Unit 4: Fingerprints

Forensic Science
1. What causes fingerprints?
2. Can they be altered?
3. What makes fingerprints unique?
Objective

• SWBAT
  – Discuss origination and need for fingerprint identification.
  – distinguish fingerprints due to unique characteristics.
  – compare fingerprint detection techniques.
1. History of Fingerprints
2. Types of Fingerprints
3. Fingerprint Detection
4. Henry Classification System
5. Forensic Files
History of Fingerprinting
What is a Fingerprint?

- The impression left by a finger’s friction ridges upon contact with a surface

- DACTYLOSCOPY
What is a fingerprint?

- Folds in the basal layer of the epidermis are formed during the 8th week of fetal gestation.

- These folds are reflected on the surface skin.

- These ridges remain unchanged throughout life.
History of Fingerprints

• Fingerprints were not always used to identify people...

• Alphonse Bertillon’s Anthropometry measurements were used to identify prisoners in the 1880’s.

• The Will West case brought the need for a better system to light.
Partner activity

• Read and discuss the Will West case article.
History of Fingerprints

• Over 3,000 years ago fingerprints were used in ancient China.
• In ancient Babylon some people signed clay tablets with their prints.
History of Fingerprints

1858: William Herschel, a British civil servant stationed in India, required natives to sign contracts with hand imprints.

1880: In Japan Scottish doctor Henry Fauld published his views on using fingerprints to identify criminals (Used FP on whitewashed wall to ID a thief).

1892: Englishman Francis Galton published the textbook *Finger Prints* discussing anatomy, patterns, and recording techniques.
History of Fingerprints

• **1891**: Police officer **Juan Vucetich** devised a workable fingerprint system in Argentina.

• **1897**: Englishman **Sir Edward Richard Henry** developed another classification system that was adopted by the Scotland Yard 4 years later.
  – Most English-speaking countries still use some version of this classification system today!

• **1903**: **Will West** case

• **1904**: Scotland Yard officers train American police officials in fingerprinting at the World’s Fair in St. Louis.
History of Fingerprints

• **1924**: Fingerprint Records of the Bureau of Investigation and Fort Leavenworth prison were merged and became the core of the identification records of the new **FBI**.

• **1970’s**: New technology allowed for the classification and retrieval of fingerprints by computers; **AFIS** (Automated Fingerprint Identification Systems) was born.

• **1999**: state AFIS systems were linked to FBI databases to form **IAFIS** (Integrated Automated Fingerprint Identification Systems).
History of Fingerprints

• 1999: Admissibility of fingerprint evidence was challenged in the case of *United States. vs. Byron C. Mitchell*, but the judge ruled that human friction ridges are unique and permanent.

• Today: Fingerprints can be scanned digitally
Timeline Activity

• Create a colorful, pictorial timeline to organize important events in fingerprint history.
• Include name, year, and description for:
  – Ancient use
  – Bertillon system
  – Herschel
  – Fault
  – Galton
  – Henry
  – Will West case
  – New FBI ID system
  – AFIS
  – IAFIS
• …and any other info you feel is pertinent
Principles of Fingerprints
Types of Fingerprints

• **Patent** which means... ?
• These are visible prints made by touching a smooth surface after the ridges have been in contact with a colored material such as blood, ink, paint, grease, etc.
Types of Fingerprints

- **Plastic** which means…?
- These are actual impressions left by finger ridges in a soft material such as putty, wax, soap, dust, clay, etc.
Types of Fingerprints

- **Latent** which means…?
- These are invisible prints caused by the transfer of body perspiration or skin oils present on finger ridges to the surface of an object.
3 Fundamental Principles

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

- According to Galton’s estimates, there are 64 billion possible fingerprints, (probably more)
- FBI has ~50 million prints in its database and so far no two are alike
3 Fundamental Principles

2) A fingerprint remains unchanged during an individual’s lifetime.

