

A Link for the Missing — DNA “Fingerprinting”

Secrets of the Sequence Video Series on the Life Sciences • Grades 9 – 12

Teaching materials developed by VCU Life Sciences.

V i r g i n i a C o m m o n w e a l t h U n i v e r s i t y

Classroom Tested Lesson

Video Description

“Secrets of the Sequence,” Show 127, Episode 2

“A Link for the Missing” – approximately 7 minutes viewing time.

The process of DNA profiling was developed by British geneticist Alec Jeffries in 1984 and has been instrumental in the forensic analysis of crime scene evidence leading to the conviction of perpetrators and the freeing of innocent convicts. This segment looks at the use of DNA fingerprinting as an additional way to identify children in the event of their disappearance.

Ward Television

Producer: Julie James

Featuring: Dr. Paul Ferrara, Chemistry and Forensics Science, Virginia Commonwealth University and
Director, Virginia Department of Forensic Science

Lesson Authors; Reviewers: Catherine Dahl; Dick Rezba, Kieron Torres

Trial Testing Teachers: Lender Luse, Pam Sparks, Lynn Visoni

National and State Science Standards of Learning

National Science Education Standards Connection

Content Standard C: Life Science.

As a result of their activities in grades 9 – 12, all students should develop understanding of:

- molecular basis of heredity.

Content Standard F: Science in Personal and Social Perspectives.

As a result of their activities in grades 9 – 12, all students should develop understanding of:

- science and technology in local, national and global challenges.

Selected State Science Standards of Learning Connections

Use <http://www.eduhound.com> (click on “Standards by State”), or a search engine to access additional state science standards.

Virginia

BIO.6 The student will investigate and understand common mechanisms of inheritance and protein synthesis. Key concepts include

- the structure, function, and replication of nucleic acids (DNA and RNA);
- use, limitations, and misuse of genetic information; and
- exploration of the impact of DNA technologies.

Colorado

Quality Core Curriculum Standards and Resources, Biology, Standard 5: Students know and understand interrelationships among science, technology, and human activity and how they can affect the world. As students in grades 9-12 extend their knowledge, what they know and are able to do includes

- demonstrating the interrelationships between science and technology (*for example, building a bridge, designing a better running shoe*); and
- explaining the use of technology in an occupation.

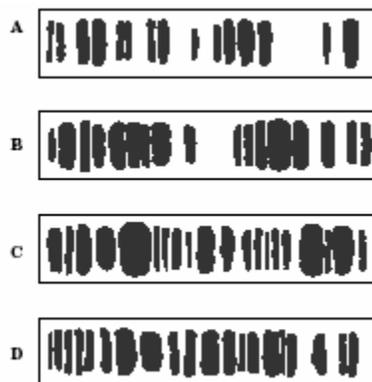
Testing: A Sample related multiple choice item from State Standardized Exams

Puppy



The DNA fingerprints were made from blood samples taken from a puppy and four possible sires of this puppy in an effort to determine the puppy's pedigree. **According to this information, which sire was probably the father of this puppy?**

BY07E403.AR2



Answer: D

(Source, Virginia Department of Education, Division of Assessment and Reporting, Standards of Learning Examination, Biology, Spring 2002.)

Overview

This lesson is designed to show the importance of DNA and DNA technology in the investigation of crime scenes. The background of DNA structure is presented, along with samples of where DNA can be found in a crime scene. An attached Web lesson also will present the procedure and techniques for analyzing a DNA fingerprint. Using this knowledge, the student will determine the alleged perpetrator of the "crime." This lesson can also be used as an introduction to the study of DNA and its structure as well as an introduction to gel electrophoresis.

Video Preparation

Preview the video and make note of the locations you will need later to pause the video for discussion.

Note: If time is allowed, teachers can also refer to the Secrets of the Sequence video on “The Secret of Life-Discovery of the DNA structure” with the accompanying student activity, “Making a model of the DNA Molecule”. (Note: Some trial testing teachers use the questions in the Before Viewing and During Viewing sections to make an extra handout for students to use with the video.)

