



INTEGRATED  
CURRICULUM UNIT  
ON FORENSICS

# Crime Scene Investigation

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# Crime Scene Investigation

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# Crime Scene Investigation

## UNIT OVERVIEW

### **Essential Question for This Unit**

What are the appropriate roles for scientific technology and human judgment in arriving at verdicts in criminal cases?

### **Unit Summary**

In this unit, students take on the role of crime scene investigators to solve a murder that has occurred at the school. They will integrate math, science, and language arts into the study of forensic science and associated health science careers such as pathology, forensic science, and medical examination.

In Subunit 1, students are introduced to the unit and the task of crime scene investigation. They will read and analyze a classic mystery, *The Blue Carbuncle*. Students will also learn about the techniques of various branches of forensic science and how advances in biotechnology have helped to solve crimes.

In Subunit 2, students will learn and apply the various techniques used during a crime scene investigation, including what types of evidence to collect and how that evidence can be used to deduce information about the crime and/or perpetrator. In this unit, students will learn such investigative strategies as measuring stride length from footprints left at the scene to calculate height; using the victim's temperature to estimate the time of death; and collecting blood and other DNA samples from the scene in order to conduct a variety of biological tests—including blood typing and DNA fingerprinting that can match a suspect to the crime.

In Subunit 3, students examine the results of forensic science. In World History, they examine how forensic science has been used not only to solve individual crimes, but also to shed light on crimes against humanity. In English Language Arts, students interview professionals engaged in various aspects of forensic science. They also will marshal the evidence from their own investigations into a case against the primary suspect. Students will write up their arguments, as well as present them orally.

### **Culminating Event**

Because this unit focuses on solving a crime, the most logical culminating event would be to conduct a trial. Some students can assume the role of lawyers, preparing opening and closing statements that summarize the strengths and weaknesses of the case and the evidence. Other students can assume the role of police officers and scientific experts called as witnesses to testify.

### **Key Questions/Issues**

- What tales can dead men tell? What can you learn about a crime by examining the victim? (Health Science I, Biology, Algebra I and II, Geometry)
- What kinds of clues and evidence can be gleaned from a crime scene? What types of evidence are left behind? (Health Science I)
- What factors and evidence should be used to determine a person's guilt? Is some evidence better or worse than others? (Health Science I, English Language Arts)
- Should circumstantial evidence play a role? Why or why not? (English Language Arts, Health Science I, World History)
- Why take the temperature of a dead body? (Algebra II)
- How have advances in DNA technology helped to ensure justice is being served? (Biology)
- Should juries rely solely on DNA evidence in determining the guilt of accused individuals in capital murder cases? How reliable is DNA evidence? (English Language Arts, Health Science I)

### **Learning Scenario to Kick Off the Unit**

A young man has been found dead in an unused classroom with a knife stuck in his chest. A group of three students found the body this morning. The deceased was on his back when discovered, and the room was in a little bit of disarray, chairs turned over and desks shoved out of place. Bloody footprints and the murder weapon were left at the scene!

# Crime Scene Investigation

## UNIT OVERVIEW

Everyone in school is shocked and wondering what happened. When the name of the victim is released, it turns out that he was a former student who graduated last year, and not a very popular one at that! He had a history of trouble with teachers, administrators, and other students—probably with others as well—so the list of suspects might be very long. When the police arrive, the crime scene investigators go to take a look at the scene. What will the police be doing to solve the crime and to ensure that they have the right perpetrator?

### ***Biomedical/Healthcare and Education Partner Roles***

- Forensic scientists from the local community can be invited to speak to students in greater depth about their job and training.
- Students can visit local hospitals or other medical facilities with pathology labs.

#### SUBUNITS AND MAJOR TOPICS (ACROSS ACADEMIC AND TECHNICAL SUBJECT AREAS)

<b>Subunit 1</b> <i>Murder Most Foul</i>	<b>Subunit 2</b> <i>Crime Scene Investigations</i>	<b>Subunit 3</b> <i>Convincing the Jury</i>
HEALTH SCIENCE I · ENGLISH LANGUAGE ARTS	ALGEBRA I · ALGEBRA II · BIOLOGY · GEOMETRY · HEALTH SCIENCE I	ENGLISH LANGUAGE ARTS · WORLD HISTORY
<ul style="list-style-type: none"><li>• Careers in forensic science</li><li>• Techniques of forensic science</li><li>• Literary analysis including identifying or inferring the central idea, purpose, or theme and identifying literary devices and techniques, particularly those associated with mysteries</li><li>• Reasoning and problem solving</li></ul>	<ul style="list-style-type: none"><li>• Ratios and proportions</li><li>• Linear equations</li><li>• Graphing the equation of a circle</li><li>• Deriving from the distance formula</li><li>• Logarithmic equations—Newton’s Law of Cooling</li><li>• DNA structure and purpose</li><li>• Blood typing</li><li>• DNA fingerprinting</li><li>• Gel electrophoresis</li></ul>	<ul style="list-style-type: none"><li>• Investigation of war crimes and crimes against humanity</li><li>• Aftermath of World War II and the Nuremberg Trials</li><li>• Persuasive composition writing with structured arguments</li><li>• Delivery of persuasive arguments using rhetorical devices to support assertions</li></ul>

# Murder Most Foul

## SUBUNIT 1 OVERVIEW

### **Essential Question for This Unit**

What are the appropriate roles for scientific technology and human judgment in arriving at verdicts in criminal cases?

### **Subunit Goals**

Subunit 1 introduces the topic of forensic science. In this subunit, students learn about the range of fields within forensic science and the basic investigatory techniques used in a criminal investigation. Students also discuss reasoning from evidence in literature, in the form of a classic mystery story, *The Blue Carbuncle* by Sir Arthur Conan Doyle. In Lesson 1.3, students are taken to a “crime scene” within the school and asked to investigate. Students will collect evidence from the scene following the guidelines they have studied. They then analyze the collected evidence in Subunit 2.

### **Subunit Key Questions**

- How are the procedures used to collect evidence from violent crime scenes similar to and different from what we see on television? (Health Science I)
- How are criminal investigations portrayed in literature? Is Sherlock Holmes really a great detective? Can you find errors in the conclusions he draws from evidence? (English Language Arts)
- What kinds of evidence can be left at a crime scene, and what can be learned? (Health Science I)
- What are early examples of forensic investigation? How has forensic science advanced in recent years? What techniques have been developed and which ones are falling out of use? (Health Science I)

### **Lesson Summaries**

<b>Lesson</b>	<b>Subject</b>	<b>Description</b>
1.1	Health Science I	<b><i>Introduction to Forensic Investigations</i></b> Students are introduced to the field of forensic science. They are given a brief overview of the history of forensics and learn the basic procedures followed in a modern murder investigation. Students also use the Internet to discover the many branches of forensic science.
1.2	English Language Arts	<b><i>You Be the Detective: Sherlock Holmes and Deductive Reasoning</i></b> Students discuss the characteristics of the mystery genre and relate their discussion to the short story, <i>The Blue Carbuncle</i> . Following a close read of the story, students identify examples of faulty reasoning used by the main character, Sherlock Holmes.
1.3	Health Science I	<b><i>Murder in the Classroom</i></b> A murder is discovered in the classroom, and students are taken to investigate the scene. Students observe the crime scene and collect physical evidence for analysis in later lessons.



# Introduction to Forensic Investigations

## LESSON 1.1

### HEALTH SCIENCE I

#### Time

75 minutes

#### Materials

#### Equipment

Computer lab

#### Resources

- “Crime-Scene Search,” FBI *Handbook of Forensic Services* (<http://www.fbi.gov/hq/lab/handbook/intro16.htm>)
- Forensic Science Subdivisions handout
- *Forensic Science Timeline* (<http://www.forensicsdna.com/Timeline020702.pdf>)
- *Crime Scene Investigation: A Guide for Law Enforcement* (<http://www.fbi.gov/hq/lab/fsc/backissu/april2000/twgcsci.pdf>)

#### Prior Student Learning

Ask students to view an episode of a crime investigation TV program and review the *Forensic Science Timeline* before beginning the lesson.

### **Essential Question for This Unit**

What are the appropriate roles for scientific technology and human judgment in arriving at verdicts in criminal cases?

### **Objectives**

After completing this lesson, students should be able to

- Describe the range of work in forensic science, including careers that use forensic science techniques.
- Identify major procedures used in conducting a crime scene investigation and explain the importance of following procedures.
- Demonstrate multiple ways to collect forensic evidence while preserving the crime scene.

### **Lesson Activities**

#### **Lesson Springboard**

Many believe that TV shows such as *Law & Order* and *CSI: Crime Scene Investigation* have produced something called the “CSI effect.” That is, victims of crimes, jurors, and members of the general public have heightened expectations about what can be revealed from the evidence that is presented in trials. Some argue that this phenomenon is responsible for the increased use of forensic evidence in criminal cases.

Modern advances in forensic science (forensics) have transformed previously unusable clues into highly reliable evidence. Today, many “cold cases” from the past aren’t that cold anymore. For instance, in 1996, using advances in DNA technology, California created a DNA database of criminal offenders. They reopened cold cases to see whether this DNA evidence would help resolve the cases. Results have been promising. For example, the offender database linked Gerald Parker, a man already serving a prison sentence for rape, to a 17-year-old murder case. Confronted with the evidence, Parker not only confessed to that crime, but also to five other murders.

Forensic scientists have not only solved cold cases, but also reopened “solved” cases. The Innocence Project, a nonprofit legal clinic reports that 205 people have been exonerated due to DNA evidence. In the case of Gerald Parker, after his confessions, another man (the husband of one of Parker’s victims) was freed after serving 16 years in prison for the wrongful conviction in the assault of his pregnant wife and murder of her unborn fetus, which Parker committed.

#### **A Brief History**

DNA evidence is just one tool in forensic scientists’ toolbox. The first written record of forensic science can be traced back to ancient China in

# Introduction to Forensic Investigations

## LESSON 1.1

a book written in 1248 titled “Xi Yuan Ji Lu” (translated as *Collected Cases of Injustice Rectified*) by Song Ci. This book describes the investigation of a person murdered with a sickle (a cutting tool). All suspects were told to bring their sickles to a central location, where it was noticed that flies were attracted to one particular sickle, presumably by the smell of blood; this led to a confession by the owner of that sickle.

Archimedes (287 BC–212 BC), a Greek mathematician, is often credited as the “father” of forensics due to reportedly being asked to determine the purity of a gold crown without melting or destroying it. While taking a bath, he noticed that his body always displaced a certain amount of water. Archimedes recognized that a supposed pure gold crown must not only weigh the same as an authenticated one, but also displace the same amount of water as an equal weight of pure gold.

Fingerprints were recognized in the prehistoric era and became an identifier in criminal cases in the late 19th century. The earliest documented cases of forensic ballistics, toxicology, pathology, and biology also occurred in the 19th century. Today, DNA evidence has established a new standard—one can only wonder what the future will hold. In 1913, the polygraph examination (lie detector test), which measures physiological responses (blood pressure, perspiration, pulse, and so on) to verbal statements, was created; it’s routinely used by law enforcement officials though test results are not admissible in many courts. Now, a new lie detection technology has been created called *Brain Fingerprinting*. It reportedly measures the presence of indicators of memory in a person’s brain, and it has already been used in court cases.

### Lesson Development

#### Direct Instruction

“Investigators should approach the crime scene investigation as if it will be their only opportunity to preserve and recover these physical clues,” according to the manual *Crime Scene Investigation: A Guide for Law Enforcement*. In this class, students should be introduced to the basic protocol for conducting forensic science investigations and the importance of following it.

