NIST Cellular Engineering Group

Vision Realize engineering biology comparable to our ability to engineer non-living systems

Goal Deliver living measurement systems to advance biometrology, tools, and standards for innovation and translation of engineering biology capabilities

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Living Measurement Systems use biological parts to measure biology and enable control in biological systems

NIST Cellular Engineering Group: Current project areas

Standards, protocols, and data

Protocols and standards for AI-ready biological data

Large-scale genotype-phenotype landscape measurements for protein engineering

Predictive modeling of genotype-phenotype landscapes with interpretable AI models

AI for engineering biology

Standards and best practices for nucleic acid synthesis and screening

Synthetic and minimal cells

Measurements to understand, optimize, and generalize whole genome transplantation

Metrology for cell-free expression systems

Quantitative assays to benchmark cell extracts, reagents, and cell-free reactions

Best practices and documentary standards to support reproducibility

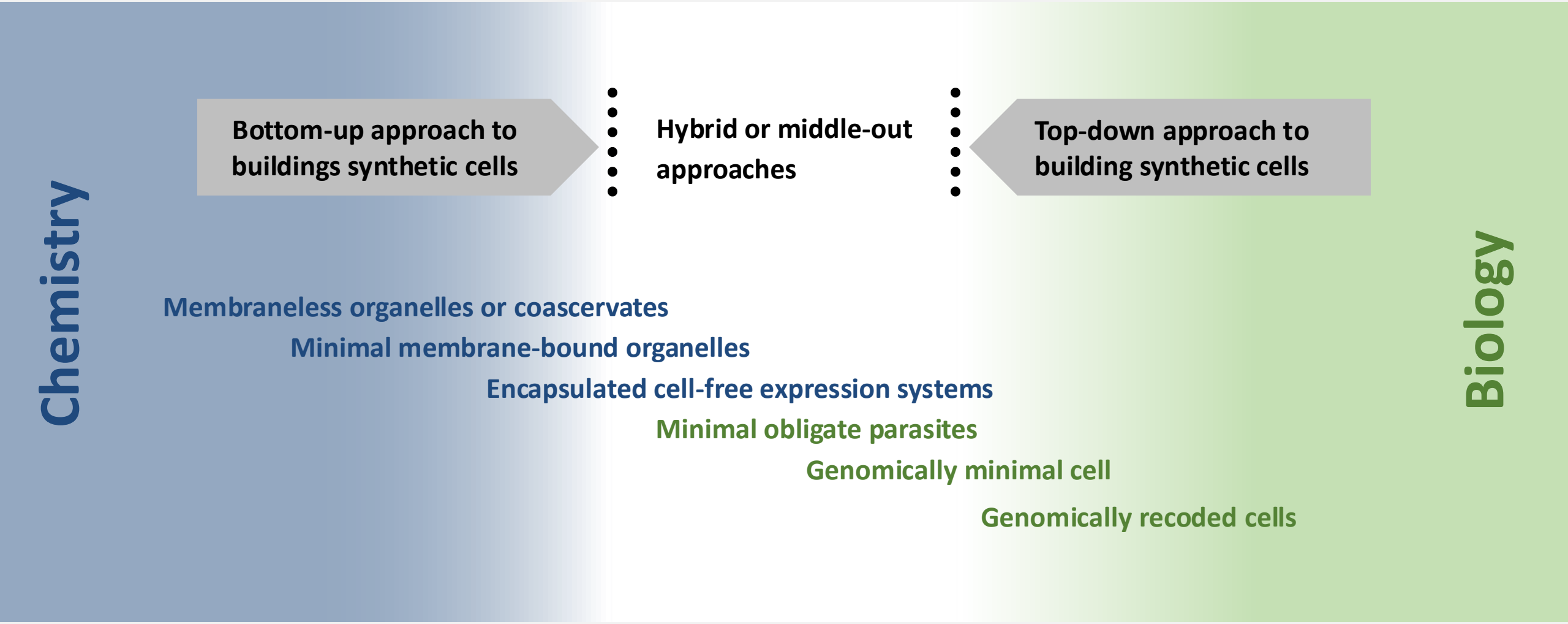
Metrology for rapid, successful scale-up of safe, effective bioproducts

RNA synthetic biology

Predictable molecular computation using RNA circuits based on nucleic strand exchange

Engineering living measurement systems for sensing using RNA

Should we explore all the possibilities for synthetic cells?

