CHAPTER 1: INTRODUCTION

A fingerprint is an impression left by the friction ridges of a human finger. Human fingerprints are detailed, unique, difficult to alter and durable over the life of an individual, making them suitable as long-term markers of human identity. Fingerprints composed of ridges and furrows, are one of the dermatoglyphic traits that can be used for identification of an individual. The formation of the ridges is governed by a multitude of genes and the environment of the embryo during its first month of development or the contents of the amniotic fluid. Once created, the ridges do not transform anymore throughout the lifetime except in case of injury. Although the ridge number in a fingerprint is not age-dependent the ridges grow further apart with an increasing age as the body size increases.

Each ridge of the epidermis (outer skin) is dotted with sweat pores for its entire length and is connected to the dermis (inner skin). The epidermis consists of several layers. Basically, the outer layer is dead skin while the inner layer is the generating layer. The dermis contains blood vessels and is feeding the generating layer with nutrients. The dermis is covered with double rows of peg-like formations called papillae. A human foetus starts forming ridge patterns, which follow a genetic master plan of placement of the papillae. Identical twins have the greatest chance of having the same genetic variations and to have the same papillae formations. Sometimes they are similar but just as often they are not.

In even a small area of the skin there are hundreds of papillae or ridge units, distinguished by pores in the outer skin. During foetal life, the individual ridge units start to develop and grow randomly. As they grow they start fusing together. The plethora of genetic and physical variables affecting the ridge formation is the reason that no two fingerprints are the same.

The ridges formed by the papillae are commonly referred to as papillary ridges or friction ridges. At about the fourth month of foetal life, differentiation begins and by the seventh month the ridge pattern is fully formed. Once formed, the ridge pattern never changes. Injuries such as superficial burns, abrasion, or cuts do not affect the ridge structure, and the original pattern is duplicated as new skin grows. However, an injury that destroys the dermal papillae will permanently obliterate the ridges.

Functions of ridges:

- They strengthen the dermal structure and resist wear and tear of skin.
- They help in the process of evaporation by keeping the sweat pores open.
- They help in the sense of touch.
- They provide elasticity and prevent from slipping.
- They are the basis of an individual identification.

The lines on a fingerprint represents the ridges of the skin and the where spaces in between are called furrows.

Friction ridge patterns are grouped into three distinct types – Arches, Loops and Whorls – each with unique variations, depending on the shape and relationship of the ridges. Arches occur in about 5% of the encountered fingerprints. The ridges of the finger run continuously from one side of the finger to the other and make no backward turn. Normally, there is no delta in an arch pattern but if it exists, there must be no re- curving ridge that intervenes between the core and delta points. Loops can be seen in almost 60 to 70% of the fingerprints that are encountered. The ridges make a backward turn in loops, but they do not twist. This backward turn or loop is distinguished by how the loop flows on the hand and not by how the loop flows on the hand and not by how the loop flows on the card where the imprint is taken. This imprint on the fingerprint is similar to the reverse image that we when we look at ourselves in the mirror. A loop pattern has only one delta. Whorls are seen in about 25 – 35 % of fingerprint patterns encountered. In a whorl, some of the ridges make a turn through at least one circuit. Any fingerprint pattern which contains 2 or more deltas will be a whorl pattern.

<u>ARCH PATTERN</u>:

Fig:1.1 Plain arch

Fig:1.2 Tented arch

LOOP PATTERN:

Fig:1.3 Radial loop

Fig:1.4 Ulnar loop

WHORL PATTERN:

Fig:1.5 Plain Whorl

Fig:1.6 Central Pocket Loop

Fig 1.7 Double Loop

A Scottish doctor by the name of Henry Faulds was a contemporary of Hershel, albeit a sworn enemy, as both men tried to solidify their place in history by claiming each were the “Father of Fingerprinting”. Faulds body of work was impressive and valuable. While working in a hospital in Tokyo, Japan, in 1874, Faulds kept records of fingerprints and concluded that fingerprint patterns were unchangeable and immutable and that the technique of rendering a set of fingerprints could best be done with printer's ink on a smooth board. Faulds was also able to lift a fingerprint from a bottle of whiskey and thus received credit for the first identification of a fingerprint.

