What is Synthetic Biology?

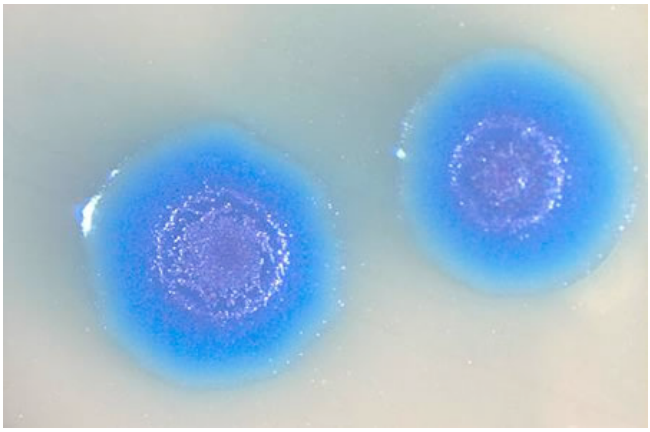
Synthetic Biology uses molecular methods to construct DNA-based devices that perform new functions.

Synthetic biologists:

- Design, model and construct new biological parts, devices and systems.
- Redesign existing, natural biological systems for useful purposes.
- An hour overview of synthetic biology and systems biology by Nobel laureate Sydney Brenner
- YouTube 5 minute summary defining synthetic biology (interview with Drew Endy).
- 1 hour lecture by Drew Endy.
- Six, 1-hour lectures by George Church (Harvard) and Craig Venter as well as several news stories about the topic and these lectrues.
- Lengthy article in *The New Yorker* (September, 2009)

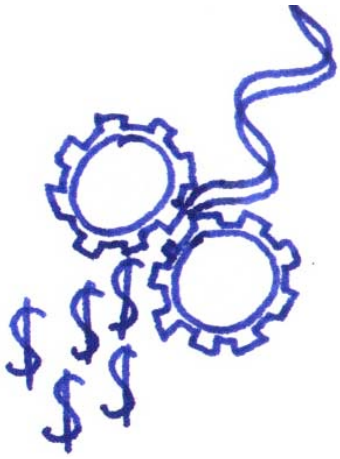
Synthetic Biology is divided into two areas:

- Entire Genome Engineering, especially on how to produce and manipulate whole-genome sized DNA, and get them into new cells. Read one example.
- YouTube 8 minute BBC story (interview with Craig Venter)
- 20 minute TED lecture by Craig Venter.
- 20 minute TED lecture by Juan Enriquez (from 2009 economy to evolution of human into *Homo evolutis*, humans v 2.0)

Investigators at the J. Craig Venter Institute are engineering whole genomes and "rebooting" cells as bioengineering chassis.
See genome synthesis paper here.
Genome transplantation paper here.