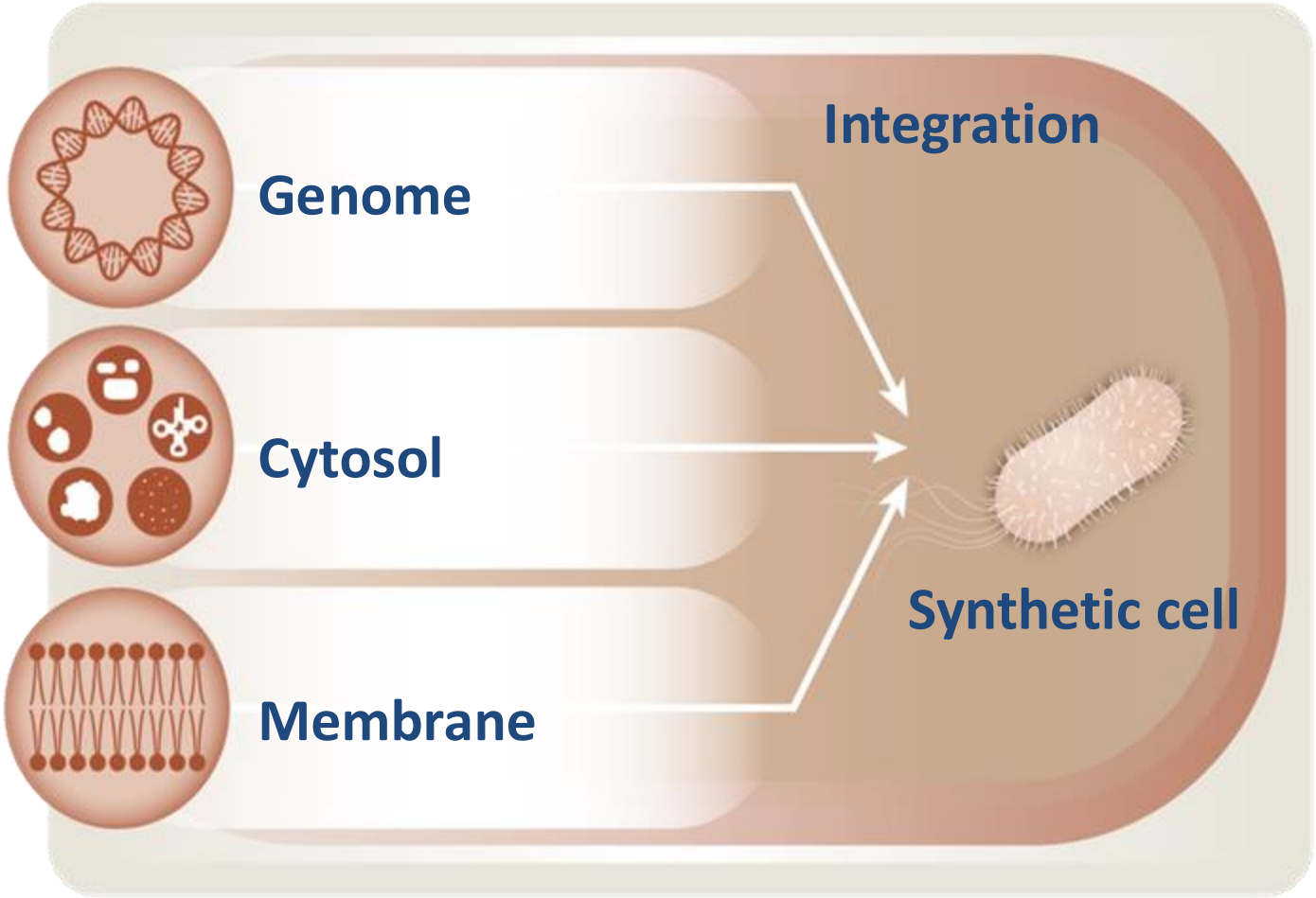


Need for measurements supporting the safe, ethical, and secure development and use of all types of synthetic cells

