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A Gateway to All Post Graduate Courses

1. Learning Outcomes

After studying this module, you shall be able to

- Know the various kinds of fingerprints.
- Identify different types of fingerprint patterns.
- Know the various ridge characteristics in a fingerprint.
- Identify different ridge characteristics in a given print.

2. Introduction

Look at the tips of your fingers. You could see the innumerable lines, criss-crossing and making spherical shapes. These lines are commonly referred to as ridges and their pattern makes a ‘fingerprint'. Fingerprints are an impression or mark made on a surface by a person's fingertip. The study of finger impressions is referred to as Dactyloscopy. Dactyloscopy originates through the Greek words *'daktylos'* signifying finger and *'skopein'* to examine.

Fingerprints are the most widely used human characteristics for the identification of an individual. Although loops, whorls, and arches, together with deltas and cores, provide an effective means for classification of fingerprints, but the identification of the impression depends on the finer aspects confined in ridge patterns. The area of the hand i.e., palm and the area of the feet i.e., sole are enclosed within two entirely different classes of marks. The least noticeable marks, but the most abundant by far, are known as ridges. If you see your own hands you will notice that it is superficially covered with tiny lines commonly referred to as ‘ridges'.

Ridges enclose entirely palms and fingers of your hand and the soles of your feet and toes. They are known as ‘Friction Ridge Skin' as skin on these area of the body is different from that covering the rest of your body. It mainly helps us to grip things. We will observe that the ridges form patterns, substantial in magnitude and of an inquisitive diversity of shapes, whose margins can be definitely outlined, and which are little worlds in themselves. They have the unique virtue of retaining all their peculiarities unchanged throughout life, and offer in consequence an incomparably unquestionable criterion of distinctiveness than any other bodily feature. You already know that ridges and valleys make a fingerprint pattern in a manner that valleys are placed in between the ridges. In this module, you shall learn about the different types of ridge characteristics, which are referred to as minutae. The ridges once established do not change with age and are totally unaffected by the environment.

These features are present in the friction skin ridges, which leave behind impressions of its shape when it comes into contact with an object. The impressions from the distal phalanges are called as fingerprints. The ridge characteristics serve to individualize a person.

The science of friction ridge skin inspection, which is grounded on the premise that the arrangement of friction ridges is unique, and therefore can be individualized to a single source of origin, began as an observation more than three hundred years ago. Fingerprints have been used for forensic identification purposes, due to features within their patterns called ridge characteristics or minutiae.

3. Fingerprints

Fingerprints are the suggestions of an impression from the friction ridges of any part of a human hand. Though it is true that each fingerprint is different from the other, yet it is also true that all fingerprints have common characteristics among themselves. These common characteristics are what make fingerprint classification possible. The fingerprints may be categorized into three general pattern types: - arches, Loops and Whorls. The common characteristics that make up these patterns are known as pattern area, type lines, delta and core.

Pattern area is a part of a loop or a whorl where appears the core, deltas and ridges that are primarily responsible for classifying fingerprints. It exists in all patterns but in most arches, it is indefinable. Type lines enclose the pattern areas of loops and whorls.

Type lines are the ridges that determine the pattern area of loops and whorls. The arches lack presence of type lines. These may be well-defined as the two inner most ridges starting parallel or run parallel to each other then, diverge and tend to covers the Pattern Area. They do not form two continuous ridges. Infact, they are frequently seen to split apart.

Delta is formed when a ridge bifurcates and two arms of the bifurcating ridge diverge or when two adjacent ridges running side by side diverge causing an interspace within which the pattern lies.

Core is the central point of the pattern. The core is approximately the center of the finger impression.