- Small Devices and Systems Engineering

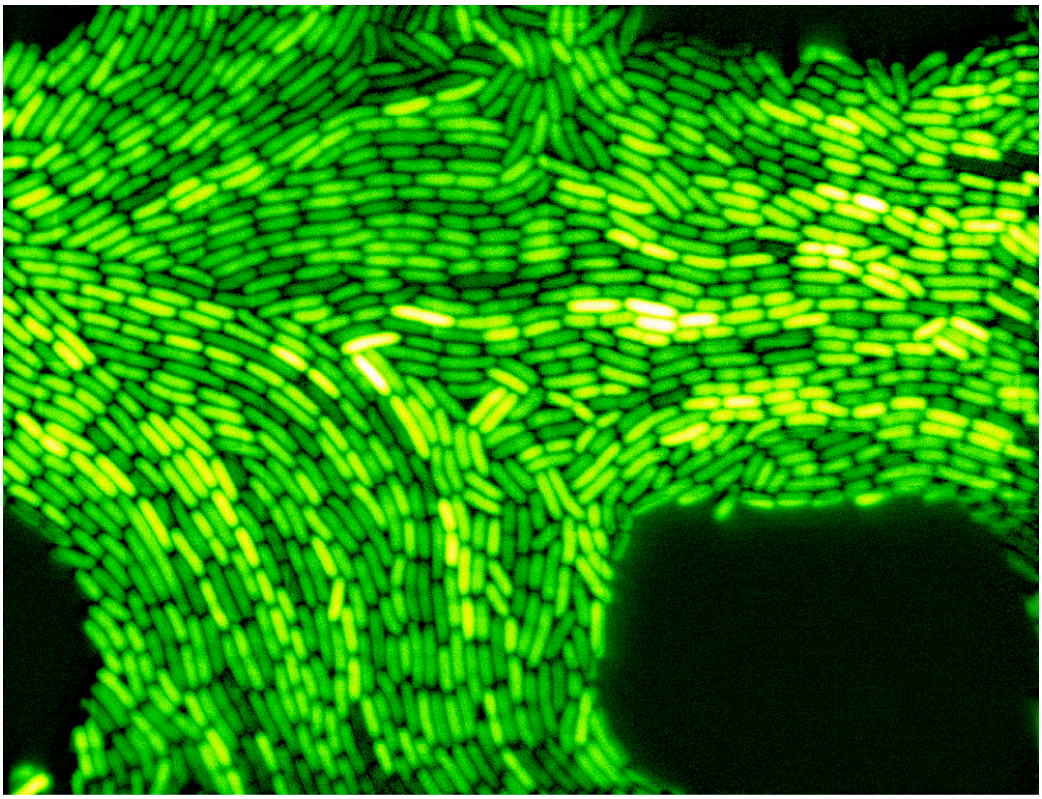



Synthetic biologists at UT Austin developed the world's first bacterial photography. Shine light on the cells and they turn black.
Read profile of artists working with synthetic biologists.

Synthetic Biology is Win-Win Research

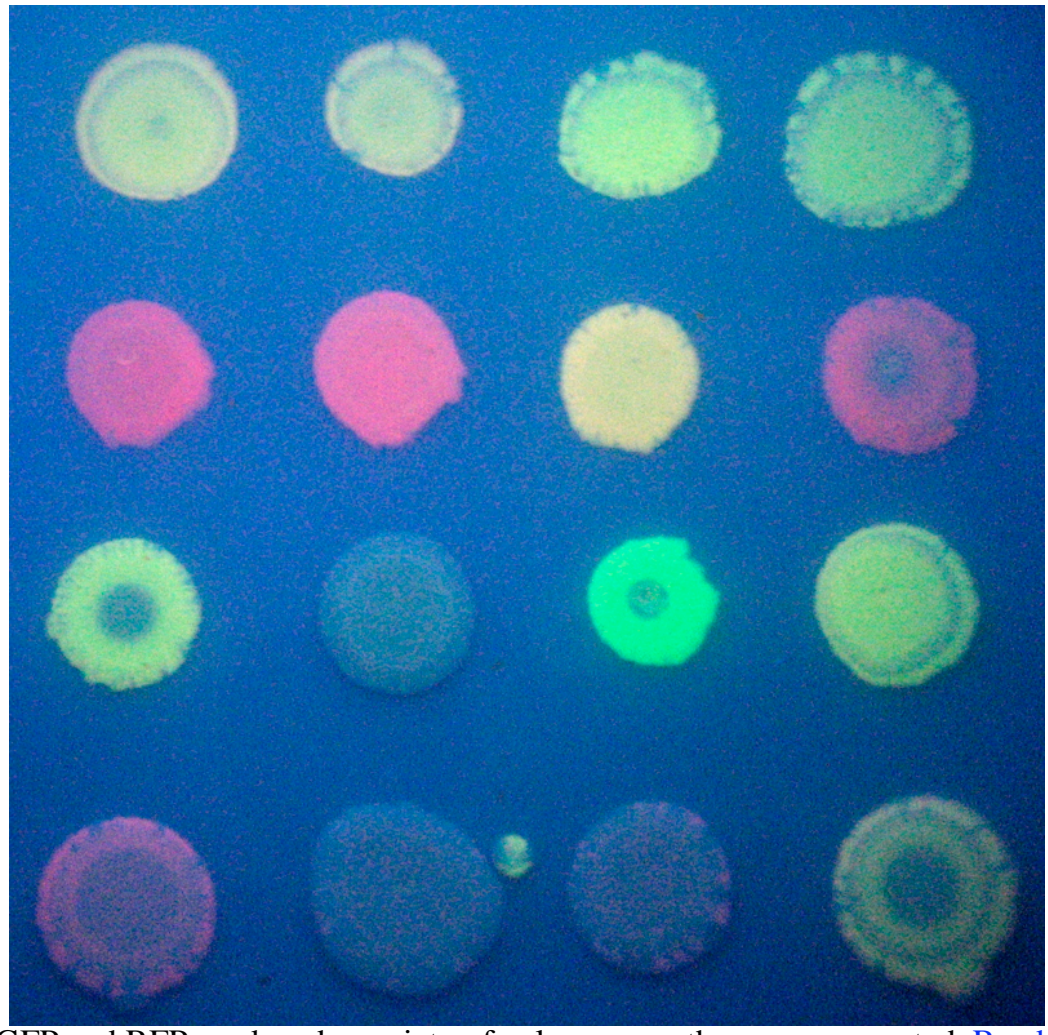
- Win #1: your design functions as expected.
- Jay Keasling 2006 Scientist of the Year, *Discover* magazine (2

