

**NOTE:** The following information should be studied in conjunction with the chapter III 'The Friction Ridge Medium' in the book by David Ashbaugh, 'Quantitative-Qualitative Friction Ridge Analysis – An Introduction to Basic Ridgeology', used as a text on the Forensic Identification course.

## STRUCTURE OF THE SKIN

The skin is one of the largest organs in the body. Depending on the size of the individual, it is typically about 1.5 m<sup>2</sup> in total surface area.

It performs several simultaneous functions:

- it acts as a container for the skeletal structure and internal organs
- it provides sensory input about varied external conditions such as heat and cold, wet and dry, sharp and soft
- it provides a means for the elimination of waste products such as salts, amino acids, ammonia and urea

This latter function is of particular importance in the field of identification since these materials react with various chemicals to develop fingerprints.

A small fraction of the total area, about 0.08 m<sup>2</sup>, which is the main focus of forensic identification, is called friction skin.

The two surfaces of the body that are covered with friction skin are the palms of the hands (palmar surfaces) and the soles of the feet (plantar surfaces). The patterned skin ridges found in these areas have been described using various names such as friction ridges, epidermal ridges, papillary ridges or, occasionally, as rugae. The spaces between the ridges are known as the furrows or sulci.

Although not technically correct, for the purposes of identification work the skin can be considered to be composed of two layers. The outer layer is known as the epidermis, while the inner layer is known as the dermis. The bottom of the epidermis, where it is adjacent to the dermis, is the generating layer of the epidermis

and it is in this layer that new cells are formed. (See the section on Ridgeology for more details) As these cells multiply they push both up, toward the surface where they form the ridges, and down, into the dermal layer.

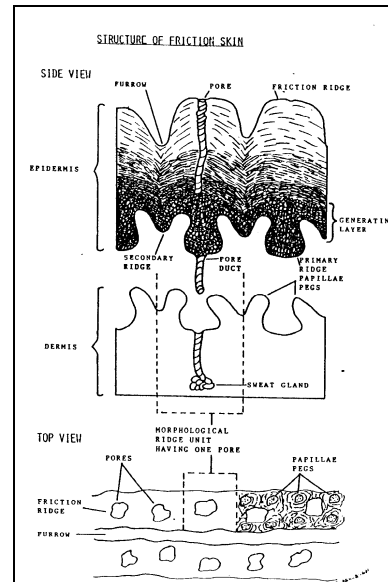


Diagram by D. Ashbaugh

Expansion of the generating layer down into the dermis causes the appearance of double rows of peg-like formations to form on the top layer of the dermis. These are called papillae and each double row is aligned with a surface ridge. This fact has been used, on occasion, to make fingerprint identifications from the dermal layer of decomposing bodies from which the epidermal layer of the skin was missing.

Note that the surface formations that we call friction ridges are known as primary ridges in the generating layer. Likewise, the spaces between the friction ridges are called furrows on the surface but are called secondary ridges in the generating layer.

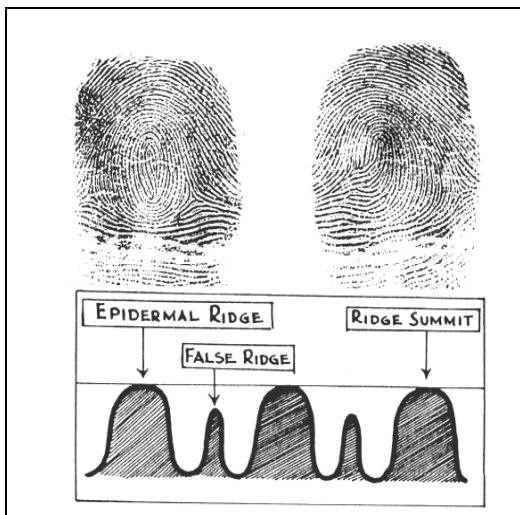
### INCIPIENT RIDGES

Some individuals have friction ridges that have not fully formed. Okajima described their growth in his discussion of "incipient ridges". They are also described as "false" "rudimentary," or "nascent" ridges. Their relationship to true ridges can be seen in the illustration.

