Student Worksheet

Double Jointed *continued*

5 Now examine your shoulder joint. This is called a *ball-and-socket joint*. Try moving your arm around the shoulder. How is the motion of the ball-and-socket joint different from the hinge joint?

6 Can you locate any other joints in your body that might be a ball-and-socket joint? List them here:

7 Now we're going to move up to the neck. Move your head around. How many different ways can you move it?

8 Your neck is called a *pivot joint*. Can you find any other pivot joints in your body? List them here:

9 Last but not least, we're going to take a look at the bones of your skull. While it may seem like the skull is one big bone, it's actually many smaller bones that are joined together. The joints between bones of your skull are called *fused joints* because the bones cannot move. Since your skull bones can't move, what do you think their main purpose is?

Think About It

When you were born, you actually started with about 350 bones. But over time, many of these bones fuse together. Why do you think this happens?

Going Further

The Human Machine: Our bodies can really be thought of as a complex machine. You have a computer in your brain, a pump in your heart, photoreceptors in your eyes, and sound detectors in your ears. Nowhere is the human machine more evident than in your skeleton. The bones of your arms and legs are really nothing more than a series of levers with the joints serving as fulcrums. Your shoulder and hip joints are really wheels and axles in action! Compare your skeleton to different simple machines and see how many different connections to the mechanical world we really have!

PROBLEM:

Three weeks ago a local bakery was robbed at gunpoint. The thief wore a mask, so even when the police found a suspect the bakery owner couldn't make a positive ID. However, as the CSI processing the scene, you collected several fingerprints from various parts of the bakery.

The police have identified a suspect, but he says he's never been to that bakery. It's your job to see if the suspect's fingerprints match any of those recovered at the scene of the crime.

ACTIVITY:

Students are first introduced to the three main types of fingerprints: **loops, whorls, and arches.** Using a balloon and a number two pencil, each student will determine the total numbers of loops, whorls, and arches on his or her ten fingers. The teacher can then add the individual totals to determine the total numbers of loop, whorl, and arch fingerprints in the class as a whole. Students should record this information on their worksheets.

The students are then shown a bar graph illustrating the percentage of loop, whorl, and arched fingerprints in the United States population. After answering several questions about his graph, they are prompted to construct a similar bar graph using their classroom percentages for each type of print. The students are then asked a series of questions designed to test their understanding of the activity.

Lastly, students are presented with copies of the suspect's fingerprints and those obtained from the crime scene. The students are instructed on how to identify various **ridge characteristics** (island, ridge ending, bifurcation, etc.). Using the ridge characteristics of the prints, the students should be able to identify which of the prints at the crime scene were left by the suspect—even to the point of which finger they came from. One of the crime scene prints (from the display case) will not match the suspect. This is to be expected in a public crime scene where several people (customers, owner, workers) have been present.

TEACHER NOTES:

ıgerprints have been used for identification throughout history, but it was Sir William Herschel in Jungipoor, India, who first recognized their true potential. He was the first to espouse the theory that all fingerprints are unique to an individual and are permanent throughout a person's lifetime. These principles were later scientifically investigated and promulgated by Sir Fracis Galton, a British anthropologist. A student of his, Juan Vucetich, made the first criminal fingerprint identification in 1892 when he used Francis Rojas bloody fingerprint to convince a jury she had murdered her two sons. Today, we now accept as common fact that 1) all fingerprints are unique, and no two are exactly identical, 2) a fingerprint will remain unchanged during a person's lifetime, and 3) fingerprints have distinct patterns that can be classified and used for comparison.

Fingerprints can be divided into three main types: loops, whorls, and arches. Loops are the most common type of fingerprint; on average 65% of all fingerprints are loops. Approximately 30% of all fingerprints are whorls, and arches only occur about 5% of the time. There are subcategories for each of these. Loops are subdivided into radial loops (the loop enters and exits the finger on the side closest to the thumb) and ulna loops (the loop enters and exits the finger on the side closest to the pinky finger). Arches can be plain (the ridges are flat or only show a slight peak) or tented (sharp, well defined peak). Whorls can be plain, central pocket (elevated, usually smaller whorl pattern), double loop (whorl made of two distinct loop patterns), or accidental (combination of all of the above).

In order to conclusively match individual fingerprints, fingerprint examiners use **ridge characteristics**, also known as minutia. The most common types of ridge characteristics are bifurcations, ridge endings, and islands, though there are several different categories and subcategories for each of these. A single rolled fingerprint may have more than 100 different ridge characteristics. In the United States there in no minimum number of ridge characteristics that must be used to match up two fingerprints (though eight or more is considered "standard" and twelve is "sufficient"). However, the match must be made by one verified fingerprint examiner (usually trained by the International Association for Identification (IAI)) and verified by second verified examiner.

MATERIALS:

- White latex balloons (at least one per student)
- #2 pencils (one per student)

CLASSROOM MANAGEMENT:

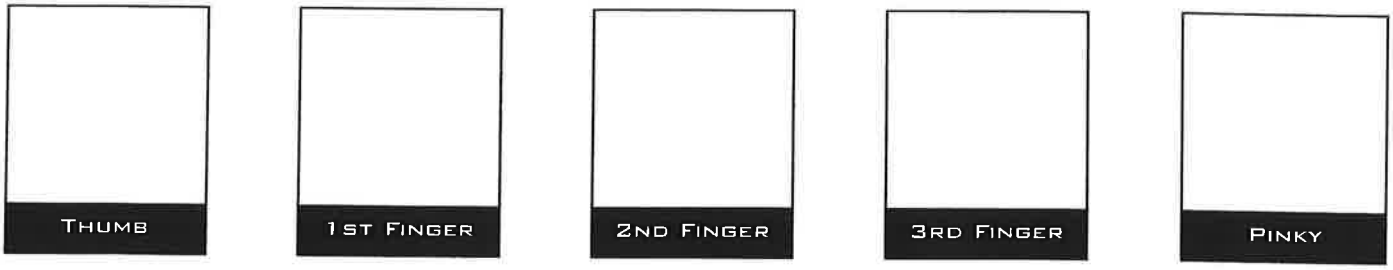
For the most part this activity is designed to be completed individually by each student, though the data from all students will be pooled together during the first part. If desired, students can work together in pairs or small teams. There will be considerable interest in sharing and comparing the fingerprints on the various balloons, especially if certain rare or unique fingerprints are discovered (e.g. arches, double whorls, etc.). These balloons can also be used to discuss why certain fingerprints, which look very similar, are still different and unique. The ridge characteristics should be relatively easy to identify on the expanded balloons.

