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Forensic Science

FUNDAMENTALS & INVESTIGATIONS

2nd Edition

Bertino & Bertino

- o Frontline the real csi

<http://www.pbs.org/wgbh/frontline/film/real-csi/>

FF Death by a salesman <https://www.youtube.com/watch?v=-GE2CpmKdzg>

FF point of origin <https://www.youtube.com/watch?v=ffM1pHuILhk>

Online links <http://sciencespot.net/Pages/kdzforsci2.html>

Catching killers <http://www.smithsonianchannel.com/shows/catching-killers/fingerprints/1003122/141423>

FF bagging a killer <https://www.youtube.com/watch?v=Bg42zy0OhSQ>

Kahoot review <https://play.kahoot.it/#/k/ae433d2e-89ec-4908-b843-544a620b27a7>





Chapter 6 *Fingerprints*

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

- 6.1 Outline the history of fingerprinting.
- 6.2 Describe the characteristics of fingerprints.
- 6.3 Compare and contrast the basic types of fingerprints.
- 6.4 Describe how criminals attempt to alter their fingerprints.
- 6.5 Present and refute arguments that question fingerprint evidence reliability.



Chapter 6 *Fingerprints*

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

- 6.6 Summarize the proper procedures for collecting fingerprint evidence.
- 6.7 Describe the latest identification technologies.
- 6.8 Determine if a fingerprint is consistent with a fingerprint on record.
- 6.9 Lift a latent print.
- 6.10 Prepare a ten card and analyze the ridge patterns of the prints.



Chapter 6

Vocabulary

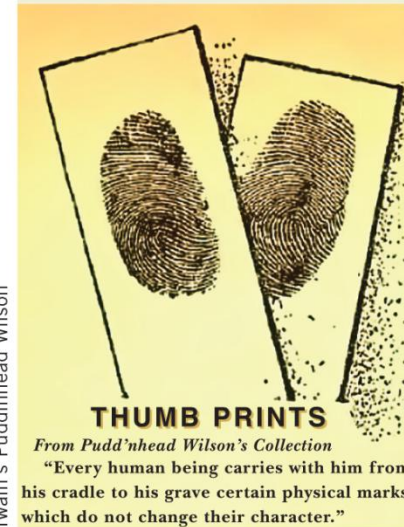
- o arch
- o core
- o delta
- o fingerprint
- o IAFIS (Integrated Automated Fingerprint Identification System)
- o latent fingerprint
- o loop
- o minutiae
- o patent fingerprint
- o plastic fingerprint
- o ridge count
- o ridge pattern
- o ten card
- o whorl

Introduction

- *Pudd'nhead Wilson* was published in 1894.
- *Pudd'nhead Wilson* states that a suspect's fingerprints are:
 - “his signature, his physiological autograph, so to speak, and this autograph cannot be counterfeited, nor can he disguise it or hide it away, nor can it become illegible by the wear and mutations of time.”



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



Twain's Pudd'nhead Wilson



History

- Ancient cultures used fingerprints as personal markings.
- Ancient Babylon 1792-1750 B.C. — Fingerprints were pressed into clay tablet contracts.
- 1684 — Dr. Nehemiah Grew described the patterns on human hands including ridges
- 1788 — Johann Mayer fingerprints are unique to each individual.
- 1823 – Jan Evangelist Purkyn described nine fingerprint patterns.



History (continued)

- 1856 — Sir William Herschel began collecting fingerprints- noted not altered by age
- 1879 — Alphonse Bertillon created a way to identify criminals that were repeat offenders.
- 1888 — Sir Francis Galton verified that fingerprints do not change with age.
 - Also with Sir Henry made classification system still used today
- 1896 — Sir Edmund Richard Henry (and colleagues) created a system that divided fingerprint records into groups. basis of ten

card.

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



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



Figure 6-3 An early example of a ten card.



