Handout 5-A
Knowing Hair Inside Out: Student Lab Investigation

Name _____ Date _____

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Your Job

Use the microscope to examine, compare, and identify human and nonhuman mammal hair.

Your Steps

1. Pull one hair from your head and measure its length. Record the length and color in the table "Comparing Human and Nonhuman Hair." (For now, just do the human hair. You will be coming back to the table to fill in the information on "Other mammals.")

2. Make a wet mount of the hair.

   a. Put several drops of water in the center of the microscope slide.

   b. Lay the hair on the microscope slide so that the root and tip are both in the water.

   c. Place a cover slip over the hair and water by setting it on edge in the water and gently dropping it over the hair.

3. Look at your hair under the microscope. Describe and draw it in the table. Then look at the hair of *other* students and record your observations. Answer questions 1–4 of "What Did I Discover?" on page 110.

4. Read "Identified by a Hair" (Handout 5-B). Answer the "What Does It Mean?" questions at the end of the handout.

5. Look at prepared microscope slides of two nonhuman mammals and record your observations in the table "Comparing Human and Nonhuman Hair" and the table "Identifying Nonhuman Mammal Hair." Answer questions 5–8 of "What Did I Discover?" on pages 110–111.

Handout 5-A

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Comparing Human and Nonhuman Hair

Name	Hair length (cm)	Draw and describe hair and color without using the microscope.	Draw and describe hair color as seen through the microscope.	Medulla width* is: -Greater than 1/3 hair width -1/3 or less of hair width -Absent
Student				
Student				
Other mammal				
Other mammal				

*The medulla appears like a dark line or broken line down the middle of a person's hair. Not everyone's hair has a medulla.

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Identifying Nonhuman Mammal Hair

Animal	Draw microscopic appearance of hair	*Medulla pattern: (Uni- or multiserial, vacuolated, amorphous, lattice)	Medullary Index = Width of medulla / Width of hair (estimate at ¼, ½, ¾, 1)

*Use "Anatomy of a Hair" (Handout 5-B, pp. 112–115) to classify medulla patterns.

Handout 5-A
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What Did I Discover?

1. What is one way to tell the difference between hairs from two people without the microscope?

2. What is one way to microscopically tell the difference between hairs from two people?

3. What was a difference between your hair and your classmate's hair?

4. Some people have hair with a dark core called a *medulla.* What type of medulla do you have? Look at hairs from other students and classify them below.

Absent medulla	_____ _____	: STUDENT(S) _____
Broken medulla	_____ _ _ _ _ _____	: STUDENT(S) _____
Continuous medulla	_____ _____ _____	: STUDENT(S) _____

5. How are medulla patterns of human hairs different from those of other mammal hairs?

   Write "human" or "nonhuman mammal" beside each description of medullary indexes.

a. _____	Absent
b. _____	Less than 1/3 of hair diameter
c. _____	More than 1/3 of hair diameter

   Compare the visible colors of a hair with its color(s) under the microscope.

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6. Explain how to tell the difference between hairs of several nonhuman mammals.

7. You are investigating a mammal poaching crime and find three different types of hair. The medullary indexes are 1/4, 3/4, and 0. How many hairs are from people and how are many from other mammals? Justify your answer.

   The human hair evidence has no medulla. The suspect's hair has no medulla.

   a. Which is true?

      _____ The hair belongs to the suspect.

      _____ The hair is in the same category as the suspect's hair.

      _____ The hair does not belong to the suspect.

   b. Explain your choice.

8. Read your comments on hair in your Investigator Notebook (*What do I know about hair? What do I want to know about hair?).* Then respond to the following question: *What have I learned about hair?*

Handout 5-B
Identified by a Hair

Name _____ Date _____

- CRIME SCENE - DO NOT CROSS - CRIME SCENE - DO NOT CROSS - CRIME SCENE - DO NOT CROSS - CRIME SCENE - DO NOT CROSS - CRIME SCENE - DO NOT CROSS -

Humans shed about 100 strands of hair each day. As a result, hair evidence is often found at crime scenes. A single strand of hair can tell investigators about the person from whom it was shed (possible ethnicity of the person, where on the body it came from), but the hair itself cannot point to one suspect. At this level of forensic examination, it is considered indirect or circumstantial evidence, meaning investigators can classify a suspect with a larger group of people having similar types of hair, but they cannot make a one-on-one match.