Type Lines

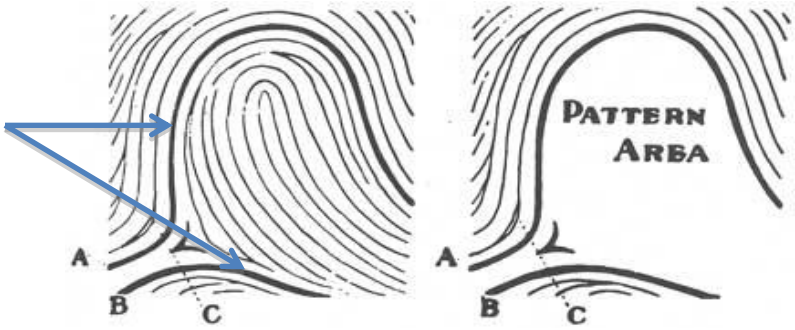
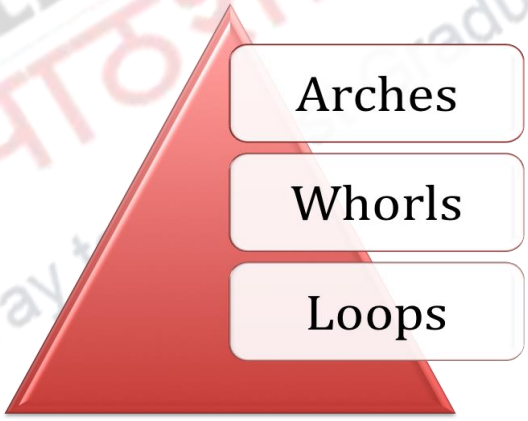


Fig 1: Type Lines and Pattern Area

4. Types of Fingerprint Patterns

Fingerprint patterns are determined by the arrangement of the ridges present on the distal phalange of the finger. There are three basic pattern types, which are as follows:



Basic Pattern	Pattern type	Symbol
Arch	Plain Arch	**A**
	Tented Arch	**T**
Loop	Radial Loop	**R**
	Ulnar Loop	**U**
Whorl	Plain Whorl	**W**
	Central Pocket Loop	**C**
	Double Loops	**S**
	Accidental	**X**

Arch

Arches are found in about 5% of fingerprint patterns encountered. In arches, the ridges of the finger run continuous from one side of the finger to the other with no re-curving. It is imperative to state that the Arches show absence of the any above-discussed patterns i.e. Type Lines, Deltas or Cores. There are two sub-groups within the arch pattern:

A. Plain Arch---this pattern has a steady flow of ridges. It begins from the one side of the finger, and then the ridge flows upward marginally, almost like a wave. The plain arch then continues its trip along the finger to the other side.

Fig 2: Plain Arch Pattern

B. Tented Arch---this pattern is similar to the plain arch (see in figure 2), it begins on one side of the finger and glides out in a similar manner to the other side. However, the dissimilarity lies in the ridges. In a plain arch, the ridges are continuous while in tented arch these are not. The ridges, which connect each other in the center, meet and thrust upward, giving the imprint the shape of a tent.

Fig 3: Tented Arch Pattern

Loops

The most common of the three general patterns are Loops. The frequency of occurrence of such patterns is 60-65%. A Loop is a type of pattern in which one or more ridges enter either side, recurve, touch or pass an imaginary line between delta and core, and tend to exit from the same side as the ridge entry.

The imprint on the fingerprint card is similar to the opposite image that we see when we look in the mirror at ourselves. Loop pattern has got two focal points: a) Delta and b) Core. Henry has identified two categories in this group:

C. Radial Loop---these are loops that drift towards the radius bone of the hand or, in other words, when the downward slope/ opening of the loop is from the direction of the little finger toward the thumb of the hand (see in figure 4), it is referred to as a Radial Loop.

