FINGERPRINTING

BOY SCOUTS OF AMERICA
IRVING, TEXAS

Requirements

1. Give a short history of fingerprinting. Tell the difference between civil and criminal identification.

2. Explain the difference between the automated fingerprint identification systems (AFIS) now used by some law enforcement agencies and the biometric fingerprint systems used to control access to places like buildings, airports, and computer rooms.

3. Do the following:

   a. Name the surfaces of the body where friction or papillary ridges are found.

   b. Name the two basic principles supporting the science of fingerprints and give a brief explanation of each principle.

   c. Explain what it takes to positively identify a person using fingerprints.

4. Take a clear set of prints using ONE of the following methods.

   a. Make both rolled and plain impressions. Make these on an 8-by-8-inch fingerprint identification card, available from your local police department or your counselor.

   b. Using clear adhesive tape, a pencil, and plain paper, record your own fingerprints or those of another person.

5. Show your merit badge counselor you can identify the three basic types of fingerprint patterns and their subcategories. Using your own hand, identify the types of patterns you see.

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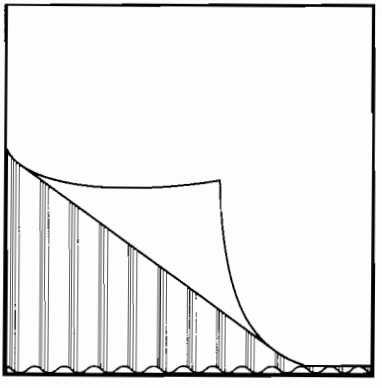
Contents

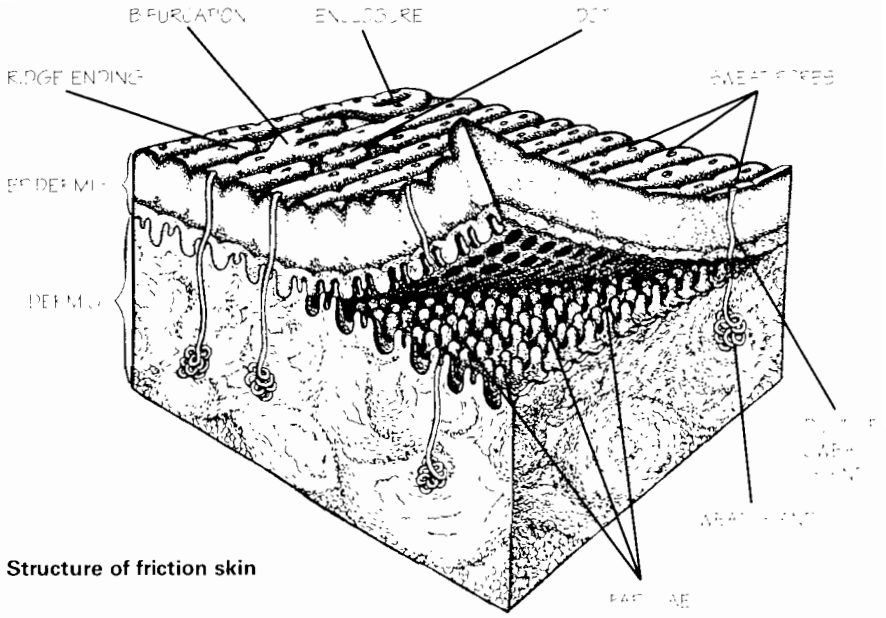
What Is a Fingerprint?

Imagine trying to pick up an ice-cold glass of water using the inside of your arm at the elbow. The smooth skin on the inside of your arm is not designed to grip or create friction the way the ridged skin on your fingers and palms will grip. Using the inside of your elbow, you are more likely to drop the glass than if you use the "friction skin" on your fingers and palms. The friction skin on your toes and the soles of your feet serves the same purpose in giving you traction on slippery surfaces.

When you transfer dirt, oil, ink, or other substances from the friction ridges of your fingers to a smooth surface, you make fingerprints. Just like an ink stamp, the ridges make contact patterns on the surface you touch. The shapes and paths of the tops of the friction ridges appear as lines in a fingerprint.



The friction skin covering the undersides of your fingers, palms, soles, and toes resembles the ridges of corrugated cardboard. Peel away the paper covering from a piece of corrugated cardboard to see the alternating ridges and grooves.



Structure of friction skin

The skin has three layers: epidermis, dermis, and (not shown in this illustration) subcutaneous tissue. The *epidermis,* the outermost layer, is about as thick as a sheet of paper over most of the body. The *dermis,* the middle layer, is between 15 and 40 times as thick as the epidermis. The surface of the dermis has many tiny "pegs," the papillae, that fit into pits on the underside of the epidermis. The *papillae* help fasten the dermis to the epidermis.

Friction ridges are technically known as *papillary ridges.* Scrapes, cuts, and other minor injuries do not change the ridge structure or the papillae; the original ridge pattern reappears in any new skin that grows.

