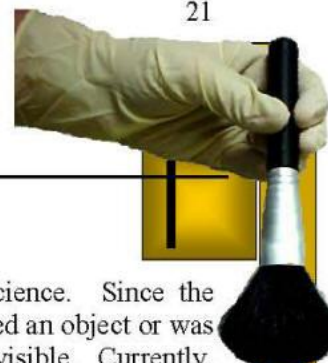




Fingerprints

(Unit 4)

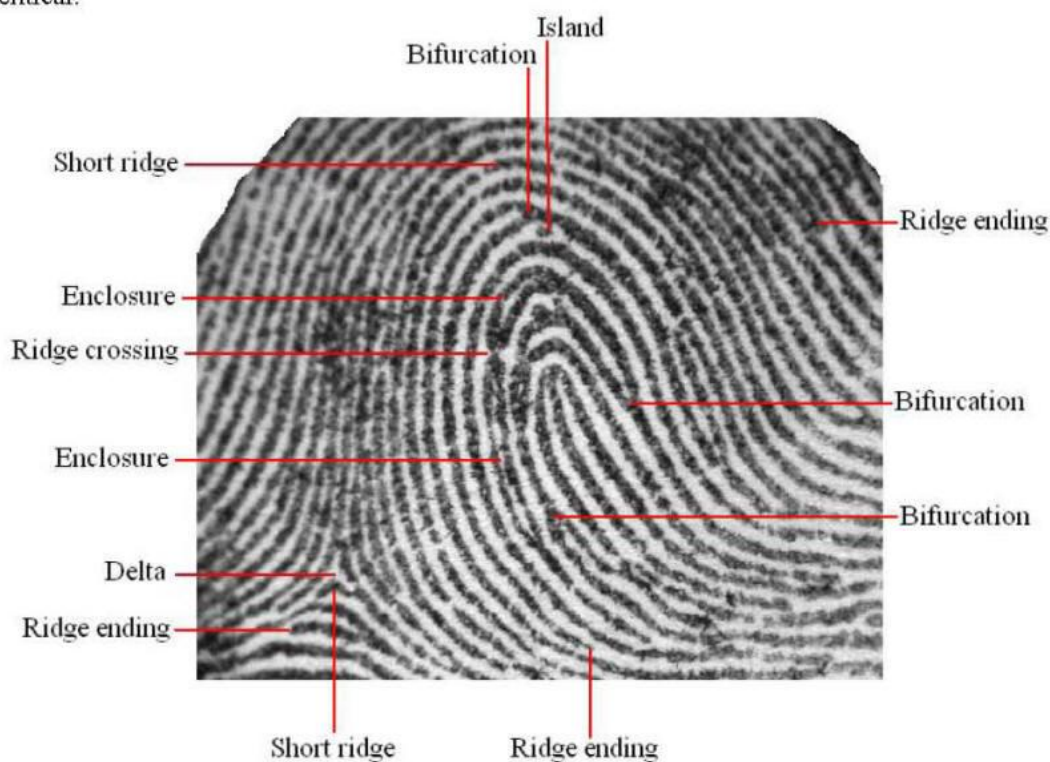


Fingerprints have long been a mainstay in the area of forensic science. Since the nineteenth century, authorities have used fingerprints to prove a person handled an object or was present in a location. Initially there were only a few ways to make prints visible. Currently, there are over one hundred different methods used to develop fingerprints, varied by the surface being examined. Each method has significantly increased the probability of recovering a useful print.

Fundamental Principles of Fingerprints

First Principle: A fingerprint is an individual characteristic; no two fingers have yet been found to possess identical ridge characteristics.

Early fingerprint experts consistently referred to Galton's calculation, showing the possible existence of 64 billion different fingerprints. Not only is this principle supported by theoretical calculations, but just as importantly, it is verified by the millions of individuals who have had their prints classified over the past 90 years—no two have yet been found to be identical.



