



Bioengineering

Opportunity in a revolutionary field



Outline

- Overview of the science behind bioengineering
- Bioengineering applications
- Hands-on activity
- Planning a career in bioengineering
- Q&A

What is iGEM?

iGEM is an annual biological engineering competition and conference centered around open source, collaborative bioengineering solutions to real world problems





What is bioengineering?



What is bioengineering?

Bio: regarding life

Engineering: to design, build, and create

Life comes in many forms







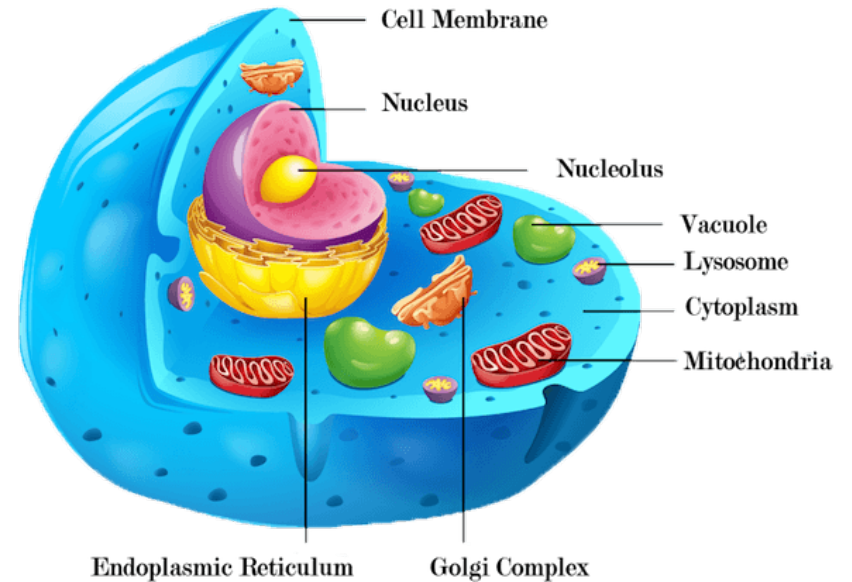
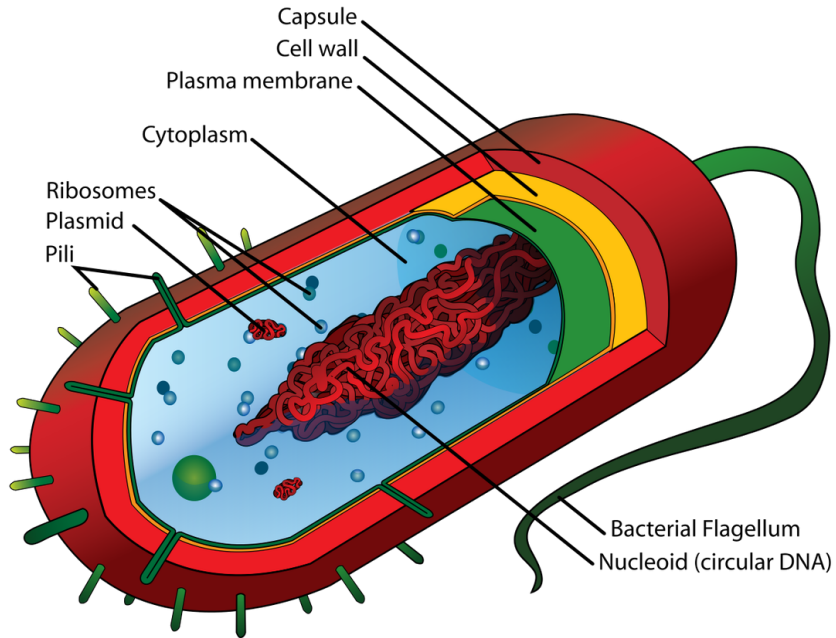




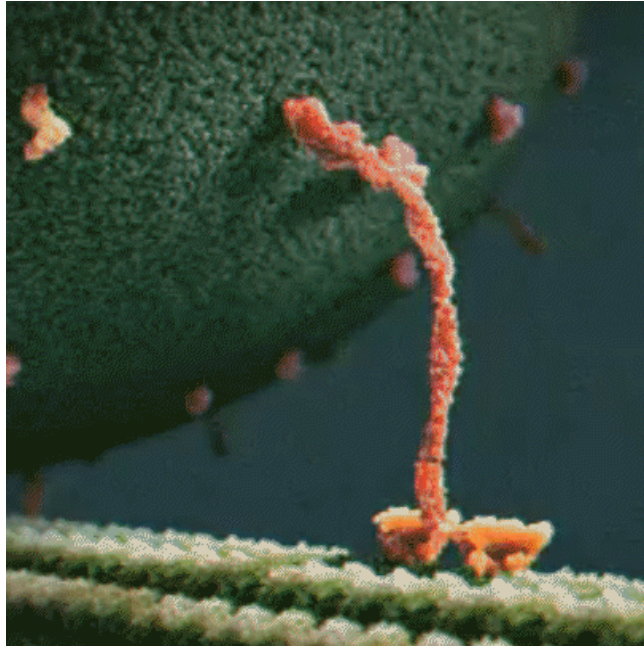


What does all life have in common?

