

BIOLOGICAL ENGINEERING OVERVIEW

The Department of Biological Engineering
Utah State University
Logan, Utah



BIOLOGICAL ENGINEERING

- ❖ What is Biological Engineering?
- ❖ Why do we do it?
- ❖ Will I get a good job with a biological engineering degree?
- ❖ What's going on at Utah State, and why should I go there? <http://21.web.usu.edu>
- ❖ Algae Test and Evaluation Center
- ❖ Synthetic Biology
- ❖ Engineering State
- ❖ Questions?

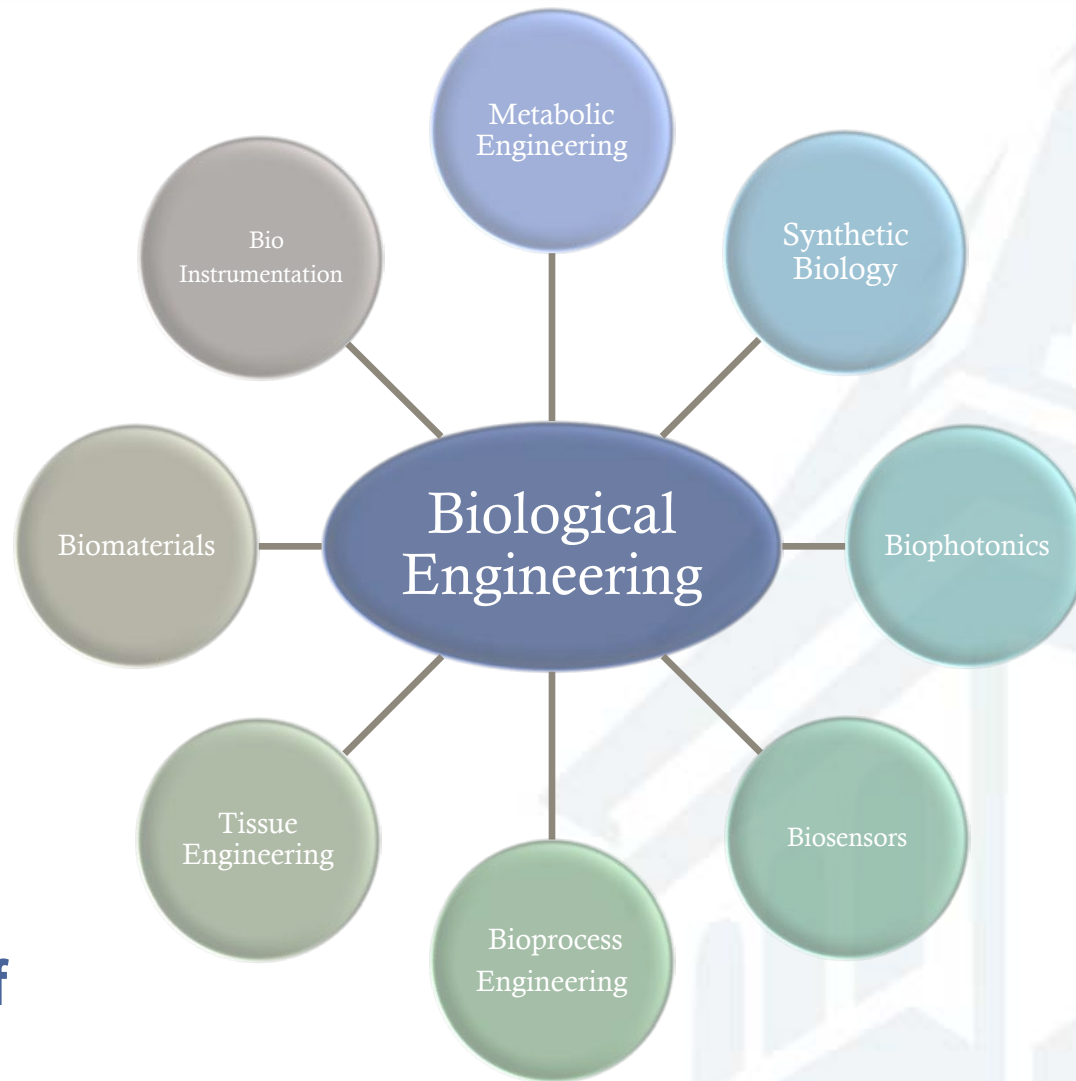


Biological Engineering

- ∞ The application of engineering principles to biological systems
- ∞ A fusion of engineering and life sciences to develop new technologies and products

Why Biological Engineering?