Before Viewing

1. Review the structure of the DNA molecule with your students.
(It is a double-stranded molecule in the shape of a helix, the monomer of which is called a nucleotide. Nucleotides consist of a phosphate, a sugar and a nitrogenous base. Nucleotides differ according to the nitrogenous base they contain adenine, thiamine, cytosine and guanine. The order of these nucleotide bases is unique for each human, making a person's DNA as unique as a fingerprint.)
2. Review the concept that DNA is found in all body cells.
(Law enforcement personnel use fingerprints to identify children who have been kidnapped. They also may use DNA, which can come from any body cell such as hair, blood or skin. It is the unique structure of a person's DNA that allows it to be used to identify lost children if their parents/guardians have a sample of the child's DNA stored.)

During Viewing

1. **START** the video.
2. **PAUSE** the video (3.40 minutes into the video) after Dr. Ferrara is introduced and you hear the sentence, “DNA profiling has fundamentally changed the way police investigators consider what is and is not potential evidence.”

Ask: “What evidence might kidnapped children leave behind that would contain their DNA?”

hair, clothing, personal items like toys, jewelry, food utensils like drink cups, spoons, gum or partially eaten food.

3. **RESUME** the video after telling your students: “Note the similarities and differences among the items we listed and those Dr. Ferrara describes as evidence.”
4. **PAUSE** the video (5.00 minutes into the video) after you hear the sentence, “That’s when DNA from an outside source gets mixed up with the DNA being tested.”

Ask: “How easily do you think DNA evidence can be contaminated?” and “How does a forensic department avoid confusing DNA profiles in a contaminated sample?” Discuss ‘controls’ and how the forensic department ‘controls’ the potential contamination of a sample.

5. **RESUME** the video and play to the end.

After Viewing

1. Tell your students, "We are now going to follow the techniques that forensic scientists use to create a DNA fingerprint from evidence at a crime scene."
2. Conduct the Student Activity: *Create a DNA Fingerprint*

Teacher Notes for Student Activity: Create A DNA Fingerprint

Materials Needed

- Copies of the student handout, *Create a DNA Fingerprint*
- Computers with Internet access and *Shockwave Macromedia* graphics (see the Student Handout for free download directions). Ideally every student should have access to a computer to complete the activity but if there is only one, use a projection system so all students can participate.

Procedure

1. Distribute copies of the handout, *Create a DNA Fingerprint*.
2. Students type the following URL into the address bar on their computer's browser:
<http://www.pbs.org/wgbh/nova/sheppard/analyze.html>

(Note: You must try this activity beforehand because the Internet directions need further explanation from the teacher. See additional directions on the Student Handout. Also you might want to bookmark this NOVA site before class.)
3. Read through the introduction page as a class.
4. Students begin the activity by clicking on Part I: It Takes a Lickin'.
5. In Part II: *DNA Fingerprinting at the NOVA Lab* students complete the necessary steps for making a DNA fingerprint from forensic evidence to identify the perpetrator of the crime. *(Note: After each step in the fingerprinting process, an explanation is provided. Students must read the explanation and click OK before starting the next step. Caution students to follow each step carefully. If they make a mistake, the computer program makes them start all over again.)*
6. Part III: Evaluate the Evidence: Choose the Culprit has the students match the DNA fingerprint with known fingerprints of the suspects.
7. Have students answer the questions on the handout, *Create a DNA Fingerprint*.

The activity in this lesson is based on the NOVA Online activity, "Create a DNA Fingerprint" by Rick Groleau for <http://www.PBS.org>, November 2000.

Student Handout: Create A DNA Fingerprint

Name: _____

Goal

Since 1984 forensic scientists have been using DNA profiling to identify the potential perpetrators of crimes and to locate missing persons. In this Web-based activity, you will:

- Use the Internet to show how a DNA fingerprint is created.
- Identify the steps of the process for creating a DNA fingerprint.
- Solve a mystery using a DNA fingerprint.

Procedure

1. Carefully enter the following URL into the address bar of the Internet browser on your computer:
<http://www.pbs.org/wgbh/nova/sheppard/analyze.html>

You should be on the NOVA Online page entitled "Create a DNA Fingerprint."

2. Read through the introductory page.
3. Click on [Part 1: It Takes a Lickin'](#). Your job is to determine which of Jimmy Sweet's sisters licked the holographic image off his NOVA hologram lollipop.
4. Click on [Part 2: DNA Fingerprinting at the NOVA Lab](#). This will take you to a screen with a virtual lab and directions for creating a DNA Fingerprint.

