Chapter Overview

If a standard DNA analysis were done on identical twins, it would show that they have identical DNA. How would a forensic investigator determine which of the twins committed a crime? Today, forensic science depends heavily on DNA analysis. However, in the case of twins, the forensic investigation team will need to use a technique that began in the mid-1800s to identify the suspect—fingerprinting. Every individual, even a twin, has a unique fingerprint made up of whorls, loops, or arches. Even today, with all of the advancement in science technology, fingerprints as a means of identifying an individual are extremely powerful in a court of law.

The Big Ideas

There is a long history behind the science of fingerprinting. A person's fingerprints develop in the womb. The ridges on our fingers in the shapes of loops, arches, and whorls are different from anyone else's. Forensic examiners look for certain characteristics, such as a core and deltas. There are three types of prints that might be found at a crime scene: patent, plastic, or latent prints. The IAFIS, developed by the FBI, is used to match prints found at the scene. Fingerprints can be collected by using tape, powders or other chemicals, and photography, and they can then be compared with criminal fingerprint cards on file.

CHAPTER 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

CHAPTER 6

Fingerprints

UNALTERED IDENTITY

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"Smiling Gus" Winkler, a gangster, thought he could stay ahead of police by surgically altering his fingerprints.

Augustus "Smiling Gus" Winkler's personal motto was "Take care of Winkler first," and his career as a gangster showed he did just that. Said to be a smooth talker, Gus began his life of crime as a member of Eagan's Rats in St. Louis, Missouri, and by the age of 20, he had earned a reputation as a skilled safe-cracker. Between 1920 and 1926 he served time for assault with a deadly weapon, and on his release he headed north to Chicago. There Gus met up with some of Chicago's most famous gangsters, Fred "Killer" Burke, Al Capone, Bugsy Moran, and Roger Touhy, and was rumored to have participated in the St. Valentine's Day Massacre. He also had connections with police, always keeping his best interest in mind.

In 1933, looking out for himself, Winkler turned in evidence on his buddies, and was key to returning some of the loot from the Lincoln Trust Bank robbery. That act did not sit well with his friends, and in 1933 he was gunned down by unknown assailants. Winkler was laid to rest in a $10,000 silver coffin wearing clothes covered in gems. Winkler was one of the many gangsters who tried to disguise his identity by trying to alter his fingerprints. Below are the fingerprints of Gus Winkler's left middle finger before and after alteration.

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Winkler's fingerprints before (left) and after (right) he had a doctor remove a narrow strip down the center.

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SCENARIO

Organize students into groups of three or four and read the scenario. Discuss the following questions as a class:

What movies have you seen that depicted criminals and the crimes they committed?

Were these criminals ever caught in the movies?

What evidence did the police have that was the key to putting the criminals behind bars?

In the movies, how do criminals try to hide their fingerprints?

KEY SCIENCE CONCEPTS

Biology: the skin; fingerprints are part of an individual's phenotype; fingerprints are formed in utero during pregnancy

Chemistry: powders and other chemicals used to recover fingerprints; skin oil can leave a fingerprint on a surface; chemical reactions can help lift latent fingerprints

Teaching Resources

- Instructor's Resource CD-ROM includes:
  - PowerPoint Presentation
  - Lesson Plan and extended Objective Sheets
  - Teacher Notes and Activities
  - Activity Forms
  - Rubric
- ExamView CD-ROM
- E-book on CD-ROM

Web site: school.cengage.com/forensicscience

Engage

Organize students into groups of two or three to read the Introduction. Then, read them the following scenario. Have them discuss it as a class: It is your first year at college and there is a break-in at the dorm. Fingerprints have been left at the crime scene. Based on this evidence, you are brought in for questioning. If the police are accusing you of stealing the missing items from the dorm based on the presence of your fingerprints, what arguments could you present to support your innocence?

Explore

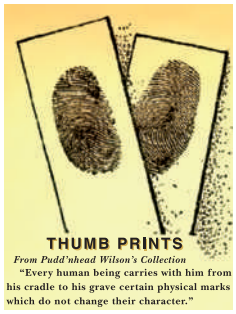
Jan Evangelist Purkyn was a science professor who played a large role in the study of physiology (the study of the biochemical, mechanical, and physical functions of living organisms). In 1823, he recognized fingerprints as a way of making identifications, and in 1833, he discovered sweat glands. He is also credited with coining the terms plasma, a yellow-colored, liquid component of blood, and protoplasma, the substance found inside cells.

INTRODUCTION

Pudd'nhead Wilson is a lawyer created by Mark Twain in the novel of the same name, published in November 1894. In his final address to a jury, Lawyer Wilson exhibits his knowledge of the cutting-edge technology of the day:

> Every human being carries with him from his cradle to his grave, certain physical marks which do not change their character, and by which he can always be identified—and that without shade of doubt or question. These marks are his signature, his physiological autograph, so to speak, and this autograph cannot be counterfeited, nor can he disguise it or hide it away, nor can it become illegible by the wear and mutations of time.

Figure 6-1. *Early, though fictional, fingerprint cards from Twain's* Pudd'nhead Wilson.



Public Domain

No one is sure how Mark Twain learned that fingerprints made good forensic evidence, but he used them in his book to dramatically solve a case in which identical twins were falsely accused of murder. Fingerprints as a means to identify individuals was a major breakthrough in forensic science in real life, as well as in novels, and it gave law enforcement around the world a new tool to solve crimes, clear the innocent, and convict the guilty. Fingerprint cards from Pudd'nhead Wilson are shown in Figure 6-1.

Obj. 6.1

HISTORICAL DEVELOPMENT

For thousands of years, humans have been fascinated by the patterns found on the skin of their fingers. But exactly how long ago humans realized that these patterns could identify individuals is not at all clear. Several ancient cultures used fingerprints as markings (Figure 6-2). Archaeologists discovered fingerprints pressed into clay tablet contracts dating back to 1792–1750 B.C. in Babylon. In ancient China, it was common practice to use inked fingerprints on all official documents, such as contracts and loans. The oldest known document showing fingerprints dates from the third century B.C. Chinese historians have found finger and palm prints pressed into clay and wood writing surfaces and surmise that they were used to authenticate official seals and legal documents.

Figure 6-2. *This ancient seal shows the fingerprint of a person who lived hundreds of years ago.*

©Photograph by Bruce & Kenneth Zuckerman and Maarily Lundberg, West Semitic Research. Courtesy USC Archaeological Research Collection.

In Western culture, the earliest record of the study of the patterns on human hands comes from 1684. Dr. Nehemiah wrote a paper describing the patterns that he saw on human hands under the microscope, including the presence of ridges. Johann Christoph Andreas Mayer followed this work in 1788 by describing that "the arrangement of skin ridges is never duplicated in two persons." He was probably the first scientist to recognize this fact. In 1823, Jan Evangelist Purkyn described nine distinct fingerprint patterns, including loops, spirals, circles, and double whorls. Sir William Herschel began the collecting of fingerprints in 1856 (Figure 6-3). He noted the patterns were unique to each person and were not altered by age.

Differentiated Learning

Teaching At-Risk Students

During the classroom discussion of the Introduction and Engage activity, encourage all students to express themselves and give opinions, even if they are different from the majority of the class. Be sure to stress to students that no one will be criticized for having a different opinion. Students who feel they will be heard are more likely to speak and engage in learning.

Figure 6-3. *Sir William Herschel*

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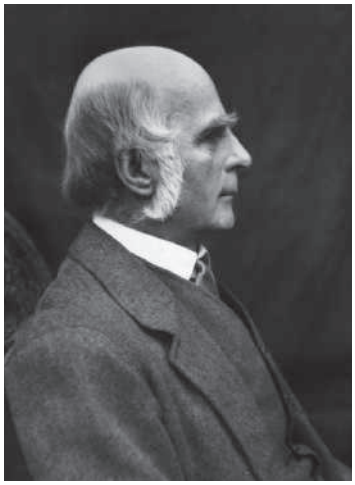
Figure 6-4. *Sir Francis Galton*



©Bettmann/Corbis

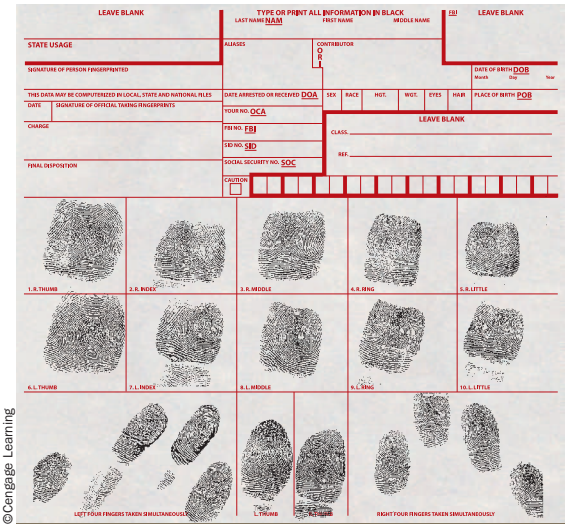
In 1879, Alphonse Bertillon, an assistant clerk in the records office at the Police Station in Paris, created a way to identify criminals. The system, sometimes called Bertillonage, was first used in 1883 to identify a repeating offender.