- ⌘ We can now “engineer” biology
- ⌘ 20th Century
 - ⌘ nanotechnology + genetics + biology + computational sciences =
Biological Engineering
- ⌘ 21st Century
 - ⌘ Biological Engineering will be used to solve problems
 - ⌘ Energy
 - ⌘ Environment
 - ⌘ Economy
 - ⌘ Health
 - ⌘ National security



The Tools of Biological Engineering

Synthetic
Biology

Synthetic Biology is the design and construction of new biological systems

Biophotonics

Biophotonics is light + biology – the interaction of photons with biological systems

Biosensors

Biosensors are engineered biological materials that monitor physiological processes

Bioprocess
Engineering

Bioprocess engineering is the production of products using a biological process



Metabolic
Engineering

Metabolic engineering is the optimization of metabolic pathways to increase or improve a cell's production of a certain substance

Biomaterials

Biomaterials are materials – synthetic or natural – that are used in contact with biological systems

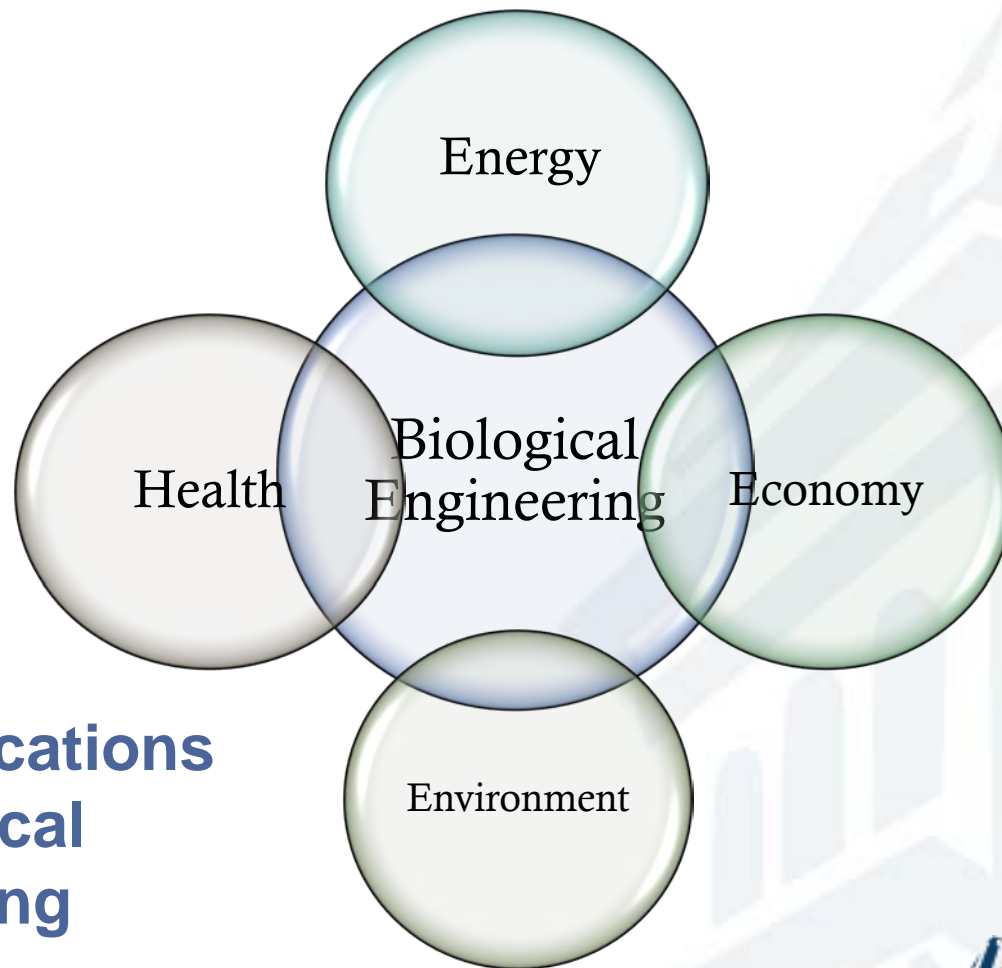
Bio
Instruments

BioInstruments are systems and devices used for the recording or transmission of physiological information