TEACHER ANSWER KEY

STICKY FINGERS

Part 1: Are some kinds of fingerprints more common than others?

1. Fill in each of these squares using a #2 pencil. Make sure each square is dark and shiny.

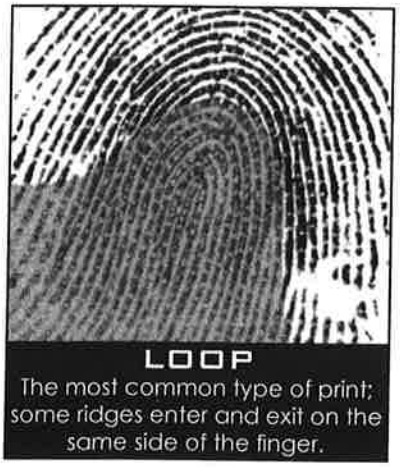


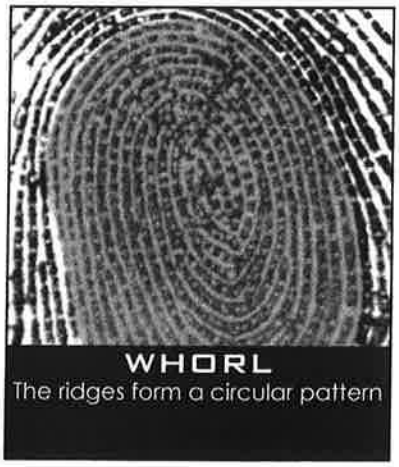
2. Blow up a balloon to about the same size as a baseball and tie it loosely.

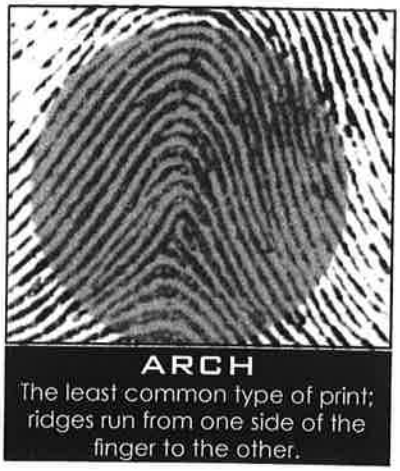
3. Press each finger into one of the boxes, then gently press it against the balloon. Use a different part of the balloon for each finger!

4. Blow up the balloon larger. Watch the fingerprints EXPAND.

5. Compare each fingerprint to the provided examples. Determine whether it is a **loop, whorl, or arch.**







6. Record your data below:

	THUMB	INDEX	MIDDLE	RING	PINKY
RIGHT HAND					
LEFT HAND					

TEACHER ANSWER KEY

STICKY FINGERS

Using the data from both your hands, count the total numbers of loops, whorls, and arches.

Total# **Loops**: _____

Total# **Whorls**: _____

Total# **Arches**: _____

As a class, calculate the total number of loop, whorl, and arch fingerprints for the entire class. Record that data here:

Classroom Total# **Loops**: _____

Classroom Total# **Whorls**: _____

Classroom Total# **Arches**: _____

Classroom Total# **All Fingerprints**: _____

Next, calculate the **percentage** of each type of fingerprint in your classroom population.
For example, the Percentage of Loops = (Total# Loops / Total# All Fingerprints) x 100

Percentage **Loops**: _____

Percentage **Whorls**: _____

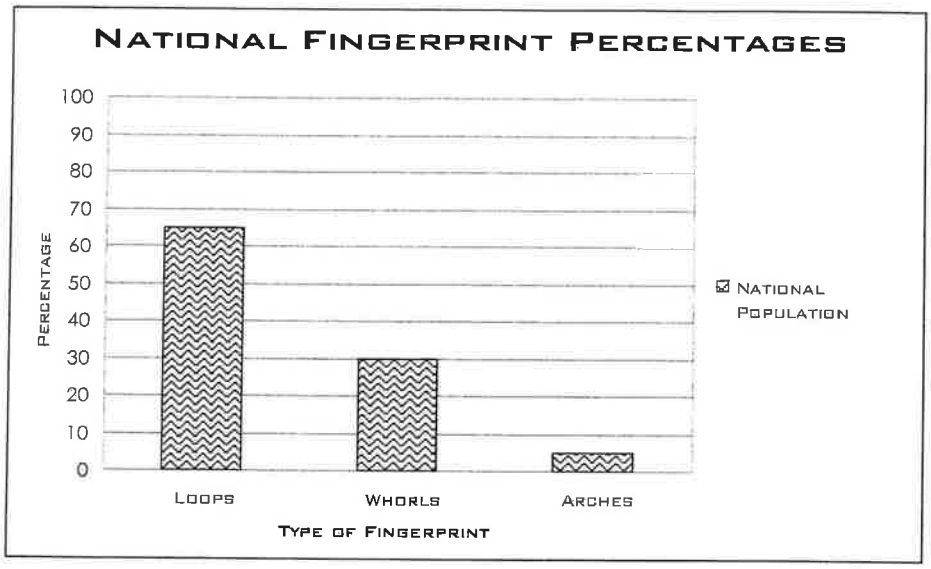
Percentage **Arches**: _____

Total Percentages: 100%

TEACHER ANSWER KEY

STICKY FINGERS

The chart below shows the how often each of these types of fingerprints occur in the national population. Use this chart to answer the following questions.