In 1902, he was credited with solving the first murder using fingerprints. Building on this success, Sir Francis Galton (1822–1911) verified that fingerprints do not change with age. In 1888, Galton, along with Sir E. R. Henry, developed the classification system for fingerprints that is still in use today in the United States and Europe. Galton is shown in Figure 6-4.

Iván (Juan) Vucetich improved fingerprint collection in 1891. He began to note measurements on the identification cards of all arrested persons, as well as adding all 10 fingerprint impressions. He devised his own fingerprint classification system and invented a better way of collecting the impressions. Beginning in 1896, Sir Edmund Richard Henry, with the help of two colleagues, created a system that divided fingerprint records into groups based on whether they have an arch, whorl, or loop pattern. Each fingerprint card in the system was imprinted with all 10 fingerprints of a person and marked with individual characteristics called a **ten card** (Figure 6-5).

Alphonse Bertillon was the first person to document incoming prisoners with a photograph, the forerunner of the modern mug shot.

Figure 6-5. *An early example of a ten card.*



©Cengage Learning

Explore

Alphonse Bertillon created anthropometry, which means the measurement of humans. Physical anthropology is the study of the measurements of living humans to understand physical variations among humans. Anthropometry, based on physical measurements of a person, was the first scientific system police used to help solve crimes.

Teaching Tip

Before discussing fingerprint patterns, ask students to view fingerprint impressions and have them devise their own method of classification.

Differentiated Learning

Teaching English-Language Learners

Connecting a face with a name is helpful for any learner. English-language learners may find it helpful to see pictures of all the scientists mentioned in the text. It may also be helpful to have students form small groups and dig deeper into the background of the men mentioned here. Finding some other contribution they made to forensic science could help students make better connections with the topic.

Digging Deeper

In Digging Deeper, students researched the first person to apply fingerprints to solving crimes. Students may want to research how it was first discovered that Super Glue™ helped develop fingerprints in a way that other methods could not. To learn more about the fingerprinting process, go to the Gale Forensic Science eCollection at school.cengage.com/forensicscience.

Teaching Tip

Ask students to try to pick up a heavy object using a glove with a smooth surface. Next, try it without the glove. Which was easier? If possible, show students SEM photos of a gecko's feet. Point out that the surface area of the friction ridges on their feet is so dense that geckos are able to walk on vertical plate glass.

Teaching Tip

Several companies sell commercially prepared slides of human fingertip cross-sections. Students can look at the layers of skin, glands, and papillae. They can also see the thicknesses of each layer, which can be related to how skin thickness varies from location to location in the body.

Digging Deeper

In Digging Deeper, students researched Leonardo da Vinci's genetic fingerprint traits. Some students may want to look into whether their ancestry has specific fingerprint traits. To learn more about da Vinci's fingerprints, go to the Gale Forensic Science eCollection at school.cengage.com/forensicscience.

Fingerprints can be taken from dead bodies by chemically treating the fingertips to help them puff out. Another method involves surgically removing the finger skin and placing it like a glove onto the finger of someone else, who can then roll the print.

Digging Deeper
with Forensic Science e-Collection

Who was the first person to discover the individuality of fingerprints and their application to solving crimes? Asking this question in some scientific circles will likely spark a highly charged, spirited argument. The evidence is murky in some areas and clear in others. Search the Gale Forensic Science eCollection on school.cengage.com/forensicscience to find a review of the history of fingerprinting in solving crimes. After you read the review, make your own investigation by reading the primary sources available on that web site. Write a brief explanation of your findings. Make sure to back up your argument with sources, carefully check the dates of the publications, and apply logic to make your conclusions.

WHAT ARE FINGERPRINTS?

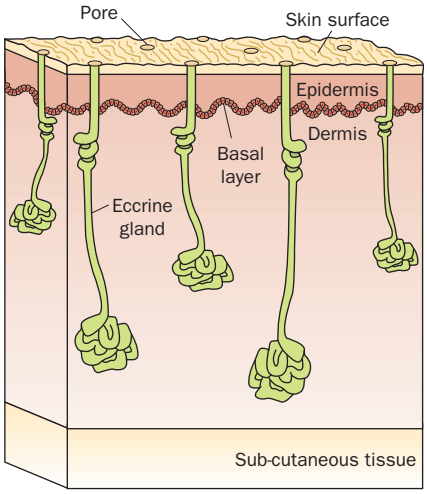


Figure 6-6 *Our fingertips are covered with hundreds of microscopic sweat pores, which make our fingers moist and able to grip better.*

Take a look at the surface of your fingers. Are they smooth and shiny surfaces? No. All fingers, toes, feet, and palms are covered in small ridges. These are raised portions of the skin, arranged in connected units called dermal, or friction, ridges. They help us with our grip on objects that we touch. When these ridges press against things, they leave a mark, an impression called a **fingerprint**.

The imprint of a fingerprint consists of natural secretions of the sweat glands that are present in the friction ridge of the skin (Figure 6-6). These secretions are a combination of mainly water, oils, and salts. Dirt from everyday activities is also mixed into these secretions. Anytime you touch something, you leave behind traces of these substances in the unique pattern of your dermal ridges.

FORMATION OF FINGERPRINTS

The individual nature of fingerprints has been known for about 2,000 years, but scientists only recently understood how fingerprints form in the womb. The

Digging Deeper
with Forensic Science e-Collection

Recent information about the fingerprints of Leonardo da Vinci has suggested that the ancient rumors that his mother was from a Middle Eastern country are most likely accurate, because his fingerprints display those genetic traits. To learn more about the forensic studies of da Vinci's fingerprints, go to the Gale Forensic Science eCollection on school.cengage.com/forensicscience and write a brief evidence report stating your conclusions about the question of da Vinci's ancestry.

Science
Biology

Your genes do have something to do with your fingerprints. They determine the general characteristics of the patterns. As the skin on your fingertips grows and folds, it forms your actual fingerprints that express these general characteristics.

Science
Biology

When a single fertilized egg splits into two, identical twins develop. Identical twins have identical DNA because both individuals' DNA formed from the joining of the same egg and sperm. Your genotype is your specific genetic makeup and order of genes. Your phenotype is the expression of these genes, or what you look like. Fingerprints are part of your phenotype, not genotype.

latest information suggests that the patterns are probably formed at the beginning of the 10th week of pregnancy, when the fetus is about three inches long. Similar prints are formed in many other areas of the body, such as the palms of the hands, the soles of the feet, and the lips.

The creation of fingerprints happens in the basal layer, a special layer within the epidermis where new skin cells are produced. In a fetus, this layer grows faster than the epidermis on the outside and the dermis on the inside. Because it grows faster, the layer collapses and folds in different directions, creating intricate shapes between the other layers of skin. The pattern cannot be altered or destroyed permanently by skin injuries, because the outer layer protects it.

CHARACTERISTICS OF FINGERPRINTS

Obj. 6.2

Fingerprint characteristics are named for their general visual appearance and patterns. These are called **loops, whorls**, and **arches** (Figure 6-7). About 65 percent of the total population has loops, 30 percent have whorls, and 5 percent have arches. Arches have ridges that enter from one side of the fingerprint and leave from the other side with a rise in the center. Whorls look like a bull's-eye, with two deltas (triangles). Loops enter from either the right or the left and exit from the same side they enter.

