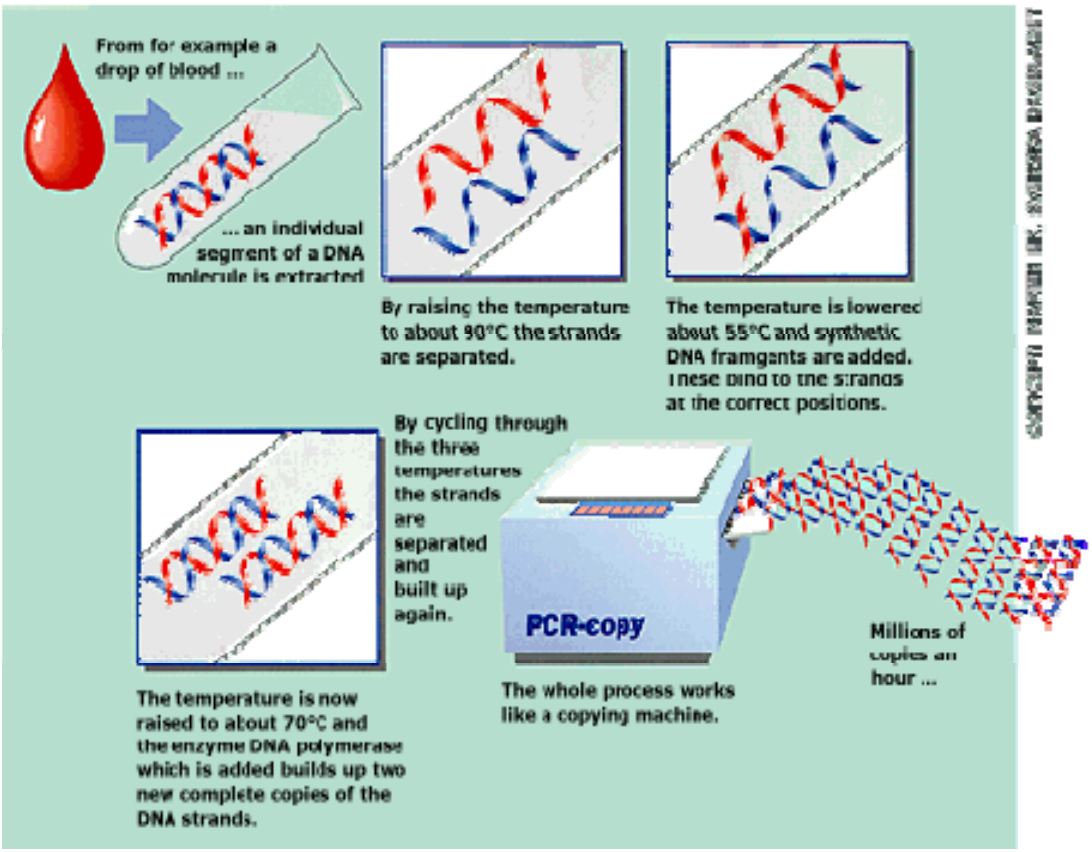
DNA Technology

Have you ever wondered how a forensic scientist can get enough DNA from a speck of blood at a crime scene to analyze the DNA? Once they obtain this DNA, what do they do with it?

First, the forensic specialist must amplify the DNA (make more of it). This is accomplished with the help of **restriction enzymes** that cleave the DNA in specific locations, permitting the resulting fragments to be copied and then sliced together to make copies of the original DNA molecule.

Scientists use these same restriction enzymes to copy and recopy DNA present in a tiny sample of saliva or blood found at a crime scene in order to produce a sample large enough to be tested. This process of DNA amplification is known as ***Polymerase Chain Reaction (PCR).***

Polymerase Chain Reaction (PCR)



Once there is enough DNA to experiment with, the next step to analyze the DNA through a process called ***DNA Gel Electrophoresis***, which is a technique used to separate mixtures of large molecules (in this case DNA but it also works with proteins) according to size.

<u>Process of Gel Electrophoresis:</u>

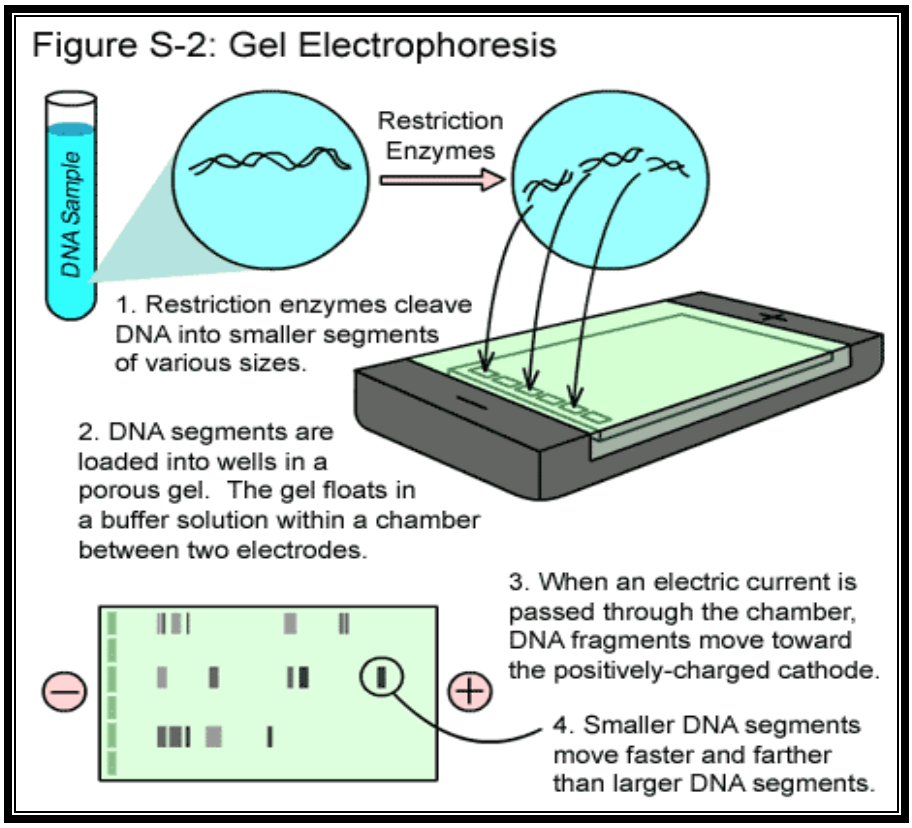
1. Restriction enzymes cut the DNA at specific points in the sequence of bases producing fragments of differing lengths. These DNA fragments will vary in size and number from one individual to the next due to the uniqueness of each person's genetic code.
2. Each restriction enzyme recognizes a different cleavage site on the DNA strand. Usually these enzymes recognize a 4-6 base pair sequence that is a ***palindrome*** (a sequence that is the same when read forward or backward in sequence).
    - Ex: GAATTC (top strand of DNA – read it forward)