Incipient ridges may not be recorded every time a subject is fingerprinted because of differences in the pressure used as the digit is rolled. For that reason they are ignored when classifying fingerprints so that the classification can be performed consistently each time the subject is fingerprinted. The ridges may be used, however, when individualizing impressions if they appear in both crime scene and inked impressions.

Depending on the stage of development at differentiation, incipient ridges may be recognized by the following factors:

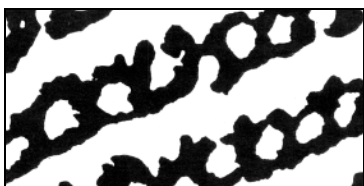
- they are often not as thick as normal ridges;
- they are frequently fragmented;
- they may contain no pores.



## SWEAT PORES

A close examination of friction ridges will reveal that throughout their length the surface is broken in an irregular fashion by sweat pores. These are the openings of the ducts leading from the sweat glands found in the subcutaneous tissue.

The study of the shapes of these pore openings is known as Poroscopy. A related area of study, known as Edgeoscopy is the study the shapes of the edges of the ridges.



Proponents of Poroscopy and Edgeoscopy suggest that fingerprints can be compared on the basis of the unique appearance of the sweat pores and the irregular edge shapes of the friction ridges.

While this is technically possible, the biggest obstacle is in obtaining both crime scene and inked impressions of sufficient clarity for comparison of such fine detail.

## ABNORMAL FRICTION RIDGES

We occasionally encounter abnormalities of the friction skin on the distal phalanx (tip of the digit). Disease or damage to the skin tissue due to accident or a particular occupational injury causes some of these conditions, while others are caused by a pre-natal condition.



If, during the fetal state, a disruption occurs while the proliferation of cells at the generating layer of the epidermis is taking place, a ridge abnormality known as **dissociation** may occur. Although the arrangement of the ridge elements does not conform to any classification system they, like normal ridges, also are unchanging and are still useful for individualizing the impressions.

## EFFECTS OF INJURY

If the epidermis is injured it re-grows very quickly and, as long as the injury has not penetrated into the generating layer of the epidermis, the pattern of the ridges on the healed surface will be identical with the pattern as it existed prior to the injury.



If, however, the generating layer is damaged, the "blueprint" for formation of the surface ridge pattern will be altered. As the injury is repaired the new growth will therefore follow the altered "blueprint". This new pattern will then remain in place unless there is a further injury to that area of friction skin.

When you examine such fingerprints, it is usually immediately apparent that an injury has taken place. The ridges are usually disrupted and the new fragments do not form a regular pattern.



As the wound heals, the scar tissue gradually contracts, and, if the wound has been extensive, the contraction may cause considerable distortion of the ridge pattern in the area surrounding the scar.



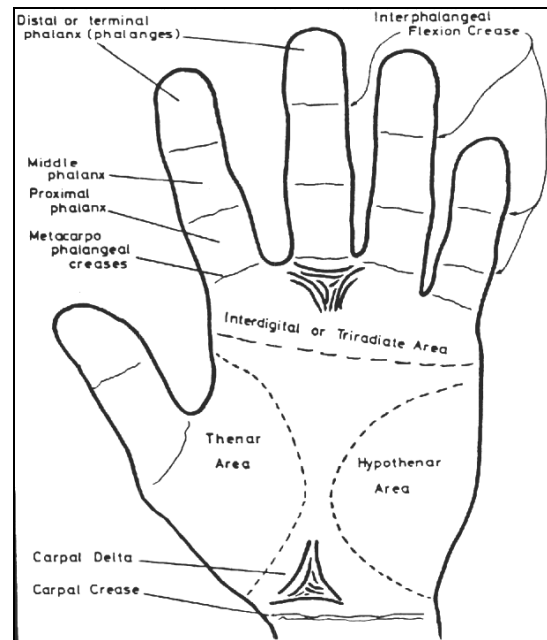
Occasionally, if a portion of the skin with its underlying tissues has partially been severed, the wound may heal with the partially severed skin

displaced. Fortunately, such distortion or displacement does not affect the value of the pattern as a means of individualization. In fact such scarring could be considered totally unique, although it may not fit into any normal classification for filing purposes.

