

WHO DUNNIT?

LEARNING OUTCOMES

Students will simulate the work of forensic science by fragmenting “DNA” and interpreting the results of an “electrophoresis”.

QCC STANDARDS

APPLIED BIOLOGY & CHEMISTRY 2:

Process Skills Standards 1 & 3

4.3 Explain how we can distinguish between two individuals by analyzing tissue samples.

10.1 Explain how new technologies can be used to detect defects in genes.

10.2 Describe the basic processes used in genetic engineering.

11.1 Identify the ways genetic engineering can benefit mankind.

11.2 Evaluate the ethical issues surrounding the use of genetic engineering.

BIOLOGY:

Process Skills Standards 1 & 3

10.1 Define important genetic terms.

11.3 List significant contributions of genetic engineering to agricultural and medical practices.

ENVIRONMENTAL SCIENCE:

Process Skills Standards 1 & 3

34.1 Describe the genetic code.

34.2 Differentiate between classical applied genetics and molecular applied genetics.

34.3 Identify the process of gene manipulations.

34.4 Demonstrate an understanding of gene manipulation techniques.

34.7 Describe various applications of biotechnology and the role it will play on future health and environmental clean up.

34.8 Compare the areas of biotechnological applications including gene therapy.

BACKGROUND & DEFINITIONS

Electrophoresis is a technology in science that allows an individual to separate molecules according to size. The procedure works analogous to a screen, in which larger particles are less likely to move through than small particles. Thus, in electrophoresis, using agarose gel as the “screen”, smaller molecules will move farther than larger particles. When these fragments have a composition that allows them to be seen, the resulting electrophoresis will produce bands of color where fragments have stopped. Ideally, if two samples are placed side by side in the gel, fragments of equal size will move an equal distance with one another, letting the scientist identify whether or not similar size fragments are in two different samples. For the molecules to move, electrical current “causes” the movement of the molecules. These procedures form the basis of DNA fingerprinting, where electrophoresis separates fragments of DNA. A blood sample from a crime scene can be compared to a blood sample from a suspect. When chemicals are used to cut up pieces of the DNA, both samples will be cut at the same place if the crime scene sample came from our suspect. When these two samples are placed in an electrophoresis device, identical banding patterns should occur, leading us to interpret that the crime scene DNA and the suspect’s DNA are the same.

MATERIALS & EQUIPMENT

Paper with DNA code
Scissors

Poster Board (To record data)

WEB RESOURCES

http://www.rit.edu/~pac8612/electro/E_Sim.html - Virtual electrophoresis
<http://ntri.tamuk.edu/electrophoresis/home.html>
<http://www.sciam.com/askexpert/biology/biology3.html>
<http://www.biology.washington.edu/fingerprint/dnaintro.html>
<http://www.pbs.org/wgbh/nova/sheppard/analyze.html>

DURATION

20-30 Minutes

PROCEDURE

1. Provide each student with a strip of "DNA". This is to represent the DNA that they supplied for testing.*
2. Instruct students to cut the DNA after a specific code, such as after every "GT" pair. This should result in students having various lengths of strips.
3. Ask students to count the number of letters on each of their strips and write that number on the back of the strip.
4. Students should place their data on the board. Prepare a grid where the x-axis is their name or initials, and the y-axis will represent the number of letters on each strip. Number this axis from 1-20, with 1 at the top and 20 at the bottom. Students should place horizontal bands above their name corresponding to the strips they cut. So, if a student has strips that contain 4, 7, 12, 13, and 18 letters, she should place a band above her name that corresponds to those numbers on the y-axis.
5. Inevitable questions: (1) "I have two strips that have the same amount of letters on them. What should I do?" – Just place one band at that location. The electrophoresis works by separating different size fragments, thus two fragments the same length should move the same length. (2) "I have a strip longer than 20 letters. What should I do?" – Just place a band at "20". Indicate that any fragment over 20 letters is too long to move through the gel.
6. You should have a strip that is identical to one given to the students. At the end, when all have placed their information up, add the "suspect" DNA.
7. Students should be able to interpret "Who Dunit?"

OTHER NOTES

This should help students understand the techniques used in forensics using genetics. Each part of this activity is analogous to what is used in real life. The scissors act as restriction enzymes, which cut DNA at specific locations. The different strips were separated by length, which is the same principle by which the gel works. There are lots of great web sites that add additional information to this. I have used this in class and students seemed to get the concepts. This alternative is much cheaper than using real chemicals in a simulation, although this might serve to help students before doing the real thing. PBS has a great site that simulates the above in a virtual world, as well (<http://www.pbs.org/wgbh/nova/sheppard/analyze.html>). One last point...although this type of science is usually used in rape or murder cases, an alternative story may be advised to use with students. An example may be that someone in the class took a bite out of Mr. Black's apple while he was out of the class and no one would admit to it.

* Simply make a word processing document that repeats the letters “A, C, G, & T” over in a random sequence. Format the page in landscape setting for longer lines. Make sure that you duplicate one of the rows to serve as the DNA of the “suspect”. It is a good idea to keep this strip with its matching pair until you hand them out to students because if no student has the identical DNA sequence, there will be no match to the suspect DNA. Cut each row of “DNA” to distribute to your students.