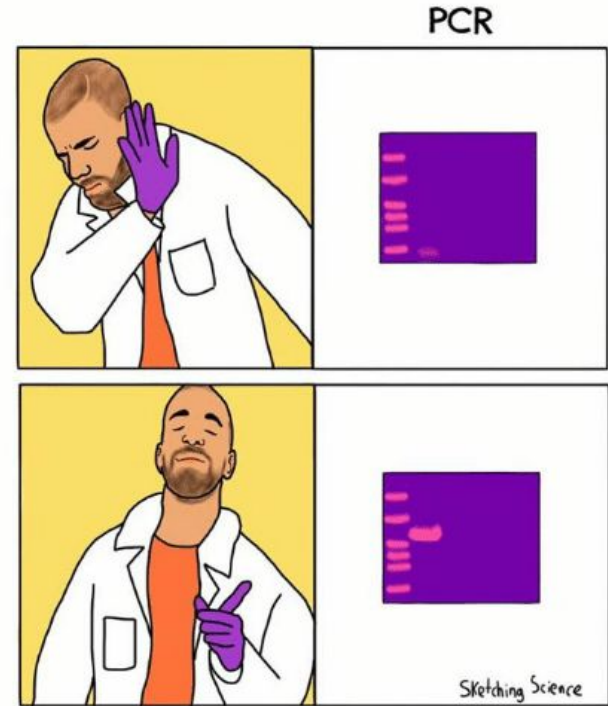


WELCOME



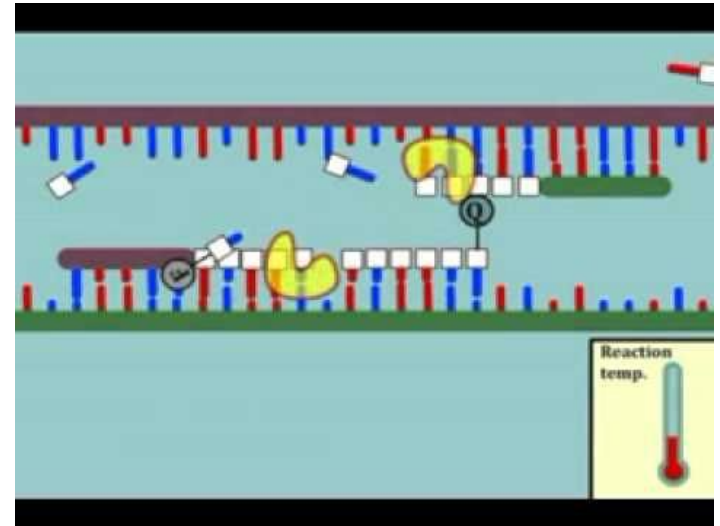
Legendary:
Bridging the Gap Between
Synthetic Biology and Business

with

cornell  iGEM

PCR

- Laboratory procedure used in molecular biology research
- Used to turn a little bit of DNA into a lot of DNA for
 - Analyzing
 - Genetic engineering
 - Putting into a different organism
- Returning to this later in the class
- A major part of what we do as part of Cornell iGEM



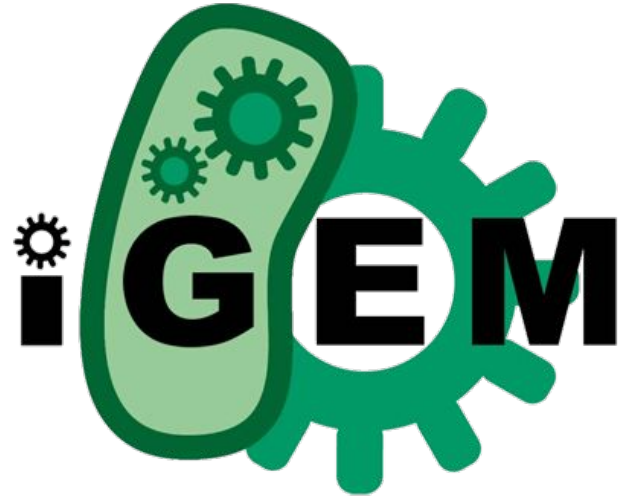
Our Team

- 40 undergraduates
- 5 subteams: Wet Lab, Product Development, Design, Policy and Practices, and Business
- Compete against **280 multidisciplinary teams** from all around the world at the iGEM World Jamboree



We combine biology, engineering, business

- Every year: Solve a problem using synthetic biology
- “International Genetically Engineered Machines”
 - Manipulate biology to create something new
 - Combine engineering/biology
- Connect the project idea to business
- Bridge the gap between science and business