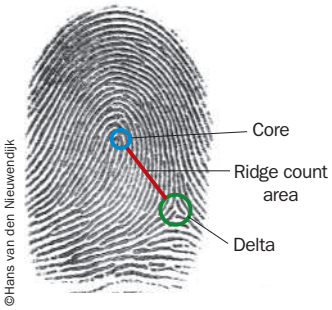
Figure 6-7. *There are three basic fingerprint patterns occurring at different frequencies in the population.*

Arches 5% *Whorls 30%* *Loops 65%*

A symptom of two rare genetic conditions is the lack of fingerprints. Dermatopathia pigmentosa reticularis (DPR) is so rare that only one family in the world is known to have it. Ectodermal dysplasia is a group of conditions related to skin disorders, including in some people the lack of fingerprints.

Two things a forensic examiner looks for on a fingerprint are the presence of a core and deltas. The **core** is the center of a loop or whorl. A triangular region located near a loop is called a **delta**. Some of the ridge patterns near the delta will rise above and some will fall below this triangular region. Sometimes the center of the delta may appear as a small island. A ridge count is another characteristic used to distinguish one fingerprint from another. To take a ridge count, an imaginary line is drawn from the center of the core to the edge of the delta. In Figure 6-8, the red line shows the area used in the ridge count from the delta to core area.

Figure 6-8. *The red line is called the core area and exists between a delta and the center of a loop or whorl.*



The basic fingerprint patterns can be further divided. Whorl patterns may be plain whorl (24%), central pocket loop whorl (2%), double loop whorl (4%), or accidental whorl (0.01%). The plain whorl (Figure 6-9A, next page) has one or more ridges that make a complete spiral. There are two deltas, and if a line is drawn between them, at least one ridge in the inner pattern is touched or cut by the line. The central pocket loop whorl (Figure 6-9B, next page) has one or more ridges that make a complete circle. There are two deltas, and if a line is drawn between them, no ridges in the inner pattern

Science

Biology

The skin is divided into three layers, each having a different function. The surface of the skin is called the epidermis. The epidermis is a relatively thin layer where the outermost cells are shed. The newer cells grow from the lowest layer of the epidermis, called the basal layer. The epidermis, when undamaged, is mostly waterproof, provides protection against bacteria and viruses from entering the body, and contains melanin that filters out UV rays from the sun. The next layer is called the dermis. This layer provides the skin with strength and flexibility, and contains nerve endings, sweat glands and oil glands, hair follicles, and blood vessels. The subcutaneous layer is the most internal layer of the skin. This layer provides the body with insulation from the cold and heat, offers a protective padding, and stores energy.

Explore

Deciding on fingerprint characteristics can be very confusing for students. Point out that arches do not have deltas. The entire basis for declaring an arch, whorl, or loop is due to the delta. For example, you can have a print that looks like an arch, but if a delta is present, it would be classified as a loop. A loop has a single delta and ridge lines that enter and leave on the same side. A whorl has two deltas.

Explore

Point out that fingerprint classification is also useful for eliminating possible suspects. For example, if a thumbprint on an object is clearly a whorl and your suspect has two loops on his or her hands, there is no need to proceed further to minutiae analysis.

Teaching Tip

Explain that most prints at a crime scene are not full and complete. Criminals do not roll their prints onto objects for the police to find. Most of the time, only partial prints are found. To consider a print valid, it must have at least twelve distinct points of minutiae. These points are interconnected to form a distinctive pattern that can be matched. This method has been replaced by a newer computerized algorithm method that plots patterns of minutiae locations.

Explore

Show students images of different minutiae types from Figure 6-11 without including the names. This method has been replaced by a newer computerized algorithm method that plots patterns of minutiae locations. Ask them what names they would give these images just based on what they see. Students often end up with the same or similar names. This helps break the ice when learning new terms like bifurcation and spur.

Explore

Explain how the prints on a ten card are made. For the upper ten impressions, each digit is individually rolled nail-edge to nail-edge on the card. This is done to obtain all available ridge detail. The prints at the bottom of the ten card are taken simultaneously without rolling. All of the fingers of each hand—except the thumb, which is printed separately—are set down at a 45-degree angle. These are referred to as plain or flat impressions. The bottom prints are taken in this manner to verify the sequence and accuracy of the rolled impressions at the top of the card.

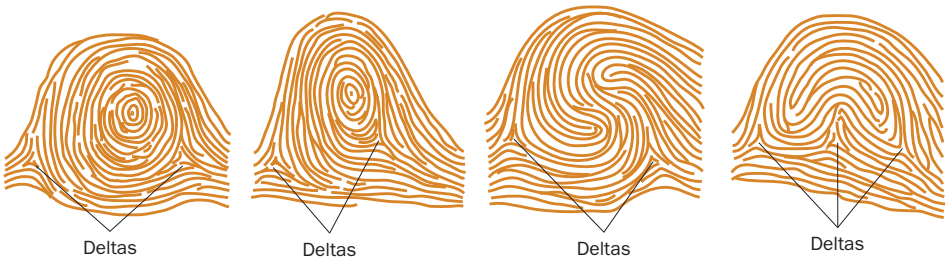
Explore

Plastic prints found at a crime scene can be preserved by taking photographs of the prints or making plaster casts of the print to be analyzed later in a lab.

Evaluate

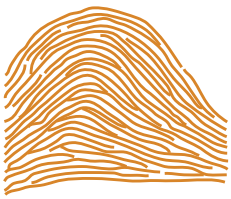
Read students the following scenario and then ask them to explain where fingerprints may be found and what type of prints—patent, plastic, or latent—they would be: A local pottery studio was robbed while the potter was out. The thieves broke a window on the studio's front door and then reached inside the broken window, turning the doorknob to get in. (A latent print might be left here as well as on whatever was used to break the window.) Designs (latent print) the potter had drawn for her future creations were strewn about the room. A fresh clay platter (plastic print) was torn in half. A cash register (a possible latent print on the register or whatever tool was used to force the drawer) was forcibly opened, and all of the cash (partial latent prints on individual coin slots) was taken. The criminals left by simply opening the back door (latent print on the knob; could be patent or visible if they had dirty hands).

Figure 6-9. *Types of whorl pattern.*

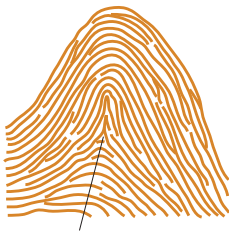


A. Plain whorl *B. Central pocket loop whorl* *C. Double loop whorl* *D. Accidental whorl*

Figure 6-10. *Types of arch pattern.*



A. Plain arch



B. Tented arch

are touched or cut by the line. The double loop whorl (Figure 6-9C) has two separate loop formations and two deltas. The accidental whorl (Figure 6-9D) has two or more deltas and is a combination of two of the other patterns (but not a plain arch).

Arches may be divided into plain arches (4%) and tented arches (1%). The plain arch (Figure 6-10A) shows ridges entering one side, rising in the center, and flowing out the other side without making an angle. The plain arch has no characteristics of the loop pattern. The tented arch (Figure 6-10B) does form an angle, or it may possess some characteristic of the loop pattern, such as a delta.

While looking at the basic fingerprint patterns can quickly help eliminate a suspect, in order to positively match a print found at a crime scene to an individual, more information is needed. Every individual, including identical twins, has a unique fingerprint resulting from unique **ridge patterns** called **minutiae** (because the details are so small). Recognizing these details in the differences between ridges, their relative number, and their location on a specific fingerprint is called *fingerprint identification.* There are about 150 individual ridge characteristics on the average full fingerprint. When forensic examiners identify a fingerprint, they are in theory identifying the unique signature of a person, and they can be pretty sure they are characterizing one, and only one, particular individual in the world. To match fingerprints, a minimum number of points of comparison are needed.

In Figure 6-11, on the next page, fingerprint minutiae are described. In the lab activities, you will practice the techniques necessary to identify and match fingerprints, including analyzing these ridge characteristics.

TYPES OF FINGERPRINTS *Obj. 6.3*

There are three types of prints found by investigators at a crime scene. **Patent fingerprints,** or visible prints, are left on a smooth surface when blood, ink, or some other liquid comes in contact with the hands and is then transferred to that surface. **Plastic fingerprints** are actual indentations left in some soft material such as clay, putty, or wax. **Latent fingerprints,** or hidden prints, are caused by the transfer of oils and other body secretions onto a surface. They can be made visible by dusting with powders or making the fingerprints in some way more visible by using a chemical reaction.

