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

WATERLOO iGEM

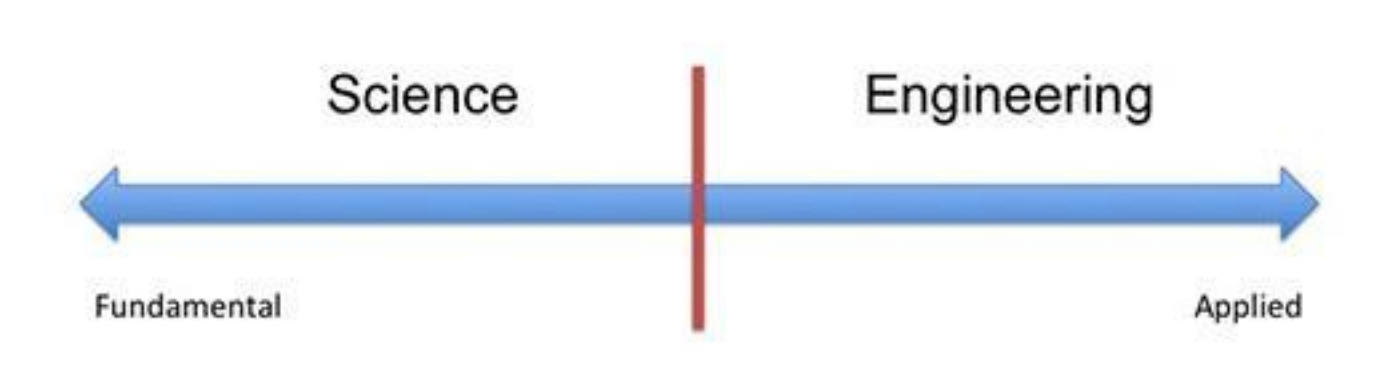
By: Austin Boucinha

Presentation Outline

- 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?