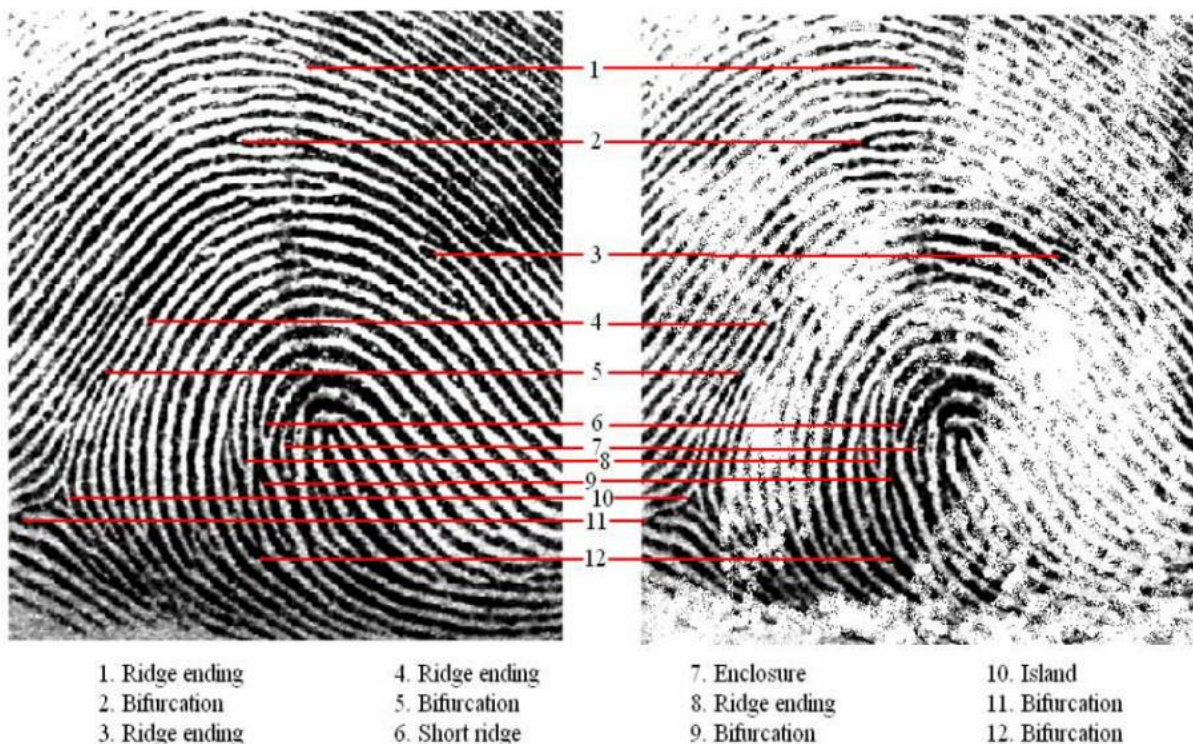
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Ridge Characteristics

The individuality of a fingerprint is not determined by its general shape or pattern but by a careful study of its *ridge characteristics* or *minutiae*. It is the identity, number, and relative location of defining characteristics, such as those shown on the previous page. In a judicial proceeding, a point-by-point comparison is normally demonstrated by an expert, with the aid of a computer or using charts similar to the ones shown below.