Two Basic Principles of Fingerprinting

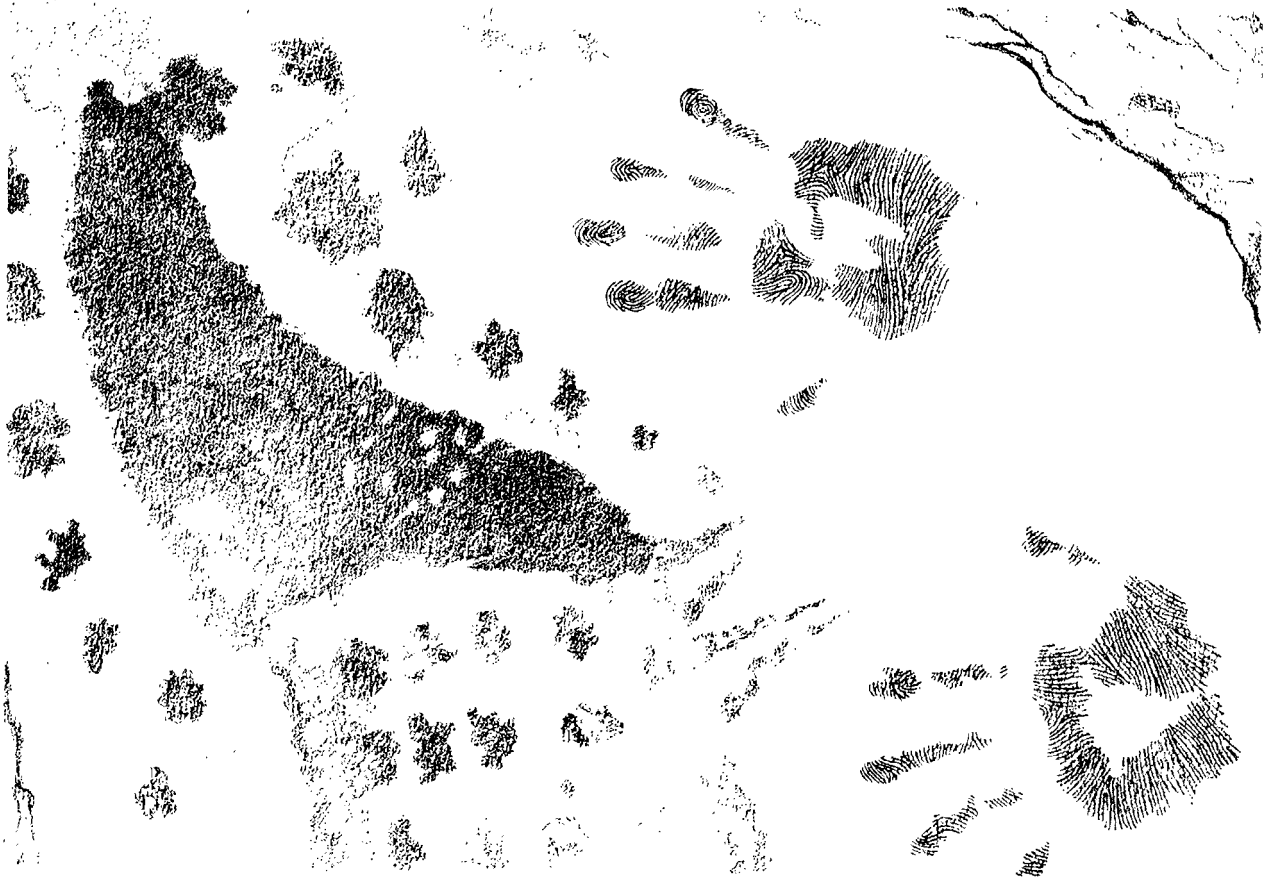
In fingerprinting science, the two basic principles are *permanence* and *individuality*.

Permanence. *Fingerprints never change.* If you draw a face on an uninflated balloon, then fill the balloon with air, the features of the face will grow with the balloon as you blow it up. Fingerprints are similar in that they remain permanent, only growing larger as a baby grows into an adult. The small ridges that form on a person's hands and feet before birth do not change shape as long as that person lives.

Individuality. *No two fingerprints are alike.* The ridges on a person's hands and feet have distinctive, individual details that are never repeated on the hands or feet of any other person. In more than 100 years of comparisons of billions of fingerprints worldwide, no two fingerprints have been found to have the same features. Even identical twins have different fingerprints.

Fingerprinting is mostly used by law enforcement agencies in investigating crimes, but fingerprints have other uses, too. Law enforcement officers use fingerprints, along with other materials like matching dental records and DNA sampling, to help identify amnesia victims, missing persons, abducted children, and others.

In earning the Fingerprinting merit badge, you will be learning about and using an important technique in law enforcement.



History of Fingerprinting

People have long been aware of the ridge patterns on their fingers and palms. On a cliff face in Nova Scotia, prehistoric "picture writing" shows a hand with ridge patterns. In ancient Babylon, fingerprints were used on clay tablets to record business transactions. For centuries the Chinese used thumbprints to seal documents.

In 14th-century Persia, official government papers were impressed with fingerprints. One government official, a physician, observed that no two people's fingerprints were exactly alike.

Despite this early awareness that fingerprints were individual and distinct, the scientific approach to fingerprinting did not begin for another three centuries. Here is a summary* of the major scientific observations that have led to the modern science of fingerprinting.

Marcello Malpighi—1686

During his studies of human skin, Italian anatomist and physician Marcello Malpighi used a microscope to study and describe the ridges, spirals, and loops in fingerprints. While his work was invaluable in the early use of the microscope, Malpighi made no mention of the value of fingerprints as a tool for identifying individuals.

Johannes Evangelista Purkinje—1823

Johannes Purkinje, a Czech physiologist, created a classification system for the variety of friction ridge patterns, but his system failed to generate much interest in the value of using fingerprints for personal identification.

*Much of the information in this section was adapted from *http: on:\.com tp.*

William Herschel—1858

The English began using fingerprints in 1858 when Sir William Herschel, a British official in India, had a local businessman press his handprint on the back of a contract to discourage the man from not honoring the agreement. The locals believed that this personal contact with the document made the contract more binding than if they had simply signed it. Herschel began requiring palm prints—and later, simply the prints of the right index and middle fingers—on every contract made with local businessmen.

Herschel's experience in India suggests that the first wide-scale, modern-day use of fingerprints was based on superstition, not science. However, as Herschel's fingerprint collection grew, he began to see that the inked impressions could, in fact, prove or disprove identity. He widened his use of fingerprints, convinced that the prints were unique to the individual and permanent throughout that individual's life.

In 1880, Henry Faulds sent Charles Darwin an explanation of his classification system and a sample of the forms he designed for recording inked impressions. Darwin later passed the materials on to his cousin, Francis Galton.

Henry Faulds—1880

During the 1870s Dr. Henry Faulds, a Scottish physician working in Japan, not only recognized the importance of fingerprints for identification, but also created a method of classifying prints. In 1880, the scientific journal *Nature* published Faulds' article about using fingerprints for personal identification and using printer's ink for taking prints. Dr. Faulds is credited with the first fingerprint identification, of a greasy print left on an alcohol bottle.

Gilbert Thompson—1882

In 1882, geologist Gilbert Thompson became the first American to use fingerprints for identification. He printed his own fingerprints on documents to prevent other people from forging his work.

Mark Twain—1883

Author Mark Twain, whose real name was Samuel L. Clemens, brought fingerprinting into the literary world with his 1883 book *Life on the Mississippi*, in which a murderer is identified by his thumbprint. Twain's 1894 novel, *Pudd'nhead Wilson*, describes a dramatic fingerprint identification during a court trial.

Francis Galton—1892

In the 1880s Sir Francis Galton, a British anthropologist and cousin of Charles Darwin, began his studies of fingerprints as a means of identification. In 1892 Galton published his book, *Finger Prints*, describing the individuality and permanence of fingerprints. Galton was able to scientifically prove what Herschel and Faulds already suspected: that fingerprints are permanent and unique. According to Galton's calculations, the odds of two individual fingerprints being the same were 1 in 64 billion.

Francis Galton defined characteristics by which fingerprints can be identified. These same basic characteristics *(minutia)* are still in use today. They are often referred to as "Galton's details."