Fingerprints can be collected by both physical as well as chemical methods. Physical method includes powdering by dusting a smooth or nonporous surface with fingerprint powder. Fingerprints often is leave residues of oils in the shape of the friction ridges, but the friction ridge skin itself does not secrete oils, and so some fingerprints will only leave a residue of amino acids and other compounds which the powder does not adhere so well. Powders having colours white, grey or black are used for almost any surface that may be encountered. White powders work especially well on glass, chromated metals, plastic bags and dark coloured surfaces. White powder generally consists of Titanium Oxide powder and an earth powder for base. The Titanium adheres well to the oils of the print and provides an excellent contrast to most surfaces it is used on, whether it is conventional or magnetic, or used on porous or non-porous surfaces. Grey powder performs best on glass, plastic and rubber. The aluminium component of the powder adheres to prints on non-traditional surfaces and provides good contrast to the background surface. Black powder is manufactured from a variety of carbon-based powders with a binder or earth powder added for stability. This staple of fingerprint powders readily adheres to the oily residues from the fingers and other body parts and is the most versatile of the fingerprint powders in that it can be applied to many surface types: porous and non-porous alike.

Chemical methods include iodine fuming, silver nitrate or ninhydrin. When one of these chemicals comes into contacts with the chemicals present in the fingerprint residue, the print become visual. Iodine fuming takes place in a fuming chamber. The process works by heating up solid crystal iodine which creates vapours that adhere to the oily residue of print, producing a brown coloured print. One of the drawbacks of using iodine fuming is that the print fades quickly after the fuming takes place and therefore must be photographed quickly. Alternatively, if the print is sprayed with a starch and water solution, it can be preserved for several weeks. Silver nitrate, when exposed to latent prints, reacts with the chloride of the salt molecules found in print residue, forming silver chloride. When exposed to ultraviolet lights, silver chloride turns black or brown, making the print visible. This method works particularly well on impressions left in cardboard and paper. Ninhydrin is more commonly used than iodine fuming and silver nitrate techniques to locate a latent print. The object on which the print is located can be dipped in or sprayed with a ninhydrin solution, which reacts with the oils in the print's residue to create a bluish print. One of the drawbacks of using ninhydrin is that the reaction is very slow, often taking several hours for the print to become visible. To accelerate the reaction, the object containing the print can be heated to 80 to 100 degrees Fahrenheit.

There are three types of fingerprints that can be found; Latent, Patent and Plastic. Latent fingerprints are made of the sweat and oil on the skin's surface. This type of fingerprint is invisible to the naked eye and requires additional processing in order to be seen. This processing can include basic powder techniques or the use of chemicals. Patent fingerprints can be made by blood, grease, ink, or dirt. This type of fingerprint is easily visible to the human eye. Plastic fingerprints are three – dimensional impressions and can be made by pressing your fingers in fresh paint, wax, soap, or tar. Like patent fingerprints, plastic fingerprints are easily seen by the human eye and do not require additional processing for visibility purposes.

Fig:1.8 LATENT PRINT

Fig:1.9 PATENT PRINT

Fig:1.10 PLASTIC PRINT

Sir Edward Richard Henry introduced the classification of fingerprints in 1896. Fingers on each hand are given an identifying number. Starting with the right thumb, fingers on the right hand are numbered from 1 to 5. On the left hand, starting from the thumb, they are numbered 6 to 10. There are five classification system. In primary classification, each finger has a definite numerical value when a whorl type pattern is present. The total of these values makes up the primary. The numerator is made up of the total sum of the values present in the even numbered fingers plus one. The denominator is made up of the total sum of the values present in the odd numbered fingers plus one. The secondary classification is composed of the pattern types in the index fingers. The number two finger is used as the numerator and the number seven finger is used as the denominator. The sub secondary classification is taken from fingers 2,3,4 (numerator) and 7,8,9 (denominator). Definite values are assigned to the ridge counts in these fingers. Whorl tracing are brought up as part of the sub secondary. The major classification is taken from the thumbs. Number 6 finger has only one set of values as loop; it is always constant. Number 1 finger has two sets of values as loop. Number 6 finger is used as the denominator. Number 1 finger is used as the numerator. In a combination of loop and whorl, the first set of values is always used for the number one finger. If whorls are present in both thumbs, the tracing are used. The final is taken from number 5 finger if number 5 is a loop, either ulnar or radial. If number is not a loop, the final is taken from the number 10 finger. If neither 5 or 10 is a loop, there is no final, with some exceptions. If whorls are present in all fingers, the whorl in number five finger is counted and brought up as a final. When counting whorls, always count as if they were ulnar loops. A whorl in the right hand is counted from the left delta to core. In the left hand, count from right delta to core. When counting double loops, a horizontal double loop is counted from the left delta to the nearest core. A vertical double loop is counted from left delta to the upright loop.