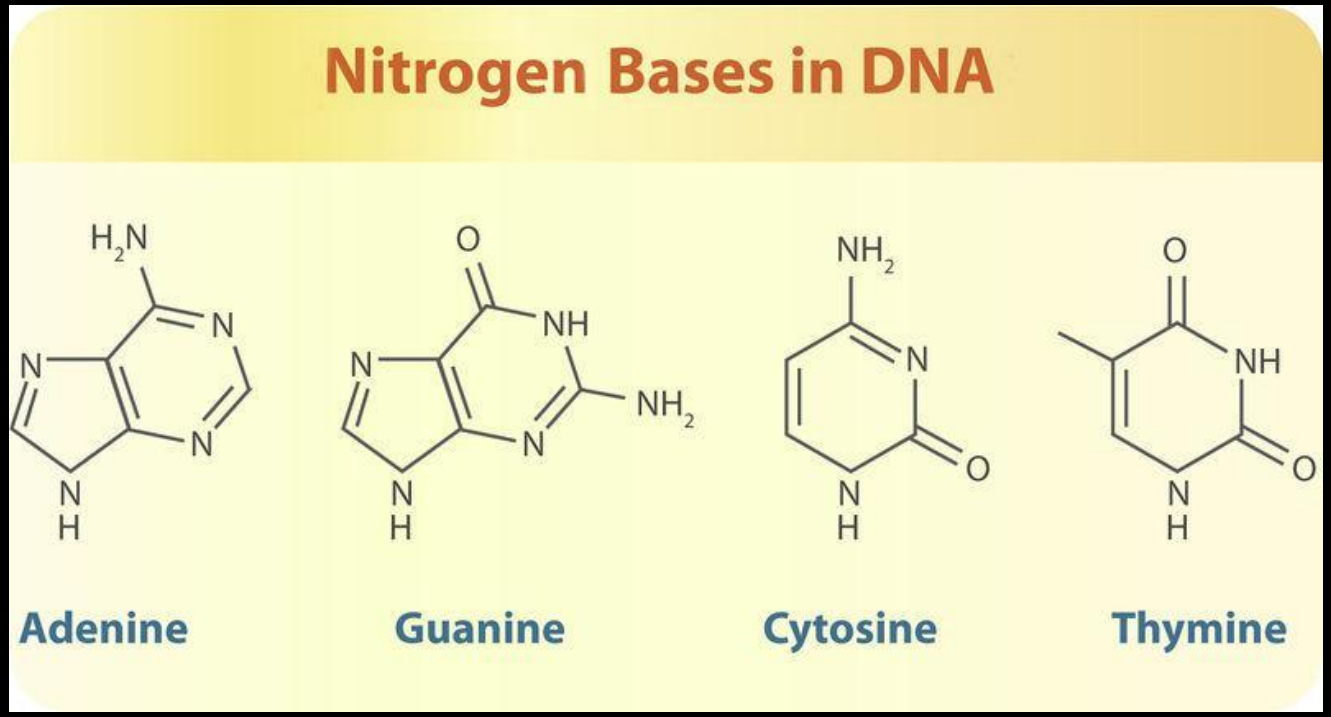
Perspectives:
Science & Engineering



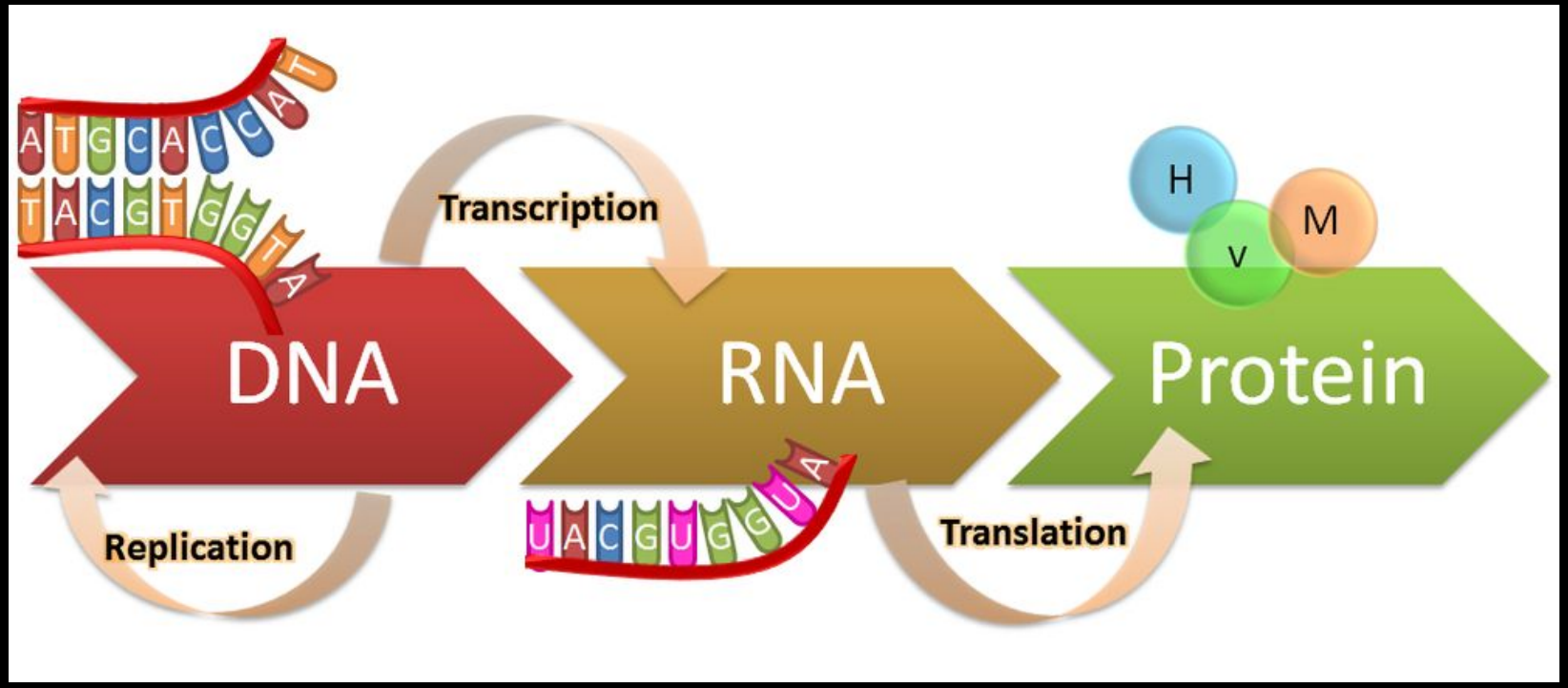
Genetics Theory Overview

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

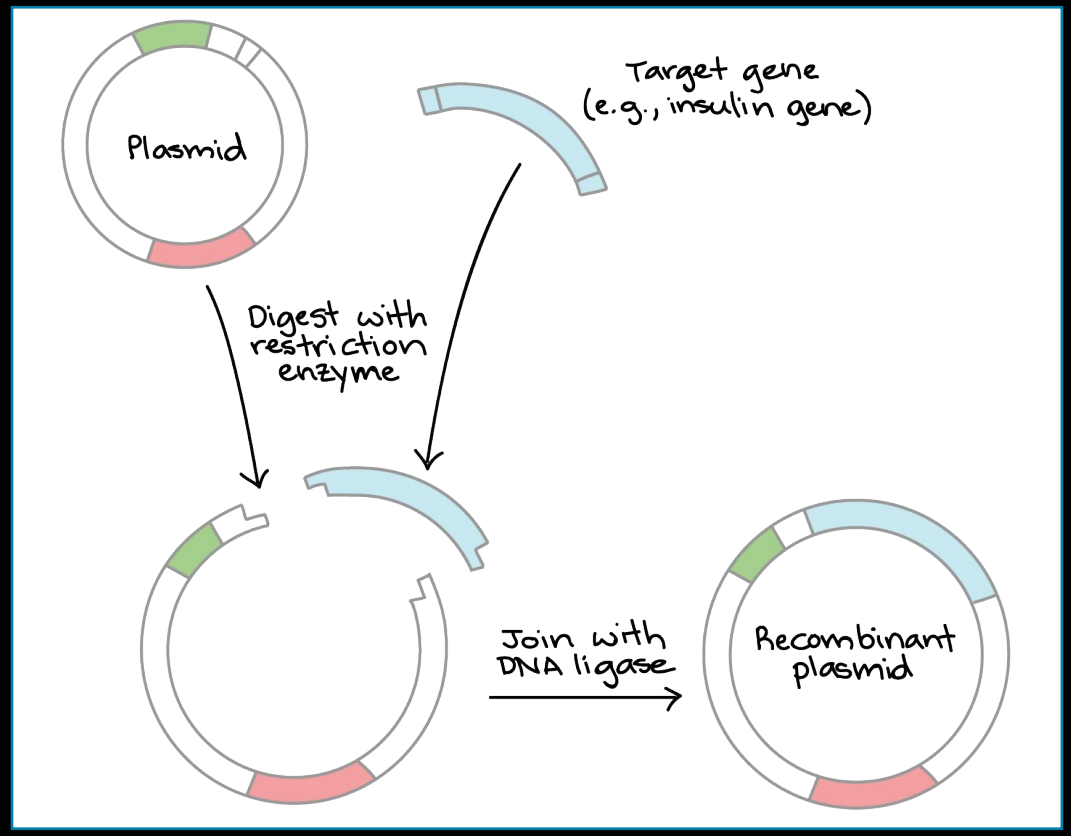
A T C G



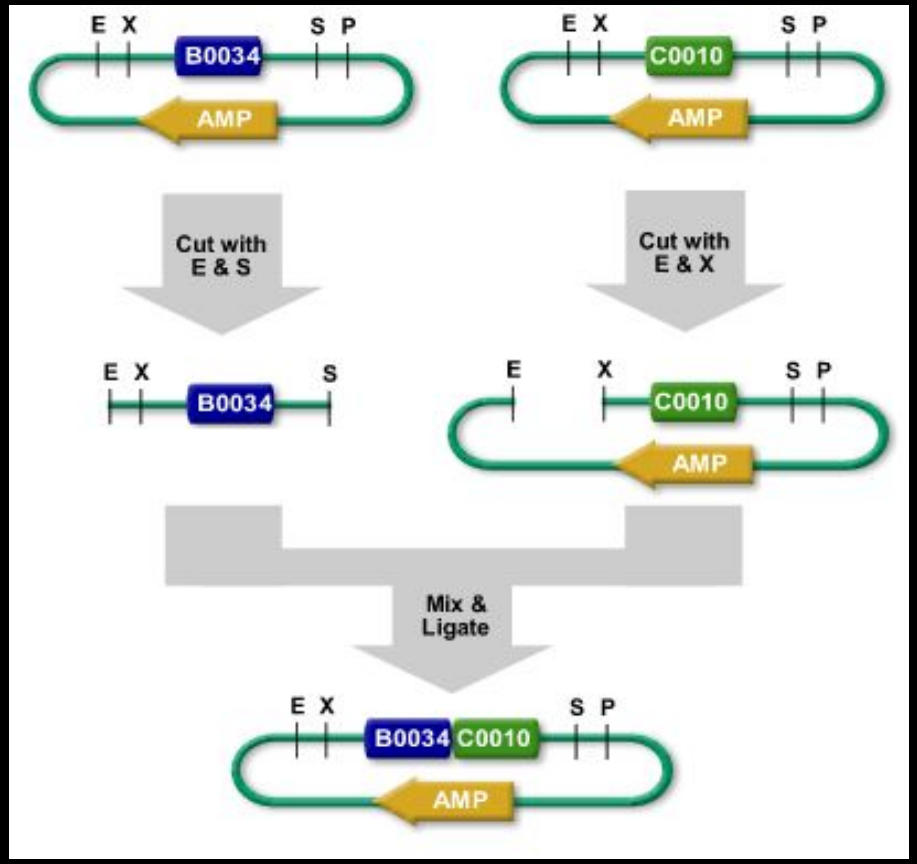
The Central Dogma of DNA



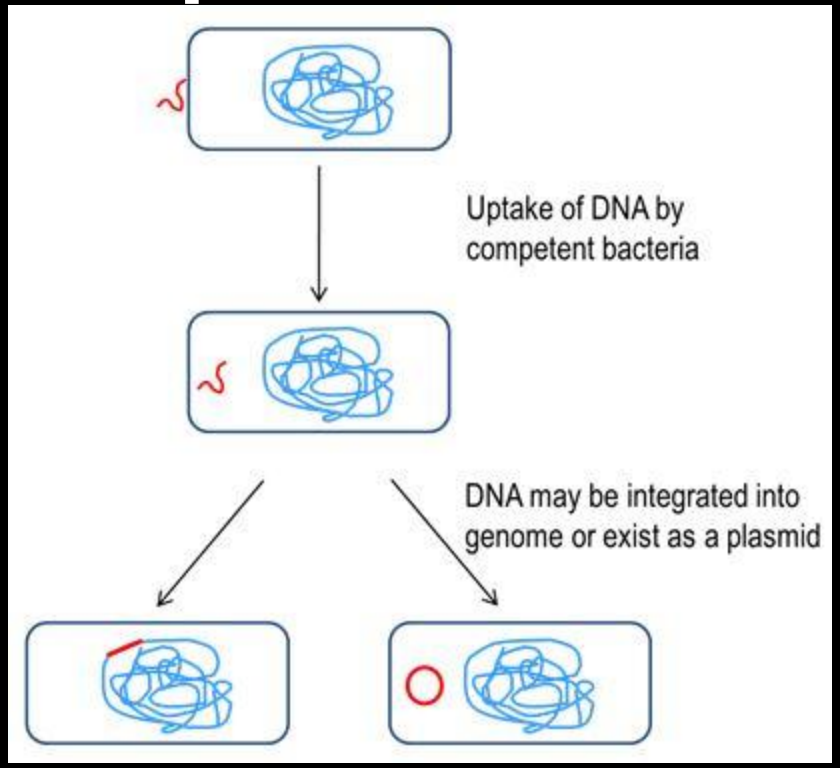
Plasmids & Restriction Enzymes



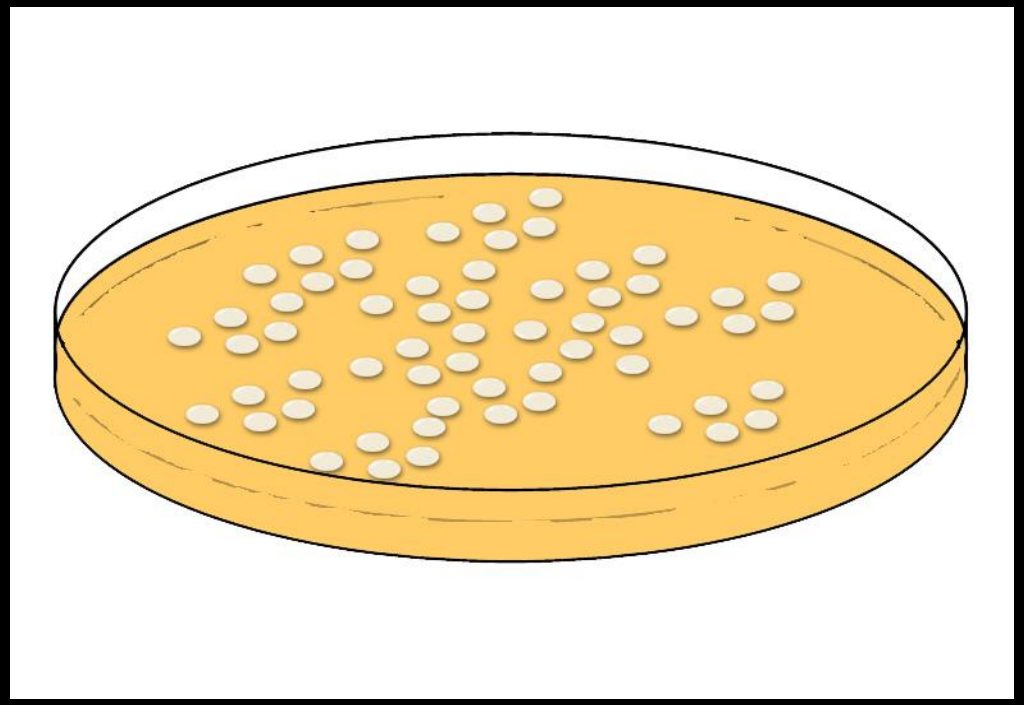
BioBricks: The Plasmid Standard



Cell Transformation & Competent Cells

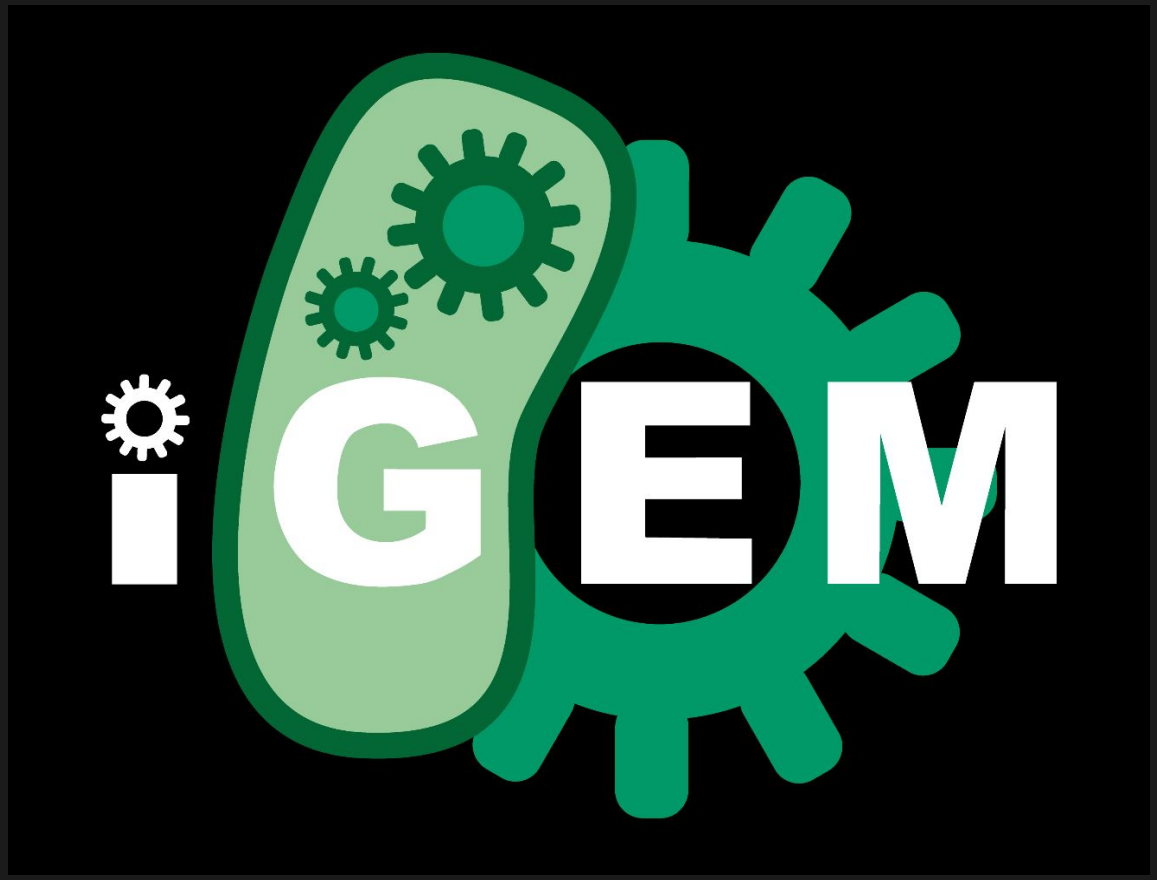


Plating Cells
& The Observation of Colonies



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

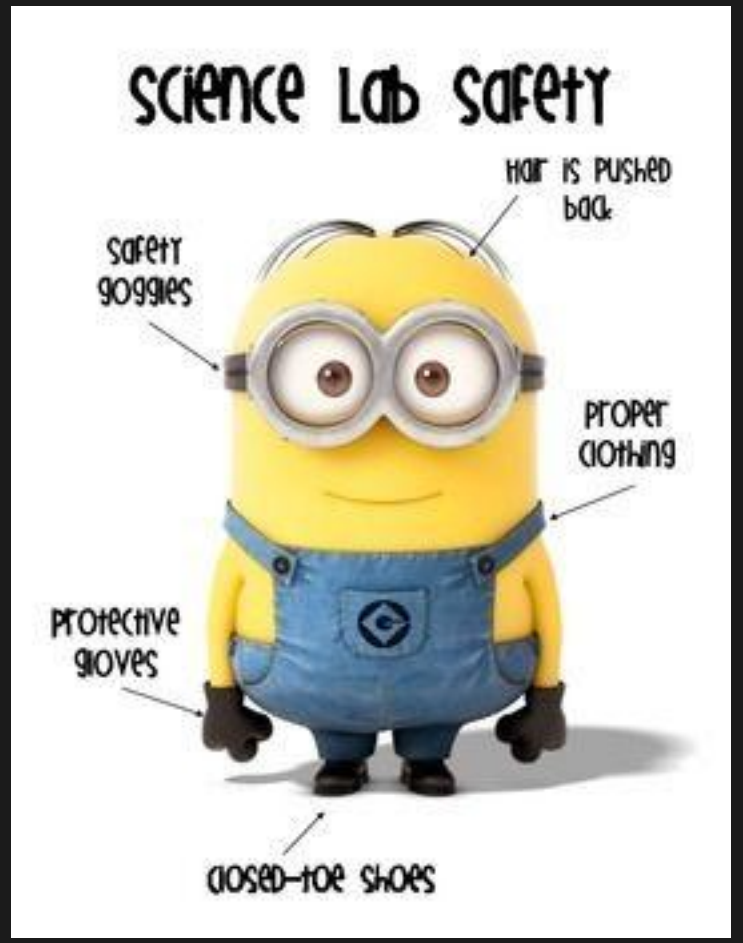
BEFORE WE CAN DO ANYTHING...