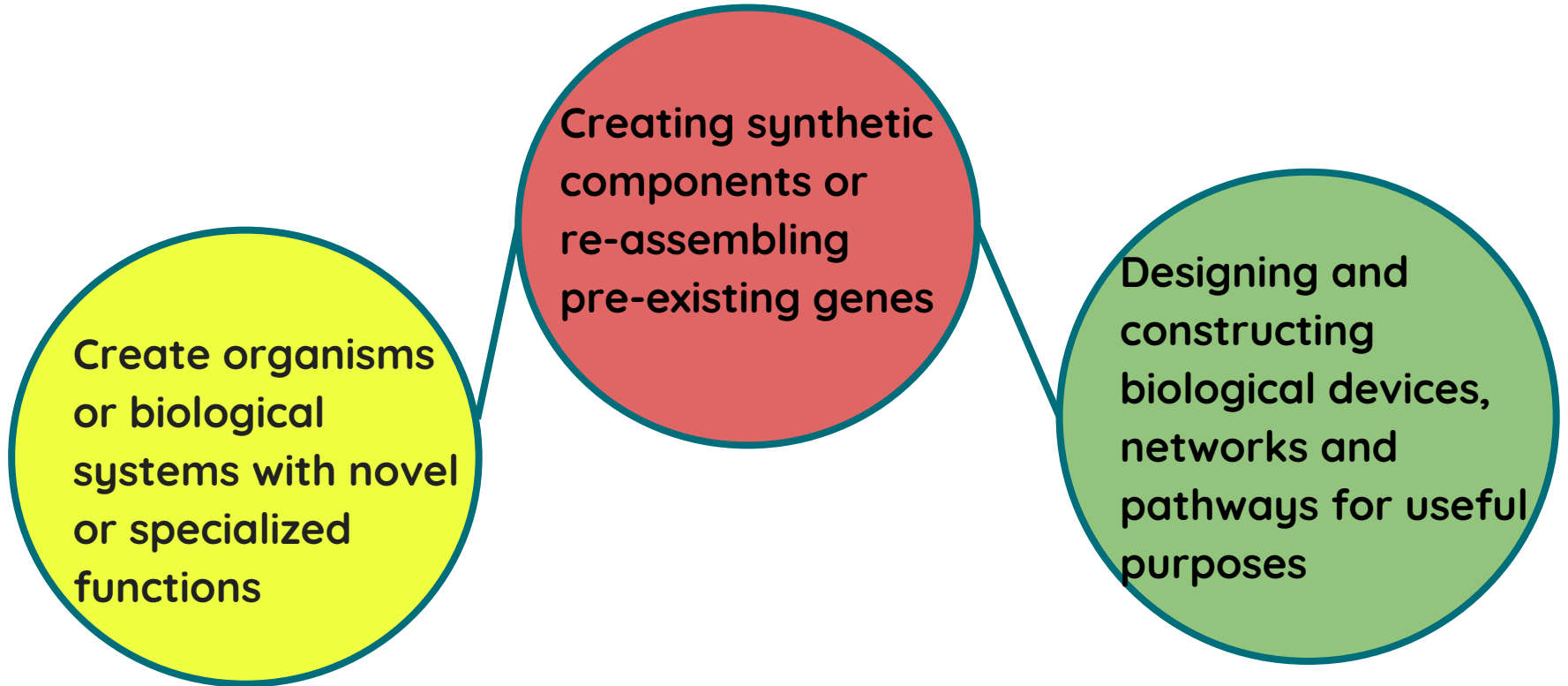


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What is synthetic biology?

Synthetic biology



So... basically make cells do whatever you want!



Combining DNA

Green
Fluorescent
Gene (from
fireflies)

+

Growth Hormone
Gene

=



- Scientists can combine DNA in ways not possible before.
- These hybrid genes are useful in many different applications.
 - Think of it as biological code.
- Right now scientists are determining the sequences of the millions of genes still unknown.
 - They are creating a library of DNA that can be used creatively.

What can you do using synthetic biology?



Write down some ideas on your index card

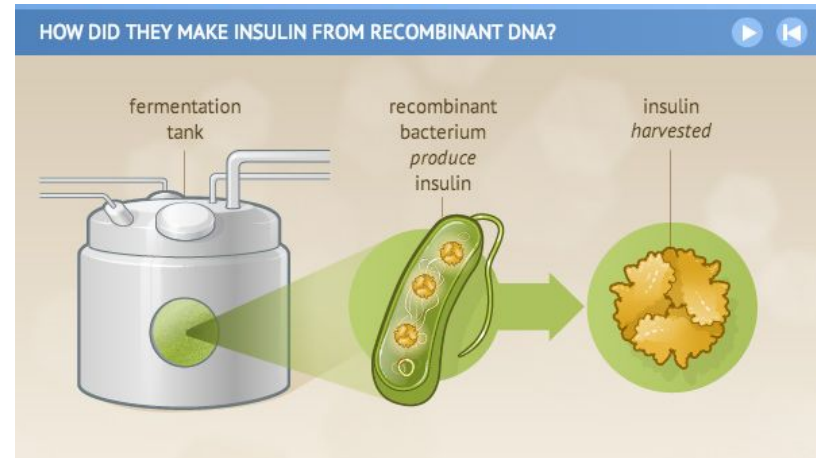
What can you do using synthetic biology?



