Hands-On Science

Forensics

Brian Pressley

WALCH EDUCATION®

Contents

To the Teacher

The investigation of a crime scene is one of the most complicated endeavors a scientist can undertake. The number of disciplines that an investigator must be familiar with is huge. The work of collecting evidence requires a methodical approach and might require a strong background in chemistry, physics, biology, geology, and any number of areas where these fields overlap.

As a teacher, you might wonder how a book on forensics is useful to you in your classroom. You may choose to use some or all of these activities. You will find that each one is a stand-alone activity, but the two summary lessons at the end are best done after many of the earlier activities have been completed. Most of the activities are meant to be finished in a single class period, although some can be made as detail-oriented as possible and can be spread across a few classes. The material covered would fit well into a general science class, and various activities would be fitting for a biology, a chemistry, a physics, or an earth science class.

There are television shows that feature forensics so intensely that the science seems like a character. Many students are captivated by the mystery that must be solved. Most shows are careful to have experts on the set to be sure that the science is right, and many of your students will be familiar with the basics. The goal of this book is to advance the scientific-thinking skills of your students by turning students into good scientists. The activities employ a number of process and inquiry skills, much like those used by a good scientist. Good scientists will:

- accept well-tested findings
- utilize time-tested procedures to produce accurate results
- see the things in front of them and not what they want to see
- change their minds when faced with new experimental evidence
- be skeptical of information but open-minded to the possibility that it is correct

Much of science is a combination of problem solving, the scientific method, and just plain hard work. Forensics might be the ultimate combination of all three. Correlation charts for the activities in this book connect each activity to the National Science Education Standards for grades 5–8 and 9–12. The correlations are listed again within each activity. You will also find a General Rubric to help you with assessment. Properly used, this book can be fun for students while still helping them strive to reach the high standards that you expect from them in your classroom.

National Science Education Standards Correlations

The National Science Education Standards are not presented in standard outline form, so referencing a particular item is difficult without presenting the entire item. A summary of correlations follows. The correlations are separated into grades 5–8 and grades 9–12. The two charts allow you to look at an activity and then to check your copy of the National Science Education Standards so that you can read the specific Content Standard and Guide to the Content Standard.

For example, part of the correlations for the first activity, Photographing a Crime Scene, look like this for grades 5–8:

Activity	Content standard	Bullet number	Content description	Bullet number(s)
1. Photographing a Crime Scene	A	2	Understandings about scientific inquiry	1–5

This indicates that under Content Standard A, you will see some bulleted items. The number 2 in the third column indicates that you need to count down to the second bullet. The second bulleted item says, "Understandings about scientific inquiry." If you look down under the section titled "Guide to the Content Standard," you will see that there is a section that has the exact same title, "Understandings about scientific inquiry." Under that section, you will find a number of bulleted items again. In this case, there are seven of them, and this activity is correlated to the first five.

National Science Education Standards Correlations (Grades 5–8)

Activity	Content standard	Bullet number	5–8 content description	Bullet number(s)
1. Photographing a Crime Scene	A	1	Abilities necessary to do scientific inquiry	1–7
	A	2	Understandings about scientific inquiry	1–5
	E	1	Abilities of technological design	1–5
	E	2	Understandings about science and technology	4–5
	G	1	Science as a human endeavor	1–2
2. Processing a Crime Scene	A	1	Abilities necessary to do scientific inquiry	1–7
	A	2	Understandings about scientific inquiry	1–5
	E	1	Abilities of technological design	1–5

(continued on next page)

Activity	Content standard	Bullet number	5–8 content description	Bullet number(s)
	E	2	Understandings about science and technology	4–5
	G	1	Science as a human endeavor	1–2
3. Fingerprints	A	1	Abilities necessary to do scientific inquiry	1–7
	A	2	Understandings about scientific inquiry	1–5
	E	1	Abilities of technological design	1–5
	E	2	Understandings about science and technology	4–5
	G	1	Science as a human endeavor	1–2
4. Detecting Blood	A	1	Abilities necessary to do scientific inquiry	1–7
	A	2	Understandings about scientific inquiry	1–5
	E	1	Abilities of technological design	1–5
	E	2	Understandings about science and technology	4–5
	G	1	Science as a human endeavor	1–2
5. Matching DNA	A	1	Abilities necessary to do scientific inquiry	1–7
	A	2	Understandings about scientific inquiry	1–5
	C	2	Reproduction and heredity	4–5
	C	5	Diversity and adaptations of organisms	1
	E	1	Abilities of technological design	1–5
	E	2	Understandings about science and technology	4–5
	G	1	Science as a human endeavor	1–2

(continued on next page)

