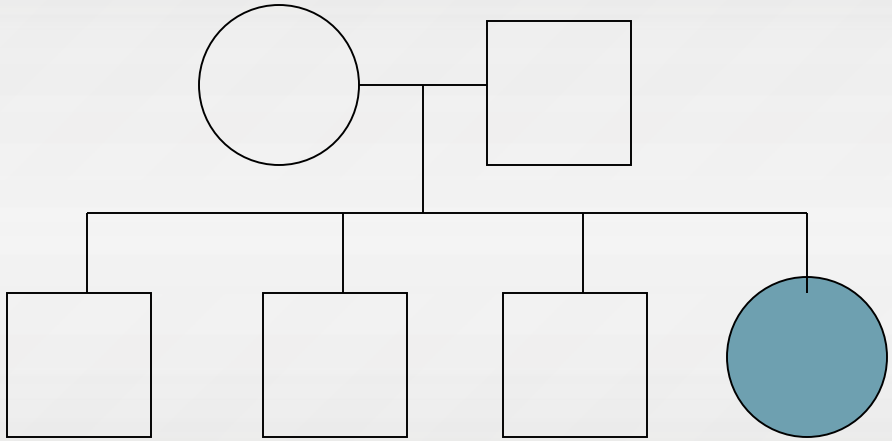
Review

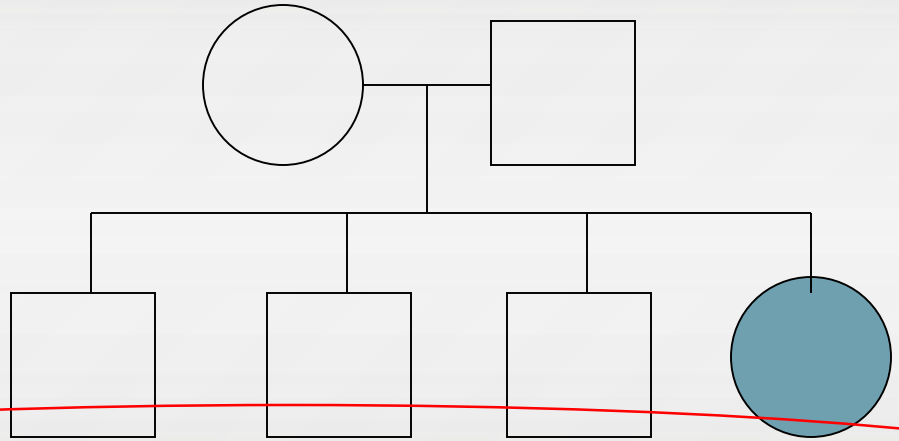
The mother in this pedigree is most likely



A. Heterozygous dominant for the trait
B. Homozygous dominant for the trait
C. Homozygous recessive for the trait
D. Deceased

Review

The mother in this pedigree is most likely



A. Heterozygous dominant for the trait
B. Homozygous dominant for the trait
C. Homozygous recessive for the trait
D. Deceased

EQ: How can DNA be manipulated by humans?

Answer:

Genetic Engineering

SB2. Students will analyze how biological traits are passed on to successive generations.

SB2.f Examine the use of DNA technology in forensics, medicine, and agriculture.

Genetic Engineering

The process of manipulating DNA to "get what you want."

Definition: the process of manipulating genes/DNA; includes moving genes from the chromosomes of one organism into the chromosomes of another organism

The way we have manipulated genes in the PAST:

Selective breeding:

1. **Inbreeding**
   - poodle + poodle
   - Continued breeding of individuals with similar characteristics. Ex: The many breeds of dogs (poodles, beagles, etc.) are maintained by inbreeding.
   - Useful for retaining desired characteristics, but risky because it may bring together two recessive alleles for a disorder.

2. **Crossbreeding** = a.k.a. **hybridization** (produces hybrids)
   - buffalo + cow = beefalo
   - Usually hardier than the parents
   - Ex: Disease resistant plant with a plant that produced a large amount of fruit. New plant has both characteristics.

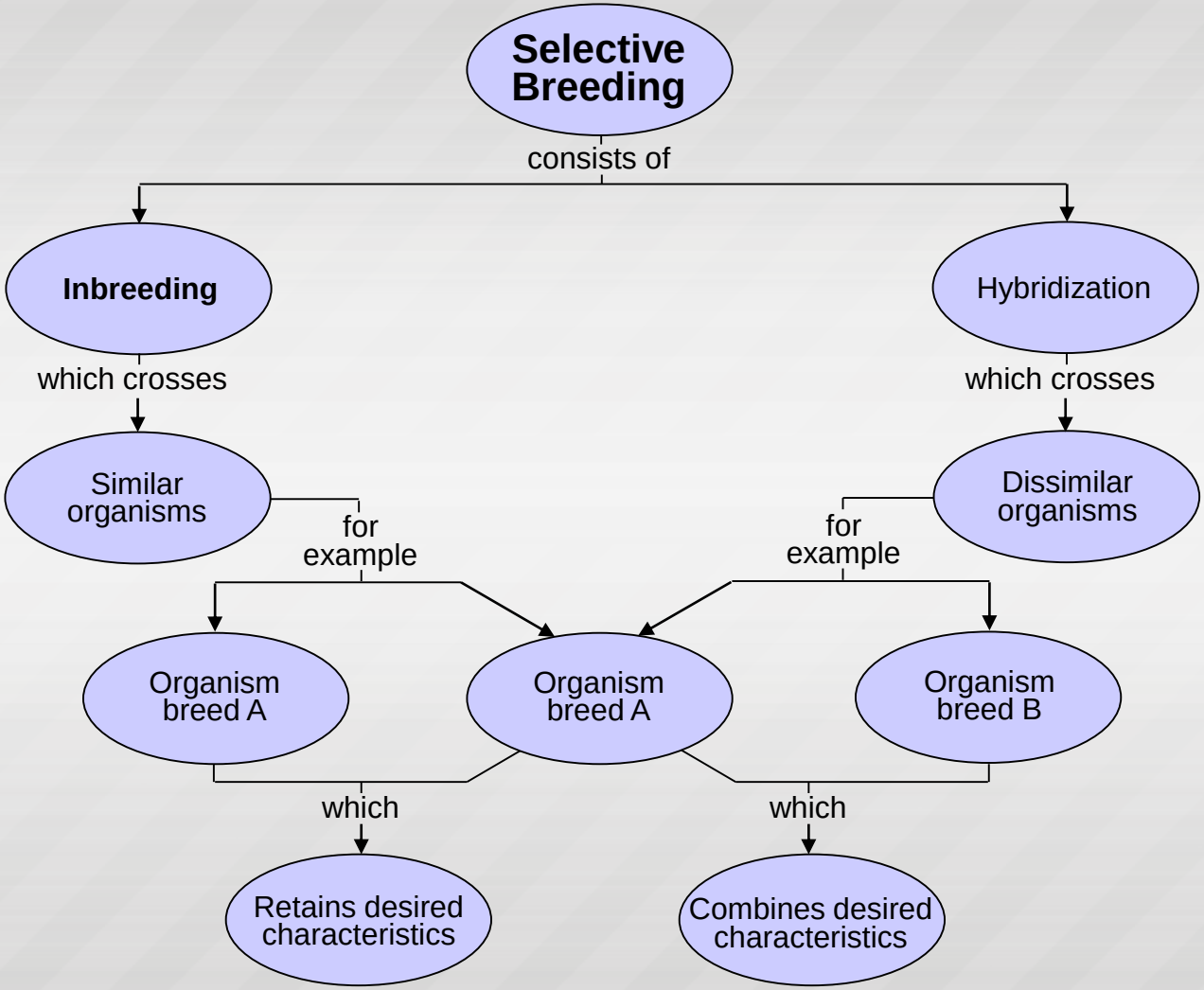
Cross Breeding

Cockerpoo = cocker spaniel x poodle

Broccoflower = Broccoli x Cauliflower

Liger = Male lion x female tiger

Concept Map of Selective Breeding



Problem with inbreeding?

Increased likelihood of having 2 recessive alleles resulting in a recessive disorder

Go to Section:

Why change/mix genes?