LEAVE BLANK		TYPE OR PRINT ALL INFORMATION IN BLACK										LEAVE BLANK	
		LAST NAME <u>NAM</u>		FIRST NAME			MIDDLE NAME						
STATE USAGE		ALIASES			CONTRIBUTOR O R I							DATE OF BIRTH <u>DOB</u> Month Day Year	
SIGNATURE OF PERSON FINGERPRINTED		DATE ARRESTED OR RECEIVED <u>DOA</u>		SEX	RACE	HGT.	WGT.	EYES	HAIR	PLACE OF BIRTH <u>POB</u>			
THIS DATA MAY BE COMPUTERIZED IN LOCAL, STATE AND NATIONAL FILES		YOUR NO. <u>OCA</u>		LEAVE BLANK									
DATE	SIGNATURE OF OFFICIAL TAKING FINGERPRINTS			FBI NO. <u>FBI</u>	CLASS. _____								
CHARGE		SID NO. <u>SID</u>		REF. _____									
FINAL DISPOSITION		SOCIAL SECURITY NO. <u>SOC</u>											
		CAUTION <input type="checkbox"/>											
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					
LEFT FOUR FINGERS TAKEN SIMULTANEOUSLY				L. THUMB		R. THUMB		RIGHT FOUR FINGERS TAKEN SIMULTANEOUSLY					

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History (continued)

- 2012 — FBI- IAFIS system had more than 76 million computerized fingerprints, mugshots, scars, tattoo photos, and other identification records.
 - The system will soon be enhanced by Advanced Fingerprint Identification Technology (AFIT).
- 2013 — The FBI compare palm prints
 - About 20-30% of latent prints at a crime scene come from the palm or side of the hand from the little finger to the wrist.



What Are Fingerprints?

- Impressions (of ridges) made by fingers, toes, feet, and palms
 - Ridges help us grip objects
 - Ridges are arranged in connected units called *dermal*, or *friction*, *ridges*
 - Fingers accumulate natural secretions and dirt
 - Fingers leave create prints on objects we touch



What Are Fingerprints?

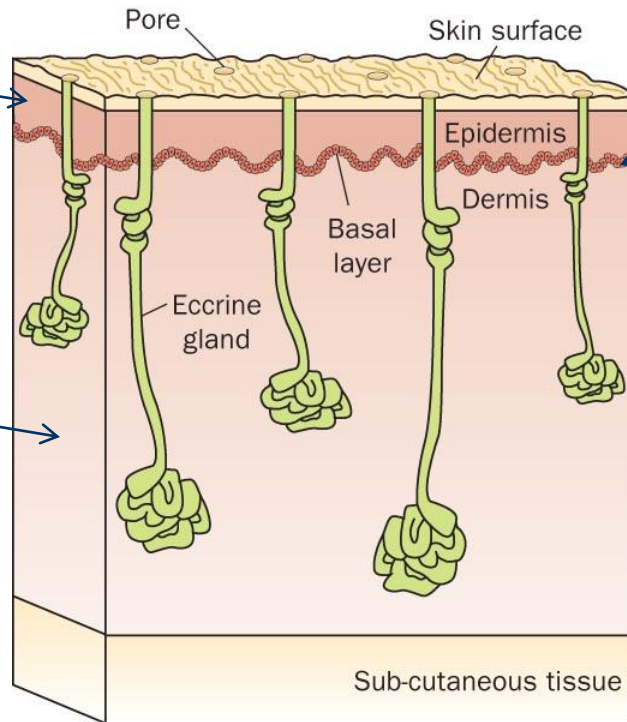
- Formation of Fingerprints
 - formed beginning at the 10th week of gestation.
 - in the basal layer of skin.
 - protected by the outer epidermis.



