The Bandit's Bad Hair Day – How DNA Fingerprinting Stopped the Phantom Bandit

TEACHER NOTES

Objectives

- Students will make a prediction about the correct suspect based on images of multiple suspects and background profiles.
- Students will learn how a Forensic DNA Analyst processes DNA to be used in matching suspects to DNA found at a crime scene.
- Students will recognize bias, wrongful convictions vs. certainty of DNA evidence.

Vocabulary

- Gel Electrophoresis
- DNA Fingerprinting
- Restriction Enzyme
- EcoR1
- Alibi
- Perpetrator
- Suspect
- Bias
- Acquit
- Phosphate Backbone
- Base-pair
- Agarose
- DNA – Deoxyribonucleic Acid
- Arraignment
- Palindrome
- Conviction

About the Lesson

- The lesson follows a fictitious scenario about a bank robbing spree by a suspect capable of by-passing the bank alarm and no obvious point of entry or exit.
- This lesson introduces the concepts of DNA fingerprinting, gel electrophoresis, and restriction enzymes.
- Teaching time: one to two 45-minute class period(s)
- As a result, students will:
  - Engage in discussions about bias.
  - Use simulations to understand the process of DNA fingerprinting.

TI-Nspire™ Navigator™

- Send out the *The_Bandits_Bad_Hair_Day.tns* file.
- Monitor student progress using Class Capture.
- Use Live Presenter to spotlight student answers.

Activity Materials

- Compatible TI Technologies: TI- Nspire™ CX Handhelds, TI-Nspire™ Apps for iPad®, TI-Nspire™ Software

Tech Tips:

- This activity includes screen captures taken from the TI-Nspire CX handheld. It is also appropriate for use with the TI-Nspire family of products including TI-Nspire software and TI-Nspire App. Slight variations to these directions may be required if using other technologies besides the handheld.
- Watch for additional Tech Tips throughout the activity for the specific technology you are using.
- Access free tutorials at http://education.ti.com/calculators/pd/US/Online-Learning/Tutorials.

Lesson Files:

Student Activity

- The_Bandits_Bad_Hair_Day.pdf

TI-Nspire document

- The_Bandits_Bad_Hair_Day.tns

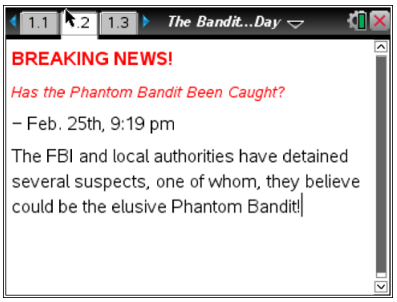
Background

STEM CAREER - This activity portrays a scenario in which the student plays the role of a Forensic DNA Analyst helping authorities match DNA found at a crime scene with that of known suspects. To do this, the Forensic DNA Analyst must understand properties of DNA and tools required to separate DNA based on fragments created from treating DNA samples with a restriction enzyme, EcoR1.

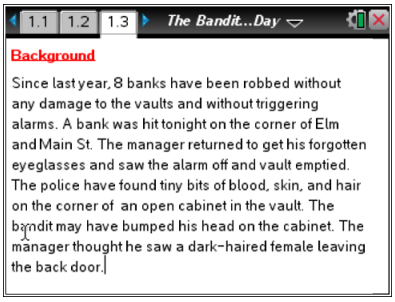
SIMULATION - This activity provides a virtual gel electrophoresis where students can augment the voltage levels and agarose density. Students can then turn on the voltage by pressing start. They'll see a time-lapse of DNA fragments migrating from the negative terminal to the positive terminal. Students must visually line up the fragments to identify if one of the suspects DNA sample matches that of the DNA evidence.

Move to pages 1.2–1.4.

1. Students are introduced to a fictitious scenario of a serial bank robber that just hit another bank. The student plays the role of a Forensic DNA Analyst helping to process samples found at the crime scene.

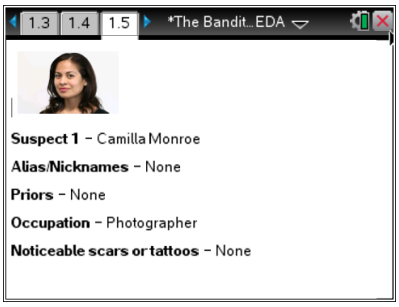


2. As the student goes through these pages they are exposed to the concept of DNA fingerprinting; the process of breaking DNA into fragments whose lengths are unique to each individual. The size of the DNA fragments found at the crime scene are compared to those from four possible suspects.



Move to pages 1.5—1.9.

3. These pages introduce suspects detained by police for questioning. Each suspect has a profile that students can refer to when making a decision on which of the suspects could possibly be the Phantom Bandit.

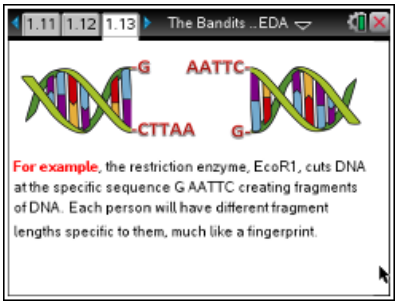


Move to page 1.10. Answer questions here or in the .tns file.

Q1. Choose who you believe may be guilty based on their picture and profile.

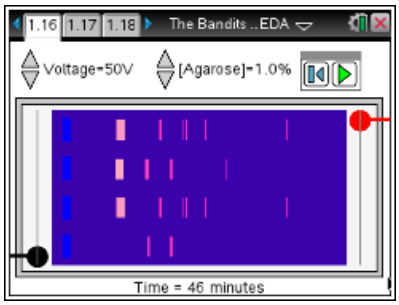
Answer: Student answers will vary. The point of this question is to enable you and the students to have a conversation about bias later in the lesson. Students will likely choose "M. Van Bruner" since she has a criminal history of theft.

