



# iGEM 2017 Shad Valley – Day 1: A Primer on Synthetic Biology



By: Austin Boucinha

# Presentation Outline

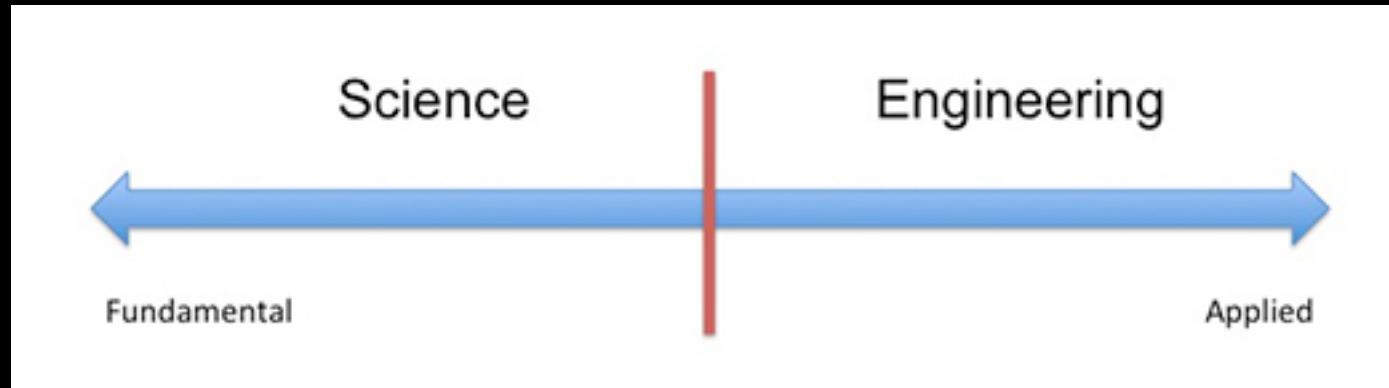
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- Overview of Synthetic Biology
- Perspectives of Synthetic Biology
- Genetics Lab Theory Overview
- Introduction to iGEM and your Shad Valley Waterloo Experience
- Connection between Genetic Manipulation and Synthetic Biology

# What is Synthetic Biology?



# Perspectives: Science & Engineering





# Genetics Theory Overview

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- Central Dogma of DNA
- Plasmids and Restriction Enzymes
- BioBricks: The Plasmid Standard
- Cell Transformation & Competent Cells
- Plating Cells & The Observation of Colonies

