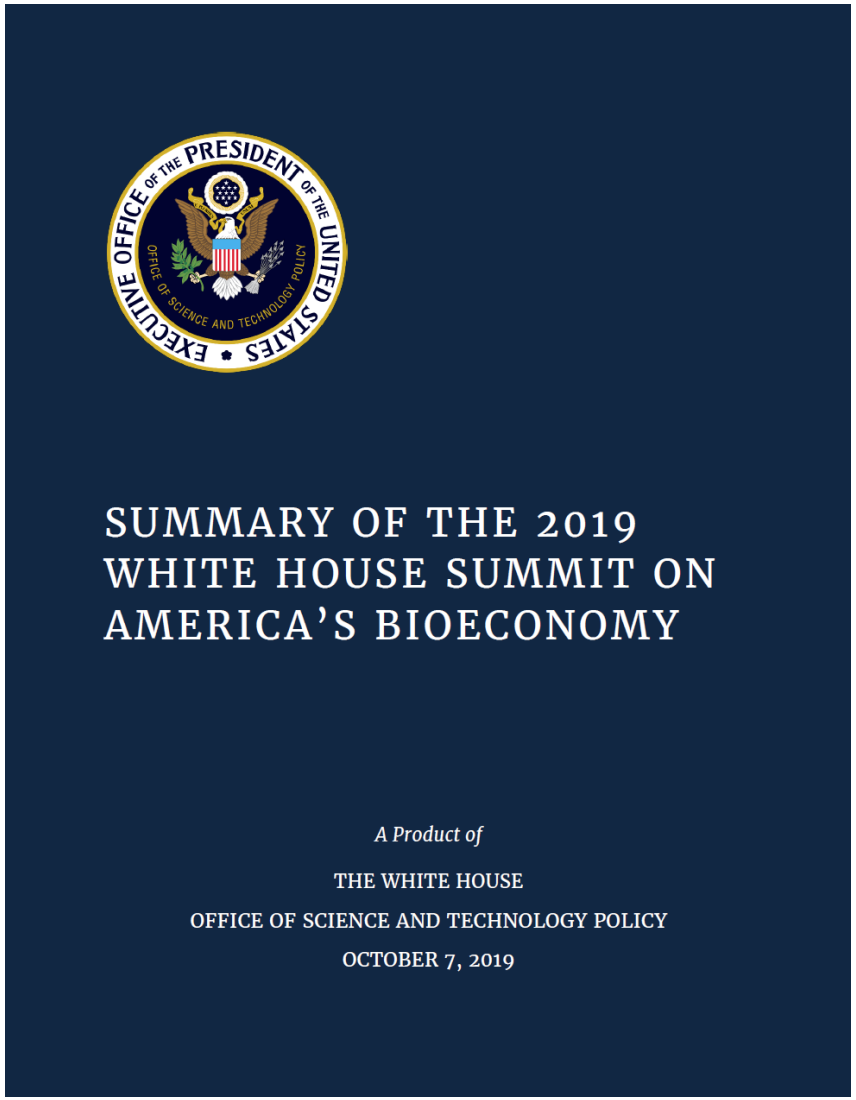
Engineering Biology

National Institute of Standards and Technology
U.S. Department of Commerce

NIST Gaithersburg

February 12, 2020

Bioeconomy



- Biotechnology added as "Industry of the Future" in Administration FY21 R&D Budget Priority Memo
- Bioeconomy – biotechnology innovation to drive economic growth and improve lives
- NIST mission (industry), expertise, and capabilities are aligned and staff are highly engaged with our Federal partners
- DOD – Biotechnology named as modernization priority
- DOD – Synthetic Biology Manufacturing Innovation Institute, in addition to BioFabUSA
- DOE – Innovation Xlab for Biomanufacturing

NSTC Subcommittees

- Biosciences Subcommittee (NIST, NSF, DOE, DOD, others)
  - Co-Chair Synthetic Biology (Sheng Lin-Gibson)
    - Interagency Workshop, Oct 18, 2019
    - Review needs, gaps, and solutions
    - Identify opportunities for interagency coordination
    - Recommendations for Bioeconomy development
  - Co-Chair Biological Data (Michael Tarlov)
    - Interagency Workshop, June 12, 2019
    - Define needs and best practices for biological data
    - Develop a roadmap for robust sharing and reuse of data
  - Co-Chair Federal workforce (Rebecca Zangmeister)
- Biodefense Subcommittee (NIST, DOD, others)