WATERLOO iGEM

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

- 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

- 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

WATERLOO iGEM

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

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

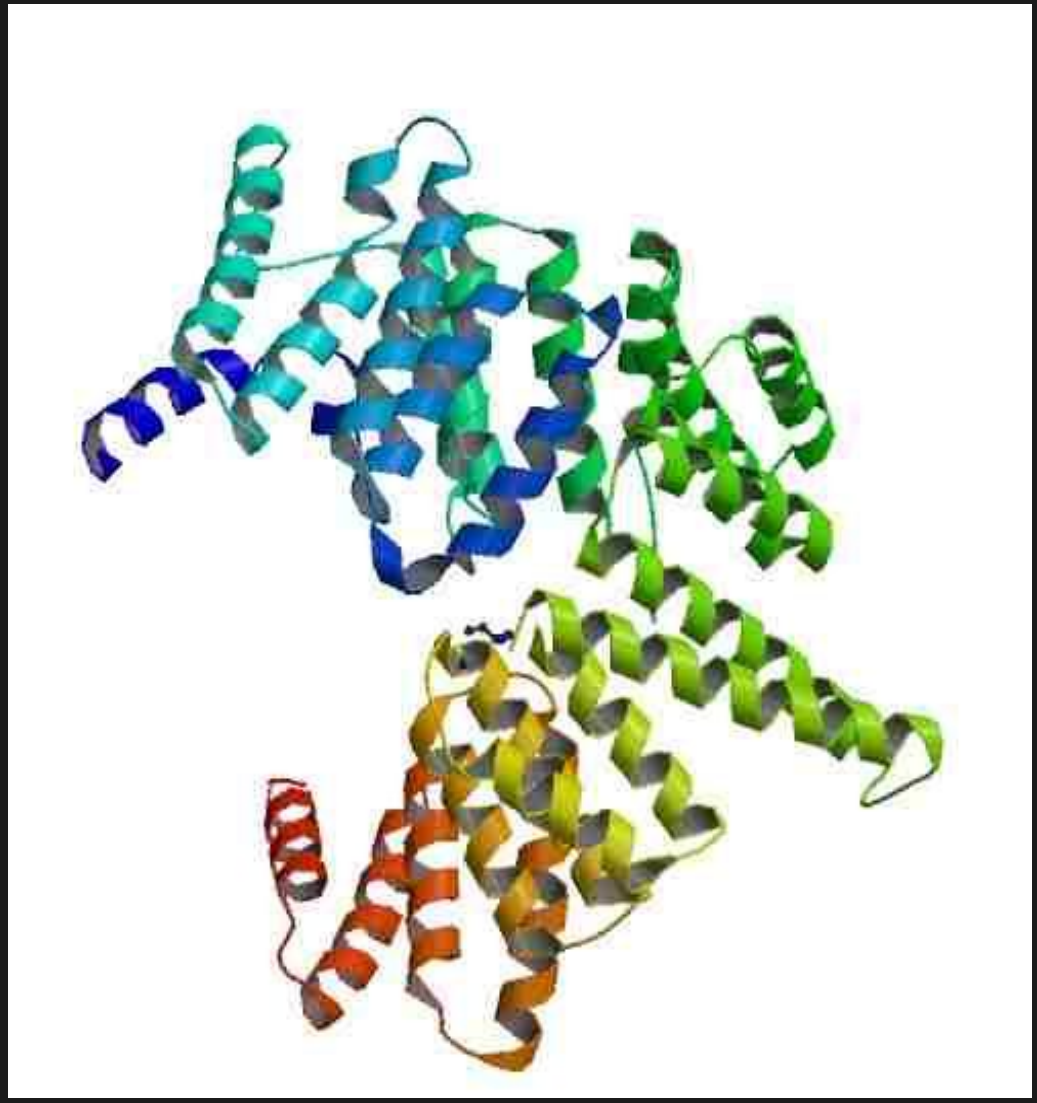
Here's What We're Doing Today…

1. Learning about the foundation of genetics!
2. Review the procedure for today's mini-prep!
3. 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

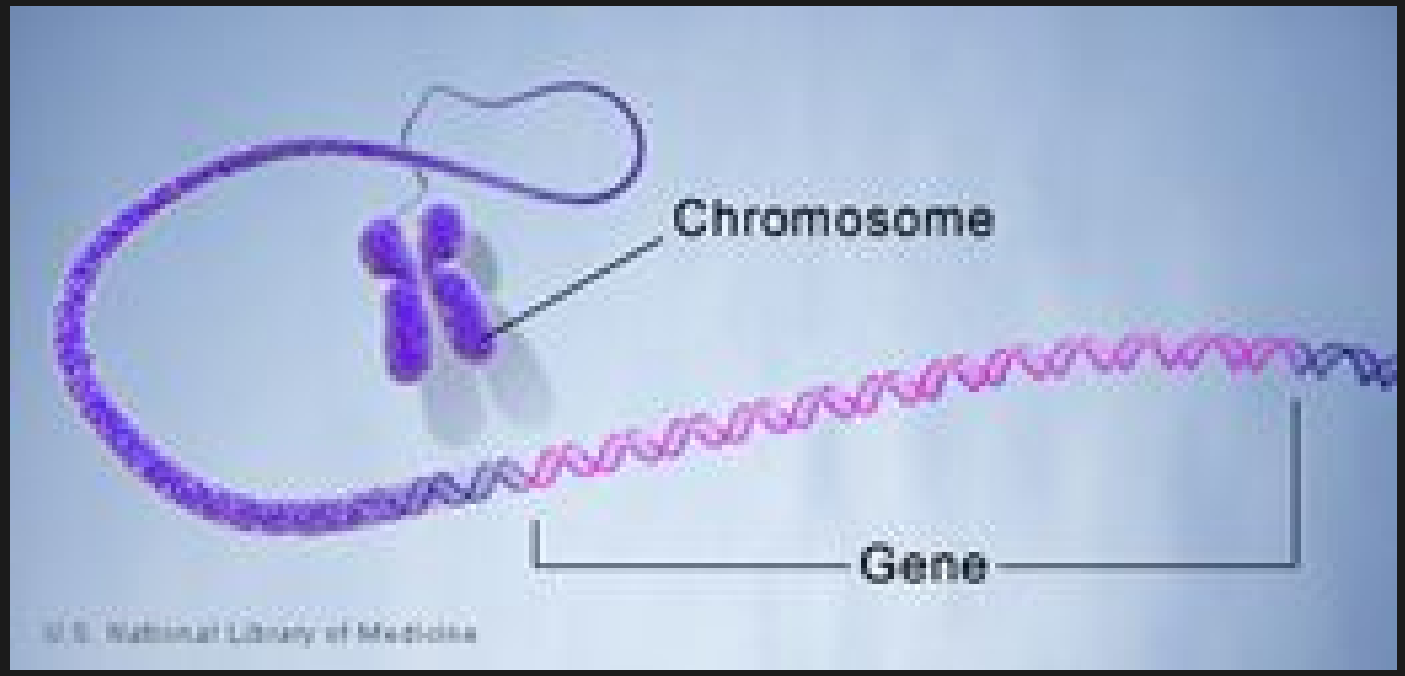
DNA

- DNA is heredity material located in the cell nucleus

Chromosomes and Genes

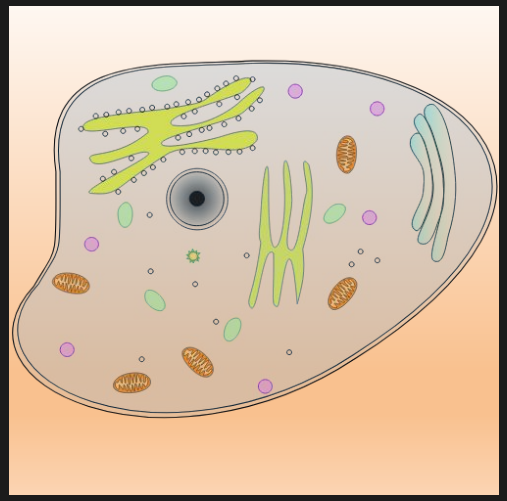
Chromosomes: structures made of both nucleic acid and proteins that helps ensure DNA is accurately copied and distributed

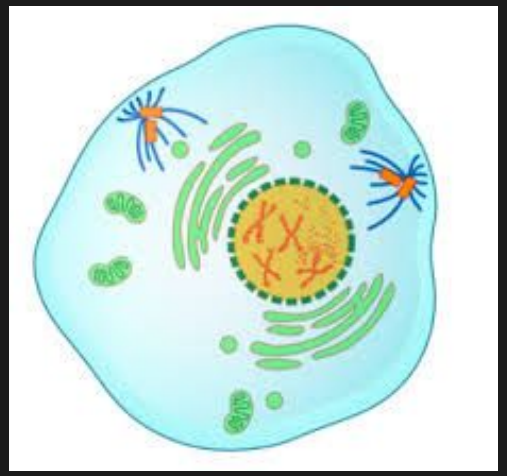
Genes: the part of the DNA that helps the cell make a protein