Juan Vucetich—1892

In 1891 Juan Vucetich, an Argentine police official, began the first fingerprint files based on Galton pattern types. In 1892, Vucetich made the first criminal fingerprint identification. He was able to identify a murder suspect from bloody fingerprints at a crime scene.

Henry System—1901

In 1901 fingerprints began to be used for criminal identification in England and Wales. The classification system was based on Galton's observations, as revised by Sir Edward Richard Henry. This began the Henry Classification System, which is still used today for noncomputerized fingerprint files in English-speaking countries.

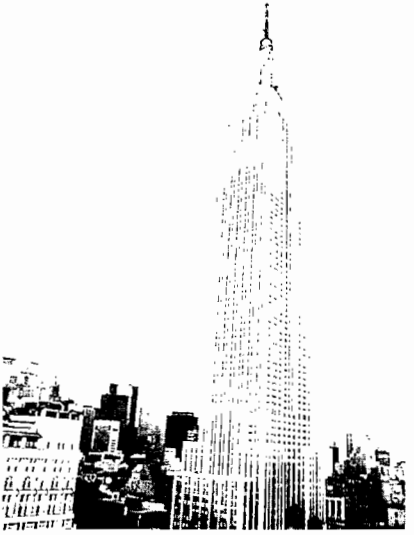
First Uses in the United States—1902–1903

Systematic fingerprinting was introduced in the United States in 1902 when the New York Civil Service Commission began fingerprinting its job applicants. In 1903, the New York State prison system became the first agency in the United States to regularly use fingerprints to identify criminals.

Fingerprint Bureaus—1904

The penitentiary at Leavenworth, Kansas, and the St. Louis Police Department established fingerprint bureaus in 1904. The Leavenworth bureau became the first to operate on more than a local basis. It gradually began to offer a free fingerprint exchange service among a growing list of participating law enforcement officers.

By 1992, if all of the 200 million fingerprint cards in the FBI's possession were stacked one on top of another, there would be 113 stacks of cards as high as the Empire State Building in New York City.



Courtesy ©www.loubopp.com

First American Military Use—1905

The U.S. Army adopted a fingerprint system for its soldiers in 1905. Two years later the U.S. Navy started using fingerprints, followed by the Marine Corps in 1908.

FBI Identification Division—1924

In the early years of the 20th century, more and more law enforcement agencies began using fingerprint systems. In 1924, Congress established the Identification Division of the Federal Bureau of Investigation. More than 810,000 fingerprint cards were collected from other agencies to form the core of the FBI fingerprint files.

International Exchange—1932

The FBI Identification Division began to exchange fingerprint information with foreign countries in 1932.

First Print Taken From Human Skin—1979

In a 1979 Miami, Florida, murder case, a latent (invisible) fingerprint lifted from the victim's hand led to the identification of the suspect. This was the first case in which a fingerprint was taken from human skin and successfully used to identify and convict a criminal.

Integrated Automated Fingerprint Identification System—1999

Today, computers perform fast electronic searches for fingerprint matches. In 1999, the FBI implemented its 21st-century Integrated Automated Fingerprint Identification System, which

Scouts learn how law enforcement agencies use computers to operate the Automated Fingerprint Identification System.

In 1993 the Identification Division, the largest division of the FBI, merged with the newly established Criminal Justice Information Services Division to form an even larger division of the FBI.

allows users to quickly scan every fingerprint card in the FBI criminal files. Whereas a single physical search through fingerprints on paper cards could take 40 days, the IAFIS can do it in two hours or less. The system also allows users to electronically transmit fingerprint data quickly, eliminating the need to exchange paper cards.

The Automated Fingerprint Identification System is the first phase of IAFIS development. When this technology was introduced in 1999, the fingerprint files were split into computerized criminal files and manually maintained civil files. The fingerprints of people who have been charged with serious crimes are in the criminal files. AFIS computers compare submitted fingerprints against 40 million criminal files.

World's Largest Fingerprint Collection—2002

As of 2002, the FBI had the largest single computerized fingerprint repository in the world. The IAFIS helps state and local agencies identify millions of people and solve thousands of crimes each year.

A Fingerprint Jigsaw

A man was arrested for trying to enter the United States illegally. His fingerprints showed he had intentionally scarred his fingertips, which raised suspicion immediately: Why would he do that unless he had something to hide?

Suspicious authorities sent the suspect's prints to the FBI, where a fingerprint examiner discovered that the man had had several triangles of skin cut from each finger and surgically rearranged. The examiner enlarged the prints, cut them apart, and pieced them back together in their original positions like a jigsaw puzzle.

The rebuilt prints matched a set in the FBI's vast fingerprint files, identifying the man as a fugitive who had been convicted on a drug charge years earlier. If the man had been able to hide his true identity, he would have served no more than six months for having an illegal passport, rather than the 25-year sentence he got for the drug conviction.

Taking Fingerprints

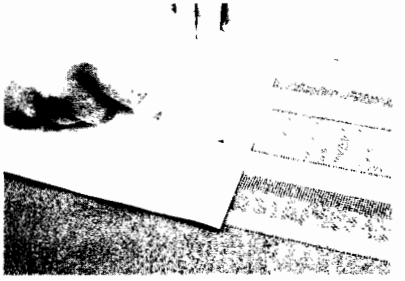
Your Fingerprinting merit badge counselor may arrange for you to do your fingerprinting at the local police station, at a unit meeting, or at another convenient location. Your counselor may provide the necessary equipment.

If you or your unit choose to assemble your own equipment, you can use it for demonstrations at unit meetings or Scouting shows.

Several types of equipment can be used. The oldest fingerprinting method uses a tube of black printer's ink, a roller, an inking plate, 8-by-8-inch personal identification fingerprint cards, and possibly a card holder. The card holder is not essential, but it helps hold the fingerprint card in place while printing so that the prints do not blur or smudge.

You may complete requirement 4 for the Fingerprinting merit badge by recording a set of fingerprints using a conventional fingerprint card or using lifting tape. Both methods are described here.

Some fingerprinting systems use a preinked pad instead of a roller and inking plate. In another system, the ink is applied from a sheet of film that is coated with black printer's ink. An inkless system uses a chemical to make fingerprint impressions. An advanced method uses a computerized live-scan device for recording fingerprints.



Using Lifting Tape

To take fingerprints using lifting tape, you need a sheet of white paper, a pencil, and clear adhesive tape (3/4-inch tape works better than 1/2-inch tape). Follow these steps.

Step 1—Draw a 2-by-1-inch rectangle near one corner of the paper.

Step 2—Using the long side of the pencil lead, blacken the rectangle, as black as you can make it.

Step 3—Thoroughly rub your thumb or the bulb of a finger on the black rectangle.