- The pattern of the dermal papillae formed during fetal development does not change

- Even if damaged, fingerprints grow back
3) Fingerprints have general ridge patterns that permit them to be systematically classified

- an older system assigns point values to each digit if it contains a whorl pattern, and then puts that into a formula.
Fingerprint characteristics are named for their general visual appearance and patterns.
Classifying Fingerprints

**LOOP**

**WHORL**

**ARCH**

65%

30%

5%

(percent frequencies in the general population)
Fingerprint Characteristics

• **Loop**

A loop must have one or more ridges entering and exiting from the same side. Loops must have one delta.

**Types**
- **Radial**—opens toward the thumb
- **Ulnar**—opens toward the “pinky” (little finger)

Which type of loop is this, if it is on the right hand? Left hand?

Triangular region: “delta”
Center of loop: “core”
Special Loops

• The double loop is made up of two loops combined into one fingerprint.

• The pocked loop has a small circle at the core.
Fingerprint Characteristics

• **Whorl**

A whorl has at least one ridge that makes a complete circuit. Whorls have at least two deltas and a core.

**Types**
- Plain whorl
- Central pocket whorl
- Double loop whorl
- Accidental whorl
Whorl Subtypes

A line drawn between the deltas touches at least one ridge in the inner pattern.

Has 2 separate loop formations and 2 deltas

A line drawn between the deltas does not touch the inner pattern

CRAZY!
(but has at least 2 deltas)
An accidental pattern contains two or more patterns, but not the plain arch, and is not covered by other categories.

It may consist of a combination loop and plain whorl or loop and tented arch.
Fingerprint Characteristics

- **Arch**

An arch has friction ridges that enter on one side of the finger and cross to the other side while rising upward in the middle. They do NOT have deltas or cores.

**Types**

- Plain
- Tented
Try It!

1 – Blow up your balloon about halfway and twist the end to keep the air from coming out. Do not tie it off!

2 – Use an ink pad to make a print with two of your fingers and label each one with a permanent marker. Write your name on the balloon as well.

3 – Blow up the balloon to full size and tie the end.

4 – Analyze the fingerprints to categorize as loop, whorl, or arch characterization.

Comparing Fingerprints
Comparing Fingerprints

• Criminals aren’t usually nice enough to leave a full 10-print set to run through an IAFIS database
  – Usually investigators have a single print or just a partial print to analyze

• There is no one official number of comparison points an investigator must find to declare that an identification has been made, though most use 10-16 points.
  – Each investigator determines how many is appropriate
Levels of Comparison

• **Level 1**: details include looking at general features and patterns. These cannot be used for individualization, but can rule out some suspects.
Levels of Comparison

• **Level 2**: details include particular ridge characteristics ("minutiae") that enable individualization of an unknown print.
  
  – Not only is having the same number of these minutiae match up between 2 prints, but also that they are in the same relative position.
Use these characteristics as points of identification when comparing fingerprint samples. The more points you can find in common, the better the match!
Levels of Comparison

- **Level 3**: details require a low-power microscope to uncover minute imperfections in a print such as cuts, scars, edge shapes, ridge contours, and even sweat gland pores.

  – Note: this level of comparison depends on how good of a fingerprint picture you have.
Ridgeology
A Closer Look at Fingerprints

Image from ftp://sequoyah.nist.gov/pub/nist_internal_reports/ir_6534.pdf

T. Trimpe 2007 http://sciencespot.net/
Ridgeology: The study of the uniqueness of friction ridge structures and their use for personal identification.¹

As we have learned in our first lesson, a fingerprint is made of a series of ridges and valleys on the surface of the finger. The uniqueness of a fingerprint can be determined by the pattern of ridges and valleys as well as the minutiae points, which are points where the ridge structure changes.

Did you know? The koala is one of the few mammals (other than primates) that has fingerprints. In fact, koala fingerprints are remarkably similar to human fingerprints; even with an electron microscope, it can be quite difficult to distinguish between the two.

¹Introduction to Basic Ridgeology by David Ashbaugh, May 1999
Fingerprint Identification

When minutiae on two different prints match, these are called points of similarity or points of identification. At this point there is no international standard for the number of points of identification required for a match between two fingerprints. However, the United Kingdom requires a minimum sixteen points while Australia requires twelve.