Fingerprints of suspects are taken by rolling each of the 10 fingers in ink and then rolling them onto a ten card that presents the 10 fingerprints in a standard format. In Activity 6-5, you will learn how to roll your own fingerprints.

Differentiated Learning

Teaching English-Language Learners

Students may have difficulty distinguishing between the terms latent and patent because they only differ by one letter. Try to come up with a clever way for them to remember these terms. For example, because latent begins with an L, that L could refer to investigators having to LOOK for these kinds of prints, hence latent prints are invisible prints.

Have students prepare plastic fingerprints in clay and identify the basic pattern of each fingerprint.

Figure 6-11. *Some minutiae patterns used to analyze fingerprints.*

Name	Visual Appearance
1. Ending ridge (including broken ridge)	1.
2. Fork (or bifurcation)	2.
3. Island ridge (or short ridge)	3.
4. Dot (of very short ridge)	4.
5. Bridge	5.
6. Spur (or hook)	6.
7. Eye (enclosure or island)	7.
8. Double bifurcation	8.
9. Delta	9.
10. Trifurcation	10.

FINGERPRINT FORENSIC FAQs

Obj. 6.4

Can Fingerprints Be Altered or Disguised?

As soon as fingerprints were discovered to be a reliable means of identification, criminals began to devise ways to alter them so they could avoid being identified. American Public Enemy Number One in the 1930s, John Dillinger (Figure 6-12), put acid on his fingertips to change their appearance, something he likely learned from stories of workers in the pineapple fields in Cuba who did not have fingerprints. This is because several chemical substances found in the pineapple plant, when combined with the pressure of handling the plants, dissolved the workers' fingerprints. What Dillinger did not learn is that when these workers ended their contact with the pineapples, their fingerprints grew back! Fingerprints taken from Dillinger's body in the morgue on his death were compared to known examples he left behind during his life of crime. Despite his efforts to destroy his fingerprints, they still allowed him to be identified.

Figure 6-12. *Wanted poster for John Dillinger.*

©AP Photo/Paul Walsh

Teaching Tip

Point out to students that Dillinger not only failed to remove his fingerprints, but by damaging his skin, he actually made his fingerprints more unique. Fingerprint patterns will not change on their own. If a trauma that produces a scar is deep enough to damage the underlying dermal papillae of the skin, then it will alter the friction ridges on the epidermal surface.

Teaching Tip

Use a flex camera to view fingerprint minutiae patterns. Fingerprint someone and enlarge several of the prints to view with a flex camera or on a transparency with an overhead projector.

Teaching Tip

The IAFIS is a database and search engine, but it does not initially evaluate or scan prints. Other software must do this. A police department buys the software and uses it to scan, evaluate, and upload the image to the IAFIS.

Teaching Tip

Tell students that cyanoacrylate is Super Glue®.

Teaching Tip

Help students learn the information in Figure 6-15 by enlarging the figure and making several copies of it. Then, cut out the squares of information and place each set of pieces into a separate envelope. Working in groups of two, have students recreate the figure from the pieces. Make this exercise into a game by assigning a point value for each piece placed in the correct position.

Science

Chemistry

Collecting latent or invisible fingerprints requires chemicals that will help investigators see and remove the prints for analysis without damaging them. The method used depends on the surface material. For example, ninhydrin reacts with traces of amino acids left on porous surfaces. Cyanoacrylate fumes adhere to latent prints on nonporous surfaces, such as plastic bags or electric tape.

Science

Chemistry

When crime-scene investigators work with metal powders, they typically use a Magna Brush. The Magna Brush is a specially designed magnet that picks up finely divided metal powder.

Figure 6-13. *Brandon Mayfield was falsely accused of involvement in the Madrid train bombing on the basis of the mistaken analysis of fingerprint evidence.*

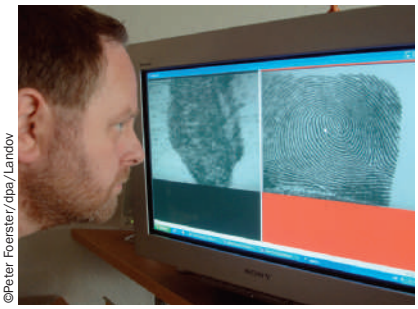
©Brent Wojahn/The Oregonian/Corbis

How Reliable Is Fingerprinting as a Means of Identification? *Obj. 6.5*

Many experts claim that fingerprint identification is flawless. However, humans input and analyze the information, and humans make mistakes. In 1995, 156 fingerprint examiners were given a test. One in five examiners made at least one false-positive identification. More recently, the Federal Bureau of Investigation (FBI) arrested and jailed Oregon lawyer Brandon Mayfield (Figure 6-13) based on fingerprint evidence that linked him to the Madrid train bombings in 2004, which killed 170 people. Mayfield, who had not traveled out of the United States for 10 years, claimed the fingerprint was not a good match. Mayfield was held in custody for two weeks, until the Spanish authorities told the FBI that the mark was, in fact, that of an Algerian citizen.

In light of the fallibility of human nature, and the serious consequences of making a mistake, it is important that fingerprint examiners be held to a high standard of performance. Results need to be checked and double-checked to prevent false convictions and to maintain the integrity of the science.

Figure 6-14. *A technician compares fingerprints in the AFIS system.*



©Peter Foerster/dpa/Landov

How Are Fingerprints Analyzed? *Obj. 6.6*

Contrary to what we see on television, fingerprint matching is not carried out by a computer in a matter of seconds. By 1987, the FBI had 23 million criminal fingerprint cards on file, and getting a match with a fingerprint found at a crime scene and one stored on file required manual searching. It could take as long as three months to find a match. In 1999, with the cooperation of the national law enforcement community, the FBI developed the Integrated Automated Fingerprint Identification System (IAFIS or AFIS).

The IAFIS provides digital, automated fingerprint searches, latent searches, electronic storage of fingerprint photo files, and electronic exchange of fingerprints and test results. It operates 24 hours a day, 365 days a year. Now agencies submitting fingerprints electronically for matching can expect results for criminal investigations within two hours (Figure 6-14). Currently, the IAFIS maintains the Criminal Master File, which is the largest database of its kind in the world. It contains the fingerprints and criminal histories for more than 47 million people. State, local, and federal law enforcement agencies submit these data voluntarily. Federal and state fingerprinting agencies do not pool their databases.

There are about 30 recorded cases of permanent, intentional fingerprint mutilations. In all of these cases, the mutilation was discovered by law enforcement.

How Are Latent Fingerprints Collected? *Obj. 6.9*

As mentioned earlier, latent fingerprints are not visible, but techniques can "bring them out." Dusting surfaces such as drinking glasses, the faucets on bathroom sinks, telephones, and the like with a fine carbon powder can make a fingerprint more visible. Tape is then used to lift and preserve the fingerprint. The tape with the fingerprint is then placed on an evidence card on which the date, time, location, and collector of the print is logged. Proper evidence collection techniques involve photographing the fingerprints before they are lifted. Metal or magnetic powders can also be used. They are less messy than carbon-based powders.

Differentiated Learning

Teaching Gifted Students

Allow students to research court cases that have been reopened or thrown out because of faulty identification of fingerprints.

Ask students to investigate when fingerprint evidence was first recognized by the courts. Ask students to research the newest methods of fingerprint identification used today.

Figure 6-15. *Methods used for visualizing latent fingerprints.*

Chemical	Uses	Application	Safety	Chemical Reaction	Latent Print
Ninhydrin	Paper	Object dipped or sprayed in Ninhydrin Wait 24 hours	Do not inhale or get on your skin	Reacts with amino acids (proteins) found in sweat	Purple-blue print
Cyanoacrylate Vapor	Household items: plastic, metal, glass, and skin	Heat sample in a vapor tent	Do not inhale or get on your skin: irritant to mucous membranes	Reacts with amino acids	White print
Silver Nitrate	Wood Styrofoam	Object dipped or sprayed in Silver Nitrate	Wear gloves to avoid contact with skin	Chloride from salt in perspiration on the print combines with silver nitrate to form silver chloride	Black or reddish brown print under UV light
Iodine Fuming	Paper Cardboard Unpainted surfaces	In a vapor tent, heat solid iodine crystals	Toxic to inhale or ingest	Iodine combines with carbohydrates in latent print	Brownish print (fades quickly) must be photographed or sprayed with a solution of starch

To recover a print from a surface that is not smooth and hard requires the use of different chemicals. When the fingerprint residue combines with these chemicals, the fingerprint image becomes visible. Figure 6-15 summarizes some of the more common chemicals used to produce a latent print, and Figure 6-16 shows a trained officer lifting a print.