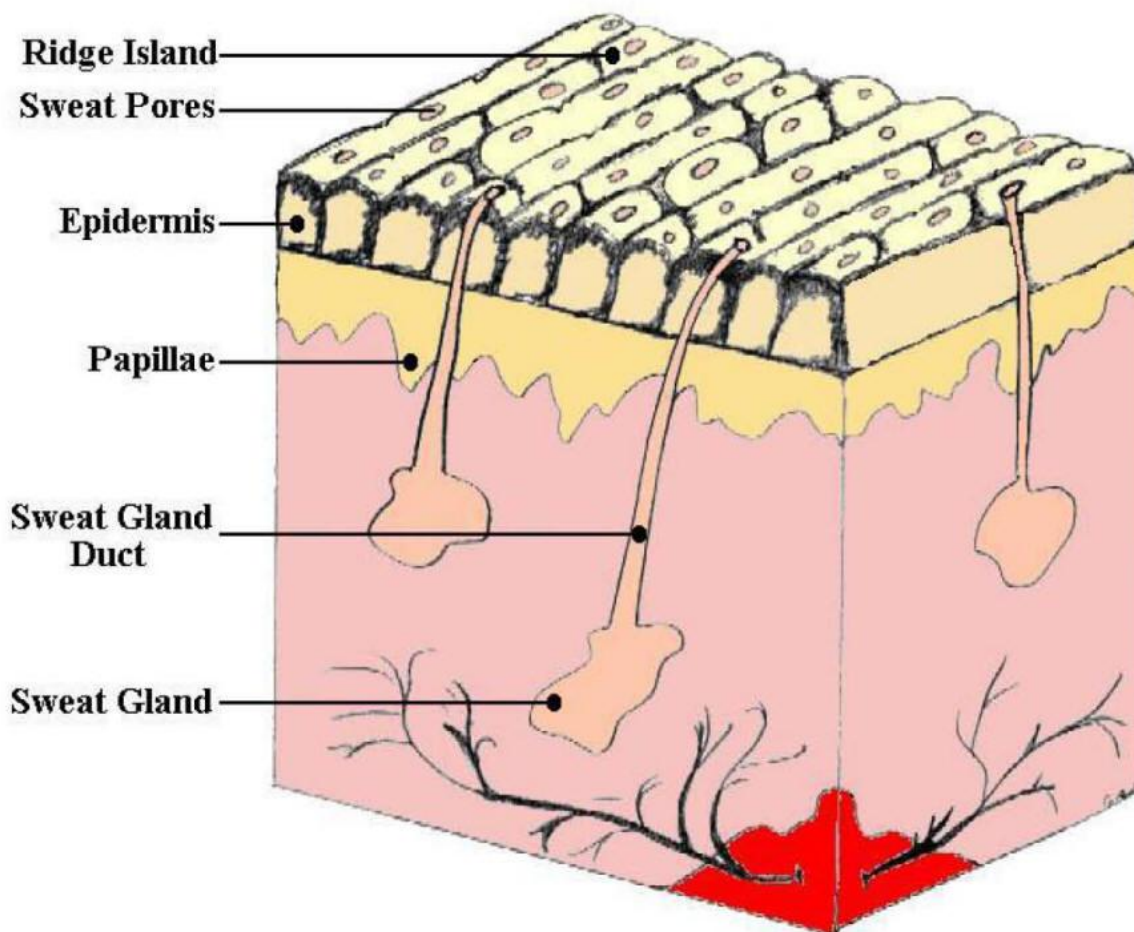


Eventually the jury will see a comparison of the characteristics of the complete fingerprint. This may be accomplished in one of two ways. A computer can slowly transpose one print over another, possibly using different colors to distinguish known and unknown prints. A more hands-on demonstration can be achieved by placing both prints on transparencies and simply sliding one print on top of the other. This has the added benefit of allowing the jury to place the prints one on top another. These demonstrations are usually not necessary since most people accept the ability of professionals to match fingerprints. However, such demonstrations are impressive to a jury and make for a convincing demonstration.

Anatomy of Fingerprints

Second Principle: A fingerprint will remain unchanged during an individual's lifetime.

Fingerprints result from friction skin ridges found on the palm side of the fingers and thumbs. Similar friction skin ridges are also be found on the surface of the palms and the soles of the feet. These skin surfaces have been designed by nature to provide our bodies with a firmer grasp and a resistance to slippage.