Structure of Skin

Outer layer -
epidermis

Inner layer -
dermis



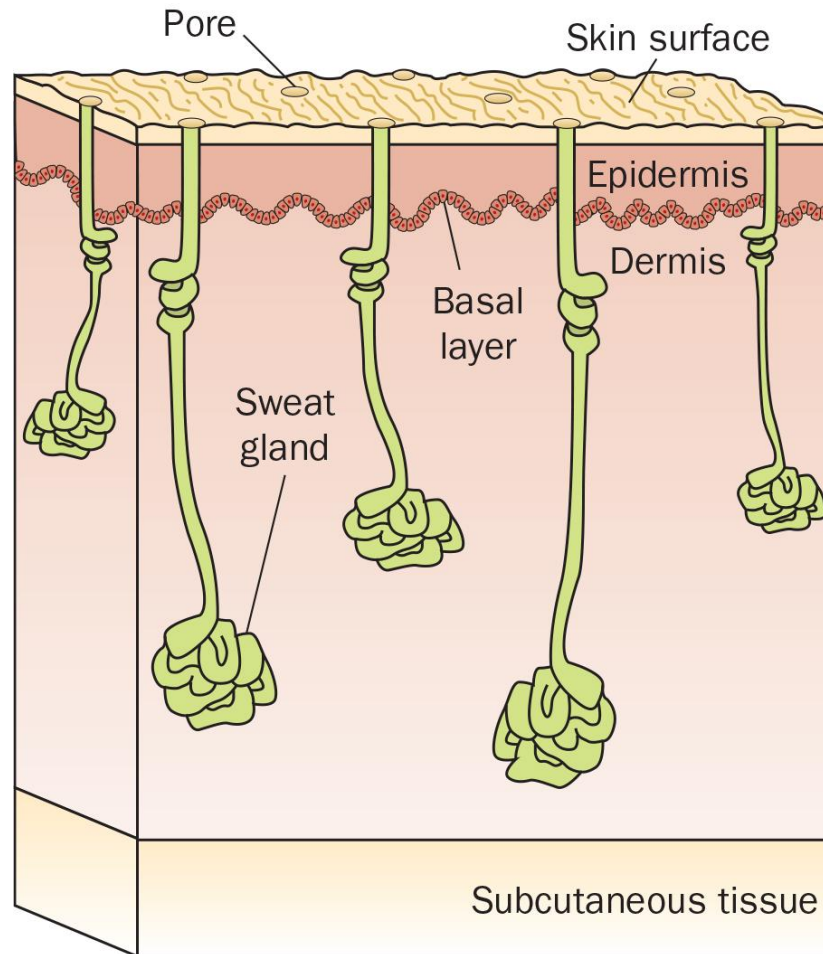
Basal layer

- Basal layer grows faster than the layers above and below it

- Basal layer collapses and folds to form intricate shapes

- Fingerprints begin forming near the 10th week of pregnancy

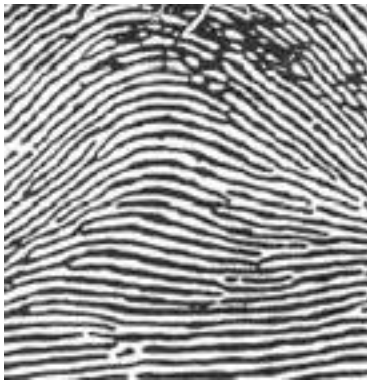
Figure 6-4 Our fingertips are covered with hundreds of microscopic sweat pores, which make our fingers moist and able to grip better.





Characteristics of Fingerprints

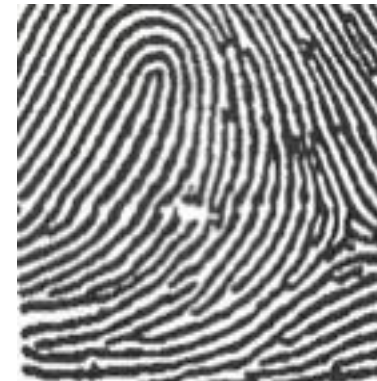
- There are 3 general fingerprint distinctions:



ARCH
About 5%



WHORL
About 30%
of the population

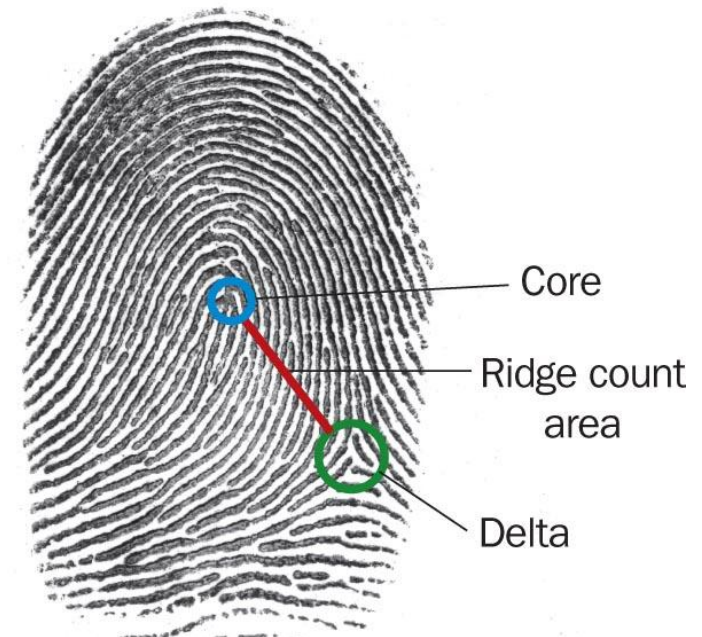


LOOP
About 65%



Characteristics

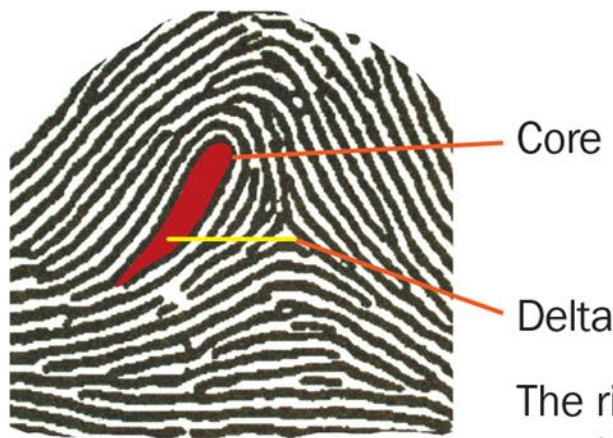
- Forensic examiners look for
 - **Core**
(the center of a whorl or loop)
 - **Deltas**
(triangular regions near a loop)
- **Ridge count**
 - Counting from the core to the edge of the delta
 - Distinguishes one fingerprint from another



Characteristics of Fingerprints (continued)



Figure 6-6 *The red patch is called the core, and it is located at the center of a loop or whorl.*



The ridge count is the number of ridges between the core and the center of the delta.

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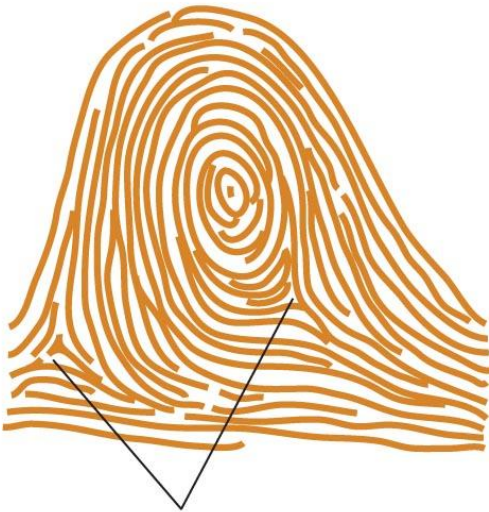
Characteristics of Fingerprints