Tissue
Engineering

Tissue engineering is the use of cells, engineering, materials, and biochemistry to improve or replace biological functions





The Applications of Biological Engineering

JOBS IN BIOLOGICAL ENGINEERING

- ∞ Biological engineering growth rate in US is greater than 21% per year
- ∞ Jobs are in energy sustainability/national security, biologically engineered products, and health
- ∞ Alternative energy in US – 1M jobs by 2022, 2M jobs by 2030
- ∞ Algal biofuels – 1B gallons by 2014. Exxon Mobil -- \$600M in algal biofuel research
- ∞ Bioplastics – 25-30% of worldwide plastic market by 2020. Over a \$10B industry in US by 2020.
- ∞ Synthetic Biology - \$233.8M global market in 2008; \$2.4B by 2013, annual growth rate of 59.8%
- ∞ Biomedical Engineering – 21% growth rate annually



USU Algae Test and Evaluation Center

- ⌘ USU Biological Engineering has the largest algae biofuels research center in the United States
- ⌘ 460 acre algae farm
- ⌘ Research
 - ⌘ Biofuel production
 - ⌘ Water quality improvement
 - ⌘ Dissolved air floatation and photobioreactors
 - ⌘ Lipids
- ⌘ <http://21.web.usu.edu/htm/research/research-labs/at-and-p>
- ⌘ <http://www.youtube.com/watch?v=EnOSnJJSP5c>





SYNTHETIC BIOLOGY

Synthetic Biology is

- The design and construction of new biological parts, devices and systems, and
- The redesign of existing, natural biological systems for useful purposes.

The Synthetic Biology Toolbox is

- DNA Sequencing
- Recombinant DNA Technologies (Cloning)
- DNA Synthesis
- Systems Biology

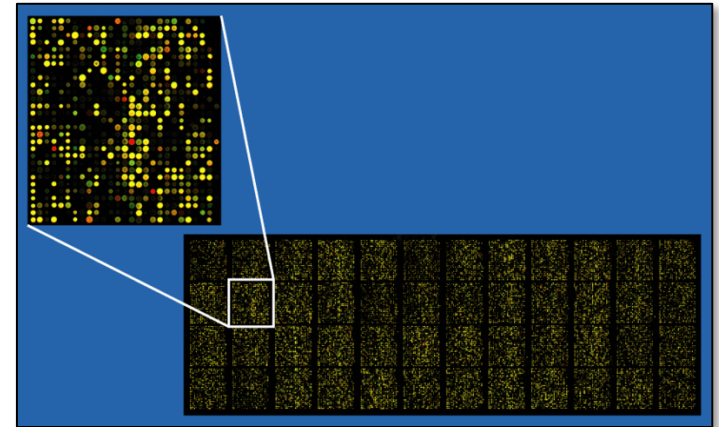


DNA SEQUENCING

DNA Sequencing Services



DNA Microarrays



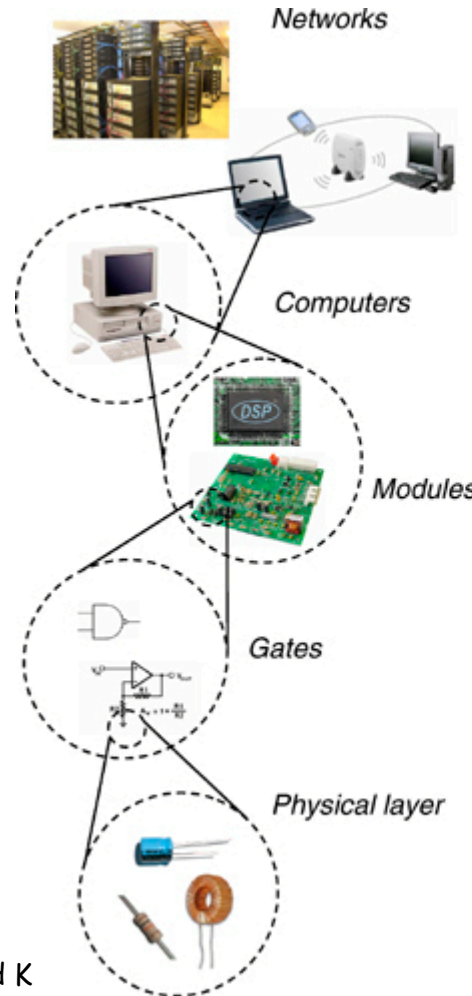
<http://www.agencourt.com/flash/facilitytour/tour.html>

