iGEM

STEAM
POWER UP YOUR FUTURE
Science Technology Engineering Arts Math

GRADUATE! TACOMA
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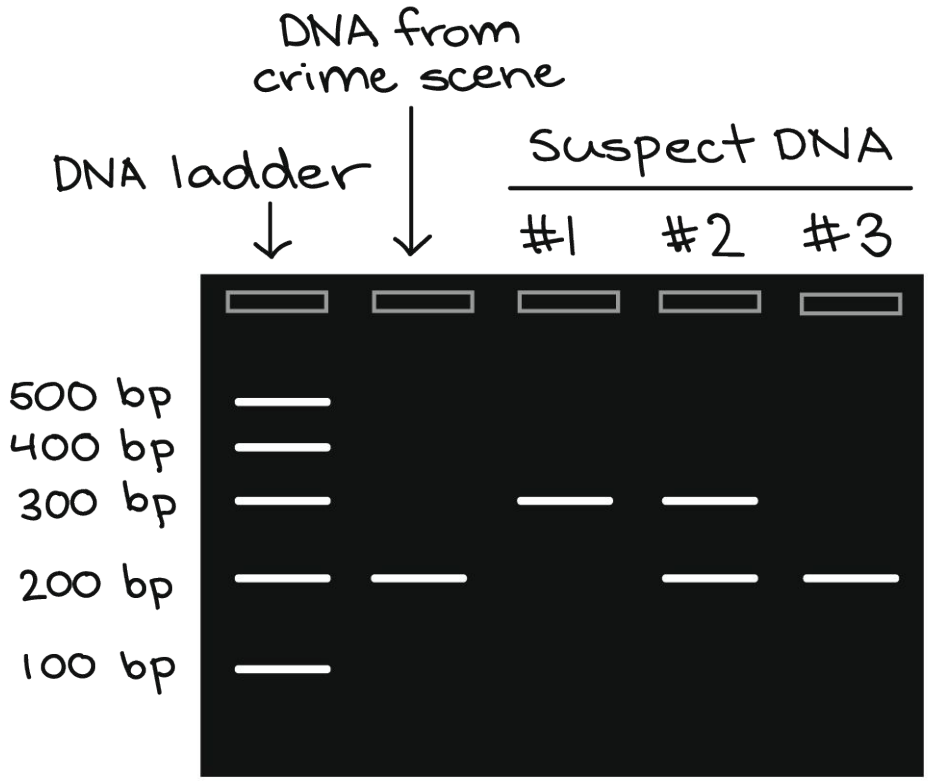
RAIN INCUBATOR

Brought to you by RAIN Incubator, Graduate Tacoma's STEAM Network, & the RAINMakers iGEM Research Team

Bioengineering Summer Camp 2019
Tuesday, July 30

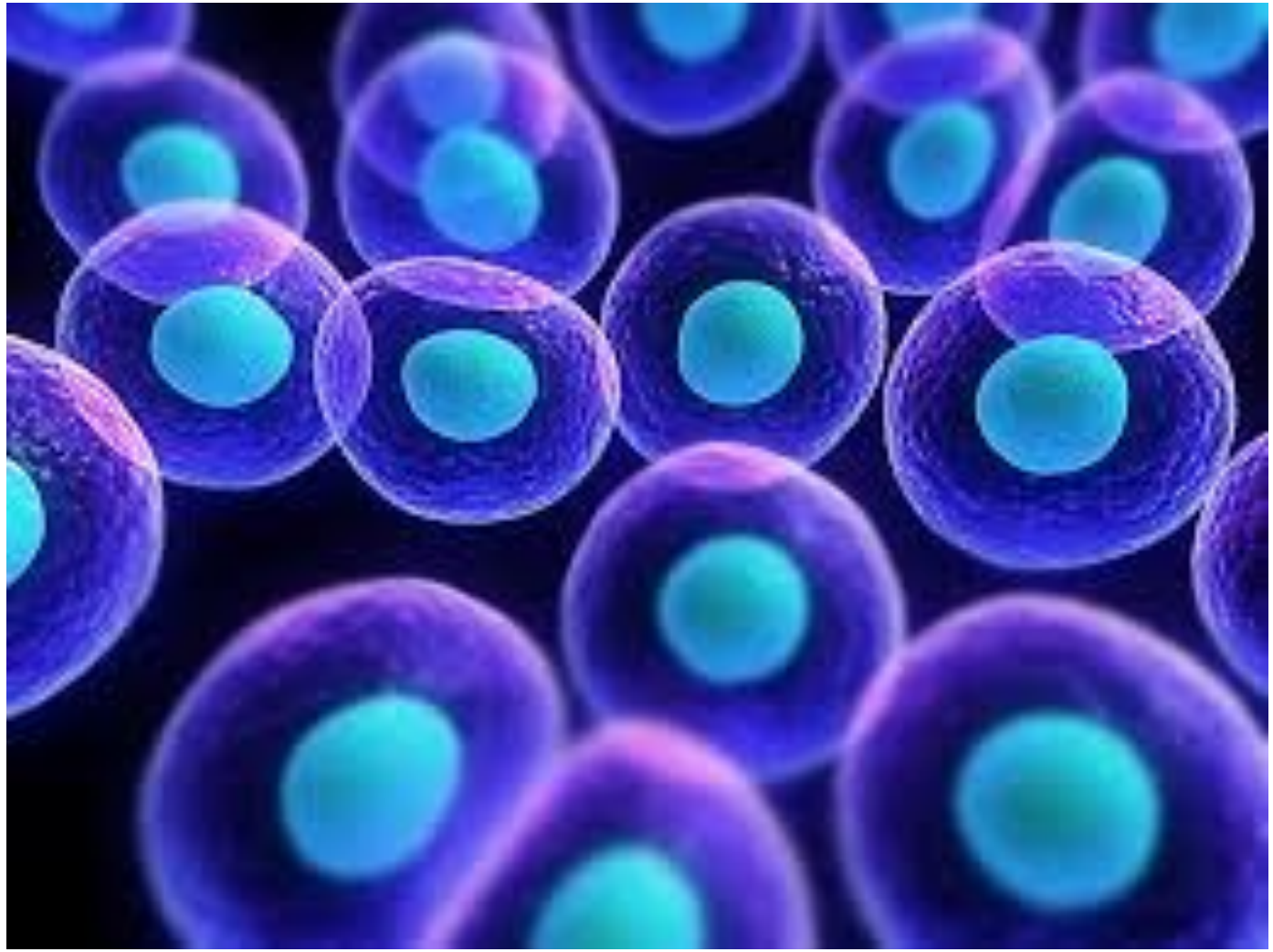


Suspect Analysis

Questions from Lab #1:

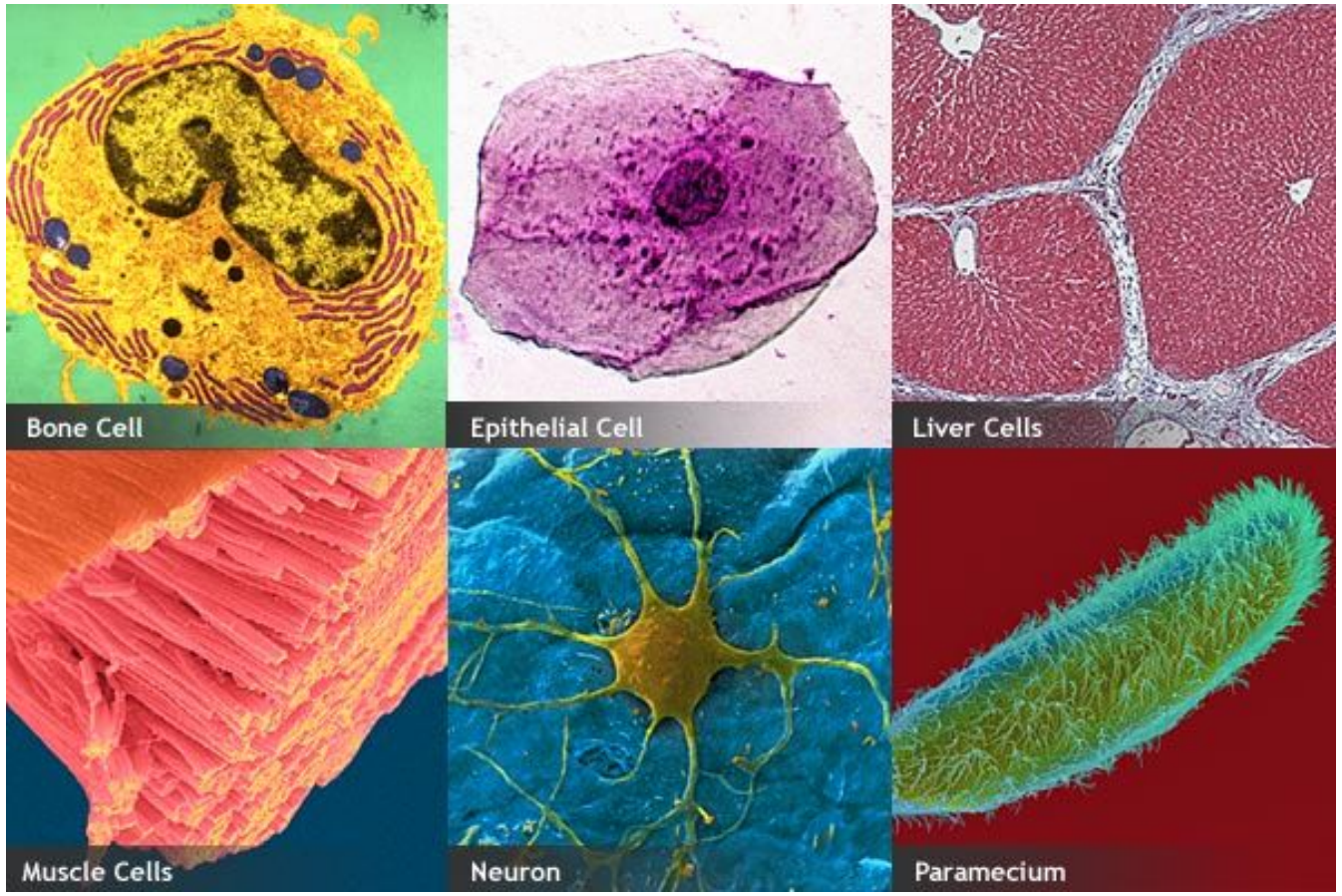
- Outline the steps of proper use of a micropipette?
- What causes the fragmented DNA to migrate through the agarose?
- The rate of DNA migration through the agarose is based on what?
- What units are used when measuring fragments of DNA?