# ATCG

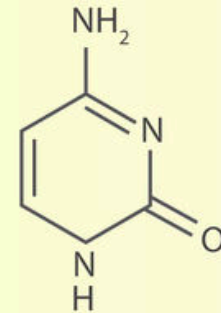
## Nitrogen Bases in DNA



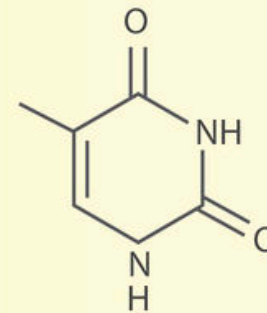
**Adenine**



**Guanine**

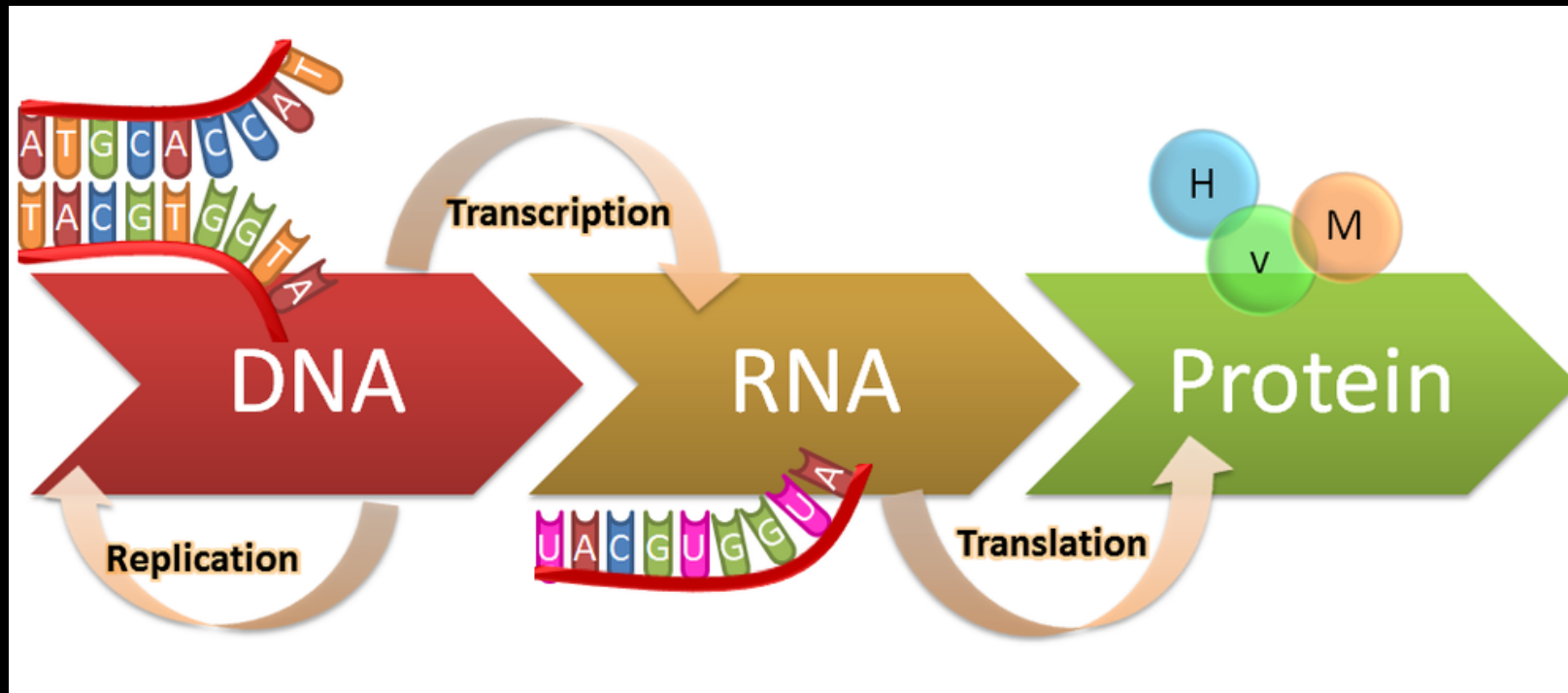


**Cytosine**

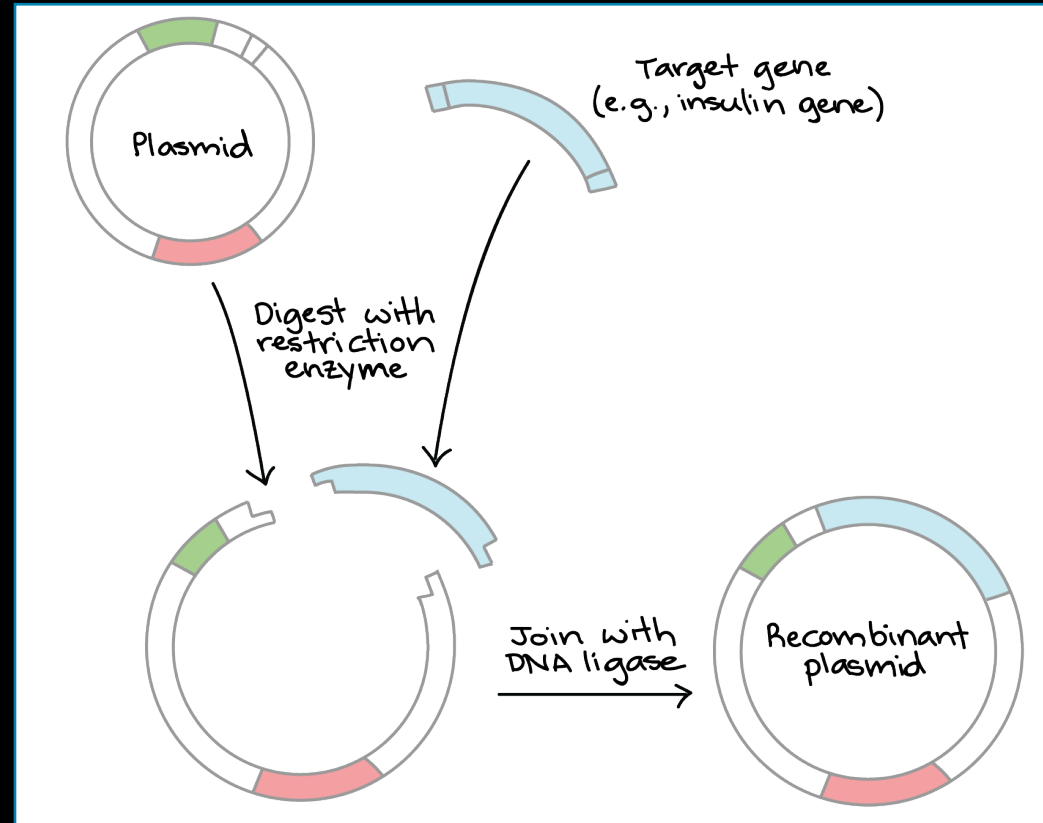


**Thymine**

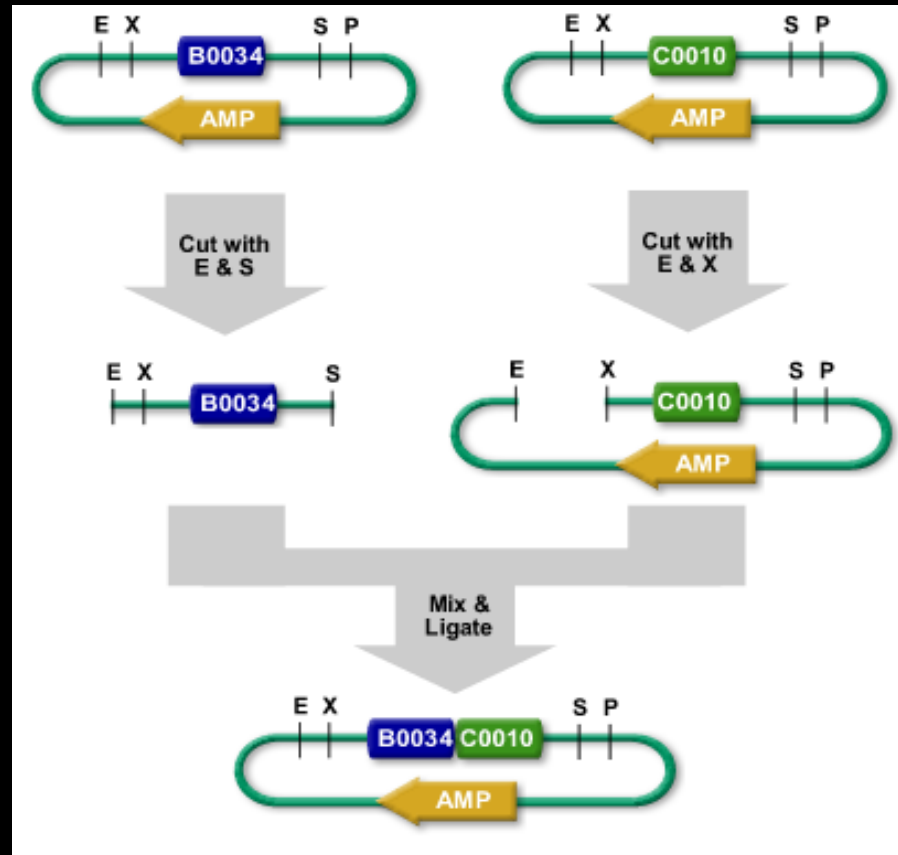
# The Central Dogma of DNA



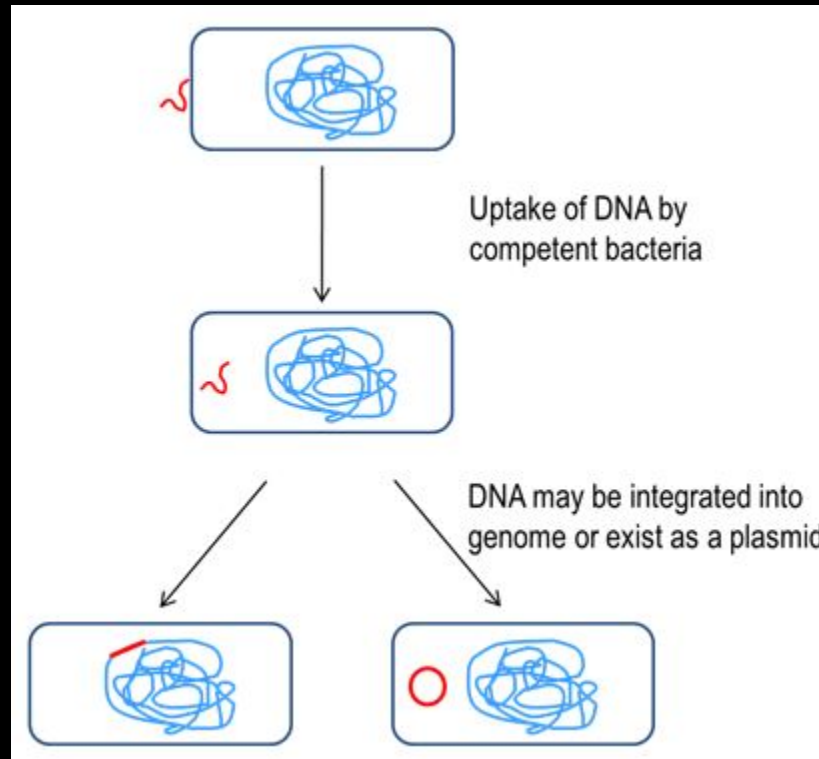
# Plasmids & Restriction Enzymes



# BioBricks: The Plasmid Standard

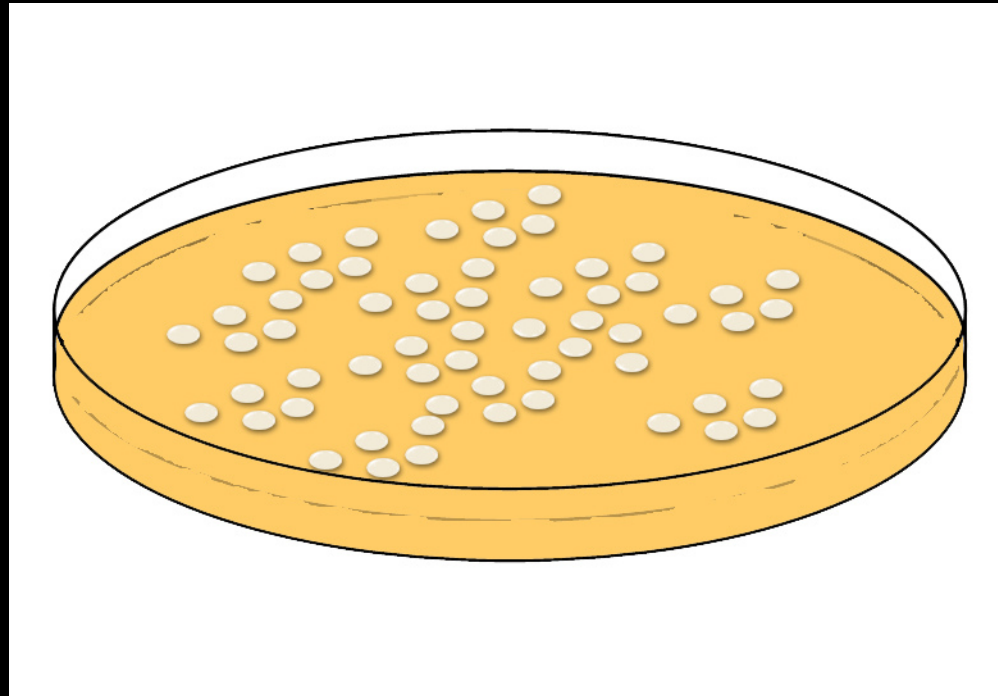


# Cell Transformation & Competent Cells



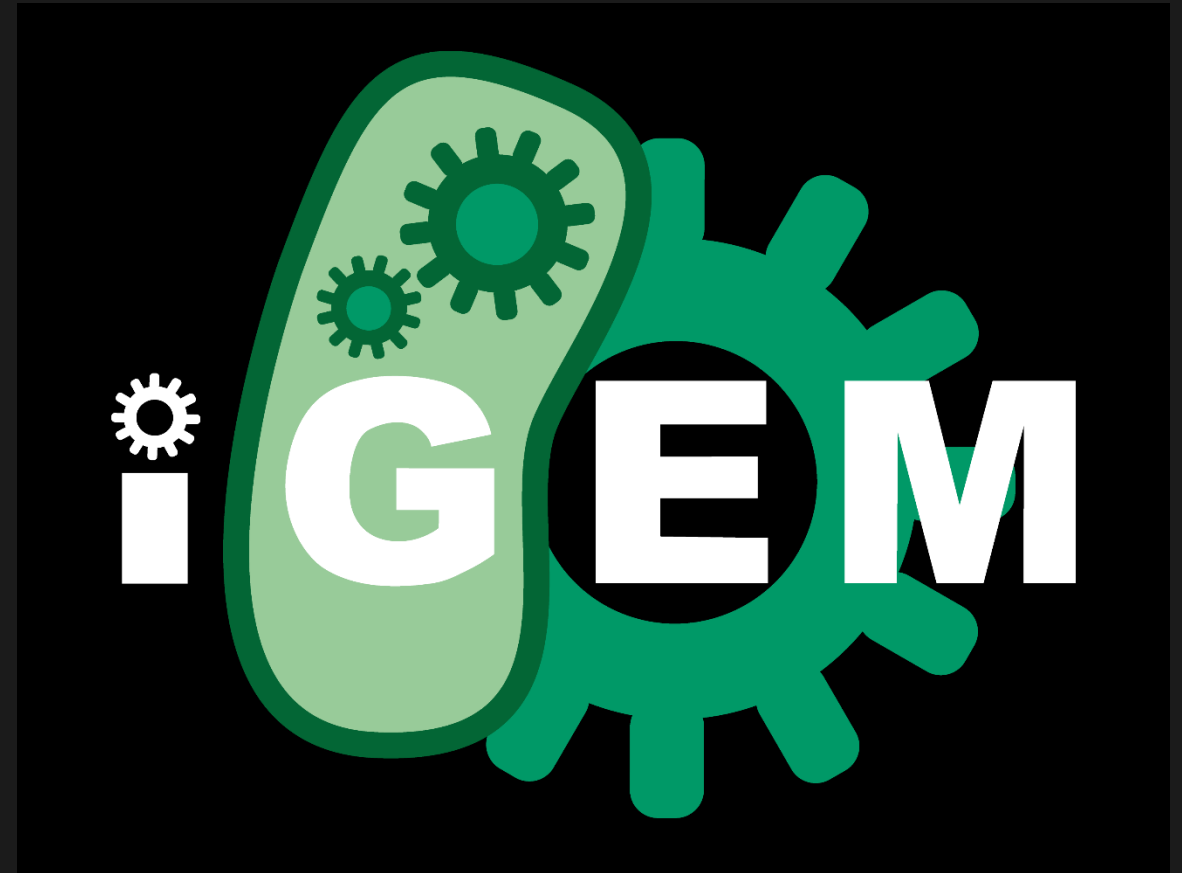


# Plating Cells & The Observation of Colonies



# What is iGEM?

- iGEM
- Teams from all over the world
- Compete in 9 tracks
- Our Team
- Our Project



# Your Experiment @ Shad Valley Waterloo

Day 1: Pipetting, Streak Plating, Lab Tour

Day 2: Mobile Genetic Elements Talk & Mini-prep

Day 3: Electrophoresis, Gels, and Ethics in Synthetic Biology

# The Link Between Genetic Manipulation & Synthetic Biology

# Lab Safety

BEFORE WE CAN DO ANYTHING...