Fingerprints are one of the potential evidences that can be collected from the crime scene which helps in personal identification. But this is possible only when we get the whole fingerprints. We can't go for individual identification in case of partial fingerprints. But also, we can determine the sex even with partial fingerprints by using ridge density. In general, the purpose of collecting fingerprints is to identify an individual. This person may be a suspect, a victim, or a witness.

As fingerprints are the trusted means of person identification, there are many features which have been studied in fingerprints such as ridge count, ridge orientation etc. in relation to various factors of human population. Sex is one such factor. Sex of an individual can be determined by the examination of epidermal ridges.

Although, there has already been much research on the differences between sexes in fingerprint ridge density and its variability in Indian population. Such studies have not included people from Kerala state. In this study, potential of ridge density will be explored for gender identification within wide age groups ranging from 20-70 from Sreekayam town, Thiruvananthapuram district, Kerala.

CHAPTER 2: LITERATURE REVIEW

2.1 The study was undertaken by Nayak.et.al (2009) to study the gender differences in fingerprint ridge density in Chinese and Malaysian population. The study done on 200 subjects (100 male and 100 female) of Chinese origin and 100 subjects (50 males and 50 females) of Malaysian origin revealed that significant gender differences occur in the finger ridge density. Fingerprint mean ridge density of 12 ridges/ 25millimetre square or less is found to be more likely to be of male and mean ridge count of more the 13 ridges/ 25millimetre square is more likely of female origin in Chinese subjects. Fingerprint mean ridge density of 11 ridges/ 25millimetre square or less is found to be more likely to be males and a mean ridge count of more the 13 ridges/ 25millimetre square is more likely of female origin in Malaysian subjects.

2.2 Acree (1999) conducted a study to determine if women have significantly higher ridge density, hence finer epidermal ridge detail, than men by counting ridges that occur within a well-defined space, the study focused on 400 randomly picked 10 print cards representing 400 subjects. The demographic composition of this sample population represented 100 Caucasian males, 100 African American males,100 Caucasian females and 100 African American females all within the age range of 16 to 67. Results showed that women tend to have a significantly higher ridge density than men and that this trend is upheld in subjects of both Caucasian and African American descent ($F=61.96$, $P<0.001$). Application of Bayes' theorem suggested that a given fingerprint possessing a ridge density of 11 ridges/ 25millimetre square or less is most likely to be of male origin. Likewise, a fingerprint having a ridge density of 12 ridges/ 25millimetre square or greater is most likely to be of female origin, regardless of race.

2.3 Gangandeep Singh (2012) carried out research with an aim to examine ridge density differences in to Northern Indian populations (Khatri and Bania). In this study it has been found that 92% of Khatri females have a mean ridge density above 13, whereas 75% of Khatri males have (a mean ridge density) below 13, while in

Bania, 100% of females have mean ridge density above 14 and 80% of males below 14. The study suggests that there are significant differences in epidermal ridge density between males and females within each of the two populations and also significant differences between the two populations.

2.4 Kumar.et.al (2013) conducted this study with an aim to establish a relationship between sex and fingerprint ridge density in Uttarakhand. The fingerprints were taken from 250 subjects (125 males and 125 females) in the age group of 18 to 60 years. After taking fingerprints, the ridges were counted in the upper portion of the radial border of each print for all 10 fingers and mean value was calculated. The results have shown that a fingerprint ridge of < 12 ridges/25millimetre square are more likely of male origin and fingerprint ridge of > 14 ridges/25millimetre square are more likely of female origin. The study suggests that there are significant differences in epidermal ridge density between males and females and also support the hypothesis that women tend to have a statistically significant greater ridge density than men.