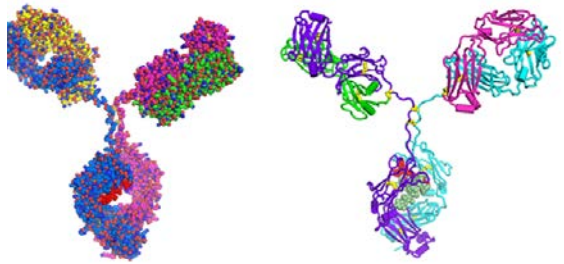
Bioeconomy – NIST programs

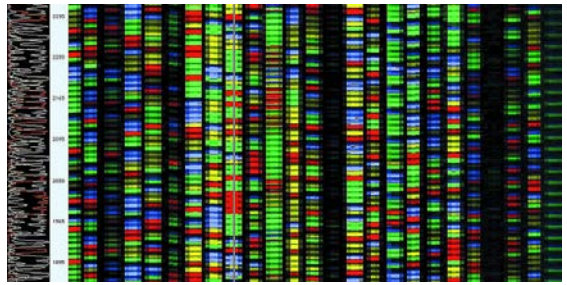
Support for the Bioeconomy	$30.5 M

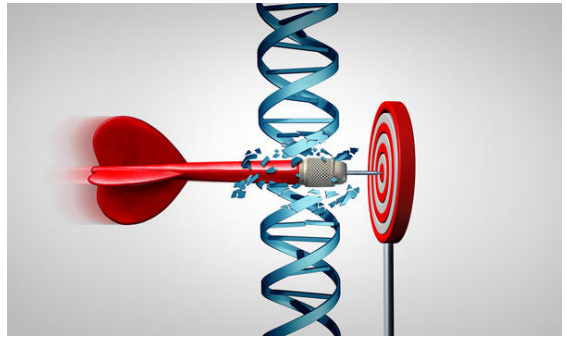
- MML Divisions:
  - Biosystems and Biomaterials Division
  - Biomolecular Measurement Division
- IBBR (UMD) / NIST JIMB (SLAC)
- Significant Activities in PML, NCNR, ITL, CTL, EL

- Biomanufacturing Initiative ($10M /yr)
- Engineering Biology IMS ($1M /yr)
- Engineering Biology Initiative ($4M /yr)
- Regenerative Medicine ($2.5M /yr)

- NIIMBL ManufacturingUSA ($70M, $129M+ match)
- BioFabUSA (DOD Manufacturing USA)
- SynBio MII (planned DOD Manufacturing USA)







Engineering Biology

Engineering Biology / Synthetic Biology

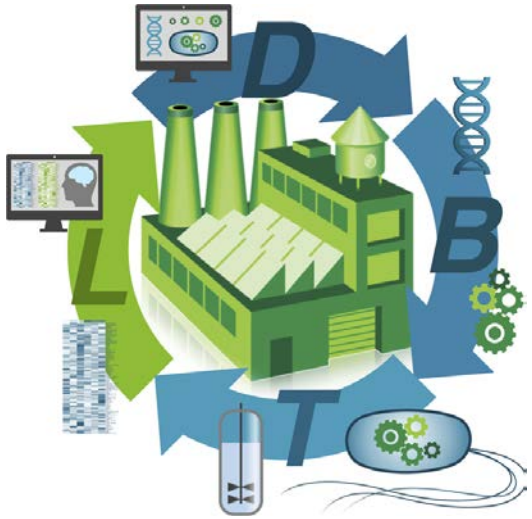
The application of engineering design principles and practices to biological systems, including molecular and cellular systems, to advance fundamental understanding of complex natural systems and to enable novel or optimize functions and capabilities.

