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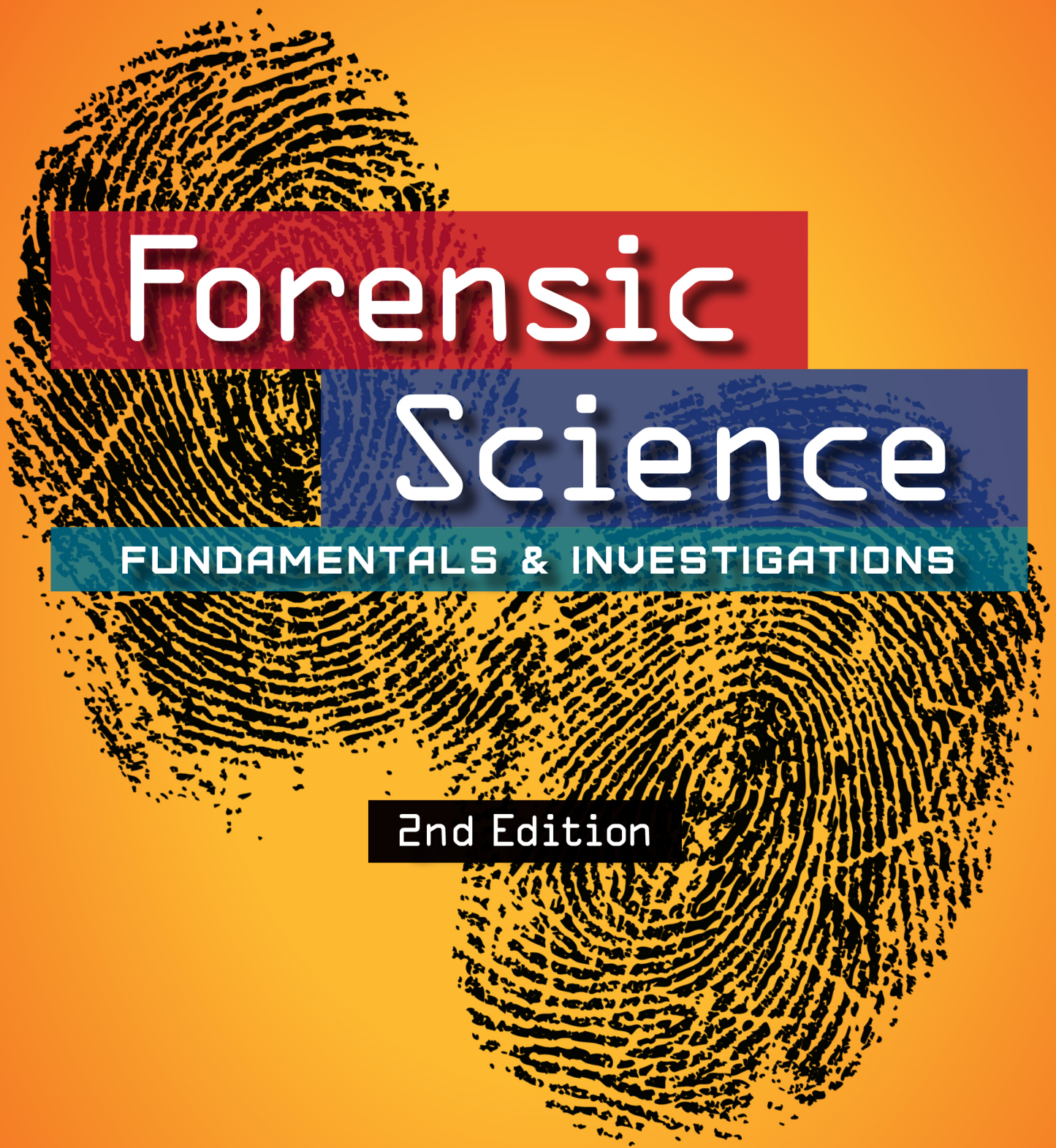

Forensic Science

FUNDAMENTALS & INVESTIGATIONS

2nd Edition

Bertino & Bertino

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Forensic Science: Fundamentals and Investigations, Second Edition
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DEDICATION

To my parents, Joe and Alice Bertino, who taught me the meaning of "doing what you like brings freedom but liking what you do brings happiness."

–Anthony (Bud) Bertino

To my father, Arthur J. Nolan, for his keen interest, guidance, and encouragement during my teaching career and his invaluable technical support of this book.

–Patricia Nolan Bertino

PREFACE

Welcome To
Forensic Science: Fundamentals and Investigations 2e

This new edition provides the science behind forensics, as well as labs and activities appropriate for high school students! ***Forensic Science: Fundamentals and Investigations 2e*** is student *and* teacher friendly. Students enjoy a hands-on approach to forensics. Extra support is offered both for at-risk students and gifted learners through differentiated learning activities in the teacher's edition. Teachers can conduct a full-year's study of forensics or select topics that can be incorporated into a half-year course. As another option, teachers can use the textbook to motivate students in all science classes by using forensics to teach basic science concepts. ***Forensic Science: Fundamentals and Investigations 2e*** integrates science, mathematics, technology, history, and political science along with writing and presentation skills using real-life applications and case studies, providing complete flexibility for any science program. ***Forensic Science: Fundamentals and Investigations 2e*** is the new standard in high school forensic science . . . case closed!

GETTING STARTED

Forensic Science: Fundamentals and Investigations 2e reveals the science used in forensic science techniques. It provides a chapter-by-chapter description of specific types of evidence and the techniques to collect, analyze, and evaluate the evidence. As students progress through the course, they refine the techniques and apply them to other areas of study. The topics covered in the 18 chapters include crime-scene investigation; the collection, handling, and analysis of trace evidence such as hair, fibers, soil, pollen, and glass; fingerprints; blood and blood-spatter examination; forensic analysis of DNA, insects, drugs, glass, handwriting, and tool-marks and impressions; firearms and ballistics; forensic anthropology; and the determination of the manner, mechanism, and cause of death and the estimation of post-mortem interval. New chapters include entomology; expanded chapters includes updated DNA content, expanded autopsy coverage, increased hands-on crime-scene investigation, and forensic botany.

One of the strengths of the textbook is student motivation. Areas of study are introduced in scenarios taken from headlines and popular media. These features engage students as they describe the historical development of forensic science techniques. Inexpensive, easy-to-perform labs provide students with opportunities for successful laboratory experiences as well as an appreciation of the true nature of forensic science problem-solving techniques. Suggestions for research projects extend and enrich student learning and interest.