- Basic patterns can be further divided:
 - Arch patterns:
 - ☞ 4% plain
 - ☞ 1% tented
 - Whorl patterns:
 - ☞ 2% central pocket
 - ☞ 4% double loop
 - ☞ 0.01% accidental
- Even twins have unique fingerprints



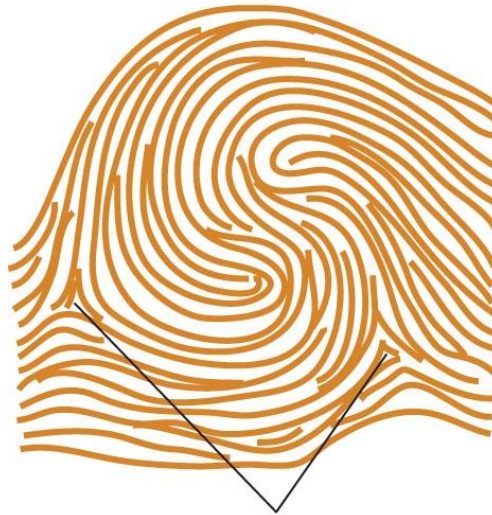
Characteristics of Fingerprints

Central pocket loop whorl



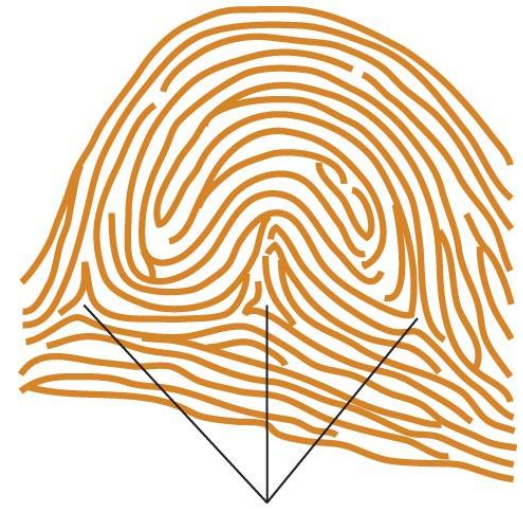
Deltas

Double loop whorl



Deltas

Accidental whorl

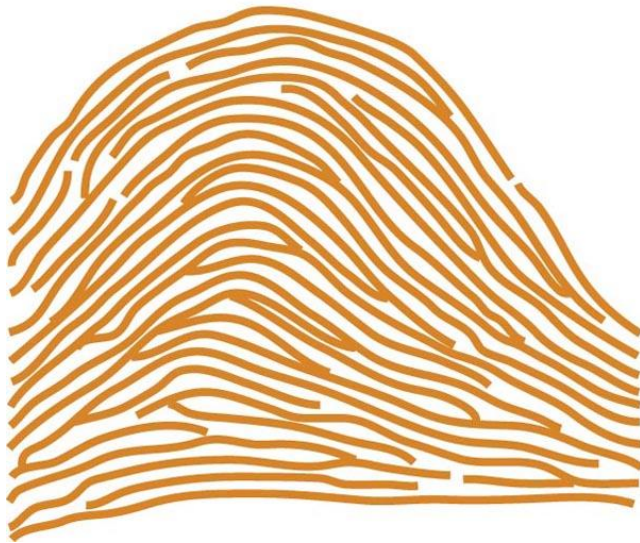


Deltas

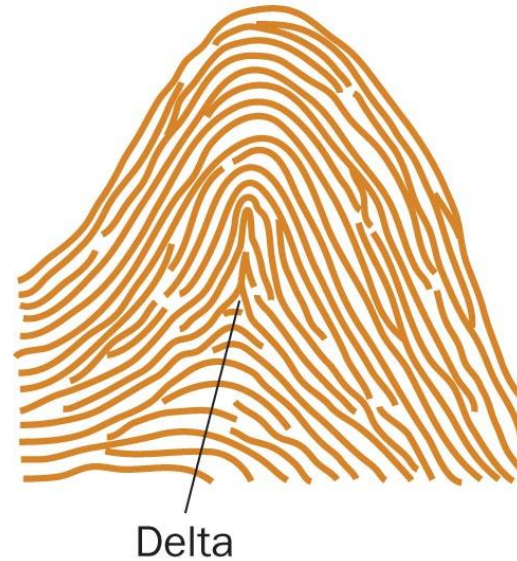


Characteristics of Fingerprints

Plain arch



Tented arch



Characteristics of Fingerprints (continued)



Figure 6-7 Types of whorl pattern.