Biomanufacturing

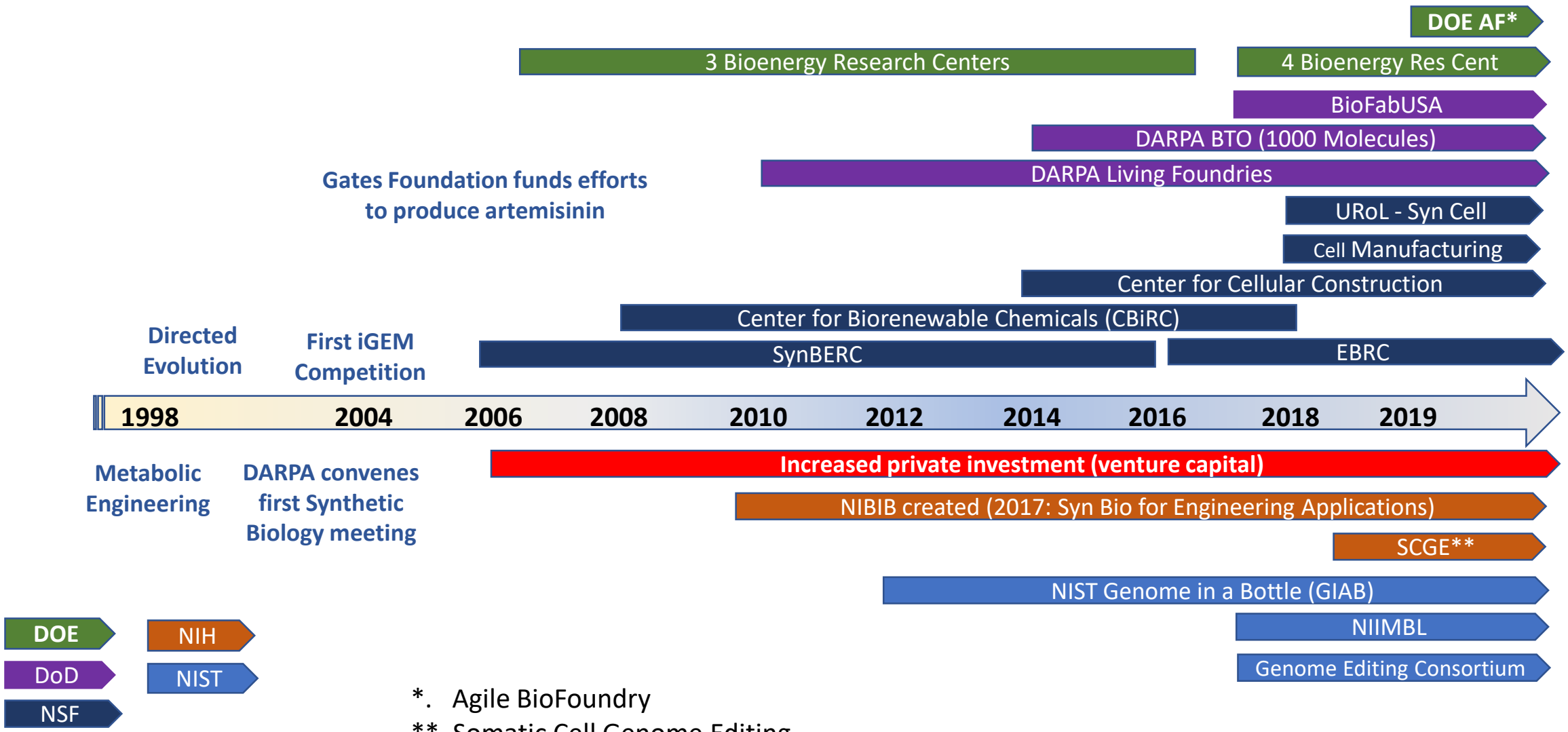
The utilization of biological systems to develop new and advance existing products, tools, and processes at commercial scale.

H.R 4373 Engineering Biology Research and Development Act (2019). DOC/NIST shall -

- Establish a bioscience research program to advance SRMs and measurements and to create new data tools, techniques, and processes…;
- Provide access to … advanced or unique equipment, services, materials, and other resources to industry, … higher education,… and government agencies to perform research and testing; and
- Provide technical expertise to inform the potential development of guidelines or safeguards for new products, processes, and systems of engineering biology



EngBio - Selected US Investments



*. Agile BioFoundry

** Somatic Cell Genome Editing

EngBio – Grand Challenge

Develop a new measurement infrastructure that provides quantitative metrics of complex living systems and processes including

