



Fingerprint Forensics

Lecture.3

By

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Brief History

- Earthenware estimated to be 6000 years old was discovered at an archaeological site in northwest China and found to bear clearly discernible حافة الاحتكاك friction ridge واضح impressions. These prints are considered the oldest friction ridge skin impressions found to date; however, it is unknown whether they were deposited by accident or with specific intent نية, such as to create decorative patterns or symbols.

The Chinese were the first culture known to have used friction ridge impressions as a means of identification. The earliest example comes from a Chinese document entitled “The Volume of Crime Scene Investigation—Burglary السرقة”, from the Qin Dynasty (221 to 206 B.C.). The document contains a description of how handprints were used as a type of evidence .

Brief History

- The first case definitively solved by fingerprints was the 1892 murder of two boys in Argentina, which led to the conviction ^{ادانة} of the children's mother, Francisca Rojas. A bloody fingerprint found at the scene was compared to Rojas's by fingerprint expert Juan Vucetich, proving she was the murderer when the print matched hers.



Fingerprint Forensics

- Is the scientific analysis and comparison of fingerprints to identify individuals.
- Two people have exactly the same fingerprints. Even identical twins, with identical DNA, have different fingerprints. This uniqueness allows fingerprints to be used in all sorts of ways, including for **background checks, biometric security, mass disaster, identification,** and of course, **in criminal situations.**

Importance of analysis fingerprint

- Fingerprint analysis has been used to identify suspects and solve crimes for more than 100 years, It remains an extremely valuable tool for law enforcement.
- One of the most important uses for fingerprints is to help investigators link one crime scene to another involving the same person.
- Fingerprint identification also helps investigators to track a criminal's record, their previous arrests and convictions, to aid in sentencing الحكم.

Principles of Fingerprint Analysis

- Fingerprints are unique patterns, made by friction ridges (raised الظاهر) and furrows (recessed غائر), which appear on the pads of the fingers and thumbs.
- Prints from palms, toes and feet are also unique; however, these are used less often for identification, so this guide focuses on prints from the fingers and thumbs.
- The fingerprint pattern, such as the print left when an inked finger is pressed onto paper, is that of the friction ridges on that particular finger.
- Friction ridge patterns are grouped into three distinct types—loops, whorls, and arches—each with unique variations, depending on the shape and relationship of the ridges:

Anatomy

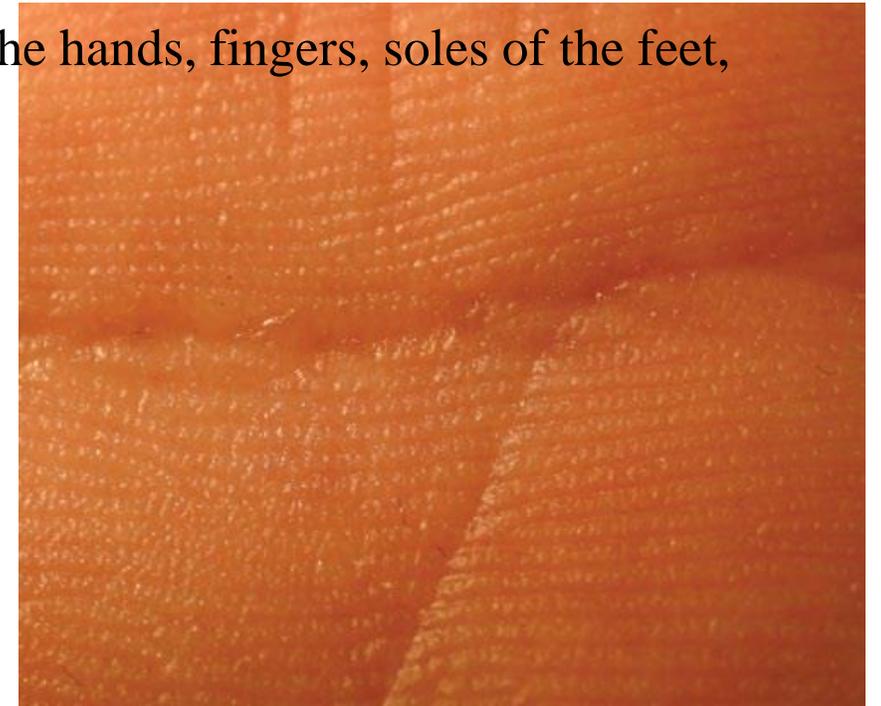
How do fingerprints arise?