1. What percentage of fingerprints in the national population are loops?

65%

2. What percentage of fingerprints in the national populations are whorls?

30%

3. What percentage of fingerprints in the national population are arches?

5%

4. Which is greater: the number of loop fingerprints in the national population, or the number of whorl fingerprints plus the number of arch fingerprint?

The number of loop fingerprints
(65% > (35%+5%))

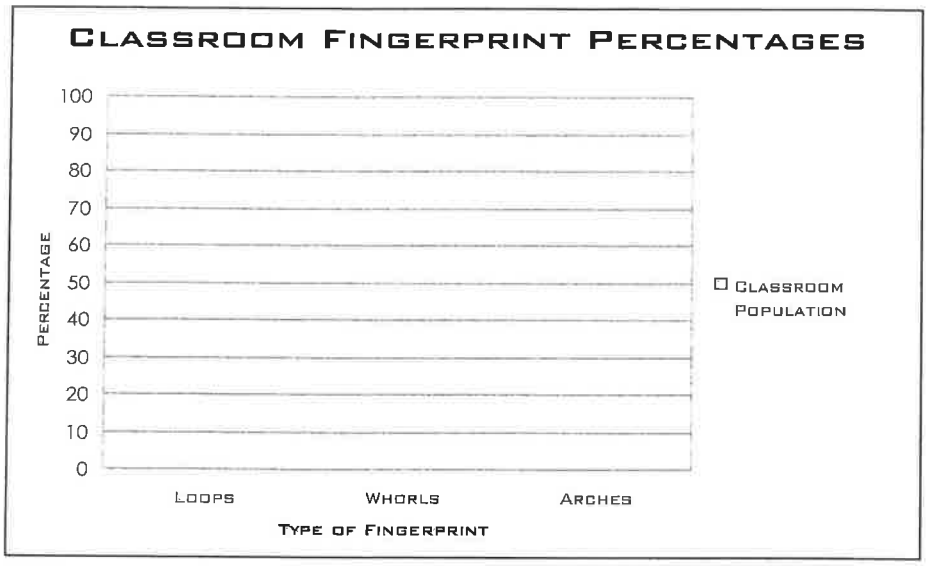
5. In a random sampling of 1000 fingerprints from the national population, approximately how many arch fingerprints can you expect to find?

0.05 x 1000 = approximately 50 arch fingerprints

TEACHER ANSWER KEY

STICKY FINGERS

Use the data collected from your class as a whole to fill in the next graph. Use the data from both graphs to answer the following questions.



1. Does the graph of fingerprints in your class look the same as the graph of the national averages? Why or why not?

Though the graphs will probably be similar, they may not be identical. There is natural variation in all populations. The first graph only shows the averages for the US population.

2. Would you predict that a graph of fingerprint patterns from another class would look the same as your graphs? Why or why not? How could you find out if your prediction is correct?

A graph of fingerprints from another classroom would probably look similar, but not identical to both graphs (the classroom and the national population). Again, this is due to naturally occurring variations. The only way to see what the graph of the other classroom would look like is to repeat the experiment in that classroom

3. The fingerprints from a recent crime scene are shown on the next page. Using the data from the national population would you say this suspect has common fingerprints? Why or why not?

Of the suspects 10 fingerprints, 3 (30%) are arches, 3 (30%) are whorls, and 4 (40%) are loops. He has an unusually high number of arches, making his fingerprints highly unusual.

TEACHER ANSWER KEY

STICKY FINGERS

EVIDENCE FROM CASE #4589241-B

FINGERPRINTS FROM CRIME SCENE

FROM CASH REGISTER

FROM DISPLAY CASE

FROM CASH REGISTER

FROM DOOR

FROM DOOR

SUSPECT'S FINGERPRINTS

RIGHT HAND

THUMB INDEX MIDDLE RING PINKIE

LEFT HAND

THUMB INDEX MIDDLE RING PINKIE

TEACHER ANSWER KEY

STICKY FINGERS

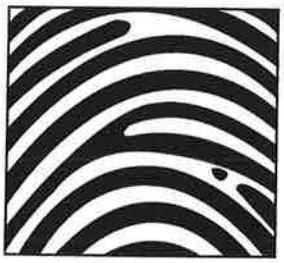
Part 2: Do the suspect's fingerprints match those at the crime scene?

In the previous exercise, you should have noticed that everybody has similar fingerprints. For example, many students in your class may have fingerprints that are all loops, or nine loops and a whorl. If everyone's fingerprints are so similar, how can forensic scientists link certain fingerprints to a specific individual?

Forensic scientists use ridge characteristics to identify an individuals' fingerprints. These include:

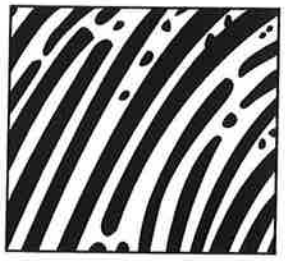
RIDGE ENDING

LAKE (ENCLOSURE)

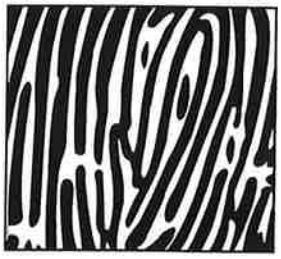


BIFURCATION

HOOK (SPUR)



DOT



DOUBLE BIFURCATION

ISLAND (SHORT RIDGE)

OPPOSED BIFURCATION

TEACHER ANSWER KEY

STICKY FINGERS

Three weeks ago a local bakery was robbed at gunpoint. The thief wore a mask, so even when the police found a suspect the bakery owner couldn't make a positive ID. However, as the CSI processing the scene, you collected several fingerprints from various parts of the bakery.