## PALMAR NOMENCLATURE

Make yourself familiar with the proper names of various parts of the hand.

These terms will frequently be found in texts and in scholarly articles. Since they precisely designate specific areas of the hand, use of these terms saves a great deal of explanation and confusion.



## CONCLUSION

On the basis of the foregoing discussion, we are able to arrive at certain conclusions that are essential to the understanding of friction skin identification:

- fingerprints are formed before birth, and remain essentially unchanged throughout life.

- no two fingerprints are the same in respect to the arrangement of their ridge characteristics.
- ridge characteristics take their form from the growth of cells and ridge units at the generating layer of the epidermis and cannot be changed except by physical damage that results in a scar.
- a fingerprint, even though damaged, will heal with its original appearance unless the generating layer of the epidermis is damaged.

## COMPOSITION OF FINGERPRINT SECRETIONS

*(Note: For simplicity in the following discussion it is assumed that "fingerprint" includes impressions of palms and soles.)*

A deposited fingerprint may be composed of naturally secreted materials, such as sweat, sebum or lipids, foreign materials picked up on the hands or a combination of any or all of them. The actual blend that forms any particular impression is always unknown. This may appear to make the choice of development techniques an insoluble problem.

However, having an awareness of the potential physical properties of a fingerprint will enable an intelligent choice to be made among the development techniques.

Two types of natural secretion glands are of interest in Forensic Identification work:

- eccrine sweat glands
- sebaceous glands

### ECCRINE SWEAT GLANDS

These glands are found all over the body, but in greater density on the palmar and plantar surfaces. The activity of these glands is controlled by the autonomic nervous system that responds to thermal, emotional and medical

stimuli. These glands cannot be consciously controlled by the individual.

### Composition of Eccrine Sweat

Because of the many variables involved, the authorities vary slightly with respect to exact proportions, but is generally agreed that the composition of eccrine sweat is approximately as follows:

Water	98.5% to 99.5%
Solids	0.5% to 1.5%

The solids are approximately 1/3 to 1/2 inorganic salts and 1/2 to 2/3 various organic substances.

### The Inorganic Salts

Chloride, bromide, iodide and fluoride form the inorganic salts, sodium chloride being the most abundant.

The concentration of salts in the sweat is subject to the following factors:

- rate and duration of sweating
- intermittent versus continuous sweating
- diet
- age and sex

The skin is one of the routes used by the body to eliminate waste products. It is also used as a method of cooling the body through the evaporation of sweat. These two functions are combined as the sweat carries the waste materials to the surface through the eccrine glands where they are washed away as we bathe.

Since there are limited amounts of waste materials to be discarded the quantity exuded at any one time depends upon the opportunity the body has had to remove them. For instance, in cool weather the body does not become overheated as frequently as in warm weather so does not need to sweat much to provide cooling. Waste products are therefore not eliminated very frequently but when sweating does eventually occur the body uses the opportunity to excrete relatively large amounts of waste. Thus the concentrations in the secretions temporarily become very high.

Conversely, in the summer when the body needs to be cooled, sweating is frequent and often profuse but there is still only the same amount of waste material to eliminate. Because the

opportunity to remove the material is almost constant, the concentration of waste materials at any particular moment is therefore much less.

This then leads to the conclusion that cooler weather, when sweating would be likely to occur only occasionally, would lead to higher concentrations of the materials for which we search with our chemical fingerprint development techniques.

## **The Organic Substances**

Of the many organic substances present in eccrine secretions, those of significance in identification work include amino acids and fatty acids. Also present are ammonia and urea. These materials are generally water soluble.

### **Amino Acids**

Many amino acids have been successfully identified in normal eccrine secretions. Under conditions of normal daily activity the concentration of amino acids decreases with high rates of sweating in proportion with the other materials.

One very big exception is that the autonomic nervous system causes the body to secrete very large amounts of amino acids when it is placed under stress. The autonomic system is the one that controls heart rate and other bodily functions over which we normally have no direct control.

