



Forensic Fingerprints



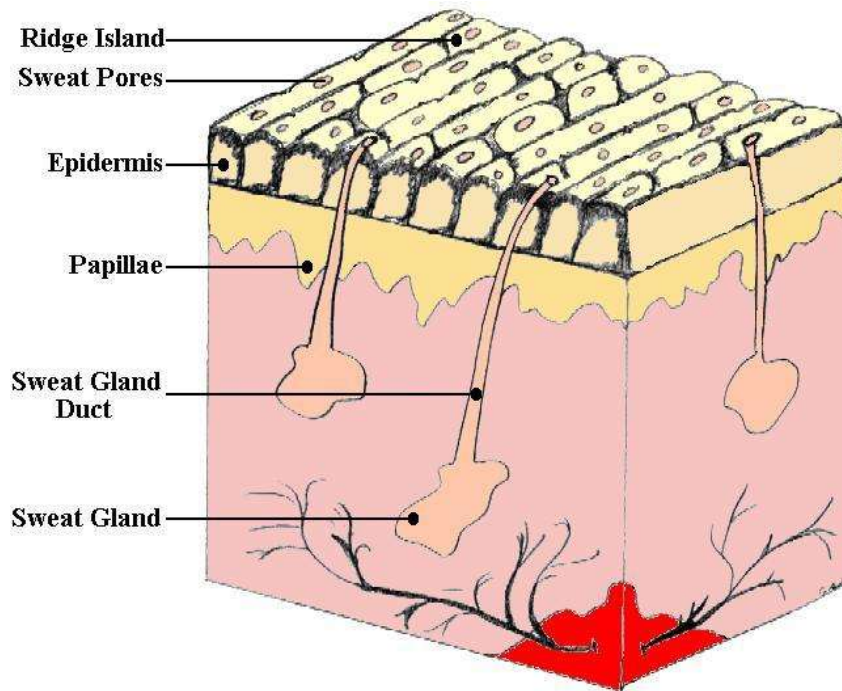


Forensic Fingerprints

- 1000 BC - archaeological evidence of ancient civilizations using fingerprints to sign legal documents
- 1880 - Dr Henry Faulds, an English physician, published a letter in the journal Nature suggesting the use of fingerprints for identification
- 1883 - Bertillon system (anthropometry)
- 1892 - English scientist Sir Francis Galton published a book entitled Finger Prints with a method for classification of fingerprints
- 1897 - Indian Police officer Sir Edward Henry proposed a modified classification system which was adopted by Scotland Yard in 1901 and is still the basis of the systems used in most English speaking countries
- 1901 - First official use of fingerprints in the USA by the New York City Civil Service Commission
- 1930 National fingerprint file set up in America by the FBI

Fingerprints

- Fingerprints form by contact of friction ridges on hands, feet, or lips with an object
- Pore openings present on the surface of the friction ridges.
- Fingerprints are formed underneath the skin in the dermal papillae. As long as that layer of papillae is there, fingerprints will always come back, even after scarring or burning.
- Prints are left because a body is constantly secreting water, oils, etc. through pores.





Principles of Forensic Fingerprints

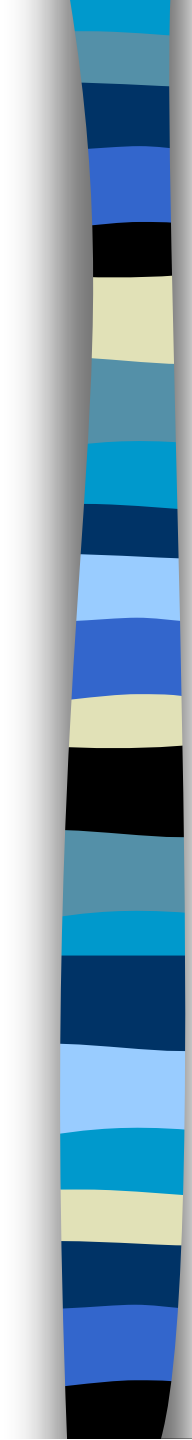
1. A fingerprint is an individual characteristic