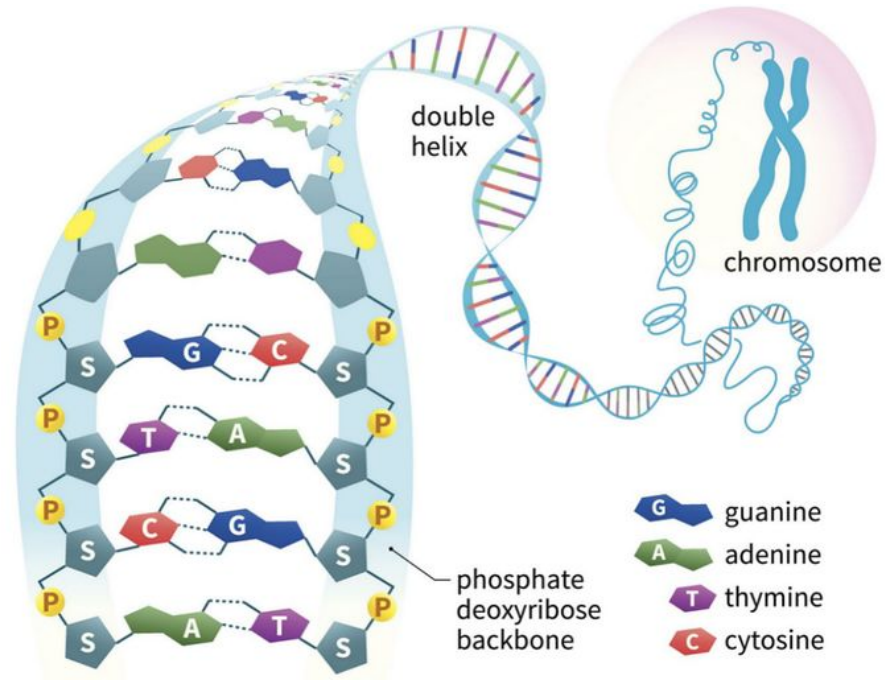
All life on Earth is made of cells



All cells use proteins to perform tasks

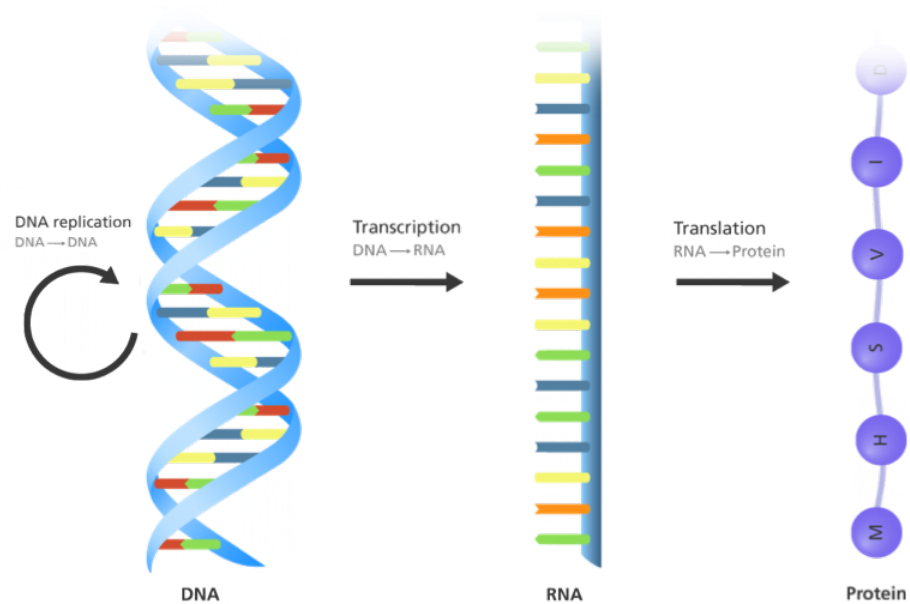


All cells use nucleic acids to encode protein



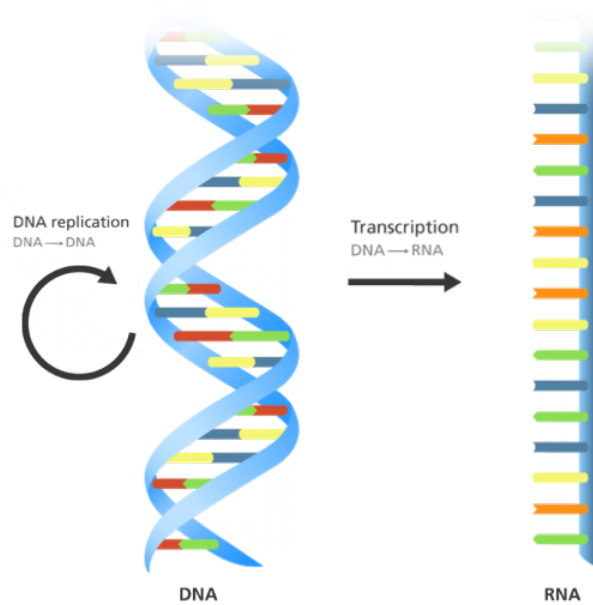


The Central Dogma describes this encoding