The police have identified a suspect, but he says he's never been to that bakery. It's your job to see if the suspect's fingerprints match any of those recovered at the scene of the crime.

1. Can you identify any ridge characteristics on the suspects prints? on the prints from the crime scene? Circle and label any ridge characteristics you find.

There are a variety of ridge characteristics. The most common will be ridge endings, lakes, and bifurcations, but there are also hooks, dots, and islands.

2. Do any of the crime scene fingerprints match the suspect's fingerprints? Label any matching crime scene fingerprints with the hand and finger they come from.

From Cash Register (top row) = Left Thumb
From Display Case = NO MATCH
From Cash Register (bottom row) = Right Thumb
From Door = Left Pinkie
From Door = Left Ring

3. Do any of the crime scene prints NOT match the suspect's prints? Who do you think could have contributed these prints?

The print from the display case does not match the suspect. This print could belong to the shop owner or a customer.

4. Do you think the suspect committed this crime? Why or why not?

Answers may vary, but students should point out that 1) the suspect has definitely been to the bakery, which contradicts his earlier statement, and 2) one of his prints was found on the cash register. Even if he was in the bakery as a customer, why would his print be on the cash register?

Name:_____ Date:_____

STICKY FINGERS

Part 1: Are some kinds of fingerprints more common than others?

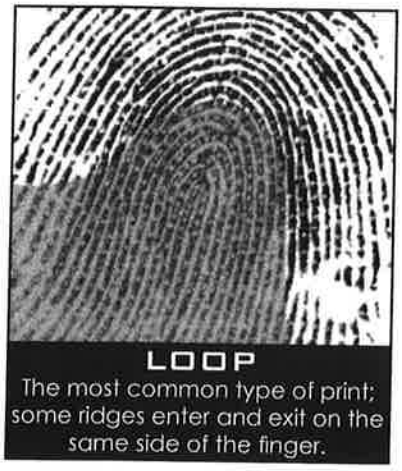
1. Fill in each of these squares using a #2 pencil. Make sure each square is dark and shiny.

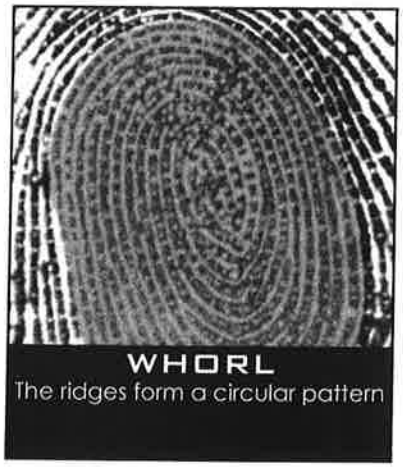
2. Blow up a balloon to about the same size as a baseball and tie it loosely.

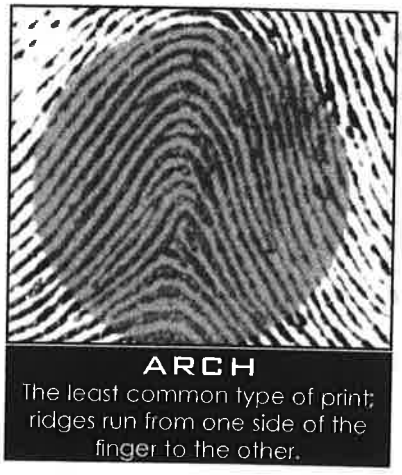
3. Press each finger into one of the boxes, then gently press it against the balloon. Use a different part of the balloon for each finger!

4. Blow up the balloon larger. Watch the fingerprints EXPAND.

5. Compare each fingerprint to the provided examples. Determine whether it is a **loop, whorl, or arch**.







6. Record your data below:

	THUMB	INDEX	MIDDLE	RING	PINKY
RIGHT HAND					
LEFT HAND					

Name:_____ Date:_____

STICKY FINGERS

Using the data from both your hands, count the total numbers of loops, whorls, and arches.

Total# **Loops**: _____

Total# **Whorls**: _____

Total# **Arches**: _____

As a class, calculate the total number of loop, whorl, and arch fingerprints for the entire class. Record that data here:

Classroom Total# **Loops**: _____

Classroom Total# **Whorls**: _____

Classroom Total# **Arches**: _____

Classroom Total# **All Fingerprints**: _____

Next, calculate the **percentage** of each type of fingerprint in your classroom population.
For example, the Percentage of Loops = (Total# Loops / Total# All Fingerprints) x 100