Cells



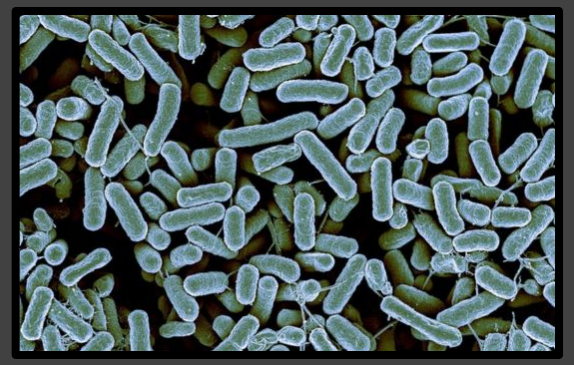
What is a cell?

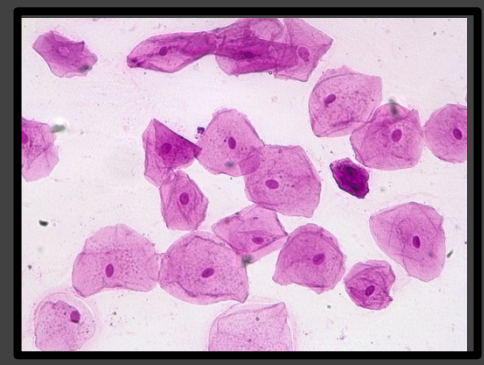
- Cells are the smallest unit of living things.
- A cell's structure is based on its function.



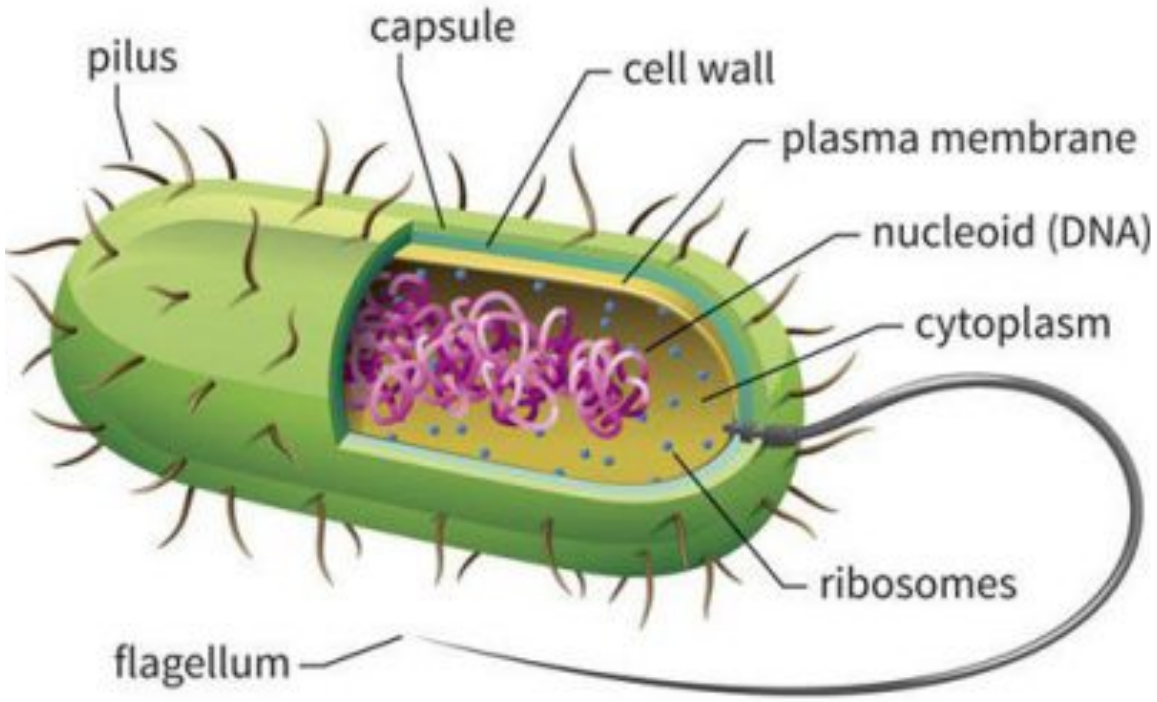
Two Types of Cells

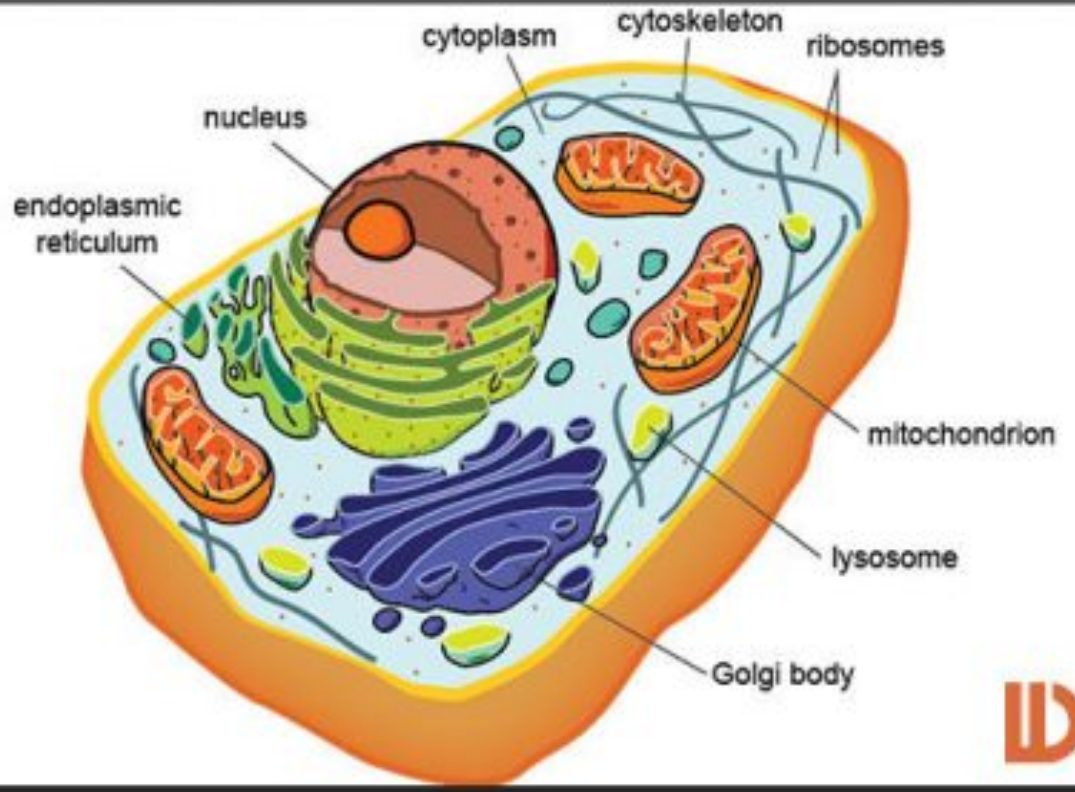
- Prokaryote
  - Bacteria
- Eukaryote
  - Plant
  - Animal





