

Ethics of Synthetic Biology

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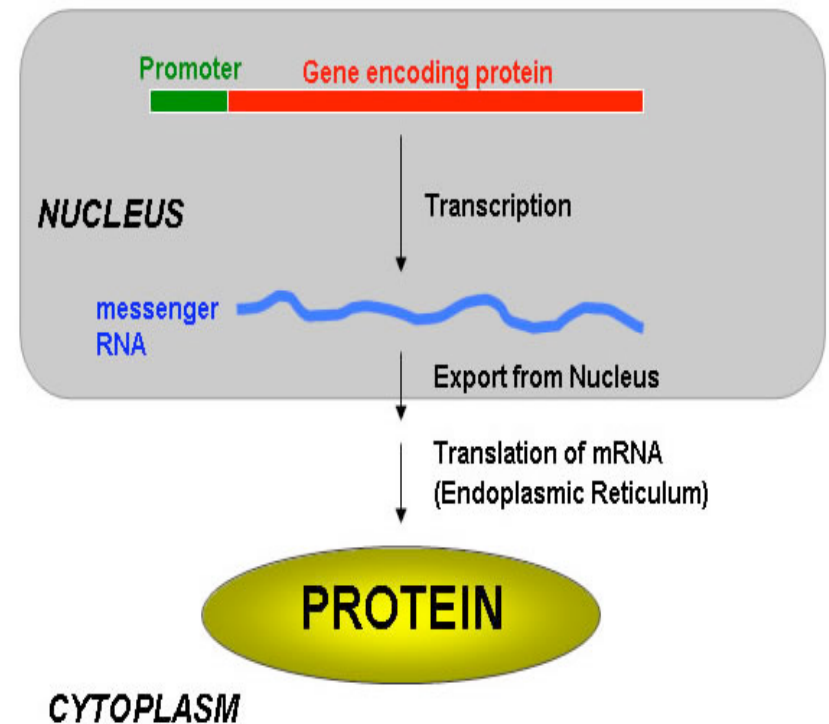
About iGEM

- ◆ iGEM (international genetically engineered machine)
 - ◆ Holds annual competition in Synthetic Biology
 - ◆ Synthetic Biology - The design and construction of new biological functions and systems not found in nature
- ◆ Synthetic biology is a quickly growing field of biology.
 - ◆ 13 teams in 2005
 - ◆ 130 teams in 2010.
- ◆ Awards
 - ◆ Food or Energy, Environment, Health or Medicine, Information Processing, Manufacturing, New Application, Foundation Advance, or Software Tool

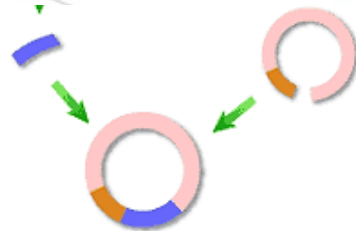
What is Synthetic Biology?

- ◆ DNA is a polynucleotide stable enough to store information, yet simple enough chemically for experimental manipulation
- ◆ By adjusting the sequence of DNA we can write our own gene of interest
- ◆ We can use bacteria as machines for our gene products
- ◆ presence of plasmids allows us to hijack the machinery of bacteria to create our desired genes
- ◆ sensitive promoters, IPTG chemicals for extreme induction, bacteria specialized for protein synthesis

Central Dogma of Biology



Steps in Engineering Biology



isolate gene product of interest



insert into bacteria to use molecular machinery



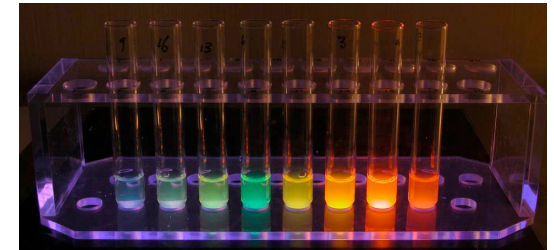
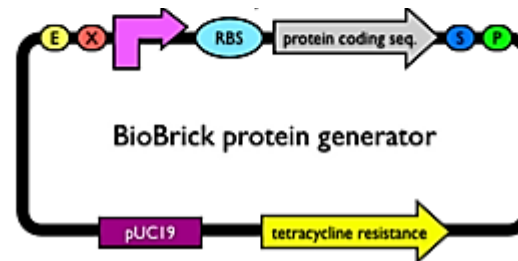
insert information into plasmids



using known sequence to create own blueprint

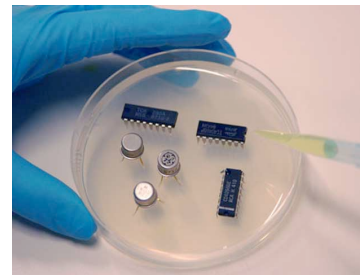


taking information about existing genes of interest



Applications of Synthetic Biology

- ◆ Designing microorganisms might be capable of producing pharmaceutical compounds
- ◆ molecular-scale ‘physician’
- ◆ make useful materials from cheap and renewable raw materials
- ◆ access to materials with new and improved properties
- ◆ sensors and detection systems with improved sensitivity and autonomous operation



CuGEM

- ◆ Student-run project team
 - ◆ students from many different majors
- ◆ Generally work independently but collaborate with our faculty advisor Xiling Shen and graduate advisors.
- ◆ Schedule
 - ◆ Plan our project during the spring
 - ◆ Design it over the summer
 - ◆ Present it at the iGEM convention during the fall

BioFactory

- ◆ Competition goal - to design new applications for synthetic biology each summer.
- ◆ Our project this year is creating a microfluidic 'factory' that will create useful chemical products.
- ◆ We attached enzymes onto the surface of the microfluidic channel in a linear order so substrate $A \rightarrow B \rightarrow C \rightarrow D$ and so on until we get out the final product.

Ethics 101

- ◆ Goal: to get you thinking about some of the problems of ethics in synthetic biology (but occurring in all engineering fields)
- ◆ Engineering is social, what you do affects society
- ◆ Therefore, it is important for engineering to consider ethical issues
- ◆ I do not have all the answers (nor does anyone)

Ways of Studying Ethics

- ◆ Utility – does the need of many outweigh the needs of a few?
- ◆ Rights – Every individual (or living thing) has rights. This is a basis of American Law.
- ◆ Think about the broader aspects
- ◆ Ask questions

Case Studies

Further Exploration of Ethics in Engineering

- ◆ **Cornell Course: ENGRG 3600/STS 3601
Ethical Issues in Engineering Practices**
- ◆ <http://bovay.ece.cornell.edu/index.html>
- ◆ Bovay Program of History and Ethics in Engineering
- ◆ Professor Park Doing (pad9) - in charge of the Bovay Program