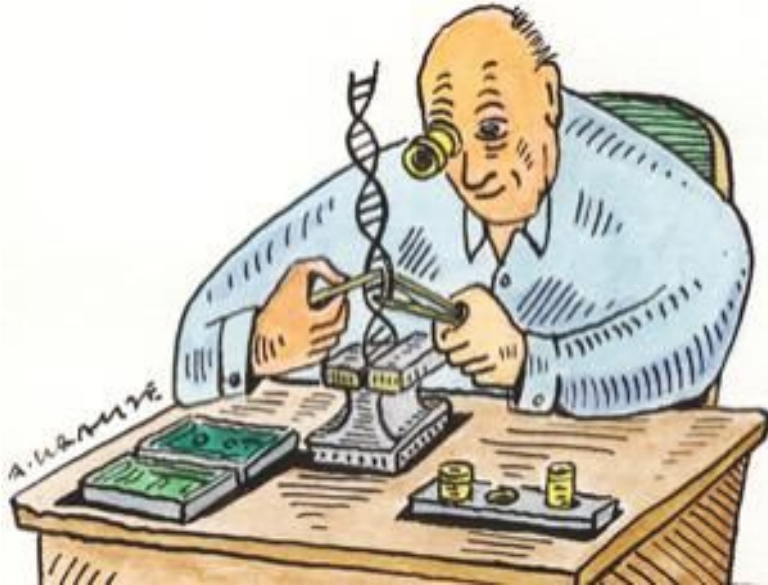
Biosensing, therapeutic treatment, biofuels,
food processing, and much more

But more specifically, so far we can:

- Naturally replicate rubber for tires
- Deliver economic, renewable acrylics
- Make green chemicals from agricultural waste
- Develop vaccines
- Engineer low-cost petroleum substitute; Produce biofuels
- Increase efficiency in bioprocessing for pharmaceuticals
- Produce insulin
- Manufacture food flavoring

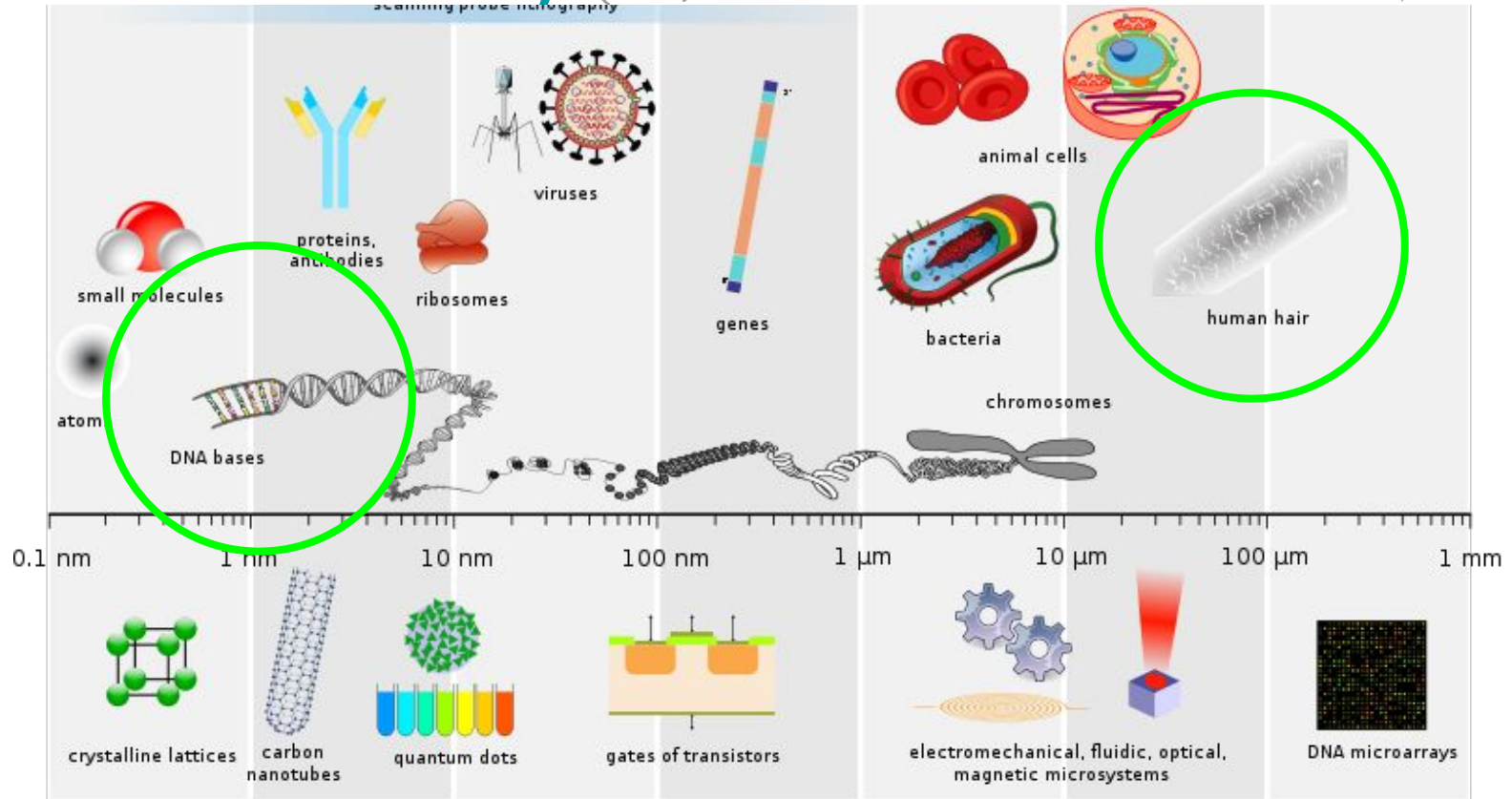


How do people work with DNA?