- The number, location and shape of specific ridge characteristics, (known as minutiae) are individual
- Most courts require at least 14-16 matched minutiae for a positive match

2. A fingerprint will remain unchanged during an individual's lifetime

- They are formed **before** a person is born
- For a permanent scar – damage must extend 2 mm below surface of skin. Scars becomes part of fingerprint
- Acid scarring and sanding fingerprints only remove a layer or two of skin, which quickly grows back with same characteristics

3. Fingerprints have general ridge patterns that permit them to be systematically classified

- 
- Gloves don't necessarily stop fingerprints. Prints can be left through surgical gloves. Gloves can also be turned inside out to yield fingerprints from the inside surfaces.
 - Leather gloves leave prints that is unique to that glove and no other – (leather comes from cow skin, similar to human skin).

Forensic Fingerprints Patterns

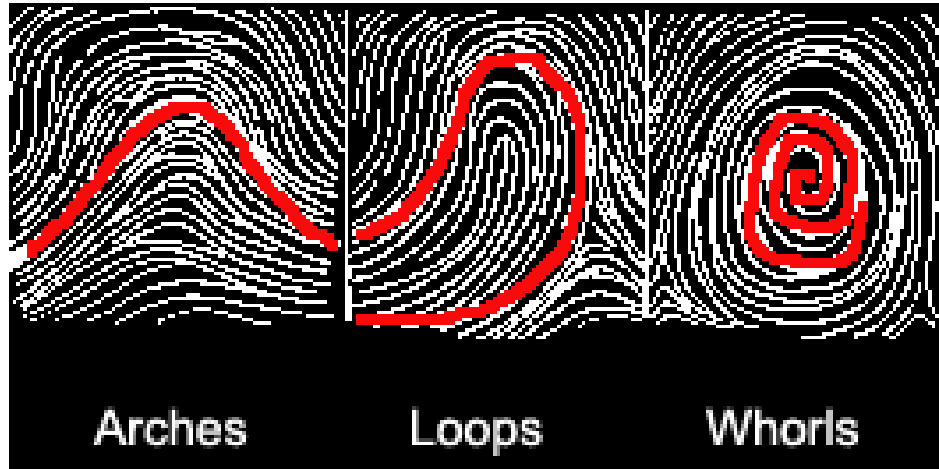
Three basic fingerprint patterns: Loops, Whorls and Arches

Loops 60 - 65 %

Whorls 30 - 35 %

Arches 5 % population

- African ancestry tend to have frequent arches.
- European background have frequent loops.
- Asians/Oriental ancestry tend to have a fairly high frequency of whorls.



Loop

- 1 or more ridges entering from one side, re-curving and exiting from the same side.

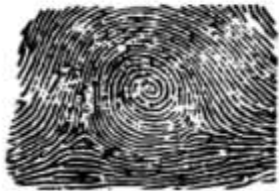
✓ **Ulnar loop** – loop opens toward little finger

✓ **Radial loop** – loop opens toward thumb

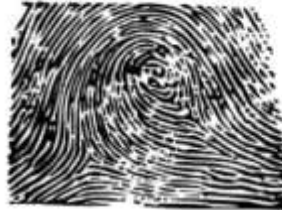
✓ Usually curving around a Delta. Loops have at least 1 delta.