PROKARYOTIC CELL VS EUKARYOTIC CELL





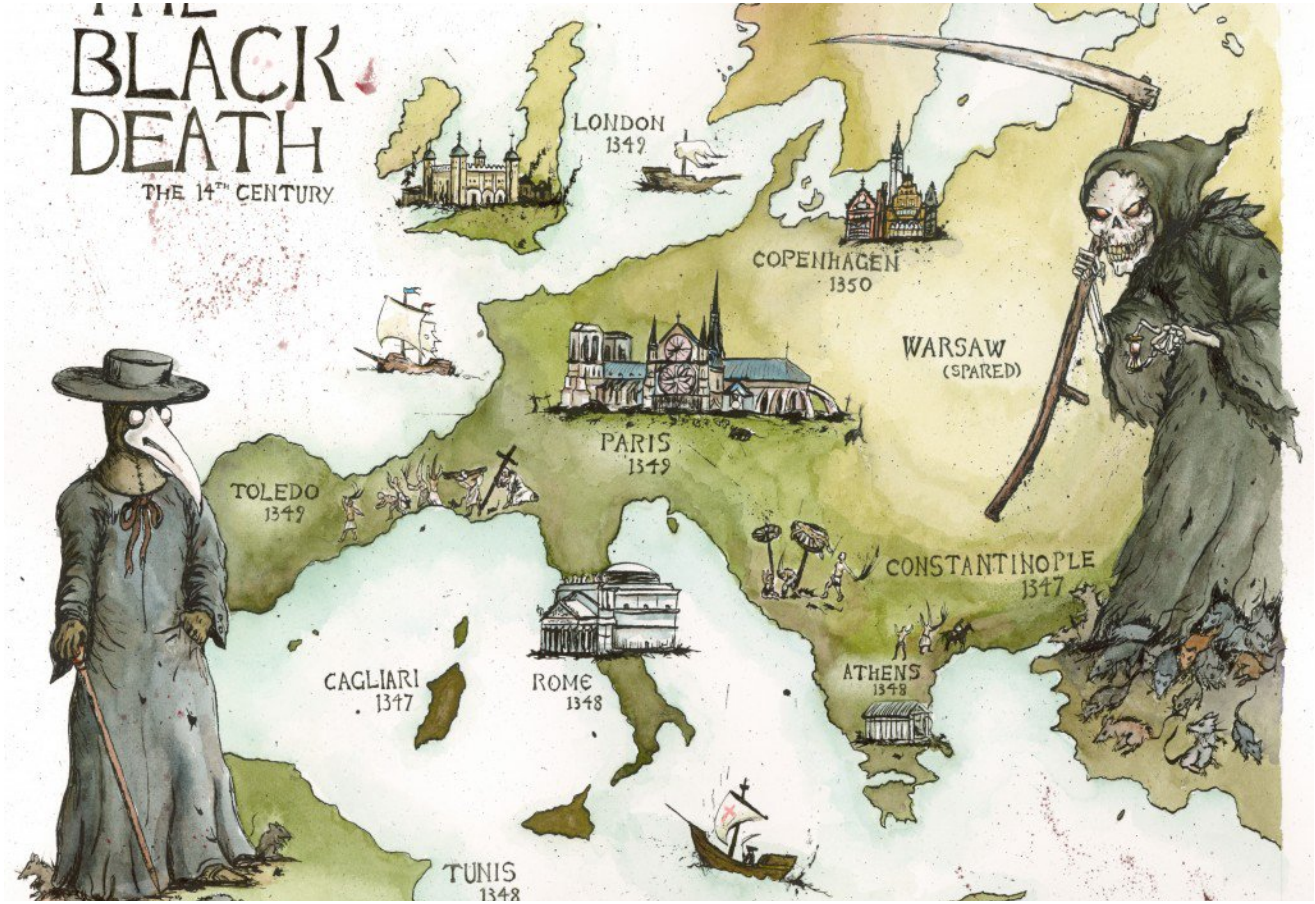
	Prokaryotes	**Eukaryotes**
DNA	DNA is naked (no histones)	DNA associated with histones
	DNA is circular	DNA is linear
	Genes do not contain introns	Genes may contain introns
	DNA found in cytoplasm (nucleoid)	DNA found in nucleus
Internal Structures	No membrane-bound organelles	Have membrane-bound organelles
Ribosomes	Have 70S ribosomes	Have 80S ribosomes
Reproduction	Asexual (binary fission)	Asexual (mitosis) or sexual (meiosis)
	DNA is singular (haploid)	DNA is usually paired (diploid or more)
Average Size	Smaller (≈1 – 5 μm)	Larger (≈10 – 100 μm)

The Good and The Bad of Bacteria

BAD

- Bacteria cause infection
- Bubonic plague (black death) killed 30-60% of the European population in the 14th century.

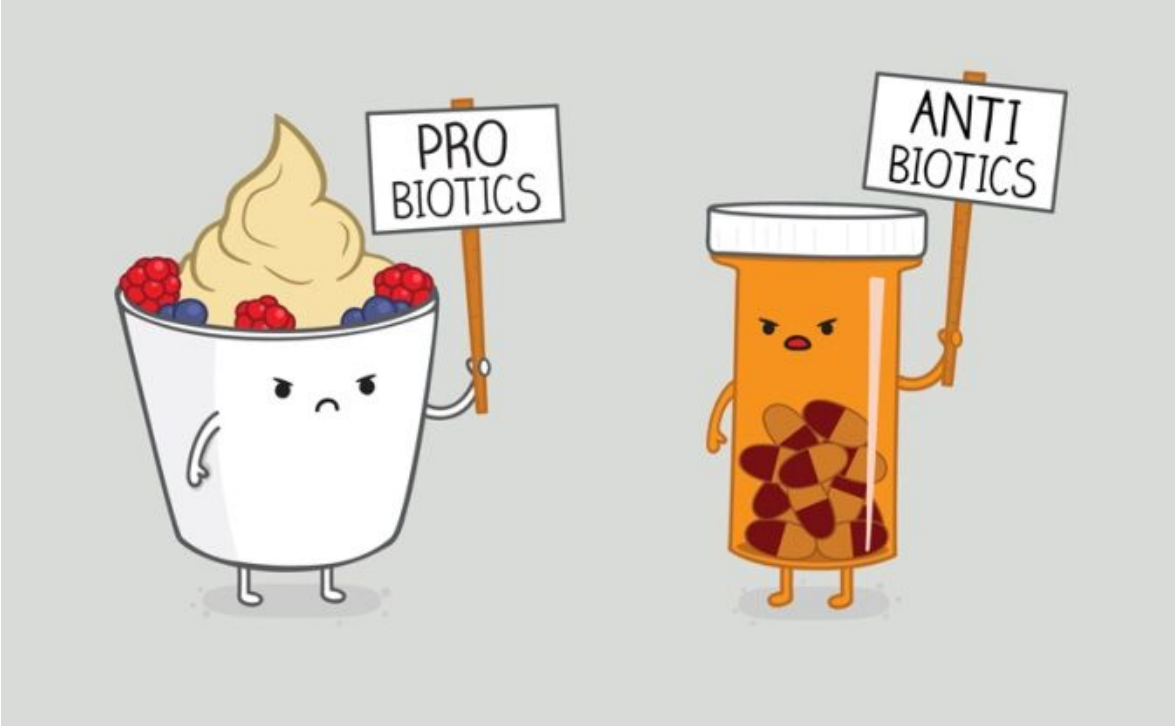
- Penicillin was discovered in 1928 by Sir Alexander Fleming, when he noticed that some bacteria that he was cultivating would not grown if a certain fungus was nearby. However, it was not until 1940 that penicillin was purified, and used as an antibiotic. Its availability in the latter stages of World War II saved the lives of numerous soldiers.



The Good and The Bad of Bacteria

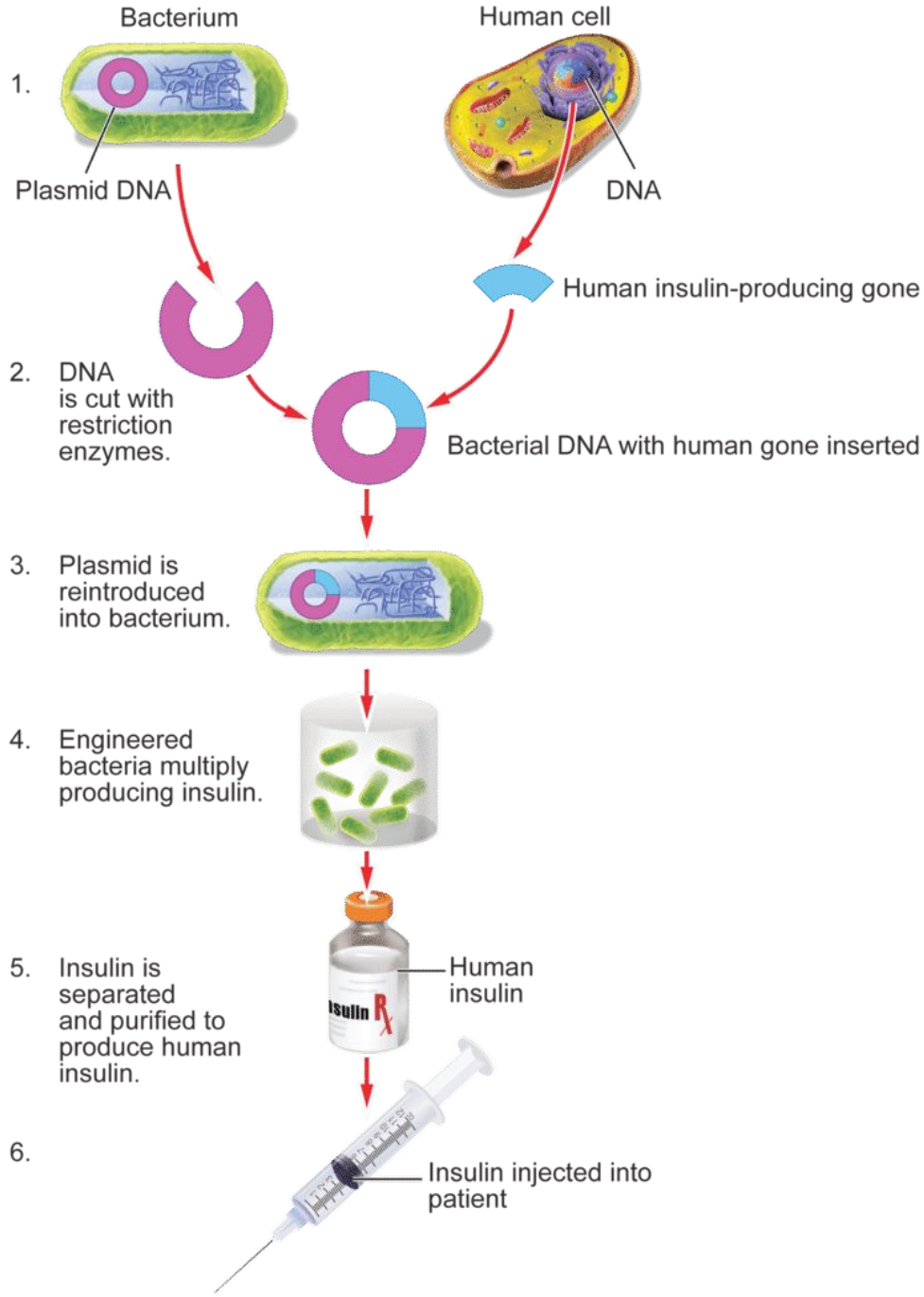
GOOD

- Bacteria are decomposers
- Bacteria help digest our food in our digestive tract
- Cheese, Yogurt, and Sourdough bread are made with the use of bacteria