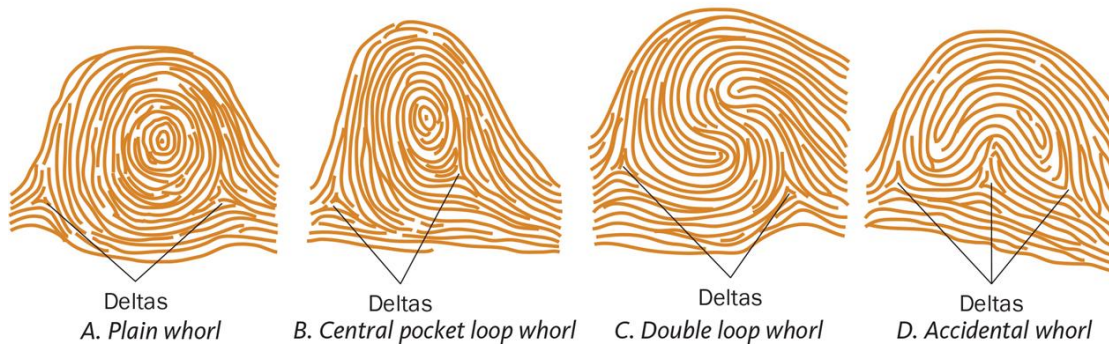


Figure 6-8 Types of arch pattern.

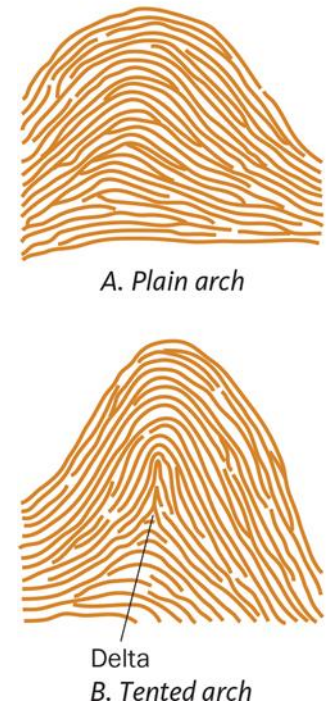




Figure 6-9 *Some minutiae patterns used to analyze fingerprints.*

Name	Visual Appearance
1. Ridge ending (including broken ridge)	1.
2. Fork (or bifurcation)	2.
3. Island ridge (or short ridge)	3.
4. Dot (or 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.



Types of Fingerprints

There are 3 types of prints that investigators look for at crime scenes:

1. **Patent fingerprints**—visible prints transferred onto smooth surfaces by blood or other liquids
2. **Plastic fingerprints**—indentations left in soft materials such as clay or wax
3. **Latent fingerprints**—made visible by dusting with powders or the use of chemicals

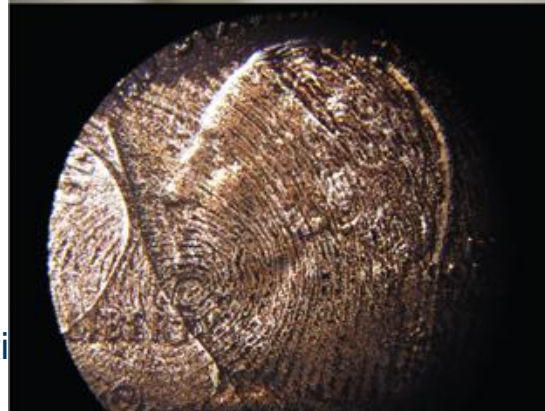
Types of Fingerprints



Figure 6-10 *Lifted latent prints: on a soft drink can (top); on a quarter (bottom).*