2.5 Chauhan.et.al (2015) conducted study on 60 samples including 30 male and 30 females aging from 18 to 55 years were taken from the population of Uttar Pradesh, North part of India. After the successful development of latent palm print on documents, the ridge densities were taken from 25millimetre square diameter. As the denouement, the procured mean ridge densities, if ≤ 11 ridges/25millimetre square or less then is likely to be from male origin, and ≥ 13 ridges/ 25millimetre square or more than that is likely to be from female origin.

2.6 Abdulla.et.al (2015) conducted this study to test the truth of the relationship between the fingerprint ridge densities and the gender of a person born and lives in Malaysia as until now, no work on such study has been reported among the population. The sample of this study consist of 50 participants coming from the age group of 18 to 60-year-old and consist of 25 males and 25 females. The fingerprint images that taken manually will be going through the image preprocessing phase using a MATLAB software before the ridge of the fingerprint from two topological areas, radial and ulnar can be counted and the mean can be calculated. The results have shown that the fingerprint ridges of less than 12 ridges/ 25millimetre square are more likely belong to a male respondent while fingerprint ridges of more than 14 ridges/ 25millimetre square is more likely to be from a female respondent.

2.7 Oktem.et.al (2015) conducted research with an aim to study the fingerprint ridge density in Turkish population sample of Baskent University students. Fingerprints were obtained from 118 women, 88 men a total of 206 students aged between 17 and 28 years old by means of simple inking method. Fingerprints from all right and left hands fingers were collected in three different area of each. The ridges on fingerprints were counted diagonally on squares measuring 5 mm*5 mm on radial, ulnar and inferior areas. The fingerprint ridge density in radial, ulnar and inferior areas and between sexes was compared statistically Mann Whitney U test and Friedman test. The ridge density was significantly greater in women in every region studied and, in all fingers, when compared to man. The fingerprint ridge density in the ulnar and radial areas of the fingerprints was significantly greater than the lower area.

2.8 Redomero.et.al (2013) conducted this study to determine the topological and sexual differences in fingerprint ridge density (RD) in native subjects from two samples of Northwest Argentina (Jujuy province) living at different altitudes. The results were compared with those obtained from a Spanish population sample. The study was based on data from all 10 fingerprints of 393 adult Argentinian men and women, 193 from the Puna- Quebrada region (more than 2500metre above the sea level) and 200 from Ramal (500metre above sea level). Ridge density was assessed for three different areas (radial, ulnar and proximal) for all 10 fingers of each subject. In both samples, significant differences between areas were obtained, so radial RD> ulnar RD > proximal RD. No significant differences were found between samples in males, while females from both samples significantly differed in the radial and proximal areas. Females have higher RD, so narrower ridges, than men, in all areas and all fingers.

2.9 Kapoor et.al (2014) conducted this study to determine if any significant difference in the thumb print ridge density of males and females in a central Indian

(Marathi) population to enable the determination of gender. The study was conducted on 200 subjects (100 males and 100 females) in the age group of 18 to 30 years. Ridge densities on the right- and left-hand thumbprints were determined using a newly designed layout and analyzed statistically. The results showed that females tend to have a higher thumbprint ridge density in both the areas examined, individually and combined. Applying the t- test, the differences in the males and females at LoC (Left of Centre), RoC (Right of Centre) and combined (LoC+ RoC) were found to be statistically significant at $p< 0.01$ levels, proving the association between gender and fingerprint ridge density. Probability densities for men and women derived from the frequency distribution (at LoC, RoC and Combined) were used to calculate the likelihood ratio and posterior probabilities of gender designation for the given ridge count for subjects using Bayes' theorem.

2.10 Sam.et.al (2014) carried out research with an aim to study the possibility of differentiation of gender using fingerprint ridge density. The study was conducted on 100 males and 100 females of South Indian population, aged between 18 and 81 years. For calculating the fingerprint ridge density, the upper portion of the radial border of each print was chosen and the epidermal ridges in a defined area counted. Results showed that women have a significantly higher fingerprint ridge density than male. Application of Bayes' theorem suggests that a fingerprint having ridge density of < 14/25millimetre square is more likely to be that of a male, and one having ridge density of > 14/25millimetre square is more likely to be that of a female.