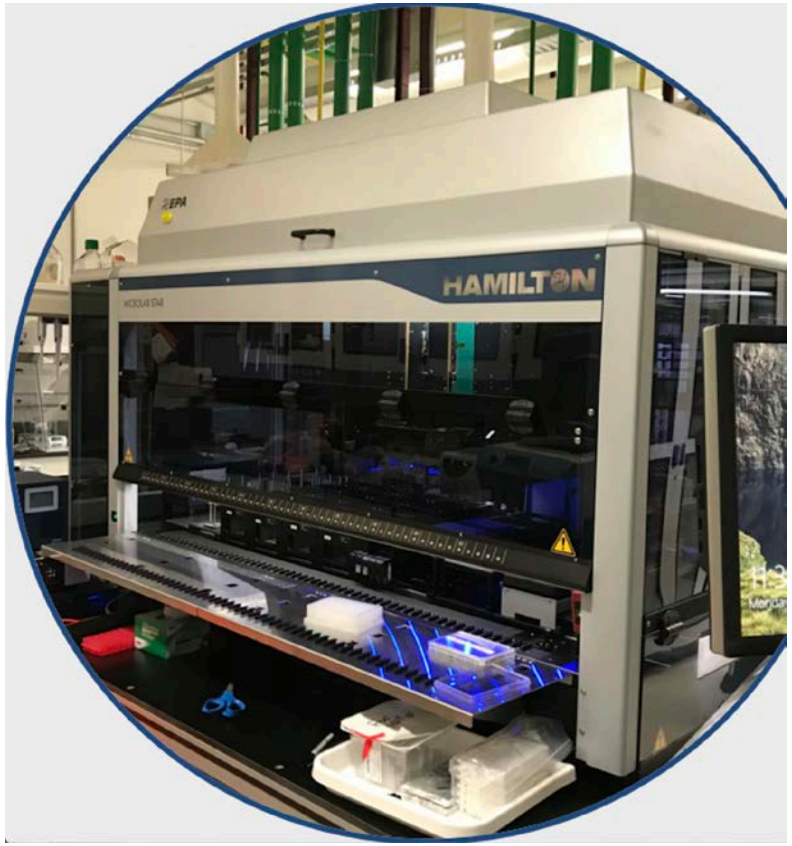
tools, platforms, and data to predictively engineer biological systems;

and global standards to accelerate R&D to commercialization.

- Build and deploy unique platforms that integrate
  Flexible automation
  Innovative measurements
  Manufacturing technologies
  Machine learning / Artificial intelligence

- Develop and deploy measurement assurance strategies and “living” cell-based reference materials

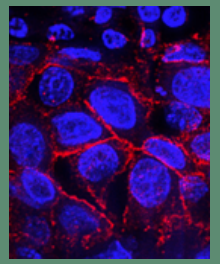
EngBio – Measurement Platforms



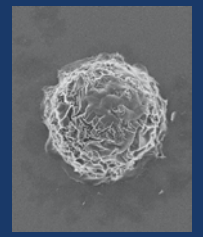
EngBio – “Living” Reference Materials

- Interlaboratory testing (understand measurement accuracy, precision, & robustness)
- Assess assay performance and foster new measurement technologies for quality assurance
- Tools for promoting cross-industry collaborations to address shared measurement problems

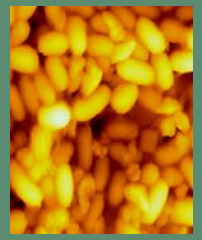
Genome in a Bottle (GIAB) cells & DNA ★



Fully consented cancer & normal cells

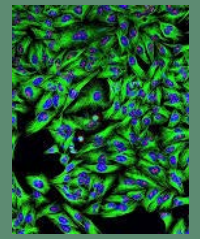


Jurkat cells with different VCN



Yeast with ERCC insert

Mixed pathogens



CHO cells that express NISTmAb

☆ Currently available

Highlight

"Organizing genome engineering for the gigabase scale"

Bryan Bartley, Jacob Beal (Raytheon BBN Technologies), Jonathan R. Karr (Icahn School of Medicine), Elizabeth A. Strychalski (NIST)

Nature Communications, on-line, 2020.

- From engineering genes to engineering genomes
- Challenge: coordination and integration of workflows and large research teams
- Adopt and extend representations for designs, assembly plans, samples, data, and workflows
- New technologies for data curation and quality control