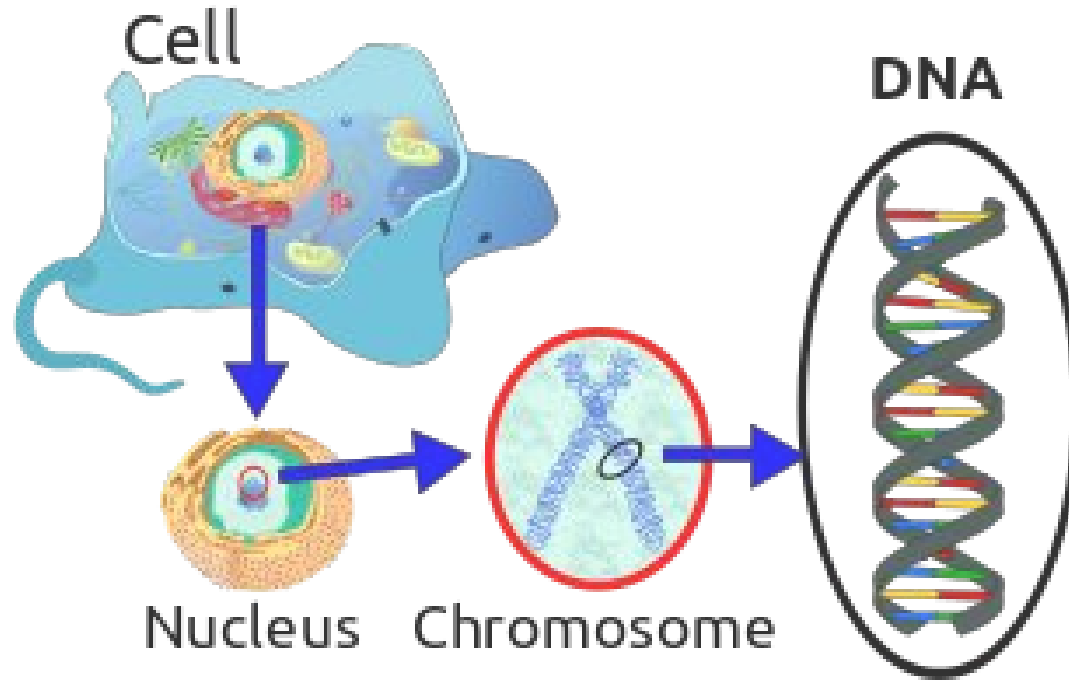


- Synthetic biology primarily involves changing DNA
- This shows some people working with DNA

Jk... DNA is tiny (100,000x smaller than a human hair...)



Also, DNA is stuck in cells





What
working
with DNA
actually
looks like

How to actually work with DNA

- 2 main ways:

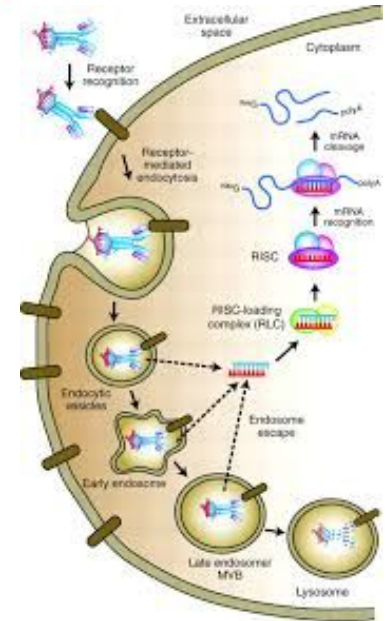
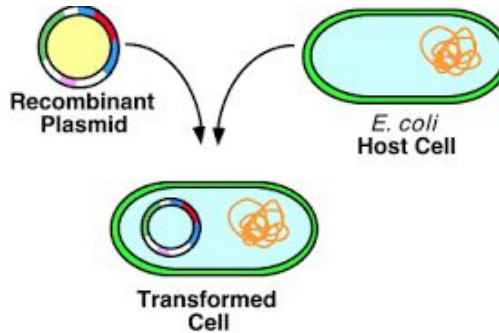
- Extract DNA, edit it, put it back in