Explain to students that the goal of most crime scene investigations is to answer some or all of the following questions:

- **Who** is the perpetrator, and **who** is the victim?
- **What** happened, **when**, and **why**?
- **How** did the crime happen?
- **Where** did it happen (the location of the body is not always at the primary crime scene)?
- **What** is the evidence?

Ask students what types of evidence would be found at a crime scene in which a victim was murdered with a knife. Students may mention

# Introduction to Forensic Investigations

## LESSON 1.1

fingerprints, the murder weapon, DNA evidence, and so on. Write their responses on the board. Inform students that a brief examination of the scene will often provide a general theory of what occurred, while forensics often reveals hidden clues. Body temperatures can be used to approximate the time of death, as well as any insect found in or on the body (the stage of development of fly larvae can also indicate the time of death). If there is blood, DNA can be analyzed. Also, hand or shoe prints can be analyzed to provide the approximate height and stride of the suspect. Both time of death and the suspect's stride can be used to approximate a radius that the suspect must be in. Investigators use many types of clues together to narrow down the potential pool of suspects.

Ask students what is the best way to find this evidence. If officers rush to the scene to collect the murder weapon, it's possible that they may destroy other evidence such as footprints. Explain to students that crime scene investigators often work in teams and follow an established procedure.

Explain the following specialized set of protocols for a crime scene investigation:

1. APPROACHING—Carefully observe persons, odors, and other elements. Exercise extreme safety.
2. CONFIRM OR DISCONFIRM DEATH—Locate and view the body, noting the success, failure, or futility of resuscitative efforts.
3. PRESERVING—Establish perimeters. Set up command posts. Determine the suspect's point of entry and egress and your own.
4. PROCESSING—Photograph scene, body, and face. Place and photograph markers. Photograph body. Sketch and search the scene. Examine evidence in detail. Take notes. Tag and bag. Describe and document.
5. IDENTIFY THE VICTIM—Estimate cause, manner, and time of death. Obtain exemplars and controls. Look for ID. Look for drag marks. Note discrepancies in mortis and body temperature.
6. NOTIFY NEXT OF KIN (and be prepared to assist the family through an autopsy and provide financial advice).
7. DEVELOP THEORY OF MOTIVE—Rely upon evidence, knowledge of victim's activities, and appearance of victim's clothing. See if any documents were written by or sent to victim recently. Determine the pre-scene activity and health status (physical and mental) of the victim.
8. SEEK ADDITIONAL INFORMATION—Do background and history checks (marital, family, sexual, employment, financial, daily routine, friends, religion, education, and criminal history). Obtain leads from people who knew the victim. Challenge discrepancies in witness' knowledge of the victim or lack of corroboration with other witnesses. Order warrants on suspects.

# Introduction to Forensic Investigations

## LESSON 1.1

9. QUESTIONING—Question all suspects. Make use of evidence during questioning. Use information withheld from the public about the case to obtain a confession. Destroy alibis.

SOURCE: “An Introduction to Crime Scene Analysis” (<http://faculty.ncwc.edu/TOConnor/315/315lect04.htm>)

(This website also provides many additional Internet resources about crime scene investigations.)

### **Small Group Work**

Assemble students into groups of four. Have them print the seven-page document “Crime-Scene Search” from the FBI’s *Handbook of Forensic Services* (<http://www.fbi.gov/hq/lab/handbook/intro16.htm>). Each student group will include a

- Person in charge (team leader)
- Photographer
- Sketch preparer
- Evidence recorder

Using the “FBI Crime-Scene Search” information as a reference, each student should write a one-half to one-page summary of the duties they would perform in their assigned role at a crime scene investigation. They should also describe how their duties combined with those of other students in their group would contribute to the overall quality and effectiveness of the investigation.

At the conclusion of this assignment, pass out the Forensic Science Subdivisions handout and provide students with Internet access to fill in the chart (students can also work in groups). Explain that many other fields of forensics are not included on the list and that they should list any additional subdivisions.

### **Lesson Closure**

Ask students if they understand why it is important to follow protocol and conduct careful investigations or if they know of any court cases where the forensic evidence collected was tainted or discredited due to improper investigative procedures. Some students may mention the O.J. Simpson murder trial in which he was acquitted of criminal liability but found liable for the crime in a civil court.

### **Possible Prior Misconceptions**

Most students will probably link forensics with crime due to popular TV shows. Yet, forensic science is any science used in the courts, the justice system, or in public investigations, and these investigative methods can be used in many situations beyond criminal cases.

Students should understand that crime scene investigations usually require a team of forensic scientists who do most of their work in labo-

# Introduction to Forensic Investigations

## LESSON 1.1

ratories because this work requires knowledge of several scientific disciplines: often one person lacks the necessary educational background and expertise to conduct the entire investigation alone. This scenario is illustrated well on popular TV shows. For example, a ballistics expert may be a physicist and a forensic pathologist will be a medical doctor, while the scientist analyzing blood samples may be a chemist or biologist.

### ***Student Assessment Artifacts***

Summary of duties

Forensic science subdivisions handout

### ***Variations and Extensions***

A law enforcement officer or forensic scientist can speak to the class about crime scene investigation and provide details about occupations in Forensics.

Students can be selected to present their summaries to the class (one student can be selected from each position) to ensure their overall understanding of the investigative process.

## National and State Career Technical Education Standards

### **NATIONAL**

#### **NCHSTE National Healthcare Skill Standards**

#### ***Foundation Standard 4: Employability Skills***

Healthcare workers will understand how employability skills enhance their employment opportunities and job satisfaction. They will demonstrate key employability skills and will maintain and upgrade skills, as needed.

- 4.15 Formulate solutions to problems using critical thinking skills (analyze, synthesize, evaluate) independently and in teams.

### **STATE**

List your state-specific standards in the space below.

Name \_\_\_\_\_ Date \_\_\_\_\_ Period \_\_\_\_\_

## Forensic Science Subdivisions

Use the Internet to fill in the following chart. Add additional fields if you find them.

FORENSIC FIELD	DEFINITION (all related to legal issues)	EXAMPLES (general or specific applications)
Forensic Accounting		
Forensic Anthropology		
Forensic Ballistics		
Forensic Biology		
Forensic Dentistry		
Forensic Document Examination		
Forensic Engineering		
Forensic Entomology		
Forensic Pathology		
Forensic Psychology		
Forensic Toxicology		

Name \_\_\_\_\_ Date \_\_\_\_\_ Period \_\_\_\_\_

## Forensic Science Subdivisions (Answer Key)

Use the Internet to fill in the following chart. Add additional fields if you find them.

FORENSIC FIELD	DEFINITION (all related to legal issues)	EXAMPLES (general or specific applications)
<i>Forensic Accounting</i>	<i>Uses accounting, auditing, and investigative skills</i>	<i>Enron accounting scandal, Martha Stewart insider trading case</i>
<i>Forensic Anthropology</i>	<i>Analyzes skeletal remains</i>	<i>Mass graves, determine lifestyle, gender, cause of death</i>
<i>Forensic Ballistics</i>	<i>Examines firearms, bullets, and other projectiles</i>	<i>JFK and MLK assassination bullet identity and trajectory</i>
<i>Forensic Biology</i>	<i>Analyzes results from serological, DNA, and other bodily fluid tests</i>	<i>DNA and blood typing, O.J. Simpson murder trial</i>
<i>Forensic Dentistry</i>	<i>Examines dental evidence</i>	<i>Determine age or identify victim or suspect through dental records</i>
<i>Forensic Document Examination</i>	<i>Examines printed and written material for dating and authenticity</i>	<i>Identify forgeries</i>
<i>Forensic Engineering</i>	<i>Examines products, materials, components, and structures</i>	<i>Determine the cause of plane crash or bridge collapse</i>
<i>Forensic Entomology</i>	<i>Analyzes insect evidence</i>	<i>Use insects to determine the time of death</i>
<i>Forensic Pathology</i>	<i>Uses medical knowledge to examine damage from disease or injury</i>	<i>Identify the fatal wound or injury</i>
<i>Forensic Psychology</i>	<i>Applies psychology to issues</i>	<i>Provide criminal profile or determine suspect confidence</i>
<i>Forensic Toxicology</i>	<i>Uses chemistry and pharmacology to perform examinations for drugs and poisons</i>	<i>Determine if drugs or poison were used, suspected DUI fatality</i>



# You Be the Detective:

## Sherlock Holmes and Deductive Reasoning

### LESSON 1.2

#### ENGLISH LANGUAGE ARTS

##### Time

50 minutes

##### Materials

- *The Blue Carbuncle* by Arthur Conan Doyle
- Faulty Reasoning handout (teacher answers)
- *The Red Headed League* by Arthur Conan Doyle (optional)
- *The Speckled Band* by Arthur Conan Doyle (optional)

##### Prior Student Learning

Assign students to read *The Blue Carbuncle* before beginning the lesson.

Students should have experience in the close reading of short stories.

#### **Essential Question for This Unit**

What are the appropriate roles for scientific technology and human judgment in arriving at verdicts in criminal cases?

#### **Objectives**

After completing this lesson, students should be able to

- Draw inferences from evidence.
- Perform a close reading of a short story.
- Understand narrative development from the introduction, to rising action and climax, to denouement.

#### **Lesson Activities**

##### **Lesson Springboard**

Police dramas are a popular genre of television programs, and solving crimes through observation of evidence and reasoning is a popular subject of literature as well. Ask students if they have read any detective stories, and if so, what constitutes a great story in this genre. Allow students time to think of some examples and be sure the ones they offer are true instances of the genre.

##### **Lesson Development**

###### **Class Discussion**

Guide students through a discussion of how detective stories are a distinct type of short story. To encourage discussion, ask the following questions:

All short stories involve people or animals (characters) who act or are acted upon (plot) and who exist in a certain place and time (setting). Stories also require a narrator and the events he or she relates. How do these elements function in a detective story and distinguish it from other short stories?

In a short story, information may be withheld from the narrator, the reader, or both. In a detective story, however, it is essential for the reader to be shown all the evidence the detective possesses. Why is this the case?

What characterizes a good suspect? Is there a reason in most detective stories why at least one suspect is wrongly accused?

What are some differences between the detective and the police? Keep in mind not only differences in their personal characteristics, but also differences in their methods for solving the crime.

## You Be the Detective: Sherlock Holmes and Deductive Reasoning

### LESSON 1.2

What are some key features of the detective? How is the detective like a scientist?

Detective stories have a special kind of ending, one that not all short stories share. What is the significance of this ending?

**Classroom Management**  
*The Blue Carbuncle* is published in its entirety on many websites. In addition, there are many websites devoted to Sherlock Holmes that include lively and contentious discussions of his methods and reasoning.

#### **Small Group Work**

Inform students that detective stories reward close and active reading, because if you pay close attention and use some logical reasoning, you can actually solve the crime, even outwitting the detective himself! *The Blue Carbuncle* is an excellent example. Close readers have identified at least eight instances of faulty reasoning by Sherlock Holmes, the world's master detective. Have students work in teams to find some of these instances.

As an example, use Holmes' description of what he has learned about Henry Baker from his hat: "Look at the band of ribbed silk, and the excellent lining. If this man could afford to buy so expensive a hat three years ago, and has had no hat since, then he has assuredly gone down in the world." "Gone down in the world"? It's just as likely that Baker owned more than one hat, and that he chose to wear his old one in order to carry a goose through London's dark streets at four in the morning!