THE FUTURE OF FINGERPRINTING

Obj. 6.7 and 6.8

Fingerprinting is not going away anytime soon. With the new scanning technology and digital systems of identifying patterns, fingerprints can be scanned at the rate of 500 to 1,000 dots per inch. This provides an image that reveals minute pore patterns on the fingerprint ridges, allowing for even better pattern matching (Figure 6-17, next page). Perhaps with time, the chances of mistakes being made will be virtually eliminated.

Entirely new uses for fingerprints are also being developed. Scientific studies have shown that much of the material we touch in our daily lives leaves trace evidence on our fingers and hands, which is in turn left behind on the objects that we touch. Dr. Sue Jickells is doing research to ask how things criminals may touch, such as explosives, cigarettes, and drugs, can leave behind traces on

Figure 6-16. *A forensic specialist lifting a print.*

©Kayte M. Deioma/PhotoEdit

Explore

Biometrics is the study of using physical traits to identify people. Finger- and thumbprint identification is the most widely used biometric technology. Fingerprints are not stored by picture but by measurements of the distances between the ridges and loops of the thumbprint. Eye scans or retina scans are also used. Retina scans test the pattern of the blood vessels lining the retina.

Teaching Tip

Point out to students that biometric technologies are being developed for use with ATMs, firearms, computers, and security systems. Large theme parks such as Disney World also use biometric fingerprint technology to decrease fraud.

Teaching Tip

Ask a fingerprint technician to visit your class and demonstrate the correct procedure in preparing a "Ten Card."

Differentiated Learning

Teaching Gifted Students

Have students research the chemical reactions involved in fingerprint recovery using ninhydrin and Super Glue.

Explore

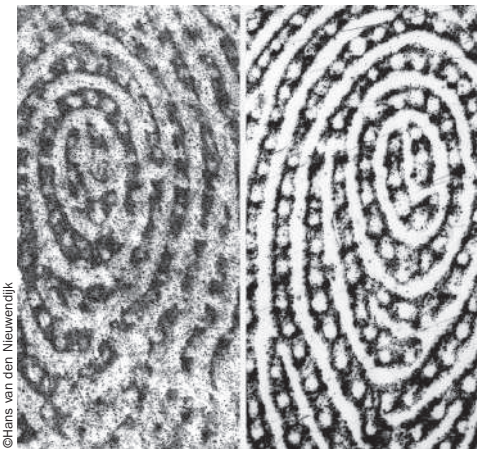
Encourage interested students to research the new methods of identification mentioned on this page and report their findings to the class.

Teaching Tip

Tell students that today all members of the military, school bus drivers, and teachers are required to be fingerprinted.

Any non-U.S. citizen entering the United States through a major airport has an electronic photo of his or her fingerprints entered into the IAFIS database.

Figure 6-17. *This high-resolution fingerprint is a digital image that shows the pores along the ridges, which appear as holes in the lines.*



the skin. When identified and studied, these trace substances could tell us much more about the lives of fingerprint donors than just their identities.

Technologies currently being developed use other physical features to identify people, including retinal patterns in the eyes, facial patterns, and the pattern of veins in the palm of the hand. Who knows what else the future holds!

SUMMARY

- Humans have noticed the patterns on their hands for thousands of years, but it was not until 1684 that these patterns were described in detail. In the mid-1800s, the idea of a fingerprint's uniqueness was studied, and the application of fingerprints to an identification system began. By the late 1800s, two effective systems were being used to identify criminals, and fingerprints were collected as evidence in crimes.
- The lines in a fingerprint are called friction ridges. Fingerprints consist of several main ridge patterns, including whorls, loops, and arches. They have a core, which is an area where ridges separate or unite after running in a parallel direction. The triangular region located near a loop pattern, or whorl, is called a delta.
- Fingerprints are formed in the womb at about week 10 of gestation. They are formed between two layers of skin, and their shape does not change during a person's lifetime. They are unique to an individual. Not even identical twins have identical fingerprints.
- Fingerprints left on an object are created by the naturally occurring ridges in the skin of fingers. Secretions from sweat glands leave small amounts of oils and salts when the ridges are pressed against an object. The residues mirror the shape of the ridges found on the finger of the donor.

- The basic types of fingerprints are patent (visible) fingerprints, plastic (indentations) fingerprints, and latent (hidden) fingerprints. They are characterized as either loops, whorls, or arches matched on the basis of minutiae.
- Criminals have sought to alter their fingerprints with chemicals, surgery, and superficial destruction. Some fingerprints can be altered by long-term contact with rough surfaces. Most attempts at fingerprint alteration have not been successful.
- Although mistakes in fingerprint analysis have led to wrongful convictions, the errors lie with the humans who are doing the analyzing. Higher standards of performance for analysts and a system of checks and balances help limit false convictions based on fingerprint evidence.
- The Integrated Automated Fingerprint Identification System (IAFIS) is a national digital database that holds about 47 million fingerprint records and operates 24 hours a day, 365 days a year.
- Fingerprints can be collected from surfaces by dusting them with certain powders and impressing them on tape, or putting them into contact with certain reactive gases to bring them out.

CASE STUDIES

Pedro Ramón Velásquez (1892)

On June 29, 1892, in the village of Necochea, Buenos Aires, two children, Ponciano Carballo Rojas, age six, and his sister Teresa, age four, were found brutally murdered in their home. Their mother, Francesca, age 27, was found with a superficial knife wound to the throat.

The police started an investigation that baffled them. Francesca told police that her neighbor, Pedro Ramón Velásquez, had committed the crime. Velasquez, a one-time suitor of Francesca's, did not confess, even after being tortured.

Inspector Commissioner Alvárez went to the crime scene to reexamine it, searching for any trace of evidence that might have been overlooked. He spotted bloody fingerprints on the doorpost of the house. Because Francesca had denied touching the bodies of her children, Alvárez believed he had found an important clue.

He took the bloody doorpost and fingerprint samples of Pedro Velásquez (Figure 6-18) to Juan Vucetich, who in late 1891 had opened the first fingerprint bureau in South America in Buenos Aires. Vucetich examined the fingerprints and found they did not match. Alvárez became suspicious of Francesca, who had been so insistent that Velásquez had committed the crime. He took a sample of her fingerprints and discovered that they matched the bloody prints found on the doorpost of the house.

When Francesca was confronted with the evidence against her, she confessed. She had murdered her own children, faked an attack on herself, and cast blame on an innocent man, intending him to die for the crime. Her reasons for the murder and for blaming Velásquez were that he had interfered in a romance between her and another suitor, and she felt she would be more appealing to the other man if she did not have children.

Evaluate

Ask students to discuss what, if anything, can be done to improve the accuracy of fingerprint evidence.

Teaching Tip

Have students discuss how a fingerprint examiner might incorrectly match two fingerprints as happened in the Stephen Cowans case. Ask: How does the case impact the confidence and reliability of fingerprint evidence?

Close

Point out to students that they have learned quite a bit of technical information in the chapter. Ask them to give you key words from the chapter. As you write each word on the board or overhead, have students tell you what it means and why it is significant.

Francesca Rojas was the first person in the Americas to be convicted of a crime based on fingerprint evidence.

Stephen Cowans (1997)

On the afternoon of May 30, 1997, Boston police officer Gregory Gallagher was shot with his own gun in a backyard in Roxbury, Massachusetts. Still carrying the gun, the assailant ran to a nearby residence, where he received a glass of water as he wiped off the gun. Stephen Cowans was eventually identified as the shooter. Investigators found a print on the glass used by the individual. The print was matched to prints of Cowans by two fingerprint examiners with the Boston Police Department. Cowans maintained his innocence. With the compelling fingerprint evidence, Cowans was convicted of the shooting and sentenced to 30 to 45 years in the state prison.