NIST assays, data, and automation methods for synthetic cytosol

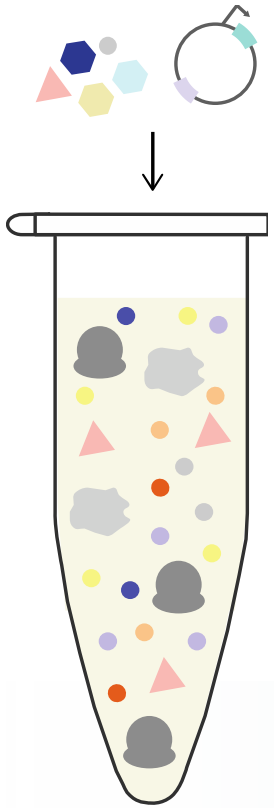
Assays for composition and performance of cell-free expression systems

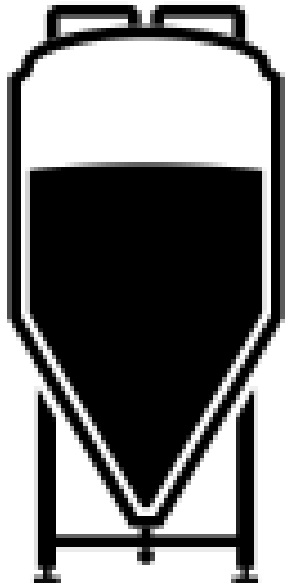
- Identify meaningful metrics
- General characterization and specific applications
- Time-course measurements of transcription and translation
- Multi-omic characterization
- Reference data for various reconstituted and lysate-based systems
- Automation methods reaction volumes from microliters to milliliters
- Data standards



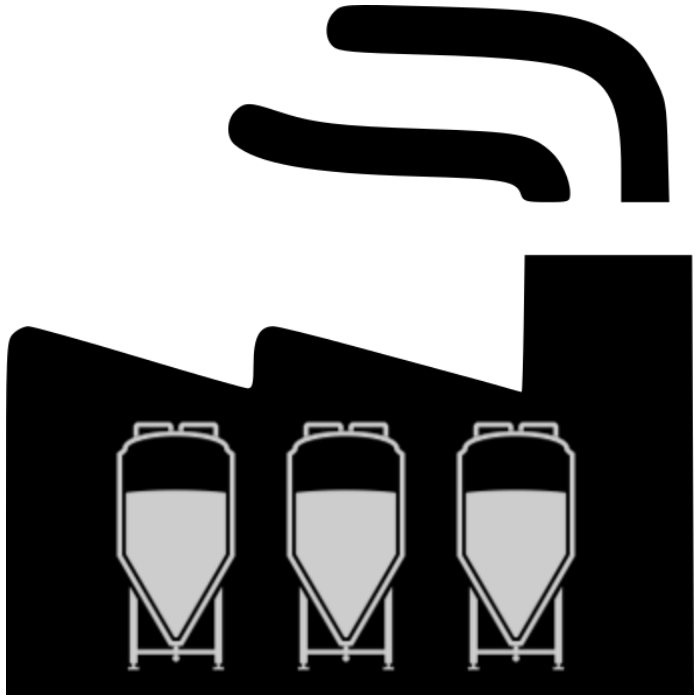
Adapted from John Glass

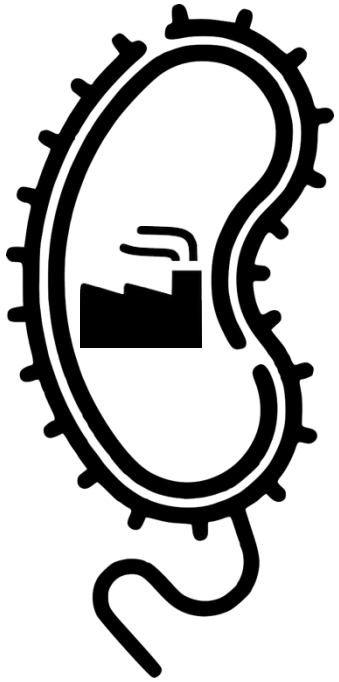
How can we leverage synthetic cells for a new manufacturing paradigm?





Scale up for current manufacturing infrastructure





Scale out for distributed manufacturing

Synthetic cells for “recursive manufacturing”

Cell-free expression systems

What measurements are needed for safety, surveillance, and containment?