http://en.wikipedia.org/wiki/DNA_microarray



Electronic Technologies

TECHNOLOGY ABSTRACTION

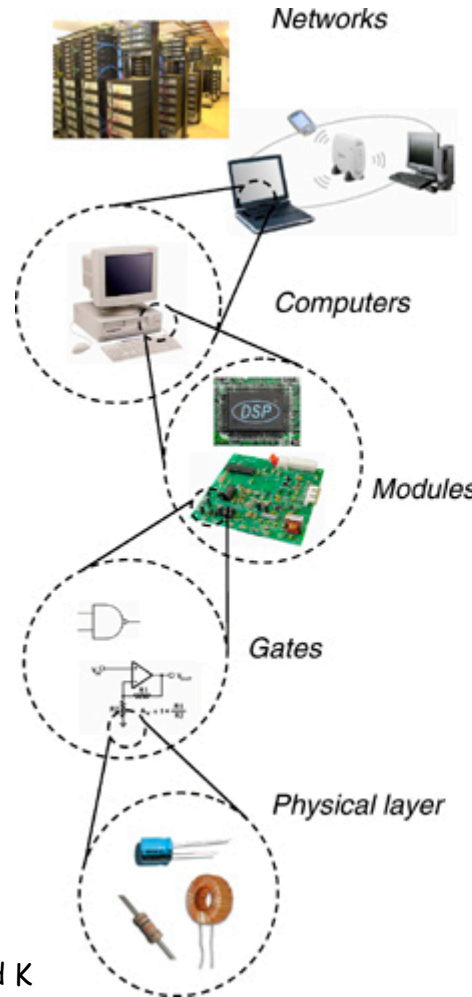


"Synthetic biology: new engineering rules for an emerging discipline," Ernesto Andrianantoandro, Subhayu Basu, David K Karig & Ron Weiss: Molecular Systems Biology, May 16, 2006.