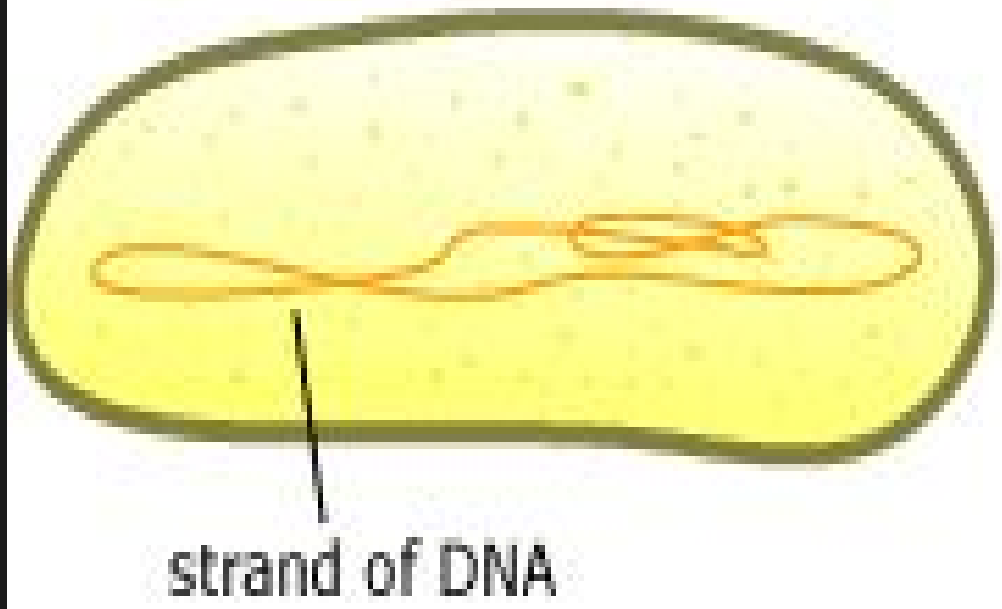
Cells

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

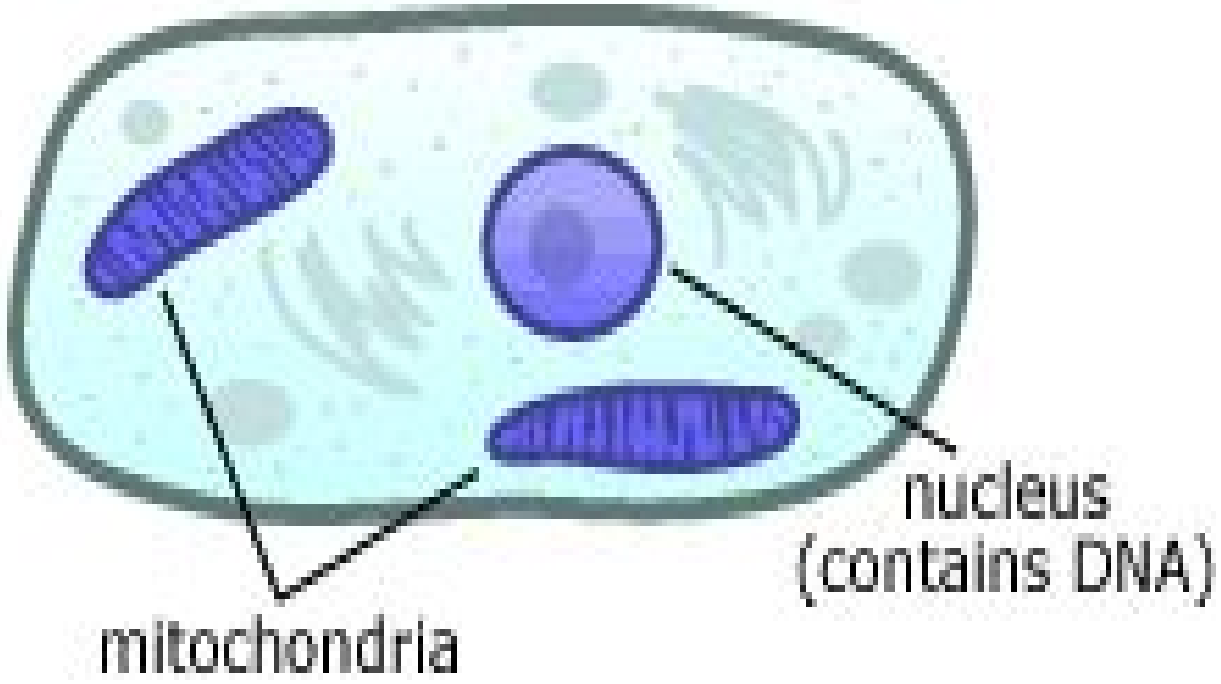




Typical prokaryote cell

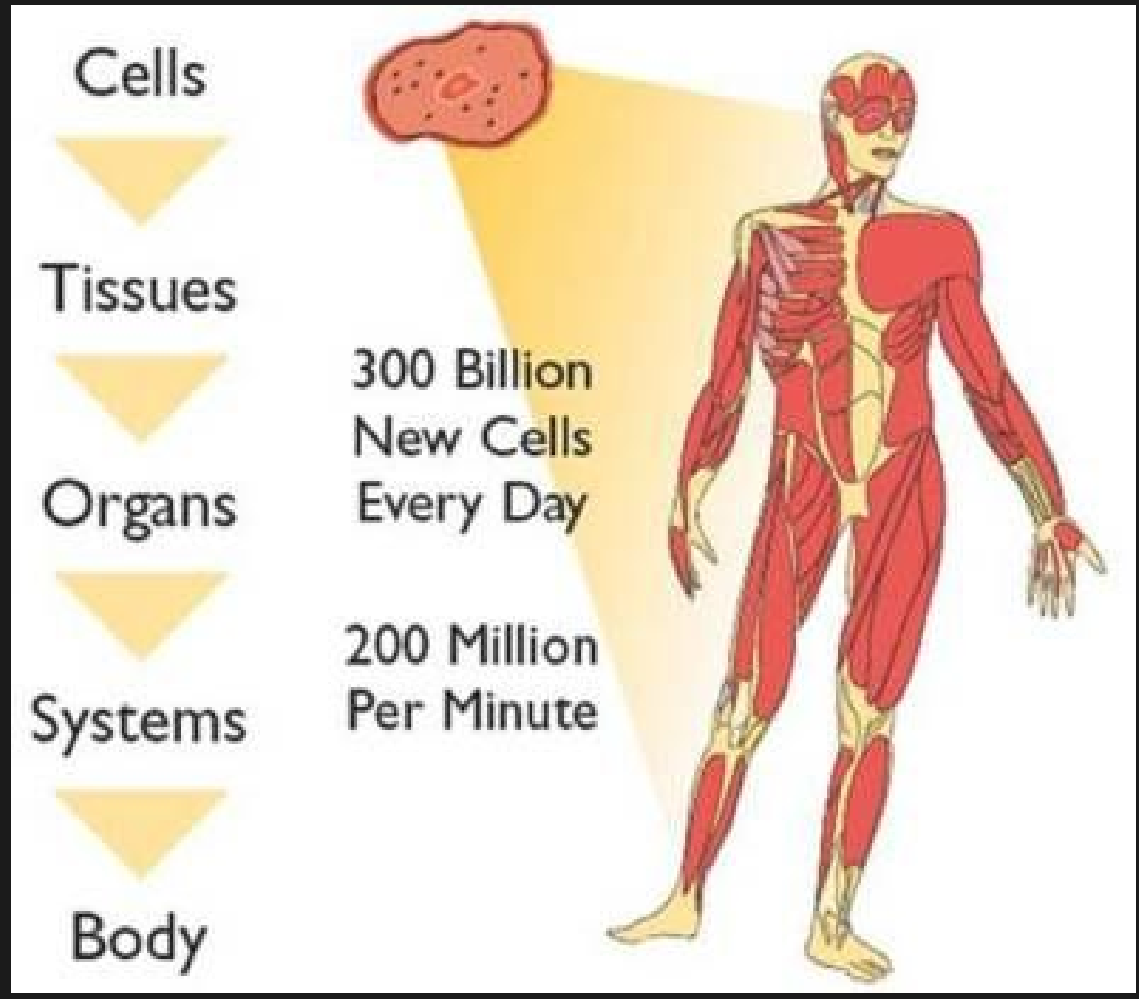


Typical eukaryote cell



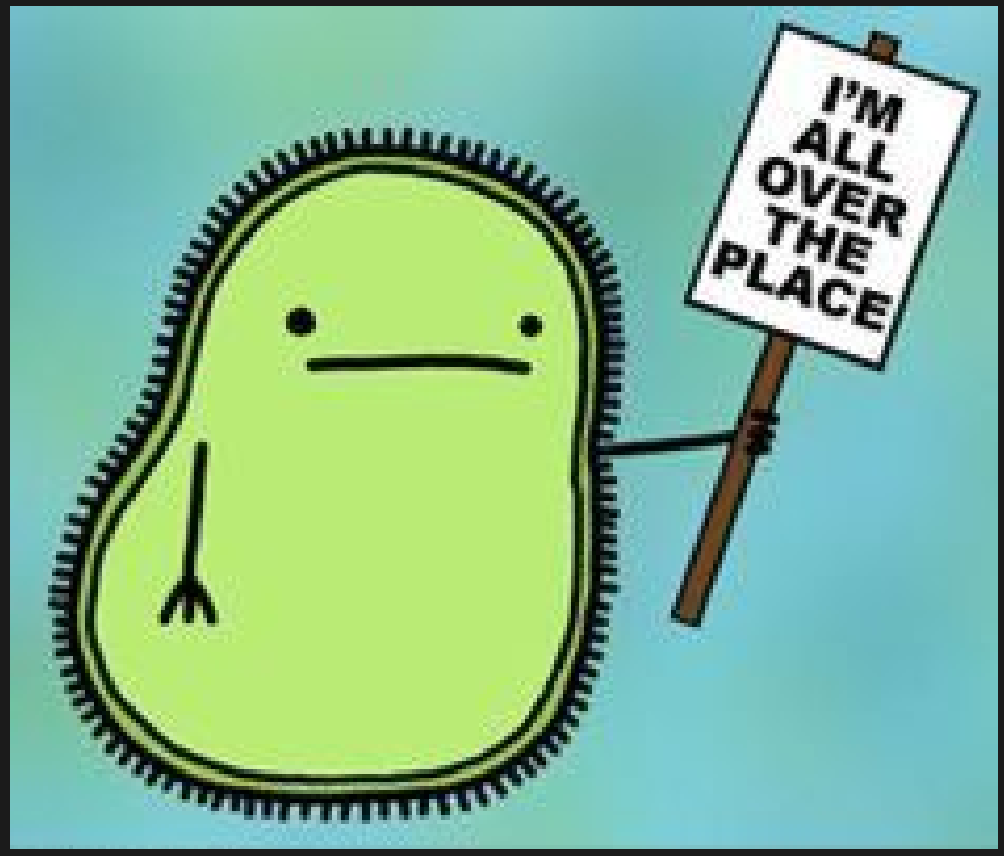
Which Are We Made Of?

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



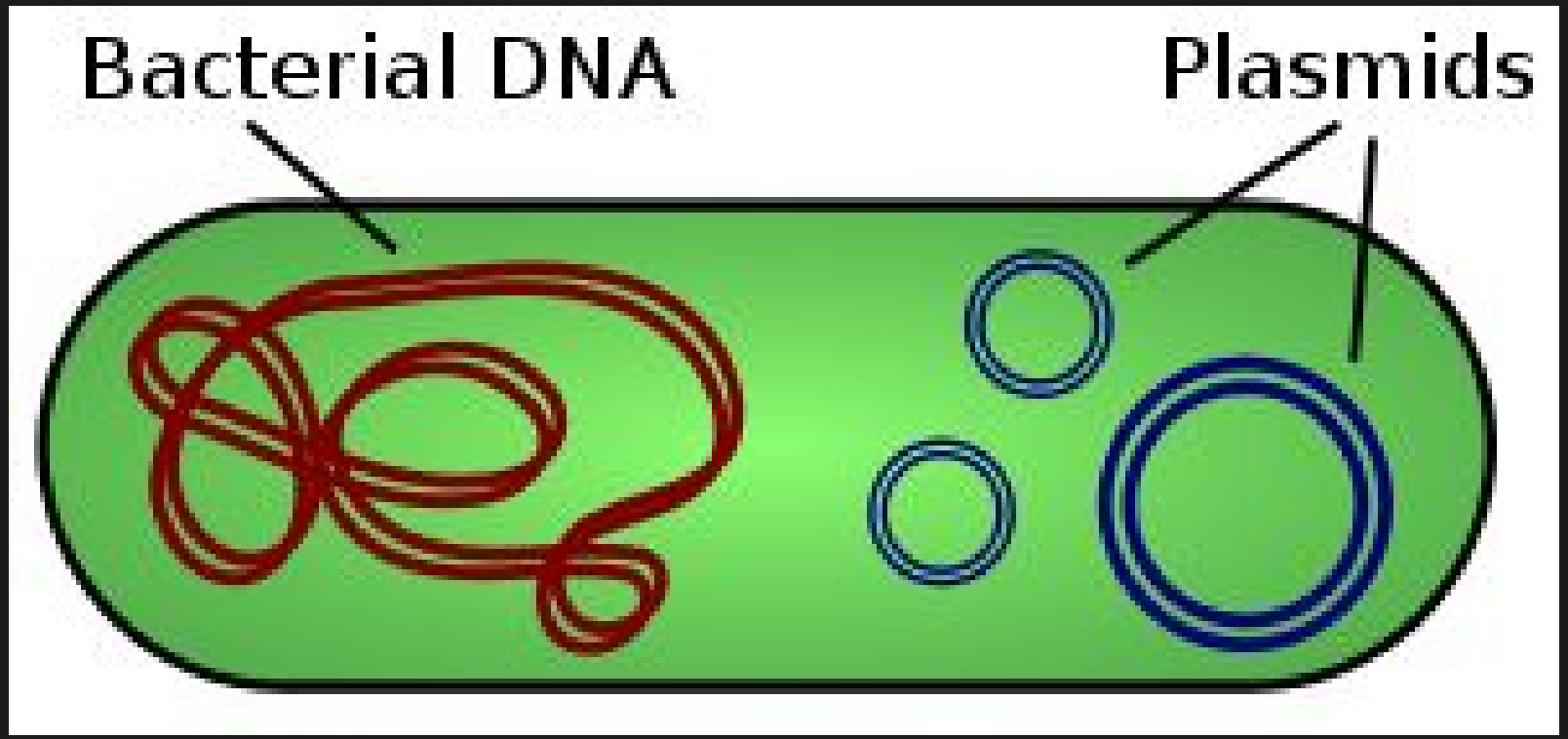
Bacteria

-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!

https://www.youtube.com/watch?v=7Xgy5_i6iOc

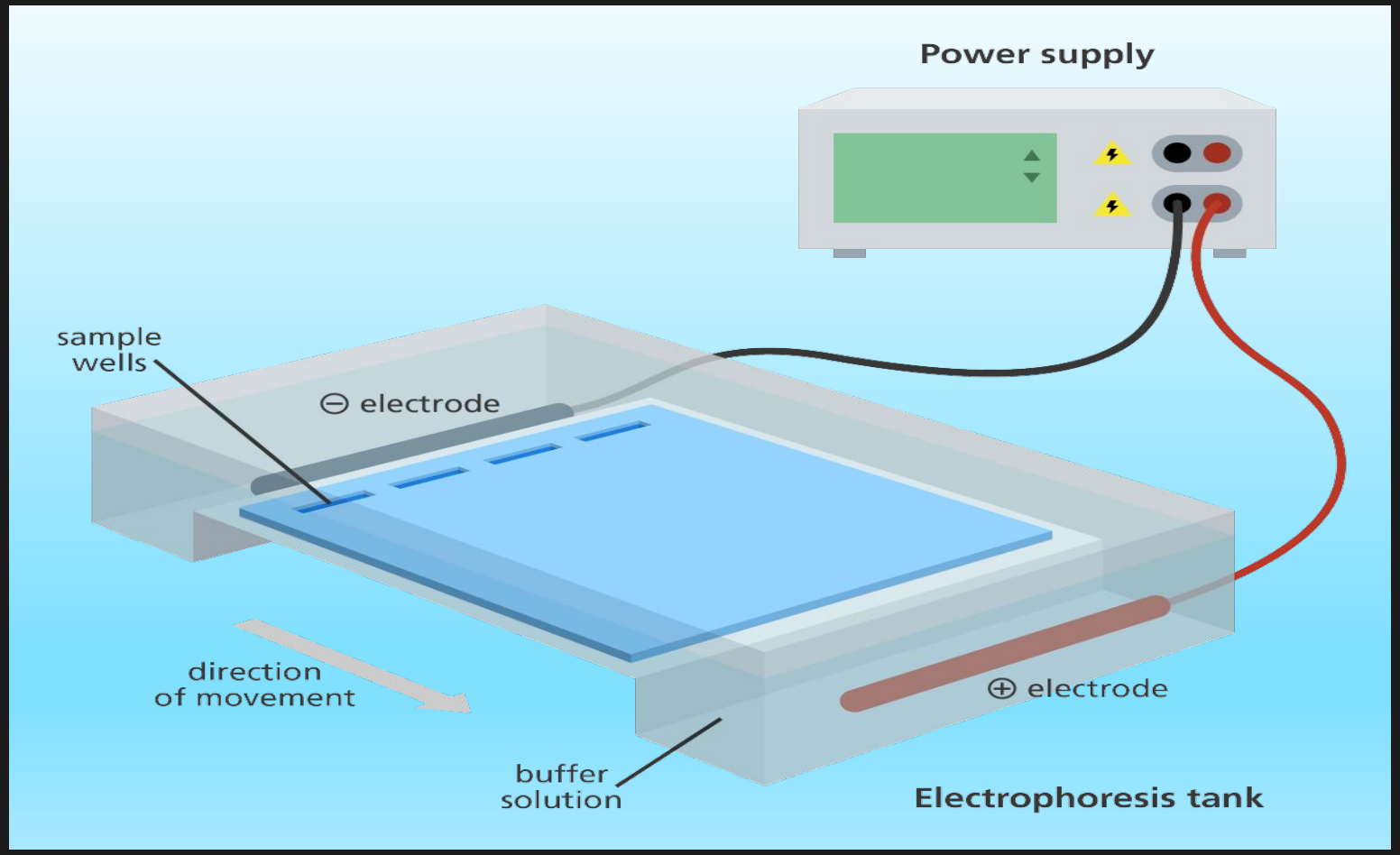
Good luck, and go knock your socks off!