Whorl



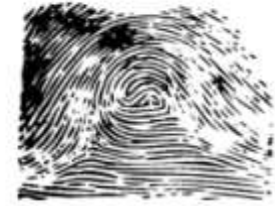
Plain whorl



Central pocket
loop



Double loop

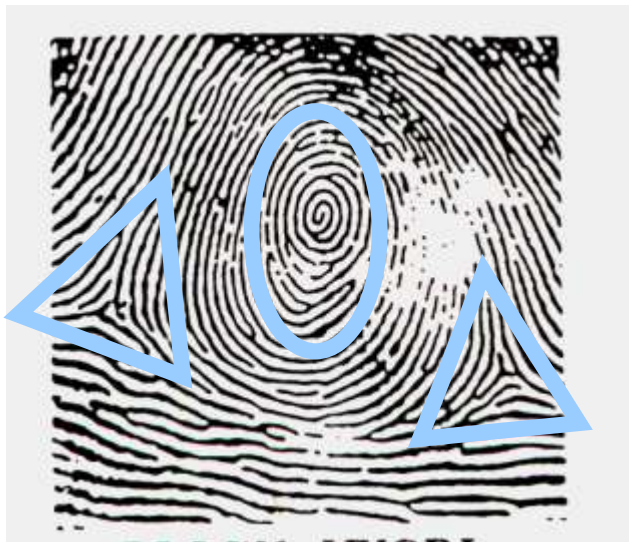


Accidental

Types

- Plain
 - Central Pocket
 - Double Loop
 - Accidental
-
- A plain or central pocket whorl has at least one ridge that makes a complete circle.
 - A double loop is made of two loops.
 - An accidental is a pattern not covered by other categories.

 - Whorls have one or more deltas and a core.



Plain Whorl



Double Loop



**Central Pocket
Loop Whorl**



Accidental

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 type lines, deltas, or cores.

Types

- Plain – wave-like
- Tented - Center rises to a spike; inside angle less than 90°