Percentage **Loops**: _____

Percentage **Whorls**: _____

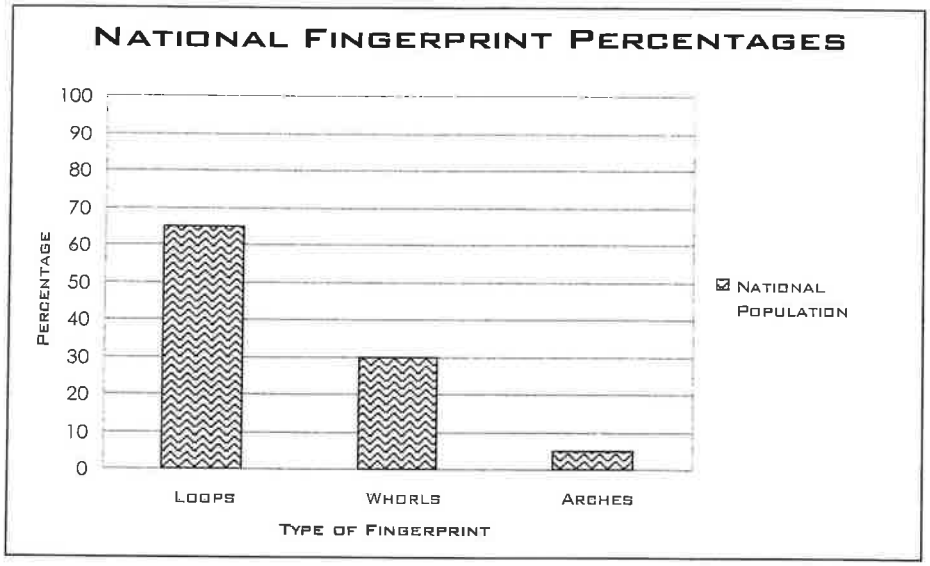
Percentage **Arches**: _____

Total Percentages: _____100%_____

Name:_____ Date:_____

STICKY FINGERS

The chart below shows the how often each of these types of fingerprints occur in the national population. Use this chart to answer the following questions.



1. What percentage of fingerprints in the national population are loops?

2. What percentage of fingerprints in the national populations are whorls?

3. What percentage of fingerprints in the national population are arches?

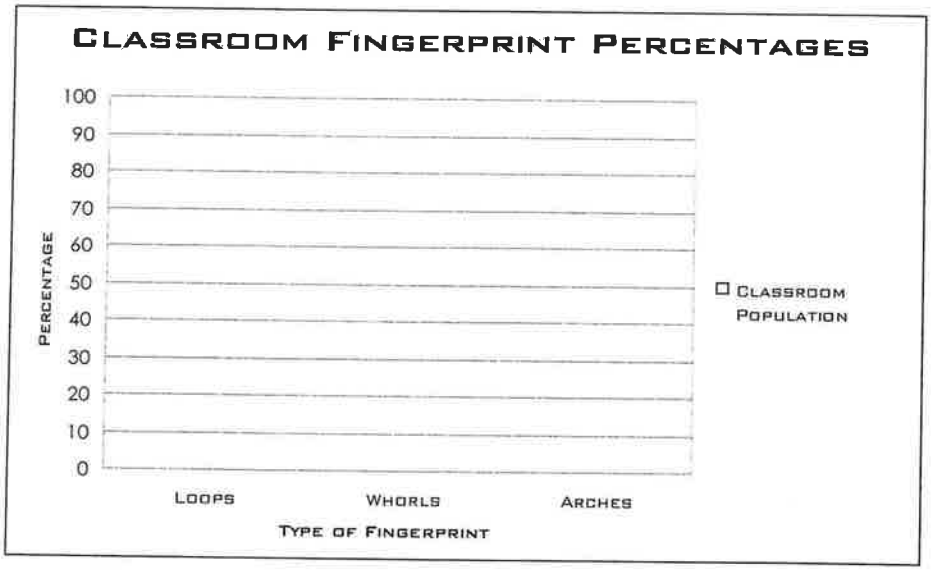
4. Which is greater: the number of loop fingerprints in the national population, or the number of whorl fingerprints plus the number of arch fingerprint?

5. In a random sampling of 1000 fingerprints from the national population, approximately how many arch fingerprints can you expect to find?

Name:_____ Date:_____

STICKY FINGERS

Use the data collected from your class as a whole to fill in the next graph. Use the data from both graphs to answer the following questions.



1. Does the graph of fingerprints in your class look the same as the graph of the national averages? Why or why not?

2. Would you predict that a graph of fingerprint patterns from another class would look the same as your graphs? Why or why not? How could you find out if your prediction is correct?

3. The fingerprints from a recent crime scene are shown on the next page. Using the data from the national population would you say this suspect has common fingerprints? Why or why not?

Name:_____ Date:_____

STICKY FINGERS

EVIDENCE FROM CASE #4589241-B

FINGERPRINTS FROM CRIME SCENE

FROM CASH REGISTER

FROM DISPLAY CASE

FROM CASH REGISTER

FROM DOOR

FROM DOOR

SUSPECT'S FINGERPRINTS

RIGHT HAND

THUMB INDEX MIDDLE RING PINKIE

LEFT HAND

THUMB INDEX MIDDLE RING PINKIE

Name:_____ Date:_____

STICKY FINGERS

Part 2: Do the suspect's fingerprints match those at the crime scene?

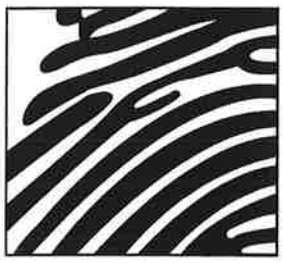
In the previous exercise, you should have noticed that everybody has similar fingerprints. For example, many students in your class may have fingerprints that are all loops, or nine loops and a whorl. If everyone's fingerprints are so similar, how can forensic scientists link certain fingerprints to a specific individual?

Forensic scientists use ridge characteristics to identify an individuals' fingerprints. These include:

RIDGE ENDING

LAKE (ENCLOSURE)

BIFURCATION



HOOK (SPUR)

DOT

DOUBLE BIFURCATION

ISLAND (SHORT RIDGE)

OPPOSED BIFURCATION

Name:_____ Date:_____

STICKY FINGERS

Three weeks ago a local bakery was robbed at gunpoint. The thief wore a mask, so even when the police found a suspect the bakery owner couldn't make a positive ID. However, as the CSI processing the scene, you collected several fingerprints from various parts of the bakery.

The police have identified a suspect, but he says he's never been to that bakery. It's your job to see if the suspect's fingerprints match any of those recovered at the scene of the crime.

1. Can you identify any ridge characteristics on the suspects prints? on the prints from the crime scene? Circle and label any ridge characteristics you find.