# Why is lab safety Important?

## Handling of Microbes

- Possible Pathogens
- Handling of Chemical Solutions
- Working with an Open Flame
- Report broken glassware immediately





# Safety Equipment

## Personal Protective Equipment (PPE)

- Lab Coats
- Closed-Toe Shoes
- Gloves
- Safety Glasses
- Long hair tied up
- Loose clothing tucked away



# Workspace

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- Always sanitize with ethanol
- Remove materials that are irrelevant to the experiment
- Maintain aseptic area with Bunsen burner
- Electronic devices are prohibited in the laboratory
- NO FOOD OR DRINKS!
- Store belongings in the provided space
- Keep test tubes upright

# Aseptic Technique

What is it?

Use of a flame to clean and maintain area near flame devoid unwanted contaminants.



# Clean Up!

- All waste in proper bins
- Pipette tips
- Nitrile Gloves
- Used Test tubes
- Sticks
- Clear Bench and wipe down paper with acetone/ethanol



# In Case of Emergency

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- Eye Wash Stations
- Shower Stations
- Fire Extinguisher

If you are unsure where any of these stations are during an emergency, please ask one of our lab members for some assistance.

Thank You





# iGEM 2017 Shad Valley – Day 2: Genetics Foundation and Miniprep



Slides by: Kingsley Wong & Alex Li | Presented by: Leah Fulton & Cody Receno

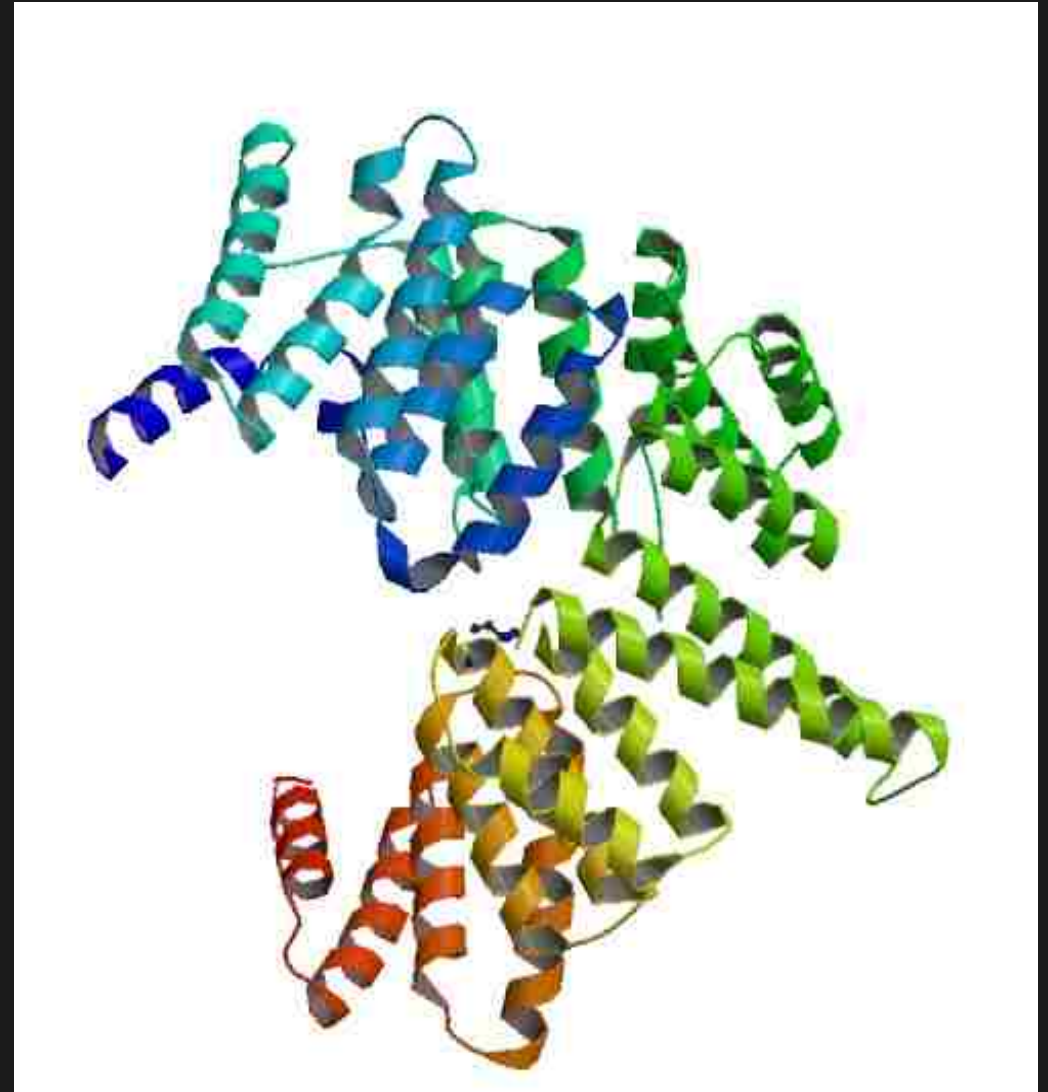
# Here's What We're Doing Today...

1. Learning about the foundation of genetics!
1. Review the procedure for today's mini-prep!
1. Perform your first mini-prep!



# Protein

- complicated 3D structures composed of one or more polypeptides
- polypeptides are molecules made of many amino acids



# Nucleic Acid

- direct the growth and development of living organism
- determine the characteristics and functions of a cell
- two types of nucleic acids, **DNA** and **RNA**
- made of nucleotides, which are composed of a phosphate group, a sugar, and a nitrogenous base

# DNA

- DNA is heredity material located in the cell nucleus

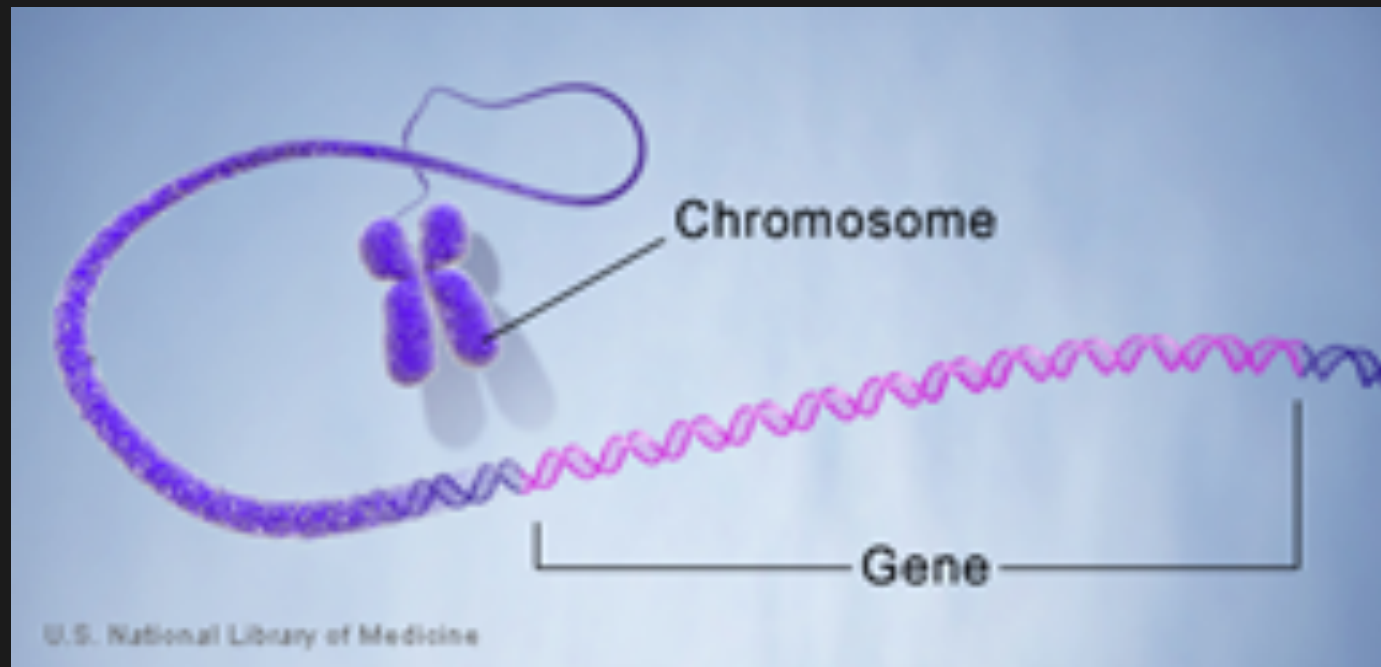




# Chromosomes and Genes

**Chromosomes:** structures made of both nucleic acid and proteins that helps ensure DNA is accurately copied and distributed