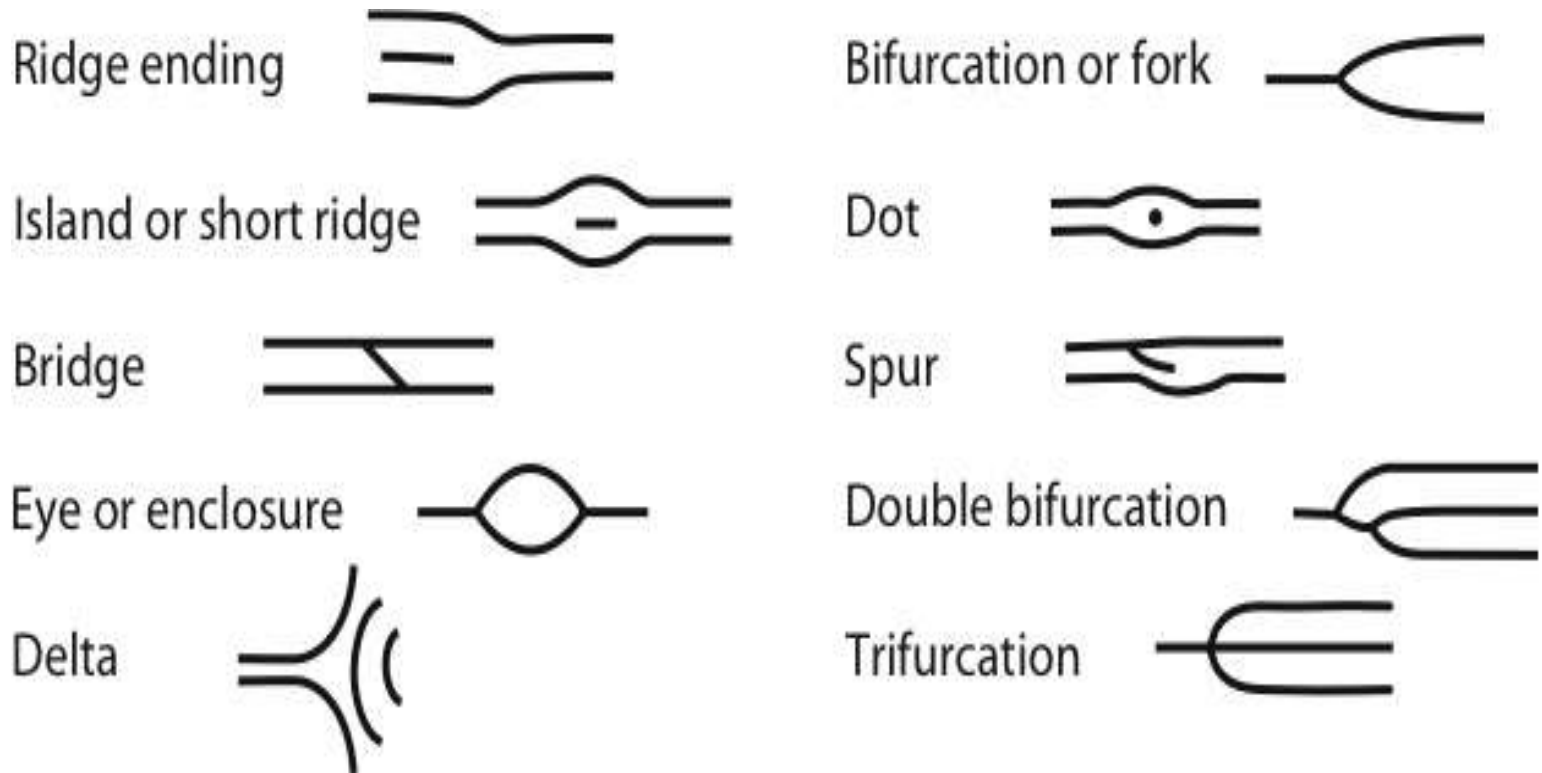
Plain Arch

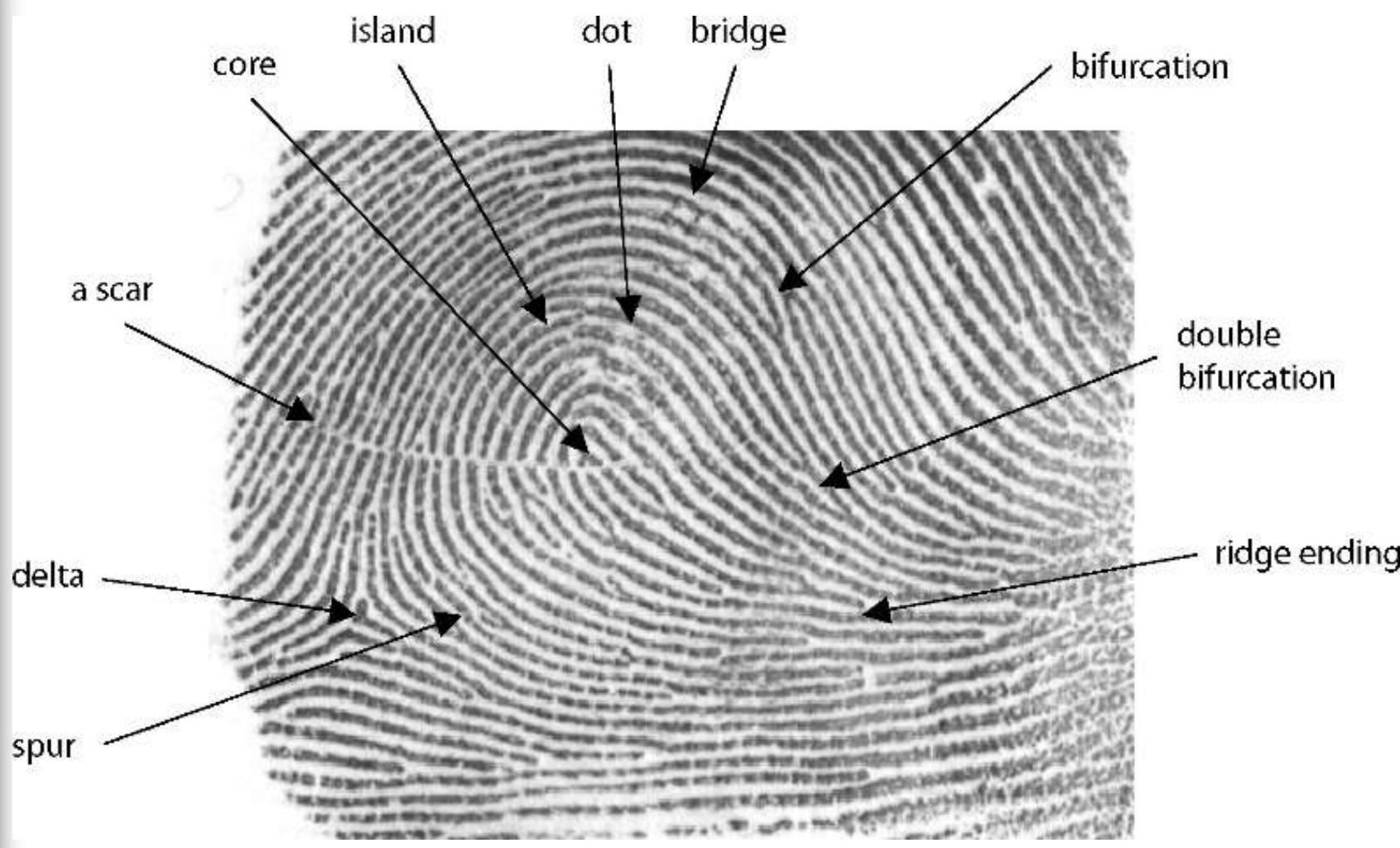
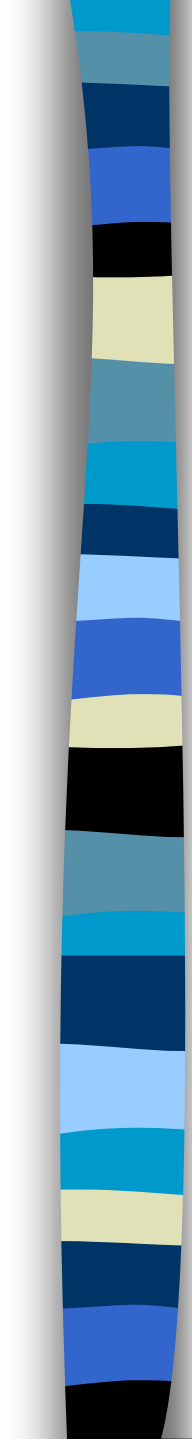