minute interview).



Engineered *E. coli* pulse lights on and off as designed. Read about the Repressilator.

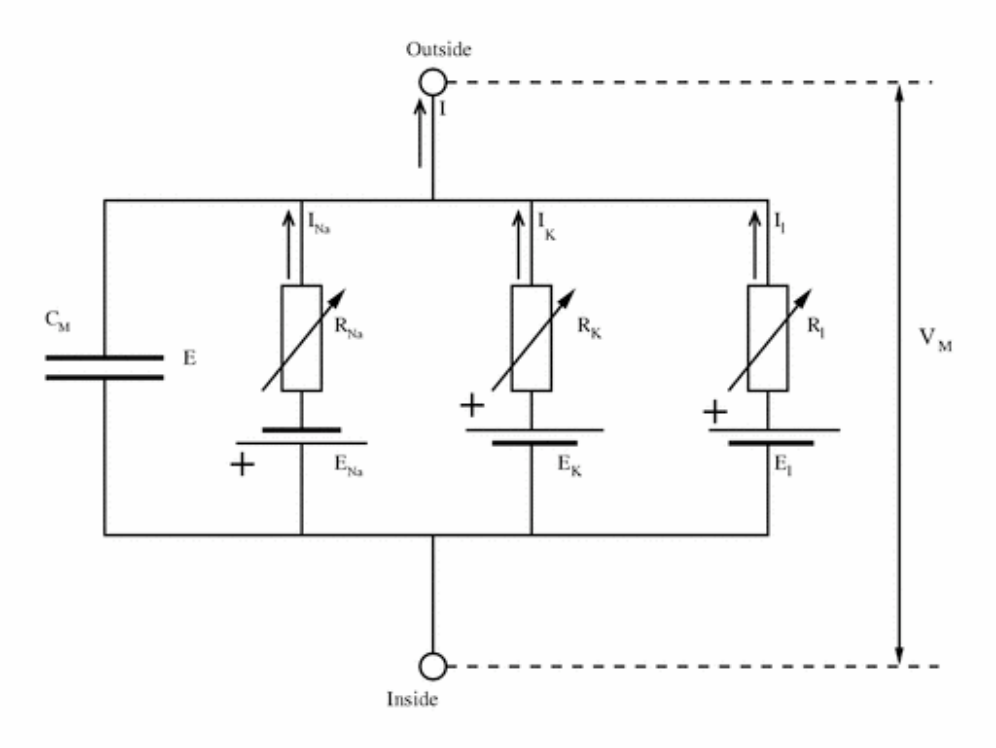
- Win #2: your design fails but you uncover basic biology



Split GFP and RFP produced a variety of colors, more than were expected. Read more.