CHAPTER FEATURES

Each chapter of ***Forensic Science: Fundamentals and Investigations 2e*** begins with a true-life story, student objectives, key vocabulary, and a Topical Sciences Key. The Topical Sciences Key identifies biology, Earth science, chemistry, physics, literacy, or mathematics concepts integrated into chapter topics.

Special features include ***Did You Know*** margin notes that provide additional interesting facts and information, and ***Digging Deeper***, additional research topics that refer students to the free online database from Gale Publishing called the Forensic Science eCollection Database.

At the end of each chapter, a ***Summary*** reviews the main points of the chapter. Nonfiction high interest books are listed next to the summary to encourage student's outside reading. A series of short ***Case Studies*** offer high-interest topics for critical thinking, writing, and class discussion. ***Careers in Forensics*** describes an occupation related to forensic science. On the bottom of the career page, inexpensive or free forensic Apps are often referenced. A ***Chapter Review*** contains both objective and

short-answer questions requiring critical thinking skills to assess student understanding. A chapter bibliography lists print and online research sources.

Each chapter has ***Activities*** that provide hands-on experiences with forensic science techniques. Each activity has clear, step-by-step directions for students of all reading levels. For teachers, they offer easy, quick preparation and minimal expense for materials. Each activity includes objectives, materials, safety precautions, procedures, and other learning support.

FOR THE TEACHER

The ***Wraparound Teacher's Edition (WTE)*** contains teaching strategies and tips to engage students. The WTE provides clarification of science content and forensic science procedures, ideas to help stimulate students, evaluation opportunities, additional questions, and suggestions for further exploration and research. Additional teaching tips are added to help address the needs of English-language learners, gifted students, and at-risk students.

An ***Instructor's Resource CD-ROM (IRCD)*** is available to teachers who adopt a classroom set of ***Forensic Science: Fundamentals and Investigations 2e***. The IRCD contains additional activities, PowerPoint presentations, student handouts, lesson plans with chapter outlines, and enrichment materials, as well as Student Learning Objectives (SLOs) for each chapter.

Cengage Learning Testing Powered by Cognero is a flexible, online system that allows you to author, edit, and manage test bank content from multiple Cengage Learning solutions; create multiple test versions in an instant; and deliver tests from your learning management system, your classroom or wherever you want!

MindTap for Forensic Science Fundamentals and Investigations 2e is a personalized teaching experience with an eBook reader with relevant assignments that guide students to analyze, apply, and improve thinking, allowing you to measure skills and outcomes with ease.

Cengage maintains a **Website** to support this text. Both students and teachers using ***Forensic Science: Fundamentals and Investigations 2e*** may access the Website at **ngl.cengage.com/forensicscience2e**. The site provides teacher resources and information about related products. Student resources on the site include forms, additional projects, and links to related sites. In addition, a link is provided to the ***Gale Forensic Science eCollection database*** which allows free online research in various journals and the Gale Virtual Reference Library.

ABOUT THE AUTHORS

Anthony (Bud) Bertino has taught science for 40 years. He has served as biology teacher and science supervisor at Canandaigua Academy. His awards include Outstanding Biology Teacher (NY, NABT), Woodrow Wilson Fellowship Award, Tandy Scholars' Award, and Outstanding Teaching Award from the University of Rochester. He is co-author of "Where's the CAT," and author of "The Cookie Jar Mystery," and many other published activities. He has served as an AP Biology consultant for the College Board and as a clinical supervisor for the University of Albany (NY), Graduate School of Education.

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The Bertinos live near Schenectady, New York and conduct summer workshops in forensic science education for teachers. They are frequent co-presenters at the National Science Teachers Association (NSTA) and many state science teacher conferences.

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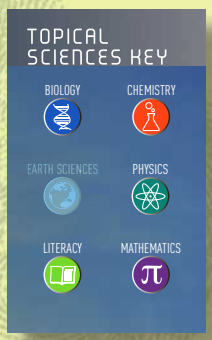
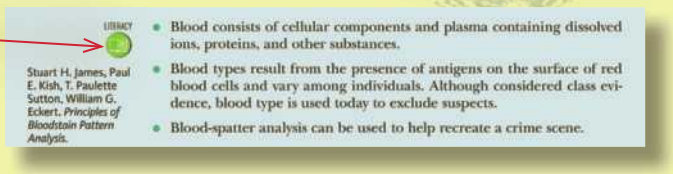


A review board, focus groups, and ongoing educator feedback guided each decision to ensure that the program meets the educational needs of your students.

Student and teacher supplements support the workflow with time-saving tools. Innovative digital resources include the innovative **Forensic Science eCollection database** and the new **MindTap™ with Virtual Labs.**

Forensic Science combines topics from math, chemistry, biology, physics, literacy, and Earth science into a single course with all materials clearly aligned with the **National Science Education Standards, NGSS,** and **CCSS**. Distinctive icons identify topics in the chapter opener and throughout the text.



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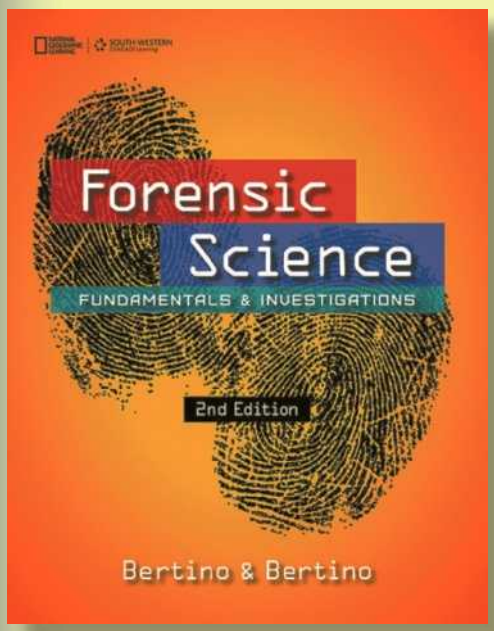
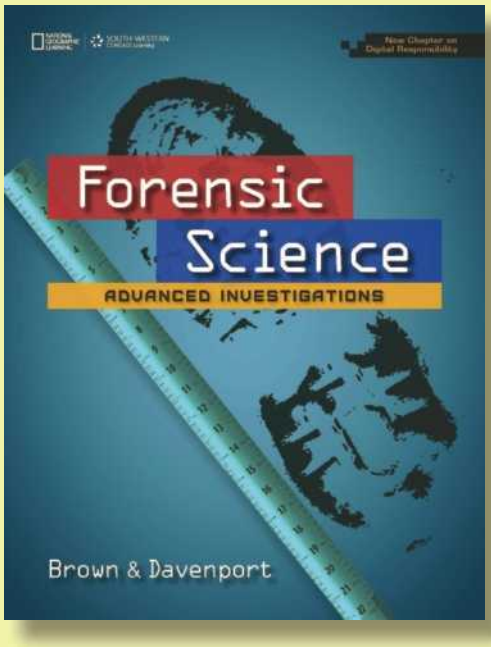
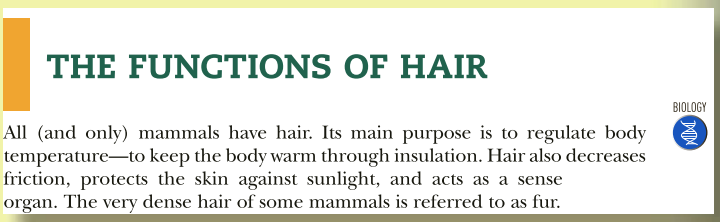