Bacteria in Bioengineering

- Bacteria can be genetically engineered to:
  - Produce Insulin, Growth Hormone, or other useful proteins
  - Produce renewable biofuels
  - Used to break down toxic waste, oil spills, or plastics in the environment

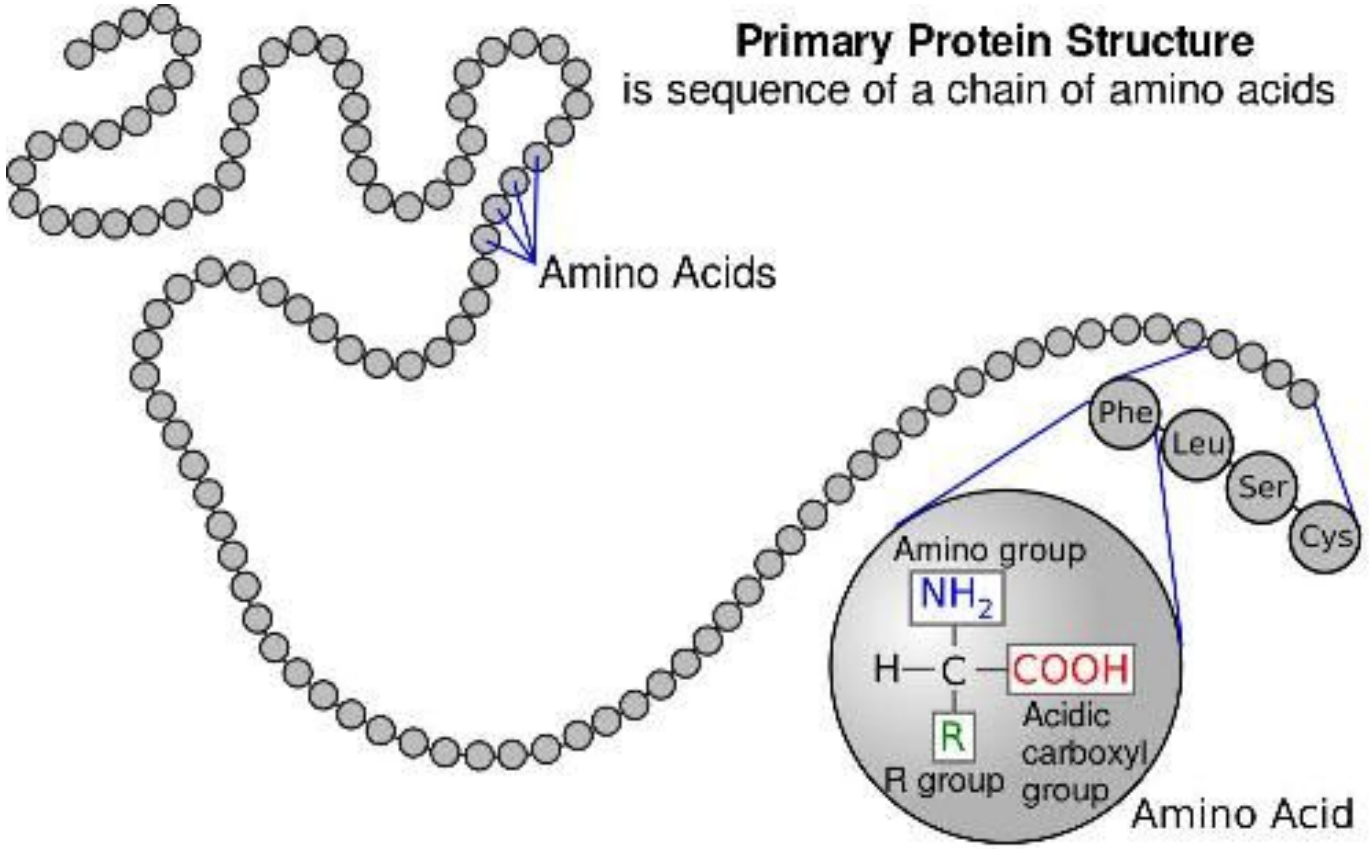


Using the Microscopes

Microscope Basics

1. Make sure the shortest objective lens is pointing down.
2. Place slide on the stage.
3. Using the course adjustment knob, bring your sample into focus.
4. Make fine-tune adjustments with the fine adjustment knob.
5. If appropriate, turn the nose piece to place the next higher powered objective lens down at the sample.
6. Only use the fine adjustment knob now.
7. Repeat steps 5-6.

What are Proteins?