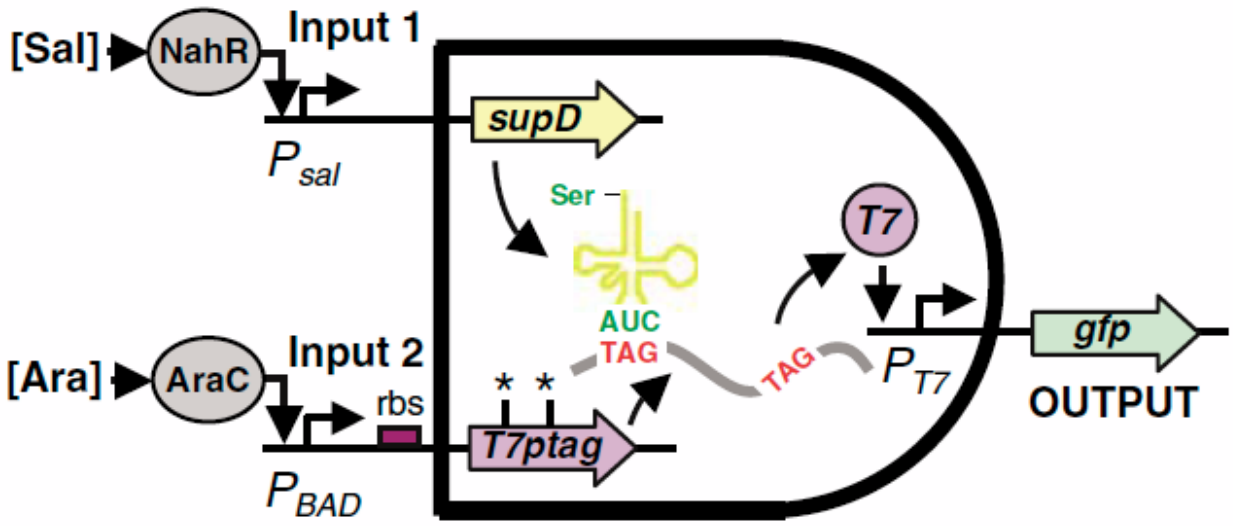
How is Synthetic Biology Different? Synthetic biology uses four principles not typically found in genetics, genomics, or molecular biology: abstraction, modularity, standardization, and design and modeling.

Abstraction: don't focus on the DNA sequences, but think of the parts as units in a circuit diagram. Abstraction means you can used parts/devices/systems without having to worry about how they work. DNA is used to make parts. Parts are assembled into devices. Devices are connected to make systems. Read more.