2. Do any of the crime scene fingerprints match the suspect's fingerprints? Label any matching crime scene fingerprints with the hand and finger they come from.

3. Do any of the crime scene prints NOT match the suspect's prints? Who do you think could have contributed these prints?

4. Do you think the suspect committed this crime? Why or why not?

Handwriting Analysis

Handwritng is unique to each individual. Although some peoples' handwriting may have similar styles and characteristics in common, acquired when these people learned to write by copying letters and words, they tend to take on individual styles with age. Also, as a person ages, their handwriting will show additional changes.

Generally, one cannot determine the age or sex of a suspect or whether they are left-handed or right-handed from a normal writing sample. Certain types of flourishes and embellishments in writing styles and detailed examination of an original document my give hints at some of some of these characteristics.

In handwriting analysis, one should look for similarities in the shapes, styles, alignment, and spacing of letters.

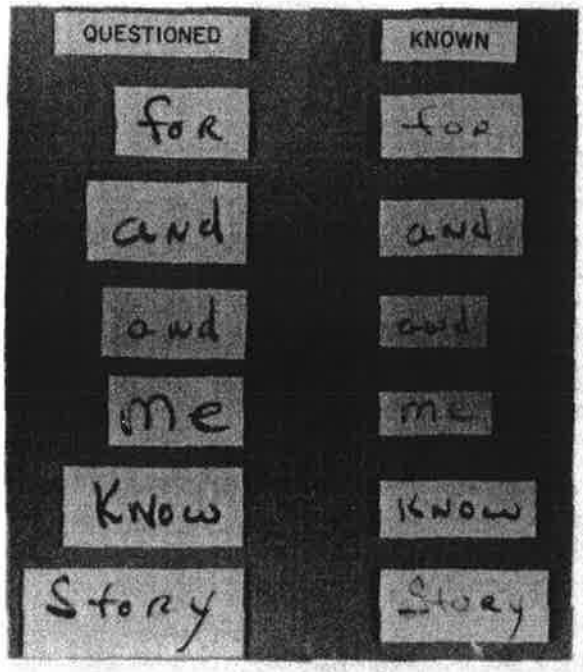


FIGURE 13–3
Court exhibit showing comparison for questioned and known handprinting samples. Comparisons require similar letter combinations.

Reference: Reproduced from Saferstein, **Criminalistics**. 5th Ed., Prentice Hall, 1995.

Material:

Documents to be examined Ruler
Protractor
Magnifying lenses

Characteristics of Handwriting

- Examine the spacing between letters and words. Use a ruler to measure typical spacing.
- Examine the relative height, width, and size of letters. Use a ruler to measure these for comparison.
- Examine pen lifts and separations. Some letters and combinations will be continuous while others may not be connected. Look at the beginning and ending strokes of words and letters and any connecting strokes.
- Are there any unusual letter formations such as loops and curls or a mixture of cursive and printing of letters?
- Is there any shading of letters due to uneven pressure applied in writing?
- Examine the slant of the letters. Do they slant left, right, or not at all? Are the slants consistent throughout the writing sample? Measure the angles of slant using a protractor.
- Examine the baseline habits. Are the words and letters on the baseline or are they above and below. A ruler will be helpful in determining this.
- Look for flourishes and embellishments. Using small circles to dot i's or for periods, loops on capital letters or ending letters, etc. Are there any unusual letter formations?
- Look at the placement of diacritics. Are the i's dotted and t's crossed? Individuals tend to dot i's and cross t's in unique fashions.

Study the ransom note in Figure H-1. Note some of the unique characteristics of the individual's handwriting.

To the President of the Super Cola Company:

I am in possession of the secret formula for Super Cola.
Unless you pay a ransom of $1,000,000 within one week,
I will sell the formula to the highest bidder from your
rival companies.
I will send you further instructions on payment
in 3 days.

Figure H-1. A ransom note.

Figure H-2 contains samples of handwriting from 5 suspects. Can you determine who wrote the ransom note shown in Figure H-1? Write your results on the data pages.

Handwriting sample from Suspect 1

I am in possession of the secret formula for Super Cola.

Handwriting sample from Suspect 2

I am in possession of the secret formula for Super Cola.

Handwriting sample from Suspect 3

I am IN possession of the secret formula for Super Cola

Handwriting sample from Suspect 4

I AM IN POSSESSION OF THE SECRET FORMULA FOR SUPER COLA.

Handwriting sample from Suspect 5

I am in possession of the secret formula for Super Cola

Figure H-2. Handwriting samples from five suspects.

Characteristics of Forged Documents

Writing in forged documents tends to be slowly written and will show a lack of individuality. Letters tend to have an unnatural appearance as if the forger was drawing the letters. This makes letters inconsistent in the document, shows unnatural starts and stops and a general lack of rhythm to the writing. Any mistakes will show a careful correction. Signatures will be identical.