Divide students into teams of four to six detectives. Tell them they will search for faulty reasoning, showing where and why Holmes has made his mistakes. From the list they create, each detective will choose a single error, write a paragraph to explain why it is erroneous, and show how the evidence could be explained differently.

#### **Class Discussion**

Ask the teams to report back to class, list the errors the detective has committed, and, if time permits, explain why they believe he is mistaken.

#### **Lesson Closure**

Remind students that detective stories contain all the elements of the short story, but use them in a distinctive way.

#### **Possible Prior Misconceptions**

Students may think that detective fiction is an inferior genre, not realizing that it is an offspring of the traditional short story.

Students may believe that all short stories conform to the same format. However, some genres such as detective fiction emphasize plot instead of character, denouement instead of climax, and present "evidence" that is as available to the reader as it is to the narrator or any of the characters.

#### **Student Assessment Artifacts**

One-paragraph report on the logical fallacies in the story

## You Be the Detective: Sherlock Holmes and Deductive Reasoning

### LESSON 1.2

#### **Variations and Extensions**

Student reports on logical fallacies can be extended to include *all* the errors they find.

Students can be challenged to read a Sherlock Holmes story closely and try to solve the crime on their own. Two stories that lend themselves to this challenge are *The Red Headed League* and *The Speckled Band*. In each, the clues are fully laid out before the short denouement at the end of the story, in which Holmes interprets them.

### National and State Academic Standards

#### **NATIONAL**

##### **NCTE Standards for the English Language Arts**

- Students read a wide range of print and non-print texts to build an understanding of texts, of themselves, and of the cultures of the United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace; and for personal fulfillment. Among these texts are fiction and nonfiction, classic and contemporary works.
- Students read a wide range of literature from many periods in many genres to build an understanding of the many dimensions (e.g., philosophical, ethical, aesthetic) of human experience.
- Students apply a wide range of strategies to comprehend, interpret, evaluate, and appreciate texts. They draw on their prior experience, their interactions with other readers and writers, their knowledge of word meaning and of other texts, their word identification strategies, and their understanding of textual features (e.g., sound-letter correspondence, sentence structure, context, graphics).

#### **STATE**

List your state-specific standards in the space below.

Name \_\_\_\_\_ Date \_\_\_\_\_ Period \_\_\_\_\_

## Faulty Reasoning: You Outwit Sherlock Holmes!

*Here are nine instances of faulty reasoning by the detective, in the order in which they appear in the story.*

- 1 Holmes assumes that a big head or big brain confers higher intelligence, a prejudice of the Victorian era that was soon disproved. He relies upon phrenology, the pseudoscientific study of the shape of the head, claimed to deduce the intelligence and personality of a person by “reading” the bumps and other features of a skull.
- 2 Baker knew that he would be walking through London in the middle of the night, and so in all likelihood, he decided to wear an older hat on this occasion.
- 3 “If this man ordered one, it is a sign of a certain amount of foresight.” Buying the hat, Baker may have merely succumbed to the persuasion of a good salesman.
- 4 Holmes infers that Henry Baker probably had not had gas lights on at his home from the presence of five tallow stains upon Mr. Baker’s battered billycock. Yet Holmes says that Baker “walks upstairs at night probably with his hat in one hand and a guttering candle in the other.” Under those conditions, how did the tallow stains get on the hat?
- 5 However, everybody, athlete or couch potato, perspires, and it would be unlikely that a 3-year-old hat would lack stains altogether.
- 6 It’s likely that Mrs. Baker is Henry’s wife, but hardly proven. She could almost as easily have been his mother.
- 7 “It cuts into glass as though it were putty.” This proves nothing, because glass cuts into putty as well.
- 8 “Carbon,” not charcoal. At any rate, no garnet has any carbon or charcoal in it. There are several statements that suggest Holmes has not identified the nature of this jewel.
- 9 When confronted by Holmes, James Ryder was quick to bring up Catherine Cusack’s name, as if to share the guilt. However, it is worth noting that Ryder only said, “It was Catherine Cusack who told me of it.” It was Holmes who made the leap to calling her a “confederate.” Was Cusack truly involved in the crime, or was she merely guilty of talking too freely about her mistress’s jewels? Wouldn’t an “upper attendant” at a hotel have reasonably free access to a guest’s room if he chose to exercise it? Did Holmes jump to conclusions too rapidly?

# Murder in the Classroom

## LESSON 1.3

### HEALTH SCIENCE I

#### Time

50 minutes

#### Materials

- Mannequin (can use a CPR dummy)
- Unused classroom or secured area
- Fake blood (recipe below)
- Knife (murder weapon)
- Yellow crime scene tape
- Teacher “suspects”
- Thermometer (optional)
- Ruler or measuring tape
- White chalk
- Notepads (or paper)
- Pens and/or pencils
- Digital camera (optional)
- Voice recorder (optional)
- Camcorder (optional)

#### Prior Student Learning

Students should be familiar with the basic procedures for investigating crime scenes.

### **Essential Question for This Unit**

What are the appropriate roles for scientific technology and human judgment in arriving at verdicts in criminal cases?

### **Objectives**

After completing this lesson, students should be able to

- Apply forensic science techniques and procedures.
- Observe and identify scientific evidence.
- Perform detailed observations.

### **Lesson Activities**

#### **Teacher Preparation**

For this class, a mock murder will be set up, and students will perform a crime scene investigation. The victim is a young adult who has been stabbed in the heart. Recruit a teacher to be the guilty party, and some additional suspects willing to play along.

Pick an area where you can leave the “crime scene” set up for the entire day. The crime scene set up will include (1) the body of the victim; (2) the murder weapon; (3) fake blood; (4) two sets of smudged footprints (victim and perpetrator); and (5) some physical evidence indicating the presence of one young adult and one older adult, perhaps two chairs near the victim, one with a book bag and one with a newspaper.

In the investigation, students have the option of collecting several different types of evidence. Footprint evidence allows students to estimate the height of the perpetrator and should reflect the actual stride of the guilty teacher. Body temperature and the law of cooling will determine that the crime took place during passing time between classes. Be sure to set up the crime scene in an area relatively close to the guilty teacher’s classroom because students will use the length of passing time and average stride to determine the radius the perpetrator could have traveled without drawing attention by running.

#### **Lesson Springboard**

Tell the class that a murder has taken place! Their job will be investigate this terrible crime and bring the perpetrator to justice. Luckily, they will be learning many techniques in their other classes that will help them solve the crime.

According to the FBI’s *Handbook of Forensic Services* (<http://www.fbi.gov/hq/lab/handbook/intro.htm>), “The successful investigation and prosecution of crimes require, in most cases, the collection, preservation, and forensic analysis of evidence. Forensic analysis of evidence is often crucial

# Murder in the Classroom

## LESSON 1.3

to determinations of guilt or innocence.” In this lesson, students will gather evidence to investigate a staged murder. In later lessons, students will use forensic science techniques to analyze the evidence. A shoe or stride print will narrow down the suspect pool by eliminating a specific gender or height of the suspect. The stride length and a time of death will restrict the number of suspects to people within a certain radius. The victim’s body temperature will indicate a time of death, which will destroy, or support, certain suspects’ alibis. Forensics coupled with witness testimony will pinpoint the suspect, and because this crime scene will contain DNA evidence, DNA fingerprinting should seal the case.

### Lesson Development

#### *The Approach*

Student teams of four should enter your classroom and see yellow tape surrounding an area indicating that a crime has occurred. Student group members should have the following assigned positions (students should delegate responsibilities among themselves):

- Person in charge (team leader)
- Photographer
- Sketch preparer
- Evidence recorder

#### *The Scene*

Inside the yellow tape, students will find the following:

- One murder victim (a mannequin or CPR dummy) who has been stabbed.
- Fake blood on and near the victim.
- A “bloody” knife near the body (or it could have been previously “discovered” and secured but available).
- “Bloody” shoe prints that will allow students to approximate the assailant’s stride and his or her height (could also be white chalk outline of shoe prints).
- Discarded newspaper
- Coffee mug
- Student backpack
- Two body temperature readings: one initial, the other at a later time period to approximate the time of death (data can also be provided).
- Evidence of a struggle, including overturned chairs

Along with the basic crime scene protocol, students should have writing material and a pen or pencil in order to take notes. If a camera or voice recorder is available, students should also complete the narrative portion of the crime scene investigation (narrative can also be written).

Students should begin the assigned task of identifying the prime suspect by using crime scene investigation techniques to uncover any forensic evidence found at the crime scene.

#### **Fake Blood Recipe**

- Corn syrup
- Red food coloring
- Blue food coloring
- Cornstarch (if not thick enough)
- Liquid dishwashing detergent (to prevent staining)

#### **Instructions:**

Mix red food coloring into corn syrup. Use blue food coloring and cornstarch as needed to provide realistic color and thickness. Adding a small amount of liquid dishwashing detergent will ensure that the mixture washes out of clothing.

# Murder in the Classroom

## LESSON 1.3

Note: Students should understand the importance of following procedures, taking accurate detailed notes, and preserving the quality of evidence (for themselves and in any other classes).

Before conducting any tests of the evidence, discuss with students how to narrow down the suspect pool based on just observation. Possible suspects could include other students, teachers, or someone from outside the school. The victim is a young man, and he appears to be the owner of the backpack. The other personal items, the newspaper and the coffee mug (as opposed to a travel mug or paper cup), indicate that an adult with access to fresh coffee on campus was also present in the room. Therefore, students might conclude that a teacher was the perpetrator.

### **Lesson Closure**

At the close of this lesson, students should be asked how they felt about this assignment. Even though students may find the class experience exciting, they should understand that in real life, murder is not fun from any perspective and that forensic scientists along with law enforcement officials have the serious responsibility of seeing that the people responsible are brought to justice.

### ***Possible Prior Misconceptions***

Students should understand that crime scene investigations of this type usually require a team of forensic scientists who perform a majority of their work in laboratories because different disciplines of science are required: often a single investigator lacks the necessary educational background and expertise to conduct the entire investigation. Therefore, a team of forensic scientists is often used. A ballistics expert may use be a physicist and a forensic pathologist will be a medical doctor, while the scientist analyzing blood samples may be a chemist or biologist.

### ***Student Assessment Artifacts***

Crime scene administrative log  
Detailed crime scene notes (narrative)  
Sketch of scene  
Evidence log

### ***Variations and Extensions***

Invite a law enforcement officer or forensic scientist to speak to the class about crime scene investigation and provide details about occupations in Forensics.

Subunit 1—Murder Most Foul  
*Murder in the Classroom*

LESSON 1.3

**National and State Academic Standards**

**NATIONAL**

**NRC National Science Education Standards**

*Science as Inquiry*

- Use technology and mathematics to improve investigations and communications.
- Formulate and revise scientific explanations and models using logic and evidence.
- Recognize and analyze alternative explanations and models.

*Science and Technology*

- Science in different disciplines ask different questions, use different methods of investigation, and accept different types of evidence to support their explanations. Many scientific investigations require the contributions of individuals from different disciplines, including engineering.
- Creativity, imagination, and a good knowledge base are all required in the work of science and engineering.

**STATE**

List your state-specific standards in the space below.

# Crime Scene Investigations

## SUBUNIT 2 OVERVIEW

### Essential Question for This Unit

What are the appropriate roles for scientific technology and human judgment in arriving at verdicts in criminal cases?