Tented Arch

Ridge Characteristics- individualization

- Within these patterns are **minutia** points - about thirty different types of minutiae points exist







Fingerprint Classification

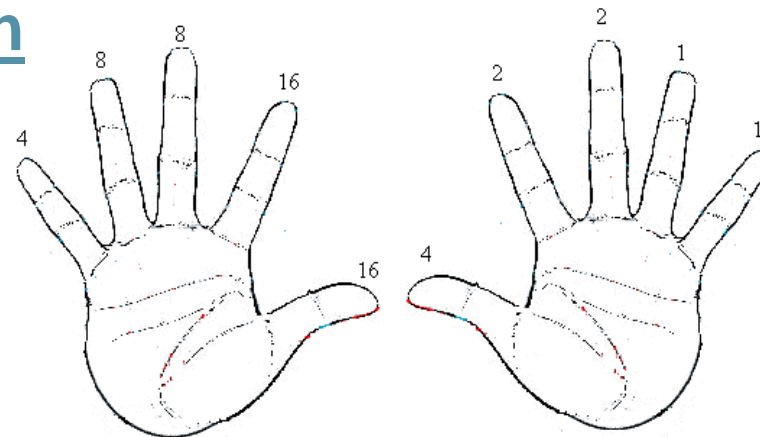
■ Primary Classification:

Henry System – 1st step in FBI system

- 10 finger system which pairs up fingers
- Based on presence or absence of whorl pattern
- Any finger having an arch or loop is assigned a value of 0
- Allows fingerprint cards to be divided into 1024 groups
- Provides the examiner with a number of candidates with indistinguishable sets of prints in the system's files

The Henry—FBI Classification

Each finger is given a point value



Henry Classification $\frac{1+ (\text{Sum of whorled, EVEN finger value})}{1+ (\text{Sum of whorled, ODD finger value})} = \text{Primary Grouping Ratio}$
 System Formula:

Ex.