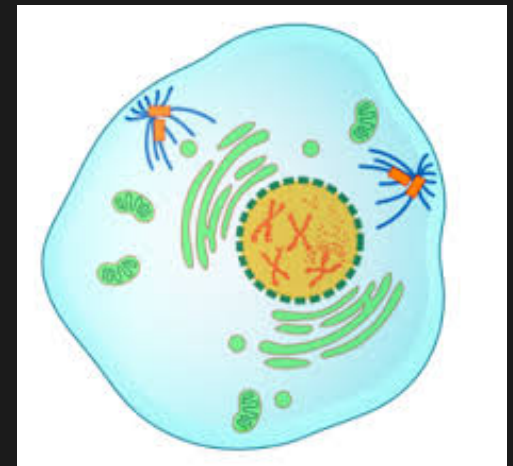
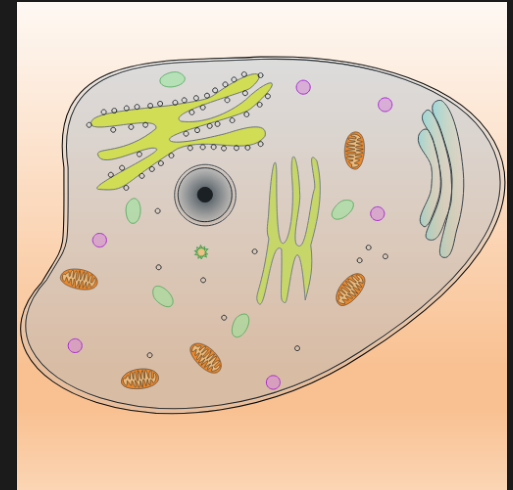
**Genes:** the part of the DNA that helps the cell make a protein



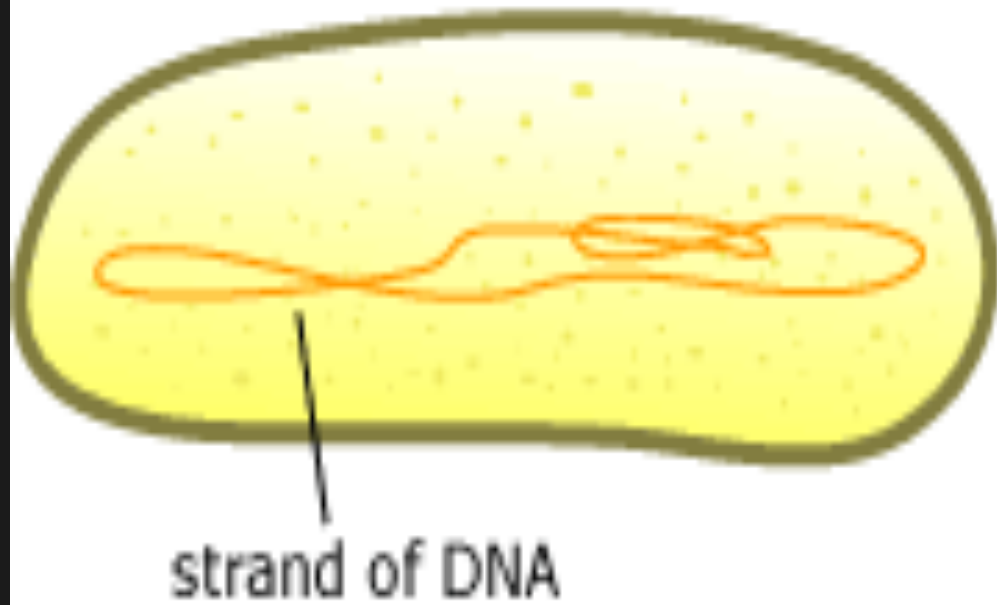


# Cells

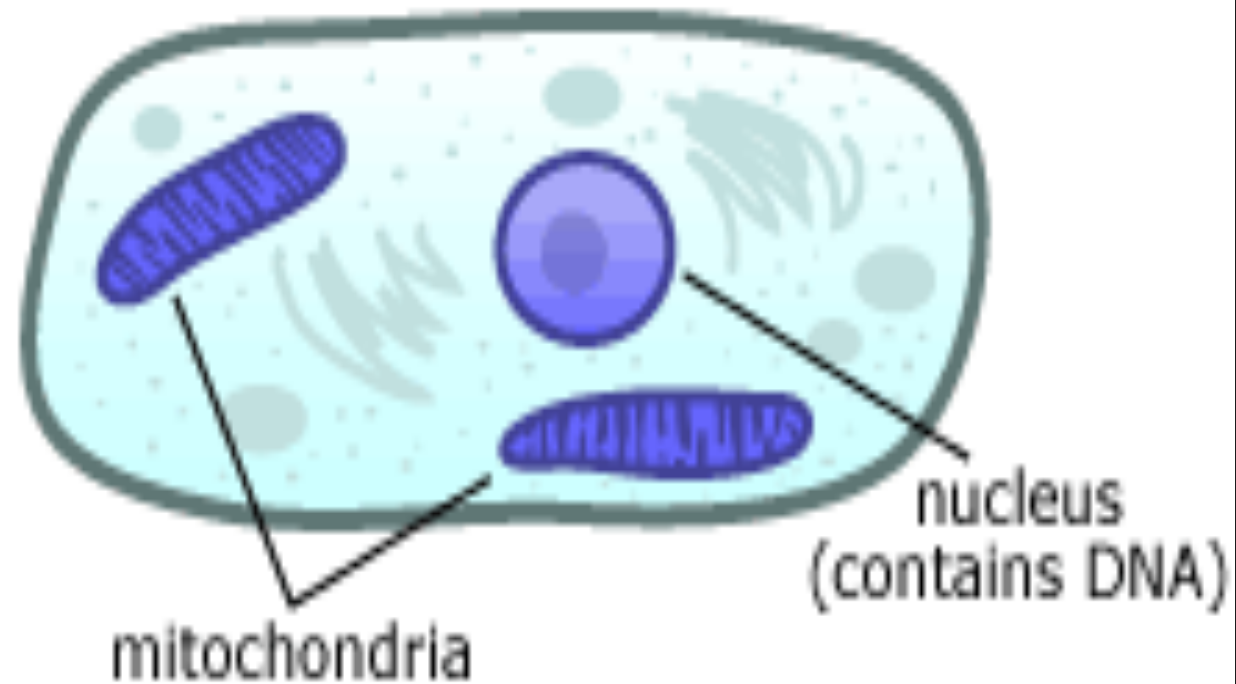
- the basic biological unit of all living organisms
- there are two types of cells: **prokaryotes** and **eukaryotes**



## Typical prokaryote cell

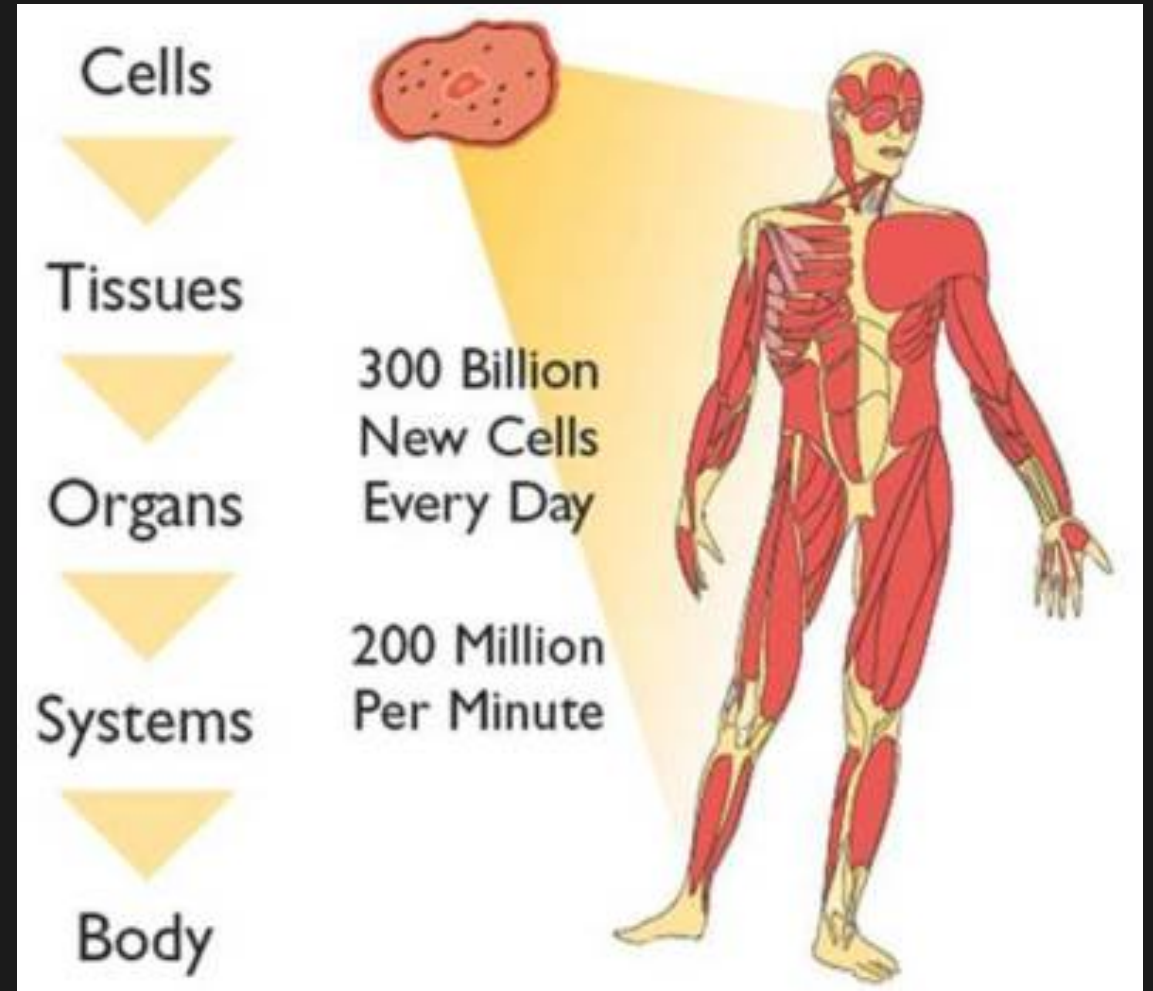


## Typical eukaryote cell



# Which Are We Made Of?

- humans are made of around 37.2 trillion cells
- in our bodies, there are hundreds of different functions
- our cells are eukaryotic