### Subunit Goals

In Subunit 2, students use mathematics and science concepts to analyze the physical evidence taken from the crime scene in an attempt to solve the crime. A set of mathematics lessons provides students with information that will narrow down their suspect list. They deduce the perpetrator's height by using proportional reasoning; calculate the time of death using Newton's Law of Cooling; and estimate the range of travel possible in the window of opportunity by deriving the equation of a circle from the distance formula. If students complete only one of the math lessons, they should be provided with the "results" of the other lessons so they will have a complete set of evidence. Students also study blood types and DNA analysis techniques in order to analyze "blood" left at the crime scene.

### Subunit Key Questions

- How can ratios and proportions be used to figure out someone's height based on their footprints? (Algebra I)
- How can a murder victim "tell" us when he or she was killed? (Algebra II)
- How can the distance formula and circle equations be used to eliminate suspects if we know the crime was committed during passing time between classes? (Geometry)
- What information can we obtain from blood collected at the scene? How can it help us find the guilty party? (Biology or Health Science I)
- Is DNA the best source of evidence? What *doesn't* DNA left at the scene reveal about a crime? (Biology)

### Lesson Summaries

Lesson	Subject	Description
2.1	Algebra I	<b>Lengthy Relationships</b> Students measure the height and stride of each class member and use proportional reasoning to determine the approximate height of an unknown person given their stride length taken from footprints at the crime scene.
2.2	Algebra II	<b>Time of Death: The Law of Cooling</b> Students apply Newton's Law of Cooling, a logarithmic equation, to the crime scene by taking temperature readings of the environment and the victim to determine the time of death.
2.3	Geometry	<b>Suspect Radius</b> Students apply the distance formula and the equation for the radius of a circle to determine the maximum area surrounding the crime scene that the murderer could have traveled to commit the crime.
2.4	Biology or Health Science I	<b>Blood Typing</b> Students apply their knowledge of blood types to eliminate possible suspects by typing the blood samples found at the crime scene.
2.5	Biology	<b>DNA Fingerprinting</b> Students apply their knowledge of DNA and restriction enzymes to conduct a simplified DNA fingerprinting activity. Students digest DNA samples from the crime scene and the suspects and separate the fragments using gel electrophoresis. Students analyze the results to determine the guilty party.



# Lengthy Relationships

## LESSON 2.1

### ALGEBRA I

#### Time

50 minutes

#### Materials

- Graph paper
- Rulers
- Yard or Meter sticks
- Butcher paper (optional)

#### Prior Student Learning

Students should already be familiar with graphing linear equations and determining linear equations from graphs.

### *Essential Question for This Unit*

What are the appropriate roles for scientific technology and human judgment in arriving at verdicts in criminal cases?

### *Objectives*

After completing this lesson, students should be able to

- Use proportional reasoning to determine the approximate height of people given their stride length.
- Create a line of best fit for their observed data and make predictions from the data.

### *Lesson Activities*

#### **Lesson Springboard**

There were two sets of footprints at the scene of the crime. One set has been matched with the victim, and the other set has been concluded to belong to the murderer. What can investigators deduce from this evidence?

#### **Lesson Development**

##### *Class Discussion*

Brainstorm with the class about what can be learned from a set of footprints. They might mention, for example, the gender of the murderer—based on the shape of the shoe print—and the murderer’s approximate weight if the prints were on soft material like mud, etc. If not already mentioned, ask the class whether they could determine the perpetrator’s approximate height, and if so, how.

We can assume that the longer a person’s stride, the taller the person. Tell students that they will be collecting and analyzing data in order to draw some conclusions about the murderer’s approximate height.

##### *Small Group Work*

As a class, decide whether everyone will use metric or customary units. Then have students break into small groups and allow them to measure and record each person’s height. After that, groups must figure out the most accurate way to measure each person’s average stride length while walking. Butcher paper can be helpful for recording footprints if available. Students may come up with several different methods, and the class will evaluate those methods later on.

When each group has finished measuring the average stride length and height of each member, record all of the class data on the board. Have each group graph the data and identify any patterns.

Subunit 2—Crime Scene Investigations  
*Lengthy Relationships*

LESSON 2.1

***Class Discussion***

As a class, discuss the relationship on the graph and whether it is best generalized as linear, parabolic, or something else. Then have students draw their line of best fit, determine the slope and y intercept of their line, and write an equation relating height and stride length.

Students will have different lines of best fit and resulting equations. Discuss the reasons for these differences. If appropriate, mention that mathematicians have developed methods to get accurate lines of best fit, and students will be learning about those methods later on.

Discuss the different methods for finding a person's average stride length. Ask the class to consider which method they think is the best and why. Decide whether the data each group collected were accurate enough to include in the final data analysis. Have students justify their opinion as to whether the best-fit line they created needs to be moved. Choose or create a graph, line of best fit, and equation that best represents the relationship between height and stride length.

***Lesson Closure***

Plug in the stride length of the murderer into the equation the class has created to find his or her approximate height. Discuss what would be an appropriate margin of error for this conclusion. Finally, eliminate teachers from the suspect list based on their height.

***Possible Prior Misconceptions***

Students may believe that each stride they take is the same length and may want to take only a single measurement per person in their group, rather than taking multiple measurements and calculating an average.

Students may want to plug in the murderer's stride length into their equation and believe that they will get an "exact" height. It is important to discuss an appropriate range for their conclusion concerning approximate height.

***Student Assessment Artifacts***

Data table of height and stride length measurements

Graph of data with line of best fit and equation

List of teachers who are still suspects due to their height

***Variations and Extensions***

Students may suggest that the murderer could have been running, rather than walking, making the stride length longer. The class could conduct a similar study with running stride lengths.

Students may want to create a direct proportion between their individual height and stride length and the stride length of the suspect to calculate the suspect's height. Ask them to use that method and compare their answer to what the class's best-fit line suggests. Ask students to think about which method would produce the most useful results, and why.

Subunit 2—Crime Scene Investigations  
*Lengthy Relationships*

LESSON 2.1

**National and State Academic Standards**

**NATIONAL**  
**NCTM Standards of School Mathematics**

*Algebra*

Instructional programs from prekindergarten through grade 12 should enable all students to—

- understand patterns, relations, and functions
- represent and analyze mathematical situations and structures using algebraic symbols
- use mathematical models to represent and understand quantitative relationships
- analyze change in various contexts.

**STATE**

List your state-specific standards in the space below.



Subunit 2—Crime Scene Investigations

# Time of Death: The Law of Cooling

## LESSON 2.2

### ALGEBRA II

#### Time

50 minutes

#### Materials

- Graph paper
- Scientific calculators

#### Resources

“Teacher Page for the Exponential and Logarithmic CSI Project”  
(<http://webpages.csus.edu/~sac46677/teacherpage.htm>)

#### Prior Student Learning

Students should already be familiar with logarithmic equations and the constant  $e$ .

#### Essential Question for This Unit

What are the appropriate roles for scientific technology and human judgment in arriving at verdicts in criminal cases?

#### Objectives

After completing this lesson, students should be able to

- Solve logarithmic equations for an unknown.
- Graph logarithmic equations.

#### Lesson Activities

##### Lesson Springboard

When the body was discovered, an astute investigator took the victim's temperature and the temperature of the room. An hour later, the investigator took the temperature of the victim again. With this information, can the time of death be determined? Who can be eliminated as a suspect once the time of death is known?

##### Lesson Development

###### Direct Instruction

Introduce the idea that scientists can estimate the time of death of a person by calculating how long it would have taken the body to cool to the temperature observed at the time it was found. The body doesn't cool in a linear fashion, according to Newton's Law of Cooling and actual forensic studies.

Newton's Law of Cooling states that:

$$T(t) = T_s + (T_0 - T_s)e^{-kt}$$

where:

$t$  is the time in the preferred units (seconds, minutes, hours, etc.)

$T(t)$  is the temperature of the object at time  $t$

$T_s$  is the surrounding constant temperature (room temperature)

$T_0$  is the initial temperature of the object

$k$  is a constant to be found

Explain that  $k$  must be determined for the body in question before the actual time of death can be calculated. Give the class the data about the room temperature and the two body temperature readings that the investigator (or your class) measured.

##### Small Group Work

As a class, decide what unit of time the entire class will use. Then, have students solve for  $k$  in small groups using the recorded data. Students will have to remember how to solve logarithmic equations. Circulate

# *Time of Death: The Law of Cooling*

## LESSON 2.2

among students to check whether they understand how to solve these equations.

If there is time, have one group present their findings to the class and come to a consensus about the value of  $k$  for this human body.

Now that the value of  $k$  has been established, have each group graph the equation they created for the cooling rate of human flesh. Use this graph to estimate the time of death. Then, have groups solve for the time of death by manipulating the equation algebraically, assuming that  $t = 0$  is the time that the first temperature reading was taken at the crime scene. Allow a group to present their findings and justify their mathematical reasoning as to the estimated time of death for the victim.

### ***Class Discussion***

Students should check their answer by graphing their equation for the cooling rate of human flesh on their graphing calculator, and then by using the “trace” or “calculate” function. Discuss any inconsistencies that the groups may have found.

### **Lesson Closure**

Discuss the accuracy of this calculation in terms of the actual time of death. Narrow the window of time in which the crime could have been committed and eliminate suspects from the suspect list.

### ***Possible Prior Misconceptions***

Students may have assumed that the cooling rate of bodies is linear. When they discover it is logarithmic, they may assume that the  $k$  constant will be given to them and that it is the same for all human bodies. Asking the class solve for  $k$  makes the constant specific to the victim’s body. This also provides needed practice in solving these types of equations.

### ***Student Assessment Artifacts***

Working in groups or as individuals, students can produce a written report showing the calculations and graphs that led them to eliminate certain witnesses. “The Teacher Page for Exponential and Logarithmic CSI Project” (<http://webpages.csus.edu/~sac46677/teacherpage.htm>) offers another murder mystery scenario that uses the same concepts as this lesson and can be assigned as a reinforcement exercise.

### ***Variations and Extensions***

This lesson can easily be combined with a physics lesson on Newton’s Law of Cooling and temperature experiments.

# Time of Death: The Law of Cooling

## LESSON 2.2

### National and State Academic Standards

#### **NATIONAL**

#### **NCTM Standards of School Mathematics**

##### *Algebra*

- understand patterns, relations, and functions;
- represent and analyze mathematical situations and structures using algebraic symbols;
- use mathematical models to represent and understand quantitative relationships;
- analyze change in various contexts;

##### *Problem Solving*

- build new mathematical knowledge through problem solving;
- solve problems that arise in mathematics and in other contexts;
- apply and adapt a variety of appropriate strategies to solve problems;
- monitor and reflect on the process of mathematical problem solving.

#### **STATE**

List your state-specific standards in the space below.



# Suspect Radius

## LESSON 2.3

### GEOMETRY

#### Time

50 minutes

#### Materials

- Graph paper
- Rulers
- Yard or Meter sticks
- Timers
- Map of the school campus
- Compass

#### Prior Student Learning

Students should already be familiar with the distance formula and its derivation.

Students will have completed the lesson on determining the approximate time of the victim's death.

### *Essential Question for This Unit*

What are the appropriate roles for scientific technology and human judgment in arriving at verdicts in criminal cases?

### *Objectives*

After completing this lesson, students should be able to

- Graph the equation of a circle given its center and radius.
- Give the equation of a circle given its center and radius.
- Determine whether a point lies in the interior or exterior of a circle from its equation.
- Derive the equation of a circle from the distance formula.

### *Lesson Activities*

#### **Lesson Springboard**

From previous forensic investigations, we have already determined the approximate time of death, and that the murderer was most likely a teacher. Witnesses have confirmed that everyone on the faculty was either teaching a class or in a meeting during the 2 class sessions overlapping the time when the murder could have occurred. No teachers were late to their classes or meetings. Therefore, the murder occurred during the passing time between classes.