Gel Electrophoresis

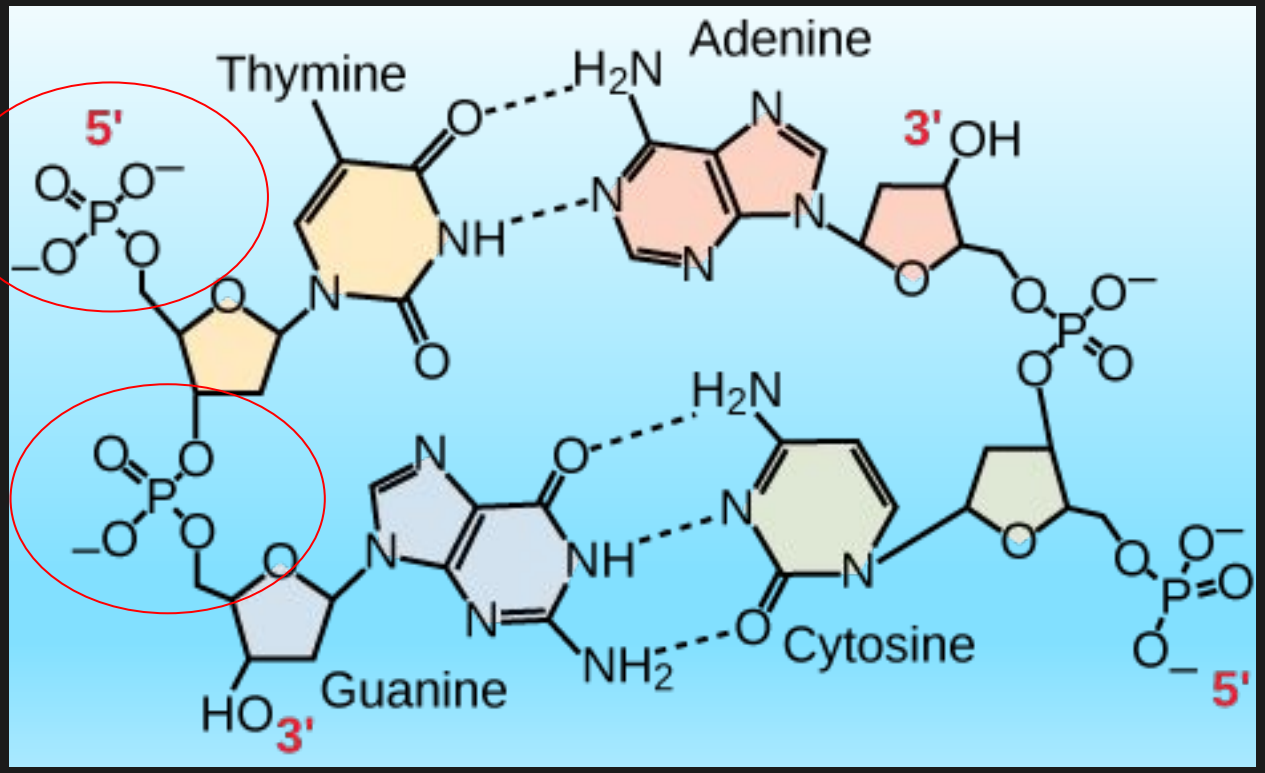
Using electricity to separate DNA fragments

Slides by Clara Fikry, Presented by Monica Chung

Agarose Gel Electrophoresis

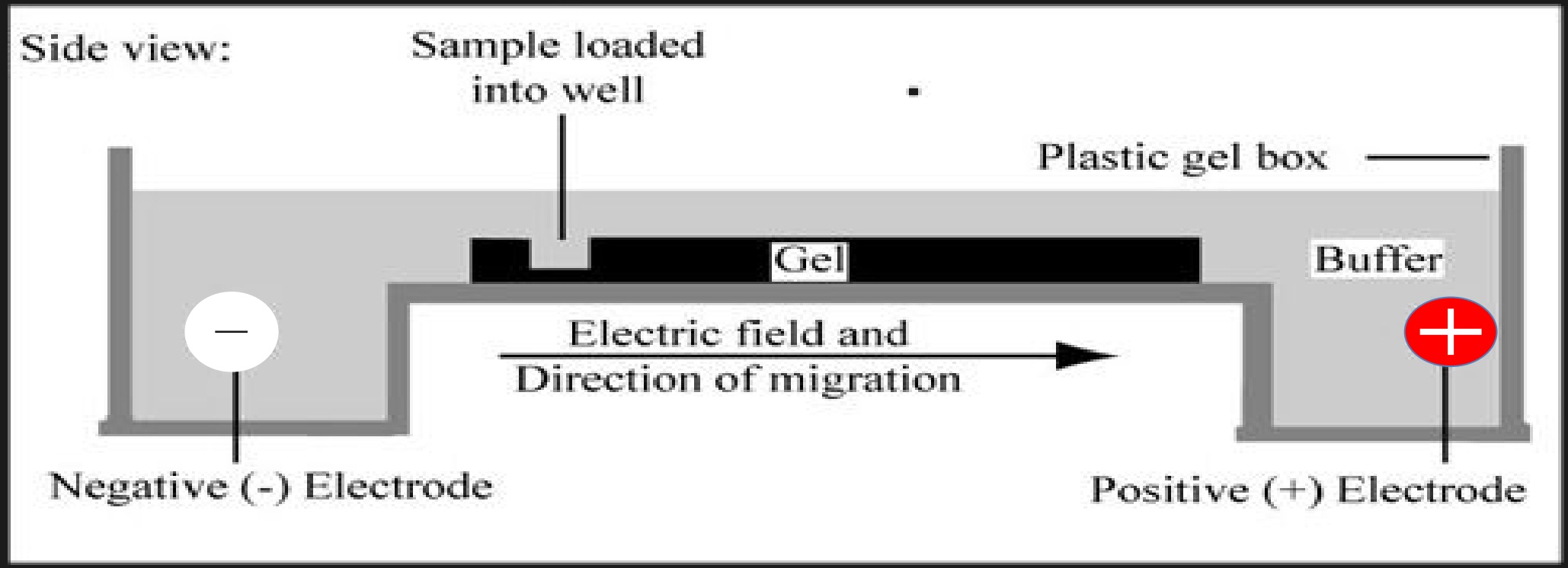


How do we sort DNA?

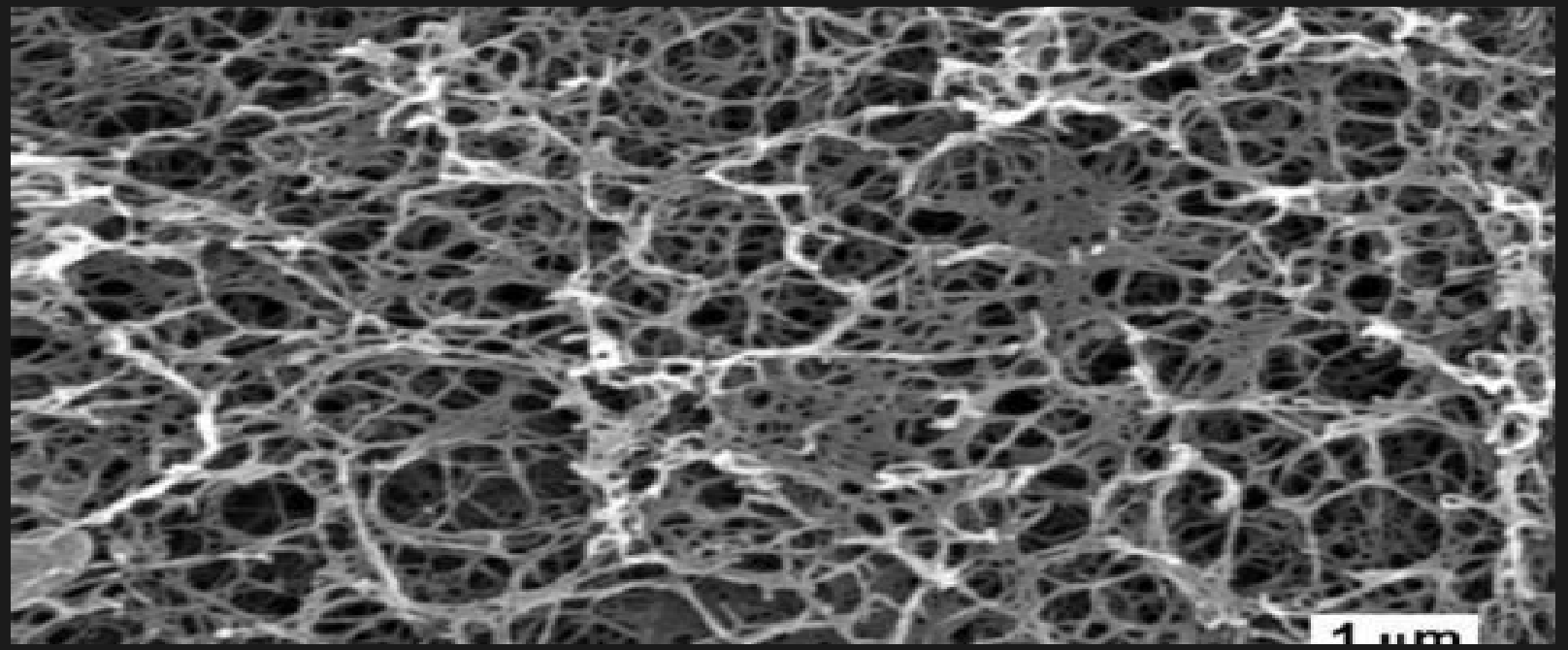


What's the charge on DNA?

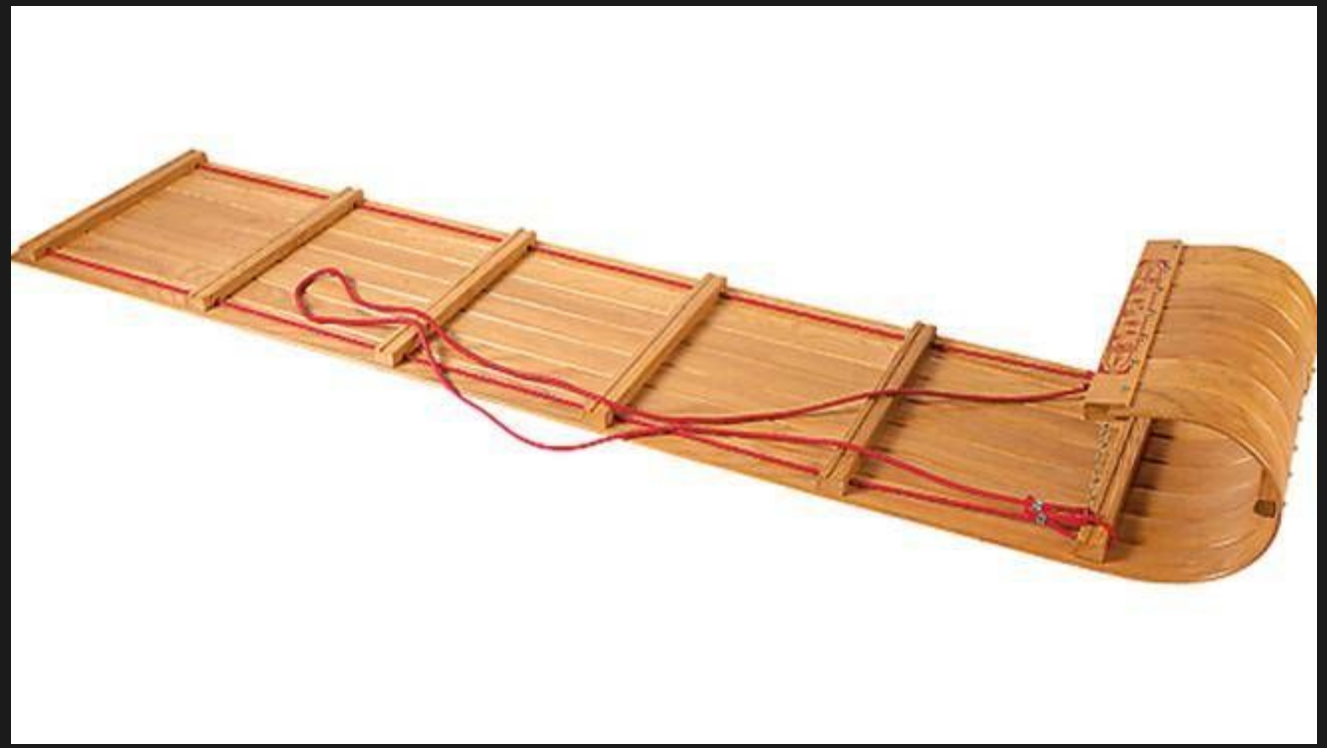
Negatively charged DNA moves to positive end