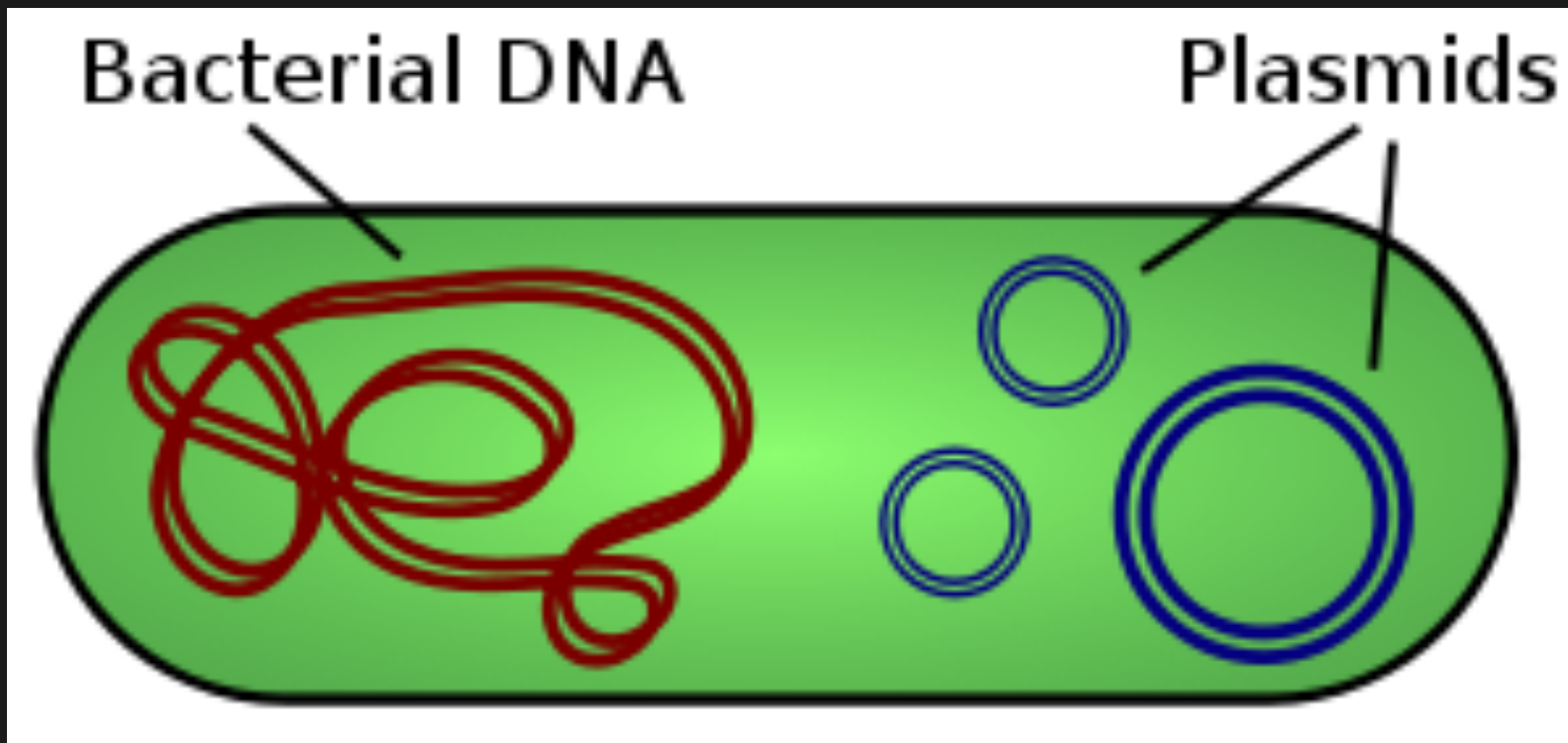
# Bacteria

- prokaryotic, functional organisms
- they're almost everywhere, but not all of them are dangerous!
- bacteria were one of the first lifeforms on earth
- in one drop of water, there are about one million bacteria cells



# Plasmid

- circular, double stranded DNA molecules often found in bacteria
- often used to manipulate genes



# And Now for the Miniprep!



# What Are We Doing?

*The goal of a miniprep is to isolate plasmid DNA from a bacterium to use the plasmid for other things!*

*(Tomorrow we will separate the DNA by size through electrophoresis)*

# Video Time!

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[https://www.youtube.com/watch?v=7Xgy5\\_i6iOc](https://www.youtube.com/watch?v=7Xgy5_i6iOc)



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**Good luck, and go  
knock your socks off!**