Copyright Update



WHAT'S NEW IN THE NEW EDITION (BERTINO AND BERTINO) AND COPYRIGHT UPDATE (BROWN AND DAVENPORT)

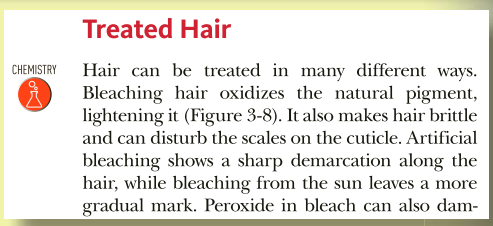
- **What's NEW!—*Forensic Science Fundamentals & Investigations, 2e***, new coverage for various topics such as:
    - A new chapter (11) on entomology
    - Scientific changes in DNA technologies (7)
    - More coverage of autopsy (12)
    - More coverage in crime-scene investigation (2)
    - Pollen chapter is now Forensic Botany (5)
- **What's NEW!—*Forensic Science Advanced Investigations, CU***, new coverage for various topics within such as:
    - A new chapter (15) on Digital Responsibility and Social Networking



THE FUNCTIONS OF HAIR

BIOLOGY

All (and only) mammals have hair. Its main purpose is to regulate body temperature—to keep the body warm through insulation. Hair also decreases friction, protects the skin against sunlight, and acts as a sense organ. The very dense hair of some mammals is referred to as fur.

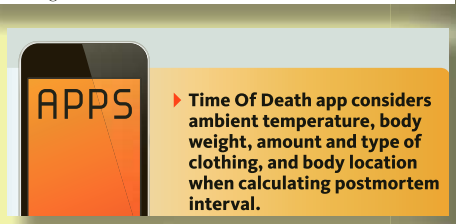


Treated Hair

CHEMISTRY

Hair can be treated in many different ways. Bleaching hair oxidizes the natural pigment, lightening it (Figure 3-8). It also makes hair brittle and can disturb the scales on the cuticle. Artificial bleaching shows a sharp demarcation along the hair, while bleaching from the sun leaves a more gradual mark. Peroxide in bleach can also dam-

- **Aligned to National Standards**—This text combines topics from math, chemistry, biology, physics, literacy, and earth science into a single course with all materials clearly correlated to the National Science Education Standards, NGSS, and CCSS. The topics are identified by distinctive icons in the chapter opener as well as throughout the text.
- **A Wide Variety of High-Interest Lab Activities**—Many updated end-of-chapter lab activities give students the hands-on experience needed to fully understand and truly integrate their knowledge of science and related subjects.
- **Capstone projects** are updated and give students the opportunity to apply key topics learned throughout the year, as well as extend the learning process with the opportunity to synthesize this knowledge and new content.



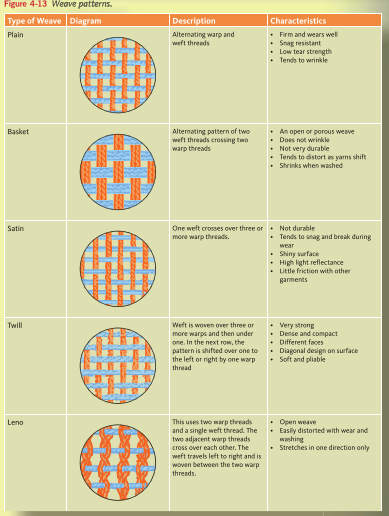


Figure 4-13 *Weave patterns.*

Type of Weave	Diagram	Description	Characteristics
Plain		Alternating warp and weft threads	• Firm and wears well • Snag resistant • Low tear strength • Tends to wrinkle
Basket		Alternating pattern of two weft threads crossing two warp threads	• An open or porous weave • Does not wrinkle • Not very durable • Tends to distort as yarns shift • Shrinks when washed
Satin		One weft crosses over three or more warp threads.	• Not durable • Tends to snag and break during wear • Shiny surface • High light reflectance • Little friction with other garments
Twill		Weft is woven over three or more warps and then under one. In the next row, the pattern is shifted over one to the left or right by one warp thread	• Very strong • Dense and compact • Different faces • Diagonal design on surface • Soft and pliable
Leno		This uses two warp threads and a single weft thread. The two adjacent warp threads cross over each other. The weft travels left to right and is woven between the two warp threads.	• Open weave • Easily distorted with wear and washing • Stretches in one direction only

- **The Gale Forensic Science eCollection**™**—**This database allows you and your students to investigate the mysteries of forensic science in-depth with online access to hundreds of recent articles—from highly specialized academic journals to general science-focused magazines.
- **NEW—Forensic Science MindTap**™ **and Virtual Labs—**Give your students real-world lab experience within an online environment with MindTap! **MindTap** is a fully online, highly personalized learning experience that combines readings, multimedia, activities, and assessments into a singular Learning Path. **Virtual Lab** activities include: background information, 3-D crime scenes, clear instructions, Toolkits, post-lab assessments, and critical-thinking and research activities.
- **NEW APPS** feature that discusses Web Apps for related tools and topics. Available with Forensic Science Fundamentals & Investigations.
- **NEW "Further Reading"** for CCSS literacy details additional reading references. Available with Forensic Science Fundamentals & Investigations.