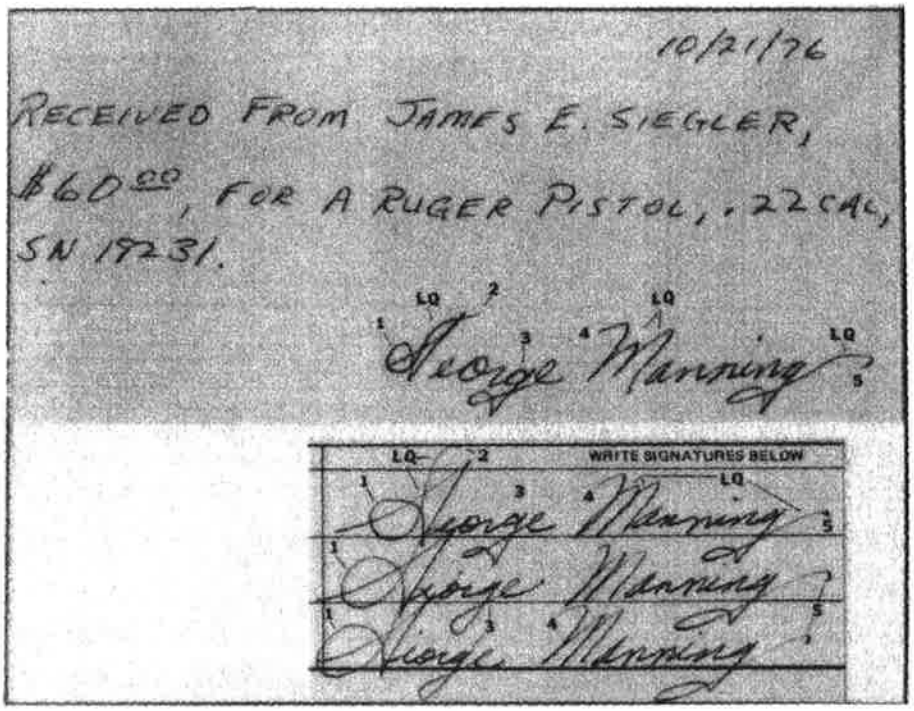


FIGURE 13-4 A case involving a simulated signature. The George Manning signature on the note was "drawn" by a person who had a good signature to use as a guide. As in most simulations the line quality (LQ) is very poor. (1) The loop of the *G* in the simulated signature is too small and confined, whereas the real writer is quite free with that loop. (2) The direction of approach is different. (3) The bowl of the small *g* is much larger in the simulated signature than in the known. (4) The approach stroke in the *M* in the simulated signature is blunted, whereas in the known writing that stroke feathers—a sign of movement. (5) The terminal stroke on the *g* in the questioned signature is tapered (showing movement), whereas the real writer comes to an abrupt halt at that stroke. These and many characteristics label the signature a simulated forgery.

Reference: Reproduced from Saferstein, **Criminalistics**. 5th Ed., Prentice Hall, 1995.

Try this:

Write your signature five times in the spaces below:

_____

_____

_____

_____

_____

Now, try to write your signature **exactly** as you did in the 5th sample, above.

_____

Ask your lab partner to write your signature **exactly** as you did in the 5th sample, above.

_____

Complete the information on the data pages.

Disguised Writing

If a suspect attempts to disguise their writing, they will generally exhibit inconsistent slant and letter formations with a major change in the size of their letters. Capital letters will be different and they often will use block lettering. As they write, there will be a lack of rhythm, irregular spacing, and unnatural starts and stops. Occasionally they will add excessive ornamentation. Some individuals will try to write with the wrong hand.

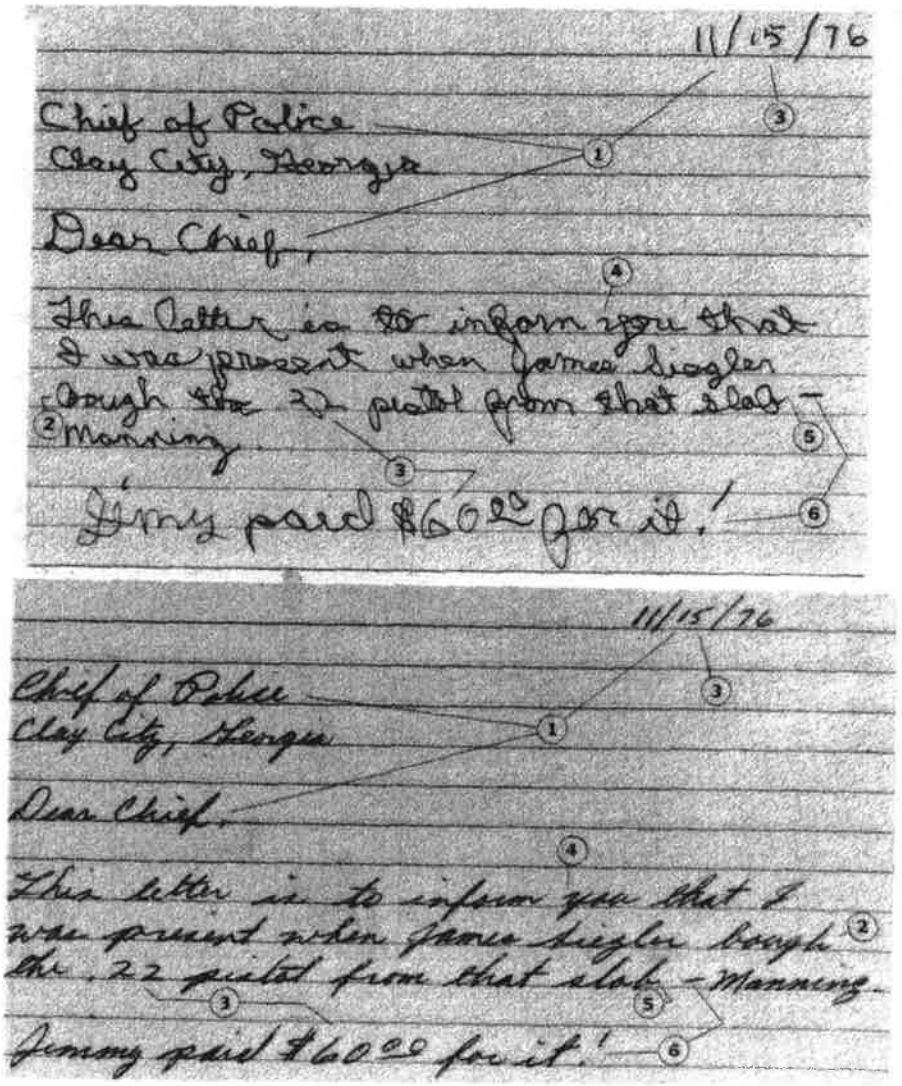


FIGURE 13–5 In a case of disguise it is up to the questioned document examiner to penetrate the writing and identify sufficient habitual characteristics that have remained. In this case, the questioned note was, in all likelihood, written with the unaccustomed hand, while the writing below was written with the accustomed hand. Some of the characteristics that remained in the questioned note are the (1) placement of the words on the paper, (2) spelling errors, (3) consistent abbreviations in both questioned and known, (4) initial strokes, and (5) punctuation, and, of course, the combinations of these characteristics.

