

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.

OBJECTIVES

By the end of this chapter you will be able to

- ✓ Discuss the history of fingerprinting.
- ✓ Describe the characteristics of fingerprints.
- ✓ Identify the basic types of fingerprints.
- ✓ Describe how criminals attempt to alter their fingerprints.
- ✓ Determine the reliability of fingerprints as a means of identification.
- ✓ Explain how fingerprint evidence is collected.
- ✓ Describe the latest identification technologies.
- ✓ Determine if a fingerprint matches a fingerprint on record.
- ✓ Use the process of lifting a latent print.

VOCABULARY

arch a fingerprint pattern in which the ridge pattern originates from one side of the print and leaves from the other side

core a center of a loop or whorl

delta a triangular ridge pattern with ridges that go in different directions above and below a triangle

fingerprint an impression left on any surface that consists of patterns made by the ridges on a finger

latent fingerprint a hidden fingerprint made visible through the use of powders or other techniques

loop a fingerprint pattern in which the ridge pattern flows inward and returns in the direction of the origin

minutiae the combination of details in the shapes and positions of ridges in fingerprints that make each unique; also called ridge characteristics



patent fingerprint a visible fingerprint that happens when fingers with blood, ink, or some other substance on them touch a surface and transfer the pattern of their fingerprint to that surface

plastic fingerprint a three-dimensional fingerprint made in soft material such as clay, soap, or putty

ridge pattern the recognizable pattern of the ridges found in the end joints of fingers that form lines on the surfaces of objects in a fingerprint. They fall into three categories: arches, loops, and whorls

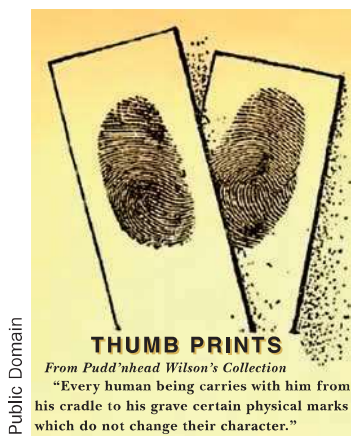
ten card a form used to record and preserve a person's fingerprints

whorl a fingerprint pattern that resembles a bull's-eye

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:

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



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.

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.

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.



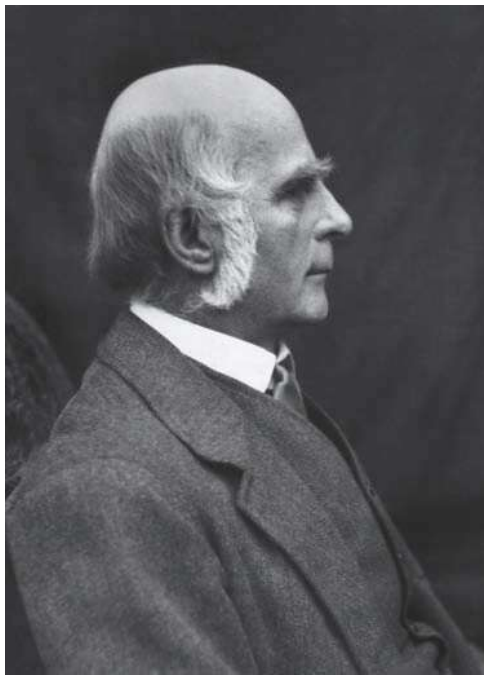
In Western culture, the earliest record of the study of the patterns on human hands comes from 1684. Dr. Nehemiah wrote a paper describing the patterns that he saw on human hands under the microscope, including the presence of ridges. Johann Christoph Andreas Mayer followed this work in 1788 by describing 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.

Figure 6-3. Sir William Herschel



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Figure 6-4. Sir Francis Galton



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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).