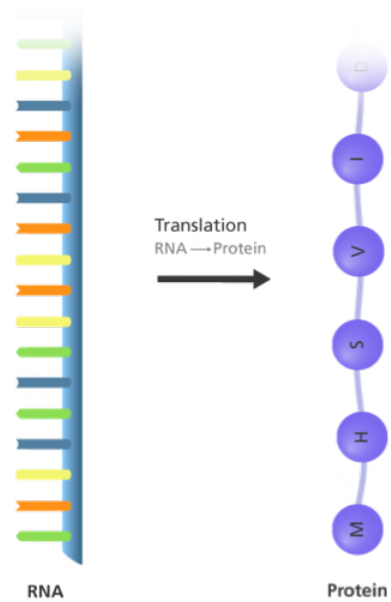


Transcription



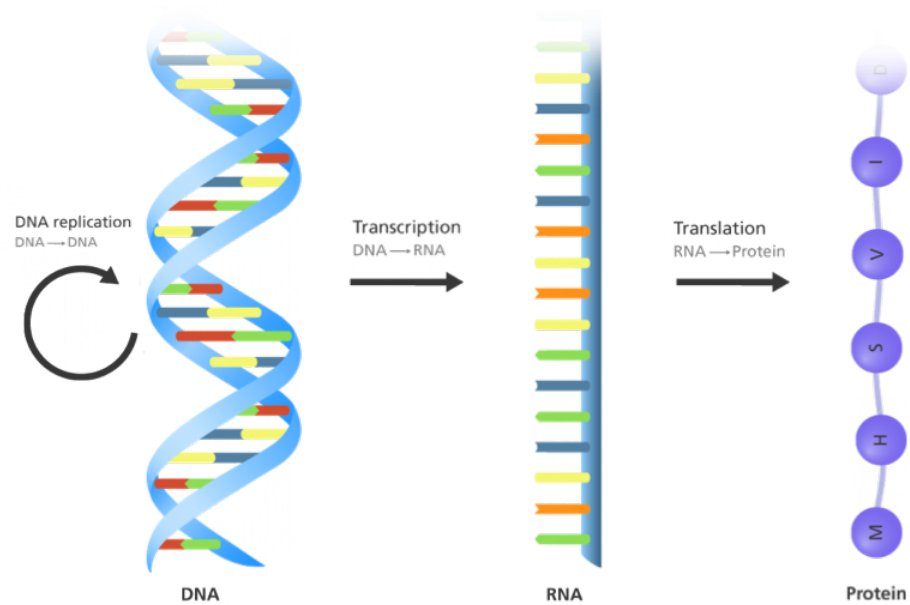


Translation

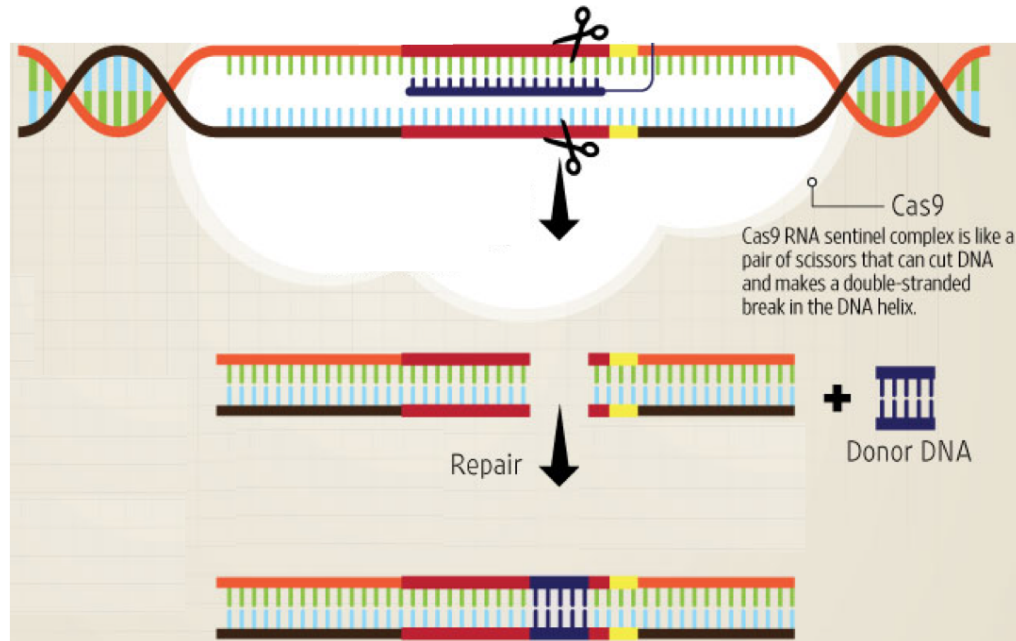




This process is universal

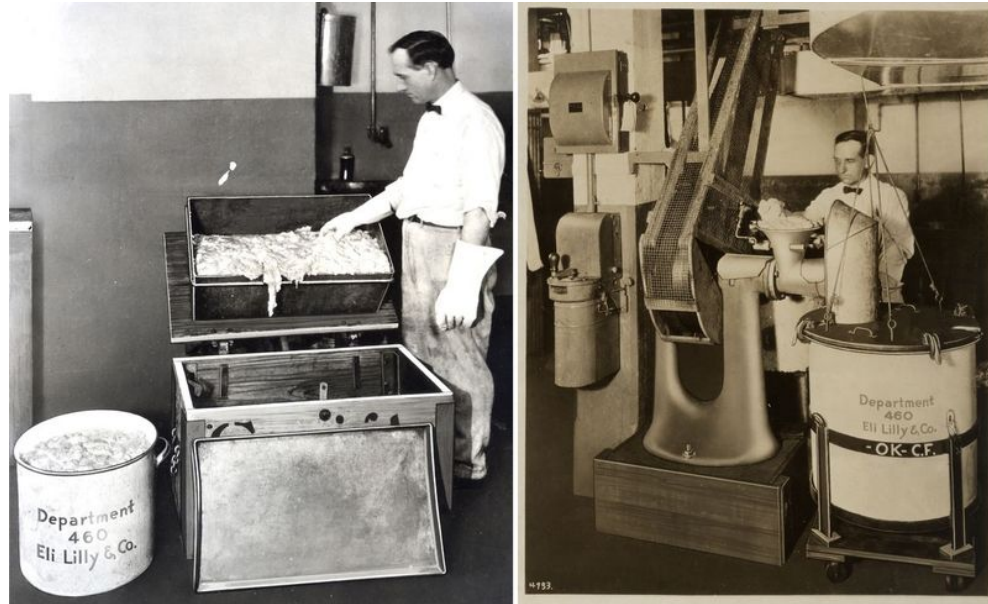


Gene editing let us change organism's DNA



