

PowerPoint Presentation

Introduction

Students solve a crime using paper DNA strips to model gel electrophoresis. This can be used as an introductory lab for a later gel electrophoresis lab or be used to introduce the process of gel electrophoresis if the materials for a wet lab are not available.

This activity was selected to give students basic concepts that are vital for understanding agricultural biotechnology:

- 1. Different organisms have different DNA sequences.
- 2. The four nucleotides can create a large number of sequences.
- 3. DNA can be manipulated and identified by using laboratory techniques.
- 4. Restriction enzymes can be used to cut DNA strands.

Hawaii Standards

- 1. SC.BS.4.2 Describe different cell parts and their functions.
- 2. SC.BS.4.5 Describe the components and functions of a variety of macromolecules active in biological systems.
- 3. SC.BS.5.3 Explain the structural properties of DNA and the role of DNA in heredity and protein synthesis.
- 4. SC.BS.2.1 Explain how scientific advancements and emerging technologies have influenced society.

Slide 1

You will be solving a fictional crime by simulating processes that are used in forensics, medicine and research.

Slide 2

The famous singer, Ima Star is in Waikiki for the first stop of her around the world tour.

Slide 3

After checking into the room she carefully put her good luck shark's tooth necklace into the room safe and created a new 4 digit code to lock it. She used the numbers 11/14, her mother's birthday.

Slide 4

Later, when she opened the safe to take out the necklace, it was empty. Ima Star is devastated because she cannot stay on pitch unless she is wearing it. She believes her career is over.

You have been called to solve the crime. There is fear that the theft will make international news so the governor and the Hawaii Visitor's Bureau have asked you to give the crime top priority.

Slide 5

When you get to the hotel you note that the safe was not damaged, indicating an inside job.

There is one significant piece of evidence. A single drop of blood is on the bottom of the safe. Ima is sure that it was not there when she put the necklace in and it is possible that the thief was cut by the shark's tooth. The blood sample is taken for DNA analysis.

You need to identify suspects to obtain DNA samples from. This case is unusual because the stolen property was not of any great value. In fact, the missing piece can be purchased at any ABC store for \$6.99. Obviously, someone has an ulterior motive for stealing the necklace and you question the singer's entourage to determine who knew the mother's birth date and who might benefit from ending her career. Three suspects are identified.

Slide 6

The hotel security manager - Has an override code to help guests who forget their codes. Multiple trips to Vegas have put him in severe debt. A competing record label may be paying him off.

The step-sister - Works as the back-up singer for Ima. They have the same mother, so she knows the birthday. It is well known that she would like to have her own record contract.

The drummer - Have been friends since high school. Gave her the necklace before the first gig their garage band had together. The band played at Ima's mother's 40th birthday party, so he knows the date. There is some speculation that he is in love with Ima, but she doesn't seem interested.

Cheek swabs are taken from each of the suspects to obtain DNA samples. It is your job to determine if any of the DNA samples match.

Slide 7.

Two processes are needed to create the DNA fingerprints that will be used to compare the suspect's DNA to the DNA found in the safe. You will simulate these two lab processes with paper.

The first process is the use of restriction enzymes. Restriction enzymes are proteins that are made naturally by bacteria. Bacteria make these enzymes to fight viruses that attack them. These enzymes cut DNA at specific places where there is a specific sequence of base pairs. The enzymes that are used in forensics cut in places where there is a lot of variation in human DNA. The cuts result in short fragments of DNA that are different lengths in different people.

Lets look at two examples.

The *HaeIII* enzyme cuts the DNA between GG | CC and CC | GG.

AACTGGCCTACTATGCGGTTCTCGG TTGACCGGATGATACGCCAAGAGCC

Will be cut into

AACTGG CCTACTATGCGGTTCTCGG TTGACC GGATGATACGCCAAGAGCC The result will be one short fragment and one long fragment.

Real DNA fragments are hundreds of base pairs long.

Now lets look at the second example together.

Slide 8

Your DNA fragments are still in the solution. To separate the fragments so that they can be compared you will use a process called gel electrophoresis. The gel is a gelatin block that the DNA will travel through. Electricity is used because DNA has a negative charge. It will try to move towards a positive electrode. Phoresis means movement.

Slide 9

So, we will use electricity to pull the DNA through gelatin. It is easier for small fragments to move through the gel than large fragments. This means that the fragments will separate by size with the small pieces traveling farther than the large pieces. Fluorescent dye is used to visualize the results.

Slide 10

You will imitate the use of restriction enzymes and gel electrophoresis to determine if one of the suspects dropped blood at the scene of the crime. You will cut DNA strips and then place them on a chart. Once the strips are placed on the gel electrophoresis chart it will be easy to compare them and determine if the blood drop belongs to one of the suspects.

Slide 11

Work in groups of 4. Each person will get a DNA sequence strip to cut and place on the gel electrophoresis chart. An important part of forensics lab work is maintaining the purity of each sample, so each person should only work with their own strip and be careful not to allow mixing with other strips.

Slide 12

Here are a few questions to discuss with your group. Real police labs use at least 9 types of restriction enzymes to make sure the probability is high that they have a match.

Slide 13

Epilogue: Ima gave you 10 tickets to her concert.

The sister confessed and returned the necklace. It turns out she was jealous because Ima always got more attention. She did not go to jail because the stolen item was not very expensive, but was required to do 20 hours of community service working with handicapped children. This changed her life and she now sings on educational videos to help children have more self-esteem. She and Ima are on good terms.

The manager went to rehab for his gambling addiction.

The drummer told Ima his true feelings for her and they are now dating and very happy. Ima is also working with an excellent psychologist to help her have confidence in her talents instead of in a good luck charm.

Slides 14-20 - Templates for DNA and for gel electrophoresis chart Make one copy of pages 15, and 17-20 for each group of four students.

Comments:

The lengths of real restriction enzyme fragments are hundreds of base pairs long. This is necessary so the distance can be visualized when the gel electrophoresis is done.