To make hair a more powerful piece of direct evidence, DNA can be extracted to create a DNA fingerprint. So where is DNA in hair? Hair is made of keratin, a protein also found in human fingernails and toenails and in animal claws, horns, and hooves. Keratin itself does not have DNA, but the follicle at the base of the hair, with thousands of cells rich in DNA, is a scientist's treasure chest.

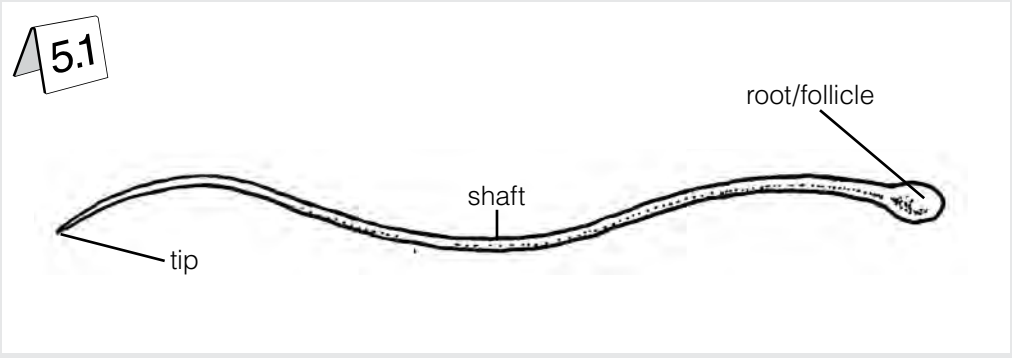
What Do Forensic Scientists Need To Know?

Even without testing DNA, forensic scientists can learn much from a single hair. By knowing hair structure, they can determine if the hair is from a human or another mammal. Once that distinction is made, scientists can narrow it down further, matching the hair to a particular species. This process is essential for identifying victims in crimes against wildlife.

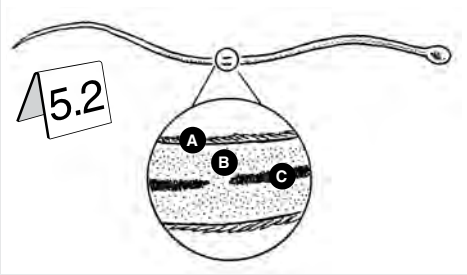
Anatomy of a Hair

Visible Structure of Hair

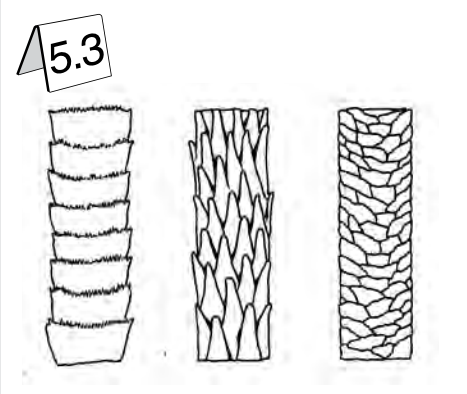
Hair, made of the protein keratin, is an outgrowth of skin in mammals. It can be described visually by length, color, root/follicle and tip appearance, and amount of curl (Figure 5.1).



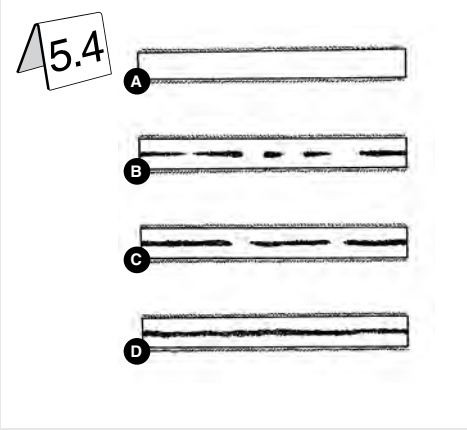
Handout 5-B
Identified by a Hair



A: Cuticle
B: Cortex
C: Medulla



Scale Patterns



Human medullas
A: Absent
B: Trace (fragmentary)
C: Broken (discontinuous)
D: Continuous

Microscopic Structure of Hair

When examined microscopically, the three distinct parts of hair can be seen: the cuticle, the cortex, and the medulla (Figure 5.2).