In 2004, Cowan's defense team requested DNA testing of the glass and a baseball cap dropped at the scene of the shooting. Neither DNA sample matched Cowan's DNA, although they did match each other. The original verdict was overturned. As Suffolk County reexamined the fingerprints as it prepared to retry Cowans, the assistant district attorney discovered "conclusively and unequivocally that . . . the purported match was a mistake." Cowans was released from prison after 6½ years. As a result, Boston police and the Suffolk County District Attorney's office established new guidelines for identification and evidence handling.

Think Critically **"To get a conviction, I would rather have one good fingerprint than a pound of hair and fiber evidence." Do you agree or disagree? Support your answer.**

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CAREERS IN FORENSICS

Peter Paul Biro

A Hungarian immigrant currently living and working in Canada, Peter Paul Biro is an art conservator who, in 1984, was the first to make studies of the fingerprints left behind on paintings by artists. After years of careful study, he began using these marks as a means of identifying artists.

Biro's job is to discover, by the use of fingerprint comparison, who painted a work of art and to put forward evidence to support the claim. No two fingerprints are alike, so Biro's evidence is extremely valuable to those who buy and sell art, because a painting that can be positively attributed to a particular artist rises in value.

Biro only uses fingerprints on artworks that were clearly made during the original creation of the work. These include imprints left in the paint while it is still wet, or prints left as a result of the use of a fingertip to apply paint (Leonardo da Vinci often used his fingertips as paintbrushes), or a palm print that might have resulted from applying varnish by hand. The fingerprint used for comparison should come from unquestioned works of art by the artist.

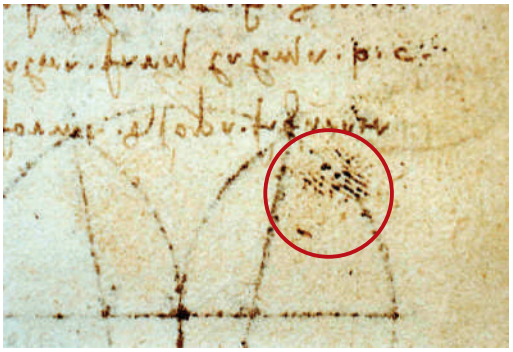
In 1993, Biro examined a painting discovered in the early 1980s entitled "Landscape with Rainbow" that was thought to be painted by the famous artist J. M. W. Turner. During the restoration process of this painting, fingerprints were discovered in the paint. Even though a match was found between a fingerprint on "Landscape with Rainbow" and fingerprints photographed on another Turner painting, "Chichester Canal," art experts and scholars alike discounted the evidence. Turner, who was known to work alone with no assistants, had used his fingertip on both paintings to model the still-wet paint and was the only possible donor for both prints. When an independent fingerprint examination by John Manners of the West Yorkshire Police confirmed the conclusions that the fingerprints on both paintings were identical, the unbelievers changed their minds. This case was the first successful use of fingerprints to authenticate artwork. The newly authenticated Turner painting sold for much more money that it would have otherwise.

The fingerprint in Figure 6-18 is that of Leonardo da Vinci. Although not visible in this photograph, Biro and other experts found nine distinct characteristics to identify da Vinci's prints.

Courtesy, Peter Paul Biro, Forensic Studies in Art, Montreal, QC, Canada.

Peter Paul Biro.

Figure 6-18. *Leonardo Da Vinci's fingerprint is in the right center of this document.*



©AP Photo/Piero Lucco

Learn More About It
To learn more about the work of a fingerprinting expert, go to school.cengage.com/forensicscience.

CAREERS

Point out to students that many other forensic tools are used to authenticate artwork. Carbon dating can be used to determine the age of an object that is biological in nature, up to as much as 50,000 years old. X-rays can detect what is hidden underneath the surface of a painting. Dendrochronology, or counting of the tree rings present, is used to date wooden objects. Thermoluminescence (TL) is used to date pottery. TL is light produced by heat. Pottery that is older produces more TL when heated than does a newer piece of pottery.

Chapter 6 Review

True or False

1. True
2. False
3. False
4. False
5. True
6. False
7. True
8. False
9. False
10. True

Multiple Choice

11. c
12. a
13. a

CHAPTER 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

CHAPTER 6 REVIEW

True or False

1. Fingerprints are a result of oil and secretions from skin mixing with dirt. *Obj. 6.2*
2. Fingerprints are considered to be a form of class evidence. *Obj. 6.5*
3. It is necessary to obtain a full print from a suspect in order to match his fingerprint with a fingerprint found at the crime scene. *Obj. 6.5, 6.6, and 6.7*
4. Plastic prints must be dusted or treated in order to identify the ridge patterns. *Obj. 6.6 and 6.7*
5. Loops are the most common form of fingerprints. *Obj. 6.3*
6. Fingerprints are formed deep within the dermis layer of the skin. *Obj. 6.2*
7. With the aid of IAFIS, it is possible to obtain a "match" within several hours. *Obj. 6.7*
8. The type of powder used to dust prints will vary depending upon the weather conditions when the print is lifted. *Obj. 6.6 and 6.9*
9. Fingerprints of the left hand are mirror images of the fingerprints on the right hand. *Obj. 6.2*
10. Similar print or ridge patterns can also be found on the toes. *Obj. 6.2 and 6.3*

Multiple Choice

11. Fingerprints are formed *Obj. 6.2*
    a) shortly after birth
    b) at about two years of age
    c) at 10 weeks' gestation
    d) at 17 weeks' pregnancy
12. Fingerprints that are actual indentations left in some soft material such as clay or putty are referred to as *Obj. 6.3*
    a) plastic fingerprints
    b) patent fingerprints
    c) latent fingerprints
    d) indented fingerprints
13. The use of fingerprints in identification is not perfect because *Obj. 6.5, 6.6, and 6.7*
    a) The current technology depends on humans to input and analyze the information, and humans make mistakes
    b) Many people have the same exact fingerprints
    c) People can easily change their fingerprints
    d) All of the above are correct answers
14. The three main types of fingerprints are classified as *Obj. 6.3*
    a) loops, whorls, and deltas
    b) whorls, bifurcations, arches

c) loops, whorls, and arches
d) arches, core, and deltas

15. A small triangular region is one characteristic found in a fingerprint. This triangular region is known as a *Obj. 6.3*

a) spur
b) eye
c) bridge
d) delta

Short Answer

16. Describe how to take a ridge count from a fingerprint. *Obj. 6.2*

_____

_____

_____

17. Write a brief definition of the term fingerprint. *Obj. 6.1*

_____

_____

_____

18. Describe how fingerprints are formed. *Obj. 6.2*

_____

_____

_____

19. Is it possible to alter fingerprints? Defend your answer. *Obj. 6.4*

_____

_____

_____

20. Another way to make prints visible is to apply certain chemicals. What aspect of a fingerprint chemically reacts with each of the following?
a. ninhydrin *Obj. 6.6*

_____

_____

_____

14. c
15. d

Short Answer

16. To take a ridge count, an imaginary line is drawn from the center of the core to the edge of the delta.
17. Sample answer: All fingers, toes, feet, and palms are covered in small ridges. These are raised portions of the skin, arranged in connected units called dermal, or friction, ridges. They help us with our grip on all objects we touch. When these ridges press against things, they leave a mark, or an impression, called a fingerprint.
18. Sample answer: Fingerprints are formed in the womb at about the 10th week of pregnancy. The basal layer of skin produces new skin cells and helps create unique fingerprints. These cells grow fast and fold and bend on top of each other, creating intricate shapes between each layer of skin. During the time in the womb, fingerprints are exposed to the uterine wall and amniotic fluid, which helps form and shape the prints to become even more individualized.
19. Possible answer: It is possible to alter fingerprints superficially, but the scar or change that is made may make the fingerprints even more unique if permanent damage to the dermal papillae occurred.
20. Ninhydrin: reacts with amino acids or proteins found in sweat. Cyanoacrylate vapor: amino acids. Silver nitrate: Chloride from salt in perspiration on the print combines with silver nitrate to form silver chloride. Iodine Fuming: Iodine combines with carbohydrates in latent prints.

Connections

Sample answer: Both prints have whorl ridge patterns with two deltas. (Students should do a ridge count on each print.) Students are also encouraged to note the presence of ridge endings, sort ridges, island and bifurcations. The FBI file print has two deltas found at the base of the whorl pattern, while the suspect print only has one. This is not a match.