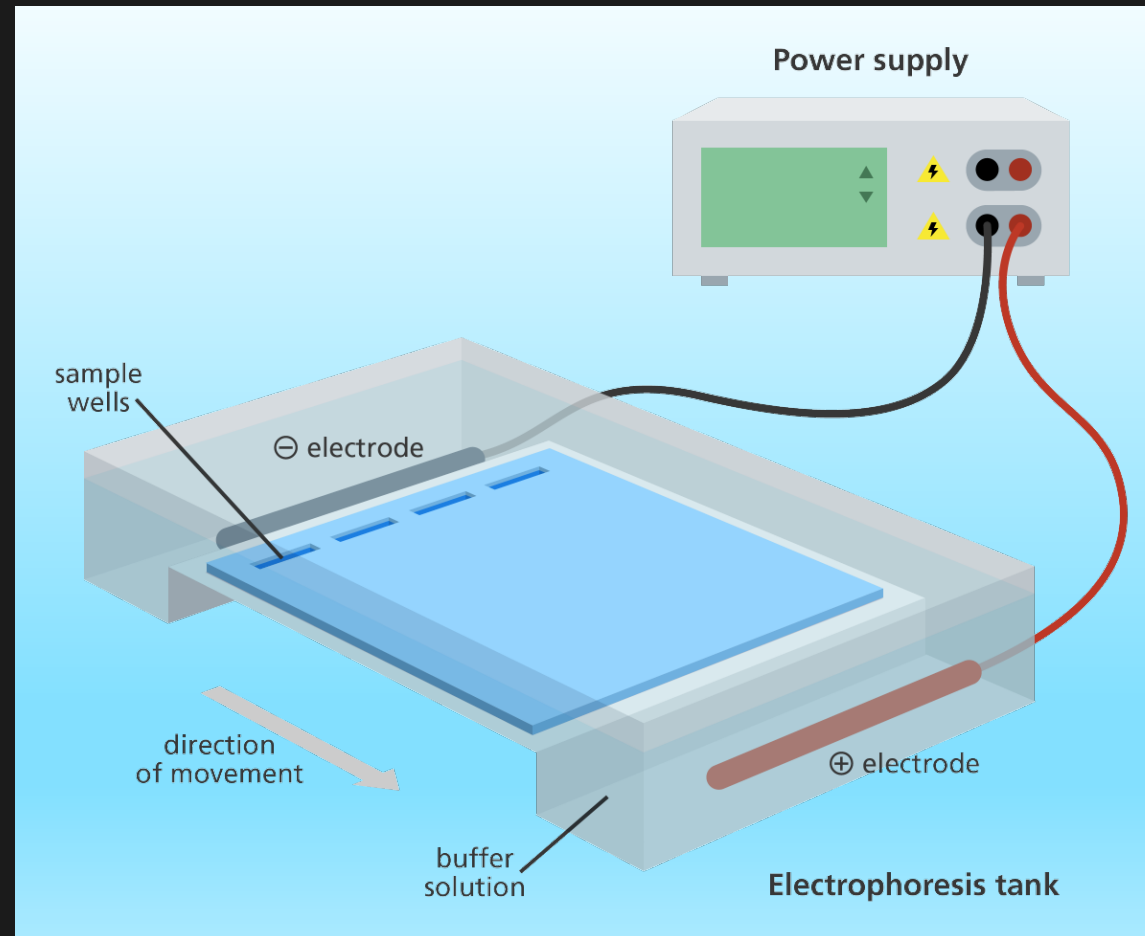
# Gel Electrophoresis

*Using electricity to separate DNA fragments*

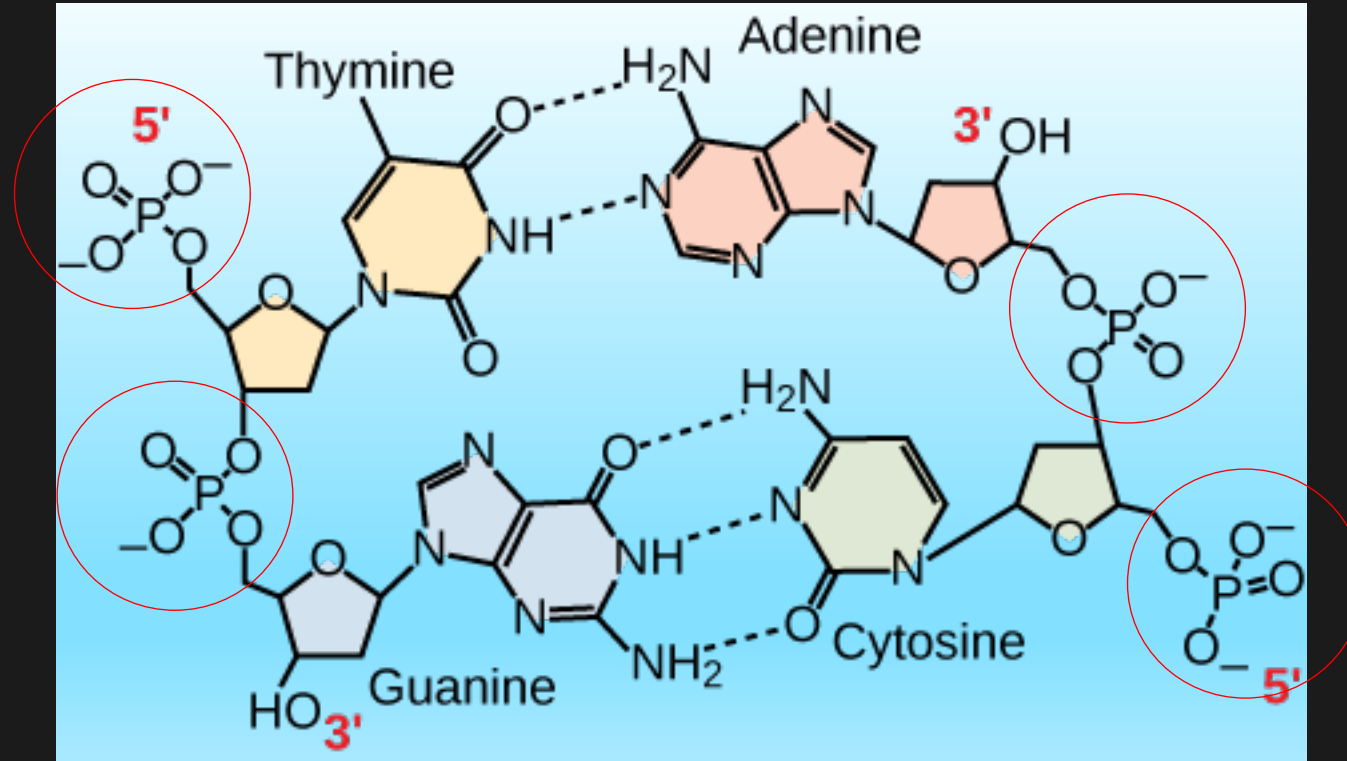


Slides by Clara Fikry, Presented by Monica Chung

# Agarose Gel Electrophoresis

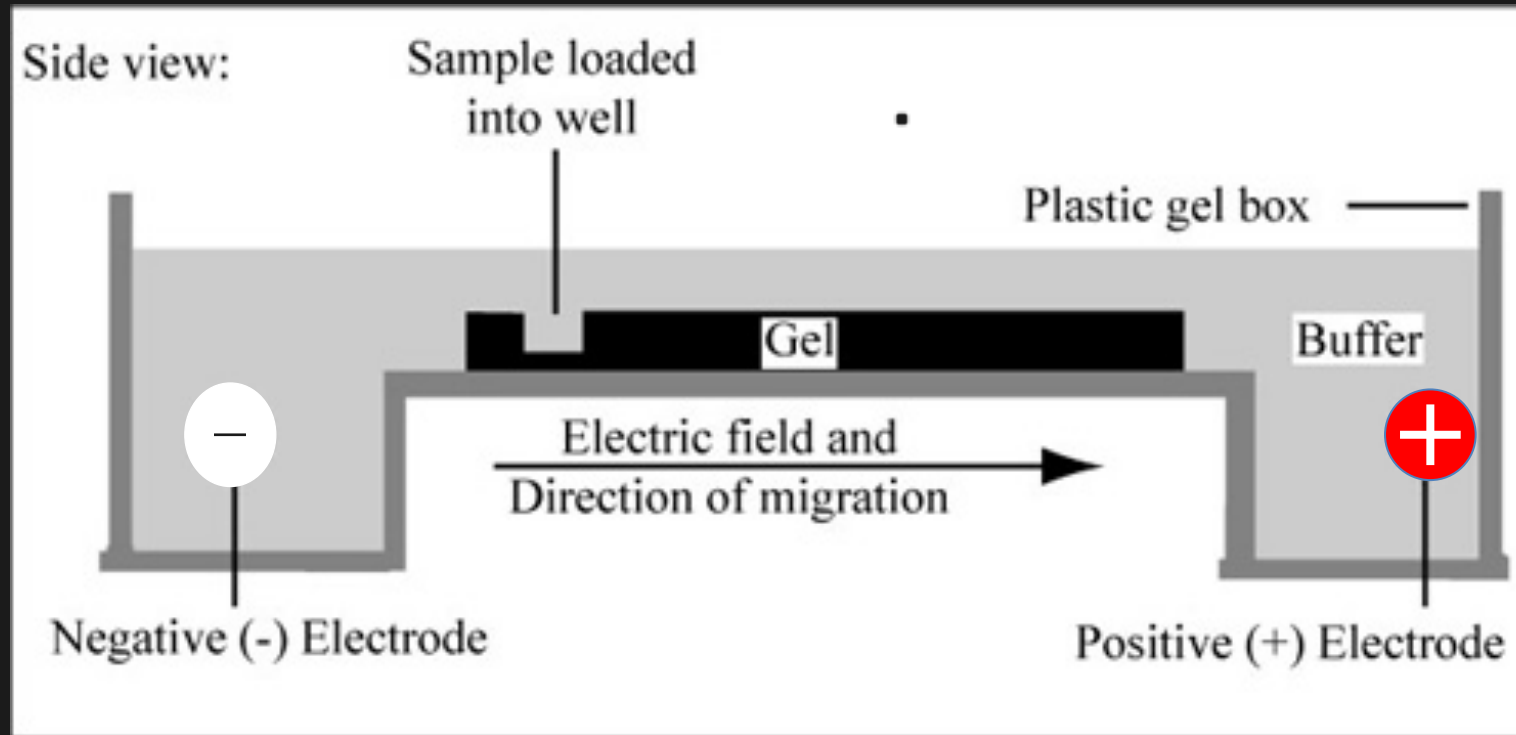


# How do we sort DNA?

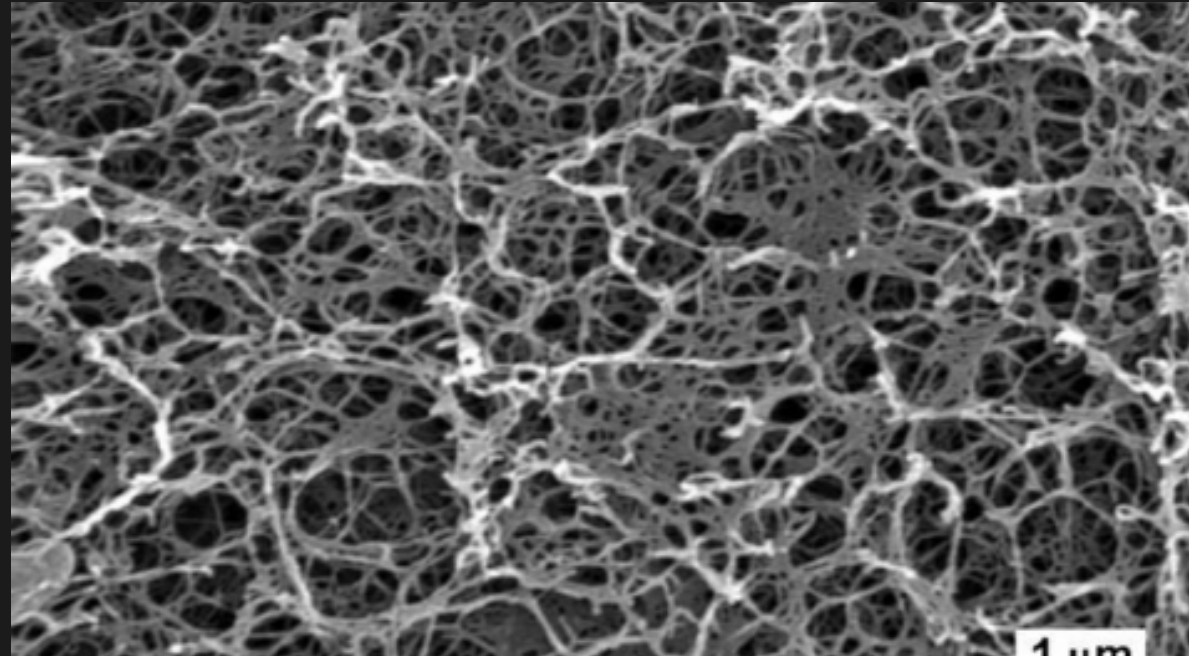


What's the charge on DNA?