Bioengineering cheaper insulin

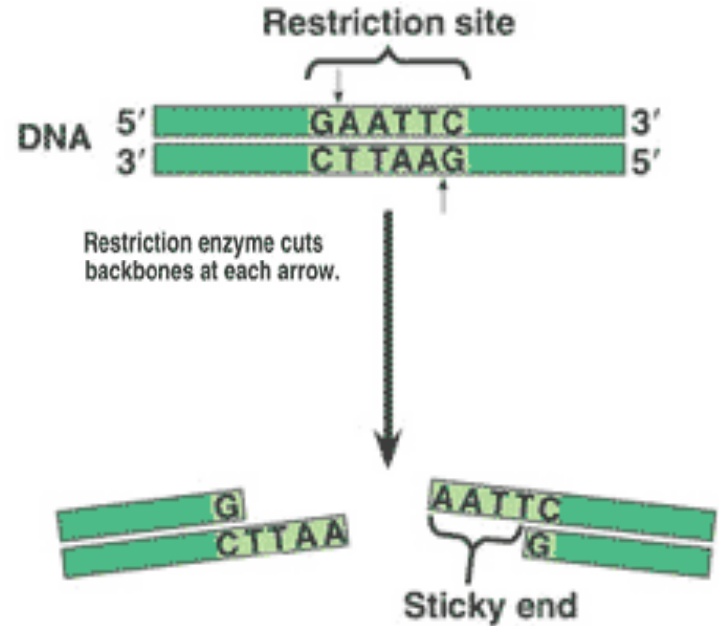
- Type I diabetes
- Can be treated by insulin injections
- For decades the only source was from pigs and other animals
- In 1978 researchers used “restriction enzymes” to enable bacterial production of insulin