- DNA cloning

- Send in special molecules/molecular parts to change the DNA within cells

- siRNA

- CRISPR-Cas9



Wheat Germ DNA Extraction

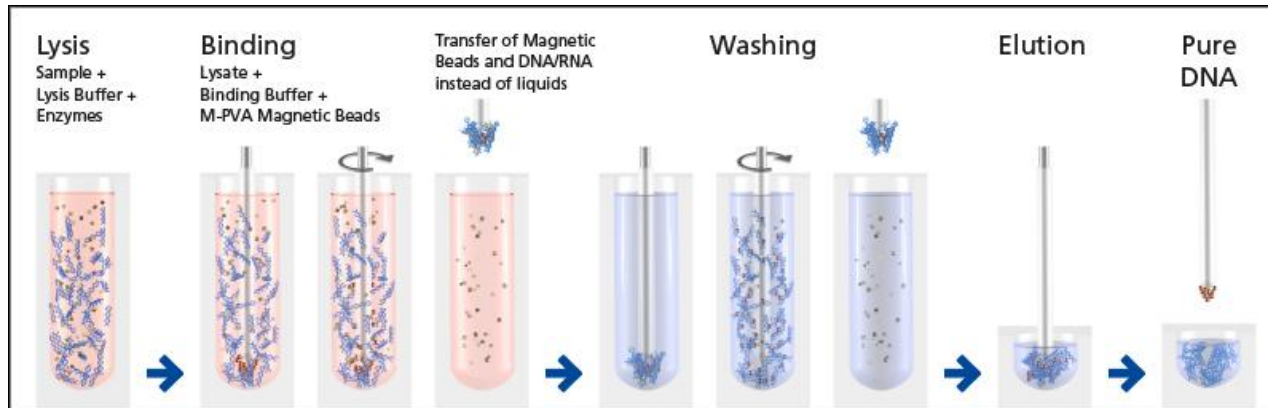
- We're going to extract DNA from some wheat!
- What we've done:
 - Mixed detergent and meat tenderizer to help break the cells apart
- Put our mixture and some wheat germ in the tube and shake
- DNA is the stringy looking stuff that forms



DNA Extraction in the Lab

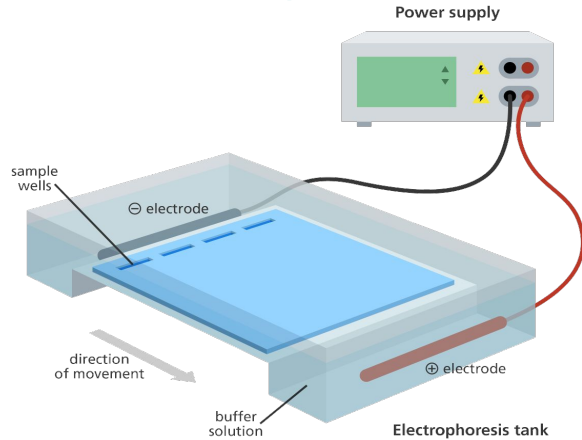
- First step in DNA cloning
- How is it done? (miniprep)
 - Grow lots of cells in the lab (culture)
 - Break open cell (lyse)
 - Take out everything not DNA (purify)

NOTE: this is usually done sterilely in the lab to allow for the DNA to be put back in living organisms

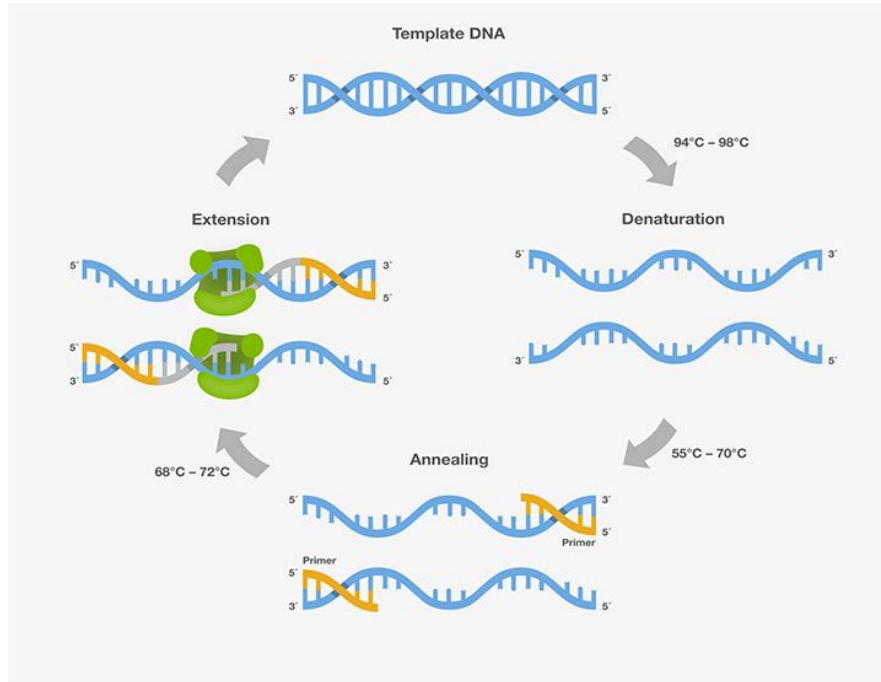


More Techniques in synthetic biology

- PCR
- Electrophoresis
- Cloning
- Miniprep
- Protein gels
- Westerns
- Manipulate viruses
- Crystallization
- Make new organisms