- curiosity or desire
- cure our illnesses – repair faulty
- produce more food
- produce tastier food
- produce compounds/drugs we need
- create useful organisms
  - bacteria that digest oil to clean oil spills
  - Drought-resistant crops
  - Pest-resistant crops (Bt corn)

Cloning

- Produces a genetically identical individual – but will **not** be the same age

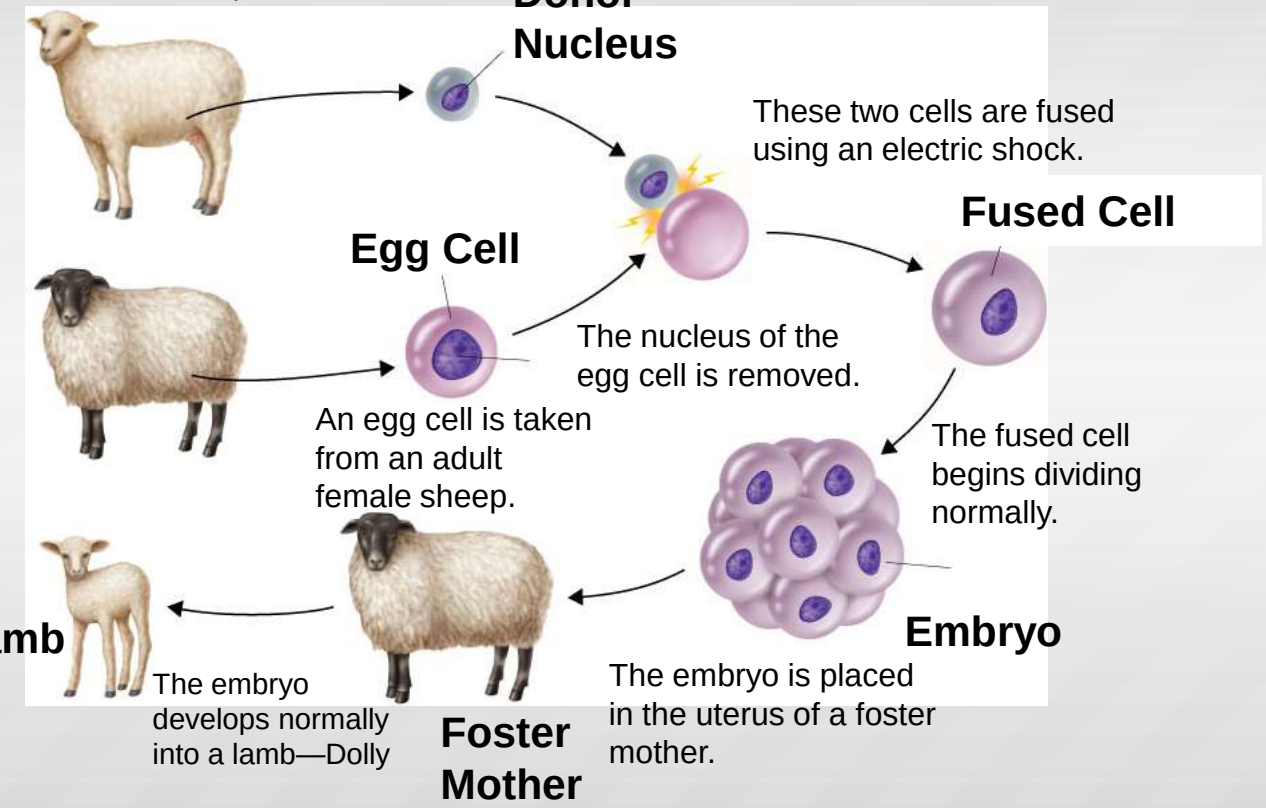
Who was the first cloned mammal?

- A sheep named **Dolly**

Figure 13-13 Cloning of the First Mammal

How was "Dolly" produced?

Section 13-4



Go to Section:

Section 13-4

Steps of Cloning

1. A body cell is taken from a donor animal.
2. An egg cell is taken from a different donor animal.
3. The nucleus is removed from the egg.
4. The nucleus from the body cell and egg are fused by electric shock.
5. The fused cell begins dividing, becoming an embryo.
6. The embryo is implanted into the uterus of a foster mother.
7. The embryo develops into a cloned animal.

Go to Section:

- The Clone Age

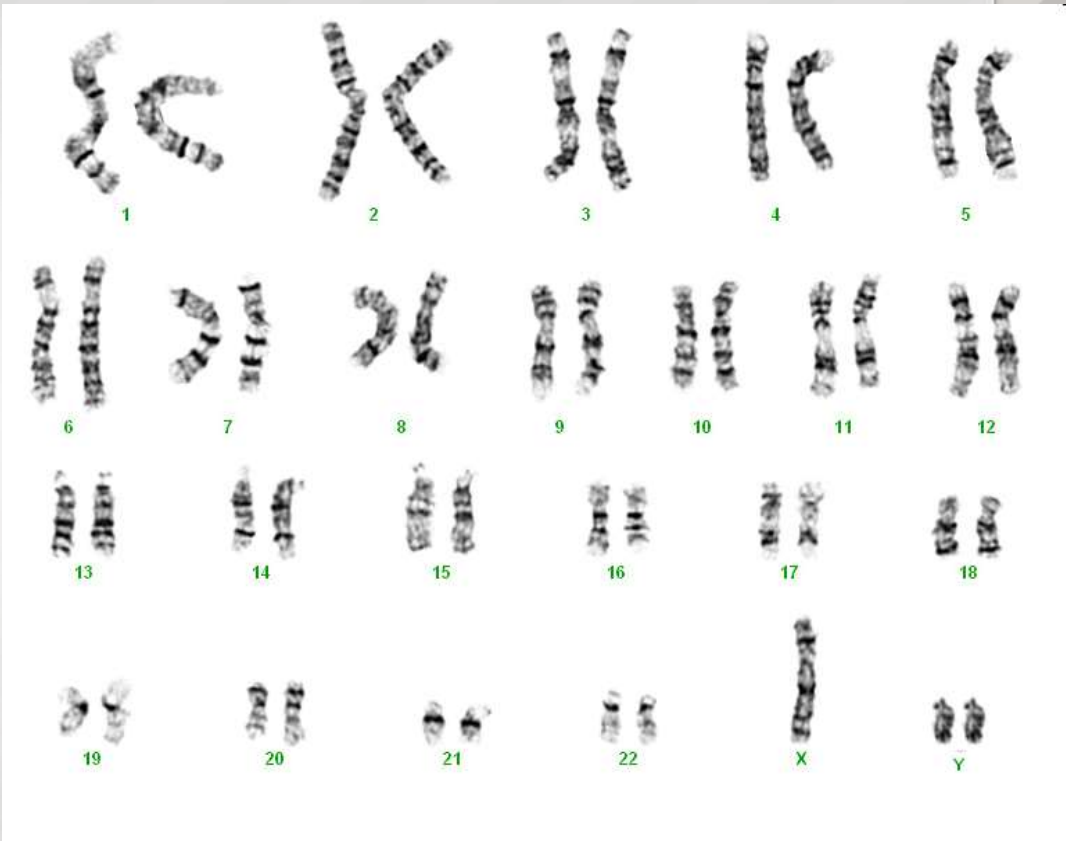
Today's Warm-Up

The picture to the right shows nondisjunction.

a) What is the definition of this term?

b) Where is the mutation?

c) The picture to the right is a human ___?___.



Today's Warm-Up

The picture to the right shows "nondisjunction."

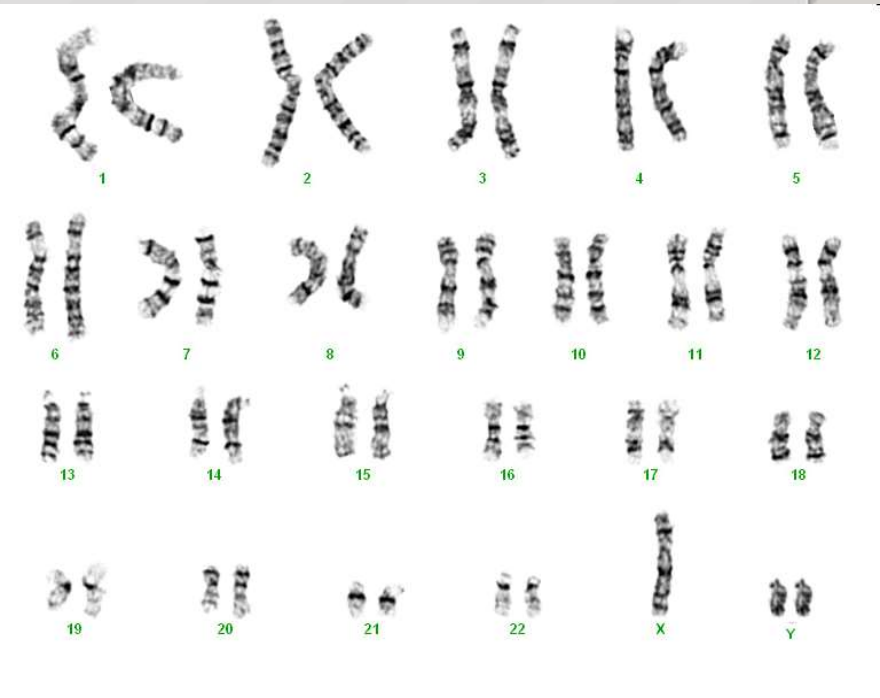
a)What is the definition of this term?

The failure of chromosomes to separate properly in Meiosis.

b)Where is the mutation?

XYY

c) The picture to the right is a human karyotype.