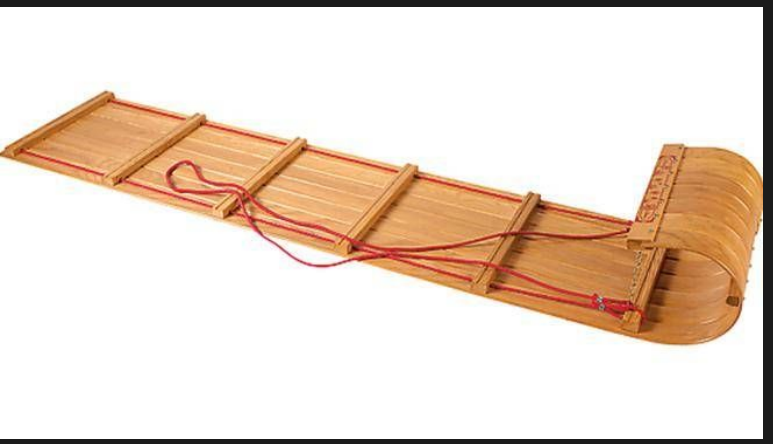
Agarose gel



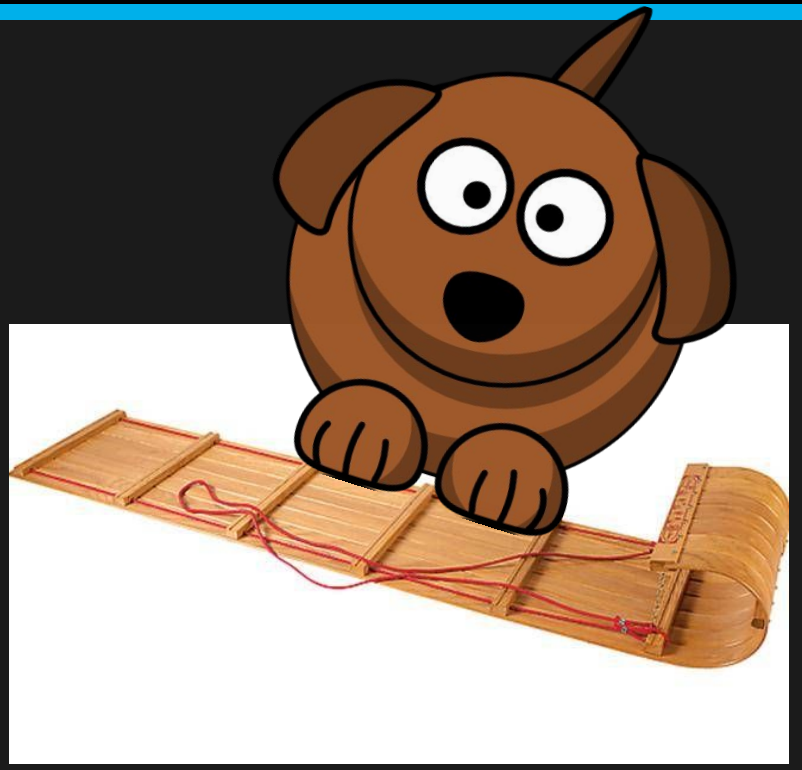
Imagine Pulling a Toboggan Across a Field



What Will Travel Faster

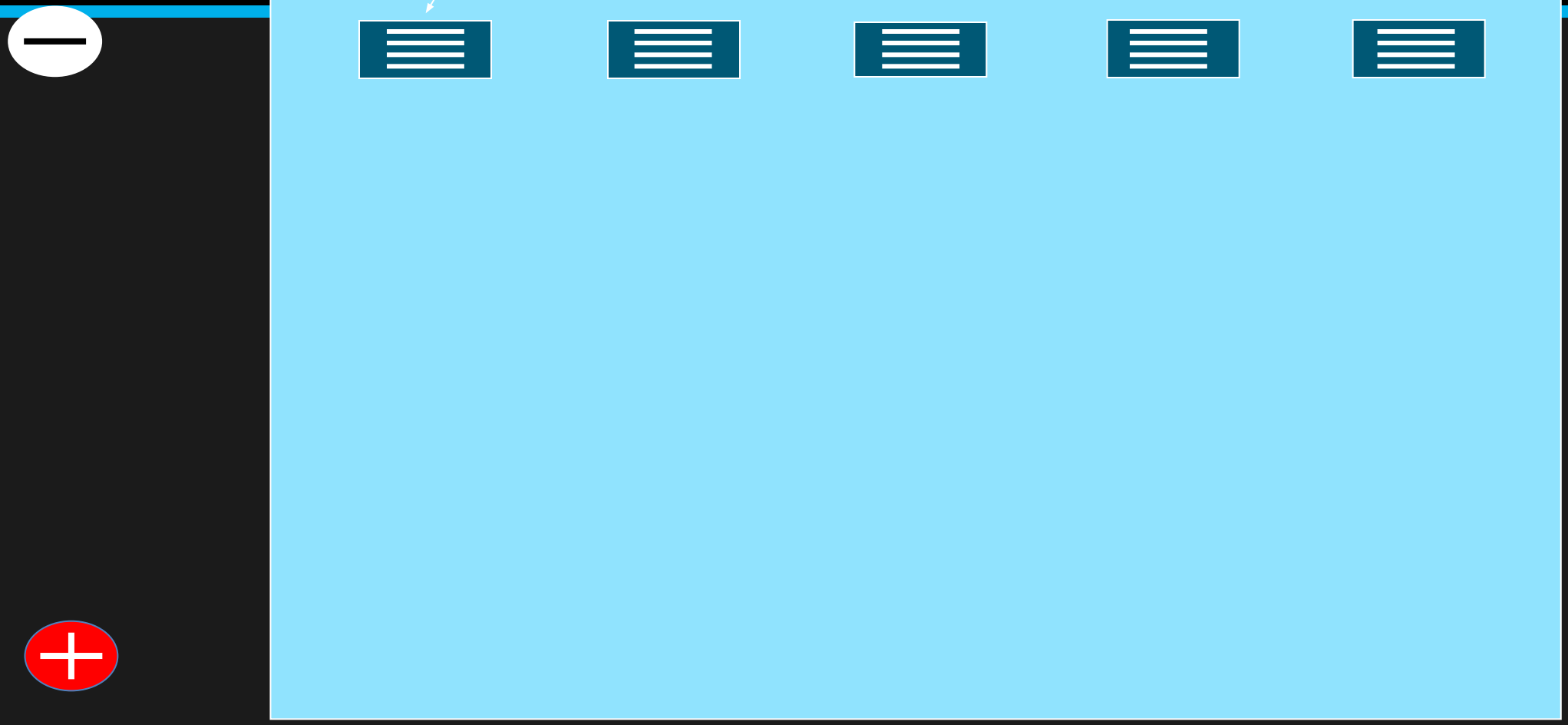


V.S.