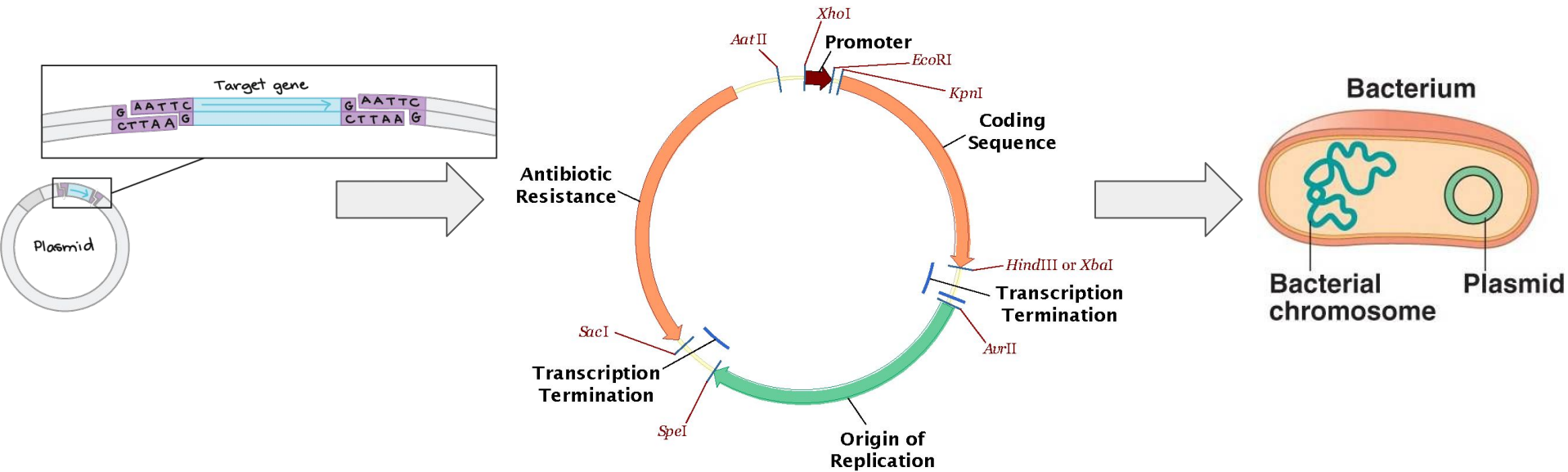
Polymerase Chain Reaction (PCR)



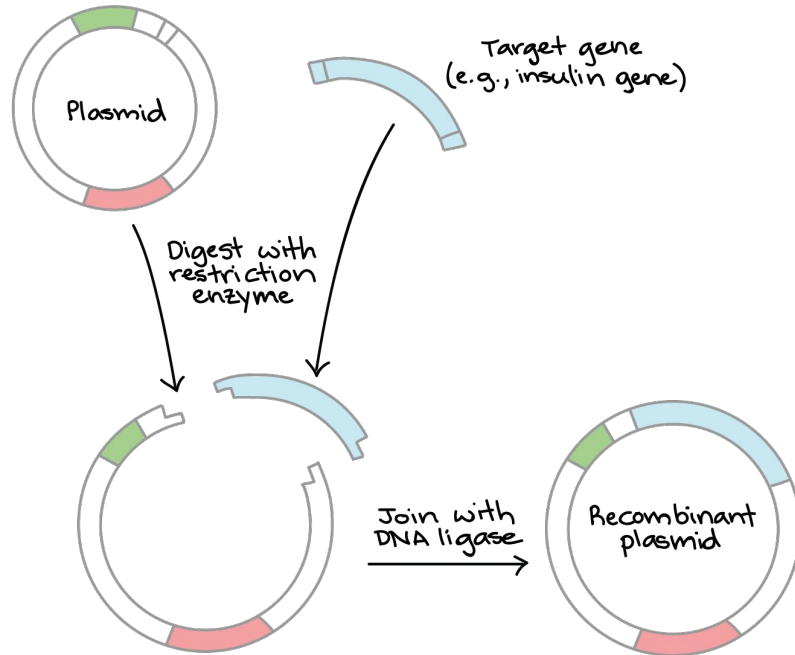
- Common laboratory technique to *get more* copies of DNA
- Cycle (doubles DNA each time),
 - **Denature:** two strands of DNA come apart (raise temp.)
 - **Anneal:** primers bind (lower temp.)
 - **Amplify:** DNA polymerase II copies DNA (ideal temp. for enzyme)
- Usually 35 times: 2 -> **34,359,738,368**

DNA Cloning in Bacteria

- Plasmids! -- Small Circular DNA sequences that can be customized
- Can extend to plants, and even animals under the right conditions!

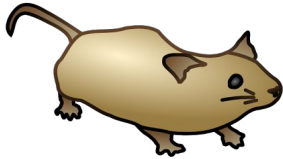
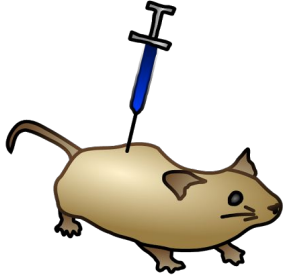
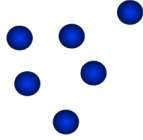


This is combining different parts of DNA



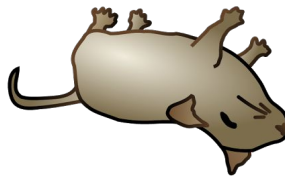
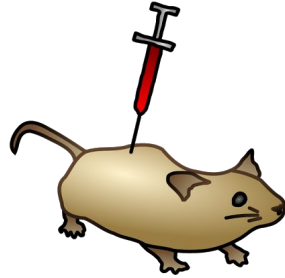
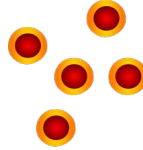
Can put in any gene of interest into an organism

rough strain
(nonvirulent)