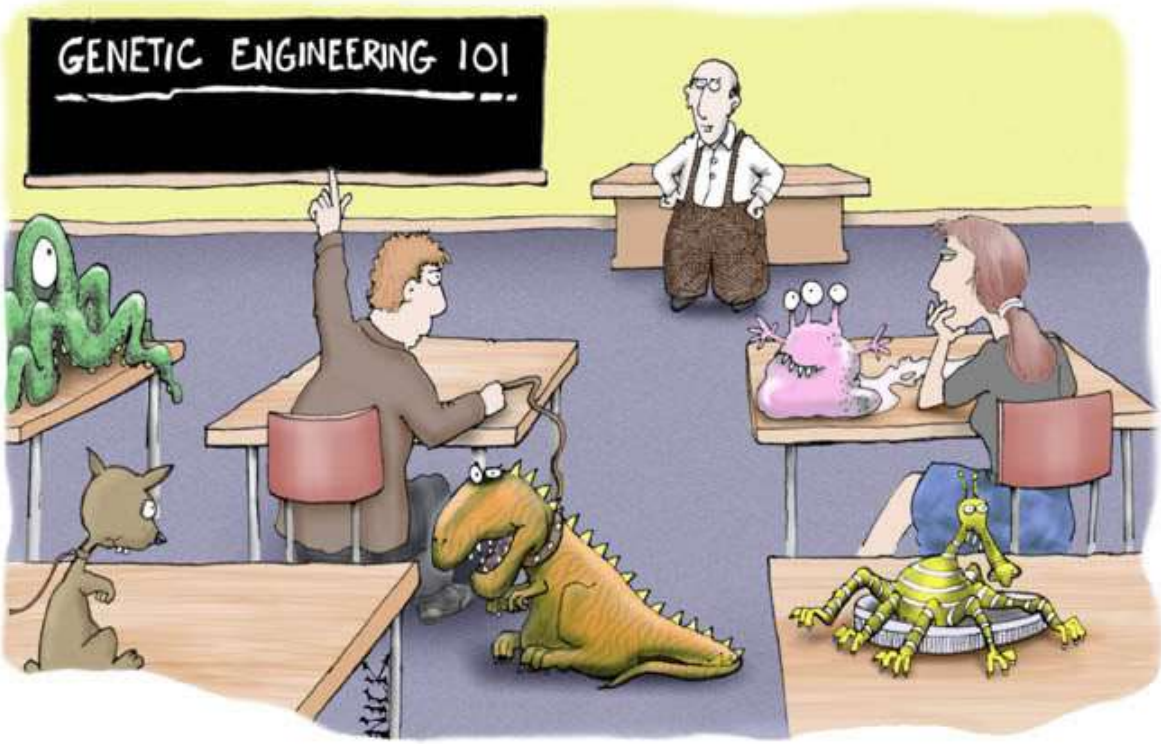


Day 2

Genetic Engineering

KEY CONCEPT - Biotechnology relies on cutting DNA at specific places.

EQ – How can scientists engineer DNA?



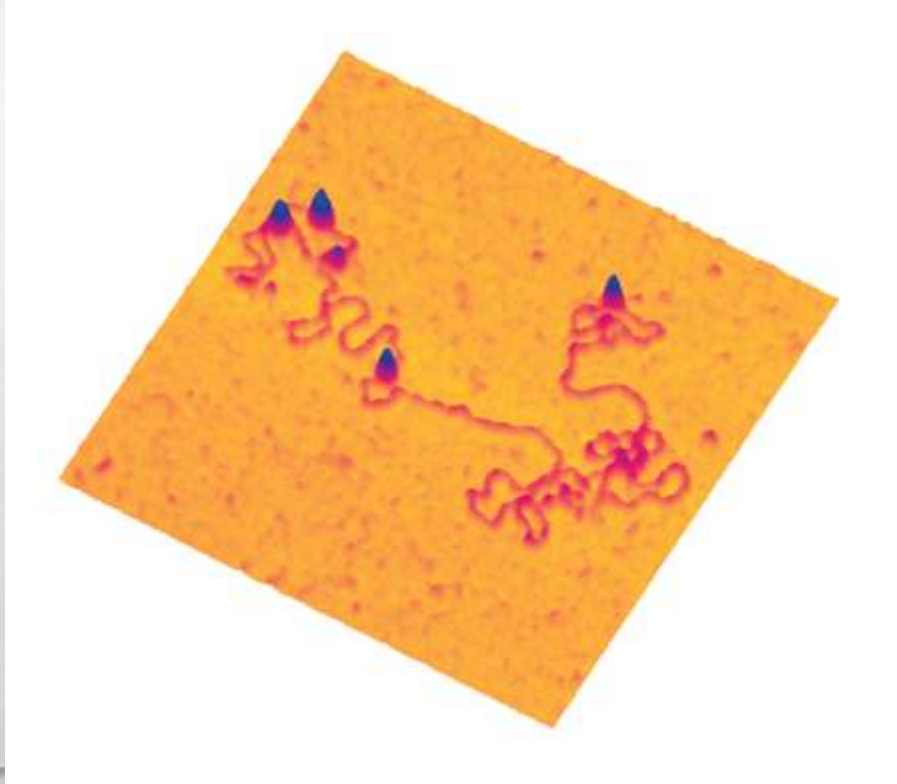
"Okay—is there anybody ELSE whose homework ate their dog?"

Genetic Engineering Cont. DAY 2

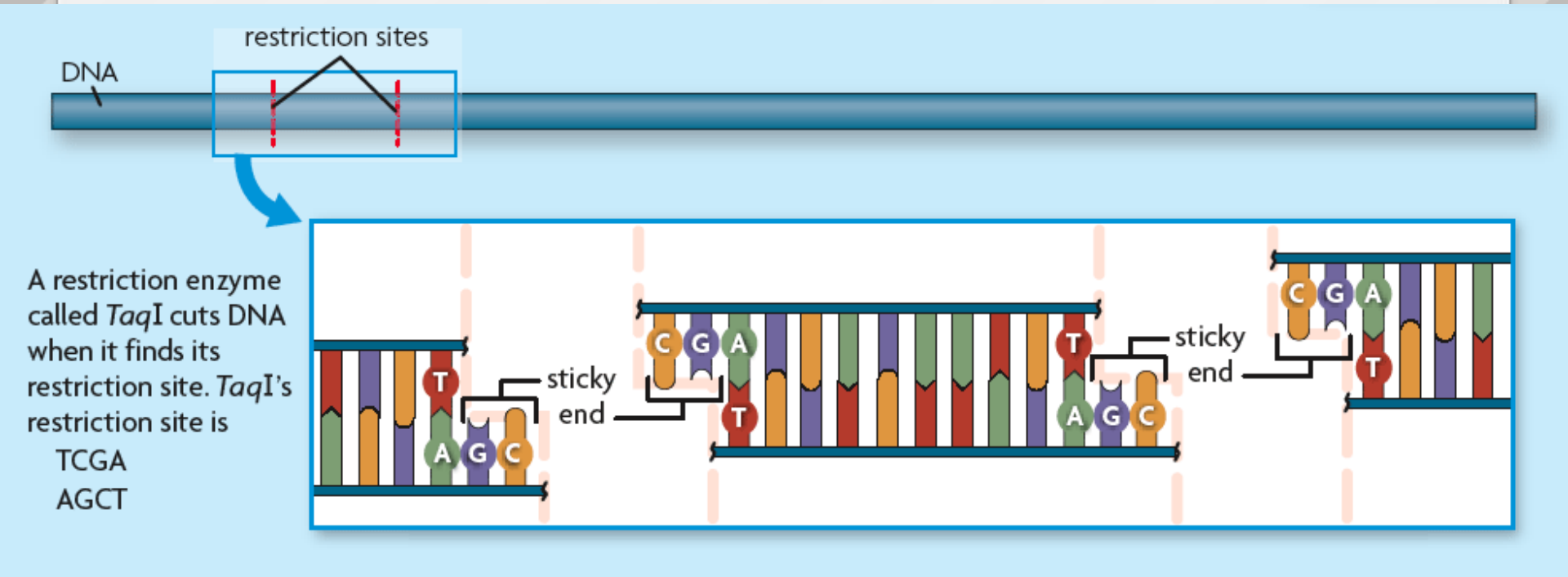
- Scientists can insert genes from 1 organism into a different organism.
  - Based on the use of **recombinant DNA**
    - Recombinant DNA is DNA that contains DNA (genes) from other organisms.
  - Genetic engineering produces organisms with new traits. These organisms are called **transgenics**.

Restriction enzymes cut DNA.

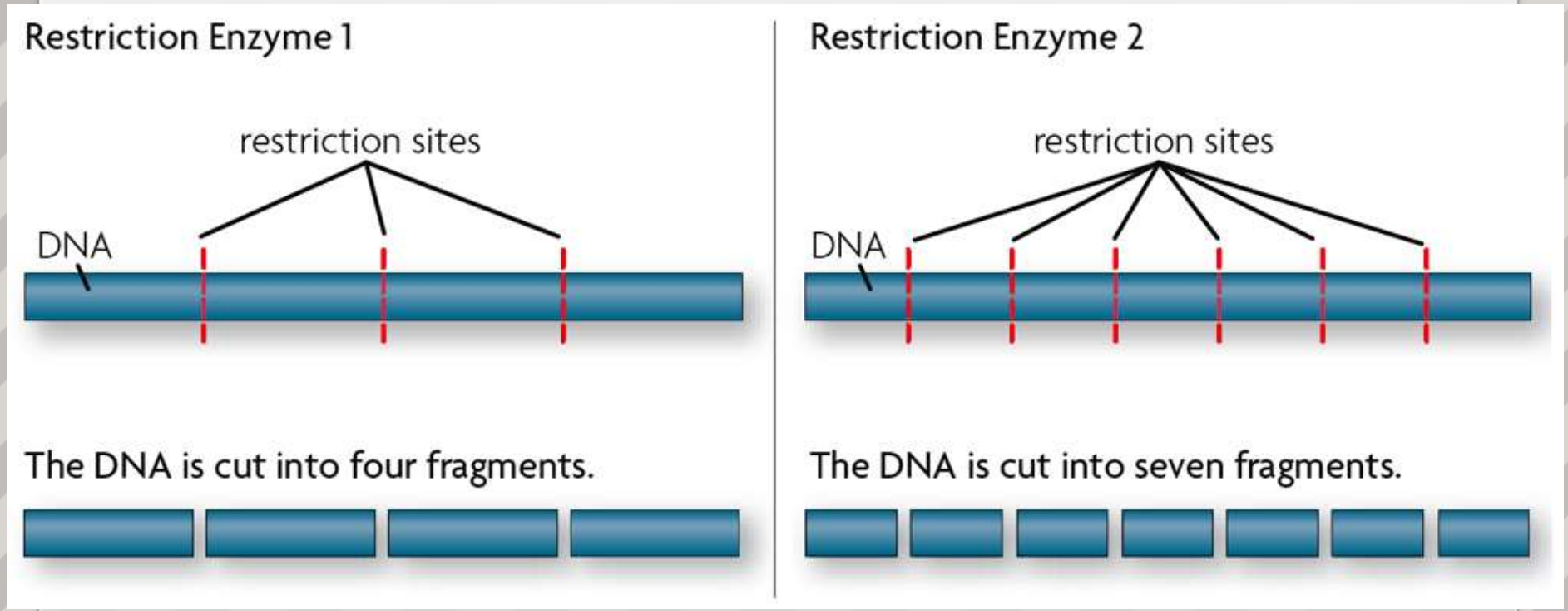
- **Restriction enzymes** act as "molecular scissors" that cut DNA.
  - come from various types of bacteria
  - allow scientists to more easily study and manipulate genes
  - cut DNA at a specific nucleotide sequence called a **restriction site**