Step 4—Apply a piece of adhesive tape to the coated (gray) area of your thumb or finger, working smoothly from the tip down or from the first joint up.

Step 5—Touching as little as possible of one corner of the tape, peel the tape off. Carefully stick it on your paper. Alongside the fingerprint, write what hand and finger it came from.

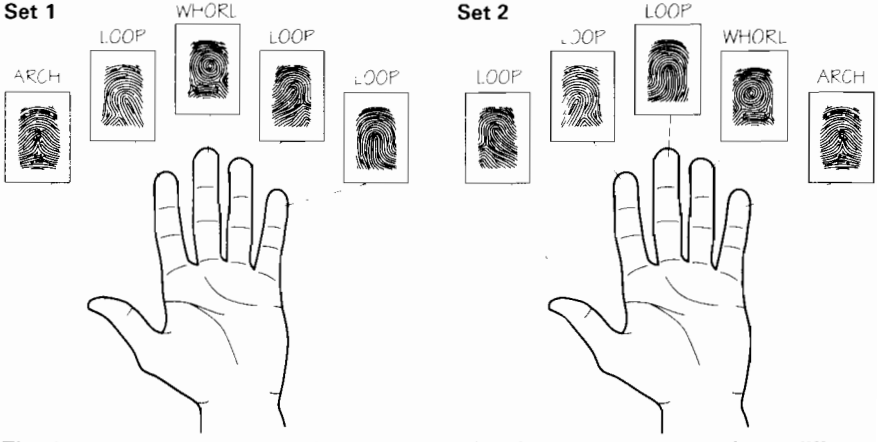
Repeat steps 1 through 5 until you have taken a clear, complete set of prints from one hand.

Using Fingerprint Cards

To make rolled and plain impressions on a fingerprint identification card, you need the following equipment.

- *Black printer's ink* gives the best results because it dries quickly. You can handle fresh work immediately with little danger of smudging. Plain writing ink or ordinary stamp-pad ink is not satisfactory; prints taken with such inks usually are illegible.
- The *roller* best suited to fingerprinting work is similar to the rubber roller that printers use to apply ink to the press.
- *A metal plate or an ordinary piece of glass* 1/4 inch thick, 6 inches wide, and 12 to 14 inches long makes a good inking plate.
- You will need *cleansing fluid and a cloth* to prepare the subject's fingers and to clean the roller and inking plate thoroughly after each use. Denatured alcohol works well as a cleansing fluid.
- You can get *paper fingerprint cards* from your local police department. Be sure to ask for the personal identification type.

When you have learned the three basic types of fingerprint patterns (see the next chapter, "Fingerprint Pattern Types"), identify and label your fingerprints by pattern type.



The drawing shows two sets of fingerprints, taken from the left hands of two different people. Notice that each set has three loop patterns, one arch pattern, and one whorl, but the order of the patterns in each set is different. The order of the patterns helps to identify different people.

COPPELL POLICE DEPARTMENT
OPERATION FINGERPRINT

Name

Last First Middle

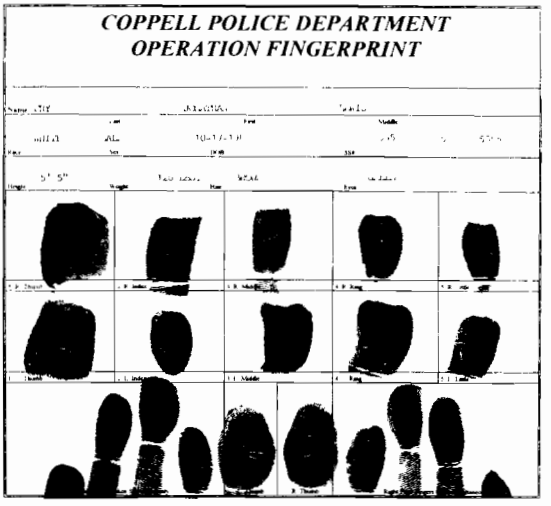
Race Sex DOB SS#

Height Weight Hair Eyes

1. R. Thumb	2. R. Index	3. R. Middle	4. R. Ring	5. R. Little
1. L. Thumb	2. L. Index	3. L. Middle	4. L. Ring	5. L. Little

Left Four Fingers Taken Simultaneously | L. Thumb | R. Thumb | Right Four Fingers taken Simultaneously

Reproduce this form at 200 percent to get a standard 8-by-8-inch card for requirement 4a.



For requirement 4a, complete the card as shown here.

Making Prints

Position the inking plate at a height that lets the subject's forearm be horizontal while the fingers are being inked. The subject's arm may be placed on the edge of a counter or a table of counter height. With the arm in such a position, you can avoid strain and pressure on the fingers and you should be able to make uniform impressions.

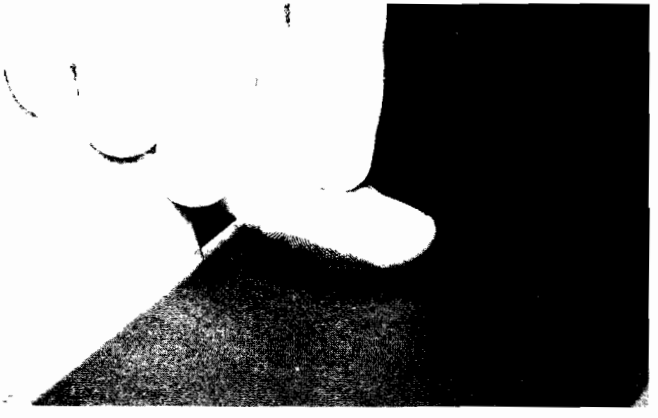
Take finger impressions on 8-by-8-inch fingerprint cards, a size that has been generally adopted because the cards are easy to file. Complete the form as shown on the previous page.

The illustration shows two types of impressions. The upper 10 prints are taken individually and are known as *rolled impressions*. The smaller prints at the bottom of the card are taken by printing the thumbs separately but printing all the fingers of each hand together. These are called *plain impressions* and are used as a check on the rolled impressions.

ROLLED IMPRESSIONS

To start printing, place a small daub of printer's ink or the inking glass or plate. Roll it thoroughly with the roller until a thin, even film of ink covers the plate's entire surface.

Have the subject stand in front of and at forearm's length from the inking plate. Place the entire first joint of the finger upon the inking plate, with the plane of the fingernail at right angles to the plane of the plate. Roll the finger from one side



Ink the finger evenly. Roll thumbs toward and fingers away from the center of the subject's body.

Just how much pressure to apply in inking and taking rolled impressions is important. You learn this best by experience and observation. Tell the subject to relax and not try to help you by exerting any pressure. If he does apply pressure, you cannot gauge or estimate the pressure on the paper, and you will get blurred results.

