SN EDUCATOR GUIDE

May 26, 2018

An Open Book

Activity Guide for Students: DNA Fingerprinting

Purpose: To understand how DNA data can be interpreted and applied.

Procedural overview: Work individually or in small groups to analyze simulated DNA data from different people to solve the crime.

Supplies:

- PDF Packet of short tandem repeat (STR) DNA data

Directions:

DNA can serve as a distinctive "fingerprint" for forensic analysis of crime scenes, testing paternity or identifying other relatives. Rather than having to spend the money and time to sequence the entire human genome, one can recognize a distinct DNA fingerprint by spot-checking a few small regions within the genome. In particular, there are several regions, or loci, in DNA with what are called short tandem repeats (STR) — units of two to 13 nucleotides repeated numerous times in a row on a DNA strand. STRs are often referred to as microsatellites. Different people tend to have different numbers of repeats at each STR locus. Two unrelated people might have the same number of repeats at one STR locus, but the odds of having the same numbers of repeats at many different STR loci are astronomically small, similar to the odds of having the same fingerprint. Investigators usually examine 15 to 20 STR loci simultaneously to identify people.

Your job is to use STR loci to solve a crime. A priceless purple diamond was just stolen, and when the crime scene unit swept the premises for clues, the unit found blood on the diamond's shattered glass case. Police have six suspects. The accompanying graphs show: data from a typical STR analysis, STR analyses of DNA samples A and B from the crime scene and STR analyses of the suspects' DNA.

Look at the typical STR analysis. The top (blue) graph shows four different STR loci on different chromosomes labeled with overhead gray boxes with names like "D8S1179." The DNA at each STR locus has been separated by size, or number of repeats. The number of repeats increases from left to right. Vertical colored peaks show where the greatest quantities of DNA are. Numbers above the horizontal axes indicate the length of the STR in base pairs. (Bear in mind that each repeat is usually four to five base pairs long.) Numbers on the vertical axes indicate the amount of DNA (in arbitrary units) for each length.

These analyses are generally performed by computer software, which assigns a number of repeats for each major DNA peak. Note: Computer programs are not perfect, so sometimes the program might not assign a number of repeats to a peak if the peak is not high enough, or the program might assign a non-integer number of repeats instead of the closest integer.

Under most STR loci will be two peaks with different numbers of repeats, one from each copy of that chromosome (one copy inherited from the mother and the other copy inherited from the father). If there seems to be only one peak, it means that the two copies have the same number of repeats, and therefore

appear together on the graph as one big peak. (The number of repeats assigned by the computer is the number of repeats in each copy of that DNA.)

Typically, four different colors of fluorescent molecules are attached to copied DNA from different STRs to help avoid confusion. The first (blue) line shows four STR loci. The second (green) line shows five more STR loci. The third (black) line shows four more STR loci. The fourth (red) line shows the final three STR loci.

The bottom leftmost (red) STR locus is on the X and Y sex chromosomes, so it shows if the DNA sample came from a male (X and Y chromosomes, with one peak each) or a female (two X chromosomes, appearing together as just one peak).

1. How many different STR loci are used for this DNA fingerprint analysis?

2. Under the second (D21S11) STR locus on the top (blue) line of crime scene sample A, the computer program thought there were peaks with 31 and 31.2 repeats. What DNA samples or copies do you think are really present?

3. Under the second (D21S11) STR locus on the top (blue) line of crime scene sample B, the computer program thought there were peaks with 27 and 30.2 repeats. What DNA samples or copies do you think are really present?

4. Under the last (D18S51) STR locus on the third (black) line of crime scene sample B, there are two peaks, but the computer program only assigned a number of repeats to one of them. What DNA samples or copies do you think are really present?

5. What is the sex of the person (or people) that left two DNA samples at the crime scene?

6. Based on the suspects' DNA samples, what is the sex of each suspect?

Now compare the STR loci for all six suspects with the STR loci of both crime scene samples.

7. Which (if any) of the suspects is the best match for crime scene sample A?

8. Which (if any) of the suspects is the best match for crime scene sample B?

9. What have you learned about forensic DNA analysis?