- **Blunt ends** occur when some cut straight across
- **Sticky ends** are left when some make staggered cuts



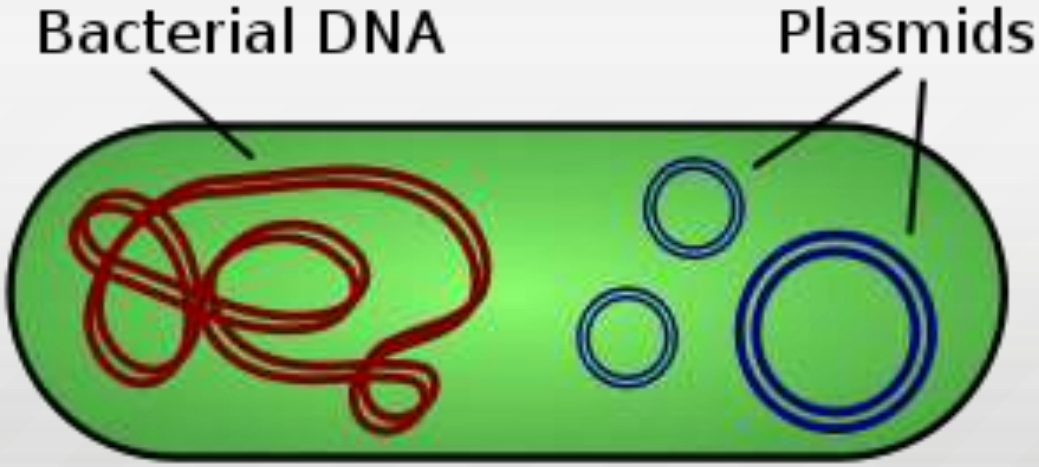
- **Different restriction enzymes cut DNA in different ways.**
  - each enzyme has a different restriction site



- Restriction enzyme video clip (DVD)

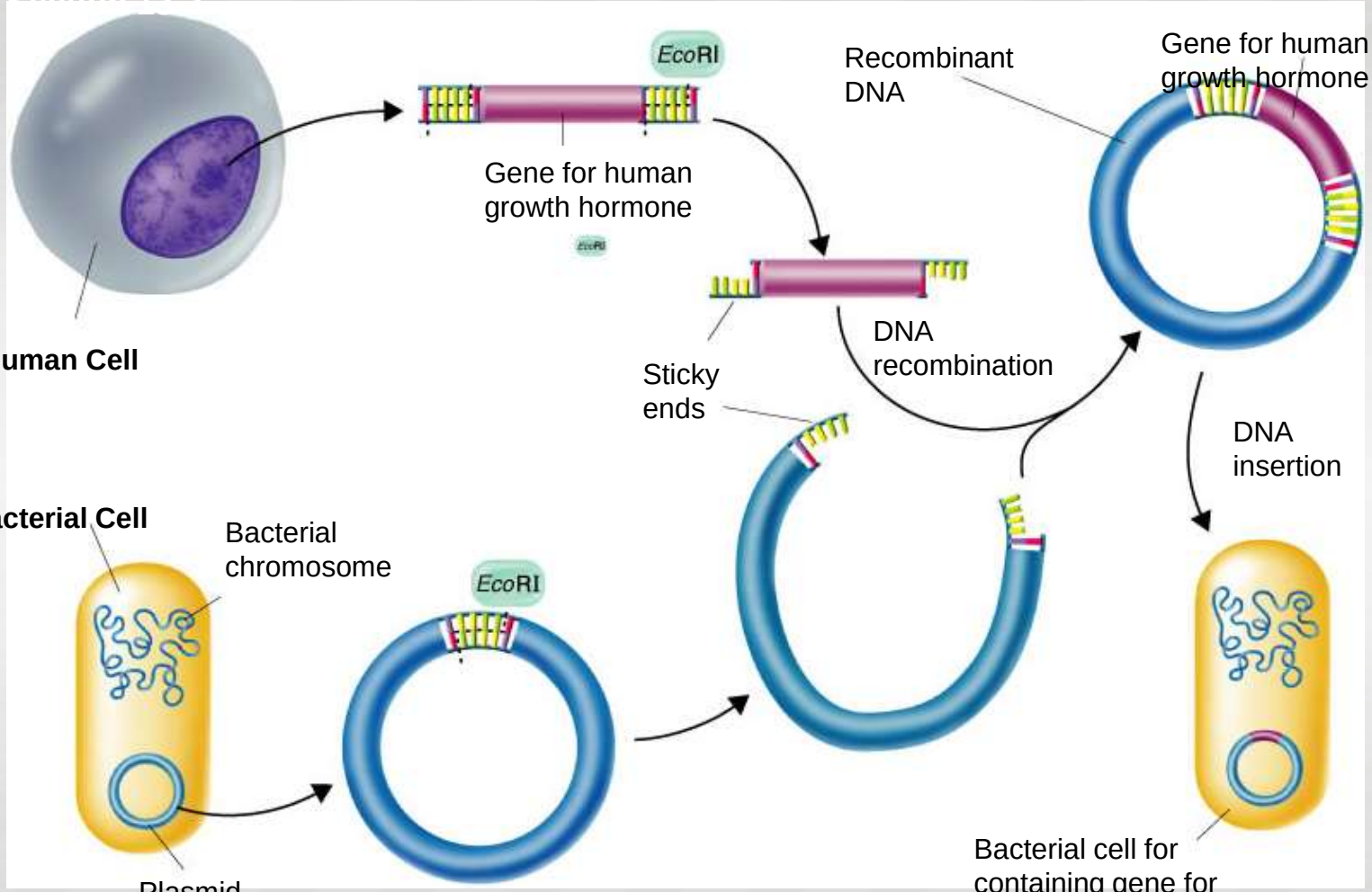
Making Recombinant DNA

- 1. Isolate donor DNA and the vector.
  - Donor DNA is the DNA you "want".
  - The vector is what you are putting the donor DNA in to. (typically a plasmid from a bacterium.)