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

The form is titled "TYPE OR PRINT ALL INFORMATION IN BLACK" and includes the following fields:

- STATE USAGE
- ALIBIS
- CONTRIBUTOR OR
- SIGNATURE OF PERSON FINGERPRINTED
- DATE OF BIRTH DOB (Month, Day, Year)
- THIS DATA MAY BE COMPUTERIZED IN LOCAL, STATE AND NATIONAL FILES
- DATE ARRESTED OR RECEIVED DOA
- SEX
- RACE
- HGT.
- WGT.
- EYES
- HAIR
- PLACE OF BIRTH POB
- DATE
- SIGNATURE OF OFFICIAL TAKING FINGERPRINTS
- YOUR NO. OCA
- CLASS.
- CHARGE
- FBI NO. FBI
- REF.
- SID NO. SID
- SOCIAL SECURITY NO. SOC
- FINAL DEPOSITION
- CAUTION

The fingerprint section is divided into ten numbered boxes:

1. R. THUMB
2. R. INDEX
3. R. MIDDLE
4. R. RING
5. R. LITTLE
6. L. THUMB
7. L. INDEX
8. L. MIDDLE
9. L. RING
10. L. LITTLE

At the bottom, there are three boxes for simultaneous impressions: "LEFT FOUR FINGERS TAKEN SIMULTANEOUSLY", "L. THUMB", "R. THUMB", and "RIGHT FOUR FINGERS TAKEN SIMULTANEOUSLY".

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



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.

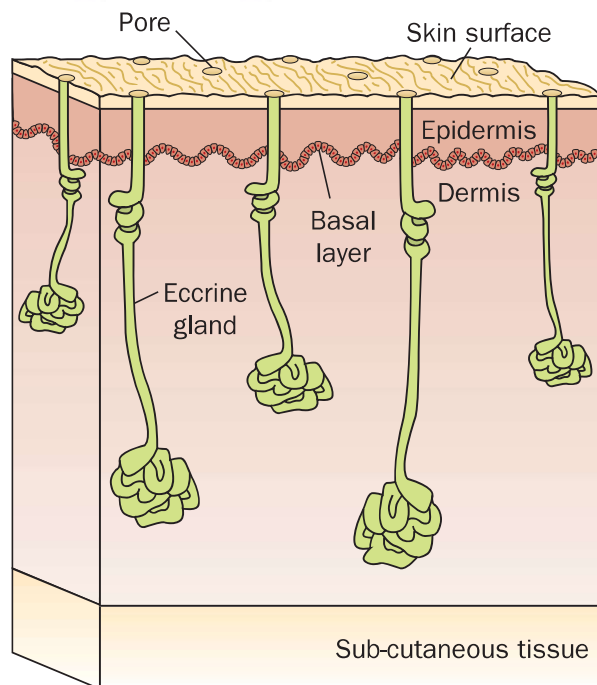
Digging Deeper

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?



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

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

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.



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.

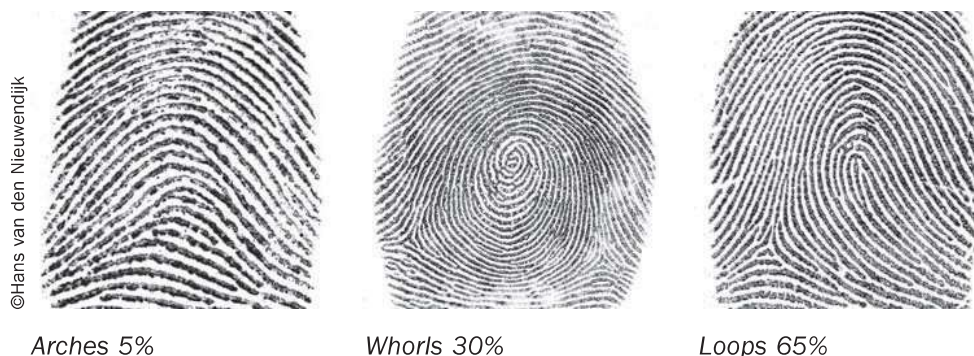
The creation of fingerprints happens in the basal layer, a special layer within the epidermis where new skin cells are produced. In a fetus, this layer grows faster than the epidermis on the outside and the dermis on the inside. Because it grows faster, the layer collapses and folds in different directions, 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

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.



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.