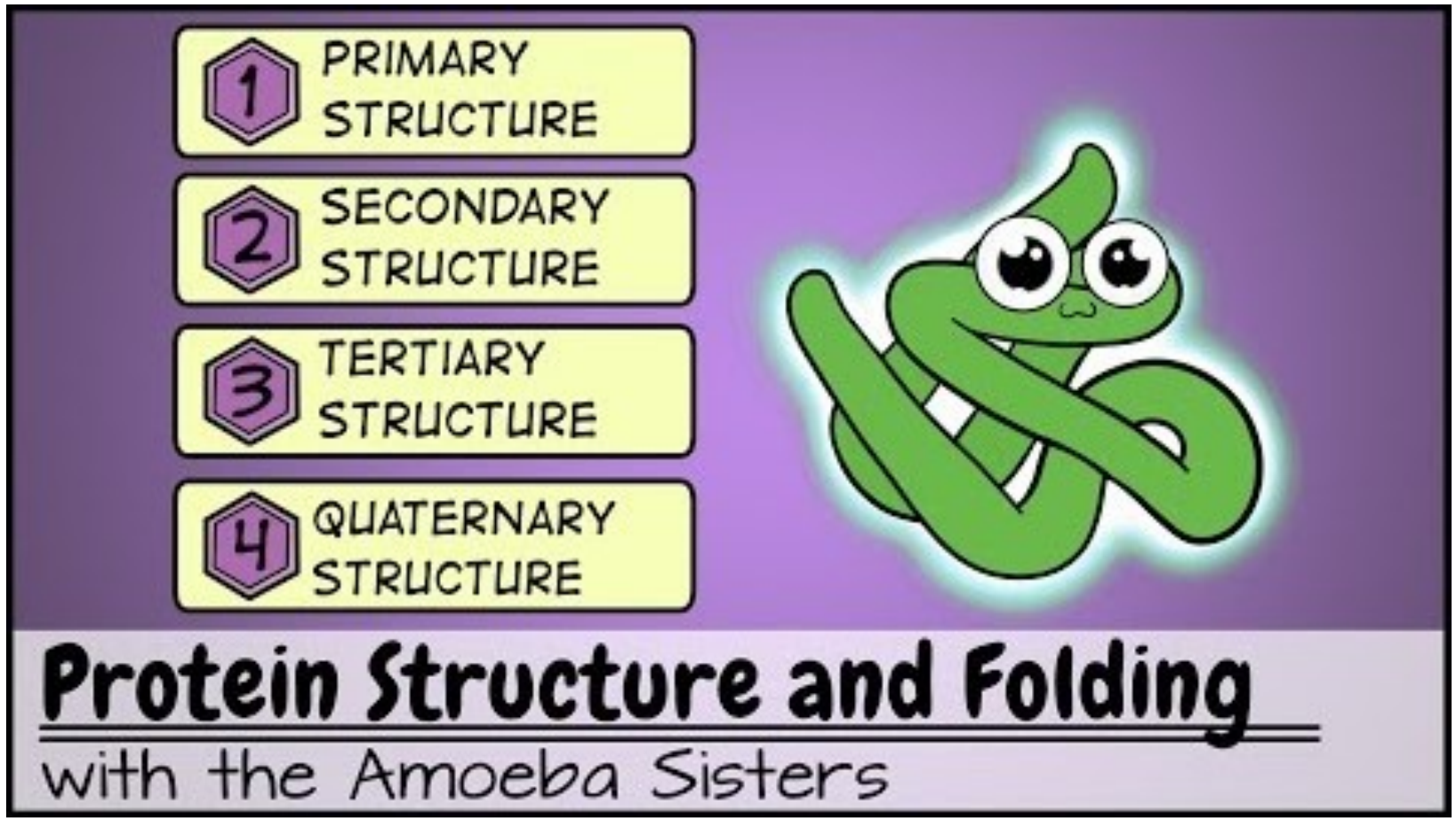


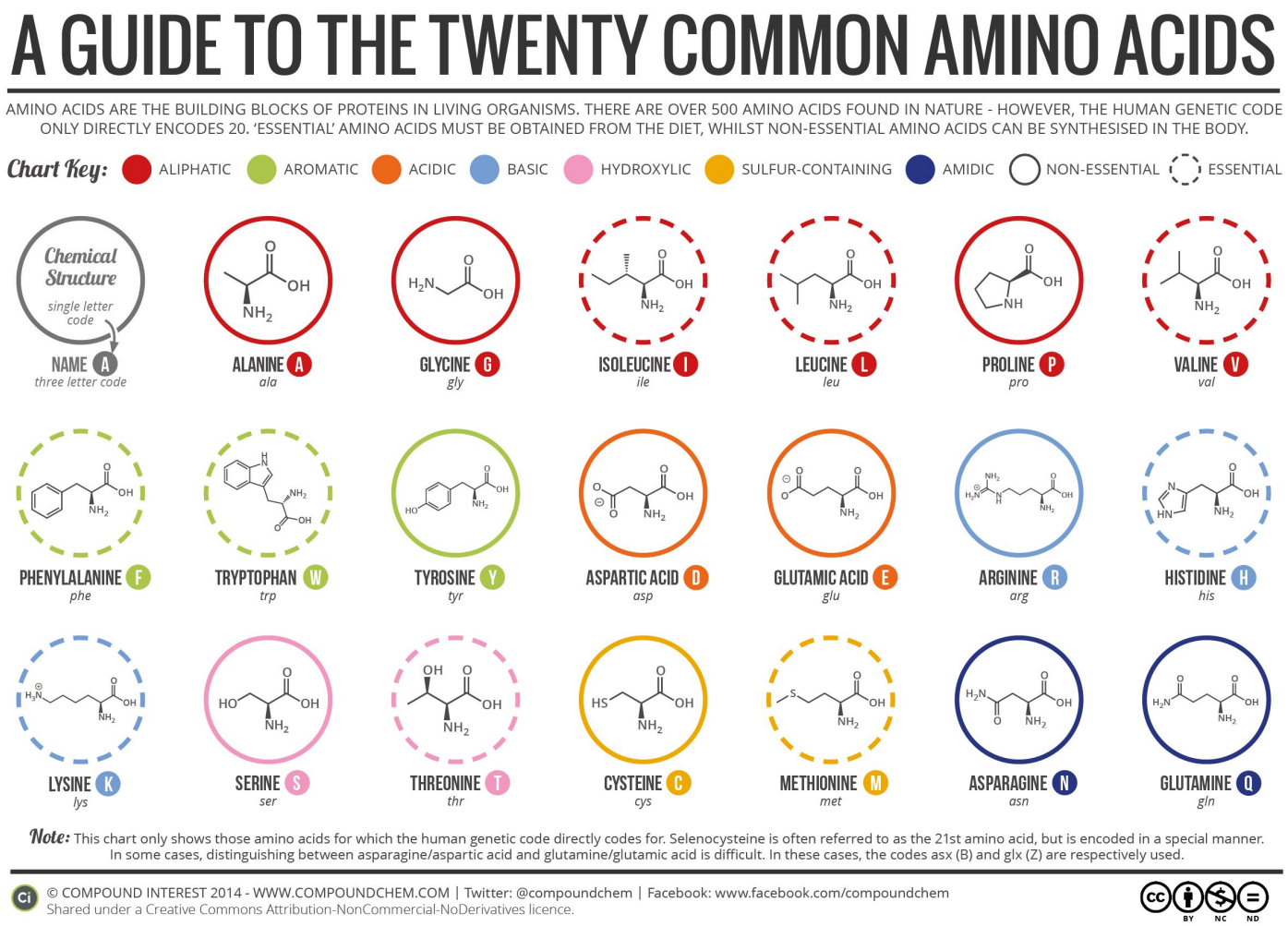
- Proteins are long chains of amino acids.
- There are thousands of different proteins in the human body.
- They provide all sorts of functions to help us survive.

Examples of protein functions

Function	Description	Example
Antibody	Antibodies bind to specific foreign particles, such as viruses and bacteria, to help protect the body.	Immunoglobulin G (IgG)
Enzyme	Enzymes carry out almost all of the thousands of chemical reactions that take place in cells. They also assist with the formation of new molecules by reading the genetic information stored in DNA.	Phenylalaninehydroxylase
Messenger	Messenger proteins, such as some types of hormones, transmit signals to coordinate biological processes between different cells, tissues, and organs.	Growth hormone
Structural component	These proteins provide structure and support for cells. On a larger scale, they also allow the body to move.	Actin
Transport/storage	These proteins bind and carry atoms and small molecules within cells and throughout the body.	Ferritin

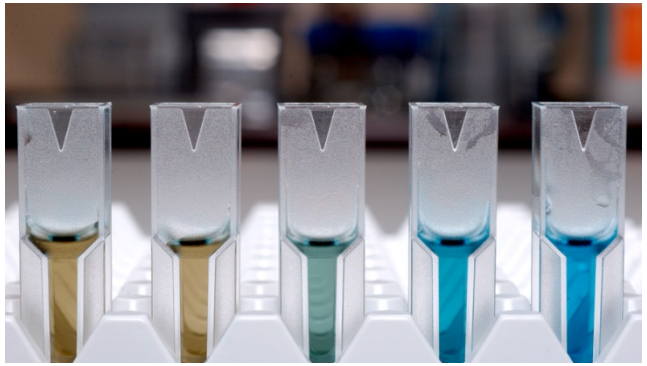
Protein Synthesis





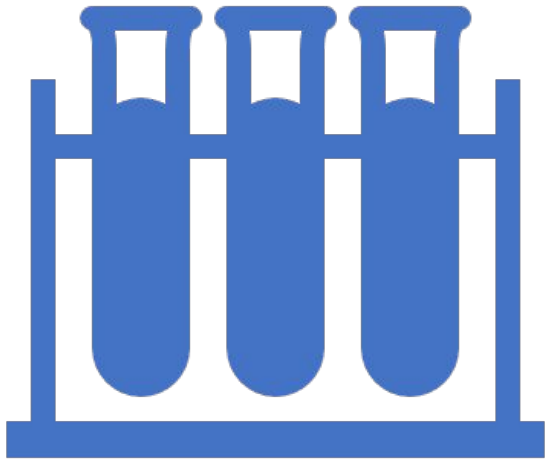
- Amino acids are special organic molecules used by living organisms to make proteins.
- The main elements in amino acids are carbon, hydrogen, oxygen, and nitrogen.
- There are twenty different kinds of amino acids that combine to make proteins in our bodies.
- Our bodies can actually make some amino acids, but the rest we must get from our food.

What Are Amino Acids?



Protein Concentration Testing

- The Bradford protein assay is one of several simple methods commonly used to determine the total protein concentration of a sample. This method is based on proportional binding of the Coomassie dye to proteins. It is also colorimetric, meaning the color will be different based on protein concentration.
- The protein used in this lab is called Bovine Serum Albumin (BSA) because it is low cost and doesn't react with other chemicals.



Protein Concentration Pipetting Artwork

Bioengineering In Our World

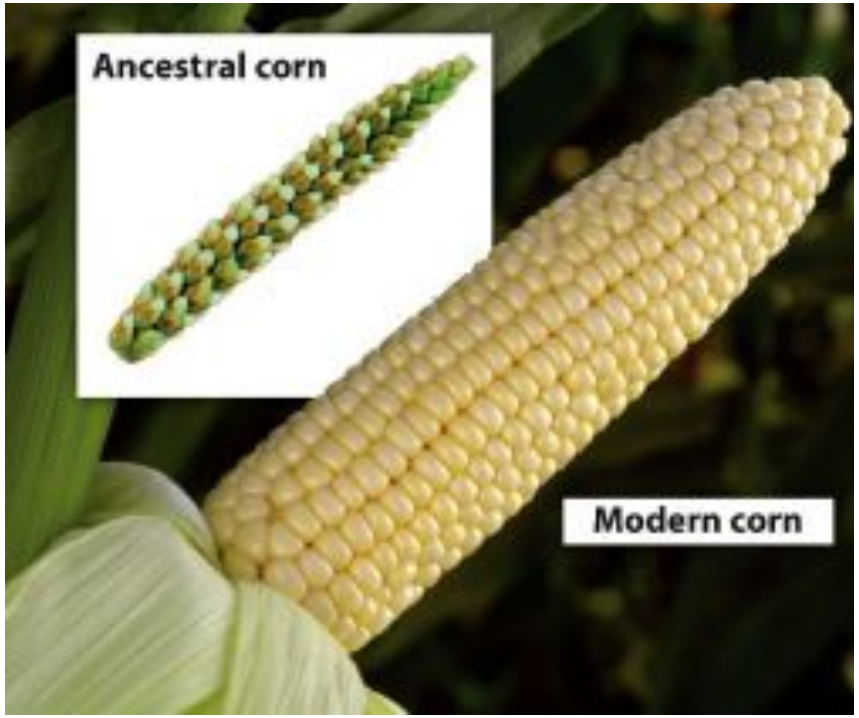
A Short History and a Look Into the Future

Genetics

- **Natural Selection** – When organisms choose mates based on survival traits for their environment and those traits are passed on to offspring over many generations
  Example – Female peacocks picking a mate with the prettiest tail
- **Artificial Selection or Selective Breeding** – When people cross organisms, or breed them, with particular mates in order to select for a specific trait.
  Example – Labrador breeders crossing two dogs with the shiniest fur or farmers crossing two plants with the highest yield.
- **Cloning** – is the process of producing one or more genetically-identical sections of DNA, cells, or individuals.
  Example – Identical twins or Dolly the Sheep
- **Genetic Engineering** - deliberate, controlled manipulation of the genes in an organism with the intent of making that organism better in some way
  Examples to follow…

Looking Back

- Biotechnology goes back hundreds of years
  - Using tiny living organisms called yeast to make bread, beer, and wine.
  - When a trait in an organism is preferred people select those organisms to pass on their traits, called **Selective Breeding.**



Genetically Modified Organisms (GMOs)

- GMOs are foods produced from organisms that have had changes introduced into their DNA using the methods of genetic engineering.
- In 1994, Calgene, a California company, brought the first genetically engineered crop to market, the Flavr-Savr tomato. The company's researchers were able to inhibit a gene that produces a protein that makes a tomato get squishy
- Golden Rice is conventional rice that has been genetically engineered to have high levels of beta-carotene, the precursor to vitamin A.

What Is a GMO?