# Negatively charged DNA moves to positive end

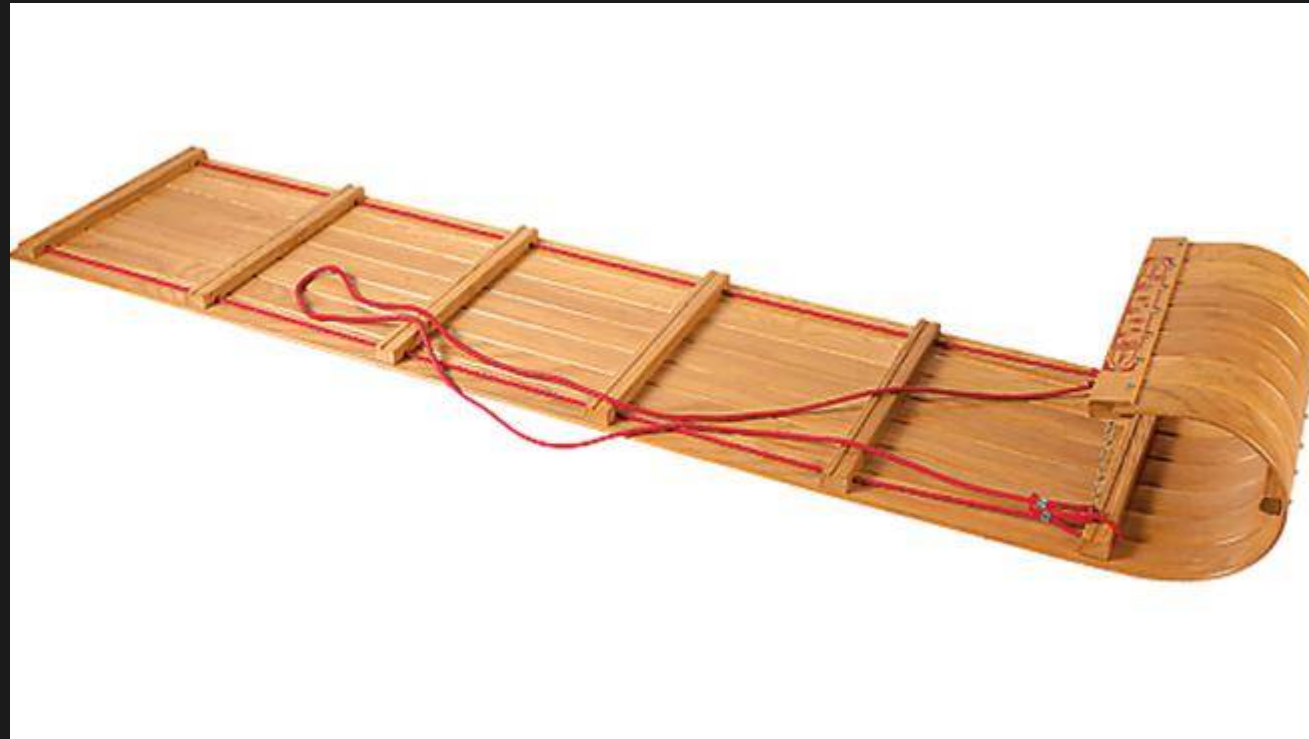


# Agarose gel

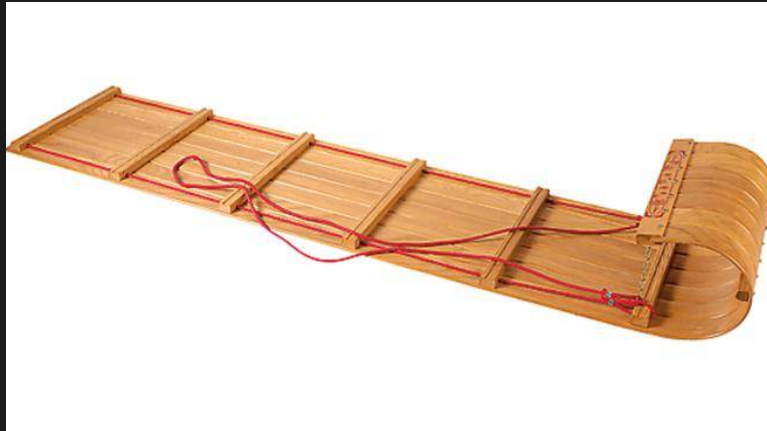




# *Imagine Pulling a Toboggan Across a Field*



# What Will Travel Faster



V.S



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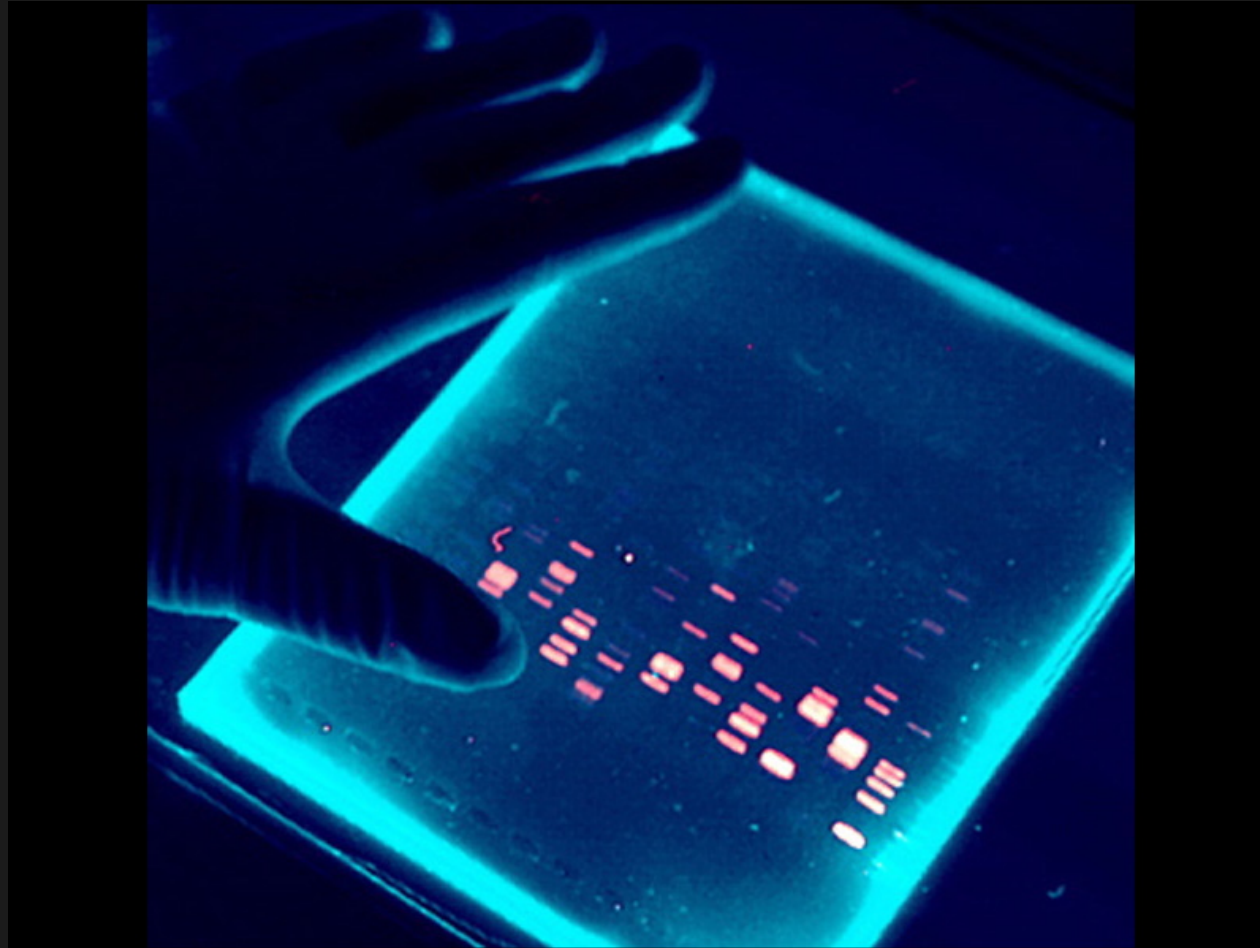
# *Friction*

