


Assessment of *Engineering Biology*

This 2021 Assessment reports on progress in the field relative to EBRC's 2019 technical roadmap, *Engineering Biology: A Research Roadmap for the Next-Generation Bioeconomy* (available at <https://roadmap.ebrc.org>).

KEY: Central number corresponds to the respective Goal as listed.

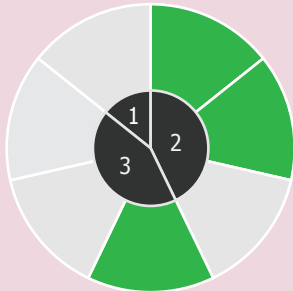
 Progress towards this Breakthrough Capability is ahead of roadmap predictions

 Progress has met, or is expected to meet prediction

 Progress is behind

Engineering DNA

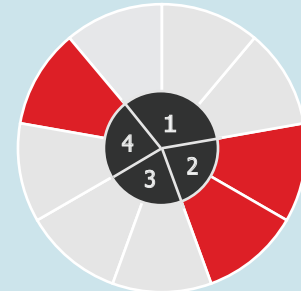
- 1 Manufacture thousands of very long oligonucleotides with high fidelity
- 2 Many-fragment DNA assembly with simultaneous, high-fidelity sequence validation
- 3 Precision genome editing at multiple sites simultaneously with no off-target effects



Enzymatic DNA synthesis; Advancements in enzymatic DNA synthesis are enabling the engineering of longer oligomers, improving the efficiency of engineering more organisms.

Biomolecular Engineering

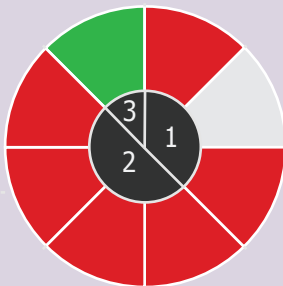
- 1 On-demand design, generation, and evolution of macromolecules for desired functions
- 2 Special considerations for on-demand design, generation, and evolution of macromolecules that rely on non-canonical/unnatural building blocks
- 3 Holistic, integrated design of multi-part genetic systems (i.e., circuits and pathways)
- 4 Integrated design of RNA-based regulatory systems for cellular control and information processing



Protein structure modeling and prediction; Advancements in software and platforms, like AlphaFold 2, are enabling more efficient and accurate prediction and modeling of protein structure.

Data Science

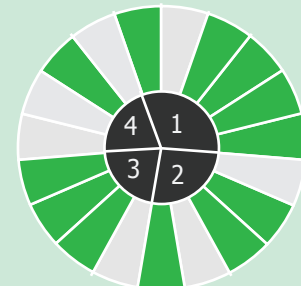
- 1 Establish a computational infrastructure where easy access to data supports the DBTL process for biology
- 2 Establish functional prediction through biological engineering design at the biomolecular, cellular, and consortium scale
- 3 Establish optimal manufacturing processes from the unit-operation to the integrated-screening scale



Computational resources and shared data; Deficiencies in shared and accessible data and a paucity of computational resources are slowing some advancements in engineering biology.

Host Engineering

- 1 Cell-free systems capable of natural and/or non-natural reactions
- 2 On-demand production of single-cell hosts capable of natural and non-natural biochemistry
- 3 On-demand fabrication and modification of multicellular organisms
- 4 Generation of biomes and consortia with desired functions and ecologies



Genome engineering; New platforms and tools, such as integrases and CRAGE, are enabling greater engineering of host genomes, including in non-model organisms.