GMOs are the product of a specific type of plant breeding where precise changes are made to a plant's DNA to give it characteristics that cannot be achieved through traditional plant breeding methods.

SELECTIVE BREEDING

Plant breeders look for, select and cross-breed the best performing plants in the field, similar to how farmers have naturally improved the crops they grow since farming began.

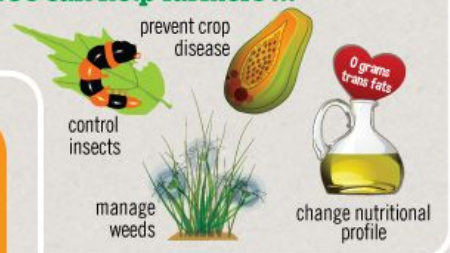
ADVANCED BREEDING

Breeders identify and tag desirable characteristics (traits) within a plant genome. They use this information to pick which plants to cross-breed and create better performing crops.

GM PLANT BREEDING

If a plant needs a trait that can't be achieved through advanced breeding, a gene can be turned off or moved, or a gene from another source can be inserted.

GMOs can help farmers ...

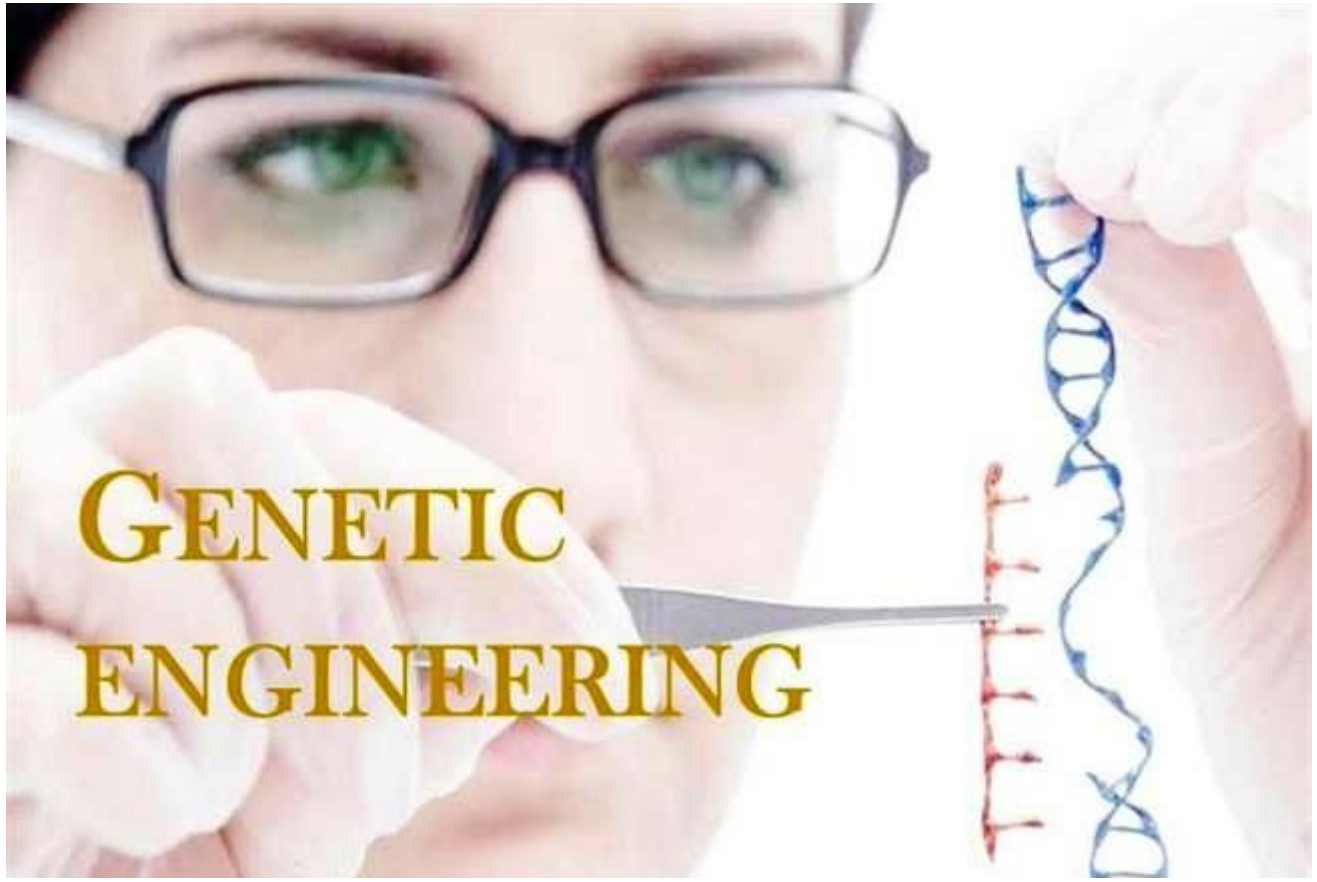


There are eight GMO crops available in the U.S. today:

For more information, visit www.GMOAnswers.com

Are GMOs bad?

Pros & Cons of Genetic Engineering



Monsanto

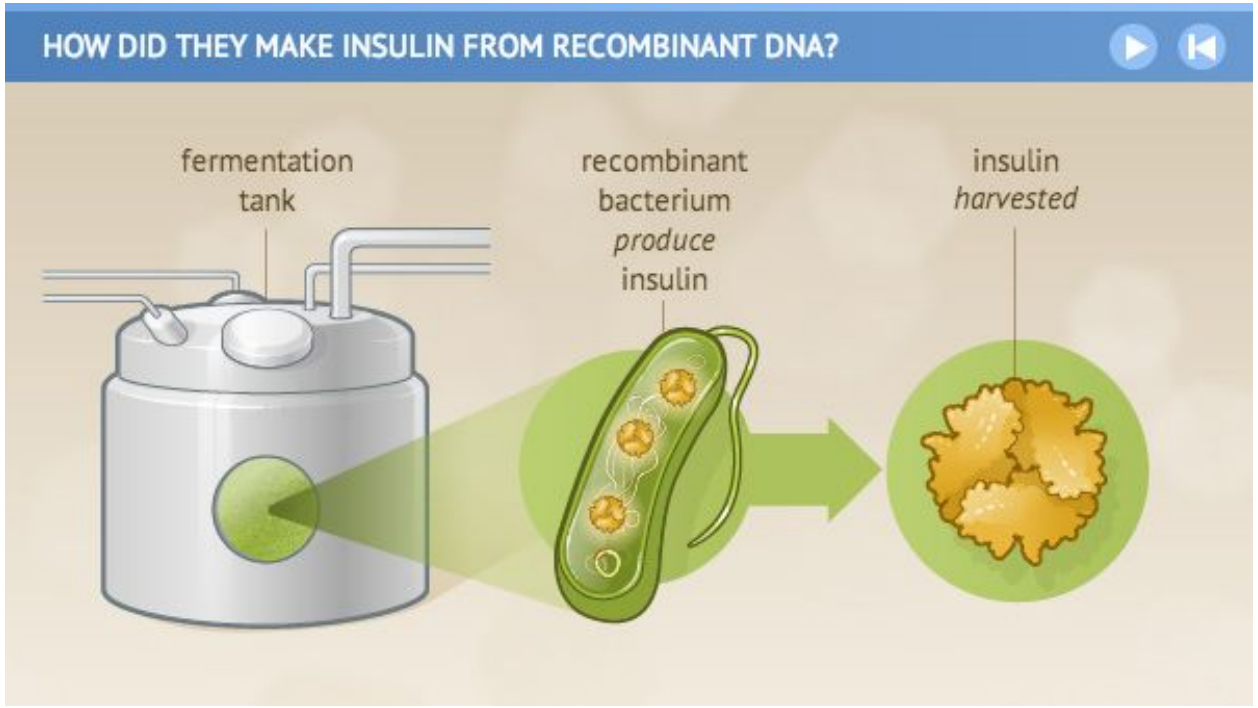
- Monsanto is an agriculture company that primarily focuses on seeds, including genetically modified seeds, and herbicides. It offers farmers a range of seeds including **corn, soybeans, cotton, wheat, canola and sugar cane**.
- Controversy over:
  - DDT-insecticide
  - PCB
  - Agent Orange
  - Round Up

Other Ways Biotech & Bioengineering Impact Our Lives

- Disease Treatments, Preventions, and Cures
- Infertility Treatments
- Global Warming
- Environmental Waste Clean-Up
- Biofuels
- Wearable Technology
- CRISPR-CAS9

- Currently 100,000 individuals who are waiting on a kidney transplant list.
- Earlier this year, a team at Emory University in Atlanta, Georgia, announced that a kidney from a genetically engineered pig had sustained a rhesus macaque monkey for more than 400 days before being rejected, breaking the record by more than 250 days.