Automated Fingerprint Identification System (AFIS)

AFIS is a computerized system capable of reading, classifying, matching, and storing fingerprints for criminal justice agencies. Quality latent fingerprints are entered into the AFIS for a search for possible matches against the state maintained databases for fingerprint records to help establish the identity of unknown deceased persons or suspects in a criminal case.

http://www.fdle.state.fl.us/CrimeLab/images/fingerprint%20comparison%20for%20afis.jpg
Ridge Characteristics

- Crossover
- Core
- Bifurcation (fork)
- Ridge ending
- Island
- Delta
- Pore
- Scar

http://cnx.org/content/m12574/latest/properties.jpg
How many ridge characteristics can you identify in this fingerprint?
Identify each fingerprint pattern.

A: Left Hand
B: Right Hand
C: Right Hand
D: Right Hand
E: Left Hand
Common Questions about Fingerprints

1) Can you sand off fingerprints?

– Yes it is possible, but it will leave scars on your hands that will be permanent and unique, creating more individuality to your fingerprints. This would ultimately make your fingerprints *easier* to identify.
Common Questions about Fingerprints

2) Can you surgically alter your fingerprints by cutting them off all the way down to the dermal papillae?

– Yes, it is possible, but no successful cases have been noted.
3) Can you graft someone else’s surgically removed fingerprints onto yours?

– Yes it is possible, but again no successful cases in a criminal arena have been noted. A plastic impression of someone else’s fingerprint can be made and then that piece of material can be laid over your fingerprint. This has been depicted on TV and movies and it does work.
(Mythbusters clip)

• Background: The Mythbusters crew is trying to see if they can fool fingerprint scanners (on a laptop and a fancy door lock) with their teammate’s fingerprint over their finger, made from/on

  • Flexible ballistics gel
  • Latex
  • Printed on paper
Taking Fingerprints: Ten-print
Review

Q: What are fingerprints used for?
A: A variety of purposes including:
   – Solving crimes
   – Identity confirmation (passport, cashing checks, etc.)
   – Determining the identity of the deceased
   – Entrance control for buildings and rooms
   – Clearance for employment
It’s time to make some prints!

Avoid Partial Prints

GOOD PRINT
Get as much of the top part of your finger as possible!
Creating a “Tenprint” Card

• You may have had your fingerprints taken before, and someone else probably helped you with it.

• It is unlikely that you were allowed to stamp official fingerprints on your own.

• By having a specially trained person take prints, the results should be more uniform and better suited for further analysis.
Taking a Tenprint

- “Tenprint” refers to a standardized card containing inked fingerprints for all ten fingers.
Taking a Tenprint

• Each finger is assigned a number. The tenprint card usually also has the finger written out.
Step 1: Communicate

• (clean fingertips with alcohol to remove oils)
• Tell your subject that you are going to take their prints
• They should relax their hands, and let you do all the work.
• If they try to “help,” stop, ask them to let you control their hands.
Step 2: Rolled Prints

- Print each finger, one at a time
- Roll the finger on the inkpad from side to side to cover the whole tip in ink
- Roll fingers side to side, one at a time, onto the tenprint card without pressing down
- Print should be wide and not resemble typical print size, may appear square
Step 3: Plain Impressions

• The bottom of the card has a space for 4 fingers at once, as well as a space for a “plain” print for each thumb.
  – Roll the 4 fingers on the pad from the top down to cover them in ink
  – Print all 4 fingers at once onto the bottom of the card.
    • Do the left set first, then right.
  – Finally, ink the thumbs.
  – These prints will have the typical size and shape, instead of the rolled square.
Step 4: Clean Up

• Remove the print card
• Rub soap into fingers’ friction ridges to remove ink
Factors Affecting Fingerprints

- Negative effects could arise from:
  - Allowing subjects to print themselves
  - Excessive pressure
  - Not enough pressure
  - Perspiration, wetness
  - Sickness/disease
Special Situations

• Sometimes full fingerprints may not be available because of:
  – Amputations
  – Bandaged fingers or hands
  – Scars
  – Deformities
  – Worn fingerprints
  – Extra fingers
  – Webbed fingers
Development of Latent Fingerprints
Review...