2.11 Krishnan.et.al (2014) conducted research with an a to study the variability of palmprint ridge density in a North Indian population, and its significance in inference of sex in forensic examinations. The sample consisted of 157 healthy young adults (110 females and 47 males) from Shimla city in North India. Bilateral palmprints were taken from all the participants following standard methods. The palmprints were manually analyzed in four defined areas of each palmprint that included the central prominent part of the thenar eminence (P1), the mount distal to the axial triradius on the hypothenar region(P2), the mount proximal to the triradius of the second digit (P3) and the mount proximal to the triradius of the fifth digit(P4).

The ridge density was calculated diagonally using a square measuring 5mm*5mm. The sex differences in palm print ridge densities were statistically analyzed for each of the designated areas using statistical considerations

2.12 Richard Jonathan O. Taduran conducted research on sex Determination from Fingerprint Ridge Density and white line counts in Filipinos. This study derived Filipino- specific probability formulae from fingerprints to be used for sex discrimination in human identification cases. Ridge density from three different areas – distal radial area, distal ulnar area, and proximal area – as well as white line counts from fingerprints of 200 male and 200 female Filipinos were collected and analyzed statistically. Ridge densities of radial and ulnar areas emerged as displaying significant differences between the sexes, with 16 ridges/ 25millimetre square or more in radial area and 15 ridges/ 25millimetre square or more in ulnar area being more likely to be female, whereas 13 ridges/ 25millimetre square or less in radial area and 12 ridges/ 25 millimeter square or less in ulnar area were more likely to be male.

CHAPTER 3: AIM AND OBJECTIVE

AIM:

To determine the sex from Fingerprint using ridge density in Thiruvananthapuram district, Kerala.

OBJECTIVE:

- To compare the Fingerprint Ridge Density between male and female.

CHAPTER 4: MATERIALS AND METHODOLOGY

MATERIALS:

1. Fingerprint samples
2. OHP sheet
3. White fingerprint powder
4. Fingerprint brush
5. Cello tape
6. Marker (Rorito)
7. Fingerprint magnifiers (Technomaxx)

Fig:4.1- FINGERPRINT MAGNIFIER

METHODOLOGY

For the study, 50 rolled fingerprints (25 from male and 25 from female) were recorded. Rolled Fingerprint impression was taken from nail to nail. For recording the samples, white fingerprint powder was gently applied on the fingers using fingerprint brush. White powder is used for the greatest contrast with a dark coloured surface or background and is often preferred as an alternative to grey powder. Black backing cards should be used to provide a sharp contrast with the resulting ridge detail. After applying powder to the fingerprint, carefully place the piece of tape on top of the fingerprint and press down. It's best to use fingerprints on the flattest surface of the object; it can be difficult to adhere tape to a round or curved area. Peel the piece of tape off the object carefully and look to see if the fingerprint is imprinted on it. If it is, place the piece of tape down onto an OHP sheet and press the tape down flat.

The data or the sample was collected and recorded successfully. Then a database is created for analysis. The samples were collected from the age limit of 20 to 70 years. From the collected 50 samples, male and female fingerprints are separated, because the study is about sex determination by fingerprints. For this study, I have considered only the right thumb of every person as the ridges in thumb were more clearly distributed and thus it is easy to examine.

For analyzing the fingerprints ridge density, take a specific area as a border for counting the ridges within the specified area only. Therefore, a square of $1cm^2$ was drawn over the fingerprint pattern. Then it is divided into four equal parts. The frictional ridges were counted diagonally from the selected area with the help of Fingerprint magnifiers with a magnification of 5X. This methodology was repeated for both male and female. The ridge counts were noted and tabulated. From the tabulated value, a graph is drawn for comparison.