“Humanized” Pig Organs for Transplants

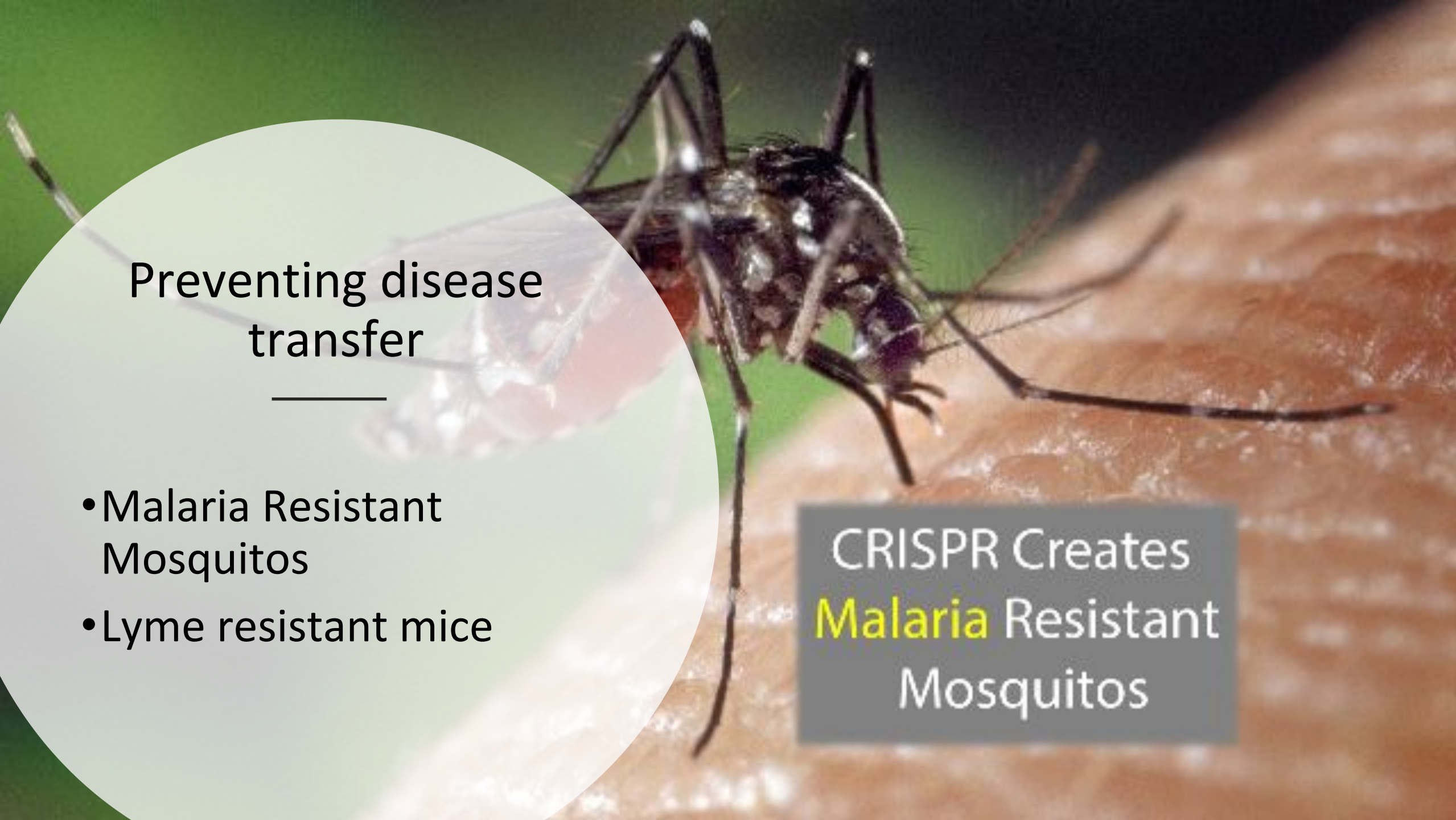


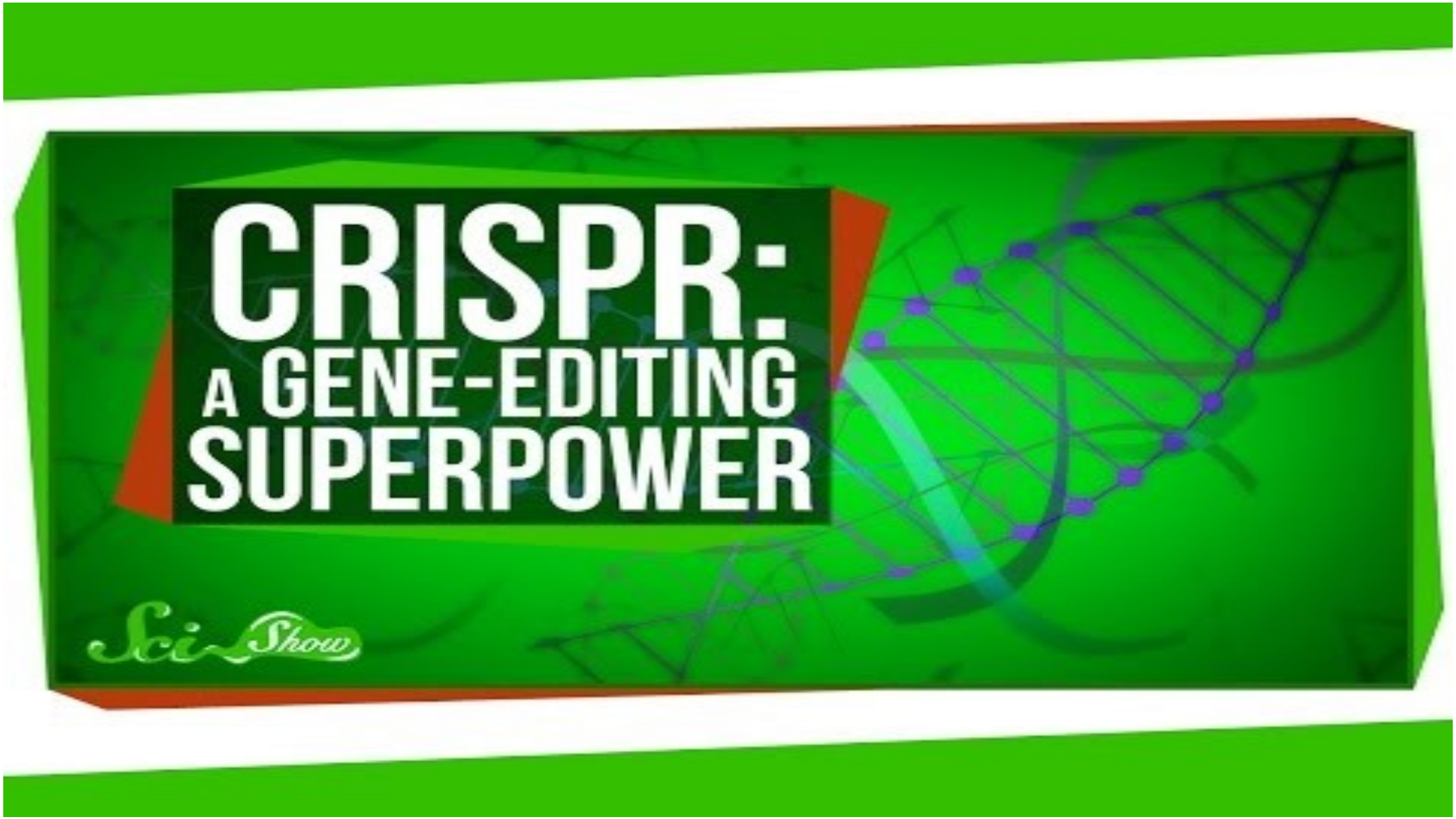
- Insulin, hormone production by genetically engineering bacteria to produce it.
- Genetically modify bacteria to detect a chemical released by cancer tumors.
- Bananas that vaccinate!