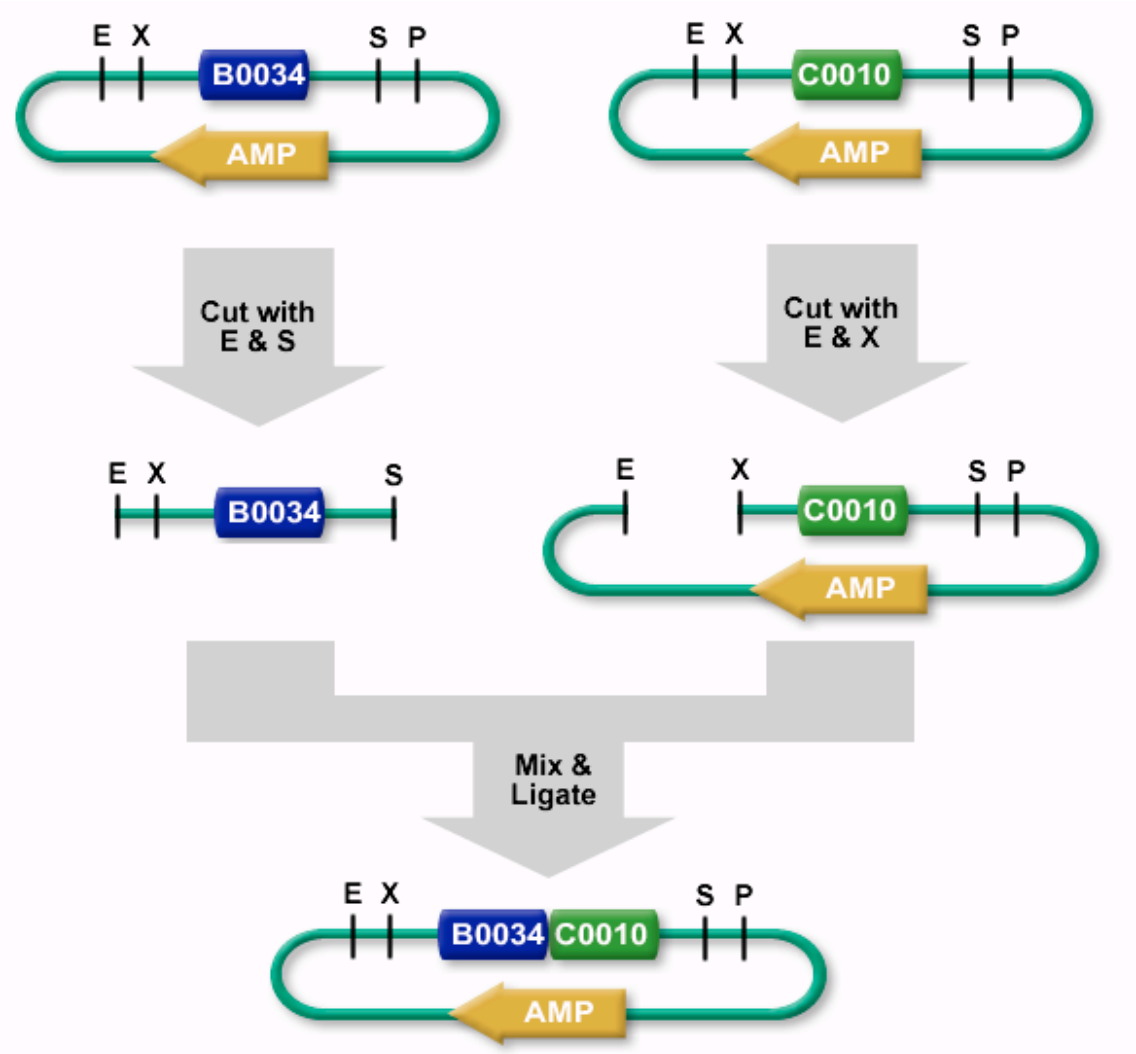
Circuit diagram for membrane potential.

Modularity: parts, devices and systems can be connected as self-contained units and combined in any combination you want.