If any of the subject's fingers are amputated, mark the space for the missing finger "AMP." If any of the fingers cannot be printed because of cuts, burns, or bandages, print them later.

Roll the inked finger on the card in the same way you applied the ink. If you want, practice on plain paper first.

of the fingernail to the other, in one continuous movement. *Do not roll it back and forth.* Take care to see that the finger is inked evenly from the tip to just below the first joint.

Then lift the finger to the card and roll it using the same technique, until the bulb of the finger faces the opposite direction. Always roll the thumbs toward and the fingers away from the center of the subject's body. This leaves the fingers relaxed at the completion of rolling, so they may be raised easily from the printed surface without danger of smudging the impression.

By pressing the finger lightly on the card and rolling as just described, you can get a clear impression of the finger. You get the best results by inking and printing each finger separately, beginning with the right thumb and then, in order, the index, middle, ring, and little fingers.

Printing a rolled impression

To record plain impressions, ink fingers as shown; do the same with the thumb.

PLAIN IMPRESSIONS

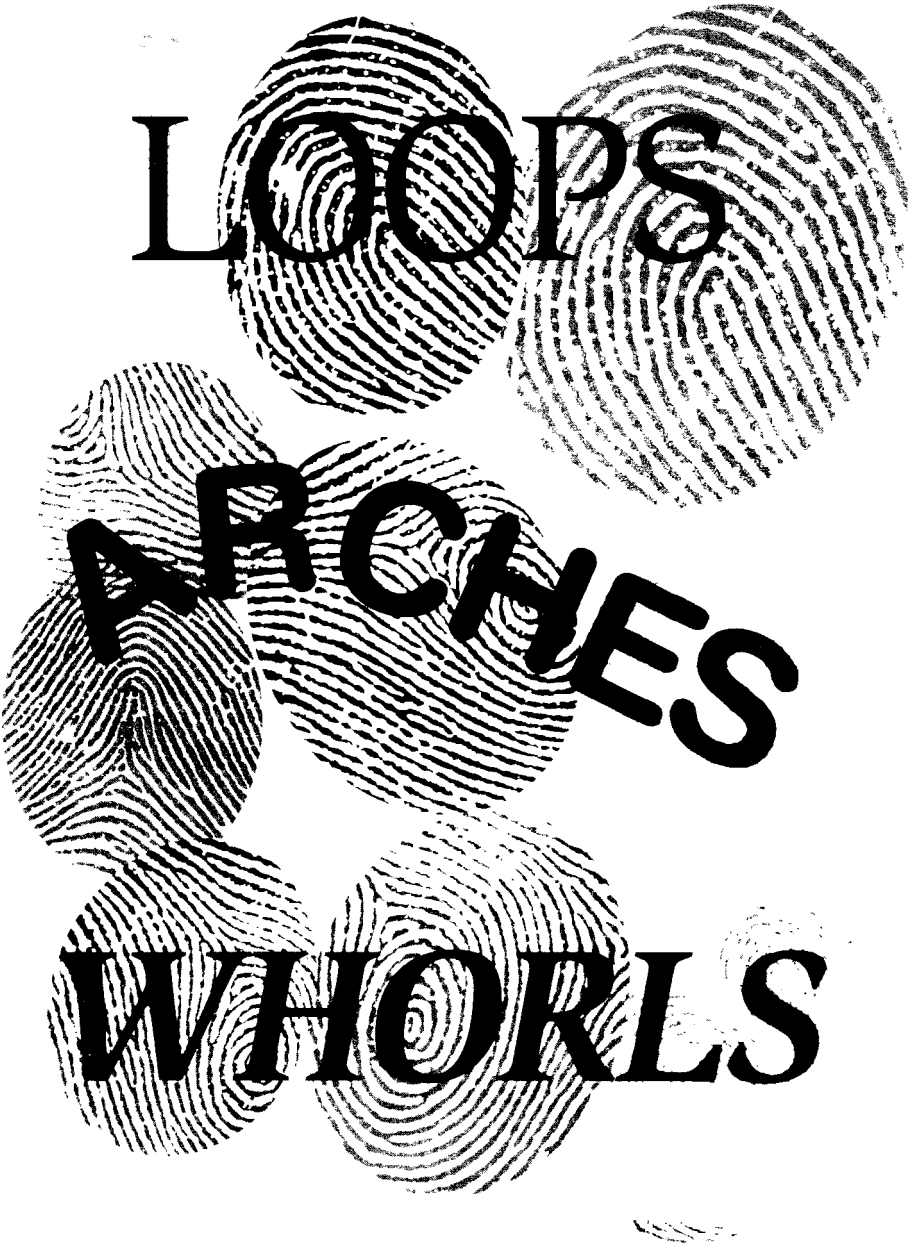
To take plain impressions, lightly press all the fingers of the right hand on the inking plate, then press them simultaneously on the card in the space provided. After doing the same thing with the left hand, ink and print the thumbs of both hands.

Prints of all the person's fingers are necessary to complete the classification by which a set of fingerprints may be filed and then retrieved in the future.

Finishing the Card

There is more to do in preparing a fingerprint card than just taking the subject's finger impressions. You must type or plainly print the subject's name, age, date of birth, sex, and other identifying information on the fingerprint card, as soon as possible after fingerprinting.

Print the plain impressions by placing inked fingers on the card at the same time.


LOOPS
ARCHES
WHORLS

Fingerprint Pattern Types

Fingerprints are classified into three basic types—*loops*, *arches*, and *whorls*—based on the patterns made by the ridges that cover the skin of the fingertips. Learning to recognize these general patterns and their subcategories is not hard. Study the examples shown in this pamphlet, then complete the worksheet found toward the end of this pamphlet to show your counselor you can identify the three basic types of fingerprint patterns. Also identify the pattern types of your own fingerprints.

Loops

In the loop pattern, the ridges begin on one side of the finger, curve or turn back sharply, and end on the same side. The loop may slope or "lean" toward either the thumb or the little finger.

If you can identify the two bones in your forearm—the radius and ulna—then you can remember the two subcategories of loops. The ridges of a *radial* loop begin and end on the same side of the hand as the thumb (or the radius, the bone that is on the inside of the arm). The ridges of an *ulnar* loop begin and end on the outside of the hand (closest to the ulna). You must know which hand a loop print is from to correctly identify it as a radial loop or an ulnar loop.

The loop is the most common fingerprint pattern. Loops make up about 65 percent of all fingerprints.