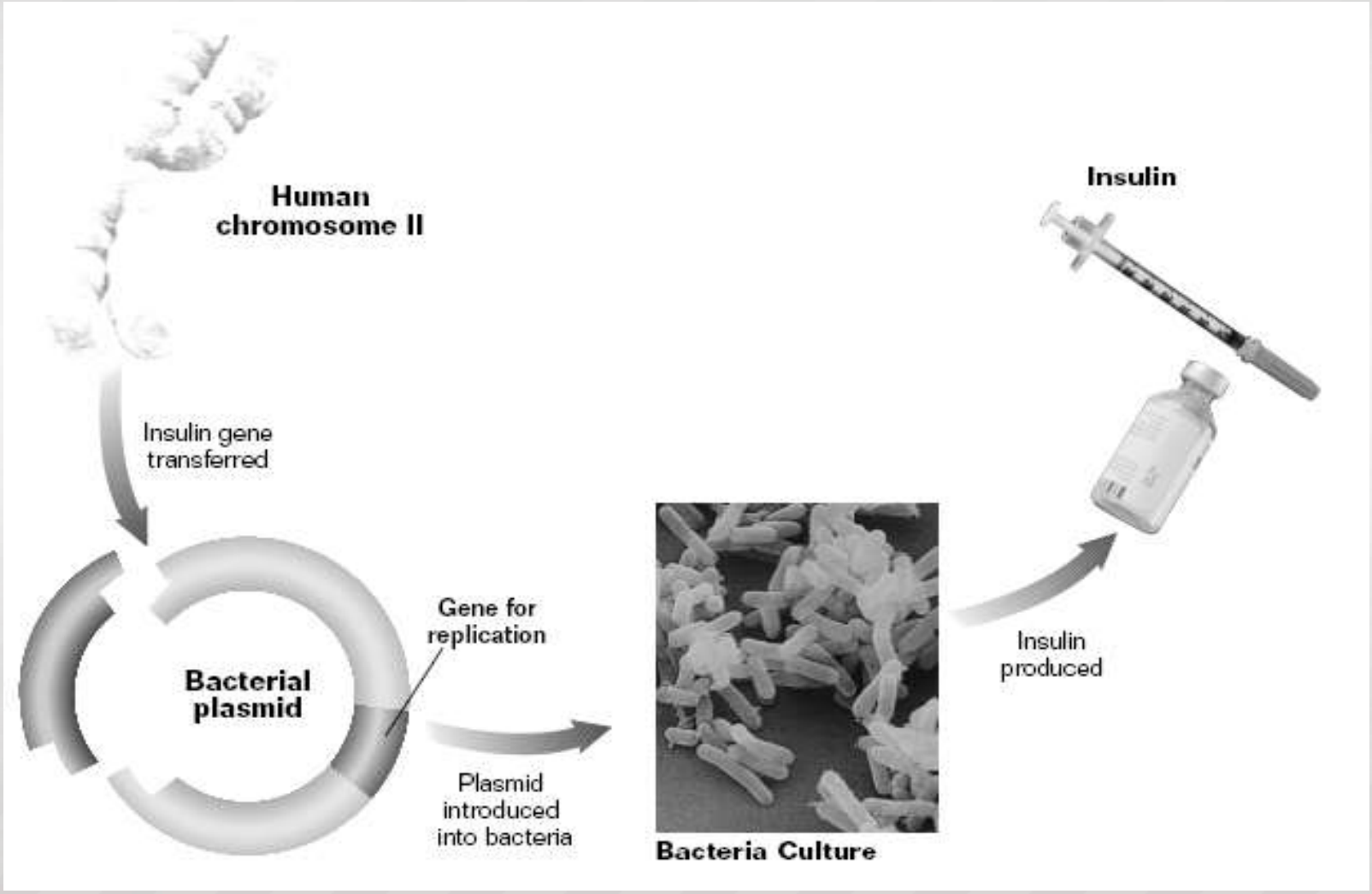


- 2. Cut the donor DNA and the plasmid using "molecular scissors" called restriction enzymes.
- 3. The "sticky ends" of the donor DNA and the plasmid are then joined together. This is now called recombinant DNA.
- 4. The recombinant DNA then enters the bacterium and can make many copies.

Making Recombinant DNA



Making genetically engineered drugs



Recombinant DNA is used in the production of:

- Insulin
- Human growth hormone
- Bacteria that can eat oil, produce alcohol and other chemicals, and process minerals
- Clotting Factor (Factor VIII) for hemophiliacs
- Sheep are used in the production of alpha-1 antitrypsin (treatment of emphysema)
- Goats are used in the production of a protein to aid in the treatment of cystic fibrosis

Day 3

Genetic Engineering

- Genetic engineering video clip (DVD)

Today's Warm-up

A trait that is inherited on sex chromosomes is:

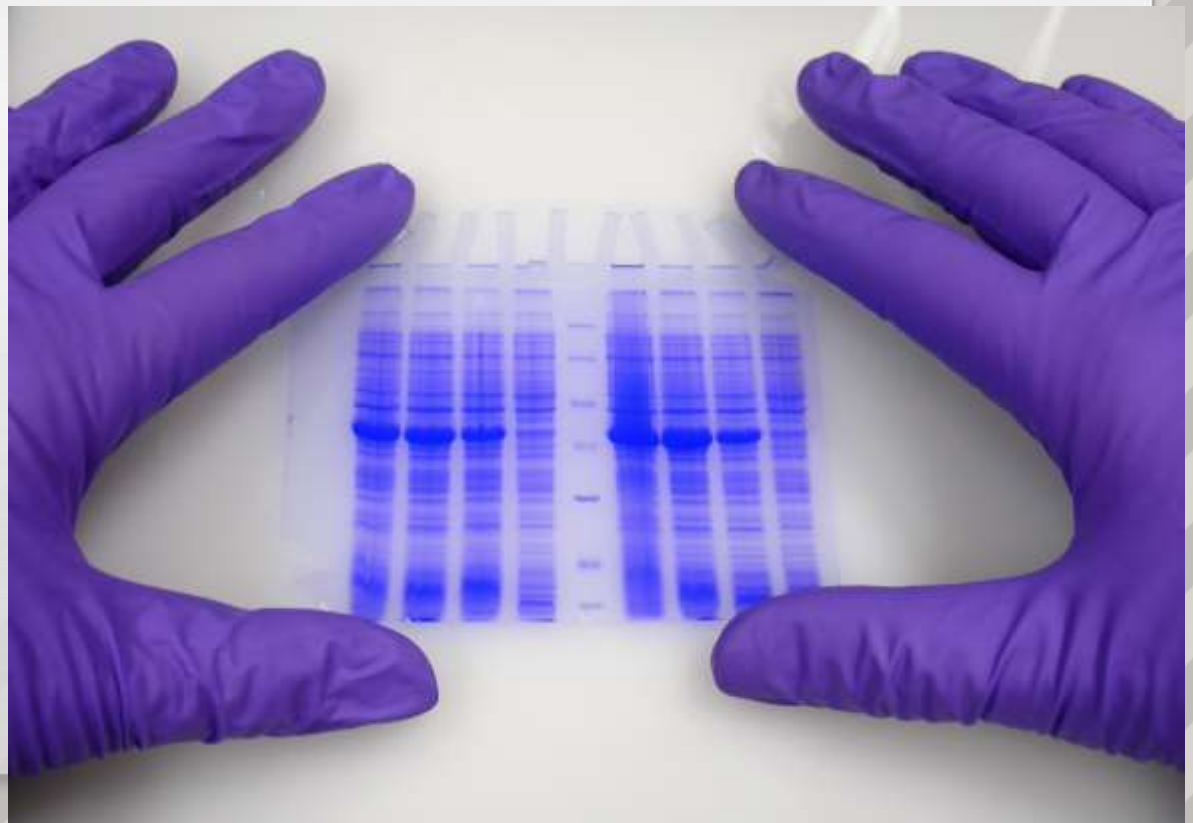
A. Eye color
B. Dyslexia
C. Color blindness
D. Hair color

KEY CONCEPT

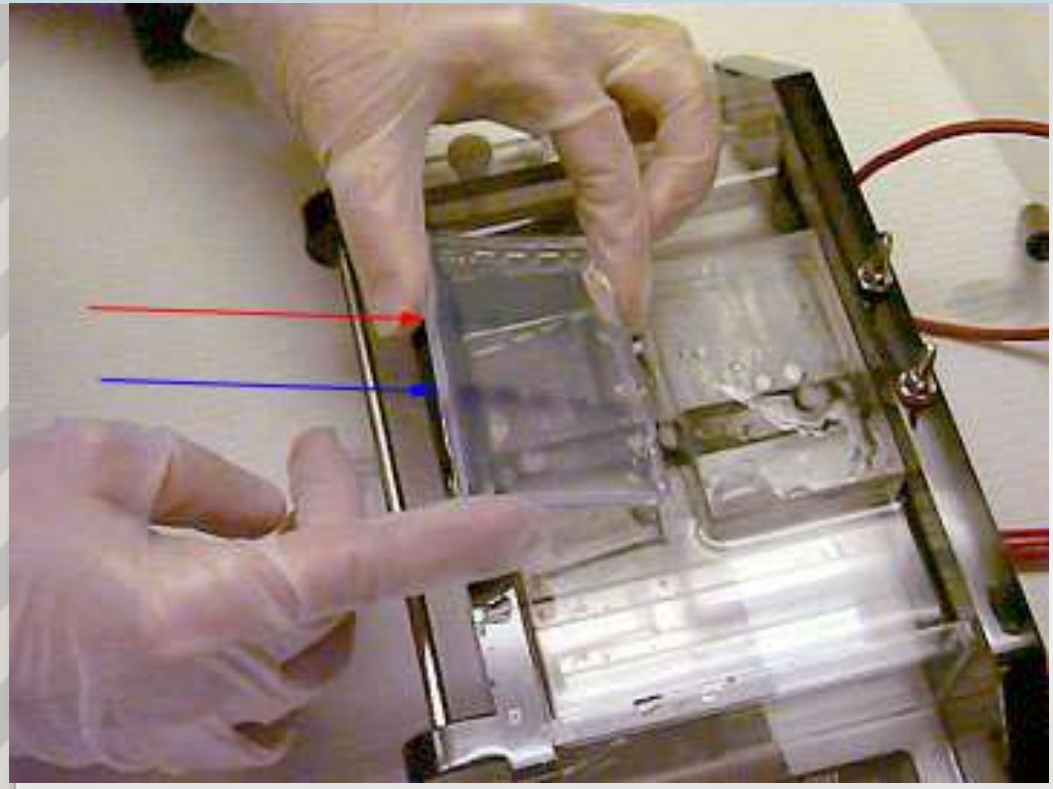
DNA fingerprints identify people at the molecular level.