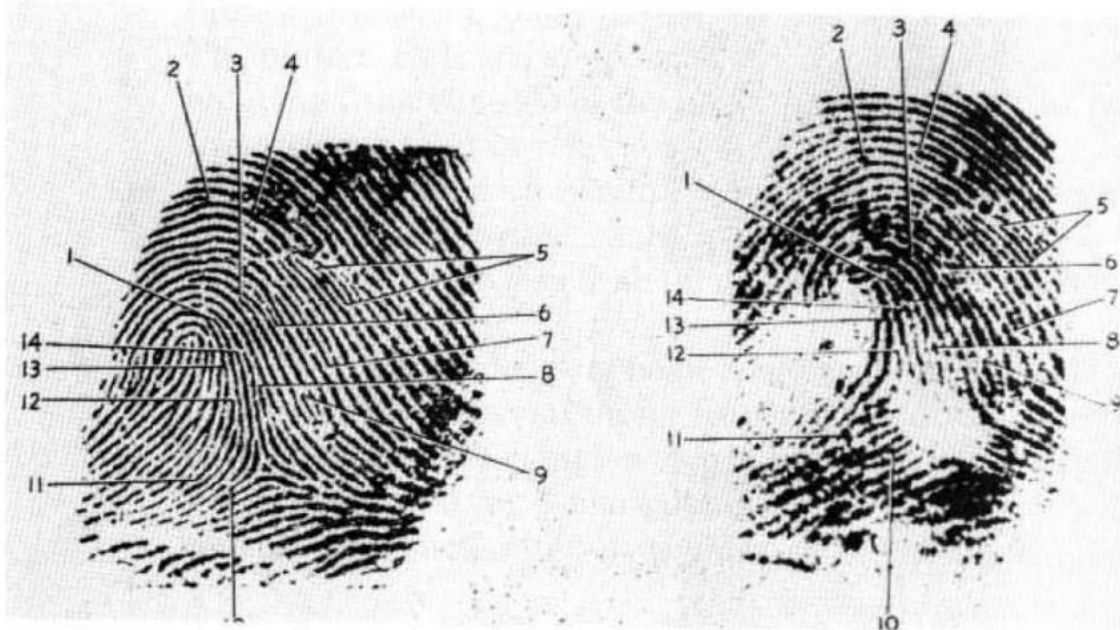


Each skin ridge contains rows of pores which are connected to sweat glands. It is through these pores that perspiration is released and deposited on the surface of the skin. Once a finger touches a surface, perspiration and body oils are transferred onto that surface, thereby leaving an impression of the finger's ridge pattern—a fingerprint. Prints deposited in this manner are invisible to the eye and are commonly referred to as *latent* or *hidden fingerprints*. Such prints must be developed before use in an investigation.

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Although it is impossible to change one's fingerprints, there has been no lack of effort on the part of some criminals to change or remove them. To remove or change any part of a fingerprint, an injury must reach deeply enough into the skin to damage the dermal papillae. However, for this to happen, such a wound would have to penetrate 1 to 2 millimeters beneath the skin's surface. Indeed, efforts at intentionally scarring the skin can only be self-defeating, for it would be totally impossible to obliterate all the ridges on the hand. In most situations, an attempt to alter one's fingerprints results in a scarring which actually makes the fingerprints easier to identify

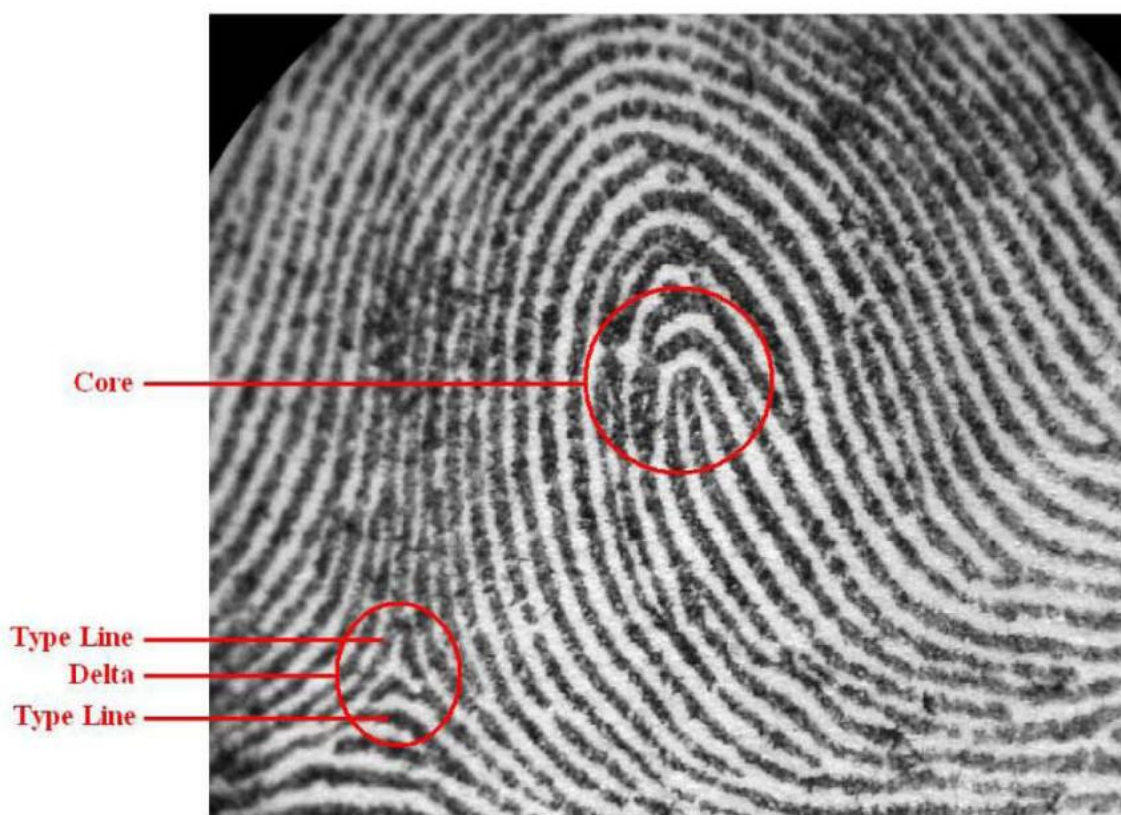
Perhaps the most publicized attempt at removal of fingerprints was conducted by the notorious gangster John Dillinger. He attempted to destroy his own fingerprints by applying a corrosive acid to them. Prints taken at the morgue after Dillinger was shot to death were compared with fingerprints recorded at the time of a previous arrest. As seen below, the prints still matched!