LOOPS

Arches

PLAIN ARCH

TENTED ARCH

In an arch, the ridges enter from one side of the pattern and flow or tend to flow out the other side. If the ridges have a slight rise or wave in the center, the pattern forms a *plain* arch. In a *tented* arch, the ridges at the center make a taller, more definite angle or upthrust.

The plain arch is the simplest of all fingerprint patterns and it usually is easy to identify. Tented arches can sometimes be confused, however, with forms of the loop pattern. To tell the two patterns apart, remember that a ridge must curve sharply back on itself to make a loop. A ridge that flows from one side of the fingerprint impression to the other, even if it rises noticeably in the center, forms an arch, not a loop. Study the illustrations of arches and loops until you are able to recognize the differences between them.

The arch is the least common type of fingerprint pattern. Only 5 percent of fingerprints are arches.

Whorls

PLAIN WHORL

CENTRAL
POCKET LOOP

In a whorl pattern, the ridges form circles, spirals, or ovals. Whorls make up about 30 percent of all fingerprint patterns.

The *plain* whorl consists of one or more ridges that make a complete circuit. It can be best identified by looking for two deltas, or the point near the outside of the pattern where two ridges diverge. The delta is so named because it looks like the formation at the mouth of a river that you may remember from your study in geography. If an imaginary line is drawn between the two deltas in a plain whorl, it will dissect or touch at least one of the ridges in the complete circuit.

The *central pocket loop* is similar to the plain whorl with its recurving ridges, but this loop features an "obstruction" that appears at right angles to the direction in which the pattern flows. The central pocket loop also has two deltas, but an imaginary line drawn between them would not cut or touch the recurving ridge.

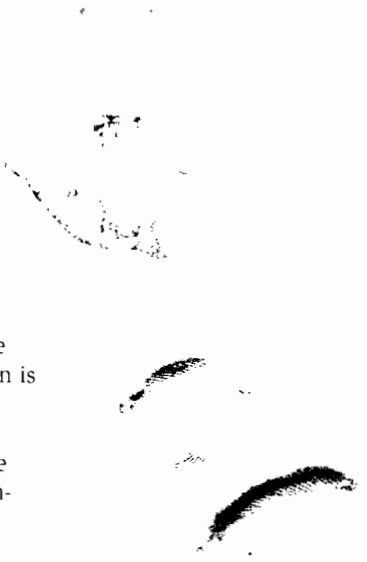
The *double loop* type of whorl pattern consists of two separate loop formations. The pattern is marked by two deltas and two separate and distinct sets of shoulders, or where the loop pattern seems to dead-end.

A fingerprint identified as an *accidental* whorl contains two or more distinct types of patterns with two or more deltas, or a pattern that has some of the requirements for two or more different types, or a pattern that conforms to none of the definitions.

DOUBLE LOOP

ACCIDENTAL

Latent Prints



If you have something on your hands—mud, wet paint, ink, grease, dirt, chocolate, blood—and you touch an object, you will leave a visible fingerprint. *Visible* prints are out in the open and easy to see.

Touch a substance like softened soap, putty, wax, or tar—some squishy material your fingers sink into—and you will leave your fingerprints pressed into the material. This type of fingerprint impression is called *plastic*. It also is a visible print; it is easily seen.

Handle an object with your clean, bare hands and you will leave faint, invisible fingerprints on it. Invisible or "hidden" prints are called *latent* fingerprints.

In a criminal investigation, police experts search a crime scene looking for latent fingerprints. When the police are able to find and recover these latent prints, they can use them to identify the suspect, if the person's prints are in police files. A fingerprint specialist compares latent prints recovered from a crime scene with the known (inked) fingerprints of suspects in the case or of other people who might have left the impressions.

How the Process Works

To earn the Fingerprinting merit badge, you do not have to know how the police recover fingerprints left at the scene of a crime. But the process is interesting, and learning about it will help you better understand the value of fingerprinting in law enforcement.

The human body naturally gives off perspiration and oils. Sweat pores dot the friction ridges on the fingers and palms, and a little perspiration builds up on the ridges. Sweat is about 99 percent water, but it also contains solids such as salt and acids.

Comparing a fingerprint found at a crime scene with impressions taken from a suspect is a highly skilled job. Most police forces have specially trained officers who do the work.

Anytime people touch an object with their bare hands, they transfer some perspiration and body oils to the object, leaving a fingerprint or palm print. These prints are latent prints—usually they are invisible or only partially visible.

Latent impressions on hard surfaces such as glass, metal, or furniture can be *developed* (made visible) by dusting with fine powder. The fingerprint expert uses the tip of a brush to carefully apply a colored powder to the surface. The powder sticks to the oils in the print and makes the print show up.

When the latent print becomes visible, it can be photographed for preservation. The print also can be "lifted" from the surface with sticky tape and fixed onto a card as a permanent record.

Latent prints on porous surfaces such as paper, cloth, and unpainted wood may be chemically developed. Different chemicals react with different substances that may be in the print, such as oil or fat, acids, or salt. The reactions make a colored image show up; this image then can be photographed.

Special X-ray techniques can make fingerprint impressions on skin become visible. Some latent prints can be developed only with a laser, a device that emits a powerful ray of light. The laser light makes the perspiration in a fingerprint shine, and while it shines the print can be photographed.

You can try dusting for fingerprints using the techniques described on the following page.

Dusting for Prints

Do you want to try dusting for prints, the way a fingerprint specialist would at a crime scene?

You will need:

- 1 clean, clear glass or plastic cup, or a clean jar such as a baby-food jar, wiped clear of fingerprints
- 1 small container of talcum powder or graphite powder
- 1 feather or a soft brush
- Adhesive tape
- Construction paper (black if you use talcum powder; white if you use graphite powder)
- Magnifying glass

Step 1—Rub your finger on your nose to get more oil on your finger.

Step 2—Carefully put your other hand inside the vessel (the glass, cup, or jar) to hold it still. Then touch your oily finger to the outside of the vessel to make a fingerprint. Do not otherwise touch the outside of the vessel.

Step 3—Look for the fingerprint you just made. Can you see it?

Step 4—Now dust or tap a tiny amount of talcum or graphite powder onto the print. Use the brush or the bottom half of the feather (the part closest to the quill) to smooth the powder gently and evenly over the print. Gently blow off any excess powder.

Step 5—Stick a small piece of adhesive tape to the print. Holding the tape by one corner, carefully lift it off. The print should come up with the tape.