Teaching Tip

Have students use transparency film to mark minutiae on the crime scene fingerprint and check to see if the same minutiae appear on the FBI fingerprint at the same location.

b. cyanoacrylate

_____

_____

_____

c. silver nitrate

_____

_____

_____

d. iodine fuming

_____

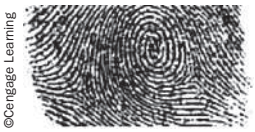
_____

_____

Connections

Refer to the two prints below. The first print is taken from the FBI files of a known suspect. The second print has been lifted off a glass taken from a crime scene. Determine if this is a match. Justify your answer.

- Identify the type of ridge pattern found in both prints.
- Use colored pencils to circle areas of similarity or differences.



ACTIVITY 6-1 *Ch. Obj. 6.3*

STUDY YOUR FINGERPRINTS

Objectives:

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

1. Identify your fingerprints.
2. Compare your fingerprints to those of your classmates.

Time Required to Complete Activity: 40 minutes

Materials:

clear, adhesive tape ¾ inch in width
ruler
pencil
3 × 5 card
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 patch of graphite about 2 by 3 inches.
2. Rub your right index finger across the graphite patch, gently rolling from side to side 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 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, into the box provided on the next page.
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.

Arches – 5%

Whorls – 30%

Loops – 65%

ACTIVITY 6-1

Background

This activity gives students an opportunity to examine their own fingerprints and compare them with their classmates' prints. Students use tape to make an impression of their fingerprints and determine what type of pattern they have.

Safety Precautions

Students should wash their hands after using the graphite pencils.

Teaching Tip

You may want to order special inkless print kits for the activities in this chapter to reduce the mess.

Procedures

1. Print, copy, and distribute Activity Sheet 6-1 from the IRCD.
2. Clear, ¾-inch-wide adhesive tape will not be wide enough for a thumbprint. If you can find a wider tape, use it.
3. If students are having trouble getting a good print with the graphite pencil, use less graphite. They could also try using an inkpad instead, but point out that less ink is better. Too much ink fills in the areas between the ridges, and you get a blob instead of a print.

Answers

Check students' data tables.

Questions

1. Answers will vary. (Tips: Be prepared to address averages that greatly deviate from the percentages given by the experts. Pool the data with other class periods and save them from year to year so students can see the power of having more data when drawing conclusions.)
2. Possible answer: The larger your sample size, the more accurate the data will be.

Tape your fingerprint into the space provided and identify its pattern type.

Which hand? _____

Which finger? _____

Fingerprint pattern? _____

Data Collection from Class:

Complete the table: Count the number of students showing each of the three types of fingerprint patterns and place those numbers in the Data Table.

Data Table

	Loop	Whorl	Arch
Number of students showing trait			
Total size of class (This will be the same total for each column)			
Percentage of class showing the trait (Divide the number of students with trait by the total size of class, then multiply by 100%)			
Experts say this percentage should be	65%	30%	5%

Questions:

1. Did the class percentage agree with the value given by experts (yes or no)? Explain your answer using data for support.
2. Describe how to improve this data-collecting activity so that your results might be more reliable.

150 Fingerprints

Further Research and Extensions

This activity allows students to examine one of their fingerprints. If time permits, you can allow them to make prints of each of their fingers and describe the pattern each has. They can also compare and contrast their two index fingers or their two thumbs. You might also have them identify other classmates' fingerprints, giving them even more practice.

ACTIVITY 6-2 *Ch. Obj. 6.3*

GIANT BALLOON FINGERPRINT

Objectives:

By the end of this activity, you will be able to:
Create a giant fingerprint for use in studying various ridge patterns.

Introduction:

Ridge patterns help make fingerprints unique and identifiable. By studying your own thumbprint and those of your classmates, you will be able to identify these patterns.

Time Required to Complete Activity: 20 minutes

What you will need to do this experiment: a white balloon and an inkpad.

Materials:

1 large white balloon
fingerprinting inkpad
hand soap or moist wipes
paper towels

Safety Precautions:

Before doing this activity, determine if any students are allergic to latex. If so, you can substitute purple nitrile gloves in place of the latex balloon.

Procedures:

1. Slightly blow up a large balloon or half inflate a large balloon.
2. Ink your thumb from thumbnail to thumbnail and past the first joint.
3. Carefully roll your thumb over the balloon from nail edge to nail edge, leaving a thumbprint. Make sure your print is situated about a quarter of the way from the top, and two-thirds of the way from the bottom.
4. Fully inflate the balloon and examine your thumbprint.
5. Identify your thumb pattern as a loop, whorl, or arch.
6. Examine the balloons of your classmates and identify the ridge types you find.
7. Deflate your balloon and save it.

Further Research and Extensions

This activity does not take a lot of time. To extend the activity, ask each student to examine the balloons of every student in the class. Remind students to write their initials on their balloon to keep track of the balloons. Give students two minutes to observe a balloon print. For each print they examine, they should record the fingerprint pattern and the initials written on the balloon. After two minutes, have students switch balloons until all students have examined every balloon. Compile the class data and determine the percentage of students with arches, whorls, or loops.

ACTIVITY 6-2

Background

In this activity, students use a balloon to enlarge their thumbprint so the ridge lines will be easier to see and identify. Instead of looking under a microscope, students enlarge the image of their fingerprint by inflating the balloon.

Safety Precautions

Some students may be allergic to latex. You may want to have students sign a waiver stating that they are not allergic to latex. It may be helpful to talk to the school's nurse before doing this activity. Local hospitals or clinics might be willing to donate latex-free gloves.

Procedures

Placement of the print on the balloon is critical to enlarging the print. It should be placed about one-quarter of the way from the top and two-thirds of the way from the bottom of the balloon for optimal results. Semi-inflate the balloon to about one-third capacity before applying the fingerprint. Then inflate it fully to magnify the fingerprint.

Answers

At the end of this activity, collect all balloons from the students. Students should staple a piece of paper to the end of the balloon before turning it in. The piece of paper should have their name, which finger they printed, the fingerprint pattern, and any other identifying marks. Turning in the balloon will allow the teacher time to enter grades for this activity based on completeness and participation.

ACTIVITY 6-3

Background

In this activity, students touch a piece of glassware and dust the glass to reveal the latent fingerprint.

Safety Precautions

1. Make sure to cover the work area with newspapers.
2. Emphasize that students must handle the dusting powder with care, because it can be very messy.
3. Be prepared. Dust will settle on everything in the room no matter how careful the students are.
4. Emphasize to students how important it is to be careful blowing off the excess dust.
5. Have a broom ready for cleanup at the end of the lab.

Procedures

Fingerprinting tape purchased from a supply store really works the best. If you don't have the budget for this special tape, a wide, clear tape works well.

ACTIVITY 6-3 *Ch. Obj. 6.6 and 6.9*

STUDYING LATENT FINGERPRINTS

Objectives:

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

1. Explain the significance of fingerprint evidence.
2. Describe how to take and identify latent fingerprints.

Introduction:

Every person has a unique set of fingerprints, even identical twins. Whenever you touch a surface without gloves or other protection, you leave behind an invisible fingerprint. Law enforcement agencies use various fingerprint powders and chemicals to help visualize these telltale prints.

Time Required to Complete Activity: 40 minutes

Materials:

newspaper
black dusting powder
adhesive tape ¾ inch wide
dusting brush
cloth
magnifying glass
drinking glass, watch with glass face, other pieces of glass or Plexiglas®
soap or premoistened handwipes
paper towels

Safety Precautions:

Cover the work area with newspapers.
Handle the dusting powder with care, because it can be very messy.

Procedure:

1. Cover the worktable with newspaper.
2. Wipe off a drinking glass, watch glass, piece of window glass, or Plexiglas® with a clean cloth.
3. Take your thumb and run it along the side of your nose or the back of your neck. These areas of your body are rich in oils and will help lubricate the ridges of the thumb to produce a clearer print.
4. Choose an area on the glass object and touch the glass with your thumb. Use a paper towel or other type of cloth in your other hand to prevent leaving other fingerprints. Be careful to avoid placing any other fingerprints in this area.
5. Dip the dusting brush lightly into the fingerprint powder. Place the brush between your hands and gently twist the brush, so that the bristles spin off excess powder near the surface of the object you are dusting. A latent (hidden) fingerprint should begin to appear. Continue to dust lightly, touching the surface until you have exposed as much

of the latent print as possible. Gently blow off the excess powder. (Be prepared for dust to settle on everything in the classroom.)