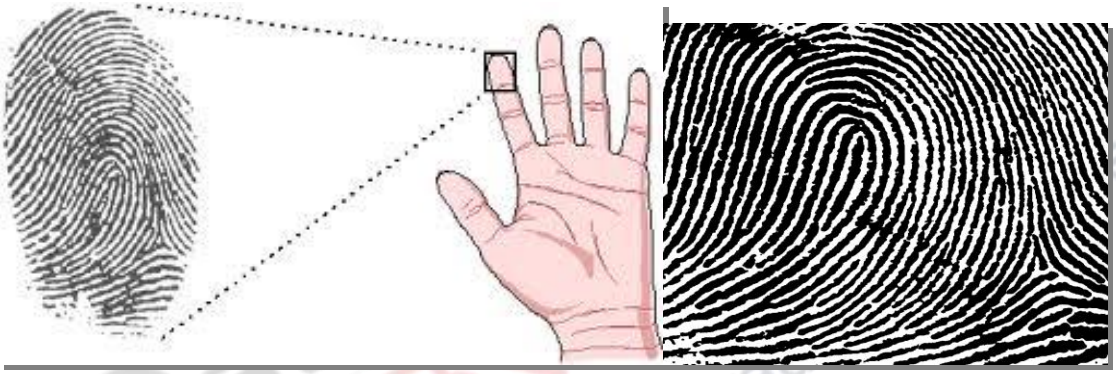


Fig 4: Showing Radial Loop Pattern

D. Ulnar Loop--- are loop pattern that stream towards the ulnar bone of the hand or, when the descending slope/ opening of the loop is from the direction of the thumb toward the little finger of the hand (see in figure 5), it is denoted to as Ulnar Loop.

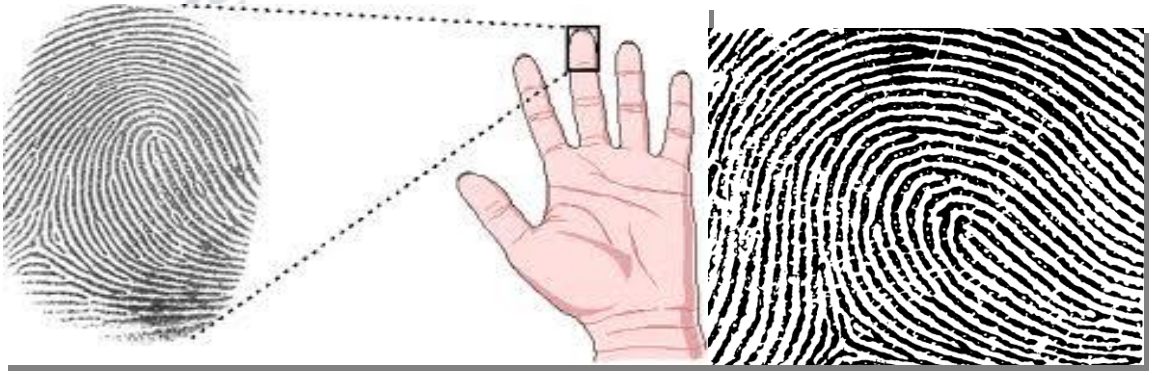


Fig 5: Showing Ulnar Loop

Whorls

The second most common of the three general patterns are whorls. The existence rate of such pattern is 30-35%.
In whorls, generally have more than two deltas (delta is the first ridge adjacent to the divergence point of two type lines) and there exists a recurve before reaching each delta. There are four sub-categories of whorls:

E. Plain Whorl--- A plain whorl pattern possesses type lines and at least two deltas. It also has at least one ridge that makes a complete trip. This ridge may be in the form of a spiral, oval, circle or variant of a circle. The plain whorl is the most common form of whorl and the mostly found. For a pattern to be a true Whorl, it must be composed of two deltas comprising of recurve in each front.

Fig 6: Plain Whorl Pattern

To help discern whether a pattern has two deltas and might therefore be a plain whorl, if they are joining it indicates plain whorl, draw a hypothetical line joining the two deltas along any one of the spiral ridges inside the delta nearest to the core.

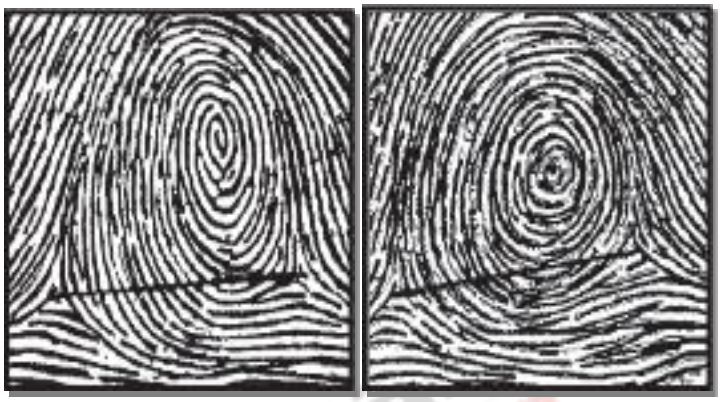


Fig 7: Imaginary line drawn between two deltas

F. Central Pocket Loop --- in these whorls, one or more of the simple recurves of the plain whorl recurves a second time.