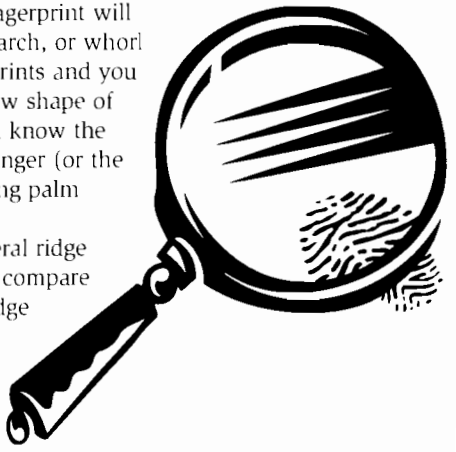
Step 6—Stick the print on black construction paper if you used talcum powder, or on white construction paper if you used graphite powder.

Step 7—Use a magnifying glass to examine the print. What pattern type is it?

Prints that are already visible—those made by dirty hands or pressed into a soft, yielding surface—are photographed as they are. They do not need to be developed with powder or chemicals or by other means.

Comparing and Identifying Fingerprints

Just as you can see an overall view of a plowed farm field from an airplane, you can easily see the general ridge flow or pattern shape of a fingerprint, often without needing a magnifying glass. An overall view of a fingerprint will show parallel ridge lines in typical loop, arch, or whorl shapes. If you are comparing two fingerprints and you can see that the basic pattern or ridge flow shape of the two prints is quite different, then you know the two impressions are not from the same finger (or the same palm, foot, etc., if you are comparing palm prints, footprints, etc.).



If the two prints have the same general ridge flow or pattern shape, the next step is to compare the details of the two impressions: the ridge endings, *bifurcations* (Y-shaped deltas in which one ridge splits into two), dots (very short ridges that look like dots), and combinations of these features. The fingerprint expert looks closely at the latent (unidentified) impression, selects a small group of its features, and memorizes their relationship to each other and to the ridge flow. Then the expert compares those features against an inked (known) impression to see whether the same features exist in the same relationship to each other. If they are present in both impressions, these features are used like road maps to determine the presence or absence of additional similarities between the impressions.

Beyond this level of detail, even finer features of individual ridge shape and thickness, and the location and shape of individual sweat pores (seen as small white circles on some fingerprint ridges), are used in comparison and identification.

Fibers, Flecks, Fingerprints: Forensics

Forensic scientists apply science to the detection of crime. Forensic scientists known as *criminalists* use their knowledge of science to analyze the physical evidence of a crime—evidence that can include not only fingerprints but also fibers, hair, bloodstains, broken glass, twisted metal, wood splinters, paint flecks, and handwriting samples. Physical evidence may be anything: evidence as big as an airplane, or so tiny you would need a microscope to see it.

Criminalists try to link pieces of evidence together to show how a crime was committed, or—sometimes—to help prove that a crime really occurred. Forensic scientists are sharp thinkers, good with details, good at putting pieces of a puzzle together, and endlessly curious.

Does that describe you? If you want to learn more about becoming a criminalist, here are a few things you can do now to explore this career field.

- Contact your local police department and ask if you can tour the crime lab.
- In school, take courses in chemistry, biology, physics, math, and English composition. You will need to be good in science and also good at writing an understandable scientific report.
- Practice taking fingerprints, using the methods described in this pamphlet. Compare different sets of prints and see if you can correctly identify them.

Human skin is flexible, and people move. Fingerprints left at the scene of a crime may be blurred and incomplete, unlike the carefully inked impressions set out in the numbered boxes of a fingerprint card. Because of these factors, there will always be some dissimilarities between any two fingerprints made by the same finger. Fingerprint experts study the nature of friction-ridge impressions for years to understand what are normal variations and what are unexplainable differences caused by truly different fingers.

For an identification to be made, the friction-ridge details from two impressions must match without *any* unexplainable dissimilarities. Even one unexplainable difference means the fingerprints are not from the same finger.

No minimum amount of area or minimum number of features or points is required to make an identification. Often, an area as small as the tip of a pencil eraser may be identified, if the friction-ridge detail that is present is clearly represented. If the quality of the impression is poor, then a larger area of detail may be required before an identification is possible.

Civil Versus Criminal Identification

Fingerprinting is usually associated with police work. Identifying the parties who commit crimes is *criminal* identification. But fingerprinting has other uses, too.

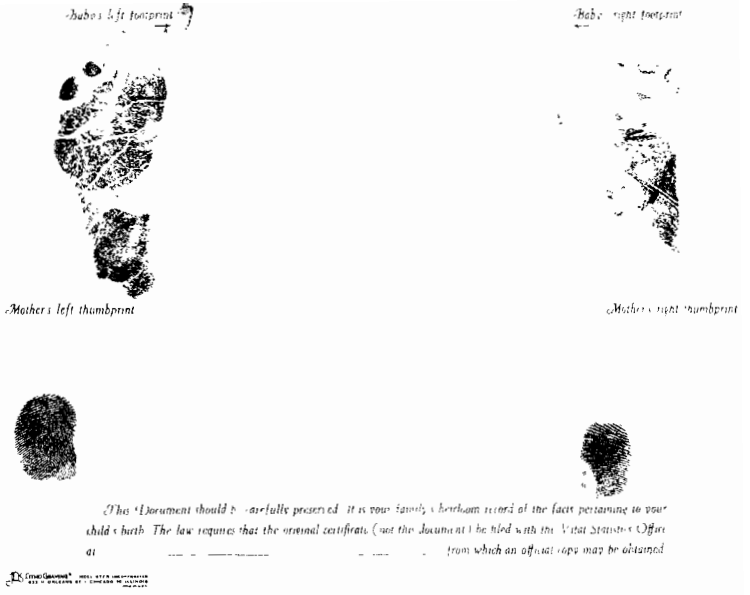
Missing persons, amnesia victims, casualties of war, and people killed in catastrophes such as explosions, fires, airplane crashes, epidemics, floods, and hurricanes may be positively identified by fingerprints. Often, if there are no known inked fingerprint records of a person killed in a disaster, it is possible to find latent prints on personal belongings at the victim's home or business. By comparing these latents with prints taken from the deceased, experts may make positive identifications.

This type of identification is known as *civil*—involving the general public. Several states allow children to be fingerprinted to help police identify them if they get lost or are missing. People enlisting in the military, applying for gun permits, and seeking jobs in law enforcement, government, and child care are also usually fingerprinted.

It is fascinating to realize that the ridges we all have on our fingers, palms, toes, and soles can be used to identify the criminal, to clear the innocent, and to give back something precious—their names—to missing persons, lost relatives, disaster victims, and the unknown dead.

Lost and Found

From a phone booth in a southwestern city, a man called the police, asking for help. When the officers arrived, they found a tall, young, red-haired man waiting for them. He had a gun in a shoulder holster and he told police he did not know who he was or where he came from. The police took the man's fingerprints and sent them to the FBI. The FBI matched the prints with a set that had been taken when the young man enlisted in the Navy, 11 years before. Using this information, the police were able to tell the amnesia victim his name and give him many details of his forgotten life.