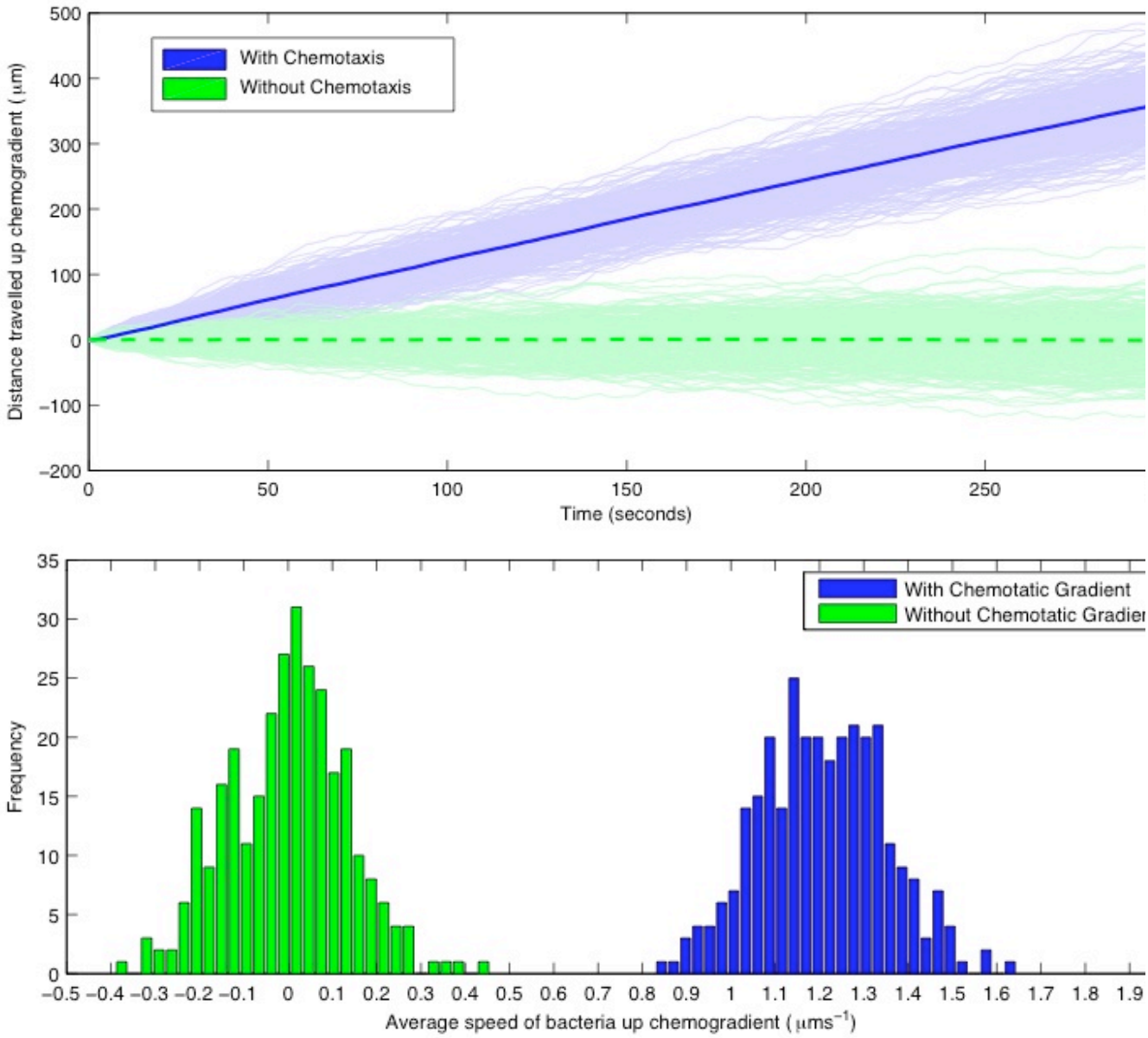
Modular AND logic gate built by Chris Anderson at UC Berkeley.
Read the paper. Read about logic gates.

***Standardization*:** by agreement, many aspects of the designs are standardized to improve overall function. One example is the standard way parts, devices, and systems are connected so that new designs will fit with old designs. An everyday example is that all light bulbs fit into any socket! 