Fig 8: Central pocket loop pattern

An illusory line can be drawn amongst the two Deltas and does not cross or touch a ridge inside the type lines. One delta appears to be significantly adjacent to the center of the pattern than the other delta.

Fig 9: Imaginary line drawn joining two deltas in a central pocket loop

G. Double Loop--- A Double Loop pattern, as the name denotes, is made up of two loops joint into one fingerprint. It comprises of two separate loop developments with two individual and different groups of shoulders and two deltas.

Fig 10: Double loop pattern- lateral pocket loop

Fig 11: Double loop pattern – twinned loop

H. Accidental --- These are certain composite pattern inside the whorl group as they arise infrequently and their existence is purely by chance or by accident. In these, the combination of the pattern is derived from two diverse kinds of forms with at least two deltas. Accidental whorls can follow in some of the arrangements given below:

I.

- Loop and a whorl
- Loop and a tented arch
- Loop and central pocket loop
- Double loop and central pocket loop

Accidental whorls are very rare and unique and occur with a frequency of only one to three percent. The fingerprints depicted in figure 9 are an example of an accidental whorl because these do not follow to any other definition, pattern or category type.

Fig 12: Accidental pattern

5. Ridge Characteristics

The palmar surface of the hands as well as the soles of the feet found both in men and monkeys are enclosed with minute ridges that possess a superficial resemblance to those made on sand by wind or flowing water.

The ridges are subject to certain breaks or interruptions presenting various kinds of characteristics referred to as minutiae. These minutiae are able to describe the invariant and discriminatory details and are helpful to identify fingerprints**.** The friction ridges have certain basic features, which are present in sufficient number in every fingerprint. A single fingerprint may possess as many as 100 or more minutiae on a fingertip as depicted in Figure 13 below.

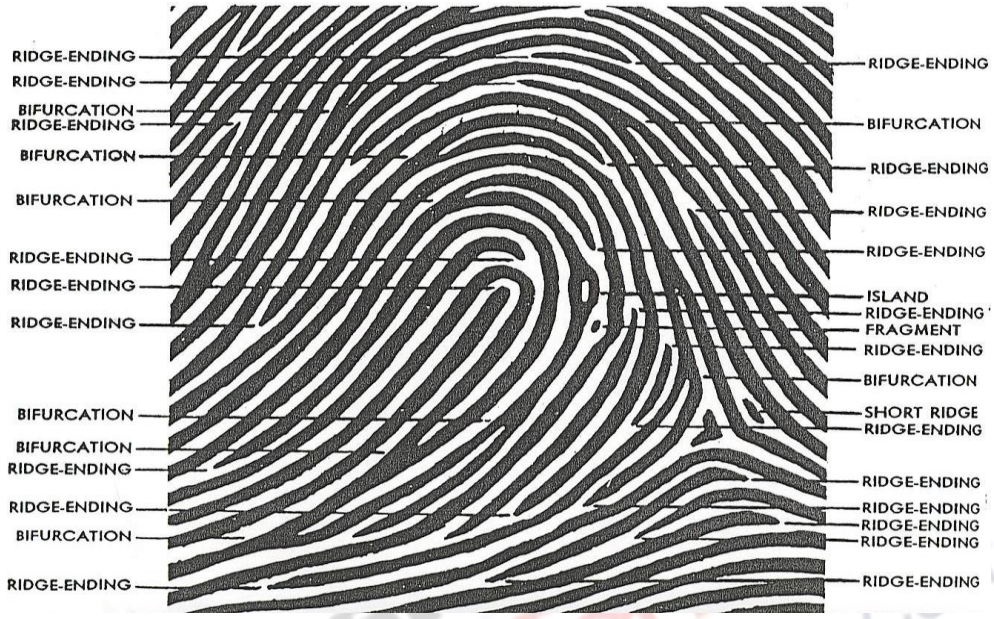


Fig: 13 Various ridge characteristics

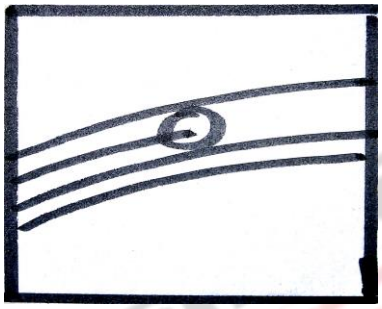
These minutae can be easily identified based on their shape or appearance. Each and every fingerprint comprises these ridge characteristics, though it is their sequence that makes a fingerprint unique. They are also sometimes referred to as Galton's details. As Sir Francis Galton was the first one to notice that the ridges on the fingers do not path in line without breaking and he identified numerous ridge characteristics to support the identification of the fingerprints.

