; exploitation of multiphase reactions (especially at gas/liquid and liquid/solid interfaces); and integration of hybrid biological and electro/chemical catalysis for the conversion of CO2.

Single Cell Characterization *[POC: Susannah Tringe]*

Development and application of novel approaches that enable the isolation and characterization of single cells from environmental or cultured cell populations or single cells derived from tissues of multicellular organisms, using droplet emulsion, microparticle cultivation, cell sorting or other

cell segregation methods in combination with single cell-scale profiling of genomes, transcriptomes, proteomes or metabolomes. Cells may be of bacterial, archaeal, fungal, algal, plant, protist or animal origin. Development of novel computational analysis and data integration strategies that enable the robust and meaningful biological interpretation of single cell-derived omics data sets.

Plant- and Microbe-mediated Carbon Capture *[POCs: Susannah Tringe & Nigel Mouncey]*

Development of approaches and systems for enhanced carbon capture or storage by plants, fungi, bacteria, algae, or microbial communities. Development of new tools to assess plant, bacterial, fungal and/or algal functions important in carbon cycling. Development of models to predict key drivers of carbon allocation and long-term stability.

Quantum Imaging and Sensing *[POC: Paul Adams]*

Development of new approaches for imaging or sensing of biological systems by exploiting quantum phenomena. For example, this may include the use of effects such as quantum entanglement to measure biological systems with sensitivity and resolution exceeding the limits of classical imaging or sensing.

Integrated Hybrid Methods *[POC: Paul Adams]*

Development of physical or computational approaches to combining data from multiple measurement modalities to better understand biological systems. This includes advances in instrumentation that enable multiple measurements on the same biological sample, either simultaneously or sequentially. This also includes new computational approaches that enable biological insights by combining multiple measurements.

COVID-19 Platform Technologies and Research *[POC: Paul Adams]*

Development of new platform technologies (e.g. self-driving labs, high-throughput biological characterization capabilities) or research (e.g. inverse design of therapeutic compounds, ecosystem surveillance) that address critical scientific challenges related to SARS-CoV-2 and COVID-19. Application of technologies or research to testing and diagnostics, therapeutics and treatments, or detection and mitigation of viral spread for SARS-CoV-2 and COVID-19. Research on SARS-CoV-2 or COVID-19 topics that can be translated to future DOE (or other federal agency) mission research.