6. Tear off a three-inch piece of adhesive tape and place it over the fingerprint and press down.
7. Peel off the tape and place it on the Data Table. This process is called lifting the print.

The three types of fingerprints.

loop arch whorl

Data Table

	Thumbprint #1
Tape your latent print in the box to the right.	
Identify your print pattern as either loop, arch or whorl.	

Further Study

If time permits, clean the glass and place additional fingerprints on the surface and repeat the technique; then exchange your glass for a classmate's. Dust, lift, and identify his or her print.

Answers

Check students' data tables.

Teaching Tip

Ask students to watch episodes of *CSI* or movies that show a variety of surfaces from which fingerprint evidence was collected, then compare the differences in techniques and materials used to collect them.

Further Research and Extensions

This activity can be extended by having four students leave thumbprints on a piece of glassware. Lift these prints yourself. Then ask students to match each print with the person who made it by comparing the prints to those collected earlier in the activity.

ACTIVITY 6-4

Background

In this activity, students print a complete ten card to take home.

Safety Precautions

1. Cover the work area with newspaper.
2. Be sensitive to the fact that some students may have gotten into trouble and have had to submit their fingerprints on a ten card before. Because this is sometimes an issue for parents as well as students, you might send a letter home with students explaining the activity.

Procedures

1. Sirchie Fingerprint Laboratories (www.sirchie.com) may have a demo video to show students the proper way to print a ten card or how to dust for prints. The company lists videos available on its Web site, so check it out before beginning the lab.
2. Washable markers will also work instead of inking strips or an ink pad. They are cheaper than ink pads, and when capped, they will resist drying out much better than ink pads. Simply paint the surface of the skin with a dark-colored marker and proceed as normal.
3. Explain to students that the best parts of the print (such as a delta) are usually closer to the knuckle crease than to the fingertip. Knowing this in advance, students may be able to roll their fingerprints more carefully and get more of the print to appear, making it easier to assess.

Answers

Before students take their ten cards home, ask them to show the cards to you, so you can give them lab participation points.

ACTIVITY 6-4 *Ch. Obj. 6.6*

HOW TO PRINT A TEN CARD

Objectives:

By the end of this activity, you will be able to:
Produce a fully printed ten card to take home with you.

Introduction:

Law enforcement officials prepare and use fingerprint cards to identify individuals such as criminals, security workers, teachers, and bus drivers, and to register children and those persons licensed to carry firearms.

Criminals are not the only people who are fingerprinted.

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Time Required to Complete Activity:

50 minutes

Materials:

ten card
inking strips or an inkpad
magnifying glass
pre-moistened cleansing wipes, soap, paper towels, newspaper

Safety Precautions:

Cover the work area with newspaper.

Procedure:

1. Cover the work area with newspapers.
2. Fold the ten card along the line between the right-hand fingers and those of the left hand.
3. Place the fingerprint card on the front edge of the table.
4. Starting with your right hand, ink your thumb side to side from fingernail edge to fingernail edge and from the first joint to the tip of the finger. Try to keep your fingers parallel to the surface of the card when printing.
5. Working from the inside to the outer edge, place your thumb in the first square of the card and gently roll side to side using constant pressure. Do not rock back and forth. Make only one wipe. A good print should include from the joint of the finger to the tip.
6. Continue to ink and roll each finger, printing them in order in the squares on the ten card.
7. When you are finished fingerprinting the right hand, fold the card so that the squares for printing the left hand are closest to the edge of the table.
8. Repeat steps 5 to 6 for the left hand.
9. Re-ink the fingers of the right hand and press them gently into the box labeled "first four" for the right hand. Do the same for the right thumb and place the print in the box labeled right thumb.
10. Repeat the above process for the left hand.
11. Using the magnifying glass, examine each fingerprint and label them as a loop, arch, or whorl.

Further Research and Extensions

This activity is a prime opportunity to have a local police officer or detective come in to talk with the students. Prior to the lab, the speaker can ask for a volunteer and print a ten card in front of the class. This will give students a chance to ask the speaker questions and to see how to print a ten card prior to having to do it in lab.

ACTIVITY 6-5 *Ch. Obj. 6.2 and 6.3*

IS IT A MATCH?

Objectives:

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

1. Describe and identify different types of fingerprint minutiae.
2. Identify different minutiae patterns found in fingerprints.

Time Required to Complete Activity: 30 minutes

Introduction:

Latent fingerprints found at crime scenes are usually incomplete (partial) prints. Investigators need to examine the characteristics of a fingerprint very carefully. The simple identification of a whorl, loop, or arch is not sufficient. Other markers (minutiae) need to be identified.

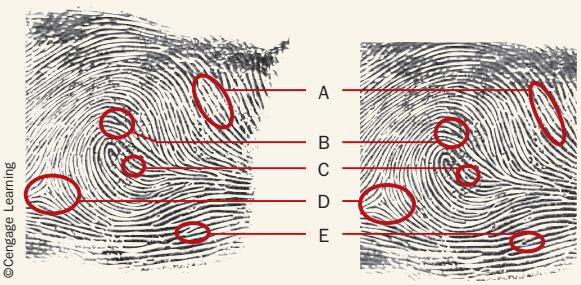
Materials:

examples of recovered latent fingerprints
red pen

Procedure:

1. Study the picture below. It shows fingerprints obtained from a suspect and a crime scene (mirror). Notice how the investigator has labeled the points of comparison with the same letter on the rolled ink print and the latent print from mirror. Use the chart of characteristics in your text to identify the specific characteristics.

Rolled ink print taken from suspect (left) and latent fingerprint lifted from the crime scene (right).



ACTIVITY 6-5

Background

In this activity, students study pictures of latent prints and examine ridge pattern minutiae.

Safety Precautions

There are no safety precautions for this activity.

Procedures

1. Hand out copies of the fingerprint minutiae chart in the text.
2. Make an overhead of the first set of prints. While the students are looking at their copy of the lab, have them also look at the overhead of the prints. Identify letter A together as a class.
3. You may wish to make an overhead of the print for Arthur and go through this print identification as a class. Let students complete the rest of the activity on their own.

Answers

Check students' information on each activity page.

Fingerprint Ridge Patterns

2. Identify each of the patterns labeled in the ridge pattern diagram. Refer to the chart on minutiae in the text.

   A. _____
   B. _____
   C. _____
   D. _____
   E. _____

3. Examine each of the fingerprints below. Using a red pen and referring to the chart in your text, circle the minutiae pattern and then label it with the appropriate number.

Arthur

1. Bifurcation
2. Island ridge
3. Ending ridge

Doris

4. Eye
5. Spur or hook
6. Ridge ending

Alice

7. Double bifurcation
8. Island ridge

Suspect

What patterns can you find in this print?

_____

_____

_____

Further Research and Extensions

Allow interested students to research Daubert criteria and then explain either through a PowerPoint presentation, poster, or research paper what these criteria are and how they are used in forensic science and a court of law.

ACTIVITY 6-6 *Ch. Obj. 6.3 and 6.9*

FINGERPRINT MATCHING

Objectives:

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

1. Match the latent crime scene print to one of the suspect's fingerprints.
2. Justify your match by identifying the fingerprint pattern along with as many fingerprint minutiae found in both the crime scene print and the suspect's fingerprint.
3. Circle the common minutiae points on both the crime scene print and the suspect's fingerprint.

Introduction:

Using a red pen, encircle and identify as many minutiae reference points shared by the crime scene fingerprint and the suspect's fingerprint.

Time Required to Complete Activity: 30 minutes

Crime-scene print

Suspect A

Suspect B

Suspect C

Suspect D

Suspect E

Suspect F

Suspect G

Suspect H

All photos ©Cengage Learning

ACTIVITY 6-6

Background

In this activity, students match a latent print to a selection of prints and label reference points.

Safety Precautions

There are no safety precautions for this activity.

Procedures

You may wish to make an overhead of the suspect print (or project the suspect's print using a flex camera) and identify the reference points together as a class. You may want to enlarge the fingerprint first.

Answers

Check students' information on each activity page.

Further Research and Extensions

Collect thumbprints from three or four teachers from your school. Make copies of these prints and pass them out to each student. Have them identify the reference points of each print and the print characteristics. If possible, ask students to decide which print belongs to which teacher.