The figure and positions of any particular finger (e.g. the ring finger on the right hand). The ridges on the feet and the minutiae differ from finger to finger in any particular person, and from person to person for toes are less complex than those on the hands and digits, and are less helpful for purpose of identification.

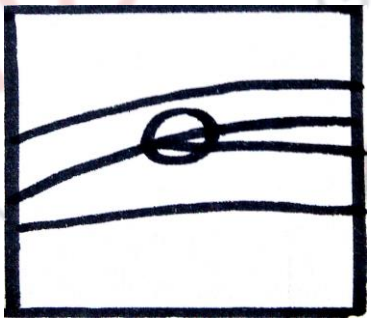
6. Types of Ridge Characteristics

Following are the main types of ridge characteristics or minutae:

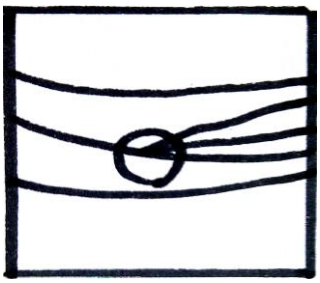
6.1 Ridge ending: This is a ridge, which abruptly ends its path. They occur very abundantly in a finger impression.



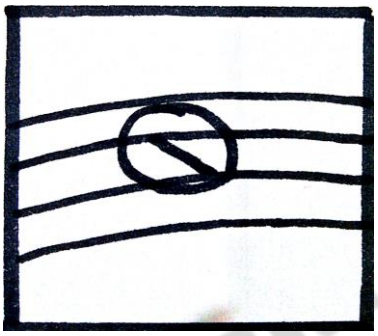
6.2 Bifurcation: It is a ridge, which splits into two small ridges forming a Y shape. It is also known as diverging fork. They give an appearance of branch points between curved lines. These are also encountered very frequently in a fingerprint.



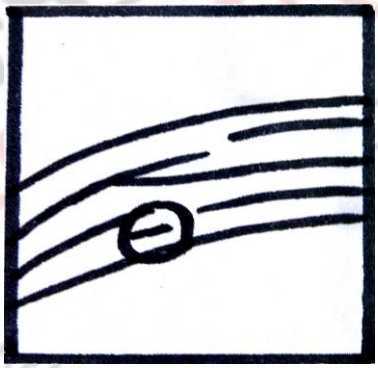
6.3 Trifurcation: It is a ridge, which splits into three small ridges. It is rare in occurrence.



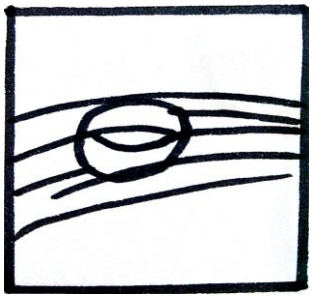
6.4 Interjunction: It is the joining of two adjacent ridges by a short diagonal ridge. It is also called a crossover.



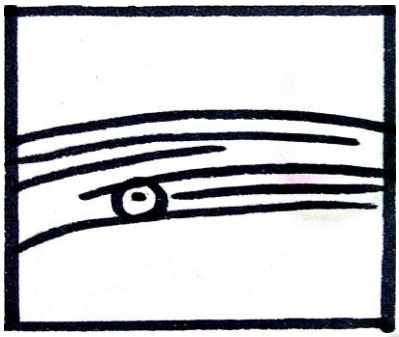
6.5 Fragment/ Short Ridge: It is an independent ridge of relatively small length.