(NOTE: You will need Shockwave to run the virtual lab. If you do not have Shockwave, there should be a link in place of the virtual lab that will direct you to the Shockwave download page. After you download the free software, the virtual lab should appear.)

Follow the steps very carefully to create a DNA Fingerprint.

- Each step in this process will be explained so take the time to read these explanations carefully.
- Each object in the directions is represented in the virtual lab.
- Follow the steps by clicking on and dragging the related object until the object does the action in the step (e.g., the restriction enzymes container turns to pour into the DNA).
- After each step you will need to click OK in order to go on to the next step.
- Note that in order to pour anything into the "tray," you will need to drag the item onto or slightly below the bottom of the tray until it changes to show the action of that step.
- If you hurry and make a mistake, you will be sent back to the beginning of the activity to start all over again.
- STOP when you get to "CHOOSE THE CULPRIT."

5. What is the source of DNA used to create the fingerprint? _____
6. What is the function of the following materials or equipment used to prepare a DNA fingerprint?

Material	Function
restriction enzymes	
agarose gel	
electrophoresis	
nylon membrane	
probes	
x-ray film	
developer	

7. Click on Part 3: Choose the Culprit or continue by clicking on Choose the Culprit from the last screen of Part 2. Click and drag the DNA Fingerprint onto the suspects' DNA fingerprint to find the culprit.
 - Which sister committed the crime? _____
 - How did you determine this? _____

This activity is an extension of the NOVA Online activity "Create a DNA Fingerprint" by Rick Groleau for <http://www.pbs.org>, November 2000.

Additional Resources

Because Web sites frequently change, some of these resources may no longer be available. Use a search engine and related key words to generate new Web sites.

<http://www.interpol.int/Public/Forensic/dna/default.asp> (Interpol's Web site with frequently asked questions)

http://www.biotechnology.gov.au/biotechnologyOnline/human/h_DNA.htm (Biotechnology Australia, A Commonwealth Government Initiative: Explains the use of DNA profiling in forensics)

<http://www.prweb.com/releases/2002/7/prweb42597.php> (PRWeb's press release concerning the use of DNA profiling in missing children casework)

<http://www.biology.washington.edu/fingerprint/dnaintro.html> This page was created as a class project at the University of Washington to provide to the Internet basic information on the structure and function of DNA as it relates to DNA fingerprinting.

<http://www.bio-link.org/> Bio-Link is a National Advanced Technological Education (ATE) Center for Biotechnology that originated in late 1998 with a grant from the National Science Foundation. Bio-Link enhances and expands biotechnology education programs by providing cutting edge professional development for instructors, by improving curriculum, by making use of technologies and by creating a system that promotes the sharing of information.

<http://www.dnalc.org/> The **Dolan DNA Learning Center (DNALC)** is the world's first science center devoted entirely to public genetics education and is an operating unit of Cold Spring Harbor Laboratory, an important center for molecular genetics research.

http://biotech.biology.arizona.edu/labs/DNA_Fingerprinting_student.html

http://biotech.biology.arizona.edu/labs/DNA_Fingerprinting_teach.html The Biotech Project assists teachers in using biotechnology techniques in their classrooms to have students answer novel research questions.

http://biology.arizona.edu/sciconn/lessons2/Vuturo/vuturo/add_info1.htm DNA fingerprinting analysis to discover the parents of Harris' Hawks nestlings. Lesson plan and worksheets.

<http://www.dnaftb.org/dnaftb/> ***DNA from the Beginning*** is organized around key concepts. The science behind each concept is explained by: animation, image gallery, video interviews, problem, biographies, and links.

Book: The Casebook of Forensic Detection: How Science Solved 100 of the World's Most Baffling Crimes by Colin Evans (Author)

Genomic Revolution

http://www.ornl.gov/sci/techresources/Human_Genome/education/education.shtml

The Web site to the government-funded Human Genome Project with links about genomics, the history of the project, and more.

Secrets of the Sequence Videos and Lessons

This video and 49 others with their accompanying lessons are available *at no charge* from www.vcu.edu/lifesci/sosg