IT'S ALL IN THE DETAILS

RIVETING DESIGN AND FEATURES OFFER A NEW WAY TO EXPERIENCE SCIENCE

TRACING THE CLUES TO STUDENT SUCCESS

From a dynamic design to captivating images, practical applications, intriguing case studies, and glimpses into actual crime and lab scenes, every part of this text appeals to students; the program presents information the way students learn best.

Chapter-opening scenarios highlight intriguing news shaping forensic science. These exciting stories, taken directly from gripping headlines, draw students into the learning path of the text. Scenarios feature well-known cases, such as Cory Monteith, Michael Jackson, Jodi Arias, and more.

Clear Learning Objectives guide how students study, helping them focus on the key topics. Chapter content and assessment materials, tagged to specific learning objectives, provide a strong framework for mastering key concepts.

Scientific Terms and Vocabulary, highlighted in each chapter, introduce key terms, ensuring students are able to understand their meaning.

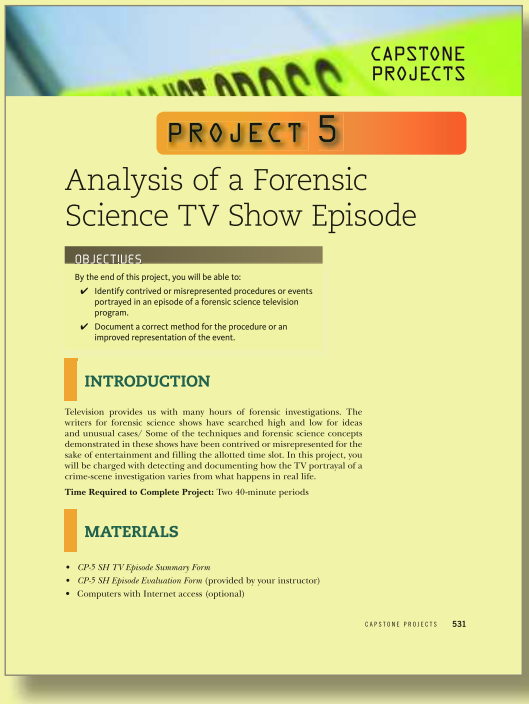
Case Studies bring closure to the chapter concepts using intriguing case facts drawn from actual forensic investigations. Questions prompt discussion and facilitate students' critical-thinking skills.

Careers in Forensic Science sections focus on the hottest careers related to forensic science today, detailing job requirements, necessary preparation, and challenges.

End of Chapter Review Questions, including true-false, multiple choice, and short answer, highlight cross-curricular connections and ensure students thoroughly comprehend principles before moving ahead.

ENGAGE THEM WITH HANDS-ON ACTIVITIES FOR THE REAL WORLD APPLICATION

The variety of high-interest lab activities (3–5 per chapter) saves you time, while giving students the hands-on experience needed to integrate their knowledge of science and related subjects. These activities outline the objectives, time required, materials, safety precautions, scenarios, background information, detailed procedures and data tables, follow-up questions, and research opportunities. Plus the affordable materials allow labs to be completed with minimal investment.


CAPSTONE PROJECTS

PROJECT 5

Analysis of a Forensic Science TV Show Episode

OBJECTIVES

By the end of this project, you will be able to:

- ✔ Identify contrived or misrepresented procedures or events portrayed in an episode of a forensic science television program.
- ✔ Document a correct method for the procedure or an improved representation of the event.

INTRODUCTION

Television provides us with many hours of forensic investigations. The writers for forensic science shows have searched high and low for ideas and unusual cases/ Some of the techniques and forensic science concepts demonstrated in these shows have been contrived or misrepresented for the sake of entertainment and filling the allotted time slot. In this project, you will be charged with detecting and documenting how the TV portrayal of a crime-scene investigation varies from what happens in real life.

Time Required to Complete Project: Two 40-minute periods

MATERIALS

- *CP-5 SH TV Episode Summary Form*
- *CP-5 SH Episode Evaluation Form* (provided by your instructor)
- Computers with Internet access (optional)

CAPSTONE PROJECTS 531


ACTIVITY 6-1

Study Your Fingerprints Obj. 6.2, 6.3

Objectives:

By the end of this activity, you will be able to:

1. Lift your fingerprint using tape and a graphite pencil.
2. Identify the ridge pattern of your finger.
3. Compare and contrast your fingerprints to your classmates' fingerprints.
4. Find two other students with the same basic ridge pattern as your own.
5. Calculate the percentage of students having each of the three different ridge patterns.

Time Required to Complete Activity: 40 minutes

Materials:

Act 6-1 SH
clear, adhesive tape ¾ inch in width or wider (not "transparent" tape)
pencil
two 3" × 5" cards or Act 6-1 SH
magnifying glass

Safety Precautions:

No special precautions

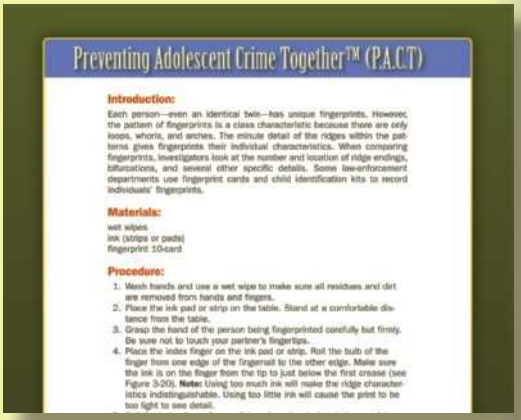
Procedure:

1. On a lined 3" × 5" card, rub the end of a graphite pencil in a back-and-forth motion, creating a dark patch of graphite about 2 by 3 inches.
2. Rub your right index finger across the graphite patch so that the fingertip becomes coated with graphite from the first joint in the finger to the tip, and from fingernail edge to fingernail edge.
3. Tear off a piece of clear adhesive tape about 2 inches long. Carefully press the sticky side of the tape onto your finger pad from the edge of your fingernail across your finger pad to the other side of your fingernail.
4. Gently peel off the tape.
5. Press the tape, sticky side down, on the clean 3" × 5" card.
6. Examine your fingerprint using a magnifying glass.
7. Compare your fingerprint to the pictured samples.
8. Identify whether your fingerprint pattern is a loop, arch, or whorl.
9. Find two other students who have the same ridge pattern as yours.