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Fingerprint Forensic FAQs

- Can fingerprints be erased?
Only temporarily; they will grow back if removed with chemicals
- Is fingerprint identification reliable?
Yes, but analysts can make mistakes
- Can computers perform matches in seconds?
No, but the FBI's Integrated Automated Fingerprint Identification System (IAFIS or AFIS) can provide a match in 2 hours



Fingerprint Forensic FAQs

o *How are latent fingerprints collected?*

Chemical	Uses	Application	Latent Print
Ninhydrin	Paper	Object dipped or sprayed in Ninhydrin. Wait 24 hours.	Purple-blue print
Cyanoacrylate vapor	Household items: plastic, metal, glass, and skin	Heat sample in a vapor tent.	White print
Silver Nitrate	Wood Styrofoam	Object dipped or sprayed in Silver Nitrate.	Black or reddish brown print under UV light
Iodine Fuming	Paper Cardboard Unpainted surfaces	In a vapor tent, heat solid iodine crystals.	Brownish print (fades quickly) Must be photographed or sprayed with a solution of starch.

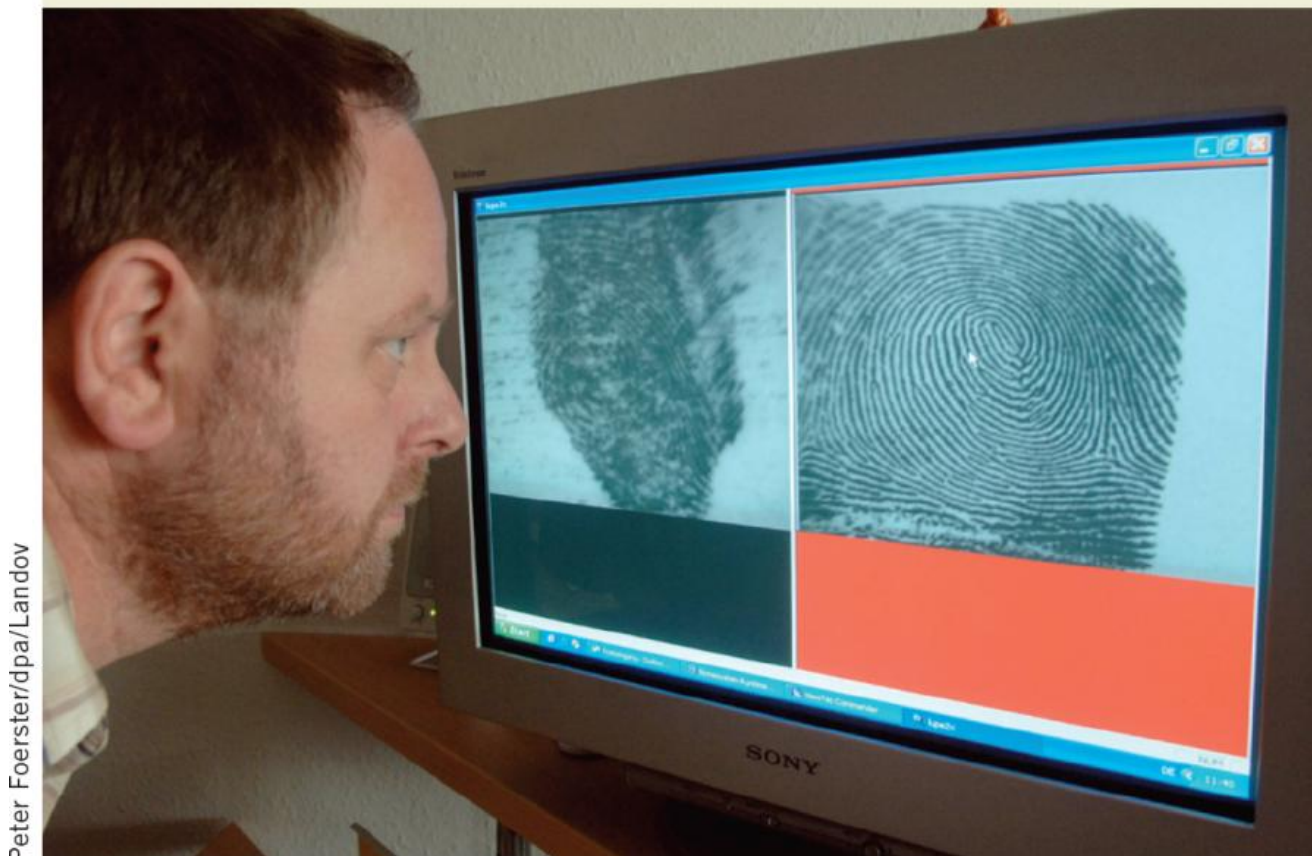


Figure 6-13 *Other methods used for visualizing latent fingerprints.*

Chemical	Uses	Application	Safety	Chemical Reaction	Latent Print
Ninhydrin	Paper	Object is dipped or sprayed in ninhydrin; wait 24 hours	Do not inhale or get on your skin	Reacts with amino acids (from proteins) found in sweat	Purplish-blue print
Cyanoacrylate Vapor	Household items: plastic, metal, glass; and skin	Sample is heated in a vapor tent	Do not inhale or get on your skin: irritating to mucous membranes	Reacts with amino acids	White print
Silver Nitrate	Wood; styrofoam	Object is 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 starch solution



Figure 6-11 *A technician compares fingerprints in the AFIS system.*



Peter Foerster/dpa/Landov



Figure 6-12 *A crime-scene specialist lifting a print.*



Kayte M. Deioma/PhotoEdit

The Future



- scanned at a resolution of 500 to 1000 dots per inch.
- Analyze trace elements on skin
- Nanoparticles added to powders making poor patterns appear even sharper.