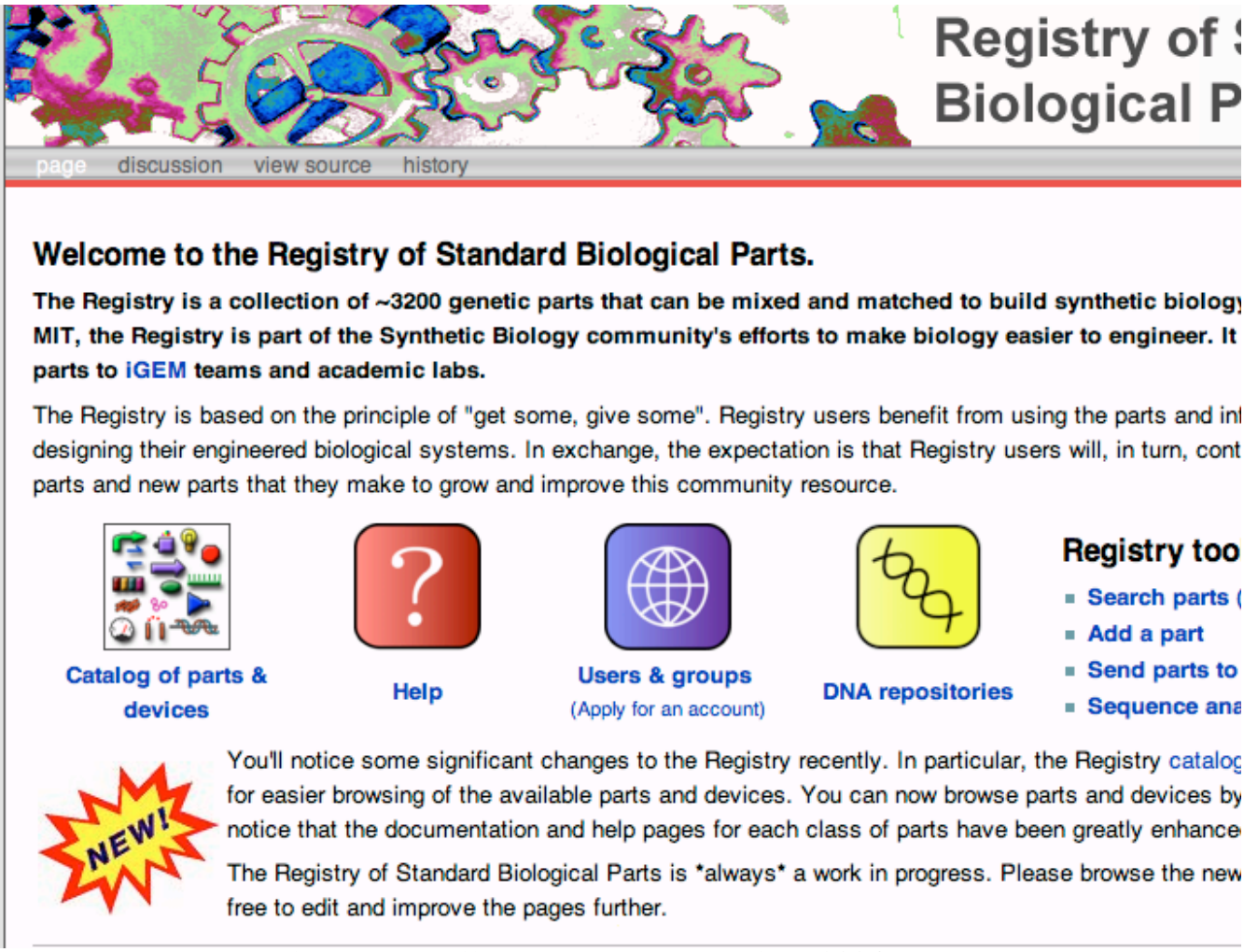
BioBrick assembly allows users to connect each others parts, devices, and systems. Read more.

Designing and modeling: before building, build a model and test the devices capacity. This not only improves design but tests basic biological assumptions that could be false.



Models of cellular chemotaxis by undergraduates at Bristol University, UK. Read more.

BioBrick Registry of Standard Parts: http://partsregistry.org/Main_Page



Parts designed and built by undergraduates since 2004. Read more.

What is iGEM?

International Genetically Engineered Machines Jamboree/Competition. Gathering of the top synthetic biology students from around the world in a friendly competition to learn and share.

Do it yourself Biology (1 hour lecture by Natalie Kuldell and Reshma Shetty)

at a glance:

1925 minutes of talks	**77** presentations
1200 participants	**24** awards
825 jamboree attendees	**22** weeks of work
84 teams	**21** countries

International Genetically Engineered Machines Jamboree/Competition 2008 photo. Read More.

Additional Resources and Information

See a PowerPoint Slide Show that includes two research projects by undergraduates. The slide show also presents a new approach to introductory biology called *Integrated Systems Biology* as a way to improve undergraduate biology education that would better prepare students for biology in general and biology research in particular.

Read an open access Burnt Pancake Problem paper published by undergraduates. You can also read another open access paper by undergraduates addressing the Hamiltonian Path Problem.

Link to some papers about synthetic biology.

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