Third Principle: Fingerprints have general ridge patterns that permit them to be systematically classified.

All fingerprints are divided into three classes on the basis of their general pattern: loops, whorls, and arches. Sixty to sixty-five percent of the population has loops, thirty to thirty-five percent has whorls, and about five percent has arches. These three classes form the basis of the classification system presently in use.

The pattern area of a loop surrounded by two diverging ridges is known as *type lines*. The ridge point nearest the type-line divergence is known as a *delta*. A fingerprint delta resembles the silt formation that builds up as a river flows into the entrance of a lake. The *core*, as the name suggests, is the approximate center of the pattern where ridges curve around or circle.



Loops

A typical loop pattern is illustrated above. A *loop* must have one or more ridges that enter from one side of the print, re-curve, and exit from the same side. This results when one core and one delta is present. A print is said to open in the direction from which most of the ridges come. This is normally the direction opposite the delta. If the loop opens toward the little finger, it is called an *ulnar loop*, if it opens toward the thumb, it is a *radial loop*.

Whorls



Plain

Central Pocket Loop

Double Loop

Accidental

Whorls are divided into four distinct groups, shown above: plain whorl, central pocket loop, double loop, and accidental. All *whorls* contain one or more cores and a minimum of two deltas. A *plain whorl* and a *central pocket loop* have at least one ridge that makes a complete circuit. This ridge may be in the form of a spiral, oval, or any variant of a circle. If an imaginary line is drawn between the two deltas contained within these two patterns, and if the line touches any one of the spiral ridges, the pattern is a plain whorl. If no such ridge is touched, the pattern is considered a central pocket loop. A *double loop* is made up of two loops combined into one fingerprint. This results in a print with two deltas and two cores. Often this results in an “S” shape. Any print classified as an accidental either contains two or more patterns (not including the plain arch) or is a pattern that does not fit any of the normal descriptions. Hence, an accidental may consist of a combination loop and plain whorl or loop and tented arch.

Arches



Plain

Tented

Arches, the least common of fingerprint patterns, contain no deltas or cores. They are divided into two groups: plain arches and tented arches. A *plain arch* is the simplest of all fingerprint patterns; it is formed by ridges entering from one side of the print, rising slightly and exiting on the opposite side. A *tented arch* is similar to a plain arch except that instead of rising smoothly at the center, there is a sharp upward thrust or spike, causing the center of the print to look like a tent. By definition, the angle of the lines on a tented print meets at less than a 90-degree angle.

Automated Fingerprint Identification Systems (AFIS)

The heart of AFIS technology is the ability to scan and digitally encode fingerprints so they can be subject to high-speed computer processing. AFIS uses scanners to convert the image of a fingerprint into digital file. The file contains data showing ridges at their points of termination (ridge endings) and the branching of ridges into two ridges (bifurcations). Basically, the computer scans in a print and then checks every point of a print with numerous other prints at millions of times faster than a human can. Speed of comparison is not the only advantage to AFIS. With the development of high speed internet and large databases of fingerprints, an unknown print can be compared with prints all over the world in a matter of hours. At one time it was nearly impossible to identify an international criminal, but as technology advances these types of matches are becoming commonplace.