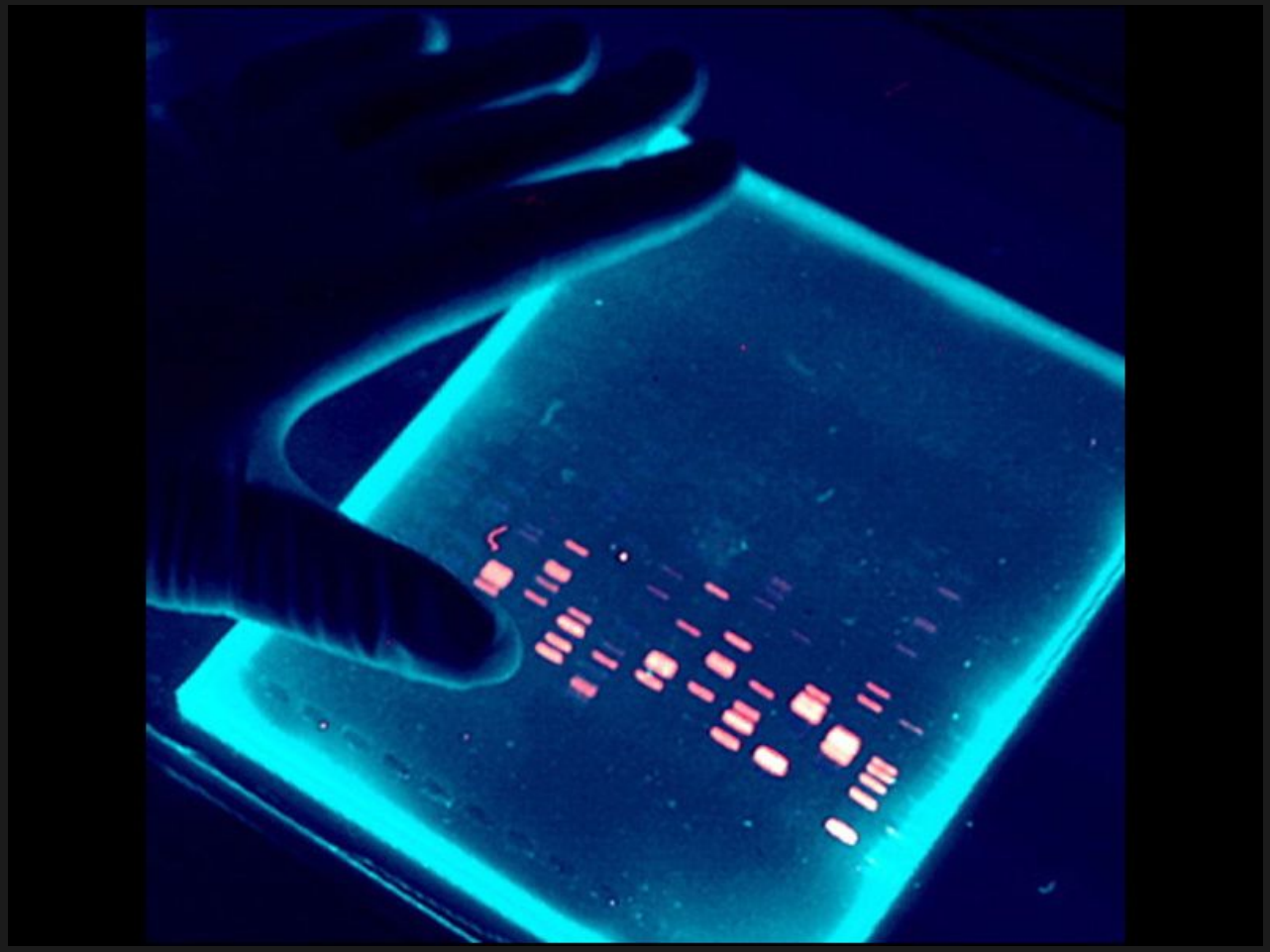
Friction

Load DNA into the wells

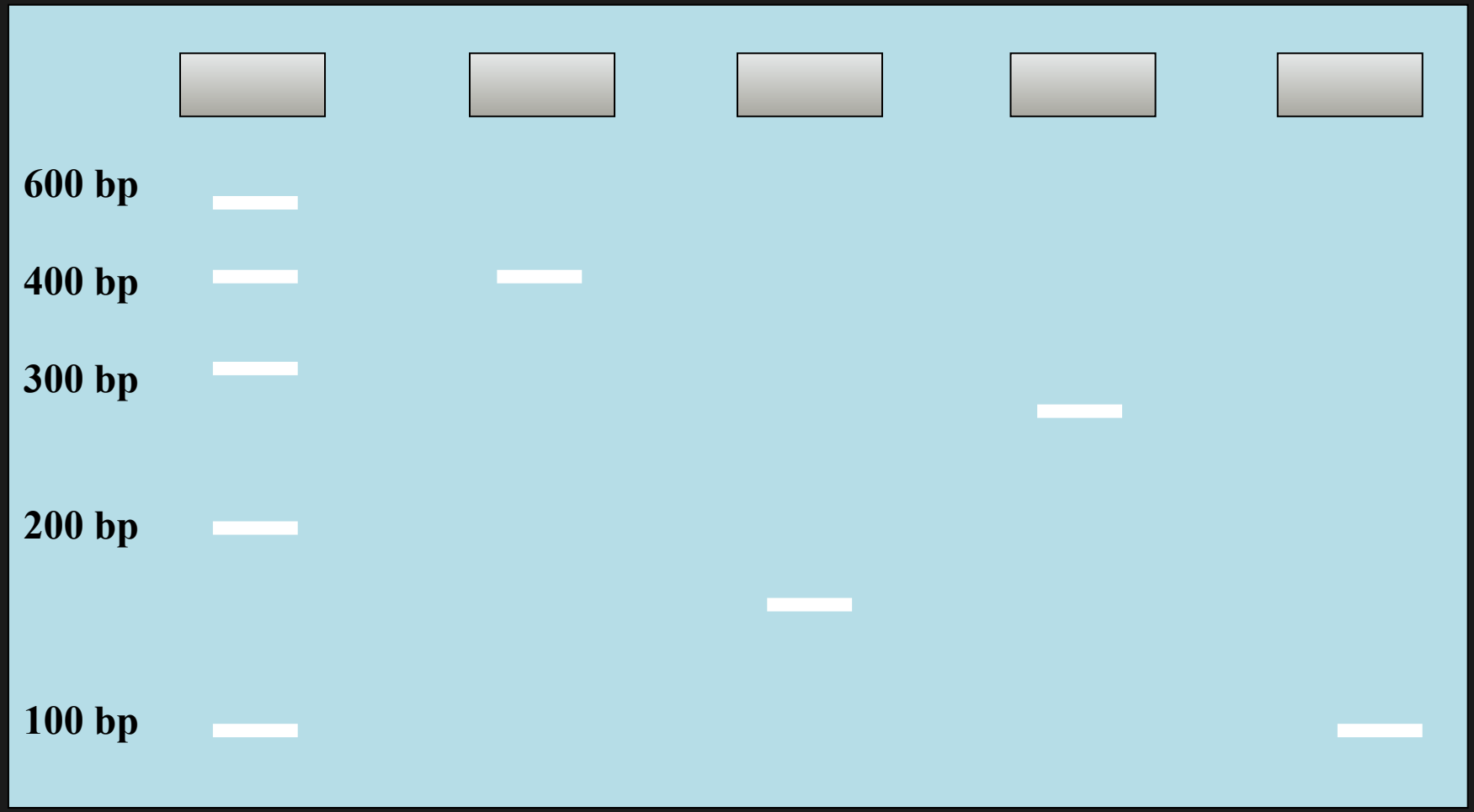


GEL ELECTROPHORESIS

Visualizing a Gel



Determining the Length of a DNA Fragment



BIOTECH BOOT CAMP

Melissa Prickaert

Ingalls Lab on Slack

Initial Thoughts

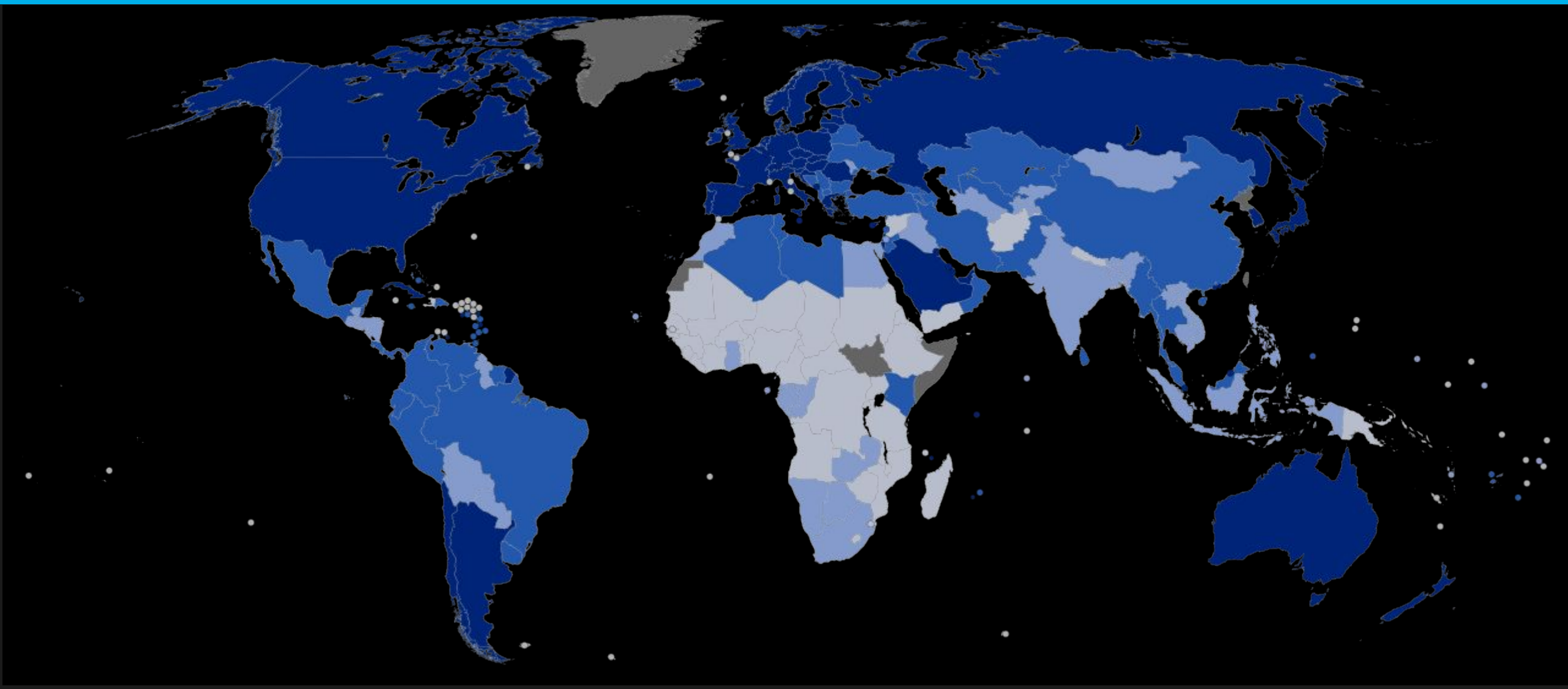

ORGANIC

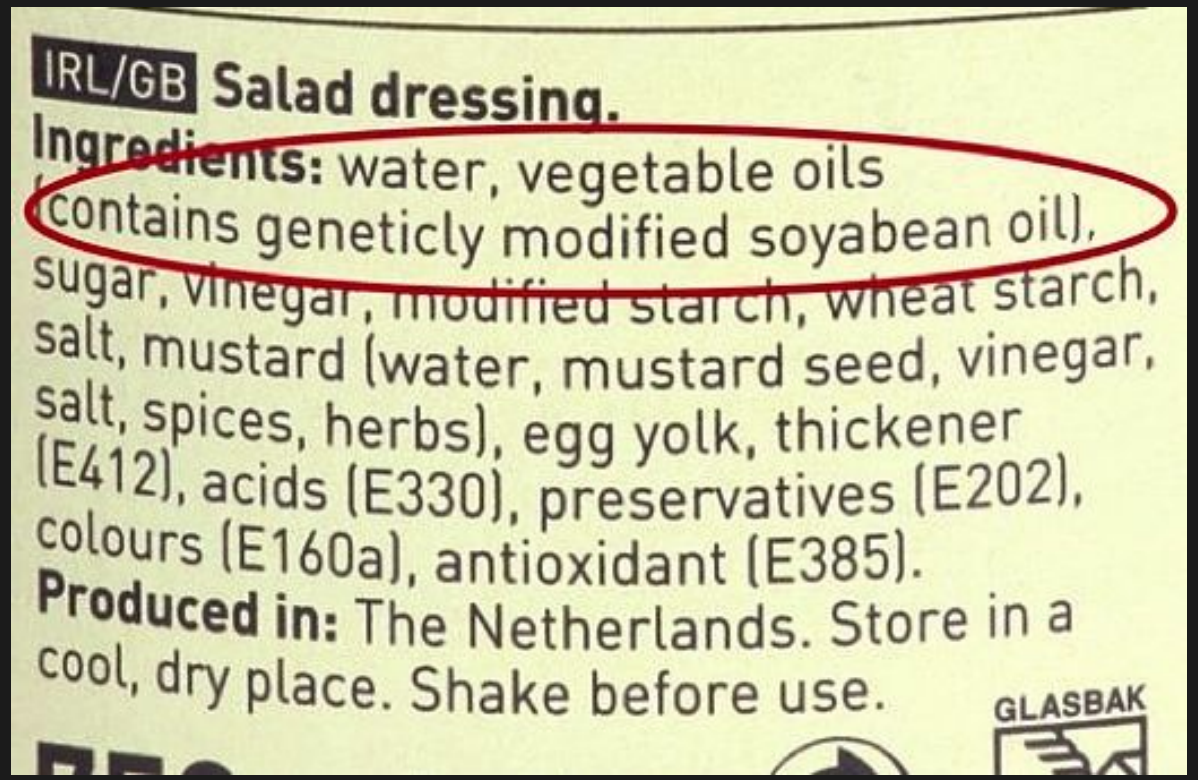
Creating Your Story

BEFORE SOMEONE ELSE DOES


IF GENETICALLY MODIFIED FOODS ARE SAFE
WHY THE FUCK ARE THEY WEARING PROTECTIVE CLOTHING?
DIYLOL.COM

Different Stakes + Different Tactics

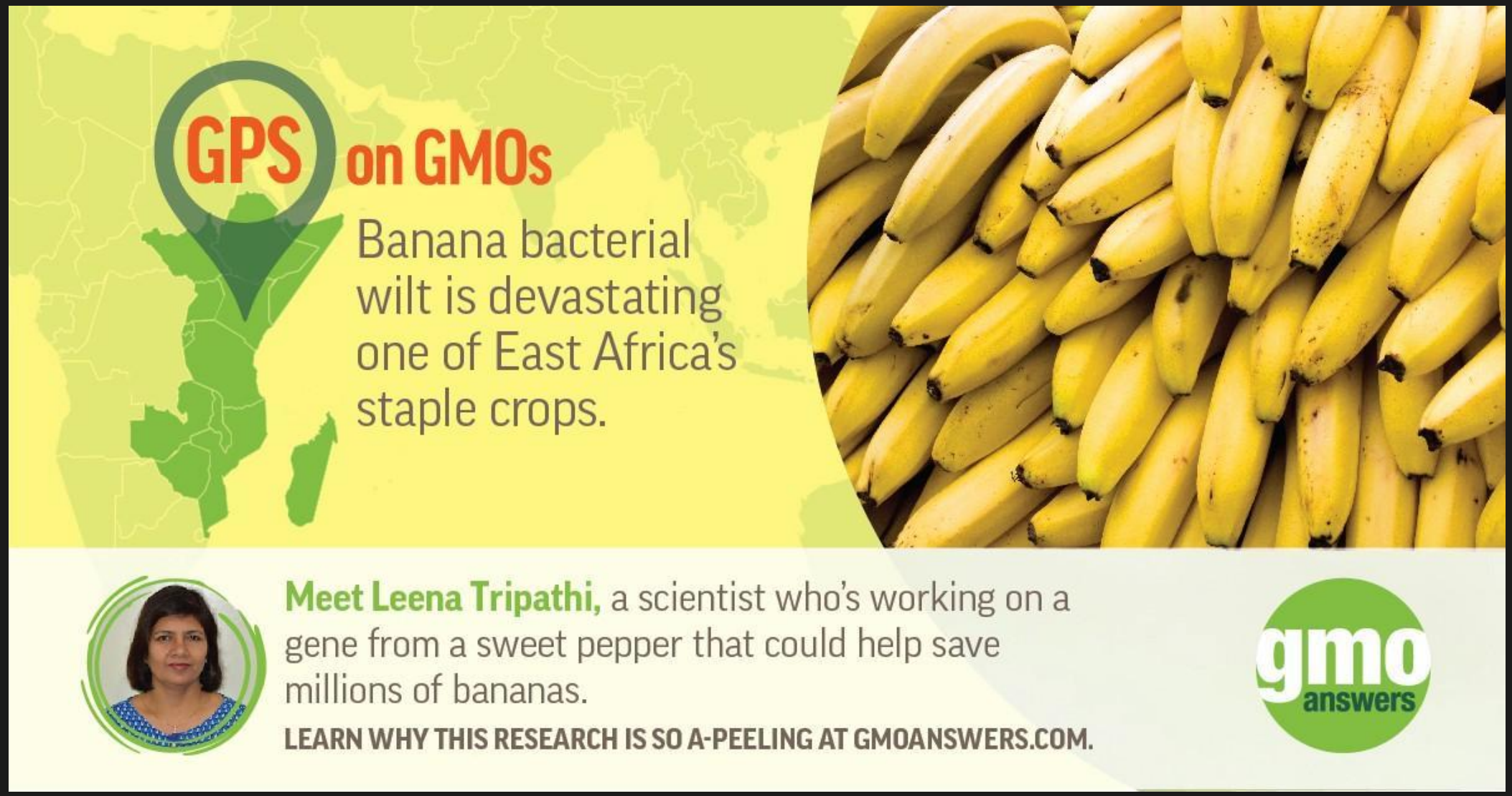


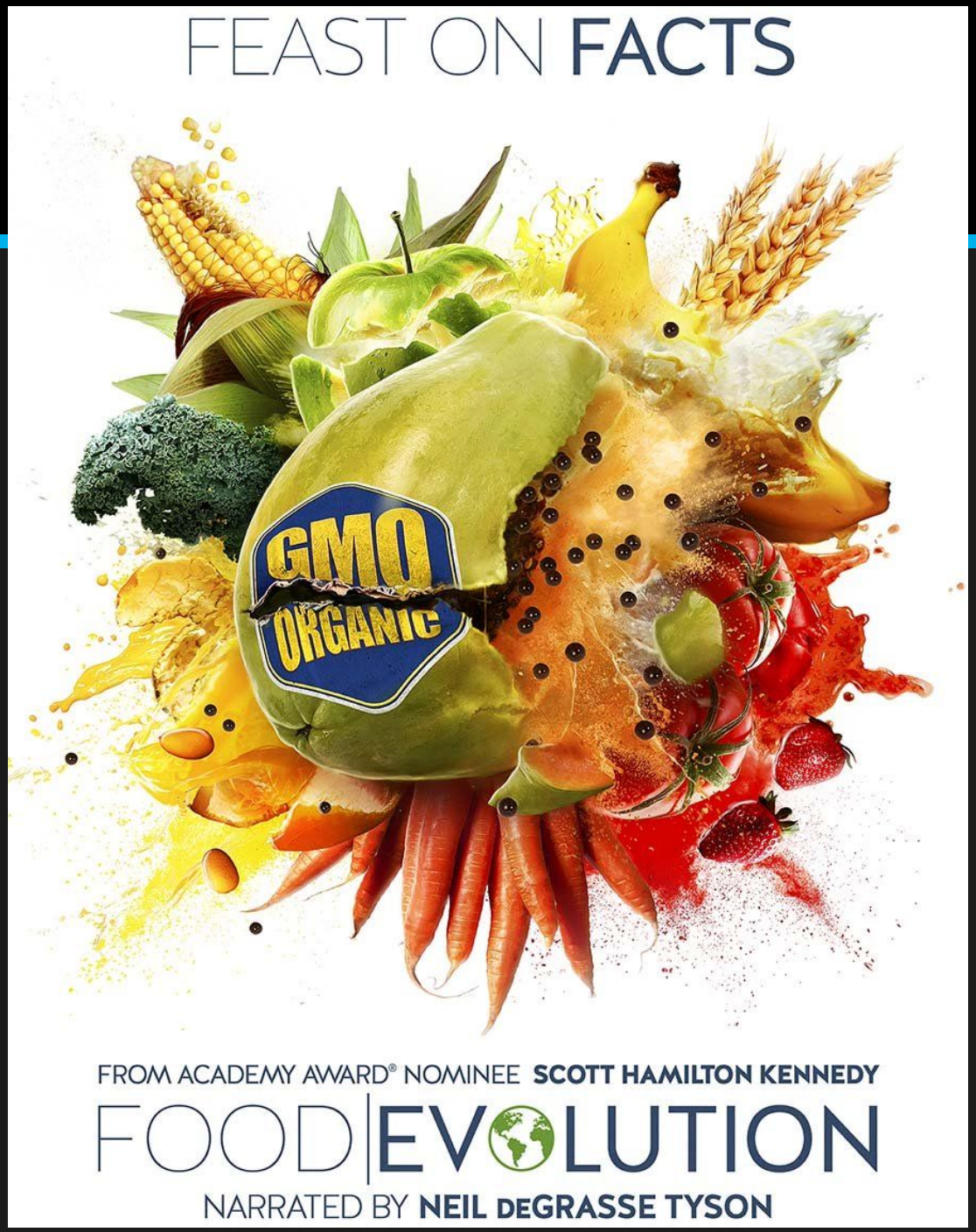


IRL/GB **Salad dressing.**
Ingredients: water, vegetable oils (contains geneticly modified soyabean oil), sugar, vinegar, modified starch, wheat starch, salt, mustard (water, mustard seed, vinegar, salt, spices, herbs), egg yolk, thickener (E412), acids (E330), preservatives (E202), colours (E160a), antioxidant (E385).
Produced in: The Netherlands. Store in a cool, dry place. Shake before use.
GLASBAK

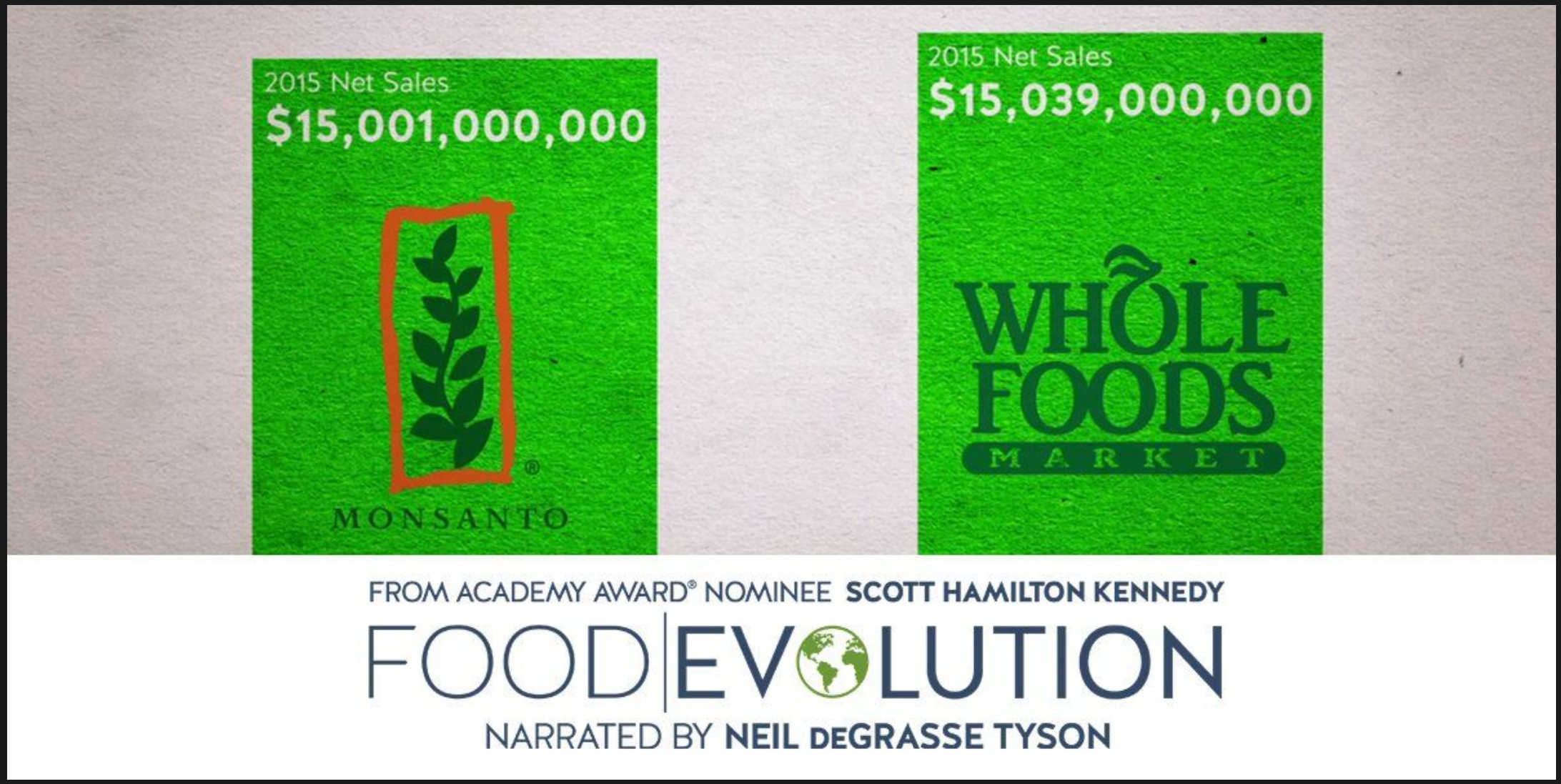

SOIL FRIENDLY - EARTH FRIENDLY
CERTIFIED GM INGREDIENTS

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.
gmo answers


FEAST ON FACTS
GMO
ORGANIC
FROM ACADEMY AWARD® NOMINEE SCOTT HAMILTON KENNEDY