As a practical example let us look at a fraudulent cheque offence scenario at a bank. The offender must control all outward signs of nervousness to avoid arousing the suspicions of the bank employees. Internally the subject is tense and the autonomic nervous system reacts to this by increasing heart rate and respiration and by secreting more amino acids among other things. As the cheque is passed the offender must handle it with bare hands in a normal fashion and thus transfers amino acids to the paper. When the document is examined, using ninhydrin development, the amino acids are stained and become visible.

This has been confirmed repeatedly at the Ontario Police College by processing student examination papers (or specimen impressions

taken during exams) for fingerprints, and comparing the results with non-stress samples.

In the large majority of cases, identifiable fingerprints develop on the exam or specimen papers. Often nothing at all or only poor quality impressions develop on the non-stress comparison samples.

### **Fatty Acids**

These naturally occurring fats and oils are found within the group of substances known as lipids. The lipid group also contains such substances as the waxes and squalenes that are found in sebum (discussed below). It is important to understand that the oils and fatty acids do not remain in a viscous state (as does motor oil, for example).

The lipids are changed over a period of time through oxidization and hydrolysis. This is sometimes referred to as 'drying out.' It would be perhaps better to use the term 'cured' to differentiate the process from simple evaporation of substances such as water.

A latent impression composed primarily of lipid materials will remain amenable to certain development techniques much longer if it is protected from the air.

### **Ammonia and Urea**

While little use is made of them in commonly used development processes, ammonia and urea are also present on the skin in quantities that vary with the rate of sweating.

It has been suggested that, in fact, ammonia is also of great importance in the ninhydrin process but this has not been positively established.

## **SEBACEOUS GLANDS**

Sebum is the secretion of the sebaceous glands and consists mainly of saturated fats, waxes and squalene. These materials do not oxidize or hydrolyse as rapidly as the unsaturated fatty acids.

There are no sebaceous glands on the friction ridge surfaces of the hands and feet. Sebum is, however, usually found there as a result of transfer from other parts of the body, such as

touching the face or arms, where the material is plentiful.

The concentration of sebum will vary from person to person and from time to time in the same person. It is one of the materials to which fingerprint powders adhere, and is also one of the materials with which the iodine fuming and physical developer processes react.

The speed at which sebum oxidizes will vary in relation to temperature, air movement and other environmental conditions. The length of time during which sebum will be useful for latent fingerprint development will also depend on the development technique chosen. It will be relatively short in the case of powders and iodine, much longer in the case of physical developer.

## Foreign Materials

The variety of foreign materials that might be found in a latent fingerprint deposit is virtually unlimited. The actual composition obviously depends on what the person has handled prior to the deposit of the impression. While it would be impossible to list them all, a few of the more likely materials can be mentioned.

- oily or greasy hair dressing.
- motor oil or grease.
- grease or dirt picked up from a window during a restaurant or service station break and enter.
- bodily secretions picked up during a sexual assault.
- grease from pizza, hamburger, french fries or other foods.

The list is endless, but a careful analysis of the details of the offence may suggest that a particular material may have been picked up on the fingers of the culprit. This in turn may suggestate which specific development technique might be most successful.

## Summary

- the various glands are controlled by the autonomic nervous system
- the individual cannot consciously affect the composition of the secretions
- the organic and inorganic substances in sweat will vary considerably in their concentration

- greatest concentrations will be found in the sweat of a person who is under stress and who is in a phase of temporary sweating as a result of that stress
- lowest concentrations will be found in the sweat of a person who is sweating continuously and profusely as a result of physical activity and/or climatic conditions
- quantity and type of secretion is affected by diet

### **CONCLUSION**

- except in unusual circumstances a Scenes of Crime or Forensic Identification Officer will rarely, if ever, know the exact composition of the latent impression which is being developed.
- neither is there any way of accounting for many of the other variables, such as amount of secretion; pressure and length of contact; temperature; humidity; air flow, reaction with the specific substrate etc.
- it can be stated as a general rule that the chance of successfully developing a fingerprint varies inversely with the time which has elapsed since it was deposited.
- in the case of anticipated powder development this rule holds because of deterioration of the secretions.
- with other types of development methods the rule still holds because of the increased possibility of damage through handling of the exhibit, accidental or otherwise, with the passage of time.
- it is, therefore, essential to attend scenes of crime as soon as possible after the event. Leaving it until the next day may make the difference between success and failure.