Whorl patterns found on right index and right middle fingers

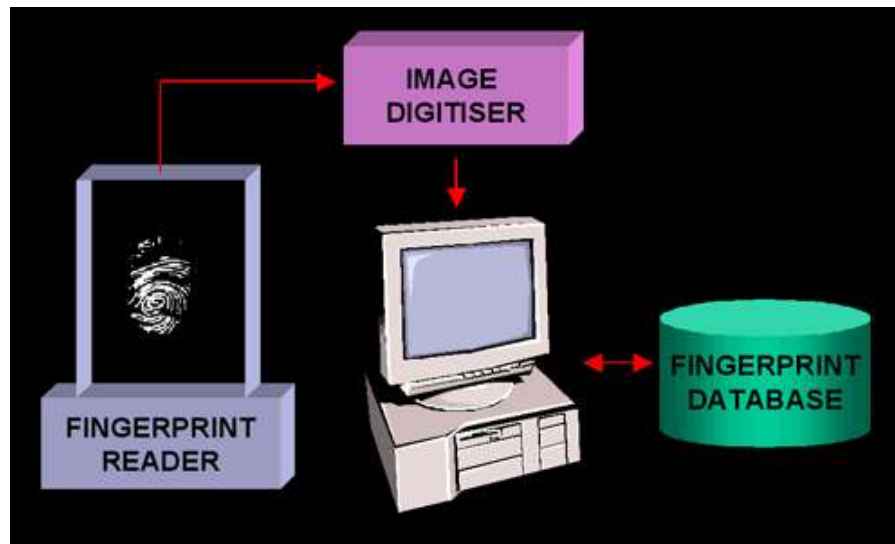
Finger #	1	2	3	4	5
Pattern		whorl	whorl		
Value	16	16	8	8	4

Finger #	6	7	8	9	10
Pattern					
Value	4	2	2	1	1

$$= \frac{(16) + 1}{(8) + 1} = \frac{17}{9}$$

Fingerprint Classification (continued)

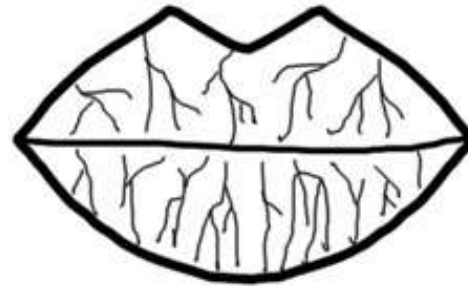
- Automated Fingerprint Identification Systems (AFIS)
 - Uses an automatic scanning device that converts the image of a fingerprint into digital minutiae
 - Computer determines the degree of correlation between location and minutiae between the latent print and the database print
 - Can make thousands of comparisons per second



Other Useful Prints

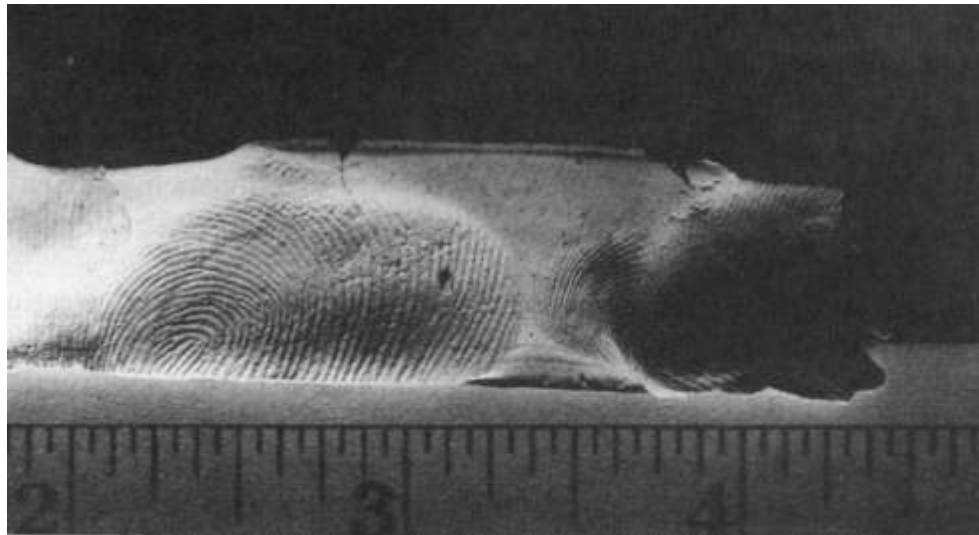


- Lip Prints (glasses, cigarettes, napkins, etc.).
- Ear Prints (windows, doors and walls).