Given that no one noticed a faculty member who was out of breath or otherwise showing signs of running, one can conclude that the murderer walked from his or her classroom to commit the crime and walked back in time to start the next class. Passing period is 5 minutes long. With this information, which teachers are still suspects? Which teachers are now eliminated from suspicion?

#### **Lesson Development**

##### *Small Group Work*

In small groups, have students figure out the approximate speed at which a person would walk in the school halls using a timer and yardstick. Have the groups share their data; ask the class to agree upon a speed that is reasonable and would not rule out any possible suspects.

##### *Discussion*

The class can now calculate the maximum distance that a teacher could have traveled during the passing period between classes. Ask the class "if you were to mark all the points on campus that were the farthest a teacher could have been when the passing period started, what shape would you end up with?" Students should realize that this maximum

*Suspect Radius*

## LESSON 2.3

distance is divided in half, because the teacher would have to reach the scene of the crime and return to his or her classroom. Then, students will reason that all points a set distance from a given point (where the murder was committed) constitute a circle.

Hand out a scaled map of the campus that already has grid lines on it, with the origin labeled at one corner of the page. Ask students to mark the place where the murder occurred and give the coordinates of that point  $(h,k)$ . Because students are already familiar with the distance formula, they can plug the point of the crime and the distance they determined from their investigation into that formula to get the equation of a circle.

The maximum distance between the scene of the crime  $(h,k)$  and the murderer at the beginning of the passing period  $(x,y)$  is  $r$ .

Distance formula:

$$\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} = d$$

Plug in  $r$  for  $d$ ,  $(h,k)$  for  $(x_1, y_1)$  and  $(x,y)$  for  $(x_2, y_2)$ :

$$\sqrt{(x - h)^2 + (y - k)^2} = r$$

Square both sides to derive the general equation of a circle:

$$(x - h)^2 + (y - k)^2 = r^2$$

Point  $(h,k)$  is the center of the circle and  $r$  is the radius.

**Individual Work**

Have all students calculate at least three points that lie on the circle and graph them on the map. Then, have students confirm that their points lie on the circle by carefully drawing the entire circle using a compass.

**Lesson Closure**

Finally, ask how a student investigator would know whether a teacher is inside or outside the circle of suspicion without looking at the map. Ask students to test points obviously in the interior and exterior of the circle to see if they find any patterns. They should discover that if the distance between  $(h,k)$  and  $(x,y)$  is greater than  $r$ , then the teacher is no longer suspect. If the left side of the equation is less than  $r^2$ , the teacher could still be guilty. Use this information to narrow down the list of possible murderers at the school.

**Possible Prior Misconceptions**

Students often consider equations of circles and other figures as completely unrelated to previous equations they have worked with. This is the ideal time to remind students that all equations and graphs are

*Suspect Radius*

## LESSON 2.3

representations of relationships between variables. It might be helpful to review the types of relationships that are represented as lines and parabolas.

The equation of a circle is a direct result of the distance formula, which in turn is derived from the Pythagorean Theorem. Students may not make the connection between the definition of a circle and its resulting equation in coordinate geometry.

***Student Assessment Artifacts***

Data and calculations to determine maximum distance from the scene of the crime

Equation of the suspect circle and graphed circle on school map

List of teachers who are still suspects due to the location of their classroom and calculations that confirm those conclusions

***Variations and Extensions***

This problem becomes more interesting if your school has multiple floors. Students can decide how much time it takes to climb up and down the stairs and then create appropriate circles of suspicion on each floor of the building.

If your school is large enough or you need more suspects, the murderer can run instead of walk. Further, the time of the murder can be changed to allow a larger (but still set) window of movement by the murderer. For example, the murder could occur during break, lunch, or between the end of the school day and the beginning of a staff meeting.

**National and State Academic Standards****NATIONAL****NCTM Standards for School Mathematics*****Geometry***

Instructional programs from pre-kindergarten through grade 12 should enable all students to—

- specify locations and describe spatial relationships using coordinate geometry and other representational systems;
- use visualization, spatial reasoning, and geometric modeling to solve problems.

**STATE**

List your state-specific standards in the space below.



# Blood Typing

## LESSON 2.4

### BIOLOGY OR HEALTH SCIENCE I

#### Time

50 minutes

#### Materials

- Simulated blood samples collected from the crime scene
- Blood typing kit or anti-sera A, B, and Rh
- Blood typing trays or glass slides
- Toothpicks

#### Resources

CSI: Blood Typing worksheet

#### Prior Student Learning

Students should have a basic understanding of the immune system and how it functions.

### *Essential Question for This Unit*

What are the appropriate roles for scientific technology and human judgment in arriving at verdicts in criminal cases?

### *Objectives*

After completing this lesson, students should be able to

- Identify and explain the differences between blood types.
- Explain the role of the immune system in blood transfusions.
- Determine the type of a blood sample through antigen testing.

### *Lesson Activities*

#### **Lesson Springboard**

Ask students whether they think all blood is the same and conduct an informal poll to determine whether students know their own blood types. Remind students that they collected blood samples from the crime scene. What kinds of information do they think they will get from the blood samples?

#### **Lesson Development**

##### *Direct Instruction*

Introduce students to the fact that there are different blood types. Begin by describing red blood cells, including their shape and their purpose (to carry oxygen to tissues).

Explain that there are four major blood types (*A*, *B*, *AB*, and *O*) determined by the presence or absence of two carbohydrates (*A* and *B*) on the surface of the blood cells. A person's immune system recognizes the carbohydrate(s) that are present in its own blood, but will attack blood with any different carbohydrates. When blood is attacked by anti-*A* and/or anti-*B* antibodies, the blood cells will clump together. This can be fatal if it occurs in the bloodstream. Therefore, it is important to make sure that transfused blood is compatible with the target. Write the following empty chart on the board and have students identify which donor blood types will be accepted by recipients.

	O Recipient	A Recipient	B Recipient	AB Recipient
O Donor	Yes	Yes	Yes	Yes
A Donor	No	Yes	No	Yes
B Donor	No	No	Yes	Yes
AB Donor	No	No	No	Yes

In addition to the *A* and *B* surface carbohydrates, human blood has another distinguishing characteristic known as the *Rh factor*. In gen-

# Blood Typing

## LESSON 2.4

eral, blood is either *Rh positive (Rh+)* or *Rh negative (Rh-)*, which refers to presence or absence of the Rh protein on the surface of the blood cell. Incompatible Rh factors will cause blood to clump together, just as with the A/B blood types. In a population of 100:

84 are RH+	16 are RH-
38 are O+	7 are O-
34 are A+	6 are A-
9 are B+	2 are B-
3 are AB+	1 is AB-

While potentially fatal within the human body, the blood clumping reaction, also known as *agglutination*, can be used to identify blood type.

### Crime Scene Lab

Pass out the CSI: Blood Typing worksheet. Using the simulated blood collected from the crime scene, have students examine the victim's blood, as well as the multiple blood samples collected from the scene, to determine the blood types of the victim and others. (Some samples should be additional blood from the victim; some should be from the perpetrator.)

### Lesson Closure

Discuss with the class what they have learned about the crime. The conversation should indicate that they know there is blood from another person at the crime scene, and that the extra blood most likely came from the perpetrator. Ask them: What steps should be taken next? How can this information be used to narrow the suspect list?

### Possible Prior Misconceptions

Many students have trouble with donor versus recipient compatibility (e.g., that AB can accept O blood, but O cannot accept AB blood).

### Student Assessment Artifacts

Completed CSI: Blood Typing worksheet

### Variations and Extensions

Before testing the blood from the crime scene, you may choose to have students examine their own blood to determine its type. This will require lancets and alcohol swabs, in addition to the anti-sera. However, two prior considerations are important. Some students may be reluctant to draw their own blood sample. And, you may not want to run the risk of any blood-borne contamination.

If this lesson is taking place in the Health Science class, you may wish to extend this lesson to include phlebotomy.

## National and State Academic Standards

**NATIONAL**  
**NRC National Science Education Standards**

*Life Science*

The Cell—

Cells have particular structures that underlie their functions. Every cell is surrounded by a membrane that separates it from the outside world. Inside the cell is a concentrated mixture of thousands of different molecules which form a variety of specialized structures that carry out such cell functions as energy production, transport of molecules, waste disposal, synthesis of new molecules, and the storage of genetic material.

**STATE**

List your state-specific standards in the space below.

Name \_\_\_\_\_ Date \_\_\_\_\_ Period \_\_\_\_\_

## CSI: Blood Typing

### Crime Scene Summary

After discovering the body, you should have collected blood samples from the victim and from the various blood spatters around the scene. Your goal is to identify the blood from the various samples. Most of the blood is probably from the victim, but you should test to be sure. If there is any other blood, that will be an important clue.

### Materials

- Blood samples
- Anti-A serum
- Anti-B serum
- Anti-Rh serum
- Blood typing trays
- Toothpick

### Reaction Chart

Anti-A Reaction	Anti-B Reaction	Blood Type
Agglutination	No Agglutination	A
No Agglutination	Agglutination	B
Agglutination	Agglutination	AB
No Agglutination	No Agglutination	O

*Anti-Rh Serum: Agglutination = Rh+*

### Procedure

1. Label four blood typing trays as *Victim*, *Sample #1*, *Sample #2*, and *Sample #3*.
2. Place 1 drop of the appropriate blood sample in each of the wells of the typing trays.
3. Place 3 drops of the anti-A serum on the blood in the A wells.
4. Stir each sample with a clean toothpick for 30 seconds.
5. Place 3 drops of the anti-B serum on the blood in the B wells.
6. Stir each sample with a clean toothpick for 30 seconds.
7. Place 3 drops of the anti-Rh serum on the blood in the Rh wells.
8. Stir each sample with a clean toothpick for 30 seconds.
9. Record your observations in the data table and use the reaction chart below to determine the blood type.

### Data Table

Blood Source	Anti-A Reaction	Anti-B Reaction	Anti-Rh Reaction
Victim			
Sample 1			
Sample 2			
Sample 3			

### Conclusions

1. What is the victim's blood type?
  
2. What are the blood types of Samples #1, 2, and 3?
  
3. Is all of this blood from the victim? How do you know?
  
4. What have you learned about the crime? What do you still need to know?

Subunit 2—Crime Scene Investigations

# DNA Fingerprinting

## LESSON 2.5

### BIOLOGY

#### Time

150 minutes

#### Materials

##### Equipment (for each group)

- EcoRI enzyme
- BamHI enzyme
- HindIII enzyme
- Ice
- Lambda DNA (0.5 mg/ml)
- 2x multicore® restriction buffer
- Loading dye
- 1Kb DNA ladder
- 1% agarose gel (1g agarose/100 ml TBE or TAE buffer—microwave and pour)
- 1X TBE or TAE Buffer
- Carolina Blue® stain (or ethidium bromide and UV source)
- Microcentrifuge tubes
- 0.5–10 µl micropipettors and tips
- 37°C water bath
- Electrophoresis equipment
- Microtube racks
- 10 mm rulers
- 10 sheets of graph paper
- Hot plate with magnetic stirrer or microwave oven

#### Resources

- Restriction Enzymes worksheet
- CSI: DNA Fingerprinting worksheet

#### Prior Student Learning

Students should be familiar with the structure of DNA.

Students should already have narrowed their suspect list to two or three individuals in the previous lessons in Subunit 2.

### Essential Question for This Unit

What are the appropriate roles for scientific technology and human judgment in arriving at verdicts in criminal cases?

