BLOSSOMS Video: Using DNA to Identify People
Teachers' Guide

Megan Rokop, Ph.D.
Educational Outreach Program Director
Broad Institute of MIT & Harvard

Learning objectives: Students will learn what DNA fingerprinting is, what it is used for, and how it is used in paternity testing and forensics. Students will see how this technique actually works in lab. Students will learn how to analyze the gels used in this technique to match babies to parents, and crime scene evidence to suspects.

Prerequisite knowledge: It would be ideal, although not absolutely necessary, if students have already learned that DNA is the genetic material, that DNA is made up of As, Ts, Gs, and Cs, and that each human on Earth has a different and unique DNA sequence. It would help if students already know that each human has two versions of every piece of DNA in their genome, one version from their mom and one version from their dad. Thus 50% of the DNA of a child comes from the mom, and 50% from the dad.

Necessary Supplies: Only paper and writing utensils are necessary, and the ability to print out or display the provided handouts.

Outline:

Segment #1: I introduce the concept of DNA, and show a picture of ~2000 letters of DNA all in a row. I ask the students, if you took this size segment of DNA sequence from me & anyone else on Earth, how many letters would be different between us?

What occurs after Segment #1: Students will guess numbers from 0 to 2000.

Segment #2: I reveal that only 1 or 2 letters would be different between any two people, because each person on Earth is more than 99.9% genetically identical to any other person. I introduce DNA fingerprinting, a technique that allows us to tell people apart based on their DNA. I show the students what it means for two people to differ in their DNA sequence. I will then ask the students to brainstorm situations in which we might use DNA to identify people.

What occurs after Segment #2: Students will brainstorm situations in which using DNA to identify people is useful.

Segment #3: I show an example of two humans differing in length of a DNA segment, rather than in sequence. I explain that we can tell two people apart if they have different lengths of DNA by using gel electrophoresis, a technique that separates DNA molecules by size. I explain how gel electrophoresis works and then ask the students two questions about this method.

What occurs after Segment #3: Students discuss how you would get DNA to move through a gel, and whether long or short DNA molecules would move faster through a gel.

Segment #4: I discuss the answers to the questions about how gel electrophoresis works, and then move on to discussing the steps of DNA fingerprinting, from isolating DNA from blood or a cheek swab, to copying just the portion of the DNA that we want to analyze, to running the gel.

I then go to lab and perform this techniques as a demonstration. I then show a sample of a gel and ask the students to analyze the sample gel for what lengths four different people's DNA are.

What occurs after Segment #4: Students will analyze sample gel results and discuss why some people only show one band while others show two bands.

Segment #5: I explain pictorially that each parent has two versions of every piece of DNA, and gives one to each of their children. Thus every child has two versions, one from their father and one from their mother. Determining which versions a child has, and which versions their possible parents have, allows one to determine if those parents match with that child. I then show a gel result from three people, and ask if it is possible that two of the people are in fact the parents of the third person, asking: Is it possible that they are the parents? Does this gel prove that they are the parents?

What occurs after Segment #5: Students will discuss whether or not it is possible that the three people are two parents and a child, based on DNA. Once they determine it is possible, they will discuss whether it proves that these are the child's parents.

Segment #6: I show a new sample gel with three sets of parents and three babies, and ask the students to analyze the gel to answer the questions: Which of the three babies can you conclusively connect to a set of parents? How did you conclude this? How would you go about determining which of the remaining sets of parents go with which baby?

What occurs after Segment #6: Students will analyze the gel and answer these questions, by assigning each parent a genotype and then determining which genotypes of children each set of parents could have.

Segment #7: I go over the answers to the exercise (i.e. Parents #3 go with Baby A) and then explain that, to decide whether Parents #2 or Parents #1 goes with Baby B or Baby C, we need to look at another portion of the DNA. I remind them that each human cell has 3 billion letters of DNA from mom and 3 billion letters of DNA from dad, and we have only looked at one tiny region so far. I then give them another gel showing another portion of the DNA, and ask the students to use this new gel to figure out conclusively which parents go with which baby.

What occurs after Segment #7: Students will analyze the gel and answer these questions, by assigning each set of parents to a different baby, conclusively this time.

Segment #8: I go over the final answers to this exercise, and then end by showing an example of a gel that one might see as a member of a jury being presented with DNA evidence from a crime scene. I ask the students to determine which of the three suspects (D, E, or F) has DNA that matches the DNA found at the crime scene.

What occurs after Segment #8: Students will analyze the gel results and conclude which of the suspects (D, E, or F) has DNA that matches the crime scene DNA.

Segment #9: I end the lesson with a short summary, and also with mention of the optional video tour at the end of the lesson, where I went to the Cambridge Police Station to the Identification Lab to see how DNA is extracted from evidence from crime scenes.