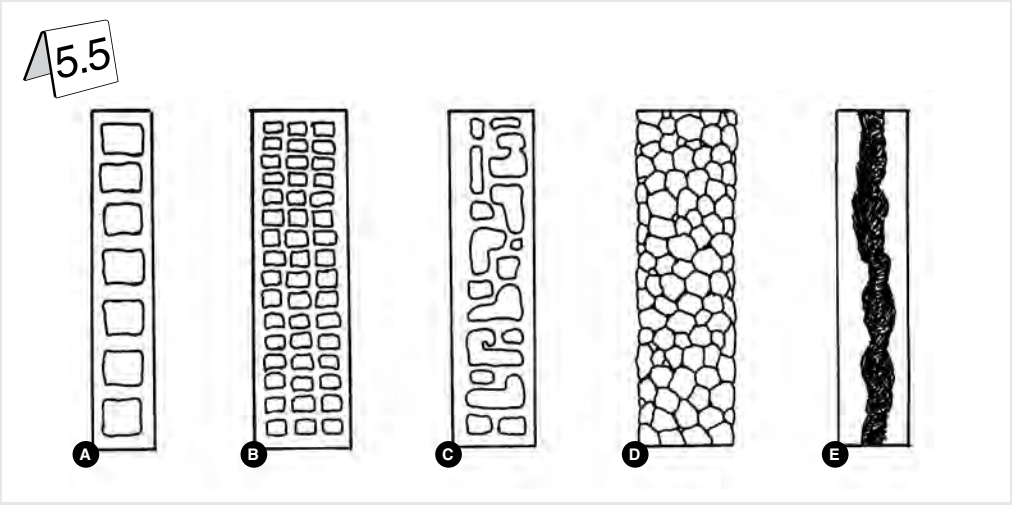
The *cuticle* is the transparent outer covering of hair that acts as a protective barrier to hold in moisture. It is seen under the microscope as a layer of scales pointing toward the tip of the hair (Figure 5.3). The shape of the scales varies among mammal species.

The *cortex* is the main body of the hair that gives it shape. It contains the pigment for hair color.

The *medulla* is a core of cells that runs down the center of the cortex through the length of the hair. Made of soft keratin and air, the medulla's unique features help match the hair to the mammal species. In humans the medulla has no clear shape (i.e., it is amorphous) and is often absent. It is categorized into four groups: absent, trace (fragmentary), broken (discontinuous), and continuous (Figure 5.4).

The medullas of other mammals are more prominent and have distinct shapes. Some are shown in Figure 5.5.

Handout 5-B
Identified by a Hair



A: Uniserial ladder (rabbit)
B: Multiserial ladder (rabbit)
C: Vacuolated (common, dog, fox)
D: Lattice (deer, elk)
E: Amorphous (common, black bear, human)

Medullary Index

The medullary index gives a number to the size ratio between the width (diameter) of the medulla and the width (diameter) of the entire hair.

$$\text{Medullary Index} = \frac{\text{width of medulla}}{\text{width of hair}}$$

For example, if the width of the medulla under the microscope is 2 mm and the width of the hair is 8 mm then the medullary index = 2/8 = 1/4.

The medullary index can identify whether the hair is from a human or other mammal. In humans the medulla is narrow or absent, with its medullary index between 0 and 1/3. In other mammals, the medulla fills much of the hair's diameter with a medullary index between 1/3 and 1.

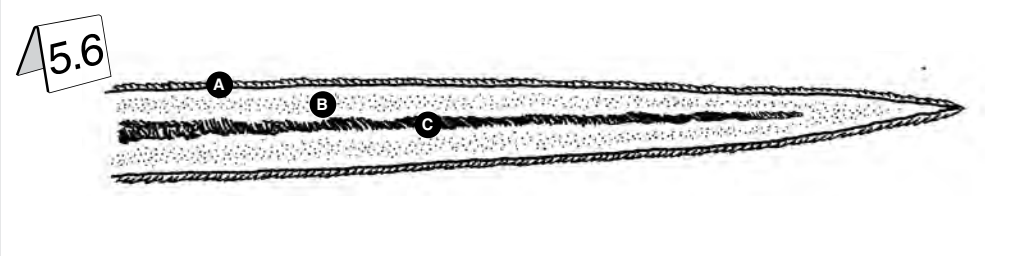
Handout 5-B
Identified by a Hair

What Does It Mean?

1. Why is hair considered indirect or circumstantial evidence in court?

2. What is the difference between the hair shaft and the hair follicle?

3. For Figure 5.6, label the following parts of a hair: cuticle, cortex, medulla. Give their function.



A: _____

_____

_____

B: _____

_____

_____

C: _____

_____

_____

4. How does the medullary index help determine if the hair is from a human or other mammal?