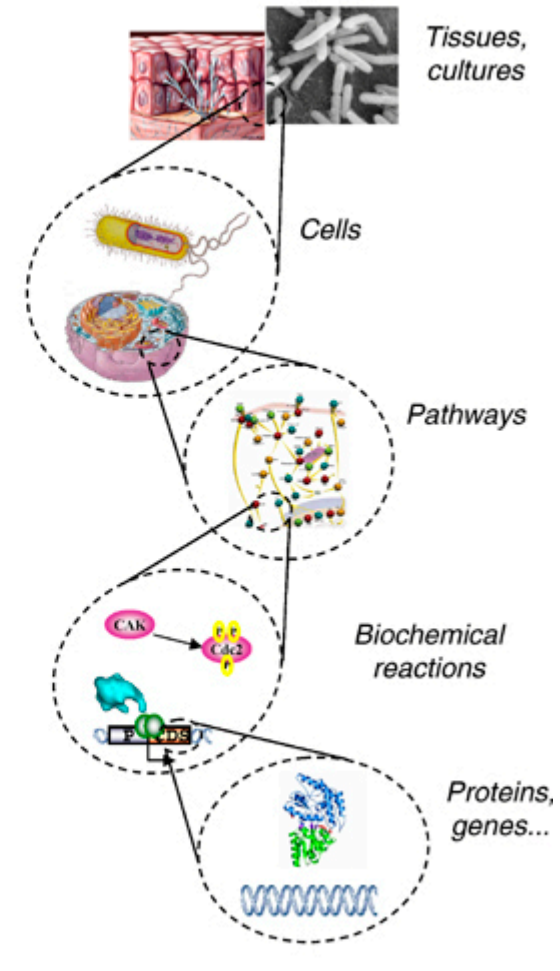


TECHNOLOGY ABSTRACTION

Electronic Technologies



Biological Technologies

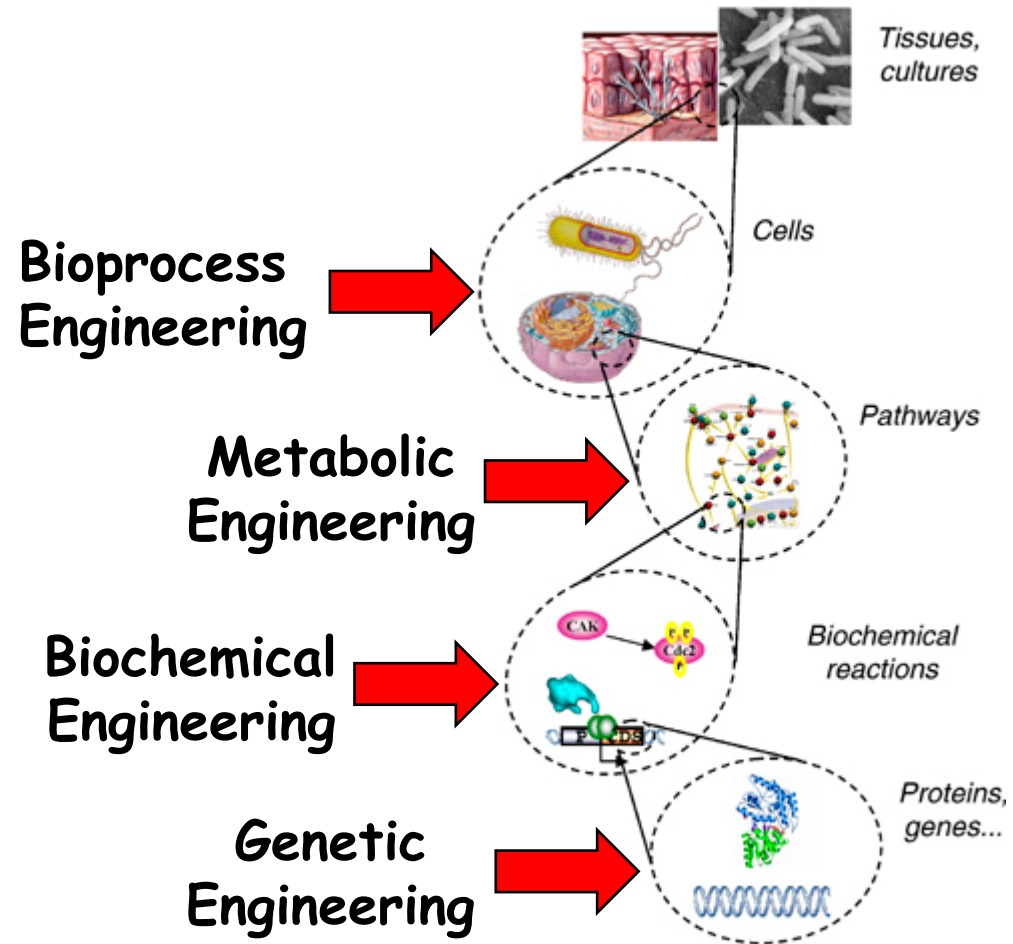


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TECHNOLOGY ABSTRACTION

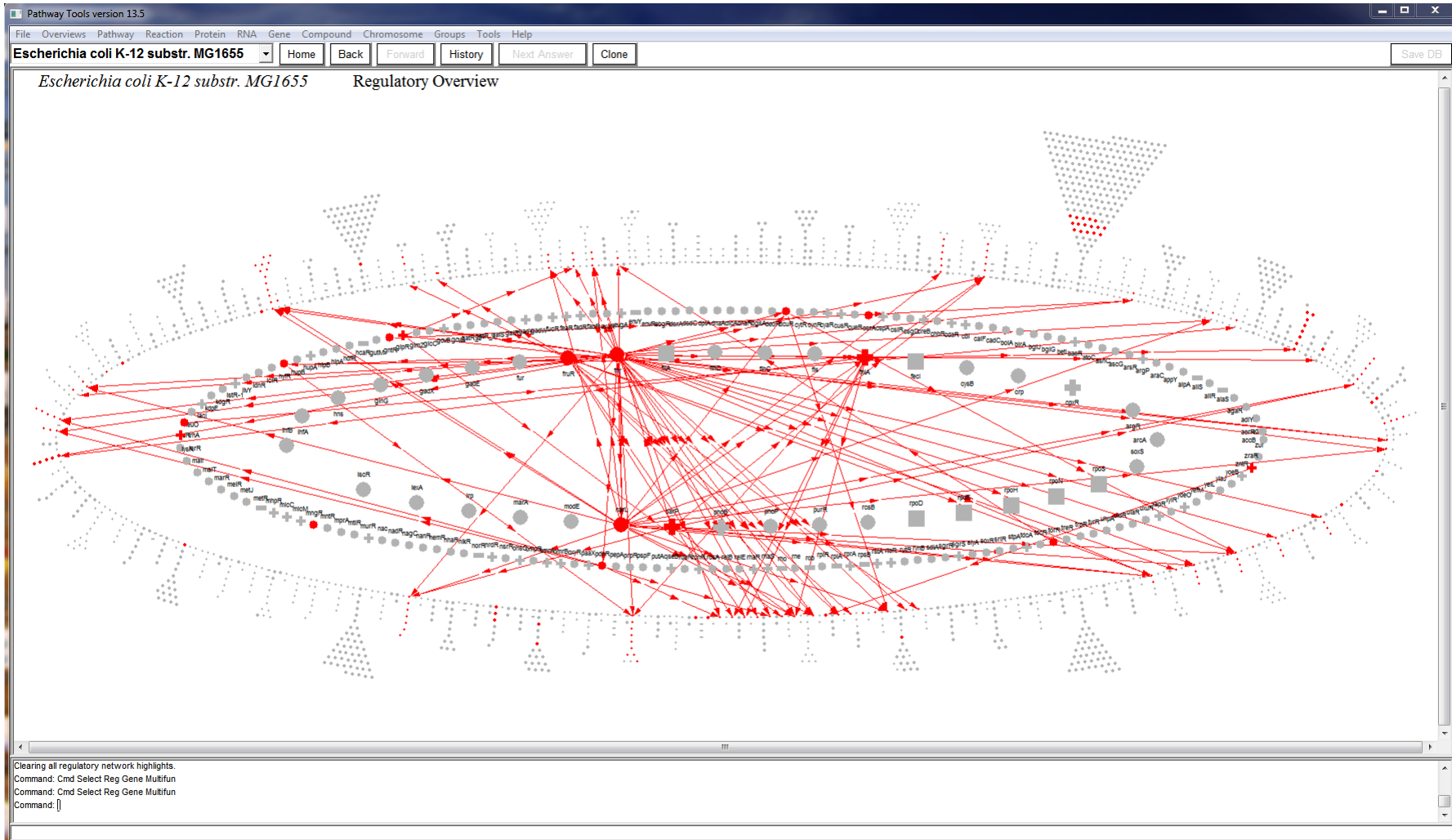
Biological Technologies



"Synthetic biology: new engineering rules for an emerging discipline," Ernesto Andrianantoandro, Subhayu Basu, David K Karig & Ron Weiss: *Molecular Systems Biology*, May 16, 2006.



E. coli CARBON METABOLISM - REGULATORY OVERVIEW





BIOBRICKS™

http://partsregistry.org/Help:An_Introduction_to_BioBricks

BioBricks™ is a standard for interchangeable parts, developed with a view to building biological systems in living cells. The picture to the left shows BioBrick™ part BBa_B0034 within a plasmid. The part is flanked by a standard BioBrick™ prefix (P) and suffix (S).