Load DNA into the wells

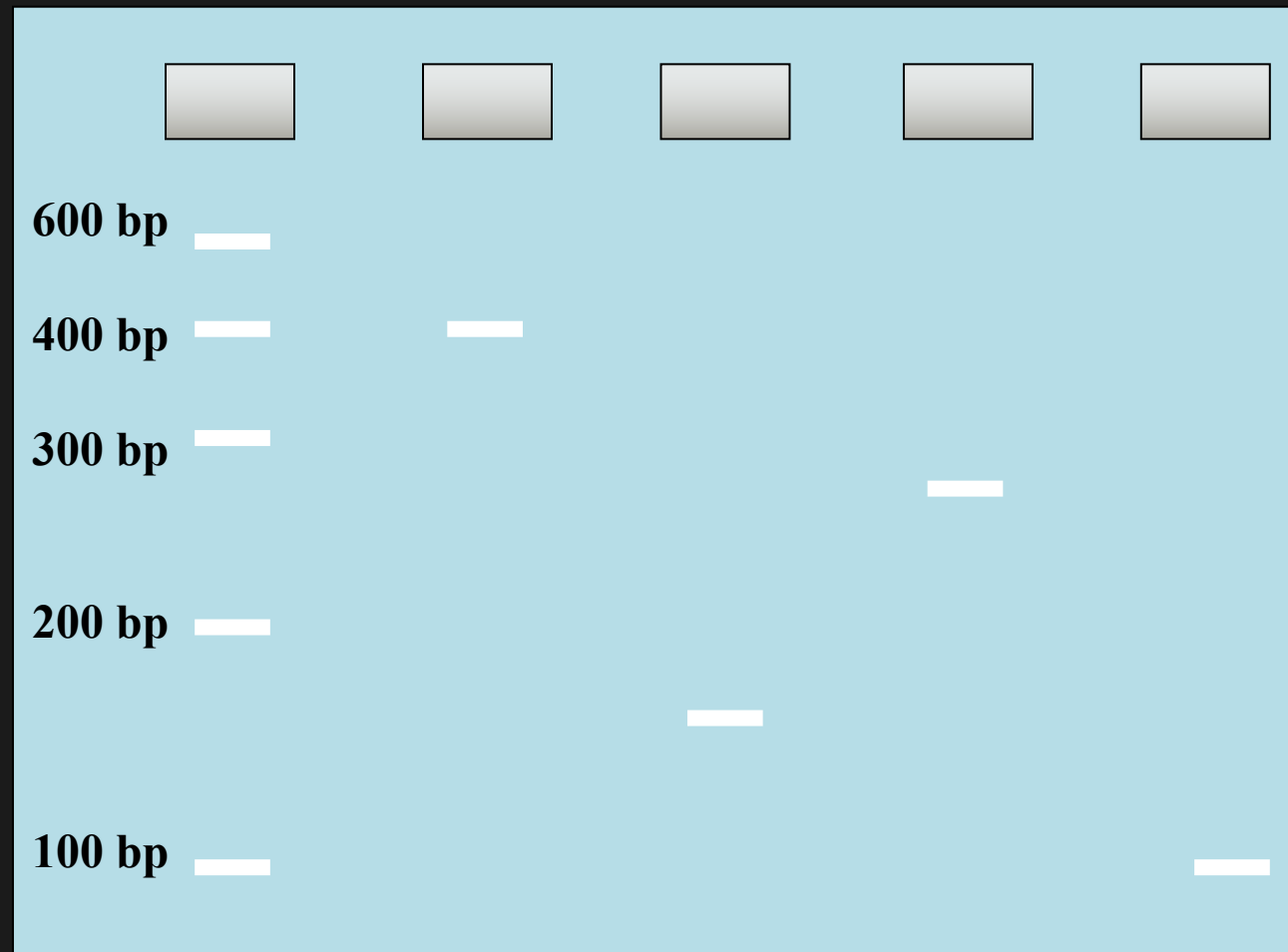


**GEL ELECTROPHORESIS**

# Visualizing a Gel



# Determining the Length of a DNA Fragment



Ladder



# BIOTECH BOOT CAMP

Melissa Prickaerts

# Ingalls Lab on Slack



# Initial Thoughts









# Creating Your Story



# BEFORE SOMEONE ELSE DOES





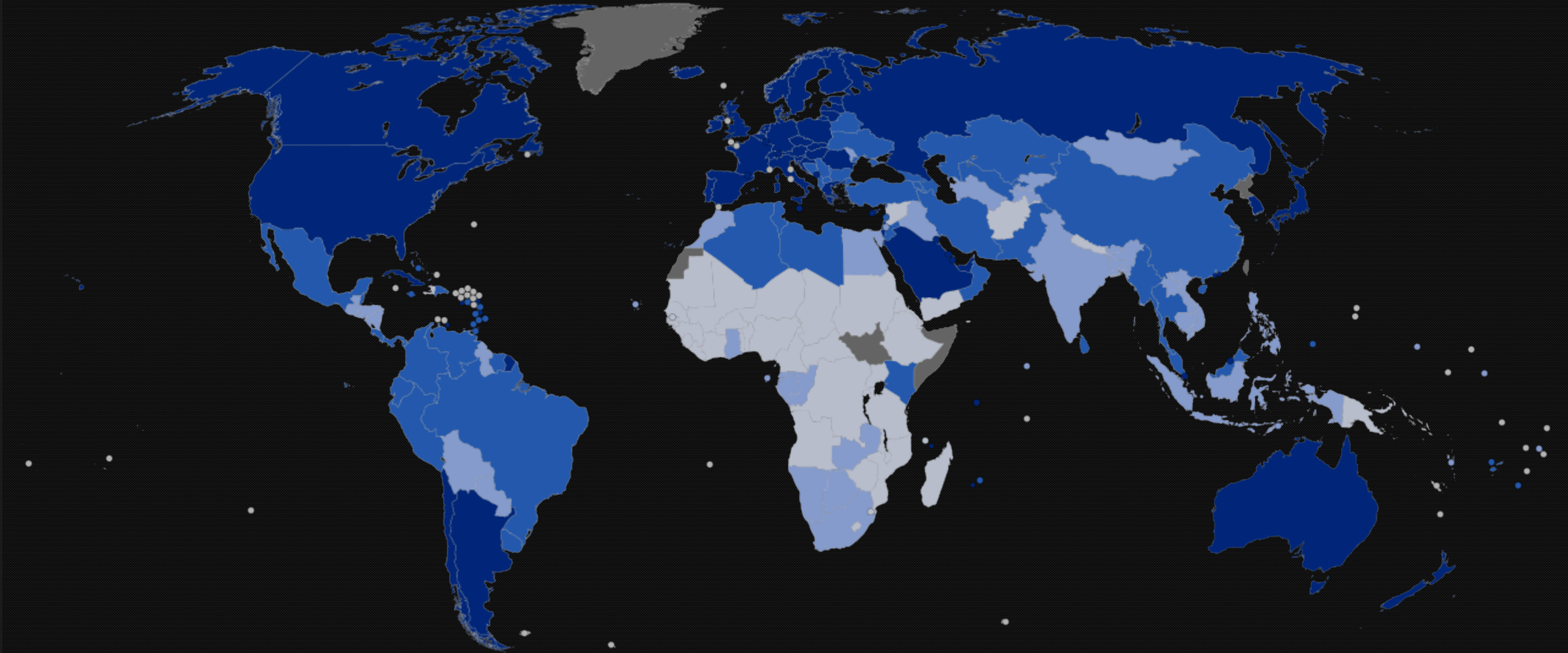
**IF GENETICALLY MODIFIED  
FOODS ARE SAFE**

**WHY THE FUCK ARE THEY  
WEARING PROTECTIVE  
CLOTHING?**



# Different Stakes + Different Tactics





**IRL/GB Salad dressing.**

**Ingredients:** water, vegetable oils  
(contains genetically modified soyabean oil),  
sugar, vinegar, modified starch, wheat starch,  
salt, mustard (water, mustard seed, vinegar,  
salt, spices, herbs), egg yolk, thickener  
(E412), acids (E330), preservatives (E202),  
colours (E160a), antioxidant (E385).

**Produced in:** The Netherlands. Store in a  
cool, dry place. Shake before use.

GLASBAK









# Banana Wilt





## GPS on GMOs

Banana bacterial wilt is devastating one of East Africa's staple crops.



**Meet Leena Tripathi**, a scientist who's working on a gene from a sweet pepper that could help save millions of bananas.

LEARN WHY THIS RESEARCH IS SO A-PEELING AT [GMOANSWERS.COM](http://GMOANSWERS.COM).



FEAST ON FACTS



FROM ACADEMY AWARD® NOMINEE **SCOTT HAMILTON KENNEDY**

FOOD|EVOLUTION

NARRATED BY **NEIL DEGRASSE TYSON**

<https://www.foodevolutionmovie.com/>





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**FOOD|EVOLUTION**  
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“Choose a healthy Future for our Kids and the Planet”

-Only Organic



# “good” organics, “bad” conventional agriculture



By adding just one more organic product to your grocery cart each week you are supporting a healthier future for all of us.



[onlyorganic.org](http://onlyorganic.org) #onlyorganic



**Yes!**  
Organic farming  
CAN feed the world.



[onlyorganic.org](http://onlyorganic.org) #onlyorganic

*“I don’t believe that these marketing strategies reflect the ethics of real organic farmers, certainly none that I’ve met”*

- Steve Savage, Phd

*“They’re [alternative food companies] building their businesses trying to portray me and my family as bad guys – for simply doing what’s best for our farm, community, family and customers.”*

- Andrew Campbell, farmer



# Understand Your Audience



# Lawmakers, The public, and newsmakers




# GMO RESEARCH, REVIEW AND REGULATION | How Does a GMO Get to Market?

On average, GMOs take **13 years** and **\$130 million** of R&D **BEFORE** coming to market

The **regulatory process** alone can take **5 to 7 years**

## REGULATORY SCIENCE

**75+ different studies**<sup>1</sup> are conducted to demonstrate each new GMO is:



- Safe to grow**
  - Crop grows the same as non-GM varieties
  - Crop exhibits expected characteristics (e.g., insect resistance)
- Safe for the environment and beneficial insects**
- Safe to eat**
  - Same nutrients as non-GM crops
  - No new dietary allergens

## REGULATORY REVIEW

More than **90 government bodies**<sup>2</sup> globally review and approve GMOs. In many countries, multiple agencies are involved in the regulation of GMOs.

GMOs have been grown or imported by **70 countries**<sup>3</sup> since 1996.



### U.S. REGULATORY AGENCY REVIEWS

USDA  
Safe to grow



EPA  
Safe for the environment



FDA  
Safe to eat





### Traditional Breeding



Crossing plants and selecting offspring

Almost All Crops

### Mutagenesis



Exposing seeds to chemicals or radiation



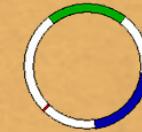
### RNA Interference



Switching off selected genes with RNA



### Transgenics



Inserting selected genes using recombinant DNA methods



#### Number of Genes Affected

10K - >300K

? No way to assess

1 - 2

1 - 4

Desired gene(s) inserted with other genetic material. No safety testing requirements.

Random changes in genome, usually unpredictable. No safety testing requirements.

Targeted gene(s) switched off or 'silenced'. Safety testing required.

Desired gene(s) inserted only at known locations. Safety testing required.

# Criticism: Very One Sided Cohort



Thoughts + Questions?

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