iGEM

Synthetic Biology

DNA

DNA is the basic molecular building block for creating life and is one of the main tools for synthetic biology.

BioBricks

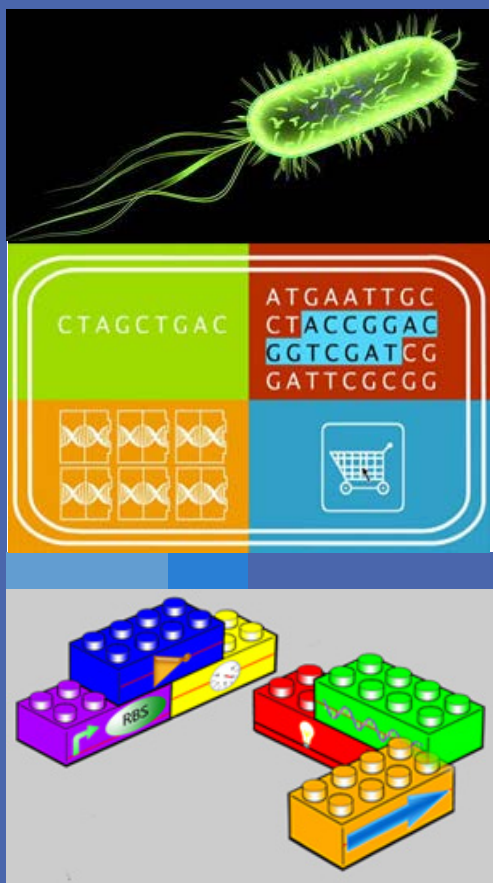
BioBricks is a standard for interchangeable parts, developed with a view to building biological systems in living cells

PCR

A method of cloning DNA using synthetic primers, enzymes, and heat to make multiple copies of the original template DNA strand.

What is Synthetic Biology?

Synthetic Biology is like a Lego building set for Biology, but with DNA; a Lego-like system where things can be easily inserted, replaced, and remade. Complex biological systems are designed and engineered using living organisms such as *E. Coli* or yeast. It is the construction of new biological parts, devices, systems, and reconstructing existing systems found in nature to produce something rationally designed by researchers.



What is iGEM?

iGEM

The iGEM (International Genetically Engineered Machine) is a competition between undergraduate and graduate university students to build biological systems using living organisms. The purpose of this competition is the advancement of synthetic biology and education of students.

Examples of some achievements of the teams that compete are: the Arsenic Biodetector, a red blood cell substitute, and recycling gold from E-Waste.

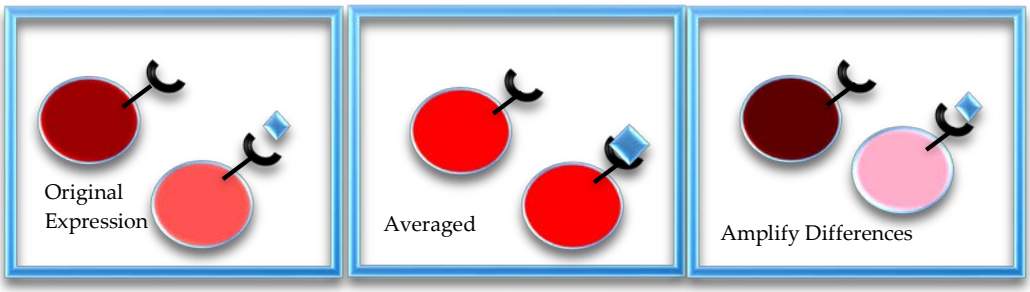
Our Team

This is the 8th year that UCSF has hosted an undergraduate iGEM team. Since UCSF is a graduate school, it has collaborated with Abraham Lincoln High School to allow recent graduates to participate in the competition. This year, the team has joined up with UC Berkeley. The team currently consists of five recent high school graduates, two returning members from last year's UCSF iGEM team, two UC Berkeley students, and an exchange student from Peking University.

Our Project

Many organisms make multicellular decisions in response to stimuli. In some cases, the decision reaches a consensus and all cells respond similarly. In others, a diversified response is preferred, and some cells respond strongly to a signal while others cease to respond. For instance, in the human immune system, even though all T cells initially react to an antigen, only those with a strong response proliferate and produce an immune response.

Our goal is to understand how a group of cells communicate to make a community decision. We are designing multicellular systems in which different yeast strains sense and secrete mating factor alpha. By engineering systems in which strains with variable initial responses develop the same response, or strains with the same initial response diverge to develop a bimodal response, we can model interesting communication systems, such as those of the immune system, leading to more novel insights about how cells interact to produce a community response.