Insulin extraction from pig pancreas (1920)

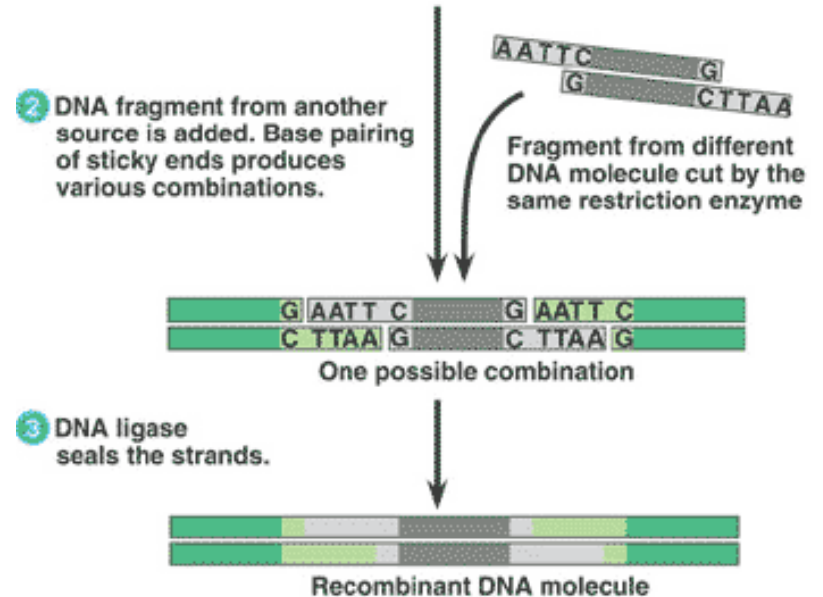
Restriction enzymes cut DNA

- Restriction enzymes cut DNA at specific **recognition sites**, leaving **sticky ends**



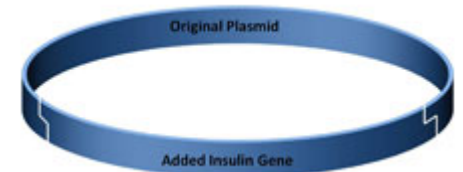
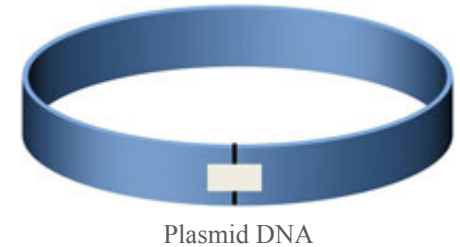
Using sticky ends new DNA can be added

- Sticky ends can bind to their matching complement
- **DNA ligase** is used to glue DNA together



Activity!

- Make recombinant DNA using restriction enzymes and ligase
- Everyone has two pieces of paper with DNA sequences: plasmid DNA and chromosomal DNA with insulin
 - Cut both of these out
- Tape the two ends of the plasmid DNA together to make a circle
- Find the recognition sites on both pieces of DNA and cut using your “restriction enzyme,” making sure to leave sticky ends



Adapted from <https://www.teachengineering.org>

- Line up the sticky ends and tape them together using “DNA ligase”



Critical Thinking Questions

- What are some other applications for genetic engineering?
- What are some potential ethical concerns regarding genetic engineering?
- How can we as scientists address these ethical questions?



Applications of bioengineering

- Permanent solutions for “incurable” genetic diseases (Cystic Fibrosis, Diabetes, Sickle Cell Anemia)
- Biological therapies
- Immunotherapy for cancer
- Biofuels and agriculture



Why be a bioengineer?

- Change the world for the better
- Work with and develop cutting edge technology
- Helps develop transferable skills useful in a wide range of careers, not just in biotechnology
- Expanding field with a need for talent



How to prepare for bioengineering

- Prioritize science and **math** classes
- Work on developing critical thinking and communications skills
- Try to get involved in research
- Look for science and technology focused universities

Q&A