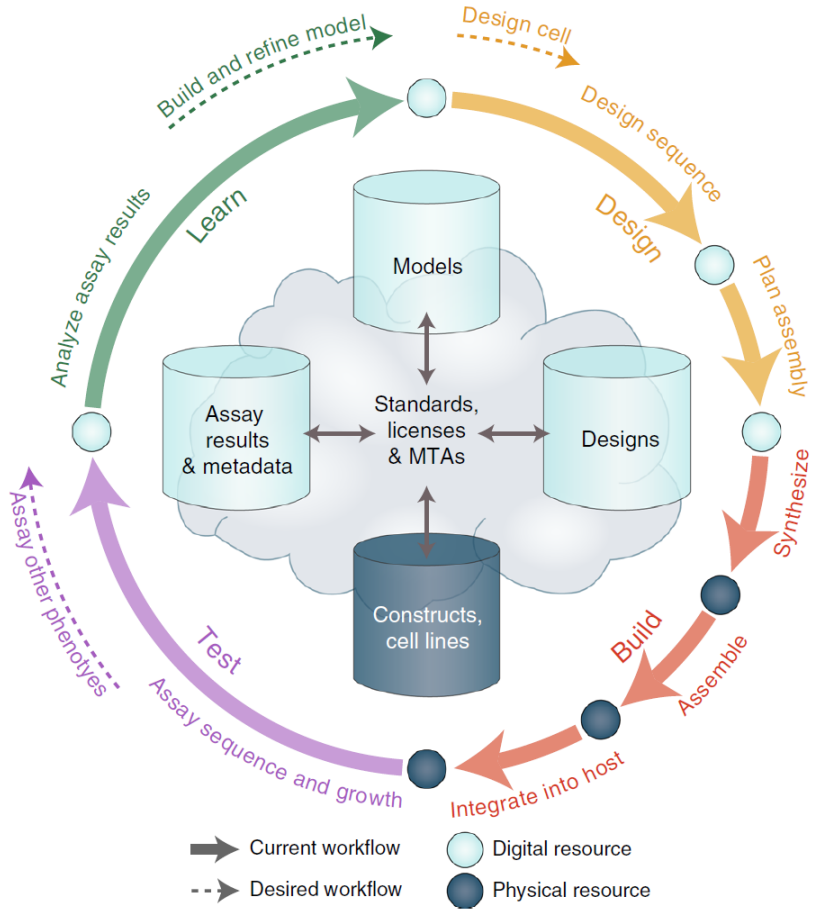
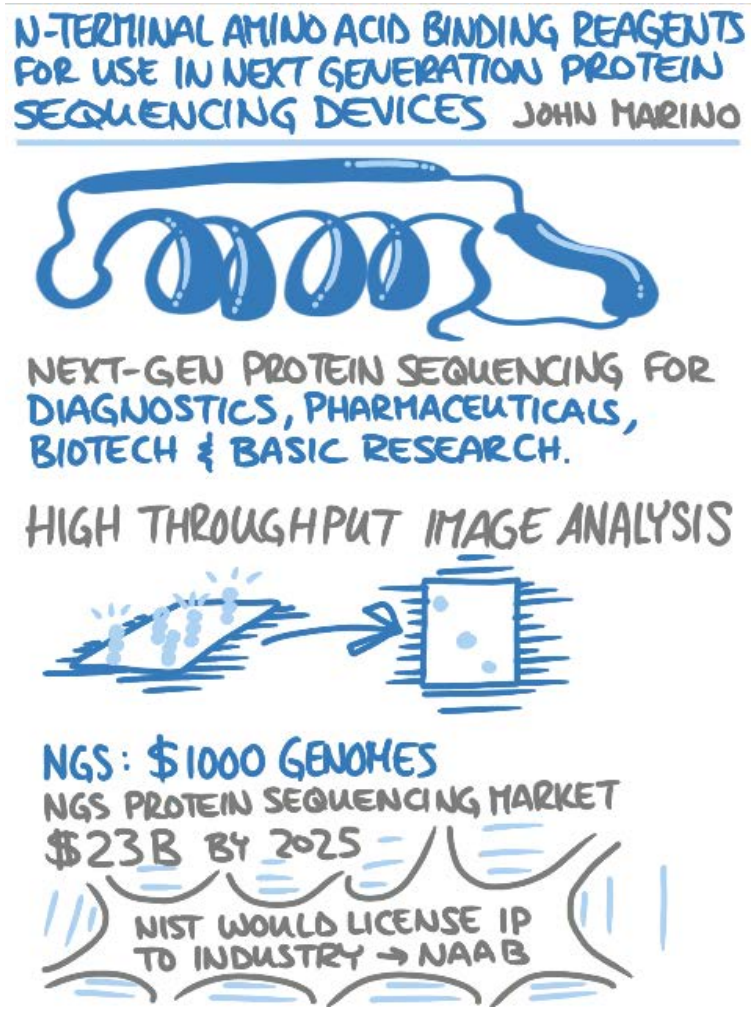


Fig. 2 The emerging design–build–test–learn workflow for genome engineering is shown schematically with current (solid arrows) and likely future (dashed arrows) tasks, interfaces (circles), and repositories (cylinders), either digital (light) or physical (dark).

Highlight



"N-Terminal amino acid binding (NAAB) reagents for use in next-generation protein sequencing devices"

John Marino, Zvi Kelman, William O'Dell, Nicholas Callahan

NIST Technology Maturation Accelerator Program

- Transformative approach to proteomic analysis, beyond genomics
- Create novel, protein-based sensors to sequence proteins at high-speed and low-cost
- Patented and licensed amino-acid-recognition reagents via evolutionary selection

DISCUSSION