Types of Crime Scene Prints

- **Latent Prints** - invisible to the naked eye and must be developed to see (Transfer of body oils to the surface of an object)
- **Visible Prints** - Made after the ridges have been in contact with a colored material
 - Blood, paint, grease, ink
- **Plastic Prints** - impressions of fingerprints in soft media
 - Soap, putty, wax,



Fingerprint in putty common in burglaries.

Visualizing Fingerprints

1. **DUSTING**

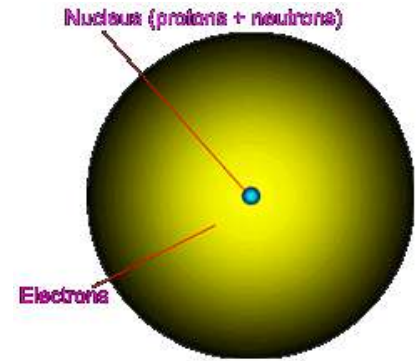
- Uses a fine powder that adheres to the traces of oil and sweat
- Suitable for hard and/or non-absorbent surfaces (glass, tiles, mirror, painted wood, etc)

Examples:

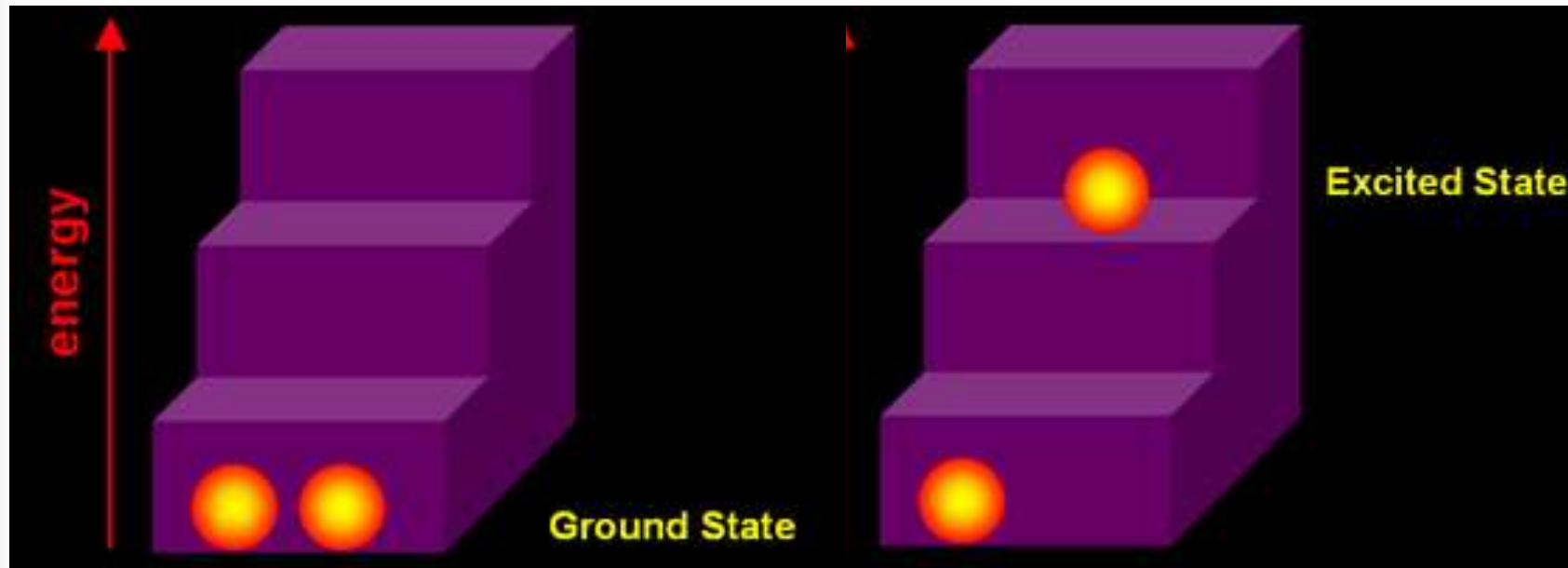
- Aluminum dust (grey and highly visible on dark and mirrored surfaces)
- Carbon black (white surfaces)
- Luminescent powders (fluoresce under ultraviolet light)
- Magnetic Powders