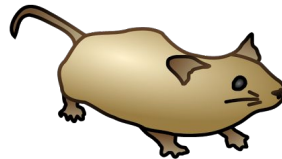
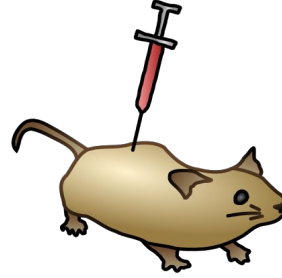
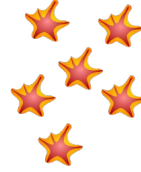
mouse lives

smooth strain
(virulent)



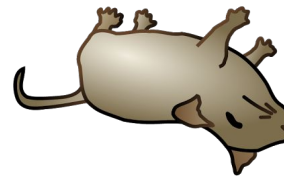
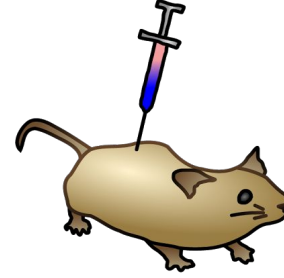
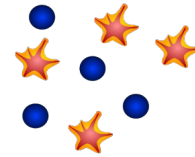
mouse dies

heat-killed
smooth strain



mouse lives

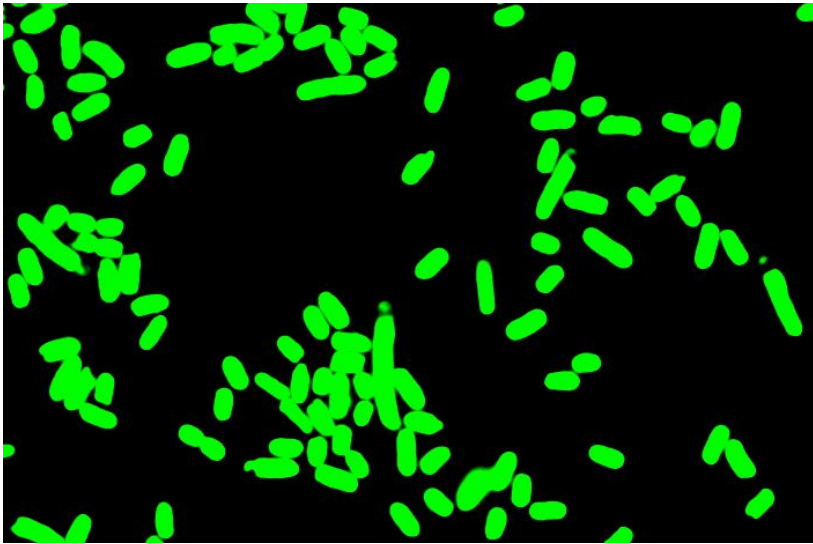
rough strain &
heat-killed
smooth strain



mouse dies

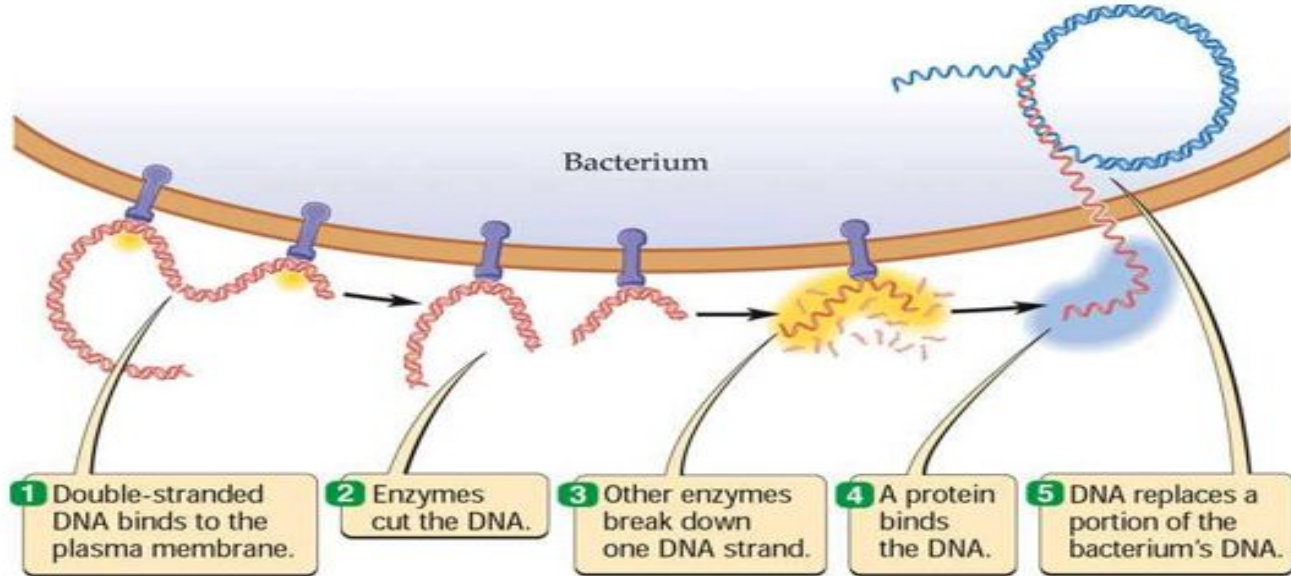
Nowadays:

