

Do-It-Yourself Biology

Synthetic Biologist Drew Endy:
Programming Living Systems

Findings

Department of Health and Human Services
National Institutes of Health
National Institute of General Medical Sciences

Drew Endy Builds Genomes

Synthetic biologist Endy works with the nuts and bolts of living things.

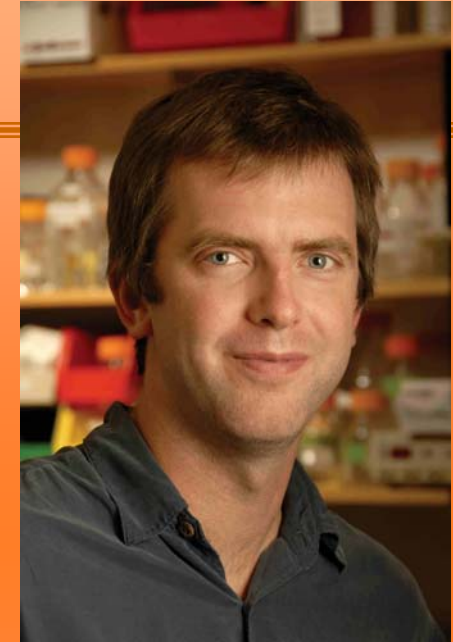


Photo: L. Barry Hetherington

Genomes

- Contain all of an organism's genetic material
- Have “parts”
- May reveal how genes affect health

Question:

Are all genomes identical?

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Answer: No

Each organism has its own genome

- But all organisms within a species have genomes with similar, or even identical, “parts”
- Sometimes the parts are similar to those in other species, too
- Genome organization—the order in which genes string together—creates templates for living things as diverse as people, penguins, and petunias

Models for Discovery



T7 bacteriophage

- Bacteriophage: a virus that infects and destroys bacteria
- Endy and other scientists study the genome of the T7 bacteriophage

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Uncovering Knowledge

Genome of T7 bacteriophage

The Parts



56 genes

- Produce 60 proteins that direct stages and types of infection

The Whole



- Genes cluster into several distinct classes
- T7 bacteriophage switches from expression of one class of genes to another to assure successful infection

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Building Knowledge

- **Problem:** DNA in T7 bacteriophage is a program that needs to be decoded
- **Typical approach:** Pry apart genome to investigate the function of each gene
- **Endy's approach:** Use genome's parts to construct a synthetic, model genome of T7 bacteriophage that includes not only viral genes but also "cut-and-paste" sites in its DNA



Investigate genes one-by-one



Build genome from scratch, then study how whole thing works

Advances in Synthetic Biology

- Endy's synthetic T7 bacteriophage genome has “cut-and-paste” sites in its DNA



What purpose do these DNA sites serve?

- Many genetic devices are designed to work only in the labs in which they were made



How did Endy and his coworkers overcome this challenge, and how have they shared this knowledge with other researchers?

- There was no common framework for organizing all the components of biological machines



What did Endy do to resolve this problem?

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Adventures in Synthetic Biology

- Synthetic biology draws from skills in engineering and biology
- Endy created a comic book to help explain it

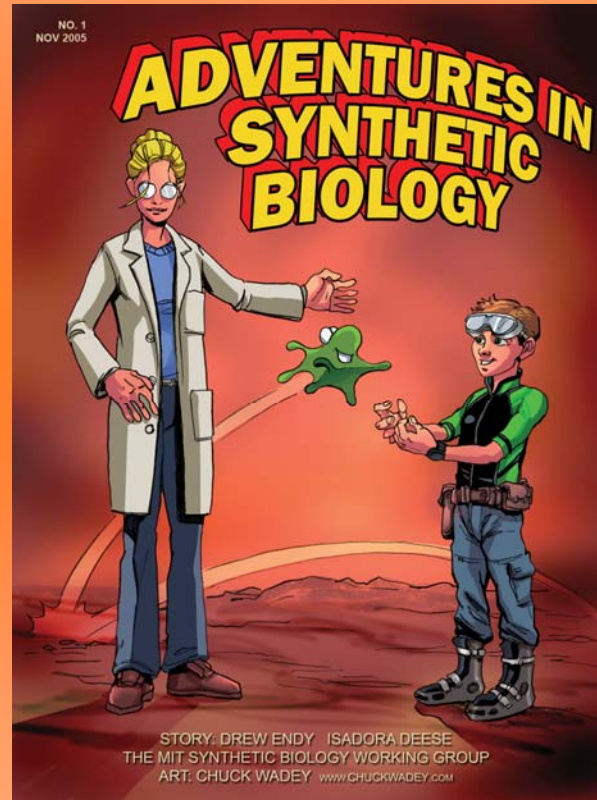


Image: Drew Endy, Isadora Deese, Chuck Wadey

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On the Same Page



Photo: Melissa Li

The iGEM Competition

- Launched in 2004
- Community teaching tool that inspires students to build genetic machines with standard biological parts
- 2006 contest hosted teams from 37 schools from around the world (Slovenia was the grand-prize winner)

The Future Is Now

Synthetic bacteria can work as machines

- Run relay races
- Lie down to create a modern version of the Etch A Sketch[®] toy
- Work as photographic film

World's first living photograph



Photo: Aaron Chevalier (UT Austin), Jeff Tabor (UCSF)

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Research Applications

What are some of the ethical and social dilemmas regarding synthetic biology?

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