### Objectives

After completing this lesson, students should be able to

- Explain the function and role of restriction enzymes in DNA analysis.
- Analyze the results of an electrophoresis gel.
- Explain the mechanisms underlying *Southern blotting*.

### Lesson Activities

#### Teacher Preparation

This lab is a simplified simulation of DNA fingerprinting using *lambda* DNA and *restriction enzymes* (*EcoRI*, *BamHI*, *HindIII*). However, to get the desired simulated results, the “DNA samples” will actually be the restriction enzymes, and the “restriction enzyme” is lambda DNA.

To save class time, prepare an agarose gel for each group prior to class. Aliquot 4 µl of each of three different enzymes and label them as DNA from three different suspects for the demonstration. Be sure to keep the restriction enzymes on ice at all times.

Aliquot 4 µl of lambda DNA and label it as a restriction enzyme. Prepare sufficient buffer solution for all groups to run their gels. A 37°C water bath should be prepared in a beaker.

#### Lesson Springboard

Have students share any examples of DNA testing they may be familiar with from popular culture. Bring in a recent news story about DNA testing, possibly a story about a criminal exoneration based on DNA evidence and share it with the class.

Explain that DNA fingerprinting, though it is considered quite reliable, is expensive and time consuming, and therefore typically not used at the outset of an investigation. However, once a field of suspects has been narrowed down, collection and analysis of DNA samples can be a key piece of evidence. At this point in their own investigation, the students’ field of suspects should be narrowed down to only two or three. Have students go out and “collect” DNA samples from their suspects.

#### Lesson Development

##### Simulation

Remind students of what they have learned about the structure of DNA. Explain the function of restriction enzymes and how they are used in

Subunit 2—Crime Scene Investigations  
*DNA Fingerprinting*

LESSON 2.5

DNA analysis. Pass out the Restriction Enzymes handout, and have students tape together several copies of a base pair sequence. Using two restriction enzymes, have students cut apart the base pair sequence and observe the different size fragments that result.

**Direct Instruction**

Introduce the concept of *DNA fingerprinting*. Only 0.001% of DNA (about 3 million bases) differs from one person to the next. However, those small variable regions are enough for scientists to generate a DNA profile of an individual, using DNA extracted from blood, bone, hair, and other body tissues or products.

Tell students that in criminal cases, DNA is extracted from both the crime scene evidence and from the suspect. Both sets of DNA are analyzed for the presence of a set of specific DNA regions (*markers*). Scientists find the markers in a DNA sample by designing small pieces of DNA (*probes*) that will each seek out and bind to a complementary DNA sequence in the sample. A series of radioactive probes bound to a DNA sample creates a distinctive pattern for an individual.

Explain that forensic scientists compare these DNA profiles to determine whether the suspect's sample matches the evidence sample. A single marker is not usually unique to an individual, so forensic scientists generally look at multiple markers. If the sample profiles don't match, the person did not contribute the DNA at the crime scene, but if the two DNA samples match at multiple regions, the odds are good that the two samples come from the same person. While there is a chance that someone else has the same DNA profile for a particular probe set, the odds are exceedingly slim, especially if there are multiple probes. Four to six probes are recommended.

Pose the following question: "How small do the odds have to be when conviction of the guilty or acquittal of the innocent lies in the balance?" Tell students that many judges consider this a matter for a jury to take into consideration along with other evidence in the case. Experts point out that using DNA forensic technology is far superior to eyewitness accounts, where the odds for correct identification are only about 50:50. The more probes used in DNA analysis, the greater the odds for a unique pattern and against a coincidental match, but each additional probe adds greatly to the time and expense of testing.

Point out that DNA fingerprinting is essentially a Southern Blot procedure that requires five general steps:

1. Isolation of DNA—DNA must be recovered from the cells or tissues of the body. Only a small amount of tissue—such as blood, hair, or skin—is needed. For example, the amount of DNA found at the root of one hair is usually sufficient.
2. Cutting—Special enzymes called *restriction enzymes* are used to cut the DNA at specific places. For example, an enzyme called *EcoRI*,

Subunit 2—Crime Scene Investigations  
*DNA Fingerprinting*

LESSON 2.5

found in bacteria, will cut DNA only when the sequence GAATTC occurs.

3. Sizing and sorting—The DNA pieces are sorted according to size by a sieving technique called *electrophoresis*. The DNA pieces are passed through a gel made from agarose (a gelatin-like product made from seaweed). This technique is the biotechnology equivalent of screening sand through progressively finer mesh screens to determine particle sizes.
4. Probing—The distribution of DNA pieces is transferred to a nylon sheet by placing the sheet on the gel and soaking the pieces overnight. Radioactive or colored probes that are added to the nylon sheet produce a pattern called the *DNA fingerprint*. Each probe typically sticks in only one or two specific places on the nylon sheet.
5. DNA fingerprint—The final DNA fingerprint is built by using several probes (5–10 or more) simultaneously. It resembles the bar codes used by grocery store scanners.

**Lab Activity**

Pass out the CSI: DNA Fingerprinting lab procedures handout. In this lab, students will simulate how DNA fingerprinting (or DNA profiling) might be used to solve a crime.

In previous lessons, students should have narrowed down their suspect list to two or three individuals. The lab simulates DNA gathered at the crime scene against that of the two or three suspects. In the lab, students perform restriction digests. In order to search for similarities between samples, they will run the restriction fragments on an electrophoresis gel. This simulates Steps 2 and 3 of the DNA fingerprinting lab procedures. This activity does not require students to isolate their DNA from cells or to use radioactive probes.

In order to make DNA fingerprinting affordable, a little deception is required on the part of the teacher. Lambda DNA is used instead of multiple plasmids. This means that the teacher will have to switch the labels on the samples given to the students. The sample labeled DNA is actually the different restriction enzymes, and the sample labeled restriction enzyme is the lambda DNA.

Have students follow the procedures on the DNA Fingerprinting handout. The lab will take about 3 days. You can save class time by doing the restriction digest yourself, and/or you can pre-run the gels and just have students stain and observe the results.

**Class Discussion**

As introduced earlier, true DNA fingerprinting involves five general steps— isolating the DNA; restriction of the DNA samples into fragments that can be handled more easily; separation by size of the various length fragments using electrophoresis; attaching radioactive probes; and then visualizing certain fragments to which radioactive probes have been attached.

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*DNA Fingerprinting*

LESSON 2.5

During the “down time” of the lab (i.e., while the gel is running or while the gel is staining), discuss the ways in which this activity is and is not an accurate simulation of true DNA fingerprinting.

**Lesson Closure**

Review the results of the activity with the students. What evidence has the DNA fingerprinting provided for each student’s case? Be sure to discuss the fact that though the DNA fingerprinting places the suspect at the crime scene, it doesn’t necessarily prove that the suspect is guilty of the crime.

***Possible Prior Misconceptions***

Students may not realize that DNA analysis is a costly and time-consuming process. In fact, the simulation activity may reinforce this misconception, so be sure to address this issue. Actual DNA fingerprinting and analysis are more complex than the activity conducted in this lab.

Some students may believe that DNA analysis is proof of guilt, rather than just proof of a suspect’s presence at the scene.

***Student Assessment Artifacts***

Completed DNA Fingerprinting worksheet

***Variations and Extensions***

If you have the time and equipment, have students isolate actual DNA from cheek cells.

If your school does not have electrophoresis equipment, you may have students participate in a virtual DNA fingerprinting lab. Links to several simulations of DNA fingerprinting of varying levels of complexity can be found at *Visible Proofs: Forensic Views of the Body* (<http://www.nlm.nih.gov/visibleproofs/resources/weblinks.html>).

Discuss with students how DNA testing can also be used to exonerate convicted criminals. A list of individuals who have been cleared of criminal wrongdoing on the basis of DNA evidence can be found at NOVA (<http://www.pbs.org/wgbh/nova/sheppard/cleared.html>).

## National and State Academic Standards

**NATIONAL**  
**NRC National Science Education Standards**

*Life Science*

The Molecular Basis of Heredity—

In all organisms, the instructions for specifying the characteristics of the organism are carried in DNA, a large polymer formed from subunits of four kinds (A, G, C, and T). The chemical and structural properties of DNA explain how the genetic information that underlies heredity is both encoded in genes (as a string of molecular “letters”) and replicated (by a templating mechanism). Each DNA molecule in a cell forms a single chromosome.

**STATE**

List your state-specific standards in the space below.

Name \_\_\_\_\_ Date \_\_\_\_\_ Period \_\_\_\_\_

## Restriction Enzymes

Cut out and tape together the DNA base pair sequence on the next page. These two sequences are identical. Cut out the restriction enzyme cards. Pick two restriction enzymes to “digest” your DNA strand. Compare the cards to the DNA sequence and cut your DNA strand in the appropriate location. Tape the fragments into the spaces below:

---

Restriction Enzyme #1 \_\_\_\_\_

---

Restriction Enzyme #2 \_\_\_\_\_

---

### Questions

1. How many fragments resulted from digestion with the first restriction enzyme? The second?
2. What would happen if you used both restriction enzymes to cut a DNA strand?
3. If you were given fragments of DNA that had been cut with EcoRI, how would you be able to tell if they had originally come from the same DNA as the strand you were given?

Name \_\_\_\_\_ Date \_\_\_\_\_ Period \_\_\_\_\_

### DNA Base Pair Sequences

Cut out the strips in each set and tape them together end to end, starting with the lightest strip and ending with the darkest strip.

A C C G A A T C C T G G A T C C A T A C C C G C G G T G
T G G C T T A G G T C C T A G G T A T G G G C G C C A C
A A T T C G G G A T C C A T C G A A T C T C C G C G G G
T T A A G C C C T A G G T A G C T T A G A G G C G C C C
A T C C G A T C C C G C T C G A T A G A A T T C C C T C
T A G G C T A G G G C G A G C T A T C T T A A G G G A G
A A C C G C G G A A T G G G A T C C C C G T G G A T C G
T T G G C G C C T T A C C C T A G G G G C A C C T A G C
A C A A T T T G A A T T C C G C G G T A T C G A G G A T
T G T T A A A C T T A A G G C G C C A T A G C T C C T A

A C C G A A T C C T G G A T C C A T A C C C G C G G T G
T G G C T T A G G T C C T A G G T A T G G G C G C C A C
A A T T C G G G A T C C A T C G A A T C T C C G C G G G
T T A A G C C C T A G G T A G C T T A G A G G C G C C C
A T C C G A T C C C G C T C G A T A G A A T T C C C T C
T A G G C T A G G G C G A G C T A T C T T A A G G G A G
A A C C G C G G A A T G G G A T C C C C G T G G A T C G
T T G G C G C C T T A C C C T A G G G G C A C C T A G C
A C A A T T T G A A T T C C G C G G T A T C G A G G A T
T G T T A A A C T T A A G G C G C C A T A G C T C C T A

### Restriction Enzyme Sites

Cut out restriction enzyme cards. Pick two to “digest” your DNA strand. Compare the card to the DNA sequence and cut your DNA strand in the appropriate location.

<b>TaqI</b>	<b>BamHI</b>	<b>SacII</b>	<b>EcoRI</b>
T   C G A A G C   T	G   G A T C C C C T A G   G	C C G C G   G G G C   G C C	G   A A T T C C T T A A   G

Name \_\_\_\_\_ Date \_\_\_\_\_ Period \_\_\_\_\_

## CSI: DNA Fingerprinting

### Crime Investigation Summary

At the beginning of our investigation, anyone and everyone at school was a suspect. Through careful examination of evidence, you have now narrowed down your suspect list to just two (or three). A DNA test will be your final, conclusive piece of evidence. Collect a DNA sample from each of your suspects. In this lab, you will see if DNA left at the scene matches any of your suspects.