Reference: Reproduced from Saferstein, **Criminalistics**. 5th Ed., Prentice Hall, 1995.

If an independent writing sample is available, it should be used for comparison.

Try this:

Look at Figure H-2. Write the sentence in the space below. Use your normal writing.

_____

Write the sentence again. This time try to make it look different from your normal writing, but try to write at a reasonable rate of speed.

_____

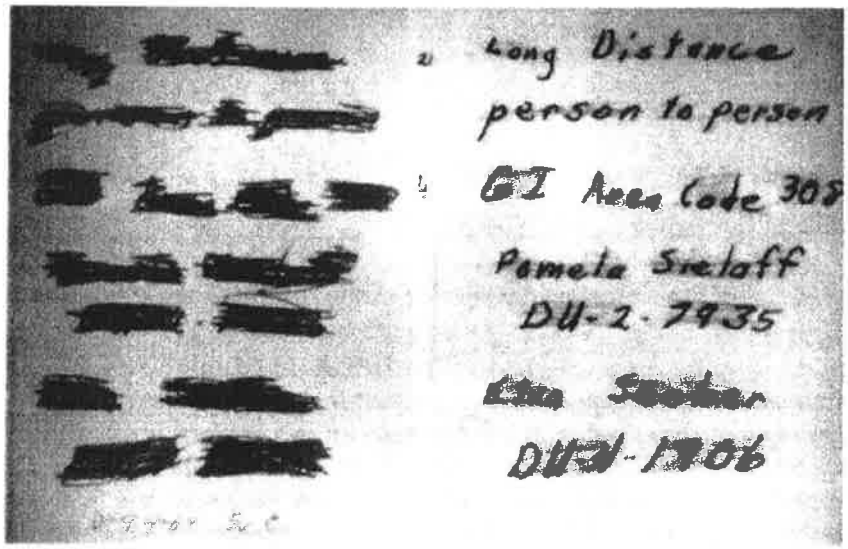
Can you write with your other hand? If so, write the sentence again.

_____

Complete the information on the data pages.

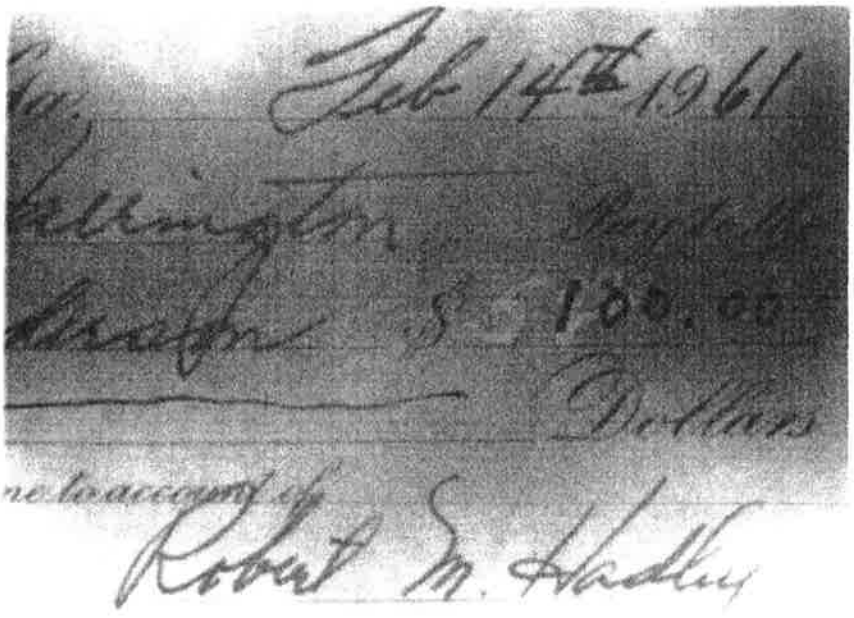
In addition to normal handwriting analysis, as discussed previously, methods can be used to detect handwriting, even when the writing has been obliterated. For example, using infrared film or infrared microscopy, some obliterated writing can be deciphered.

FIGURE 13–8 Deciphering obliterated writing using infrared-sensitive film or infrared image conversion microscopy.



Reference: Reproduced from Saferstein, **Criminalistics**. 5th Ed., Prentice Hall, 1995.

Bleaching ink on a document is a method that can be used to alter it, as in the bank check shown below. Ultraviolet light can be used to detect this if the paper, ink, or bleach has any fluorescent properties.



Reference: Reproduced from Saferstein, **Criminalistics**. 5th Ed., Prentice Hall, 1995.

HANDWRITING ANALYSIS

Data and Results

List your observations and measurements of the handwriting sample:

Spacing of words and letters

Relative height, width, and size of letters

Are there any pen lifts and separations?

Are there any unusual letter formations?

Is there any shading of letters?

Describe the slant of the writing.

Describe the baseline habit of the writer.

Are there any flourishes or embellishments?

Describe placements of diacritics.

Who wrote the ransom note? Explain.

Characteristics of Forged Documents

Are your five signatures the same? Explain.

Is your 6th signature identical to the signature you tried to copy? Explain.

Was your lab partner able to copy your signature? Explain similarities and differences.

If you examined any forged documents, describe your findings.

Disguised Writing

How good are you a disguising your writing?

If you examined any disguised writing, describe your findings.