Fingerprints develop during early fetal life. They undergo various phases, of which crucial events occur by the early weeks of the second trimester.

Outer Morphology of Friction Ridge Skin

Friction ridge skin is the specialized skin found on the palms of the hands, fingers, soles of the feet, and toes.

- Key features
- Ridges and furrows form unique patterns (arches, loops, whorls).
- Contains eccrine sweat glands, which help leave latent prints.
- Develops in the fetus (10–16 weeks gestation **الحمل**) and remains permanent throughout life.
- Provides grip **قبضه** and tactile **لمس** sensitivity in daily function.
- The basis for fingerprint identification in forensic science.



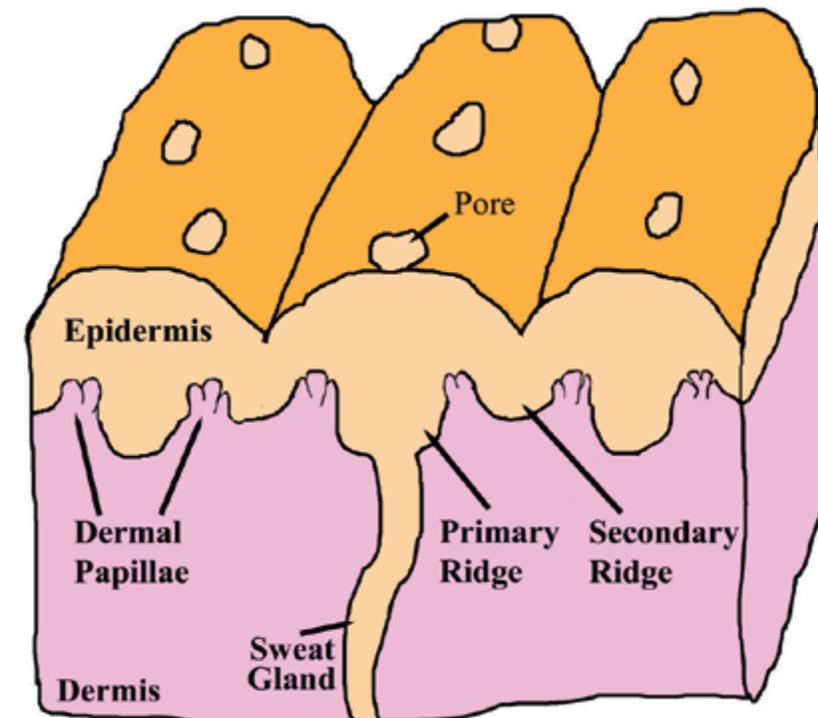
Friction ridge skin of the left palm

Skin function

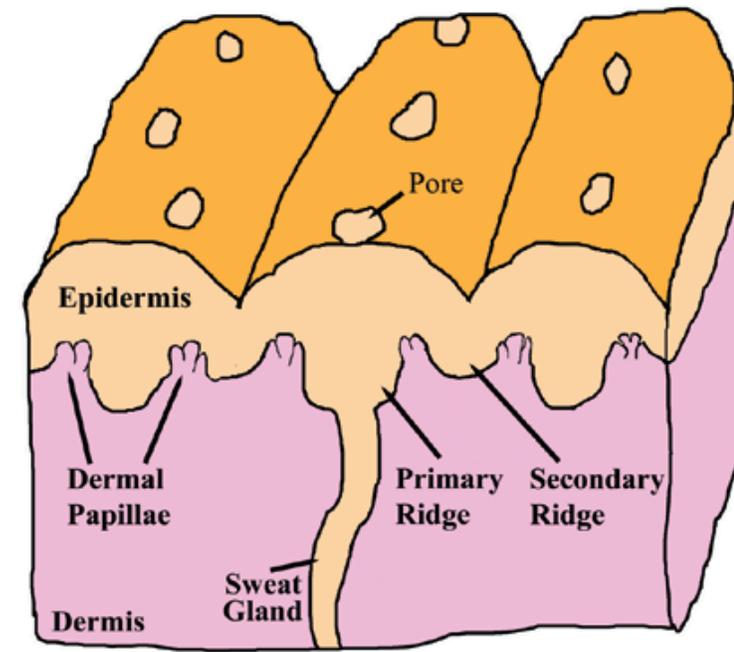
- These anatomical layers together function to provide the body with a protective barrier, body temperature regulation, sensation, excretion,
- The outer layer of skin is the epidermis. The epidermis prevents water loss through evaporation, acts as a receptor organ (Sensory organ, is a specialized structure composed of receptors that detects stimuli from an organism's internal or external environment and converts them into electrical signals for the nervous system to process), and provides a protective barrier for the underlying tissues. Melanocytes, the pigment-producing cells of the epidermis, play a key role in the protective barrier. The pigmentation produced by the melanocytes shields the DNA of the keratinocytes (primary cell type of the epidermis) from the sun's harmful rays. Additionally, the melanocytes are responsible for the synthesis of vitamin D.