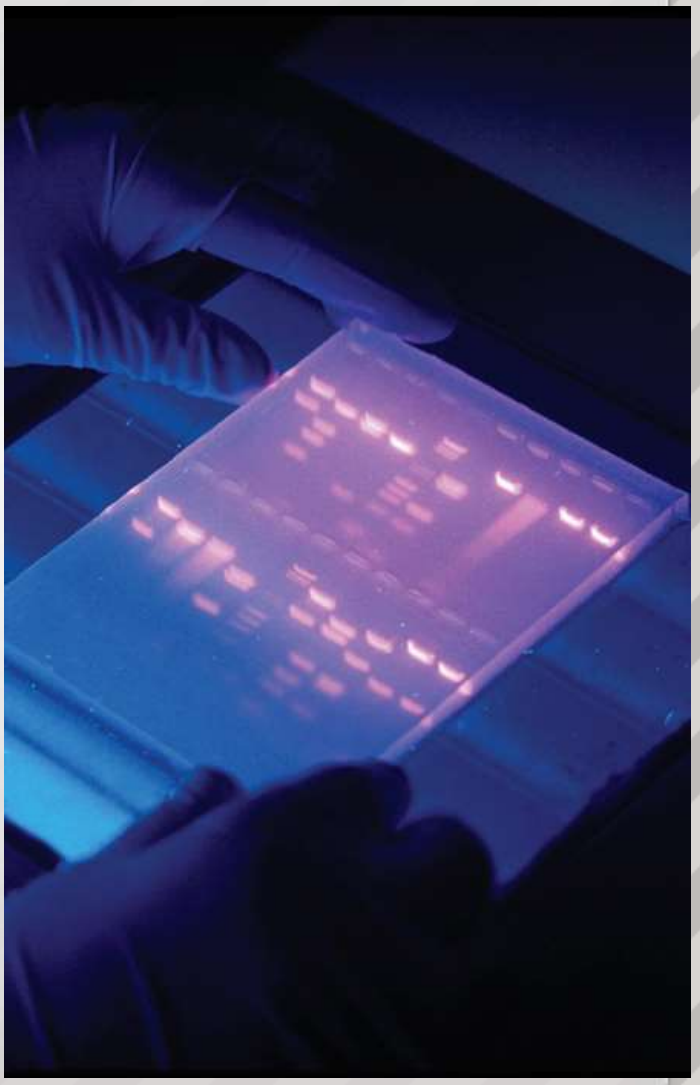
Gel Electrophoresis

- **Gel electrophoresis** is a process used to separate DNA fragments by size.
  - A DNA sample is cut with **restriction enzymes**.
  - **Electrical current** pulls DNA fragments through a gel.



- DNA has a negative charge, so it is pulled through the gel towards the positive electrode (moves from negative end to positive end).



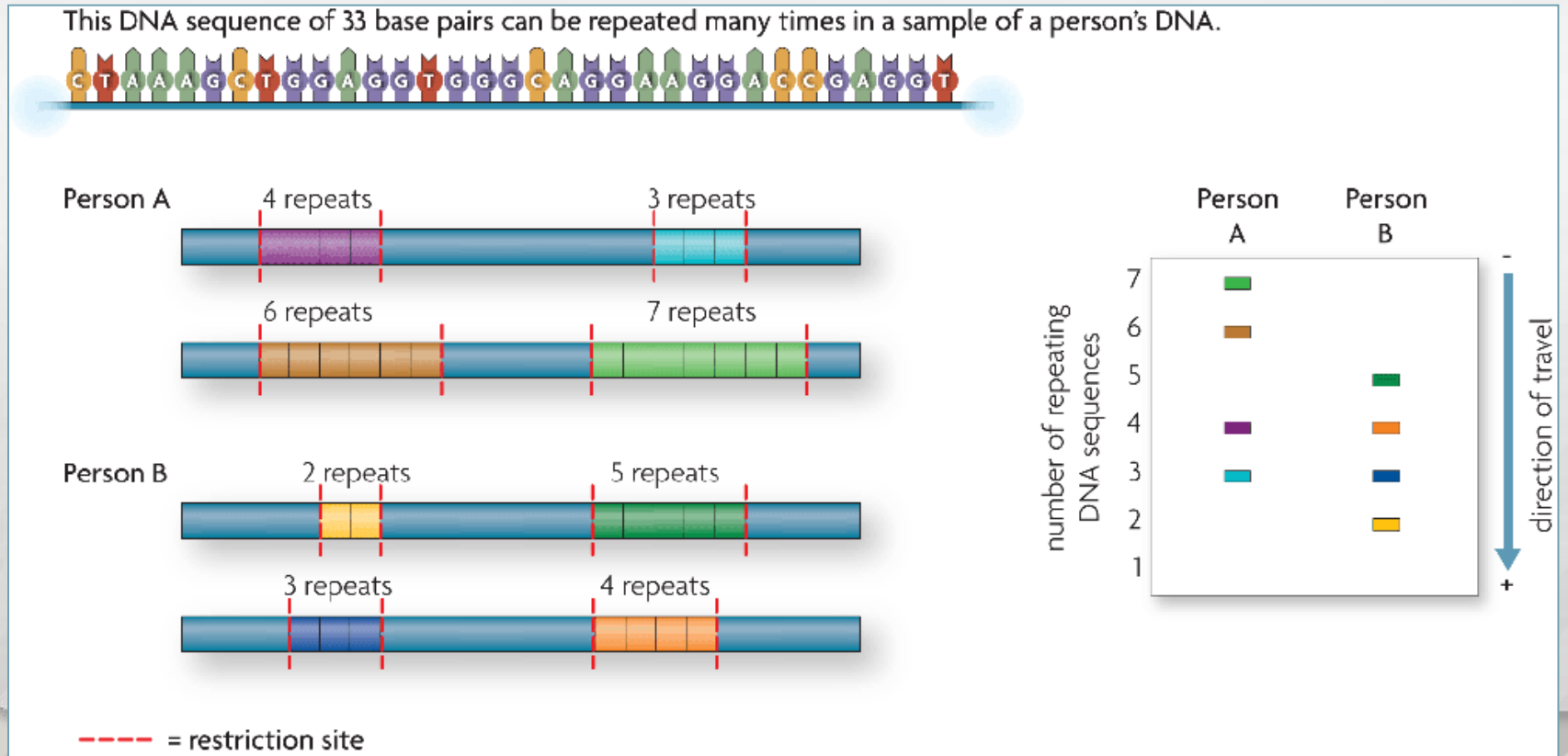


- Smaller fragments move faster and travel farther than larger fragments.
- Fragments of different sizes appear as bands on the gel.

- Gel Electrophoresis animation

- http://www.dnalc.org/resources/animations/gelelectrophoresis.html

- DNA fingerprints are based on parts of an individual's DNA that can be used for identification.
  - based on **noncoding** regions of DNA
  - noncoding regions have **repeating** DNA sequences
  - number of repeats **differs** between people
  - **banding pattern** on a gel is a DNA fingerprint



- DNA fingerprinting depends on the **probability** of a match.
  - Many people have the same number of repeats in a **certain region** of DNA.
  - The probability that two people share identical numbers of repeats in **several locations** is **very small**.

DNA fingerprints can identify both **paternity** and maternity of children (but maternity is rarely in question).

– **Individual probabilities are multiplied to find the overall probability of two DNA fingerprints randomly matching.**

$$\frac{1}{500} \times \frac{1}{90} \times \frac{1}{120} = \frac{1}{5{,}400{,}000} =$$ **1 chance in 5.4 million people**

– **Several regions** of DNA are used to make DNA fingerprints.

DNA fingerprinting is used in several ways.

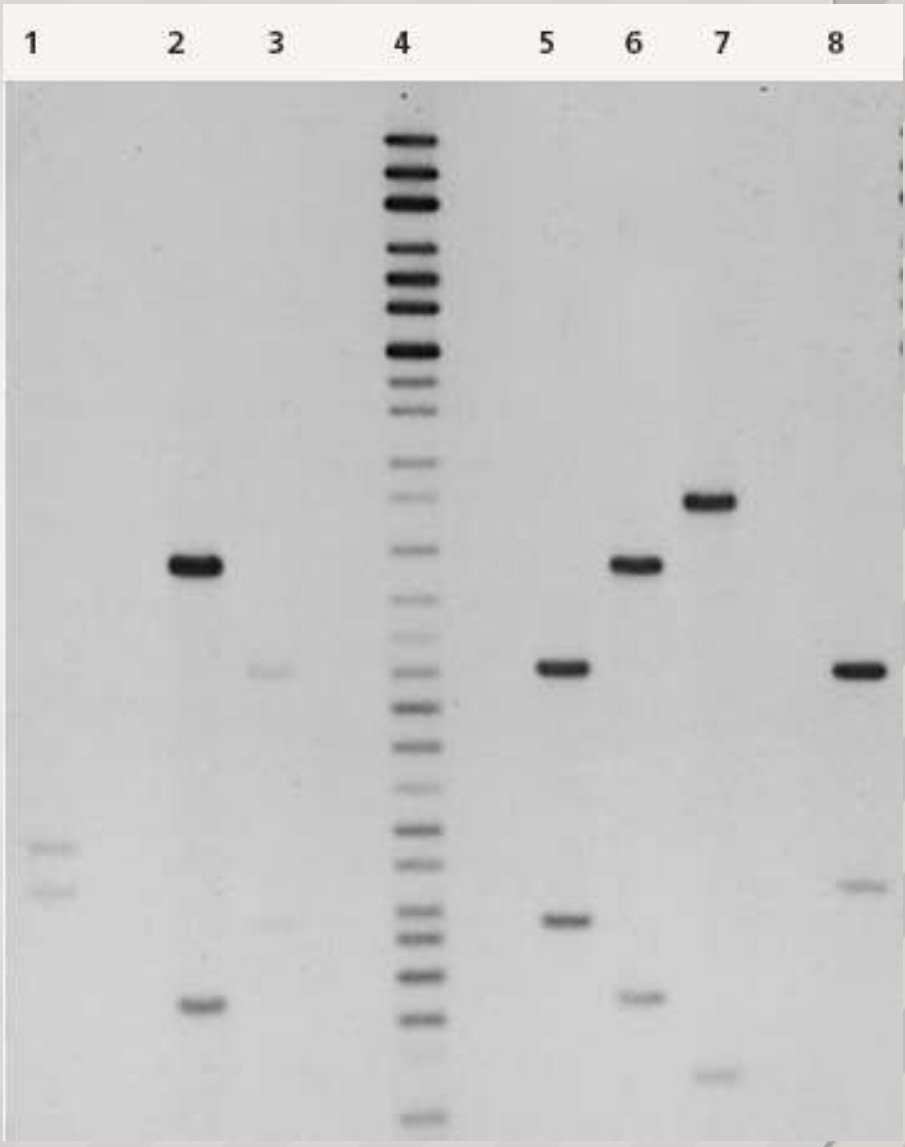
- evidence in criminal cases
- paternity tests
- immigration requests
- studying biodiversity
- tracking genetically modified crops

Electrophoresis of Forensic Samples

Key

Lane	Sample
1	Minimum DNA
2	Questioned evidence
3	Questioned evidence
4	Sizing ladder
5	Victim’s known blood
6	Suspect # 1
7	Suspect # 2
8	Suspect # 3

Importance of lane position.