Fingerprints 175

Capstone Crime Scene projects give students the opportunity to apply key topics throughout the course.

P.A.C.T.™ Activities (Preventing Adolescent Crime Together) provide service learning opportunities through projects addressing issues such as anti-bullying and social responsibility. Available with Forensic Science Advanced Investigations.


Preventing Adolescent Crime Together™ (P.A.C.T)

Introduction:

Each person—even an identical twin—has unique fingerprints. However, the pattern of fingerprints is a class characteristic because there are only loops, whorls, and arches. The minute detail of the ridges within the patterns gives fingerprints their individual characteristics. When comparing fingerprints, investigators look at the number and location of ridge endings, bifurcations, and several other specific details. Some law-enforcement departments use fingerprint cards and child identification kits to record individuals' fingerprints.

Materials:

wet wipes
ink (strips or pads)
fingerprint 10-card

Procedure:

1. Wash hands and use a wet wipe to make sure all residues and dirt are removed from hands and fingers.
2. Place the ink pad or strip on the table. Stand at a comfortable distance from the table.
3. Grasp the hand of the person being fingerprinted carefully but firmly. Be sure not to touch your partner's fingertips.
4. Place the index finger on the ink pad or strip. Roll the bulb of the finger from one edge of the fingernail to the other edge. Make sure the ink is on the finger from the tip to just below the first crease (see Figure 3-20). **Note:** Using too much ink will make the ridge characteristics indistinguishable. Using too little ink will cause the print to be too light to see detail.


CRIME SCENE S.P.O.T. Student-Prepared Original Titles

A Tale of Two Brothers

By: **Meagan Gallant and Corey Stillwaggon**

Tavares High School
Tavares, Florida

John Calabash, a tall, handsome 21-year-old, was eating lunch with his beautiful girlfriend, Casey Perez, a 20-year-old social butterfly with blue eyes and dark curly hair.

Above everything, though, he wanted to be in charge of the family business. Their father had recently died and, if anything ever happened to John, and John and Casey were married, the business would go to Casey, not Carl. The family business was the largest known drug business throughout the United States.

Later that night, John and Carl got together at John's house to talk about a big business deal coming up in a couple of weeks. Casey was reading in the other room, but she was also listening to the deal. At 9:42 p.m., as Carl was getting ready to leave, he heard a

Crime Scene S.P.O.T (Student Prepared Original Title) offers short stories written by actual students followed by critical-thinking questions and a writing activity. S.P.O.T. provides interdisciplinary instruction integrating reading and writing throughout the text. Available with Forensic Science Advanced Investigations.

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FORENSIC SCIENCE ECOLLECTION™ DATABASE

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- Teaching Resources
- Tips for Differentiated Learning
- Teaching Tips to engage, teach, explore, evaluate, and close the lesson
- Answers to end of chapter reviews and activities with additional details related to lab materials, safety precautions, procedures, data tables, and further student research
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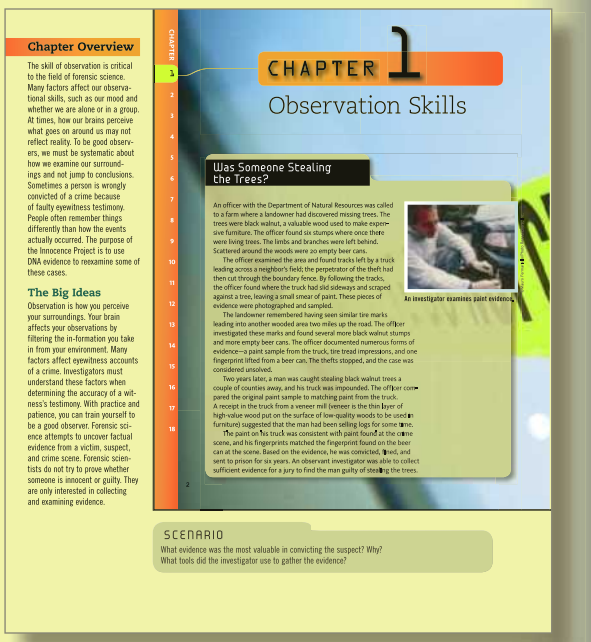

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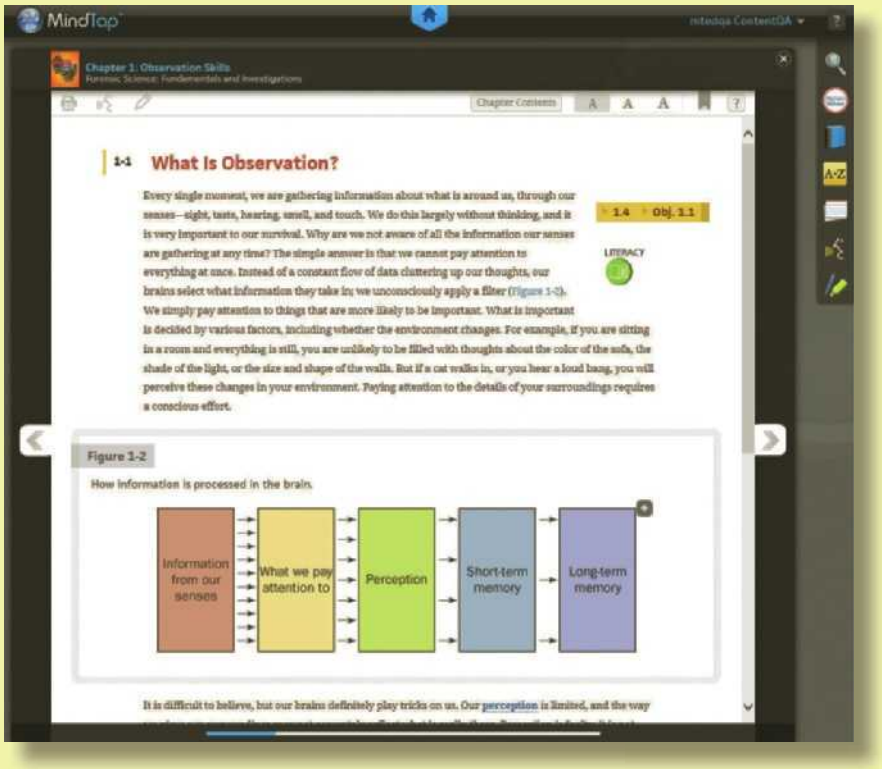
- Chapter objectives are linked to activities and key concepts to show correlation
- Terms and definitions linked to the glossary for clarification
- Flashcards, Web links, Merriam-Webster's Dictionary, and ReadSpeaker are other useful tools for research, reinforcement, and enhanced accessibility
- Photos and illustrations are linked to chapter references for navigation



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Also included within Mindtap is a Virtual Lab which can be used as a final assessment for the course. Each lab activity includes:

- Background information
- Clear instructions
- Toolkit
- Lab assessments
- Critical-thinking questions
- Research activities

As students work through the lab, they will record their findings within an auto-graded assignment. After they have completed the lab and recorded the data, there is a post-lab assessment covering the topics and techniques used within the lab.