General Anatomy of Skin

- The skin is an organ composed of three anatomical layers (Friction Ridge Skin layers):
 1. Epidermis: This outer layer contains the raised ridges and furrows *التلال والأخاديد المرتفعة*. The basal layer of the epidermis has folds that protrude into the dermis, forming the structure of the ridges.



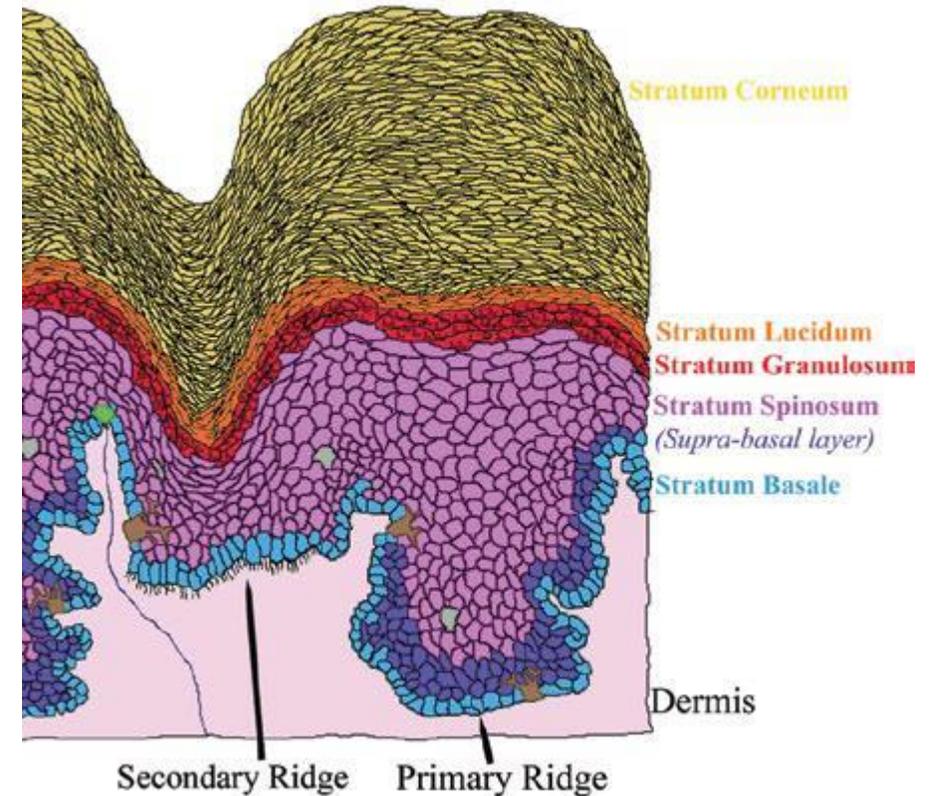
- **Dermis:** This deeper layer of skin contains the underlying structures that provide support to the friction ridges.
- **Primary Ridges:** These are the basal layer folds of the epidermis that extend into the dermis and correspond to the ridges on the surface.
- **Secondary Ridges:** These interlocked متشابكة structures, located in the valleys, also provide support and strength to the friction ridge skin.



3. Hypodermis

The hypodermis, also known as the subcutaneous tissue, is the deepest layer of the skin, located beneath the **dermis** and above the muscles and bones. It consists primarily of fat (adipose tissue), connective tissue, and blood vessels. **Key functions** of the hypodermis include storing fat for energy, providing insulation **العزل** to regulate body temperature, cushioning and protecting underlying structures, and connecting the skin to the rest of the body.

