Making biology easier to engineer.

Synthetic Biology Engineering Research Center

Synthetic Biology
Tools for Industrial Biotechnology

Peter Ackermann
Synthetic biology?

Engineering biology.

Applying the principles of...

- design
- abstraction
- composability
- standardization
- characterization

...to biological systems.
SynBERC at a glance

- 5 core institutions
- 30 professors & labs
- 25 industry members
- advisory board
- 2 retreats / year
  2½ days of cutting-edge science
SynBERC industry members

*SynBERC start-ups
Why are they members?

• Learn, acquire tools and know-how
• Connect with academics and industry
• Recruit talent
• Access infrastructure
  – SynBERC registry, members-only website
• Identify opportunities
  – Needs, markets, synergies
• Take cover
  – Best practices: safety, security, ethics
  – Public engagement, education
• Influence SynBERC research directions
Tools

Design (CAD)

• Parts registries
• Sequence handlers, calculators, debuggers
  – Clotho, RBS calculator
• Robust, context-independent, tunable expression
  – Bicistronic design + calculator
  – BioFAB Expression Operating Unit (EOU)
  – Used by Ginkgo Bioworks
• Protein engineering
  – RosettaBackrub: protein structure modeling
Tools

Build (CAM)

• Liquid-handling robots + control software
• DNA synthesis and assembly
  – j5 (JBEI / TeselaGen)
• Genomic installation of large DNA constructs
• Multiplex Automated Genome Editing (MAGE)
Tools

Molecular building blocks
- New expression control elements (cis + trans)
- Small molecule sensors
- Logic gates and devices
  - Tested in industrial strains & conditions @ DSM
- Orthogonal intra-/intercellular signaling
- New enzymes, scaffolding for co-localization
- New cellular compartments
- Refactored secretion systems
  - Used by Refactored Materials
Tools

Test (HTP ‘omics)
• Metabolomics
• DNA / RNA sequencing
• Proteomics
• *In vivo* biosensors

Safety
• Reassigned genetic codes
  – *rE.coli* chassis
• Impact studies
  – GMO footprint in wastewater treatment facility
Applications

Advanced Fermentation Organisms
• Cell density, metabolite concentration, toxicity-dependent responses, testing host-circuit interactions

Microbial Chemical Factories
• Successful demonstration of 3-HBL biosynthesis
• Refactoring nitrogen fixation & bacteriochlorophyll a

Mammalian
• Mammalian cell engineering tools
• Artificial morphogenesis

Yeast
• Upcoming, tools for yeast engineering