Some needs

Convene internationally to agree to what we should build, given what we could build

- Delineate consensus goals and moratoria and verify compliance
- Define best practices for routine, preventative surveillance of labs and environment
- Process to assign hazard level to synthetic cells
- Standards for commerce

Determine a framework for identifying “Cells of Concern (COCs)”

- Opportunity to build on screening for DNA SOCs
- Urgency to start now, because synthetic cells may proliferate outside intended contexts or environments

Engage red-teaming exercises to help determine measurement needs for

- Inadvertent release and laboratory accidents
- Attribution
- Countermeasures

Develop measurements to determine health and environmental consequences (beneficial and toxic) of synthetic cells

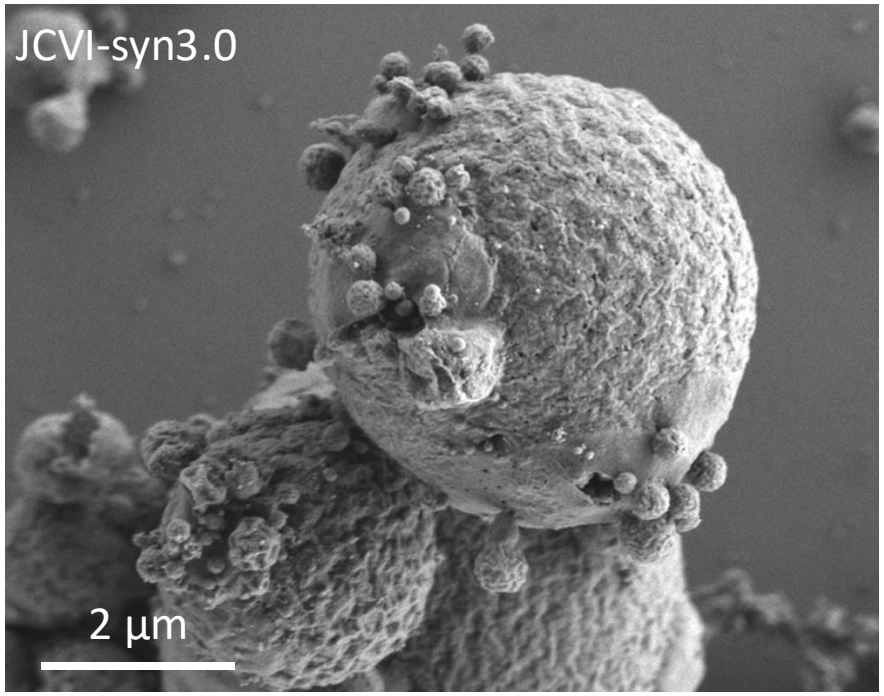
Measurements must be fit for purpose, matching the type of synthetic cell, its intended or potential function, and its context

What would make the risks of synthetic cells worthwhile?

Discovery

BBC.com

Technology



UCSD NCMIR

Mythology

starwars.fandom.com/wiki/Midi-chlorian/Legends

Acknowledgements

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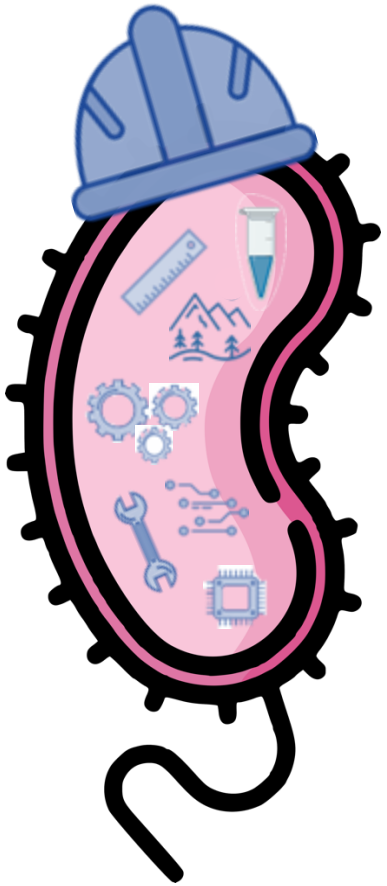

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