- the epidermis is a layered tissue that must constantly **replace the cells leaving the surface**. New cells are generated in the basal layer and pushed toward the surface. As the cells move toward the surface, they undergo sequential changes in chemical composition.



Layers of the Epidermis

1. Stratum basale (or germinativum):

This is the deepest layer, where stem cells divide to produce new keratinocytes. It also contains melanocytes, which produce melanin.

2. Stratum spinosum:

Also called the **prickle cell layer**, this is the thickest layer and contains cells with spine-like projections that connect to neighboring cells.

3. Stratum granulosum:

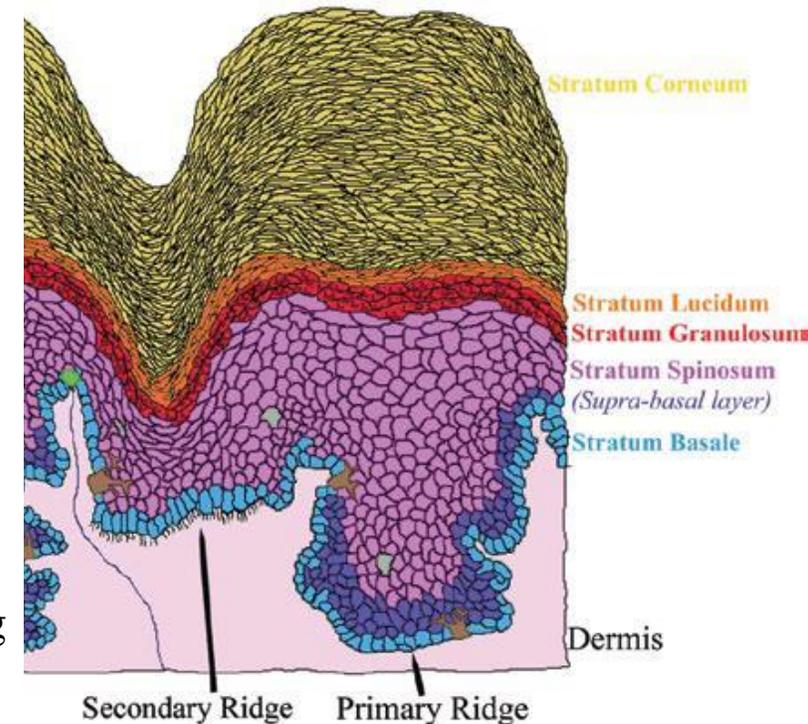
This layer contains cells with granules that help to cross-link keratin, forming a dense structure.

4. Stratum lucidum:

This translucent شفاف layer is only present in thick skin, such as the palms of the hands and soles of the feet.

5. Stratum corneum:

The outermost and most superficial layer, it consists of multiple layers of dead, flat, keratinized cells that are eventually shed from the skin's surface. This layer is crucial for skin health, regulating water loss and defending against external threats.