CTTAAG (bottom strand of DNA – read it backward)

3. A small amount of mixed DNA fragments are then loaded in wells located on one side of a semisolid gel. This gel is usually made of agrose (similar to the substance on the Strep culture plate at your doctor's office – only without nutrients)
4. There are also tiny holes in the gel that are in line with each well (picture pressing the teeth of a comb into the gel at fixed intervals)
5. The gel is placed in between two electrodes connected to a power supply. Once the electricity is turned on, one side of the gel is negatively charged, the other side, positively charged.
6. DNA has a negative charge, so it tends to move toward the positive electrode.
7. The smaller the DNA fragment, the faster is moves through the gel. Therefore, smaller fragments of DNA migrate farther down the gel than larger pieces of DNA.
8. After the power supply is turned off and the gel is stained, a distinctive DNA pattern (looks something like a bar code) is visible.

DNA Gel Electrophoresis can be used to determine:

- Paternity or in instances where parents suspect that the hospital gave them the wrong baby
- Guilt or innocence in criminal investigations where samples of skin, blood, or semen can be analyzed to determine its source and/or to determine if the suspect was present at the crime scene
- Which groups of animals are endangered due to the actions of poachers (skin samples from members of the same group will have similar DNA patterns)
- Identify genes responsible for specific genetic disorders, such as sickle cell anemia



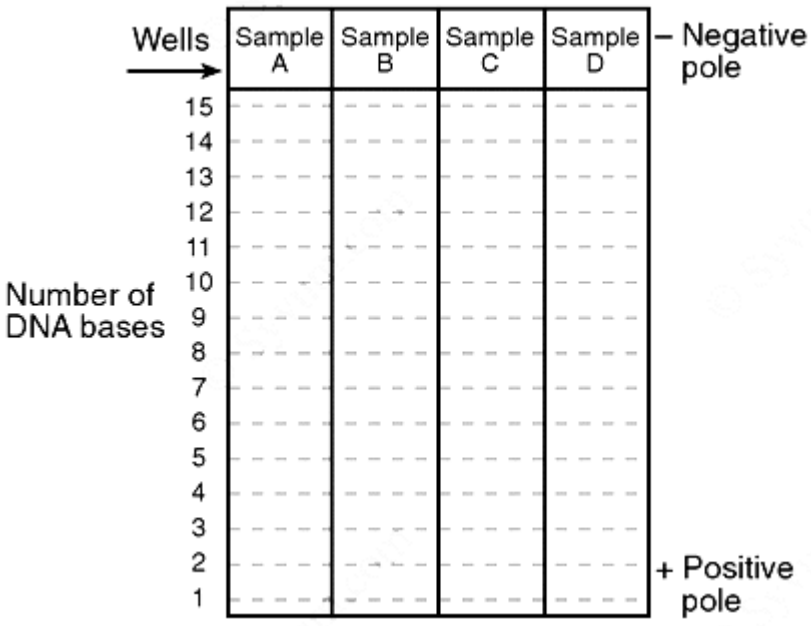
Questions:

1. Describe the function of PCR (Polymerase Chain Reaction)
2. What is the purpose of gel electrophoresis
3. In your own words, outline the steps necessary in gel electrophoresis.
4. Why do we need to run an electrical current through the gel once the DNA fragments are loaded into the wells?
5. The longer the DNA fragment, the shorter the distance it will travel through the gel during electrophoresis. Explain this statement.
6. In an investigation, DNA samples from four organisms, *A*, *B*, *C*, and *D*, were cut into fragments. The number of bases in the resulting DNA fragments for each sample is shown below.

Data Table

Sample	Number of Bases in DNA Fragments
A	3, 9, 5, 14
B	8, 4, 12, 10
C	11, 7, 6, 8
D	4, 12, 8, 11

a. The diagram below represents the gel-like material through which the DNA fragments moved during gel electrophoresis. Draw lines to represent the position of the fragments from each DNA sample when electrophoresis is completed.



b. Which two DNA samples are the most similar? **Support your answer using data from this investigation.**

Samples _____ and _____.

c. State *one* specific use for the information obtained from the results of gel electrophoresis.