- Fluorescence
- Selecting using antibiotic resistance (why antibiotic resistance is important part of plasmid)



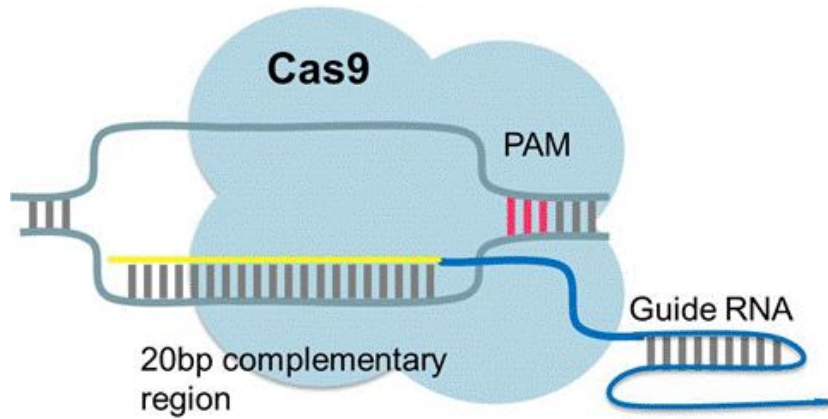
Transforming DNA in cells!

- Organisms can uptake external DNA and RNA through its plasma membrane.



Future Outlook

- CRISPR Cas9 and other RNA Technologies
 - Directly edit the eukaryotic genome with molecular ‘scissors’
 - The possibilities are endless!



How would you bring synthetic biology to the world?



Selling your synbio product!

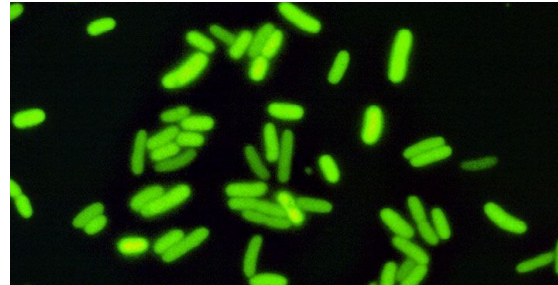
Bringing Synthetic Biology to the World

iGEM focuses on synthetic biology *applications*

LAST YEAR:



THIS YEAR:



Legendairy



Problem: Bovine Mastitis - persistent, inflammatory reaction of udder tissue in response to bacterial infection

Current treatments: antibiotics

Our solution: bacteriocins! - proteinaceous toxins made by bacteria to inhibit growth of other bacteria

Ratiometric Redox Sensor

Problem: oxidative stress in plants, leading to lower yields

Current Solution: there is none

Our Solution: monitor the oxidative stress levels via fluorescent *E. coli* and respond by making antioxidants



Business in Synthetic Biology

- Make something cool, useful, or fulfilling some need --- then **market** it
- **entrepreneurship**
 - Setting up a business and taking financial risks with the hope of making money (a profit)
- **Innovation**
 - New idea, product, action
 - Something never thought of before



You can own your ideas/inventions

Intellectual Property

Any product or invention that is the result of intellect or creativity that one has the rights for and can apply a patent to

Patent

A license that gives one the right to a product and prevents others from making, using, or selling that product

Elements to Consider* (*there's a lot of variation)

- Clear value proposition
 - What is the purpose of the project?
- Identification of needs
 - Why is your product necessary?
- Market analysis
 - Who will use your product?
- Market strategies
 - What will you say to make people want to buy your product?
 - How much will people pay for your product?
- Limits
 - Rules/regulations/laws that control your product?
 - Are there any bioethical problems?
- Catchy name
 - What will make your product sound good?

Many businesses in science based on innovation:

Biotechnology: Gilead Sciences, Amgen, Regeneron, Sanofi, New England Biolabs, Academia

“Research and Development”

- Biologists, chemists, chemical engineers, biological engineers, biomedical engineers

Do the same thing synbio with any idea!

REGENERON
science to medicine®

SANOFI 

 NEW ENGLAND
BioLabs® Inc.

be INSPIRED
drive DISCOVERY
stay GENUINE

Questions?



Your Turn!

- Work with a group to design and business pitch a SynBio bacteria
 - Choose elements of your plasmid (the design of your bacteria)
 - Business plan (value proposition, evaluation of needs, market analysis, sales strategies, rules/regulations, bioethics)
 - Catchy name
- Make a **poster** and give a short (2-3 minute) **presentation** to the group
- We'll give you a list of genes - the promoters, antibiotic resistance, and others - you can use
 - Can use multiple!
 - Ask questions and we will help you develop a “biocircuit”

Genes for Use

Promoters (what activates your gene)

Gal4 (light-sensitive)

Asr (promotes at low pH)

T7 (always-on promoter)

Antibiotic Resistance (how you select bacteria that have your gene)

Cat (chloramphenicol resistance)

Amp (ampicillin resistance)

Genes (what you want your bacteria to do)

roGFP (redox-sensitive green fluorescent protein)

cbp4 (sequesters lead)

MtrB (generates electric current)

Nisin (bacteriocin)

ngCA (removes atmospheric CO₂)