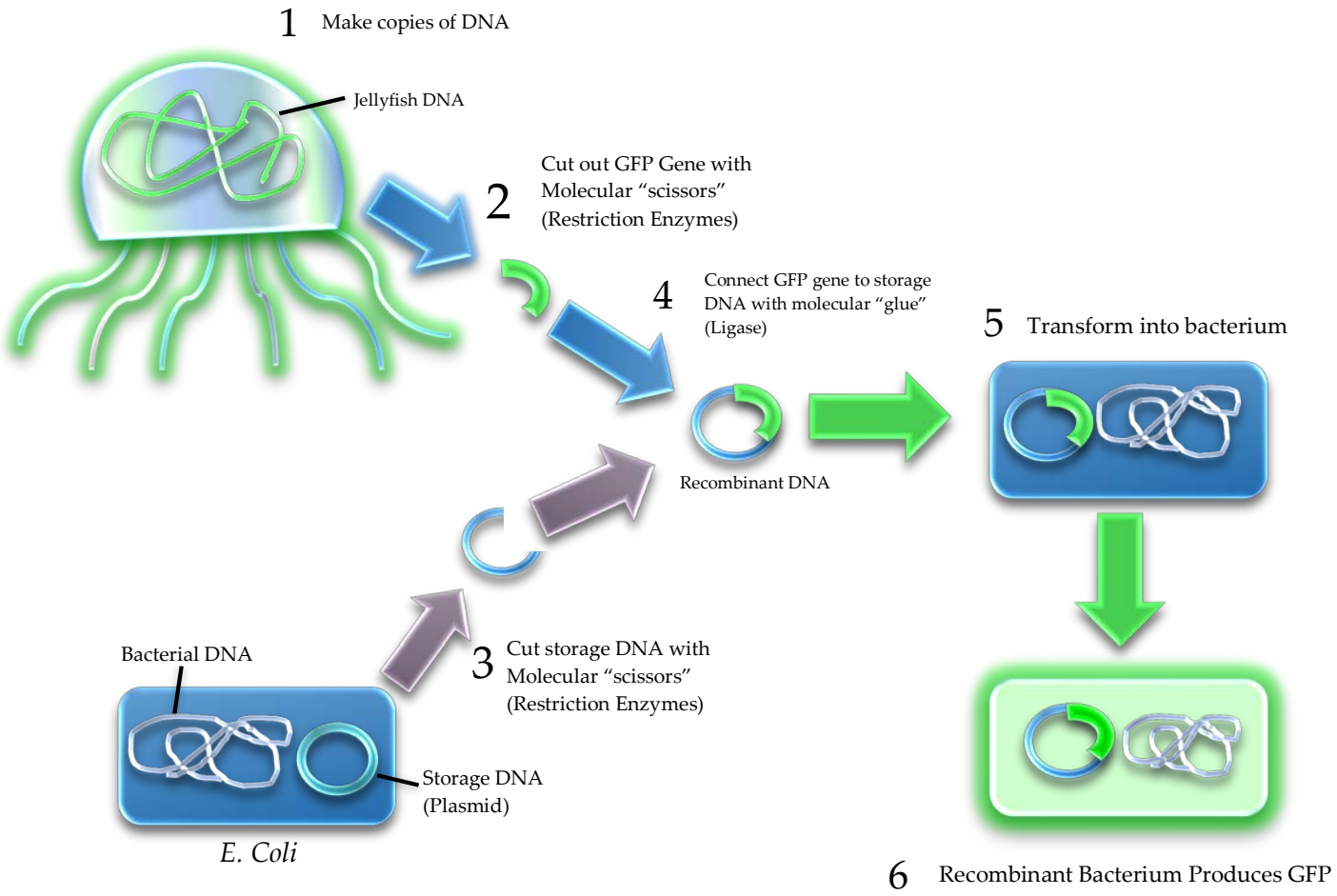


Transformation

Transformation is the process by which foreign DNA is inserted into an organism to provide it with the ability to produce different things such as proteins. Transformed organisms are able to produce drugs, biofuels, and other useful products.

GFP Transformation in *E. Coli*

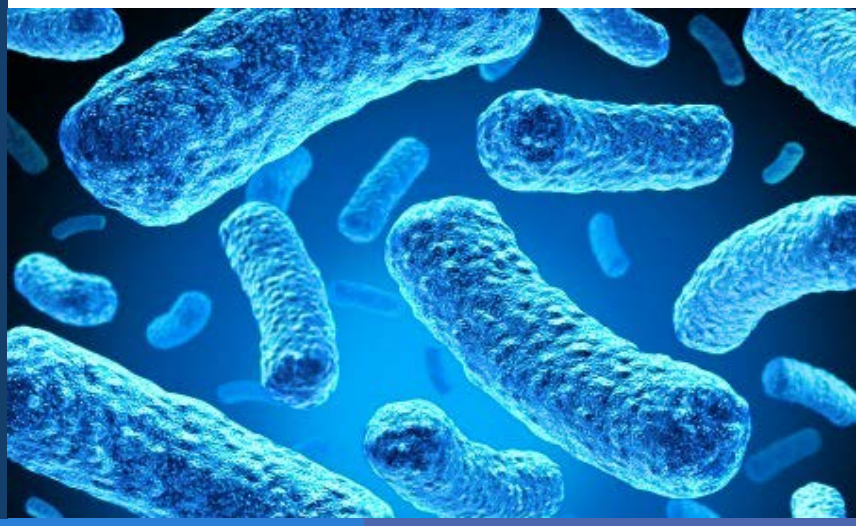
With the current availability of species and their genomes, we can now use genes from many organisms and transform them into other organisms. For example, *Aequorea victoria*, is a certain type of jellyfish that glows green because it contains a gene called GFP (Green Fluorescent Protein) in its genome. The GFP gene is widely used as a biological sensor because it causes specific parts, or proteins in the cells to glow green. Transformed cells glow green under the presence of blue light, while other cells would stay a pale color, making it easy for scientists identify the cells containing their constructed DNA.