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

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

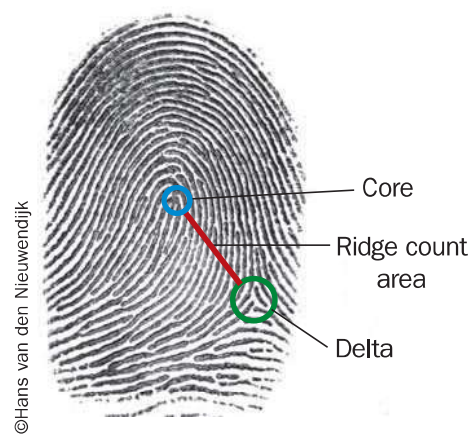
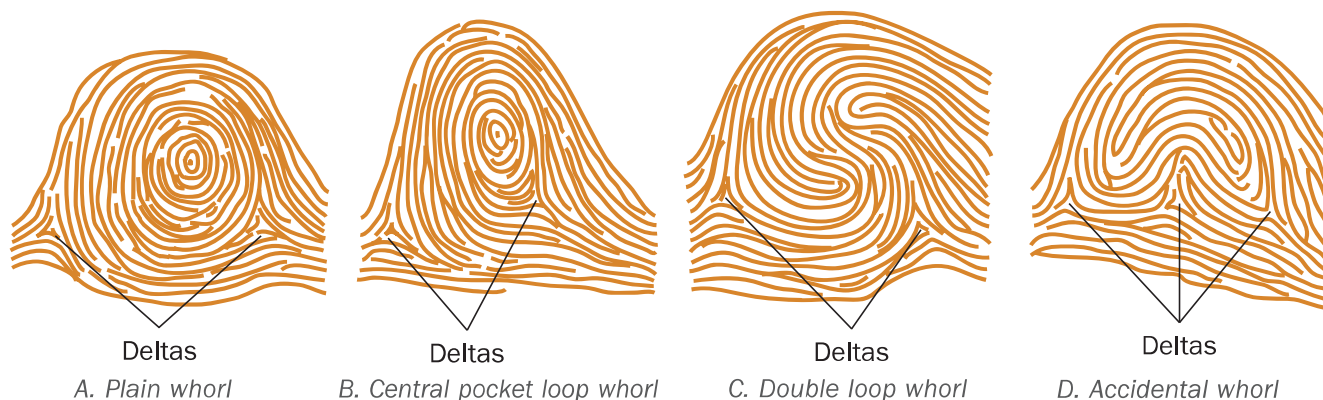
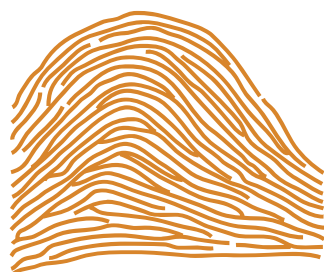
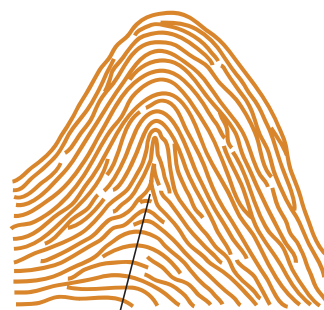


Figure 6-9. Types of whorl pattern.

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).

Figure 6-10. Types of arch pattern.

A. Plain arch

Delta
B. Tented 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

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.

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

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

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.



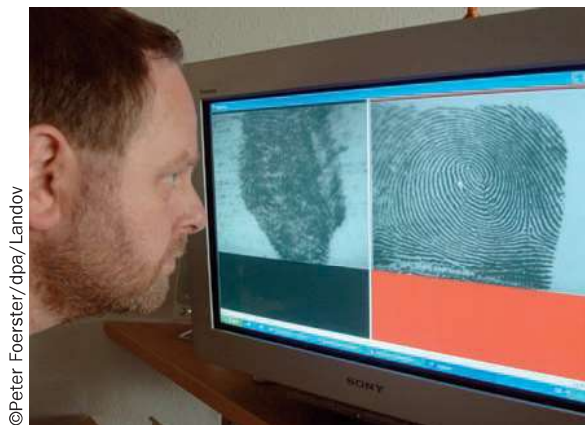
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How Reliable Is Fingerprinting as a Means of Identification?

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?

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.

How Are Latent Fingerprints Collected?

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.



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



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

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.