CHAPTER 5: CALCULATION AND OBSERVATION

$$\text{Mean} = \frac{Sum\ of\ observations}{Total\ number\ of\ observations}$$

$$= \frac{left\ upper\ region + right\ upper\ region + left\ lower\ region + right\ lower\ region}{4}$$

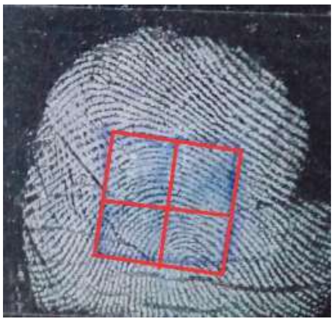
TABLE 1: MEAN RIDGE DENSITY VALUES OF RIGHT THUMB OF MALE:

SAMPLE	AGE	GENDER	LEFT UPPER REGION (LU)	RIGHT UPPER REGION (RU)	LEFT LOWER REGION (LL)	RIGHT LOWER REGION (RL)	MEAN
Sample 1	20	Male	9	10	11	9	10
Sample 2	20	Male	11	10	11	12	11
Sample 3	20	Male	9	12	9	10	10
Sample 4	22	Male	11	10	12	12	11
Sample 5	25	Male	12	11	12	9	11
Sample 6	33	Male	10	9	10	12	10
Sample 7	34	Male	13	10	12	9	11
Sample 8	37	Male	9	9	11	10	10
Sample 9	39	Male	13	11	11	11	11
Sample 10	42	Male	9	11	9	12	10
Sample 11	43	Male	12	12	9	12	11
Sample 12	45	Male	9	10	12	9	10
Sample 13	46	Male	11	9	9	9	10
Sample 14	46	Male	12	10	10	11	11
Sample 15	52	Male	11	12	11	10	11
Sample 16	52	Male	9	11	12	12	11
Sample 17	53	Male	9	11	9	10	10
Sample 18	54	Male	11	10	9	9	10

Sample 19	56	Male	12	10	9	10	10
Sample 20	59	Male	13	9	9	10	10
Sample 21	63	Male	12	12	11	10	11
Sample 22	67	Male	13	9	9	10	10
Sample 23	70	Male	14	9	10	10	11
Sample 24	70	Male	9	10	12	12	11
Sample 25	70	Male	12	13	10	9	11

Fig 5.1: Fingerprint samples of male

SAMPLE 1



SAMPLE 2

SAMPLE 3

SAMPLE 4

SAMPLE 5

SAMPLE 6

SAMPLE 7

SAMPLE 8

SAMPLE 9

SAMPLE 10

TABLE 2: <u>MEAN RIDGE DENSITY VALUES OF RIGHT THUMB OF FEMALE:</u>

SAMPLE	AGE	GENDER	RIGHT UPPER REGION	LEFT UPPER REGION	LEFT LOWER REGION	RIGHT LOWER REGION	MEAN
Sample 1	20	Female	12	11	12	12	12
Sample 2	20	Female	12	12	11	12	12
Sample 3	20	Female	13	11	13	12	12
Sample 4	20	Female	13	12	12	11	12
Sample 5	24	Female	12	13	13	13	13
Sample 6	33	Female	12	12	13	13	12
Sample 7	35	Female	12	13	13	13	13
Sample 8	36	Female	14	14	12	13	13
Sample 9	38	Female	13	12	11	12	12
Sample 10	38	Female	12	11	12	13	12
Sample 11	45	Female	12	12	11	12	12
Sample 12	46	Female	14	12	14	10	13
Sample 13	47	Female	10	14	13	12	12
Sample 14	55	Female	13	13	13	12	13
Sample 15	56	Female	12	11	14	13	13
Sample 16	58	Female	11	12	12	11	12
Sample 17	60	Female	12	13	13	13	13
Sample 18	60	Female	14	10	12	12	12

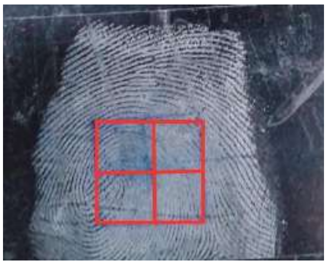
Sample 19	61	Female	13	13	13	14	13
Sample 20	63	Female	10	12	12	13	12
Sample 21	64	Female	13	13	10	11	12
Sample 22	66	Female	10	10	14	13	12
Sample 23	69	Female	12	13	13	10	12
Sample 24	70	Female	13	14	10	11	12
Sample 25	70	Female	14	14	13	12	13