FOOD|EVOLUTION
NARRATED BY NEIL DEGRASSE TYSON

https://www.foodevolutionmovie.com/


2015 Net Sales
$15,001,000,000
MONSANTO
2015 Net Sales
$15,039,000,000
WHOLE FOODS MARKET
FROM ACADEMY AWARD® NOMINEE SCOTT HAMILTON KENNEDY
FOOD EVOLUTION
NARRATED BY NEIL DEGRASSE TYSON

“Choose a healthy Future for our Kids and the Planet”

-Only Organic

WATERLOO iGEM

“good” organics, “bad” conventional agriculture

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

- Steve Savage, Phd

WATERLOO iGEM

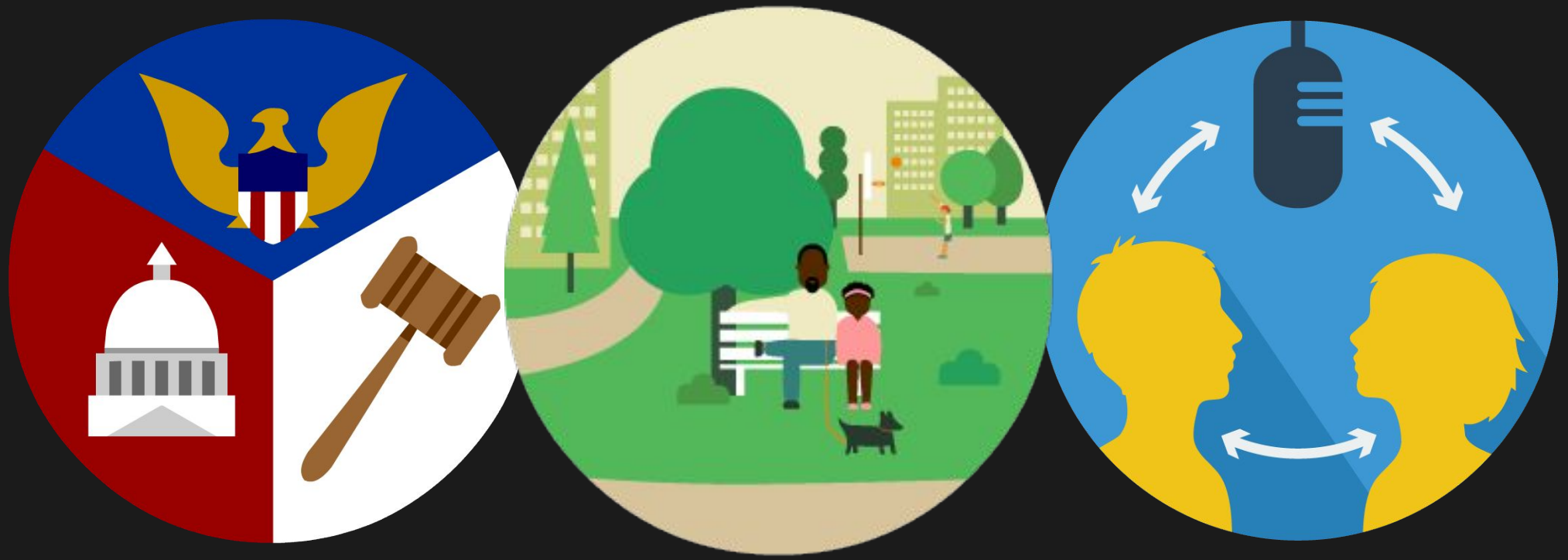
“They’re [alternative food companies] building their businesses trying to portray me and my family as bad guys – for simply doing what’s best for our farm, community, family and customers.”

- Andrew Campbell, farmer

WATERLOO iGEM

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[1] 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**[2] 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**[3] 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

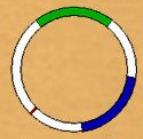
Mutagenesis

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

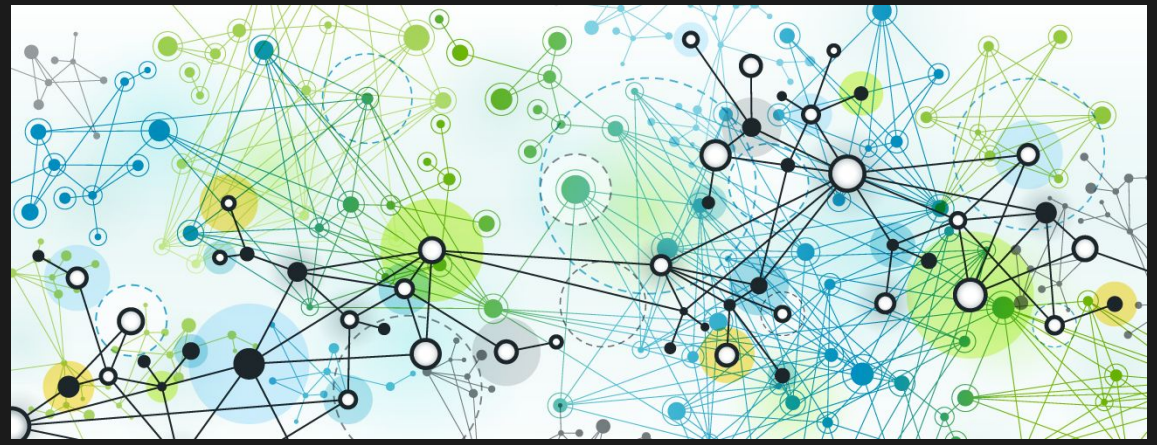
Desired gene(s) inserted with other genetic material. No safety testing requirements.

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?