Model Organisms

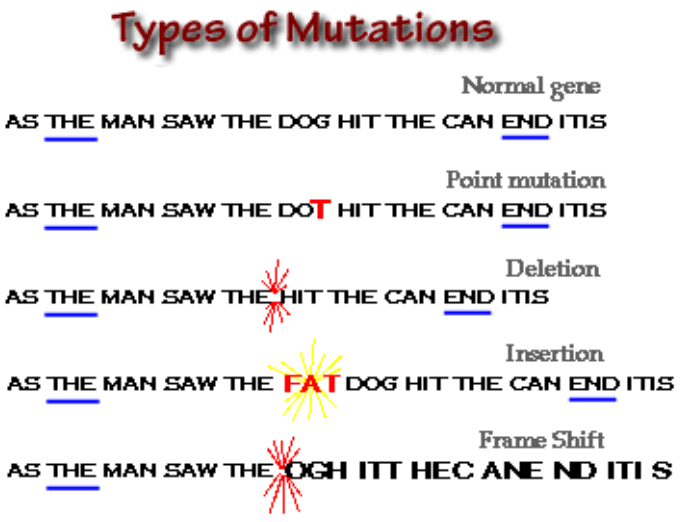
In many labs, organisms such as bacteria (such as *E. Coli*, bacteria found in the intestine) or yeast (S. cerevisiae) are genetically modified to produce pharmaceutical drugs or develop certain traits that are studied or used in experiments.

Genetic Engineering



Mutations

Mutations are changes in the DNA sequence of a genome either caused spontaneously in DNA replication or induced by a mutagen. These mutated genes can either be beneficial (such as lactose intolerance), neutral (such as hair color), or harmful (such as sickle cell disease). Mutations help increase the genetic diversity of a species and play a pivotal role in natural selection.



Types of mutations:

1. Point mutations are a change in a single base pair. This can result in :
   a. Silent mutation (same amino acids)
   b. Nonsense (premature stop codon)
   c. Missense (single different amino acid)
2. Deletions/Insertions can cause frameshift mutations that change amino acid sequences completely after the mutation. These are extremely rare.

Citations

http://www.brooklyn.cuny.edu/bc/ahp/BioInfo/MUT/Mut.Types.html
http://en.wikipedia.org/wiki/International_Genetically_Engineered_Machine#mediaviewer/File:IGEM_official_logo.png
http://assets3.parliament.uk/iv/main-large//ImageVault/Images/id_12968/scope_0/ImageVaultHandler.aspx.jpg
http://techhydra.com/wp-content/uploads/synthetic-biology.jpg
http://singularityhub.com/wp-content/uploads/2012/06/synthetic-biology.jpg
http://3.bp.blogspot.com/-_Fw6BHk6kmk/Tei5VnW3vpI/AAAAAAAAAIQ/MUFQ2SFSeAs/s1600/e-coli-streptococci.jpg
http://www.dailygalaxy.com/my_weblog/images/2007/12/04/mit_biobricks_2.jpg
http://2013.igem.org/wiki/images/b/bb/IGEM_From_Above_2013.jpg
http://biochemistry.ucsf.edu/labs/elsamad/home/Logo_CFSSB_w_NIGMS_RGB_72dpi.jpg
http://2013.igem.org/wiki/images/c/c0/Bonn_sponsor_genscript.jpg
http://synbio.berkeley.edu/images/header.jpg
https://www.neb.com/~/media/NebUs/Page%20Images/Products/Restriction%20Endonucleases/Molecular%20Cloning%20and%20Beyond/FA_RE_MCBeyond_Fig2_ClassicCloning.jpg'
http://www.sterislifesciences.com/Market-Applications/~/media/Images/LifeSciences_com/Market%20Applications/bio.ashx?w=670&h=250&as=1
http://www.ibisworld.com/media/wp-content/uploads/2013/05/biotechnology.jpg
http://www.janethull.com/healthynews/wp-content/uploads/2014/06/E.coli_.jpg