Fig 5.2: Fingerprint samples of female

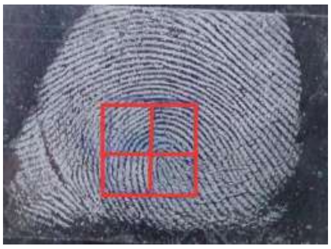
SAMPLE 1

SAMPLE 2

SAMPLE 3



SAMPLE 4



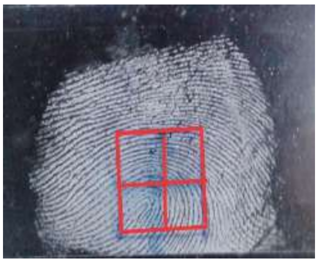
SAMPLE 5

SAMPLE 6

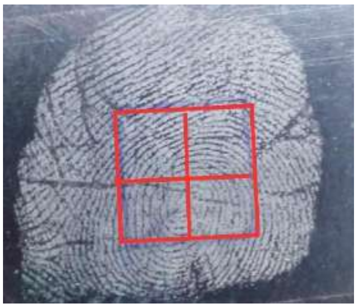
SAMPLE 7

SAMPLE 8

SAMPLE 9



SAMPLE 10

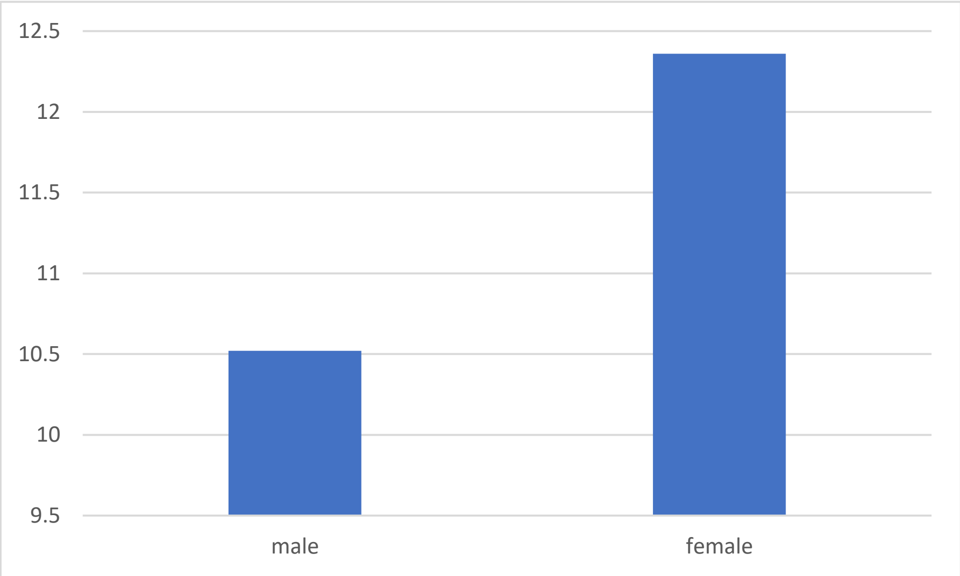


Comparison :

Graph showing variation in ridge densities of Male and Female

Total mean ridge density of Male: 10.52

Total mean ridge density of Female: 12.36



GRAPH 1: COMPARISON GRAPH OF MALE AND FEMALE RIDGE DENSITY

CHAPTER 6: RESULT AND CONCLUSION

RESULT:

Ridge densities of Male ranges between 9 to 14 ridges / 2.5-millimetre square. And ridge densities of Females range from 10 to 14 ridges / 2.5-millimetre square.

Total mean ridge density of *Male* is **10.52** and of *Female* is **12.36**.

CONCLUSION:

The results have shown that fingerprint ridge densities less than 12 ridges/ 1 cm^2 is likely of male and fingerprint ridge densities more than or equal to 12 ridges/ 1 cm^2 is likely of female. From present study, it is revealed that females have comparatively higher ridge density than male.

The study needs to analyse the sex by ridge density from Index Finger, Middle Finger, Ring Finger and Little Finger.

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