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CHAPTER 1

Observation Skills

Was Someone Stealing the Trees?

An officer with the Department of Natural Resources was called to a farm where a landowner had discovered missing trees. The trees were black walnut, a valuable wood used to make expensive furniture. The officer found six stumps where once there were living trees. The limbs and branches were left behind. Scattered around the woods were 20 empty beer cans.

The officer examined the area and found tracks left by a truck leading across a neighbor's field; the perpetrator of the theft had then cut through the boundary fence. By following the tracks, the officer found where the truck had slid sideways and scraped against a tree, leaving a small smear of paint. These pieces of evidence were photographed and sampled.

Mauro Fermariello/Science Source

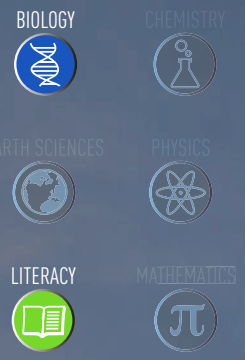
An investigator examines paint evidence.

The landowner remembered having seen similar tire marks leading into another wooded area two miles up the road. The officer investigated these marks and found several more black walnut stumps and more empty beer cans. The officer documented numerous forms of evidence—a paint sample from the truck, tire tread impressions, and one fingerprint lifted from a beer can. The thefts stopped, and the case was considered unsolved.

Two years later, a man was caught stealing black walnut trees a couple of counties away, and his truck was impounded. The officer compared the original paint sample to matching paint from the truck. A receipt in the truck from a veneer mill (veneer is the thin layer of high-value wood put on the surface of low-quality woods to be used in furniture) suggested that the man had been selling logs for some time.

The paint on his truck was consistent with paint found at the crime scene, and his fingerprints matched the fingerprint found on the beer can at the scene. Based on the evidence, he was convicted, fined, and sent to prison for six years. An observant investigator was able to collect sufficient evidence for a jury to find the man guilty of stealing the trees.

TOPICAL SCIENCES KEY



OBJECTIVES

By the end of this chapter, you will be able to:

1.1 Define observation, and describe what changes occur in the brain while observing.

1.2 Describe examples of factors influencing eyewitness accounts of events.

1.3 Compare the reliability of eyewitness testimony to what actually happened.

1.4 Relate observation skills to their use in forensic science.

1.5 Define forensic science.

1.6 Practice and improve your own observation skills.

VOCABULARY

- **analytical skills** the ability to identify a concept or problem, to isolate its component parts, to organize information for decision making, to establish criteria for evaluation, and to draw appropriate conclusions
- **deductive reasoning** deriving a conclusion from the facts using a series of logical steps
- **eyewitness** a person who has seen someone or something related to a crime and can communicate his or her observations
- **fact** a statement or information that can be verified
- **forensic** relating to the application of scientific knowledge to legal questions
- **logical** reasoned from facts
- **observations** what a person perceives using his or her senses
- **opinion** personal belief founded on judgment rather than on direct experience or knowledge
- **perception** information received from the senses

INTRODUCTION

Figure 1-1 *A crime scene is often laid out in a grid to ensure that all evidence is found.*

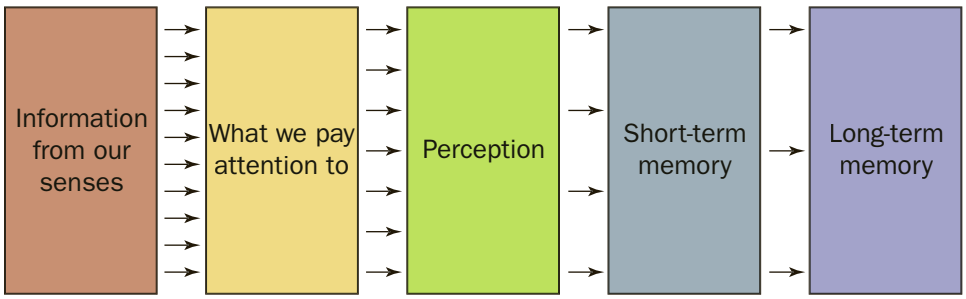
AP Images/Charles Bennett

One of the most important tools of the **forensic** investigator is the ability to observe, interpret, and report **observations** clearly. Whether observing at a crime scene or examining collected evidence in the laboratory, the forensic examiner must be able to identify the evidence, record it, and determine its significance. The trained investigator collects all available evidence, without making judgments about its potential importance. That comes later. Knowing which evidence is significant requires the ability to re-create the series of events preceding the crime. The first step is careful and accurate observation (Figure 1-1).

WHAT IS OBSERVATION? *Obj. 1.1, 1.4*

Every single moment, we are gathering information about what is around us, through our senses—sight, taste, hearing, smell, and touch. We do this largely without thinking, and it is very important to our survival. Why are we not aware of all the information our senses are gathering at any time? The simple answer is that we cannot pay attention to everything at once. Instead of a constant flow of data cluttering up our thoughts, our brains select what information they take in; we unconsciously apply a filter (Figure 1-2). We simply pay attention to things that are more likely to be important. What is important is decided by various factors, including whether the environment changes. For example, if you are sitting in a room and everything is still, you are unlikely to be filled with thoughts about the color of the sofa, the shade of the light, or the size and shape of the walls. But if a cat walks in, or you hear a loud bang, you will perceive these changes in your environment. Paying attention to the details of your surroundings requires a conscious effort.

Figure 1-2 *How information is processed in the brain.*



It is difficult to believe, but our brains definitely play tricks on us. Our **perception** is limited, and the way we view our surroundings may not accurately reflect what is really there. Perception is faulty; it is not always accurate, and it does not always reflect reality. For example, our brains will fill in information that is not really there. If we are reading a sentence and a word is missing, we will often not notice the omission but instead predict the word that we think should be there and read the sentence as though it is complete.