EQ:

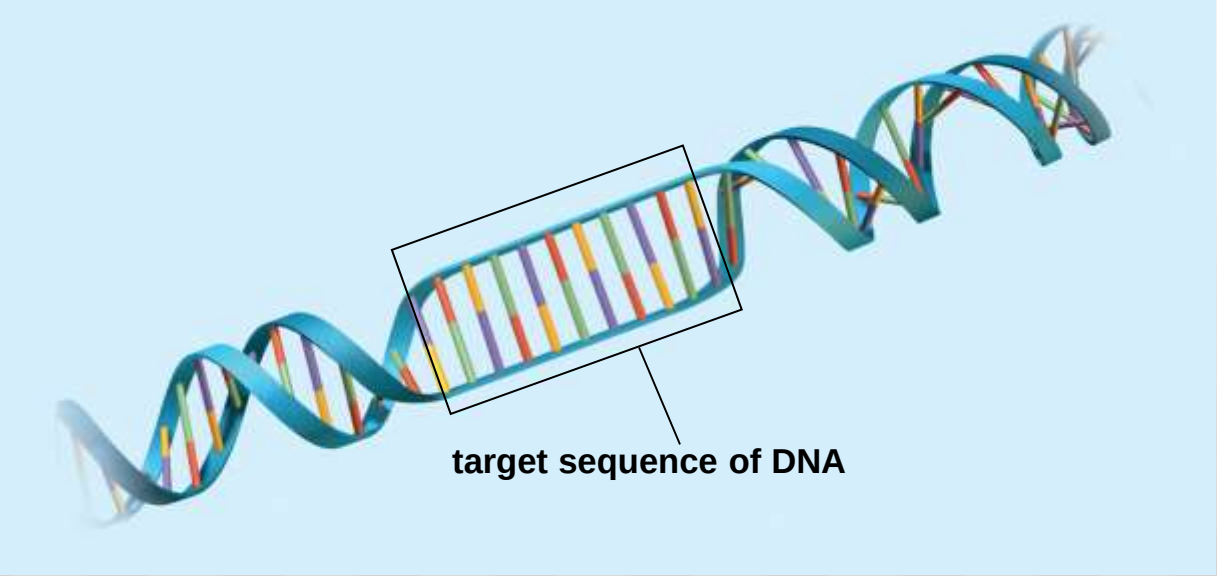
How can forensic scientists get enough DNA to test from extremely small samples or from denatured (broken down) samples?

KEY CONCEPT

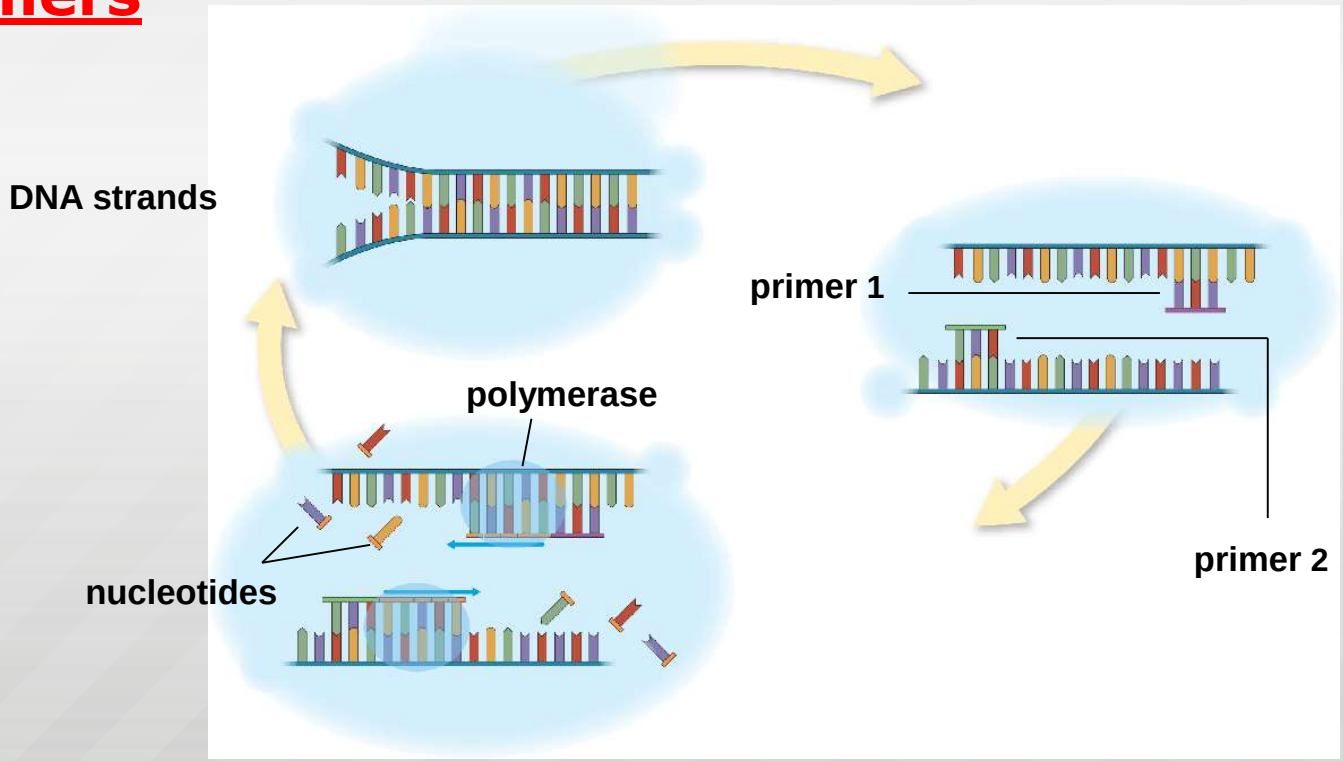
The **polymerase chain reaction (PCR)** rapidly copies segments of DNA.

PCR uses polymerases to copy DNA segments.

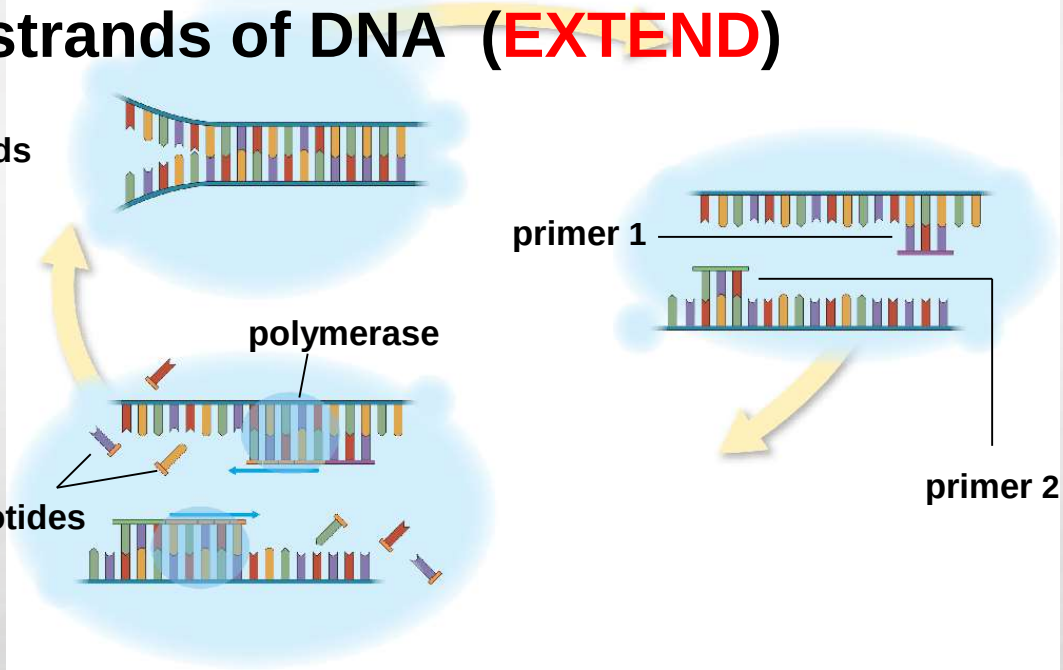
- PCR makes many copies of a specific DNA sequence in a small amount of time.
  - PCR **amplifies** DNA samples.
  - PCR is similar to DNA replication.
  - Makes millions of copies of a sequence in approximately 4 hours