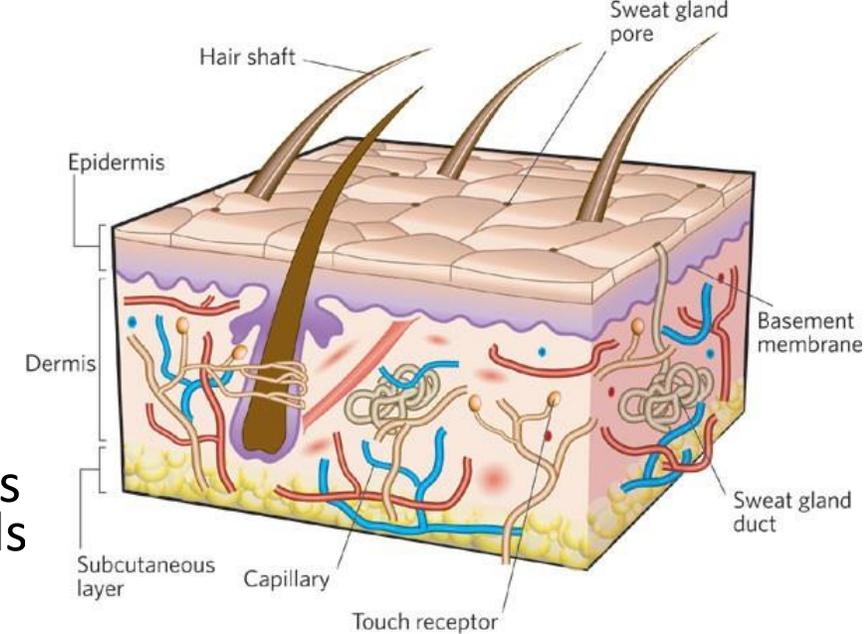


Physiology

1. Physical Attachments

There are structural features of the overall skin and of the skin cells that maintain the structure of the epidermis (even though skin cells are always sloughing **يتقشر** at the surface). There are three levels of attachment in the friction ridge skin:

- 1. Primary and Secondary Ridges.** The first level of attachment is the topography **التضاريس** at the junction of the epidermis and dermis.
- 2. Basement Membrane Zone.** The second level of attachment is the basement membrane. The basement membrane is a fibrous sheet that attaches the basal keratinocytes of the epidermis to the underlying dermis.
- 3. Cell-to-Cell Attachments.** The third level of attachment consists of the cell-to-cell attachments of the keratinocytes throughout the layers of the epidermis.



- **2. Cell Communication**

- Skin must maintain the protective barrier while existing in a dynamic steady state (i.e., cells leaving the surface must be replaced). The rate at which basal cells divide in the basal layer must coincide with the rate at which cells are leaving at the surface. There must be a mechanism in place to control the rate of cell division of the basal keratinocytes and to monitor the thickness of the skin. This mechanism is cell communication.

Genetic makeup and environmental factors link with fingerprint

- The basic size, shape, and spacing of dermatoglyphs (A person's fingerprints are based on the patterns of skin ridges) appear to be influenced by genetic factors.
- Genes that control the development of the various layers of skin, as well as the muscles, fat, and blood vessels underneath the skin, may all play a role in determining the pattern of ridges.
- The finer details of the patterns of skin ridges are influenced by other factors during fetal development, including substances taken during pregnancy and the environment inside the womb.
- These developmental factors cause each person's dermatoglyphs to be different from everyone else's. Even identical twins, who have the same DNA, have different fingerprints.

- **Clinical relevance of loss of fingerprints**
- Friction ridges can become thicker and shorter with ageing, and are more difficult to discern. Loss of fingerprints is sometimes observed in various skin diseases. These include trauma, benign and malignant skin lesions, infections and inflammatory skin conditions.
- **Infections**
- **Bacterial infection** such as pyoderma, Tinea manuum , Herpes simplex, Viral warts
- **Inflammatory diseases**
- **Ex. Hand dermatitis, including Exfoliative keratolysis.**
- **Systemic sclerosis.**

- Biometric technologies generally refer to the use of technology to identify a person based on some aspect of their biology.
- Fingerprint recognition is one of the first and original biometric technologies that have been grouped loosely under [digital forensics](#).
- With the ever-growing number of [video surveillance cameras](#) mushrooming in large cities, the use of the data captured by these cameras has been at the center of a number of privacy and human rights storms.

Biometric fingerprint technology

- Basic of biometric fingerprint identifies individuals by matching their unique fingerprint patterns to a stored template.
- This process uses Scanners to capture a fingerprint's ridges and valleys, which are then converted into a digital biometric template for is widely used in security for authentication and identification because authentication. It fingerprints are unique, stable, and cannot be easily lost, forgotten, or stolen like passwords.
- How it Works
- **Capture:** A fingerprint scanner (optical, capacitive, ultrasonic, or thermal) captures an image of the fingerprint.
- **Analysis:** Software analyzes the captured image to identify unique features like ridges, valleys, [arches](#), [loops](#), and [whorls](#).
- **Template Creation:** These features are used to create a digital biometric template.
- **Storage:** The template is securely stored for future comparison.
- **Verification/Identification:** During authentication [المصادقة](#) , a live scan is compared to the stored template.

A black and white photograph showing a hand holding a broom on the left side. On the right side, there is a circular broom head lying on a light-colored, speckled floor. The text "Thanks for your attention" is overlaid in the center in a red, serif font with a blue outline.

Thanks for your attention