Can a beer can in the woods lead to a conviction? A smashed dial on a safe betray the suspect? They have, and now it's your turn. Search the Gale Forensic Science eCollection on **ngl.cengage.com/forensicscience2e** to find a case study and demonstrate in writing how good observation skills led to the solution of a crime.

Our brains will also apply knowledge we already have about our surroundings to new situations. In experiments with food coloring, a creamy pink dessert is perceived to be strawberry flavored even though it is vanilla flavored. Our minds have learned to associate pink with strawberries and apply that knowledge to new situations—even when it is wrong. An interesting aspect of our perception is that we believe what we see and hear, even though our ability to be accurate is flawed. People will stick to what they think they saw, even after they have been shown that it is impossible.

If you are feeling like your brain is defective, do not worry: the brain, while faulty, is still good at providing us with the information we need to survive. Filtering information, filling in gaps, and applying previous knowledge to new situations are all useful traits, even if they do interfere sometimes. Understanding our limitations helps us improve our observation skills, which is extremely important in forensic science. Criminal investigations depend on the observation skills of all parties involved—the police investigators, the forensic scientists, and the witnesses.

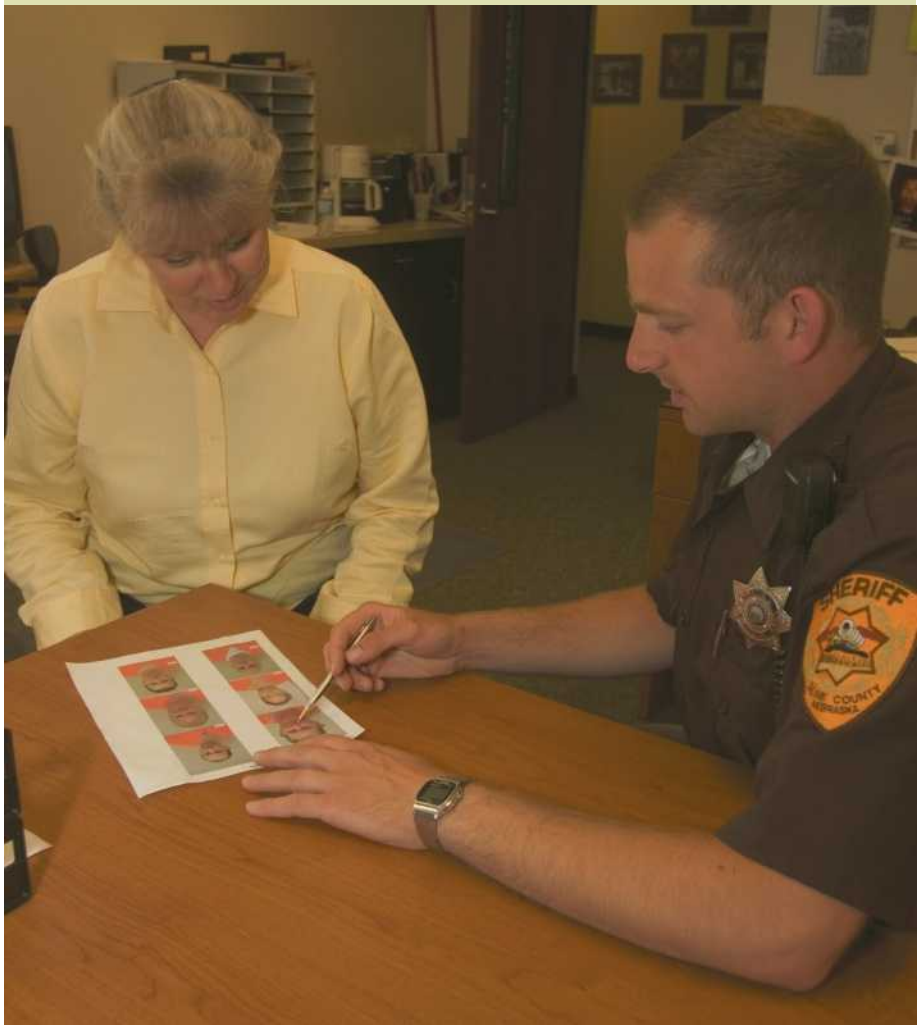
OBSERVATIONS BY WITNESSES

Obj. 1.2, 1.3, 1.4, 1.6

One key component of any crime investigation is the observations made by witnesses. Not surprisingly, the perceptions of witnesses can be faulty, even though a witness may be utterly convinced of what he or she saw. Have you ever noticed that you can walk along the street or ride in a car and be totally unaware of your surroundings? You may be deeply involved in a serious conversation on your cell phone and lose track of events happening around you. Your focus and concentration may make an accurate accounting of events difficult.

Our emotional state influences our ability to see and hear what is happening around us. If people are very upset, happy, or depressed, they are more likely not to notice their surroundings. Anxiety also plays a big part in what we see and what we can remember. Our fear at a stressful time may interfere with an accurate memory. Victims of bank robberies often relate conflicting descriptions of the circumstances surrounding the robbery. Their descriptions of the criminals committing the robbery often do not match.

Figure 1-3 *This eyewitness is searching a mug book for previous offenders who might have committed the crime she witnessed.*



Mikael Karlsson/Alamy

Nevertheless, eyewitness accounts of crimes can be valuable evidence (Figure 1-3). Bystanders who are unaware that they are watching a crime unfold are not subject to the anxiety victims are, and may provide valuable evidence. And some victims are less subject to the disruptive effects of anxiety on memory.

Other factors affecting our observational skills include:

- Whether you are alone or with a group of people
- The number of people and/or animals in the area
- What type of activity is going on around you
- How much activity is occurring around you

All of these factors influence the accuracy of a witness's observations.

Eyewitness Accounts

What we perceive about a person depends, in part, on his or her mannerisms and gestures. How a person looks, walks, stands, and uses hand gestures all contribute to our image of his or her appearance. Think about your family members. How would you describe them? What makes them unique? We also form images of familiar places. Our homes, school, and

other places we often visit (e.g., a favorite store or restaurant) are burned into our memories and easy to recognize and remember.