- . Technologies that recognize patterns in
 - Retina
 - Face
 - Veins in your palm



Figure 6-14 *This high-resolution fingerprint is a digital image that shows the pores along the ridges, which appear as bumps in the print.*



©Hans van den Nieuwendijk



Figure 6-15 *Leonardo da Vinci's fingerprint is in the right center of this document.*



AP Images/Courtesy of Piero Lucco, Chieti University, HO



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 being collected as evidence in crimes.
- The elevated regions 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.



Summary (continued)

- Fingerprints left on an object are created by the naturally occurring ridges in the skin of fingertips and secretions from sweat glands that leave small amounts of oils and salts when the ridges are pressed against an object. The residues leave an impression of the ridges found on the finger of the donor.
- The basic types of fingerprints are patent (visible) fingerprints, plastic (indentation) fingerprints, and latent (not visible to the unaided eye) fingerprints. They are characterized as loops, whorls, or arches, and are compared on the basis of their minutiae.
- Criminals have sought to alter their fingerprints with chemicals, surgery, and superficial destruction. Some fingerprints can temporarily be altered by long-term contact with rough surfaces. Attempts at permanent fingerprint alteration have not been successful.



Summary (continued)

- Mistakes in fingerprint analysis have led to wrongful convictions, mostly because of human error. New forensic standards are being developed through the Scientific Working Groups and the Organization of Scientific Area Committees.
- The Integrated Automated Fingerprint Identification System (IAFIS) is a national database that holds more than 76 million fingerprint, identifying mark, and criminal history records.
- Fingerprints can be collected from surfaces by dusting them with certain powders and impressing them on tape, or putting them into contact with certain chemicals that help reveal the fingerprints.