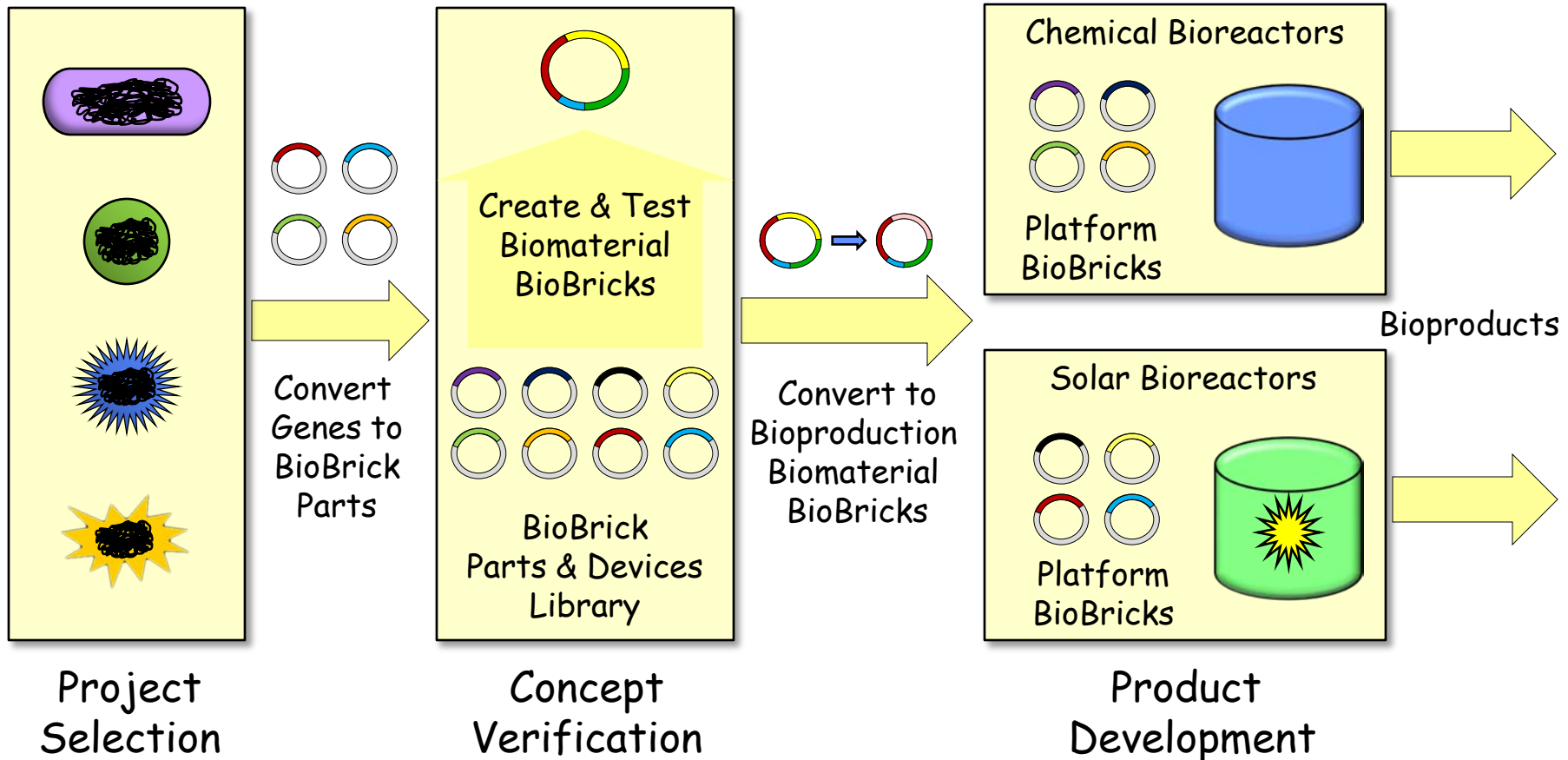


BioBrick™ parts can be assembled to form useful devices, through a process often referred to as 'Standard Assembly'. BioBrick™ parts are composable; allowing endless numbers of BioBrick™ parts to be pieced together to form complex systems. The assembly to the left shows 3 BioBrick™ parts assembled to create a simple device.