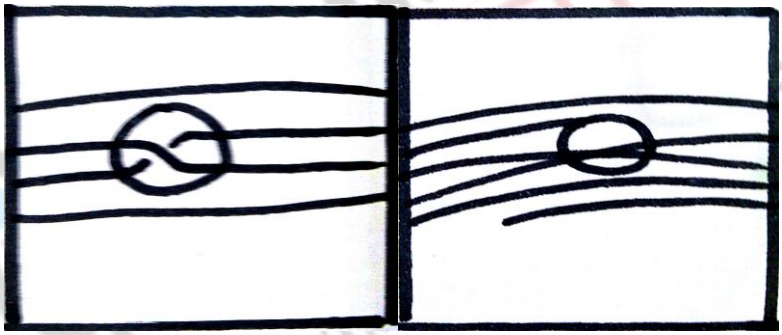
6.6 Enclosure/Lake: It is a ridge, which first bifurcates and then converges or joins back to form an elliptical enclosure. It is also called as lake. It can vary in size.



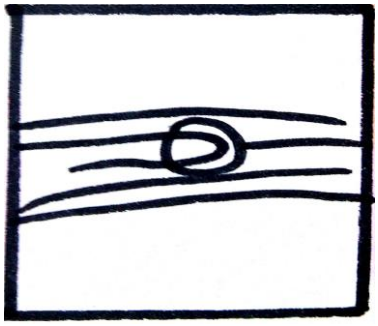
6.7 Island: It is a point or a dot within the overall pattern of a fingerprint.



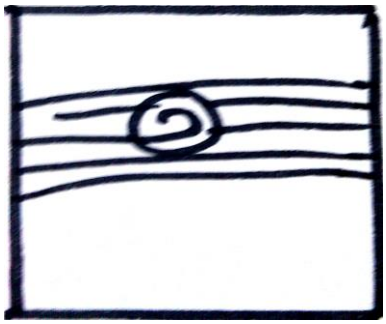
6.8 Intersection /Change Over: It is formed when two adjacent ridges change their places by crossing over each other.



6.9 Return: It is a ridge that changes its path and takes a U-turn.



6.10 Hook/ Spur: When a small curved ridge, which is attached to main ridge forms a hook or spur like appearance.



7. Formation of Ridges

The embryological progress of the ridges has been considered extensively by Dr. A. Kollmann. He conceived the ridges to be shaped through adjacent pressures between nascent structures.

The ridges become noticeable in the third month of fetal life, and are fully developed by the sixth. In children and babies the fragility of the ridges is proportional to the compactness of their stature. They develop concurrently with the overall development of the body, and remain to be sharply distinct until old age has set in, when an incipient disintegration of the texture of the skin spoils, and may largely obliterate them.

Ridges grow mostly in hands which do a reasonable quantity of work, and they are strongly developed in the foot, which has the capacity of supporting the load of the body. They are faintly developed in the hands of ladies due to manual labour.

They are obliterated on the hands of laborers and artistes due to pressure of their tools. Severe injuries tend to destroy the ridges. Minor injuries do not cause permanent damage. A deep cut leaves a scar with puckering on all sides, making the ridges at that part undecipherable, even if it does not wholly obliterate them.

8. Summary

- Fingerprints are the imprint of friction skin ridges present on fingers and thumbs.
- Fingerprint patterns can be classified into three basic types that occur in different frequency: loops (60–65%), whorls (30–35%), and arches (5%).
- Arches shows absence of type lines, deltas or cores, whereas loops have got two focal points: a) Delta and b) Core apart from distinct type lines.
- In whorls pattern types there exists two or more deltas.
- Double loop whorls and central pocket loop whorls occur with comparable frequency of 13%
- About 70% of the whorls are plain whorls, while only 3% are accidental whorls.
- Ridge characteristics or minutiae are able to capture the invariant and discriminatory information and are used to identify fingerprints.
- There are different types of ridge characteristics, which are as follows: Ridge ending, bifurcation, trifurcation, interjunction, fragment/short ridge, enclosure/lake, island, intersection/ change over, return, hook/spur.
- The individuality of any fingerprint is based not upon the general shape or pattern that it forms, but instead upon its ridge structure and its specific characteristics (also known as minutiae).
- Of all these minutae, ridge endings and bifurcations occurs most frequently in a fingerprint. The ridges are said to be first discernible in the third month of fetal life, and fully formed by the sixth.
- The number and locations of the minutiae vary from finger to finger in any particular person, and from person to person for any particular finger.