General Rubric

Criteria	Procedures and reasoning	Strategies	Communication and use of data	Concepts and content
Level				
1 (Does not meet the standard)	• Did not use scientific procedures or tools to collect data	• Failed to use reasoning • Failed to use a strategy • Failed to use a procedure	• Data not recorded • Conclusion based on data not reached • Could not use scientific terms, symbols, graphs, and so forth • Explanation of task not given or was not connected to data	• No use, little use, or inappropriate use of scientific terms • No use, little use, or inappropriate use of scientific theories or principles • No understanding, little understanding, or inappropriate understanding of the various properties or materials used in task
2 (Partially meets the standard)	• Attempted to use scientific procedures or tools to collect data, but some collected data was inaccurate or incomplete	• Used reasoning, but only completed part of the task • Used a strategy, but was not effective in completing the task • Used a procedure, but could not collect data or form a conclusion	• Data recorded but not complete • Conclusion reached not fully supported by collected data • Attempted to use scientific terms, symbols, graphs, and so forth, but used incompletely and with missing components • Conclusions that were reached were not clear.	• Some use of appropriate scientific terms • Some use of appropriate scientific theories or principles • Some understanding of the various properties or materials used in the task
3 (Meets the standard)	• Used some scientific procedures or tools effectively to collect data with only minimal error	• Used effective reasoning • Used a strategy that allowed student to complete the task • Used a procedure, recorded data, conducted an experiment, and asked questions that could be tested	• Data recorded clearly • Conclusions essentially supported by collected data • Used scientific terms, symbols, graphs, and so forth • Conclusions that were reached were presented clearly.	• Appropriate use of scientific terms • Appropriate use of scientific theories or principles • Appropriate understanding of the various properties and materials used in the task

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5. Matching DNA

TEACHER RESOURCE PAGE

Instructional Objectives

Students will be able to:

- compare DNA profiles
- explain how profiles are similar or different

National Science Education Standards Correlations

Grades 5–8

Content standard	Bullet number	Content description	Bullet number(s)
A	1	Abilities necessary to do scientific inquiry	1–7
A	2	Understandings about scientific inquiry	1–5
C	2	Reproduction and heredity	4–5
C	5	Diversity and adaptations of organisms	1
E	1	Abilities of technological design	1–5
E	2	Understandings about science and technology	4–5
G	1	Science as a human endeavor	1–2

Grades 9–12

Content standard	Bullet number	Content description	Bullet number(s)
A	1	Abilities necessary to do scientific inquiry	1–5
A	2	Understandings about scientific inquiry	3, 5
C	2	Molecular basis of heredity	1–2
E	1	Abilities of technological design	1–4
G	1	Science as a human endeavor	2

Vocabulary

- **DNA:** the abbreviation for deoxyribonucleic acid, a molecule found in almost all living organisms
- **VNTRs:** abbreviation for variable number tandem repeats, a way of saying that there are short stretches of the DNA molecule that have identically repeating parts

5. Matching DNA

TEACHER RESOURCE PAGE

MATERIALS

- sample DNA profiles
- ruler

HELPFUL HINTS AND DISCUSSION

Time frame: 20 to 30 minutes
Structure: individuals
Location: classroom

This activity provides some simple DNA profiles for comparison and allows students to connect the idea that certain genetic features are handed down through generations. It also gives students the ability to match basic components of a DNA profile. There are five children in the example, three who are the children of the mother and father, one who has a different father (without the knowledge of the man who assumes he is the father), and one who was actually kidnapped. The back story that you may share with students is that the parents have been arrested because of their link to a crime, and authorities are unable to find documentation or birth records for the five children. The results provided in the activity are the sort that would be used to confirm that the man and woman are (or are not) the biological parents.

MEETING THE NEEDS OF DIVERSE LEARNERS

You might find that students with different abilities will benefit from extra help or extra challenges. Students who need extra challenges should complete the Extension Option and the Follow-Up Activity. These students should be able to explain in detail to their peers the parentage of all five children in the activity. Students who need extra help should be asked to find the three children who are clearly offspring of this mother and father based on their very similar DNA profiles.

SCORING RUBRIC

Students meet the standard for this activity by:

- recording data indicating which individuals share common genetic factors
- appropriately matching genetic factors
- correctly supporting conclusions of parentage with evidence
- correctly using and interpreting the charts indicating genetic factors

Name _____ Date _____

5. Matching DNA

STUDENT ACTIVITY PAGE

OBJECTIVE

To compare DNA profiles for similarities and differences

BEFORE YOU BEGIN

DNA stands for deoxyribonucleic acid. DNA is a molecule found in almost all living organisms. While most of the DNA found in two people is very similar, about one-tenth of 1 percent is different. This means that there are about 3 million molecular components that can be arranged in various ways to make genetically unique human beings.

At a crime scene, evidence might be collected that contains DNA. The DNA can be compared to samples collected from victims or criminals. DNA is found in blood, skin, hair, saliva, and other bodily fluids. DNA evidence must be collected carefully so that it is not contaminated. It must be treated carefully in the lab so that as much of the material as possible survives for testing.

VNTRs stands for variable number tandem repeats. This is just a way of saying that there are short stretches of the DNA molecule that have identically repeating parts. The number of times these parts repeat is generally different from person to person. These VNTRs make it possible for a properly trained technician to compare a relatively small number of markers in a short amount of time. Looking at the whole DNA structure takes much longer.