### Materials

4  $\mu$ l DNA from crime scene in a microfuge tube  
 4  $\mu$ l DNA from suspect #1 in a microfuge tube  
 4  $\mu$ l DNA from suspect #2 in a microfuge tube  
 4  $\mu$ l DNA from suspect #3 in a microfuge tube  
 Restriction enzyme  
 2x multicore<sup>®</sup> restriction buffer  
 Loading dye  
 1% agarose gel  
 1 liter 1X TBE or TAE Buffer  
 Carolina Blue<sup>®</sup> stain (or ethidium bromide and UV source)  
 0.5–10  $\mu$ l micropipettors and tips  
 37°C water bath  
 1 set of electrophoresis equipment  
 1 microtube rack

### Procedures—Day 1

1. Get your DNA samples, restriction enzyme, and 2X restriction buffer from your teacher.
2. Using your micropipettor and FRESH tip for each tube, add 4  $\mu$ l of restriction enzyme to each DNA sample.
3. Using a FRESH tip each time, add 8  $\mu$ l of 2X restriction buffer to each sample.
4. Mix each sample by flicking the bottom tip of the microfuge tube with your fingertip.
5. Incubate your samples in a 37°C water bath overnight.

### Procedures—Day 2

6. Get an agarose gel, 1X TBE buffer, 1X loading dye, and an electrophoresis gel box from your teacher.
7. Place the gel in the gel box, and fill the gel box with 1X TBE buffer solution until the entire gel is submerged. (Pour from either end of the gel box, rather than directly onto the gel.)
8. Set your micropipettor to 10  $\mu$ l.
9. Practice loading the gel
  - a. Draw 10  $\mu$ l (microliters) of 1X loading dye into your pipettor. (Make sure there are no air bubbles in the tip!)
  - b. Center the pipette over an outside well using two hands. (Use only the outside wells for practice; the inside wells will be used for running your DNA samples!)
  - c. Holding the pipettor at a slight angle, dip the pipette tip through the surface of the buffer and gently release dye into one of the wells. (The tip must be below the surface of the buffer but do NOT push the tip through the bottom of the well.)
  - d. You may practice loading the gel with the two outer lanes on each side of the gel.





# Convincing the Jury

## SUBUNIT 3 OVERVIEW

### **Essential Question for This Unit**

What are the appropriate roles for scientific technology and human judgment in arriving at verdicts in criminal cases?

### **Subunit Goals**

Subunit 3 explores how forensic science is used in various real world scenarios. In World History, students study war crime investigations and how the use of forensic science has provided evidence of crimes against humanity that might otherwise never be known. In English Language Arts, students gain insight into careers related to forensic science investigations by seeking out and interviewing professionals in the field. Students finish the unit by compiling their evidence and analysis from the crime scene into a case against their suspect.

### **Subunit Key Questions**

- What are war crimes and crimes against humanity? (World History)
- How is forensic science used in bringing war criminals to justice? (World History)
- What is the experience of professionals who work in the field of forensic science? How is their work similar to or different from what we see on television? (English Language Arts)
- Who is the murderer, and what evidence do you have of his or her guilt? How certain are you that you know the guilty party? (English Language Arts)

### **Lesson Summaries**

<b>Lesson</b>	<b>Subject</b>	<b>Description</b>
3.1	World History	<b><i>Gathering Evidence, Bringing Justice</i></b> Students examine events and issues associated with war crimes and crimes against humanity, including the role forensic science plays in bringing war criminals to justice.
3.2	English Language Arts	<b><i>On the Case: Interviews With Professionals</i></b> Students interview a range of professionals associated with forensic investigations about their profession, including their day-to-day experiences, their training, and how their job compares to portrayals in popular media.
3.3	English Language Arts	<b><i>The Closing Argument</i></b> Students synthesize the evidence from their crime scene investigations to determine the guilty party. Students present their case in a persuasive essay.



# Gathering Evidence, Bringing Justice

## LESSON 3.1

### WORLD HISTORY

#### Time

90 minutes

#### Materials

- Newspaper articles about recent war crimes and International Court of Justice investigations
- The Nuremberg Principles
- The Nuremberg Code
- Excerpts from *The Bone Woman* by Clea Koff (optional)

#### Prior Student Learning

Students should be studying or have studied World War II and its aftermath.

### *Essential Question for This Unit*

What are the appropriate roles for scientific technology and human judgment in arriving at verdicts in criminal cases?

### *Objectives*

After completing this lesson, students should be able to

- Understand the events surrounding the Holocaust, including the reasoning behind and consequences of the Nuremberg Trials.
- Analyze the strengths and weaknesses of the Nuremberg Trials, including “victor’s justice.”
- Show familiarity with more recent cases of genocide and other crimes against humanity, their political and ideological causes, and their aftermaths.
- Discuss and define war crimes and crimes against humanity.
- Discuss the Nuremberg Principles and how they influenced later development of the International Court of Justice and other tribunals created to try perpetrators of war crimes and crimes against humanity.
- Understand how forensic anthropology aids in the process of trying war criminals.

### *Lesson Activities*

#### **Lesson Springboard**

Ask students to reflect on the personal and societal impact of crimes against humanity like The Holocaust. How do people heal and move forward after experiencing such incomprehensible violence toward themselves, their families, and their communities?

Have students write down the things that they would imagine needing in order to best heal after war atrocities. Remind the class that not only are people killed, but also families are often separated and possessions are seized. Neighbors who have lived peacefully together for decades are known to turn against each other because of their different ethnic or religious backgrounds. Students can then share their thoughts.

#### **Lesson Development**

##### *Lecture/Discussion*

Students will probably bring up the need for some form of justice during the discussion. Introduce and describe the Nuremberg Trials held at the end of World War II. Include the events and discussions held between Allied leaders that led to the Trials during the talks in Tehran, Yalta, and Potsdam. Discuss possible reasons why a judicial process was chosen instead of other options to bring justice to Nazi war criminals, including summary execution without trial, the complete denazification of Germa-

Subunit 3—Convincing the Jury

# Gathering Evidence, Bringing Justice

## LESSON 3.1

ny, and forced labor camps. Discuss the purposes and achievements of the process conducted at Nuremberg, including the *Nuremberg Principles* and *Nuremberg Code*. Hand out copies of the Nuremberg Principles and Nuremberg Code, and mention their influence on later developments in policies concerning research on human subjects and international law.

Introduce the idea of “victor’s justice.” Ask students whether they felt the Allied nations committed any war crimes or crimes against humanity as defined by the Nuremberg Principles and then have them discuss this issue.

Emphasize the fact that there have been many cases of war crimes and crimes against humanity since the Nuremberg Trials. Human rights advocates and forensic scientists have been working together with the international community to bring perpetrators of these crimes to justice. Relate the work that forensic anthropologists do at mass grave sites, prisoner of war camps, and other places to the process that students are modeling in this unit. This work involves collecting evidence to corroborate witness testimony about war crimes. Further, forensic techniques like DNA fingerprinting are used to help families reunite after years of separation and to help identify remains for proper burial by surviving family members.

If there is time, read excerpts from forensic investigations of mass graves from books such as *The Bone Woman* by Clea Koff.

### **Small Group Work**

Divide the class into small groups. Each group will investigate the causes and consequences of different war crimes that were committed after World War II. Pass out information (newspaper clippings, Internet research) on war crimes and crimes against humanity that have been or are now being investigated by an international or national tribunal. Alternatively, students can do their own research and bring it to class the next day. The following are some suggestions for research on more recent war crimes:

My Lai, Vietnam, 1968

Cambodia, 1975–1979

Former Yugoslavia, 1990s

Sierra Leone, 1991–2001

Rwanda, 1994

East Timor, 1999

### **Lesson Closure**

Have students share their knowledge of the atrocities they researched, including the causes and nature of the crimes, the efficacy of the tribunal or court involved, and any reconciliation processes that aided in healing the community involved. Also mention how forensics was used to gather evidence for trial, and what organization was charged with uncovering that evidence.

*Subunit 3—Convincing the Jury*

# *Gathering Evidence, Bringing Justice*

## LESSON 3.1

Students can discuss whether a legal trial is appropriate for war crimes and crimes against humanity, and if so, the relative importance of forensic evidence in these types of trials in comparison to trials involving other types of crimes.

### ***Possible Prior Misconceptions***

Students may think that The Holocaust was the only major crime against humanity in history.

Students may have misconceptions about the power of international courts of justice to convict and punish war criminals, and the United States government's position on international courts.

Students may have an inflated sense of the importance of forensic evidence; they may need to consider the appropriate balance of physical and eye-witness evidence in war crime cases.

### ***Student Assessment Artifacts***

Student reports on post-World War II war crimes and their related tribunals

### ***Variations and Extensions***

Invite an expert on human rights, forensic anthropology, or international law to be a guest speaker in your class.

Invite a survivor of The Holocaust or another war atrocity to be a guest speaker.

Expand the lesson to include other methods of encouraging the healing and growth of societies after atrocities are committed, including truth and reconciliation committees.

Expand the lesson to include crimes against humanity that have not been brought to trial or otherwise dealt with publicly and investigate the reasons why.

Subunit 3—Convincing the Jury  
*Gathering Evidence, Bringing Justice*

LESSON 3.1

**National and State Academic Standards**

**NATIONAL**

**NCSS Curriculum Standards for Social Studies**

*Power, Authority, and Governance*

- f. Analyze and explain ideas and mechanisms to meet needs and wants of citizens, regulate territory, manage conflict, establish order and security, and balance competing conceptions of a just society;

**NCHS National Standards in World History**

*Era 8*

4. The causes and global consequences of World War II.

*Era 9*

1. How post-World War II reconstruction occurred, new international power relations took shape, and colonial empires broke up.
2. The search for community, stability, and peace in an interdependent world.
3. Major global trends since World War II.

**STATE**

List your state-specific standards in the space below.

Name \_\_\_\_\_ Date \_\_\_\_\_ Period \_\_\_\_\_

## The Nuremberg Principles

*Principles of International Law Recognized in the Charter of the Nürnberg Tribunal and in the Judgment of the Tribunal, 1950.*

### Principle I

Any person who commits an act which constitutes a crime under international law is responsible therefore and liable to punishment.

### Principle II

The fact that internal law does not impose a penalty for an act which constitutes a crime under international law does not relieve the person who committed the act from responsibility under international law.

### Principle III

The fact that a person who committed an act which constitutes a crime under international law acted as Head of State or responsible Government official does not relieve him from responsibility under international law.

### Principle IV

The fact that a person acted pursuant to order of his Government or of a superior does not relieve him from responsibility under international law, provided a moral choice was in fact possible to him.

### Principle V

Any person charged with a crime under international law has the right to a fair trial on the facts and law.

### Principle VI

The crimes hereinafter set out are punishable as crimes under international law:

- (a) Crimes against peace:
  - (i) Planning, preparation, initiation or waging of a war of aggression or a war in violation of international treaties, agreements or assurances;
  - (ii) Participation in a common plan or conspiracy for the accomplishment of any of the acts mentioned under (i).
- (b) War crimes:
 

Violations of the laws or customs of war include, but are not limited to, murder, ill-treatment or deportation to slave-labour or for any other purpose of civilian population of or in occupied territory, murder or ill-treatment of prisoners of war, of persons on the seas, killing of hostages, plunder of public or private property, wanton destruction of cities, towns, or villages, or devastation not justified by military necessity.
- (c) Crimes against humanity:
 

Murder, extermination, enslavement, deportation and other inhuman acts done against any civilian population, or persecutions on political, racial or religious grounds, when such acts are done or such persecutions are carried on in execution of or in connection with any crime against peace or any war crime.