Medicine

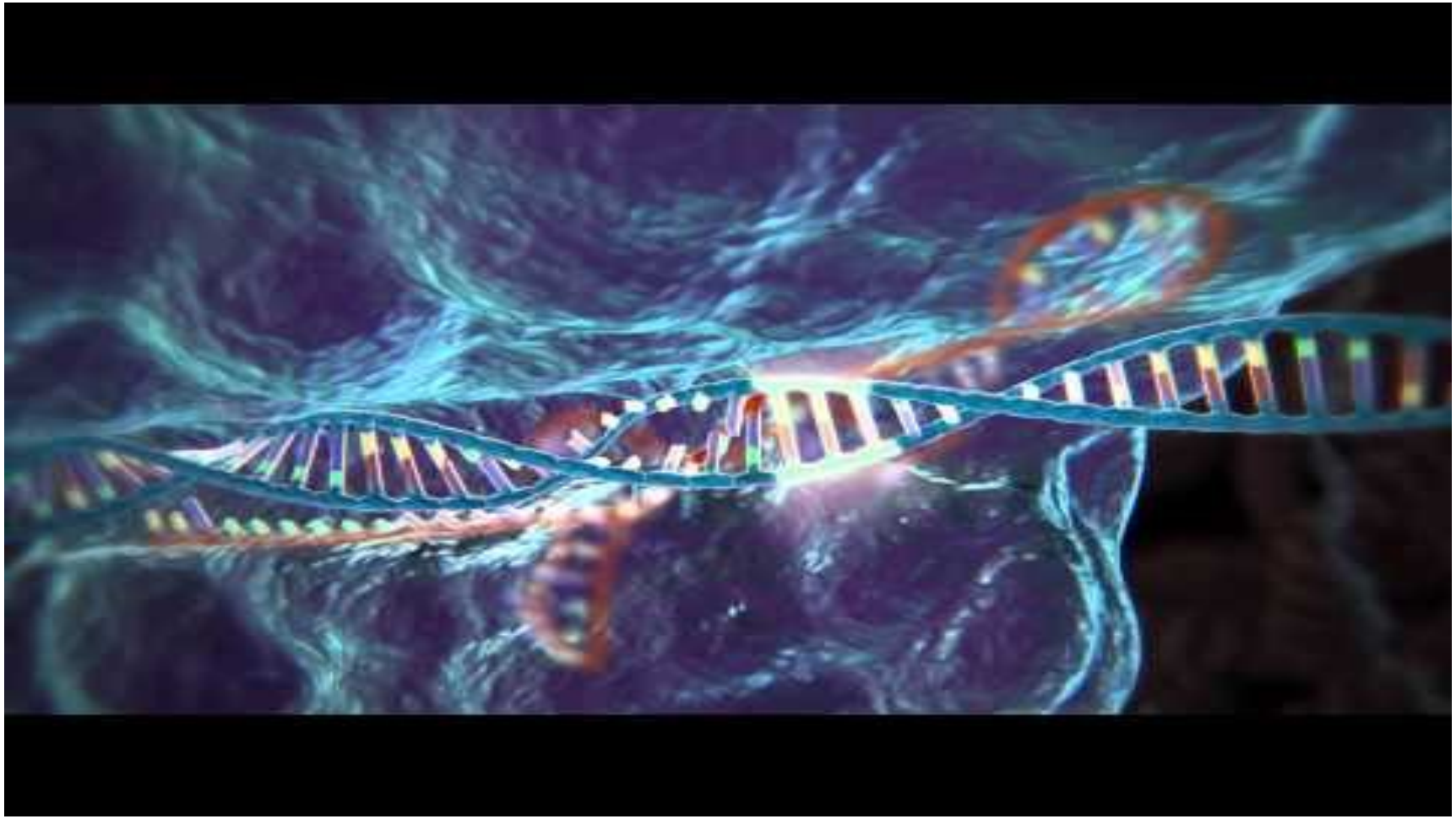
Preventing disease transfer

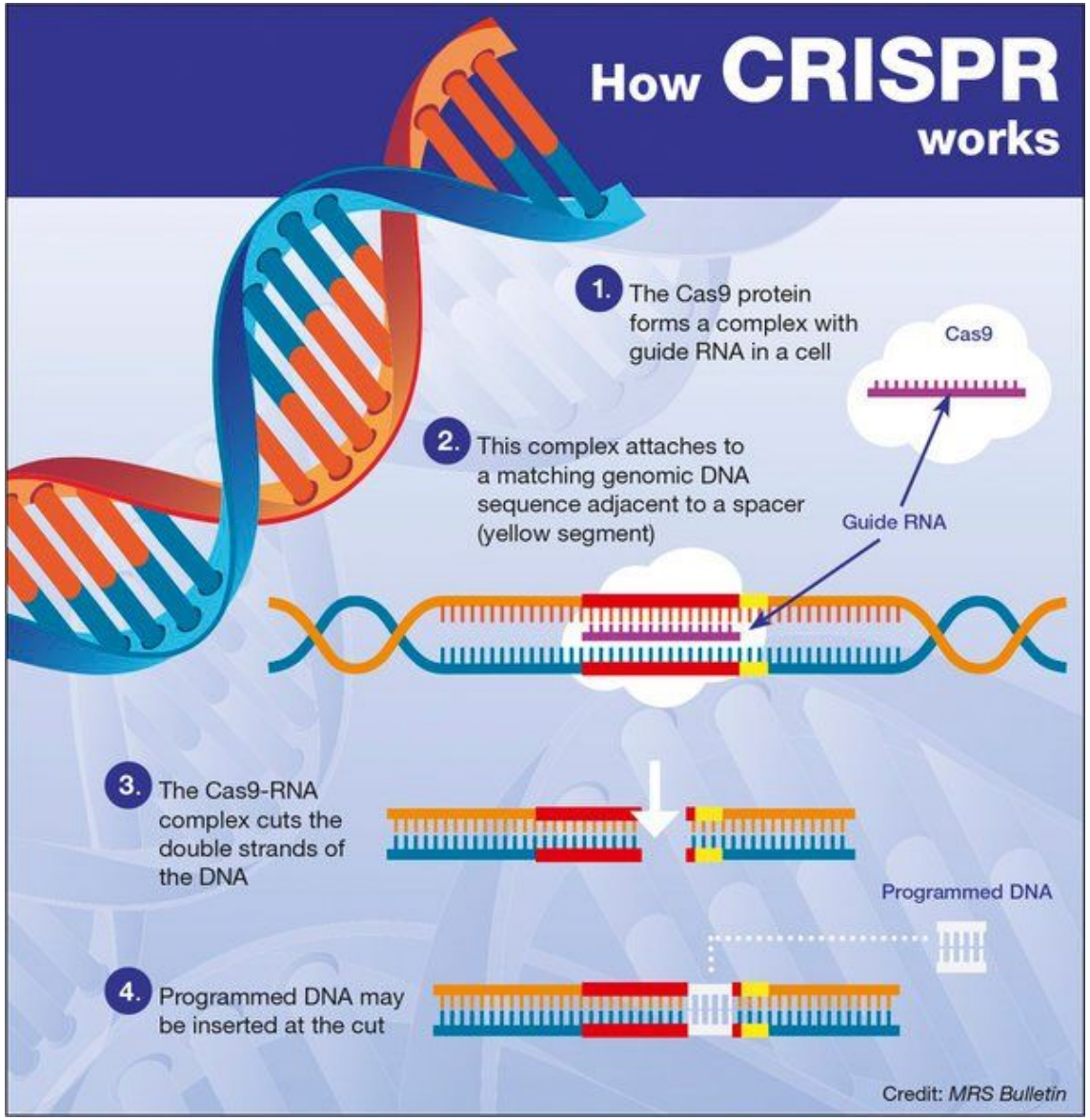
- Malaria Resistant Mosquitos
- Lyme resistant mice

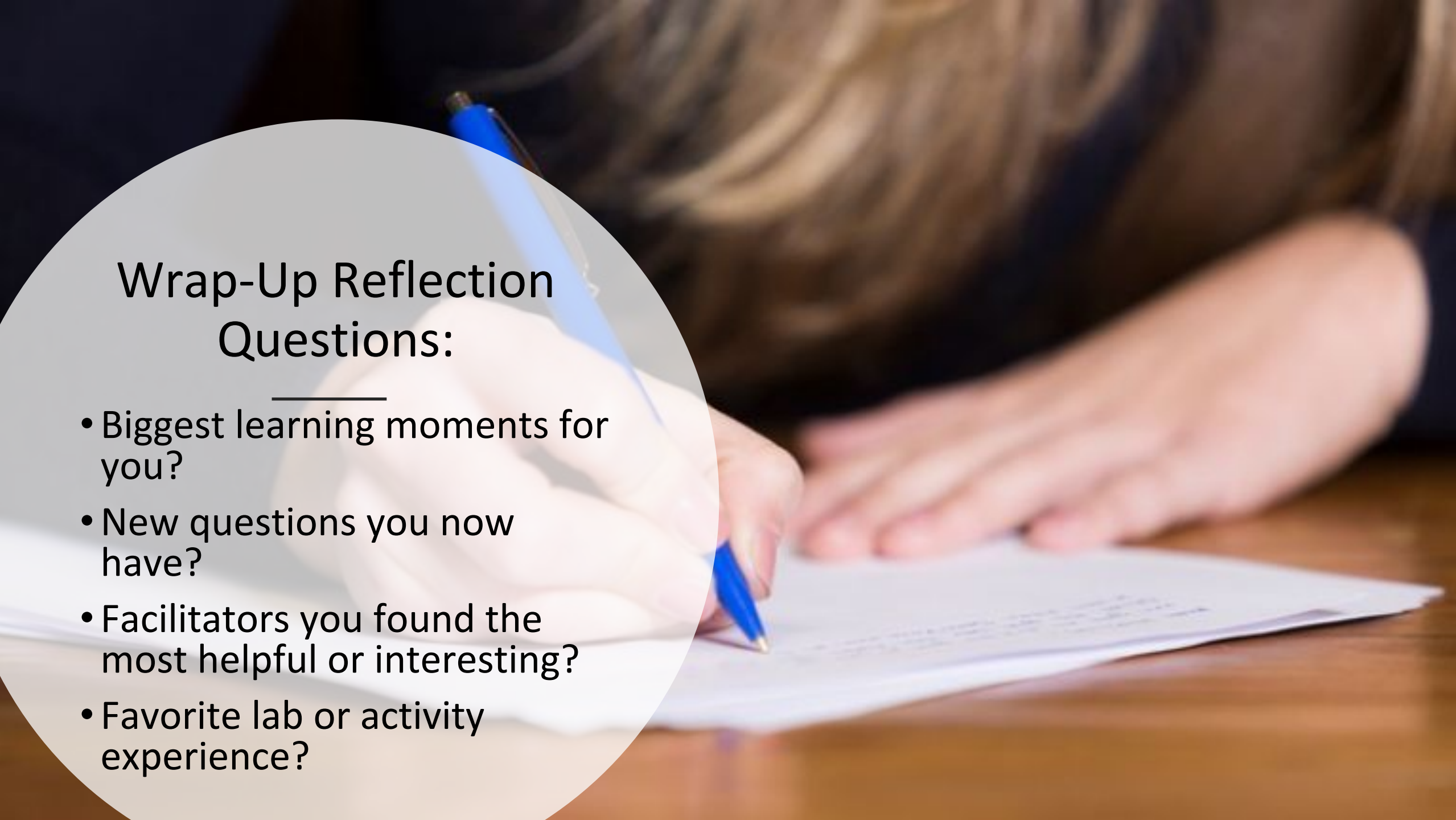



CRISPR:
A GENE-EDITING
SUPERPOWER
SciShow

Genome Editing With CRISPR-CAS9




How CRISPR works
1. The Cas9 protein forms a complex with guide RNA in a cell
Cas9
2. This complex attaches to a matching genomic DNA sequence adjacent to a spacer (yellow segment)
Guide RNA
3. The Cas9-RNA complex cuts the double strands of the DNA
Programmed DNA
4. Programmed DNA may be inserted at the cut
Credit: MRS Bulletin



Wrap-Up Reflection Questions:

- Biggest learning moments for you?
- New questions you now have?
- Facilitators you found the most helpful or interesting?
- Favorite lab or activity experience?