Crime-Scene Fingerprints

There are three kinds of crime-scene prints: visible, plastic, and latent. *Visible prints* are made by fingers touching a surface after they have been in contact with colored material such as blood, paint, grease, or ink. *Plastic prints* are ridge impressions left on a soft material such as putty, wax, soap, or dust. *Latent prints* (invisible prints) are impressions caused by the transfer of body perspiration or oils present on the finger to the surface of an object. Visible and plastic prints may simply be photographed and/or preserved with the object on which they are left. Latent prints, however, must be located and developed.

In the past, chemical treatment for fingerprint development was reserved for porous surfaces such as paper and cardboard. However, since 1982, a chemical technique known as “**Super Glue**” **fuming** has gained wide popularity for developing latent prints on nonporous surfaces like metal, electrical tape, leather, and plastic. “Super Glue” is approximately 98 to 99 percent cyanoacrylate ester, which is the chemical that interacts with a latent fingerprint. Fumes are created when cyanoacrylate ester is placed on absorbent cotton treated with sodium hydroxide. The fumes can also be created by heating the glue. The process is carried out by producing the fumes in an enclosed chamber with the object suspected of containing a fingerprint for up to six hours. The print becomes visible when fumes from the glue adhere to latent oils, usually producing a white-colored print. The fuming technique can be used before or after processing with fingerprint powders, and in fact, subsequent powdering of a fumed print may even further enhance the print's image.

There are over a hundred different methods used to develop fingerprints, depending on the surface being examined. The following are some of the more common methods.

Developing Latent Prints

Dusting



Dusting is the most effective way to obtain a print from a rigid non-porous surface such as glass, plastic, or metal surfaces. Using a camel hair brush, black carbon or aluminum powder is placed over the location of a suspected print. The dust adheres to the sweat and oil left behind by the person who touched the surface. Next, wide transparent tape is smoothed over the dusted area. When the tape is then removed from the surface, the dust and the print will be attached. Finally, the tape is placed onto a white card for display and comparison. Below, the print on the left was developed by dusting with carbon powder; the print on the right, using aluminum powder.



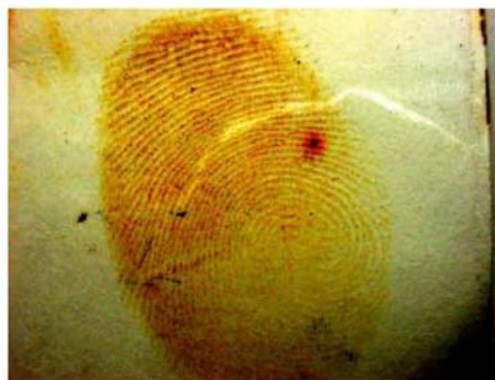
Iodine Fuming



photographed for documentation. The iodine will eventually sublime from the surface of the print, allowing the print to return to its latent state. The surface is then returned to its original appearance and can even be exposed to additional developing techniques. At right: a print developed using iodine fuming.

Iodine fuming is an excellent way to develop prints on porous and non-porous surfaces such as paper, index cards, magazines, and cardboard. To fume a suspected latent print, the surface must be placed into a container with solid iodine. The sublimation of iodine in a closed container will cause iodine vapors to concentrate, then be absorbed by the oil and sweat left behind by human skin. The

temporarily-developed print will then be visible as an orange/brown outline. Upon development, the print should be



Ninhydrin Solution

Ninhydrin is a chemical that reacts with amino acids to form a purple compound. This development technique is used primarily on porous surfaces such as paper, tissue, and clothing. The white powder ninhydrin must be dissolved in acetone before it can be soaked into a surface for development. The reaction will then develop the print within twenty four hours. Left: developing a print with a ninhydrin-acetone soaked brush. Right: a print developed by reacting with ninhydrin.



Silver Nitrate



When exposed to ultra-violet (UV) light, silver nitrate reacts with the salt in sweat to form a blackish-brown compound. Using this reaction, a suspected object is sprayed with a silver nitrate solution and the left to develop under a UV bulb. The print should become visible in five to ten minutes. This type of development is best used on porous surfaces, like paper or drywall. Top left: Spraying print with silver nitrate solution. Top right: UV light hood. Left: a print developed using silver nitrate solution and exposed to UV light.

Fingerprints



In recent years, there has been much advancement in the area of print developing. The use of advanced brushes and new chemical procedures make it possible to develop prints on a larger variety of surfaces. Some criminals wear gloves to avoid leaving fingerprints at a crime scene, but often they discard the gloves nearby. This is a picture of latent prints developed on the inside of a glove.



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