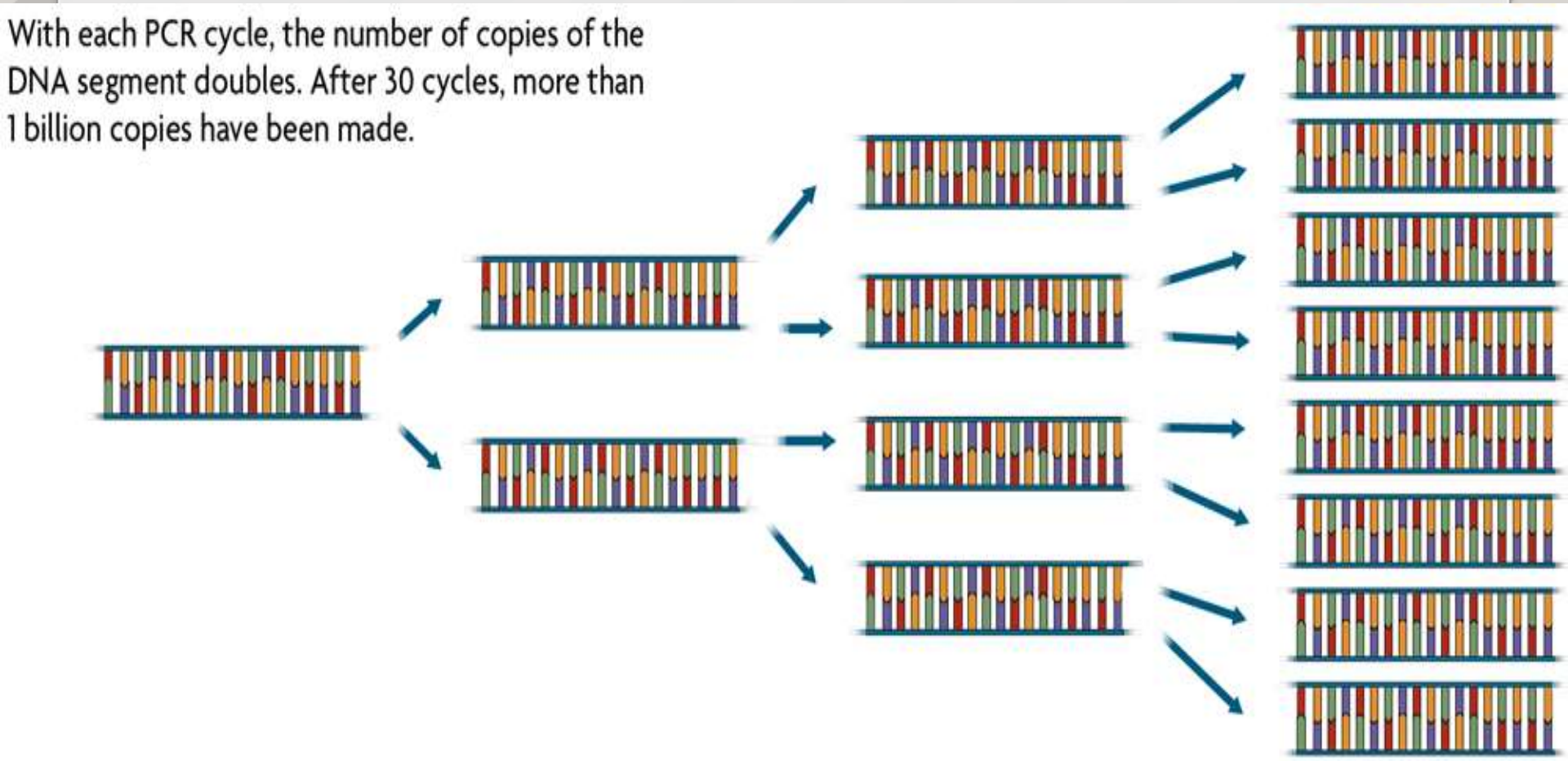
- PCR uses **four** materials.
  1. **DNA** to be copied
  2. DNA **polymerase**
  3. **A, T, C, and G** nucleotides
  4. two **primers**



- The **three steps of PCR** occur in a *cycle*.
  1. **Heat is used to separate double-stranded DNA molecules (DENATURE)**
  2. ***Primers* bind to each DNA strand on opposite ends of the segment to be copied (ANNEAL)**
  3. **DNA polymerase binds nucleotides together to form new strands of DNA (EXTEND)**



- Each PCR cycle **doubles** the number of DNA molecules.



PCR is used in:

- DNA cloning for sequencing (as in the Human Genome Project)
- DNA-based phylogeny or functional analysis of genes
- the diagnosis of hereditary diseases
- the identification of genetic fingerprints (used in forensic sciences and paternity testing)
- the detection and diagnosis of infectious diseases.

- The PCR Song

Goats that produces spider silk?

- Got silk?

Transgenics (GMOs)

EQ: What are the advantages and concerns of using genetic engineering to produce organisms with new traits?

Examples of Transgenics

- **Transgenics**: Organisms that contain genes from other organisms (also called GMOs).
- Transgenic animals are much harder to produce than transgenic plants because they are more resistant to gene manipulation.

Bt Corn

- Bt-corn is a type of genetically modified organism (**GMO**).
  - A GMO is a plant or animal that has been genetically modified through the addition of a small amount of genetic material from other organisms through molecular techniques.

Bt Corn: contains a gene from bacteria that kills the *Lepidoptera* larvae (corn borer)


bacillus thuringiensis
Bt Gene is inserted into crop
Crop is infected by European corn borer
Pest dies when feeding on any plant part

- **Genetically modified foods** are foods derived from GMO crops.
  - corn produced through biotechnology is used in foods such as corn meal and tortilla chips.
  - corn is used to make high fructose corn syrup (common sweetener)
- Currently, genetically modified foods in the U.S. ***do not*** require special labeling to notify consumers.

Transgenic plants are common in agriculture.

- Transgenic bacteria infect a plant
- Plant expresses foreign gene
- Many crops are now ***genetically modified*** (GM).
  - soybeans, maize/corn, potatoes, cotton, sugarcane, tomato, rice
  - GM salt-tolerant plants and drought-resistant plants

Examples

- Oncomouse:
  - mouse that always develops cancer.
  - Use the oncomouse to study cancer and anti-cancer drugs

How could this be beneficial for cancer research?

Jellyfish Protein Revolutionizes Molecular Biology

- Green fluorescent protein (GFP) makes the once invisible …visible!
- Helps researchers track molecules of all kinds
- Researchers use recombinant DNA technology to “attach” the gene for GFP onto another gene scientists want to study
- Click this link to view short video on GFP

Examples

- Transgenic cows can produce more milk or milk with less lactose or cholesterol.
- Transgenic pigs and cattle can have more meat on them. Sheep can have more wool.

Genetic Screening

Gene therapy

- Gene therapy applications
- Gene therapy video clip from VCU (sickle cell)

Bioethics

- We will spend the today exploring **bioethics**. You will learn:
  - What bioethics is
  - Some of the ways ethical considerations relate to biology
  - Some tools and questions to use when examining choices you face as a citizen of the 21st Century

What are some ethical questions raised by advances in biology?

- Should there be limits to how much people modify the natural world using technology?
- Should all students be required to have vaccinations?
- If you take a genetic test, who should know the results?
- Should doctors provide fatal medicine to terminally ill patients who want to end their own lives?
- Should scientists clone pets or animals for food?
- How should doctors distribute flu vaccines?
- Whom should scientists test new medicine on?

Bioethics offers ways to think about, analyze, and make decisions about difficult ethical questions related to new biomedical knowledge and innovations.

- **Ethics** seeks to determine what a person should do, or the best course of action, and provides reasons why. It also helps people decide how to behave and treat one another, and what kinds of communities would be good to live in.
- **Bioethics** explores ethical questions related to biology and its applications.

Examples of Bioethical Issues

- New inventions, medicines, and biomedical procedures are in the news daily.
  - If a new genetic test was available for a fatal disease that you knew ran in your family, should you have the test?
- People who used to die due to organ failure can now continue living if they receive an organ transplant, but the number of available organs is limited.
  - Who should receive an organ transplant?
  - Should the organ go to someone who is sickest or someone who is most likely to live the longest if they receive it?

Why do you think ethics is important?

- Ethics helps people discuss issues that need to be decided by individuals as well as members of communities.

1. What are the ethical questions?
2. What are the relevant facts?
3. Who or what could be affected by the way the question gets resolved (called the stakeholders)?
4. What are the relevant ethical considerations?
   - Respect for persons: Not treating someone as a mere means to a goal or end.
   - Minimizing harms while maximizing benefits: Acting to lessen negative outcomes and promote positive outcomes.
   - Fairness: Ensuring that benefits, resources, and costs are shared equitably.

Bioethics Questions:

1. What are the ethical questions?
   - What a person should do?
   - How people ought to interact?
   - What sort of person one should be?
   - What kinds of communities it would be good to live in?

Bioethics Questions:

1. What are the ethical questions?
2. What are the relevant facts?
   - Biological, pshychological, sociological, economic, and historical facts you need for thinking carefully about the ethical question and answering it.

Bioethics Questions:

1. What are the ethical questions?
2. What are the relevant facts?
3. Who or what could be affected by the way the question gets resolved?
   - The people and entities affected by ethical decisions (stakeholders)
   - Not always humans – animals, plants, organisms, or the environment

Bioethics Questions:

1. What are the ethical questions?
2. What are the relevant facts?
3. Who or what could be affected by the way the question gets resolved?
4. What are the relevant ethical considerations?
   - Particular concepts in ethics that help you analyze a case

Applied Genetics/Biotechnology

1. Pedigrees
2. Karyotypes
3. Genetic Testing & Genetic Disorders (including translocation & nondisjunction – monosomy & trisomy)
4. Selective Breeding (inbreeding & crossbreeding/hybridization)
5. Cloning
6. Manipulating DNA & Genetic Engineering (plasmids, restriction enzymes, recombinant DNA, gel electrophoresis)
7. DNA Fingerprinting
8. Transgenics/GMOs
9. Genetic Screening & Gene Therapy
10. Bioethics