Move to pages 1.11—1.14.



4. Pages 1.11 to 1.14 describe the role of a Forensic DNA Analyst and introduce the concepts of restriction enzymes and DNA fingerprinting.

Move to pages 1.15—1.17.



5. Page 1.15 describes a virtual gel electrophoresis with the top lane containing DNA from the crime scene (evidence) and the lower lanes containing DNA from the suspects. Page 1.16 is the simulation page. Students can change the voltage levels and agarose density to observe the effect that has on the rate at which the DNA migrates toward the positive terminal.

Students will answer the following questions

Q2. In gel electrophoresis, why does the DNA move?

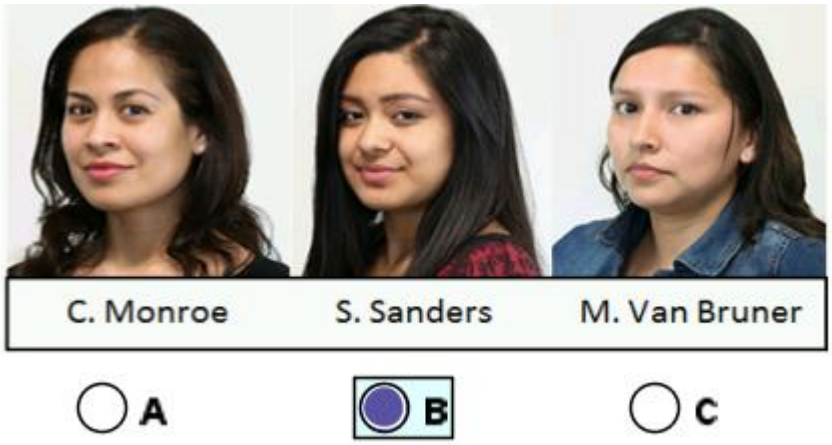
Answer: B. Due to the charge on the molecule.

Q3. Increasing the voltage across the gel causes the DNA to migrate slower.

Answer: False (Increasing the voltage more strongly pulls the negatively charged DNA molecule toward the positive terminal of the chamber.)

Q4. Based on the DNA evidence, choose the suspect you believe likely committed the crime.

Answer:



Q5. Bias can complicate the facts of a case. Did you exhibit bias when you selected the "guilty" suspect before looking at the DNA evidence?

Answer: Student answers will vary. Ideally students will realize that although someone may appear guilty based on their past or the way they look, it's important that they look at the facts of the case first.

Q6. What were some reasons for choosing the suspect you chose?

Answer: Answers will vary. Some students will describe M. Van Bruner's criminal history or that she 'looks' guilty.

Q8. The longer the electric current runs through the gel, the further the DNA migrates.

Answer: True. The longer the current is on, the farther the DNA will migrate.

Q9. If the gel runs too long, the DNA…

Answer: B. runs off the end of the gel.

Q10. Which DNA sequence would have a palindrome on its opposite strand?

Answer: TAGGAT

Q11. Why do you think WHITE blood cells are used for DNA evidence when blood is found at a crime scene? Why are RED blood cells not as useful?
Answer: White blood cells retain a nucleus and therefore have DNA. Red blood cells lose their nucleus as they mature.

Q12. In a sentence, what is the most important part of the job of a Forensic DNA Analyst?
Answer: Student answers will vary. Students may realize that the Forensic DNA Analyst must ensure that the samples are kept track of, contamination is minimized, and that the purification of the sample is done correctly.

Q13. What could happen if a Forensic DNA Analyst gets it wrong?
Answer: Student answers will vary. Students may answer that getting it wrong could help the defense attorney's case and/or get the case dismissed altogether.

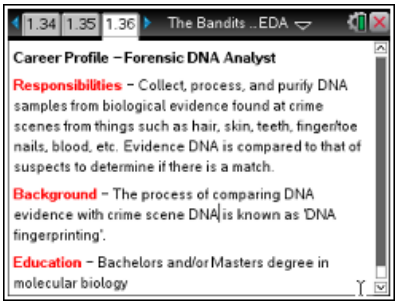
Q14. What would be the most rewarding part of a being a Forensic DNA Analyst?
Answer: Student answers will vary. Students may answer that the most rewarding part of being a Forensic DNA Analyst is helping authorities capture perpetrators and/or helping families gain closure from crimes committed against their loved ones.

Q15. Based on the context of the use of the word, "arraignment," which of the following descriptions most likely fits best?
Answer: B. court hearing to officially charge the defendant with a crime. A plea is usually entered.

Q16. DNA evidence will always determine guilt or innocence in a case. Do you agree or disagree? Why?
Answer: Student answers will vary. Students should realize that, when processed correctly, and collected at the crime scene correctly, DNA evidence can be a very certain way to determine guilty or innocence. However, if part of the process isn't done correctly, then DNA may not be a valid piece of evidence.

Move to pages 1.35—1.36.

6. Pages 1.35 and 1.36 conclude the activity by explaining how the perpetrator, Susan Sanders, accomplished the crimes. Page 1.36 talks about the Forensic DNA Analyst career in case students are interested.



TI-Nspire Navigator Opportunities

Make a student the Live Presenter to demonstrate his or her asteroid simulation graphs.

Wrap-Up

Students will have various results depending upon the angle and/or speed they have selected. Have students compare their graphs and discuss why the results are different.

Assessment

- Students will answer questions throughout the lesson to ensure they understand the concepts of DNA Fingerprinting, Forensic DNA Analysts, and Restriction Enzymes.