• Fingerprint Composition
  – Sweat
    • ~99% water
    • ~1% solids such as amino acids and salts
  – Oils and fats (sebum)
  – Bodily fluids (blood, saliva, mucus, semen, etc.)

• Latent fingerprints – hidden prints caused by the transfer of oils and other bodily secretions onto a surface.
  – They can be made visible by different methods
Fingerprint Powders

• Applied lightly to a nonabsorbent surface with a soft brush.

• They readily adhere to sweat residues and/or deposits of body oils left on the surface.
Fingerprint Powders

• Gray and black powders – the most common, chosen to make the best contrast with the surface

• Magnetic powder – applied with a Magna brush on leather and rough plastic surfaces.

• Fluorescent powders – used to photograph latent prints on multi-colored surfaces. They fluoresce under ultraviolet light.
Chemical Development

- **Ninhydrin** – reacts with amino acids in sweat to form purple-blue prints. A 0.6% solution (in ethanol or acetone) is sprayed onto porous surfaces such as paper.

![Chemical Development Image](image)

*This method has been shown to work well on older papers, even a letter 15 years old!*
Chemical Development

- **Physical Developer** – silver nitrate-based liquid reagent used on porous surfaces.
  - Can be used on samples that have previously been wet
  - Reacts with fats in fingerprints to produce a silvery-grey deposit
  - It is often used as the last resort because it destroys protein.

“old school”
Cyanoacrylate (superglue) fuming — developed in 1982 by the Japanese. It is used on a variety of materials not only to visualize latent prints, but also to semi-permanently affix them to the surface.
Chemical Development

- Iodine fuming: one of the oldest latent print development methods.
  - Solid iodine crystals sublimate and the vapor will react with fatty oils and some sweat residue.
  - The brown Iodine prints are not permanent and will begin to fade once the fuming process is stopped.
Chemical Development

- **Rhodamine 6G**: a fluorescent dye that may be used after cyanoacrylate fuming to visualize latent prints under UV light. **Good for multi-color surfaces**

- **Amido Black** – protein dye stain that can develop faint bloody fingerprints on porous and nonporous surfaces.
# Chemical Development of Latent Fingerprints

<table>
<thead>
<tr>
<th>Chemical Method</th>
<th>Advantage/Reason to Using It</th>
<th>What Do Developed Prints Look Like?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ninhydrin</td>
<td>Older paper</td>
<td>Purple-blue</td>
</tr>
<tr>
<td>Physical developer (silver nitrate)</td>
<td>Can be used on previously wet surfaces</td>
<td>Silver-grey</td>
</tr>
<tr>
<td>Cyanoacrylate (AKA superglue fuming)</td>
<td>Cheap and easy, permanently fixes prints</td>
<td>White</td>
</tr>
<tr>
<td>Iodine fuming</td>
<td>Oldest method, simple, non-permanent</td>
<td>Brown</td>
</tr>
<tr>
<td>Rhodamine 6G</td>
<td>Fluorescent, good for multi-colored surfaces</td>
<td>Fluorescent/glow</td>
</tr>
<tr>
<td>Amido black</td>
<td>Works on faint bloody prints</td>
<td>Purple-black</td>
</tr>
</tbody>
</table>
Using Developed Fingerprints

- Photograph
- Covering the print to preserve it in its entirety (if on a small object)
- Lifting the prints with adhesive tape and placing the tape with prints on a card with labels
It is **NOT** possible to determine the age, sex or race of an individual solely from their fingerprints. However:

- Friction ridges of young women are usually finer than those of young men.
- Fine ridges may be found in the very young and the very old.
- Manual labor tends to strengthen ridges.
- Women tend to perspire at a lower rate than men.
- Sodium chloride (NaCl) is lower for women.
- Creases are more common in women's FPs.
RESOURCES


• Federal Bureau of Investigations

• Investigation Discovery
  http://investigation.discovery.com/videos/forensics-videos/
Resources

• [http://sirchie.com](http://sirchie.com)
• [http://www.fbi.gov/hq/cjisd/iafis.htm](http://www.fbi.gov/hq/cjisd/iafis.htm)