Eyewitness accounts of crime-scene events vary considerably from one person to another. What you observe depends on your level of interest, stress, concentration, and the amount and kind of distraction present. Our prejudices, personal beliefs, and motives also affect what we see. Memory fades with time, and our brains tend to fill in details that we feel are appropriate but may not be accurate. These factors can decrease an eyewitness's accuracy in recalling a crime. The testimony of an eyewitness can be very powerful in persuading the jury one way or another; knowing the shortcomings of eyewitness testimony is necessary to ensure that justice is carried out appropriately.

The Innocence Project

BIOLOGY

The Innocence Project at the Benjamin N. Cardozo School of Law at Yeshiva University in New York was created by Barry C. Scheck and Peter J. Neufeld in 1992. Its purpose is to reexamine post-conviction cases (individuals convicted and in prison) using DNA evidence to provide conclusive proof of guilt or innocence (Figure 1-4). After evaluating hundreds of wrongful convictions in the United States, the Innocence Project found that faulty eyewitness identification contributed up to 87 percent of those wrongful convictions. Eyewitness errors included mistakes in describing the age and facial distinctiveness of the suspect. These mistakes resulted from disguised appearances, too-brief sightings of the perpetrator, cross-gender and cross-racial bias, and changes in the viewing environment (from crime scene to police lineup).

Figure 1-4 *Gary Dotson was the first individual shown to be innocent by the Innocence Project.*

AP Images/Seth Perlman

When evaluating eyewitness testimony, the investigator must discriminate between **fact** and **opinion**. What did the witness actually see? Often what we think we saw and what really happened differ. Someone fleeing the site of a shooting might look like a suspect but could merely be an innocent bystander running away in fear of being shot. Witnesses have to be carefully examined to ensure that they describe what they saw (eyewitness evidence), not what they thought happened (opinion).

After witness examination, the examiner tries to piece together the events (facts) of the crime into a **logical** pattern. The next step is to determine if this pattern of events is verified by the evidence and reinforced by the witness testimony.

How to Be a Good Observer

We can apply what we know about how the brain processes information to improve our observation skills. Here are some basic tips:

1. *We know that we are not naturally inclined to pay attention to all of the details of our surroundings.* To be a good observer, we must make a conscious effort to examine our environment systematically. For example, if you are at a crime scene, you could start at one corner of the room and run your eyes slowly over every space, looking at everything you see. Likewise, when examining a piece of evidence on a microscope slide, look systematically at every part of the evidence.

2. *We know that we are naturally inclined to filter out information we assume is unimportant.* However, at a crime scene, we do not know what may turn out to be important. In this situation, we need to consciously observe everything, no matter how small or how familiar, no matter what our emotions or previous experiences. So we train ourselves to turn off our filters, and instead act more like data-gathering robots.
3. *We know that we are naturally inclined to interpret what we see, to look for patterns, and make connections.* To some degree, this inclination can lead to us jumping to conclusions. While observing, we need to be careful that we concentrate first and foremost on gathering all of the available information and leaving the interpretation until we have as much information as possible. The more information we have, the better our interpretations will be.
4. *We know that our memories are faulty.* While observing, it is important to write down and photograph as much information as possible (Figure 1-5). This will become very important later when we, or our investigating team members, are using our observations to try to piece together a crime. Documentation also is important when acting as an expert witness. A judge will only accept hair evidence that has been documented in writing and with photographs taken at the crime scene. The verbal testimony of a forensic scientist alone may not be entered into evidence without the proper documentation.

Figure 1-5 *Documentation is an essential part of observation.*

AP Images/Mary Altaffer

DIGGING DEEPER

With Forensic Science eCollection

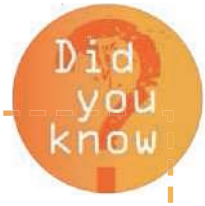
Observation is as much about finding evidence as it is about spotting patterns of criminal behavior. We know that, on average, most thieves who come in through a window will leave by a door. Search the Gale Forensic Science eCollection on **ngl.cengage.com/forensicscience2e** for articles on patterns of criminal behavior. Discuss with the class how a knowledge of criminal behavioral patterns can help to solve crimes.

FORENSIC SCIENCE Obj. 1.5

Forensic science the word conjures up images of *CSI: Miami,* lab coats, and dimly lit laboratories. "Forensic" derives from the Latin word *forensis,* which means "of the forum." The ancient Roman forum was an open area where scholars would gather to debate issues.

But forensics today is science. The debating comes later, in the courtroom, after the scientific analysis of the evidence. Science is formally defined as the use of evidence to construct testable explanations and predictions of phenomena and the knowledge generated through this process. Note that science is a process. Observations lead to a testable hypothesis, a tentative explanation of observations that may or may not be supported by testing. Through repeated testing and revising of hypotheses, diseases can be cured and serial killers can be caught.

Note that a hypothesis is not a theory; neither in the sense of "I have a theory as to where Amelia's lost cat is," nor in the sense of a scientific theory. Like a hypothesis, a scientific theory is based on natural and physical phenomena and must be capable of being tested by independent researchers and subject to alteration as developing science and technology yield new data. But unlike a hypothesis, a theory has been well-established and supported by testing and is highly reliable. Newton's physical theory of gravity, and the theories of evolution and general relativity have been supported by more than a century of data from diverse scientific disciplines.



High-ranking police officers in New York City are trained in observation skills at a local museum, the Frick Collection. The police learn to identify details in the paintings and draw conclusions about the paintings' subjects. They apply their new skills at crime scenes.

What Forensic Scientists Do

So—what do forensic scientists do? Their task is to find, examine, and evaluate evidence from a crime scene. A good forensic scientist is skilled at making observations and applying scientific knowledge to analyze the crime scene. Forensic scientists are bound by ethics to find as much evidence as possible and to fully analyze and interpret it, with all the accuracy and skill of which they are capable, without personal bias. A forensic scientist must also be a good communicator who is able to convince a jury that his/her analysis is both reliable and accurate (Figure 1-6). Often specialists deal only with certain types of evidence. Ballistics experts work with bullets and firearms; pathologists work with bodies to determine the cause of death through the examination of injuries. Textile experts, blood-spatter experts, and vehicle experts all rely on observation skills to do their jobs.

Police officers must also be trained to have good observation skills. Part of their training is learning to take in the entire scene before making an assessment based on their observations. The ability to solve a crime depends on observing all of the evidence left at a crime scene. **Analytical skills** of this type require patience and practice.

Figure 1-6 *A forensic scientist acting as an expert witness in court.*

AP Images/Dave Ellis,pool