Fingers are not the only body surfaces that have distinctive ridges. Ridges also occur on the toes, soles of the feet, and palms of the hands. Shown here is a hospital record of a new baby's footprints.

Computers and Fingerprints

Today, computers greatly simplify the process of analyzing and identifying fingerprints. Computers work with fingerprints in two different ways:

- *Automated Fingerprint Identification Systems* are used to help positively identify people from records in large fingerprint files.
- *Biometric fingerprint systems* are used to help control access and stop unauthorized people from entering a building, for example, or using a computer system.

The main difference in the two methods is that the AFIS gives positive identification of a fingerprint in a file of thousands or millions of records. Biometric systems usually determine only that a fingerprint is somewhat similar (not necessarily a positive match) when compared against one fingerprint registered to that person.

Biometric means "life measuring," and fingerprints are only one of many unique features of human beings that can be measured and compared. Some other biometric methods measure hand shape, eyes, and faces.

Biometric Systems

Some banks, military bases, and government buildings, among others, have computers that check the fingerprints of employees before letting people into certain areas. These biometric access systems are designed to control access, and they keep people out about like a combination lock. The chance that an unauthorized person might be able to guess the combination for a padlock is small. Similarly, the

chance is small that an unauthorized person will have a fingerprint similar enough to an authorized person's finger to fool a biometric system.

AFIS

Most police and government agencies with large fingerprint files use the Automated Fingerprint Identification Systems to make fast comparisons and positive identifications in a database of millions of fingerprints. Before the AFIS, it was necessary for police to carefully classify or group fingerprint records according to complicated rules, to avoid having to compare the thousands of fingerprint records already on file against each fingerprint card or crime-scene fingerprint received.

Using computers, thousands of comparisons per second can be made and it is no longer necessary to limit searches to only a small portion of the entire file. Dividing fingerprint files into small sections using elaborate rules based on the person's sex; age; presence of scars; presence of whorl, loop, and arch formations in various fingers; and other intricate classification steps are no longer required. The AFIS generally uses only loop, arch, and whorl pattern classifications. These are the same three pattern types you learn in earning the Fingerprinting merit badge.

A person may be positively identified from only one fingerprint, or even from a portion of one fingerprint. The purpose of having all 10 fingerprints on fingerprint cards was historically *not* because all 10 fingers were completely compared against each other to make an identification. All 10 fingers had to be on record for the complicated classification formulas to work, so that only a small part of a large fingerprint file (that portion with similar pattern features on each finger) needed to be searched.

Worksheet for Requirement 5

Shown on this page are the three basic fingerprint pattern types. For each type, two typical examples are given. Fill in the blanks beside each pattern type at the bottom of the page with the two letters identifying examples of that type.

A 

B 

C 

D 

E 

F 

1. Loops

   _____ and _____

2. Arches

   _____ and _____

3. Whorls

   _____ and _____

Fingerprinting Resources

Scouting Literature

Chemistry, Crime Prevention, Law, and *Photography* merit badge pamphlets

Books

Beavan, Colin. *Fingerprints: The Origins of Crime Detection and the Murder Case That Launched Forensic Science.* Hyperion, 2001.

Camenson, Blythe. *Opportunities in Forensic Science Careers.* Contemporary Books, 2001.

Campbell, Andrea. *Forensic Science: Evidence, Clues, and Investigation.* Chelsea House, 1999.

Coppock, Craig A. *Contrast: An Investigator's Basic Reference Guide to Fingerprint Identification Concepts.* Charles C. Thomas, 2001.

Evans, Colin. *The Casebook of Forensic Detection: How Science Solved 100 of the World's Most Baffling Crimes.* John Wiley and Sons, 1998.

Inman, Keith, and Norah Rudin. *Principles and Practice of Criminalistics: The Profession of Forensic Science.* CRC Press, 2000.

Jones, Charlotte Foltz. *Fingerprints and Talking Bones: How Real-Life Crimes Are Solved.* Yearling Books, 1999.

Jones, Gary W. *Introduction to Fingerprint Comparison.* Staggs, 2000.

Parker, Janice. *Forgeries, Fingerprints, and Forensics: Crime.* Raintree/Steck Vaughn, 2000.

Rainis, Kenneth G. *Crime-Solving Science Projects: Forensic Science Experiments.* Enslow, 2000.

Ramsland, Katherine M. *The Forensic Science of C.S.I.* Boulevard, 2001.

Saferstein, Richard. *Criminalistics: An Introduction to Forensic Science.* 7th edition. Prentice Hall, 2000.

Tocci, Salvatore. *High-Tech IDs: From Finger Scans to Voice Patterns.* Franklin Watts, 2000.

University of California at Berkeley, Lawrence Hall of Science. *Fingerprinting.* GEMS: Great Explorations in Math and Science, 2000.

Walker, Pam, and Elaine Wood. *Crime Scene Investigations: Real-Life Science for Grades 6–12.* Jossey-Bass, 2000.

Wiese, Jim. *Detective Science: 40 Crime-Solving, Case-Breaking, Crook-Catching Activities for Kids.* John Wiley and Sons, 1996.

Organizations and Web Sites

Education in Forensic Science

http://www.forensicdna.com

This site covers the science of forensics, including a timeline, a bibliography, a list of resources, and career information.

FBI Youth

http://www.fbi.gov/kids/6th12th/6th12th.htm

This site is maintained by the FBI. The interactive areas allow you to follow a case through the FBI lab, take a look into a typical day of an FBI agent, learn about safety when browsing the Internet, and meet the canine agents of the FBI.

International Association for Identification

http://www.theiai.org

This site is the home of an international association of professionals involved in the scientific examination of physical evidence, including identification.

Latent Print Examination: Fingerprints, Palm Prints, and Footprints

http://onin.com/fp

This site has a wealth of information ranging from the simple and general to the intricate and expert, with articles about the use of fingerprinting in current events, and a section on Automated Fingerprint Identification Systems.

Reddy's Forensic Page: Fingerprints

http://www.forensicpage.com/new17.htm

This list of links will lead you to numerous fingerprinting resources, including an interesting article about identification established by *ear prints.*

So You Want to Be a Forensic Scientist!
http://www.aafs.org/employ/brochure1.htm
The American Academy of Forensic Sciences offers this online career brochure, which they describe as "a guide to the many possibilities for satisfying life choices of careers combining science and service in the interests of society, justice, and public safety." The AAFS Web site also is home to the Young Forensic Scientists Forum, at *http://www.aafs.org/yfsf/index.html*.

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