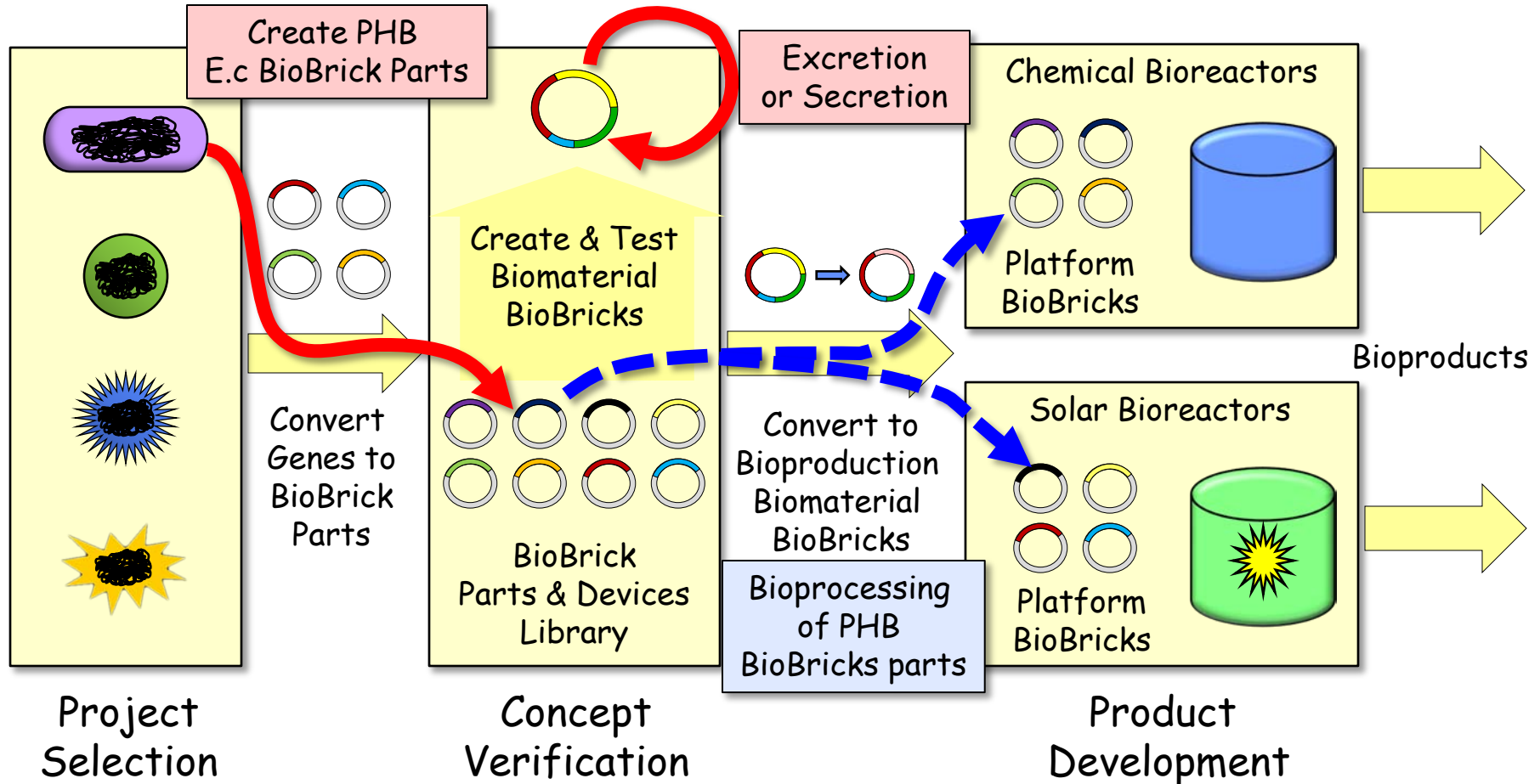


SYNTHETIC BIOMANUFACTURING PROCESS





BIOPLASTICS PROJECT



Undergraduate Research in Biological Engineering

- ❧ Undergraduate life in Biological Engineering includes hands-on laboratory research
- ❧ Team-based approach – undergraduates, graduate students, faculty work on research teams
- ❧ Biological Engineering is the leader at USU for undergrad research activities
- ❧ <http://21.web.usu.edu/htm/file23250/undergrad-research>



Engineering State 2010

June 7 – 10, Utah State University

- ❧ Four days of engineering and fun
- ❧ Overview and Challenge Sessions in each department in the College of Engineering
- ❧ Follow-on activities; scholarships
- ❧ <http://www.engineering.usu.edu/html/engineering-news/e-state>



Thank You!

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Any Questions?