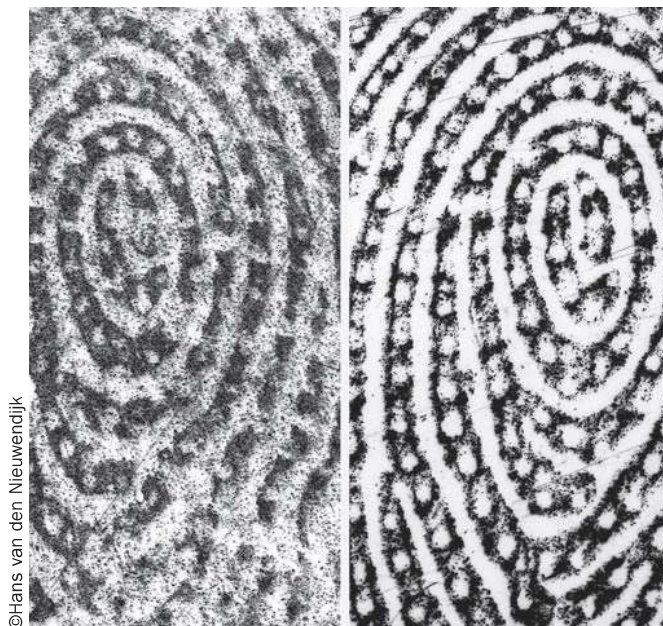


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Any non-U.S. citizen entering the United States through a major airport has an electronic photo of his or her fingerprints entered into the IAFIS database.

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 Álvarez 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, Álvarez 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. Álvarez 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.

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"



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

Peter Paul Biro.

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 than 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.

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.

CHAPTER 6 REVIEW

True or False

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

Multiple Choice

11. Fingerprints are formed
 - 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
 - a) plastic fingerprints
 - b) patent fingerprints
 - c) latent fingerprints
 - d) indented fingerprints
13. The use of fingerprints in identification is not perfect because
 - 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
 - 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
- a) spur
 - b) eye
 - c) bridge
 - d) delta

Short Answer

16. Describe how to take a ridge count from a fingerprint.

17. Write a brief definition of the term fingerprint.

18. Describe how fingerprints are formed.

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

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

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.

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ACTIVITY 6-1

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 $\frac{3}{4}$ 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%



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.

ACTIVITY 6-2

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.



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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.



ACTIVITY 6-3

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 $\frac{3}{4}$ 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.



ACTIVITY 6-4

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.

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



©Thinkstock/Jupiter Images

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.

ACTIVITY 6-5

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.

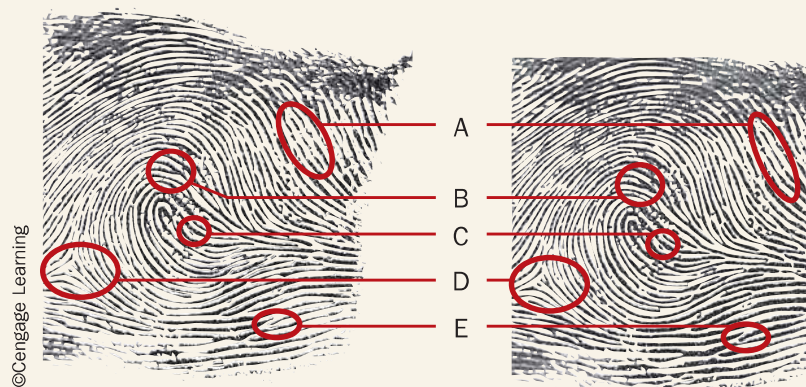
Materials:

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).



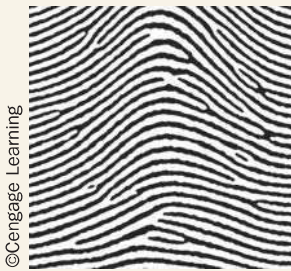


Fingerprint Ridge Patterns

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?

ACTIVITY 6-6 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



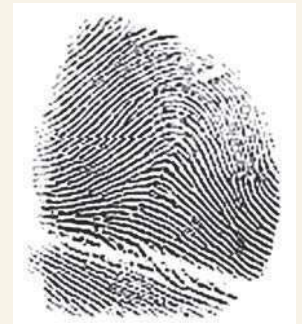
Suspect B



Suspect C



Suspect D



Suspect E



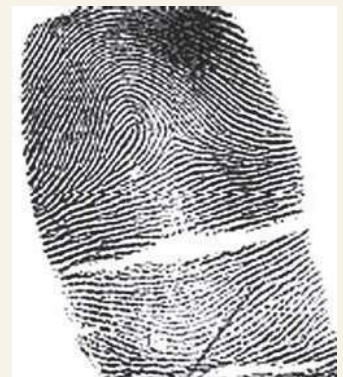
Suspect F



Suspect G



Suspect H



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