Luminescence



- An excited molecule will lose energy with the electron falling to the ground state. For some molecules the excess energy is lost in the form of light, it is this process that is known as luminescence.



Luminescence

- A common application of luminescence is washing powder that contains optical brightener. The optical brightener is a fluorescent dye that shows a blue luminescence when excited by the ultraviolet radiation present in sunlight.





Visualizing Fingerprints (continued)

2. Chemical Methods

- **Used for porous surfaces like paper or cloth**

Examples:

- iodine fuming
- Ninhydrin
- superglue fuming
- Physical developer

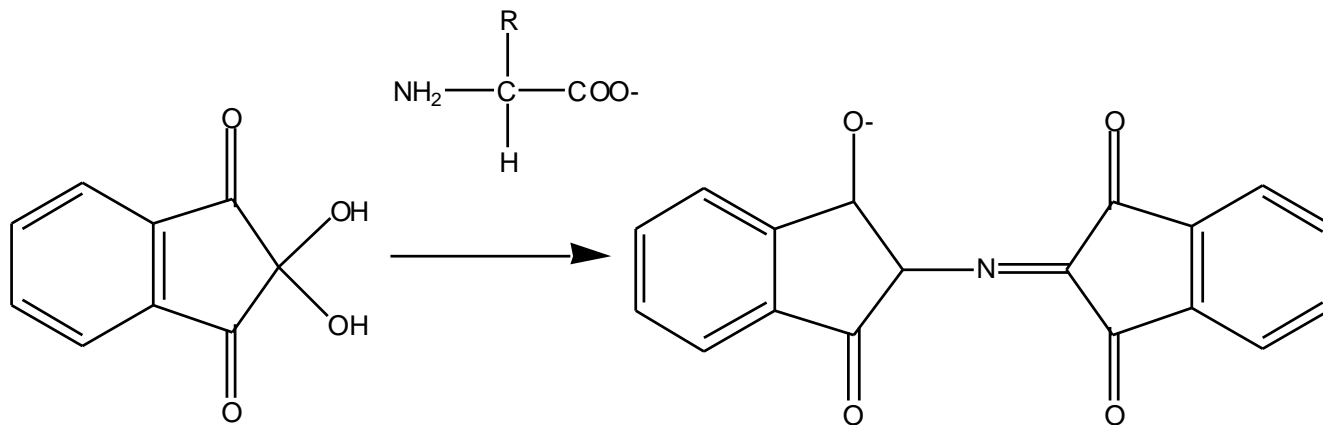
Iodine Fuming

- Iodine sublimates at room temperature.
- Object is placed in a chamber with crystals of iodine.
- Fingerprints on the object will appear as brownish prints.
- The iodine is believed to dissolve in the skin oils that make up the print
- Temporary and will fade, so must be photographed



Ninhydrin Method

- Colorless compound reacts with amino acids in sweat to form a purple colored compound.
- Sprayed on a porous surface and prints begin to appear within 1-2 hours; weaker prints may be seen after 24-48 hours
- Used to develop latent prints on paper as old as 15 years



Ninhydrin

Ruhemann's Purple

Superglue Fuming

- Used on nonporous surfaces – metals, electrical tape, plastic bags, leather.
- 98-99% *cyanoacrylate ester* which reacts with and visualizes latent prints
- Fumes adhere to print, resulting in a white latent print
- The visible prints produced are white, but are often treated with a fluorescent dye to improve visibility