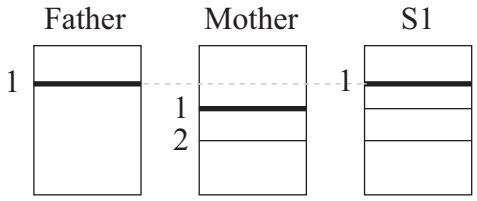
Once the data is collected, a DNA fingerprint is made. A DNA fingerprint can look like a series of bars on a chart or like sharp peaks on a line graph. Whatever the final presentation, a trained person can compare and identify identical (or different) DNA fingerprints just by looking at them.

MATERIALS

- ruler
- sample DNA profiles (see Procedure below)

PROCEDURE

1. Each numbered line represents a genetic trait, such as curly hair. Lines that are on the same level show that the child probably inherited that trait from that parent. In the example below, we see that the first son (S1) inherited trait 1 from his father because the markers in their DNA profiles are aligned. Repeat this process on the next page by comparing each parent's traits to those of each child (S1 = son 1, D1 = daughter 1, and so forth). Record your findings in the data tables by writing *yes* or *no* in each box.

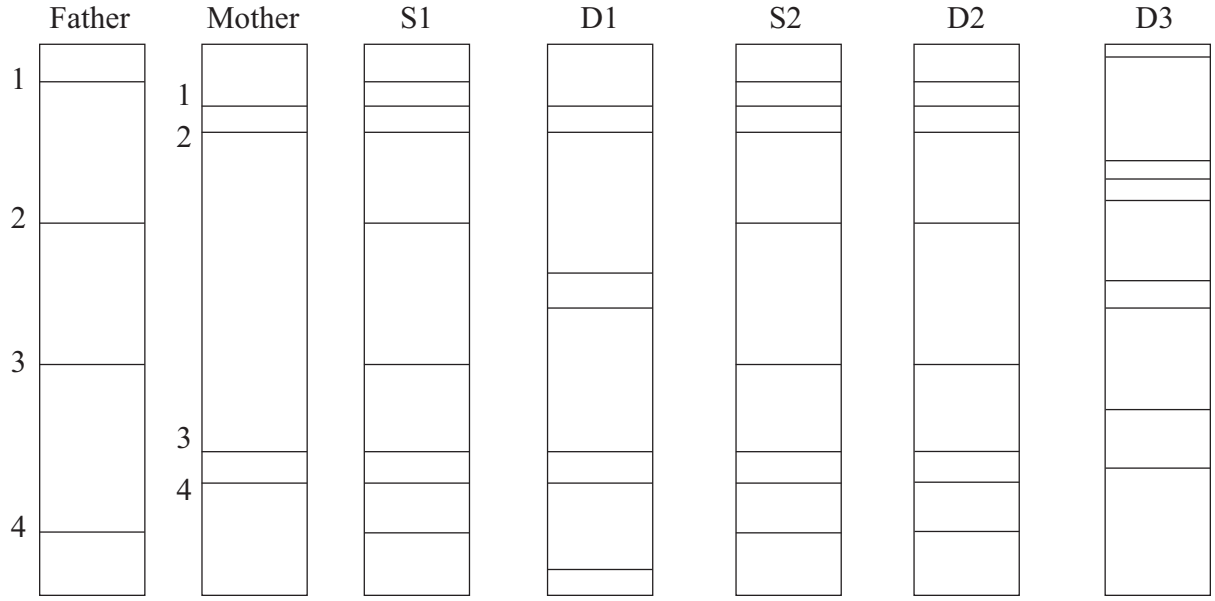


Name _____ Date _____

5. Matching DNA

STUDENT ACTIVITY PAGE

2. Check each child for trait 2, trait 3, and trait 4 of the father. Repeat with the traits for the mother.



EXTENSION OPTION

Create two plausible DNA profiles for the mother and father of Daughter 3.

DATA COLLECTION AND ANALYSIS

Child	Shares trait 1 with father	Shares trait 2 with father	Shares trait 3 with father	Shares trait 4 with father	Child of this father
Son 1					
Daughter 1					
Son 2					
Daughter 2					
Daughter 3					

Child	Shares trait 1 with father	Shares trait 2 with father	Shares trait 3 with father	Shares trait 4 with father	Child of this father
Son 1					
Daughter 1					
Son 2					
Daughter 2					
Daughter 3					

Name _____ Date _____

5. Matching DNA

STUDENT ACTIVITY PAGE

CONCLUDING QUESTIONS

1. Complete the chart below.

Child	Child of this father	Child of this mother	Child of both parents	Child of one parent	Child of neither parent
Son 1					
Daughter 1					
Son 2					
Daughter 2					
Daughter 3					

2. Knowing that this data was collected from a mother and father who were suspected of at least one crime, what conclusion might you draw about Daughter 3?

_____

_____

_____

_____

3. What might you suspect about Daughter 1?

_____

_____

_____

_____

4. How might this method be used to link a criminal to a crime using his or her DNA?

_____

_____

_____

_____

FOLLOW-UP ACTIVITY

Find some photographs of real DNA profiles upon which the simple profiles in this activity were based. Find out how many of the markers have to be in common between two samples before an investigator would be sure that he or she had a match.