### Principle VII

Complicity in the commission of a crime against peace, a war crime, or a crime against humanity as set forth in Principle VI is a crime under international law.

Name \_\_\_\_\_ Date \_\_\_\_\_ Period \_\_\_\_\_

## The Nuremberg Code

*Trials of War Criminals before the Nuremberg Military Tribunals under Control Council Law No. 10, Vol. 2, pp. 181–182. Washington, D.C.: U.S. Government Printing Office, 1949.*

1. The voluntary consent of the human subject is absolutely essential. This means that the person involved should have legal capacity to give consent; should be so situated as to be able to exercise free power of choice, without the intervention of any element of force, fraud, deceit, duress, overreaching, or other ulterior form of constraint or coercion; and should have sufficient knowledge and comprehension of the elements of the subject matter involved, as to enable him to make an understanding and enlightened decision. This latter element requires that, before the acceptance of an affirmative decision by the experimental subject, there should be made known to him the nature, duration, and purpose of the experiment; the method and means by which it is to be conducted; all inconveniences and hazards reasonably to be expected; and the effects upon his health or person, which may possibly come from his participation in the experiment.
2. The duty and responsibility for ascertaining the quality of the consent rests upon each individual who initiates, directs or engages in the experiment. It is a personal duty and responsibility which may not be delegated to another with impunity.
3. The experiment should be such as to yield fruitful results for the good of society, unprocurable by other methods or means of study, and not random and unnecessary in nature.
4. The experiment should be so designed and based on the results of animal experimentation and knowledge of the natural history of the disease or other problem under study, that the anticipated results will justify the performance of the experiment.
5. The experiment should be so conducted as to avoid all unnecessary physical and mental suffering and injury.
6. No experiment should be conducted, where there is an a priori reason to believe that death or disabling injury will occur; except, perhaps, in those experiments where the experimental physicians also serve as subjects.
7. The degree of risk to be taken should never exceed that determined by the humanitarian importance of the problem to be solved by the experiment.
8. Proper preparations should be made and adequate facilities provided to protect the experimental subject against even remote possibilities of injury, disability, or death.
9. The experiment should be conducted only by scientifically qualified persons. The highest degree of skill and care should be required through all stages of the experiment of those who conduct or engage in the experiment.
10. During the course of the experiment, the human subject should be at liberty to bring the experiment to an end, if he has reached the physical or mental state, where continuation of the experiment seemed to him to be impossible.
11. During the course of the experiment, the scientist in charge must be prepared to terminate the experiment at any stage, if he has probable cause to believe, in the exercise of the good faith, superior skill and careful judgment required of him, that a continuation of the experiment is likely to result in injury, disability, or death to the experimental subject.

# On the Case: Interviews With Professionals

## LESSON 3.2

### ENGLISH LANGUAGE ARTS

#### Time

50 minutes

#### Materials

- Computer lab with Internet access
- Tape recorder (optional)
- Video recorder (optional)

#### Resources

“Veteran Reporter Describes the Art of the Interview”  
(<http://usinfo.state.gov/dhr/Archive/2006/Apr/24-133420.html>)

#### Prior Student Learning

Students should be familiar with various career fields associated with forensic science.

### *Essential Question for This Unit*

What are the appropriate roles for scientific technology and human judgment in arriving at verdicts in criminal cases?

### *Objectives*

After completing this lesson, students should be able to

- Construct interview questions.
- Conduct effective interviews and take useful notes.
- Understand the difference between open- and closed-ended questions and their relation to developing a fluid conversational interview.

### *Lesson Activities*

#### **Lesson Springboard**

Quality interviews are often the result of two things: preparation and interview execution. Interview preparation consists of researching the interview topic, the interviewee, and preparing effective interview questions. A successfully executed interview involves perceptive listening, questioning, and note taking. Listening skills are critical because they allow the interviewer to guide the direction of the interview by asking relevant follow-up questions to the interviewee’s answers.

#### **Lesson Development**

##### *Class Discussion*

Ask students if they have ever been interviewed. Inquire about their experience. How did they feel? Were they nervous? Do they remember any of the questions? If so, what were the questions and how were they structured (open- or close-ended)? Ask students the type of skills an interviewer should possess. Have students read and discuss the article “Veteran Report Describes the Art of the Interview.”

Inform students that they will be conducting an interview. Each student will interview someone employed in the criminal justice field who can provide information on forensics and crime scene investigations. Possibilities include

- Independent forensic scientist
- Coroner or medical examiner
- Pathologist
- Forensic anthropologist
- Criminology professors or students
- Sociologist
- Journalist

As a class, brainstorm possible questions to include in an interview. Write students’ responses on a chalkboard for reference. Assist students

# On the Case: Interviews With Professionals

## LESSON 3.2

with generating effective questions and explain the difference between open- and closed-ended questions. Here are a few basic questions:

How did you select your career?

What is a typical day like for you?

How did your education prepare you for your job?

What occurs during a crime scene investigation?

What is your responsibility in crime scene investigations?

An example of a closed-ended question would be: “Do you like your job?” It elicits a one-word answer, either “yes” or “no.” While the question “What do you like about your job?” should lead to a detailed answer that provides useful information and permits follow-up questions.

### **Role Play**

Using the questions created by the class, have a student pose as a crime scene investigator and interview him or her in front of the class. Have students take notes on what you (the interviewer) do wrong and what you do right. In your questioning, provide examples of both open- and closed-ended questions, missed opportunities to ask follow-up questions, and effective follow-up questions.

Explain to students that it’s important to research and prepare interview questions in advance, and it’s equally important that an interviewer be prepared to deviate from his or her planned questions by recognizing and asking follow-up questions.

In setting up the interview, students should approach potential interviewees by phone or e-mail and explain who they are and their reason for the interview. Then, ask if the potential interviewee would be open to scheduling 30 minutes of time to either come on campus for an in-person interview or participate in an interview via phone or online (e-mail or instant message).

During the interview, students should be courteous, take notes, and remember to note the interviewee’s name, job position, organization, e-mail address, phone number, date, time, and location of the interview. They should also remember to thank the interviewee and send a thank you e-mail (students may need assistance drafting a brief thank you e-mail).

After the interview, students should use their notes and write a one-page report summarizing what they learned from the interview, incorporating at least one meaningful quote from the interview.

### **Lesson Closure**

Ask students how they felt while conducting the interview. Did they feel that preparing in advance made the interview easier? Did any students ask questions that were not on their list? Tell students that most of them

# On the Case: Interviews With Professionals

## LESSON 3.2

will be interviewed or will conduct an interview one day and that preparation often makes the process easier.

### **Student Assessment Artifacts**

Interview questions  
Interview notes (optional)  
Interview summaries

### **Variations and Extensions**

Interviews can be conducted via telephone, or online via e-mail or instant messaging. (Students should be aware that online interviewing creates the opportunity for someone other than the desired interviewee to respond to the questions.)

Bring a speaker to class and have students pose interview questions from student panels.

Watch and evaluate television interviews on NBC's *Today Show* or other news programs.

## National and State Academic Standards

### **NATIONAL**

#### **NCTE Standards for the English Language Arts**

4. Students adjust their use of spoken, written, and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.
5. Students employ a wide range of strategies as they write and use different writing process elements appropriately to communicate with different audiences for a variety of purposes.
7. Students conduct research on issues and interests by generating ideas and questions, and by posing problems. They gather, evaluate, and synthesize data from a variety of sources (e.g., print and nonprint texts, artifacts, people) to communicate their discoveries in ways that suit their purpose and audience.
12. Students use spoken, written, and visual language to accomplish their own purposes (e.g., for learning, enjoyment, persuasion, and the exchange of information).

### **STATE**

List your state-specific standards in the space below.



# The Closing Argument

## LESSON 3.3

### ENGLISH LANGUAGE ARTS

#### Time

50 minutes

#### Materials

Evidence/conclusions from each Subunit 2 lesson

#### Prior Student Learning

Students should have completed lessons from Subunit 2.

#### Classroom Management

Laptop computers will help students with this in-class writing assignment.

### *Essential Question for This Unit*

What are the appropriate roles for scientific technology and human judgment in arriving at verdicts in criminal cases?

### *Objectives*

After completing this lesson, students should be able to

- Organize information into a coherent essay.
- Employ the elements of rhetorical persuasion.
- Support their claims with convincing evidence and defend the sources from which it came.

### *Lesson Activities*

#### **Lesson Springboard**

Now that students have completed their investigation, ask them if they think they have identified the murderer. Who do they think committed the crime? Are they certain their suspect is the guilty party? How would they persuade a jury that they are correct?

#### *Direct Instruction*

Students will have completed their investigation of the murder and now must write a brief “closing argument” (200 words minimum) for the prosecutor to present to the jury. Explain to students that this is a persuasive speech, not merely a factual report. Therefore, they must make their argument convincing, provide good evidence to support their claims, and write in clear and forceful prose. In particular, they must consider these questions:

- What is my strongest evidence?
- Do I place my strongest evidence at the beginning of the argument or at the end?
- In what order do I place my other pieces of evidence?
- How do I make my evidence credible to the jury? How do I explain, in brief, that the forensic tests I performed are scientific?
- Do I include any emotional appeals to the jury at the beginning of the argument, or at the end?
- What refutations can be made against my argument? Are there ways to rebut these in the short time that I have?

#### **Lesson Development**

##### *Student Writing*

During the remainder of class, allow students to write their closing arguments. Remind them that they are writing a speech for the prosecutor who must convince a skeptical jury. They must decide which pieces of

Subunit 3—Convincing the Jury  
*The Closing Argument*

LESSON 3.3

evidence are most important; how to order these in a logical way; and how to briefly defend the forensics they have used.

**Lesson Closure**

Ask students, if time permits, to identify the piece of evidence that they selected as most important to convince the jury, and how they defended the forensics that established the evidence.

**Possible Prior Misconceptions**

Some students will think they should present the evidence in the order in which they gathered it. In fact, there are several ways to organize the closing argument, and all pieces of evidence should not be given equal weight.

Students may believe they should simply report the facts, when in reality they must write a persuasive speech. Persuasive writing includes emotional appeals.

**Student Assessment Artifacts**

Closing argument (minimum of 200 words)

**Variations and Extensions**

Students can give their closing argument in the form of a speech and then videotape it. The teacher will show several of these videos to the class, which serves as the jury and will decide whether to acquit or convict.

Assign students the task of challenging one another's closing arguments. They can use what they've learned in prior lessons on forensics to question the reliability of DNA or blood testing, the credibility of footprint analysis or witness interviews, and so on.

Students can analyze the closing argument of a prosecutor or defense attorney given at a real trial. (Many of these are available on the Internet.) They should consider the order in which evidence is presented; the type of emotional appeals, if any; attempts to explain forensic methods to the jury; and efforts to rebut any possible challenges to the argument.

**National and State Academic Standards**

**NATIONAL**  
**NCTE Standards for the English Language Arts**

5. Students employ a wide range of strategies as they write and use different writing process elements appropriately to communicate with different audiences for a variety of purposes.
6. Students apply knowledge of language structure, language conventions (e.g., spelling and punctuation), media techniques, figurative language, and genre to create, critique, and discuss print and non-print texts.

**STATE**  
List your state-specific standards in the space below.