Hairs and Fibers

*Fiber Evidence

Fibers

- A fiber is form of trace evidence.
- Since fibers are so small their transfer often goes unnoticed
- Types of transfer
  - Direct
    - Directly from victim to suspect or suspect to victim
  - Secondary
    - Transferred to suspect and then transferred to victim

* The value of the evidence depends on the uniqueness of the fiber
  * Rare fibers are more valuable
* Questions to ask
  * What type of fiber is this?
  * What color?
  * How many fibers were found?
  * Exactly where was it found?
  * What kind of textile did it come from?
  * What type of crime was committed?
  * Were multiple types of fibers transferred?
  * How much time has elapsed?

* What common police practice was stopped because of fiber transfer?

Collection Methods

- Fibers can be collected with:
  - Special vacuums
  - Sticky tape
  - Forceps
- If only a few fibers are found, only tests that do not destroy the evidence can be used
  - Example: Microscopy

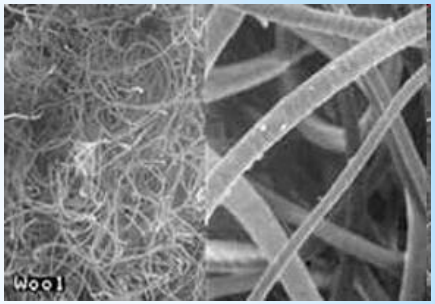
Terminology

- **Fibers** are the smallest unit of a textile.
- When fibers are spun together they make a **yarn.**
- **Textiles** are things like clothing, carpets, and upholsteries. Textiles are made by weaving yarns together.

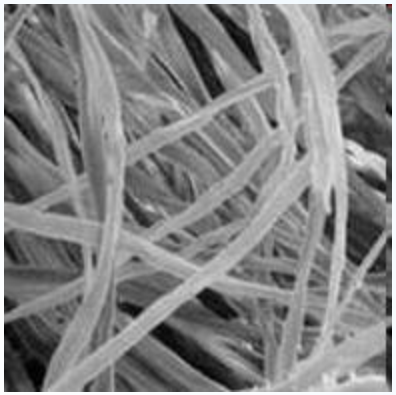
Fiber Classification

- Fibers can be classified as:
  - Natural
    - Come from animals, plants, and minerals that are mined from the ground
  - Synthetic
    - Man-made

Natural Fibers



- Animal Fibers
  - Made from proteins like keratin
  - Wool is the most common
  - Others: cashmere, mohair, angora, and silk
  - Usually shed easily



- Plant fibers
  - All contain cellulose
  - Cotton is the most common
  - Usually very short
- Mineral fibers
  - Fiber glass or asbestos
  - Very fine fibers that are sticky

Synthetic Fibers

* Began in the 19th century
* Half of all fabrics today are produced with synthetic fibers
* Categories
  * Modified natural fibers (regenerated)
    * Ex: Rayon
  * Synthetic Polymer
    * Made from petroleum products
    * Ex: Polyester, nylon, acrylic, or olefins

Fibers under a microscope

* Synthetic fibers are stronger than natural fibers and are not damaged by microorganisms
* Natural fibers don't break down in the sun and can withstand higher temperatures.

* Natural vs. Synthetic

Cotton	Flax	Silk	Wool	Synthetic
◆ Flattened hose appearance ◆ Up to 2 inches long tapering to a blunt end ◆ may have a frayed "root" ◆ hollow core not always visible	◆ "bamboo stick" appearance ◆ straight with angles but not very curved ◆ "nodes" are visible every inch or so ◆ often occur in bundles of several fibers	◆ do not taper, yet exhibit small variations in diameter ◆ may be paired (raw silk) with another fiber ◆ no internal structure	◆ surface scales may be visible ◆ hollow or partial hollow core ◆ fibers up to 3 inches long tapering to a fine point	◆ vary widely in cross-sectional shape and diameter ◆ generally straight to gentle curves ◆ uniform in diameter ◆ may have surface treatment that appears as spots, stains, or pits

*Common characteristics

*HAIR

Hair Evidence

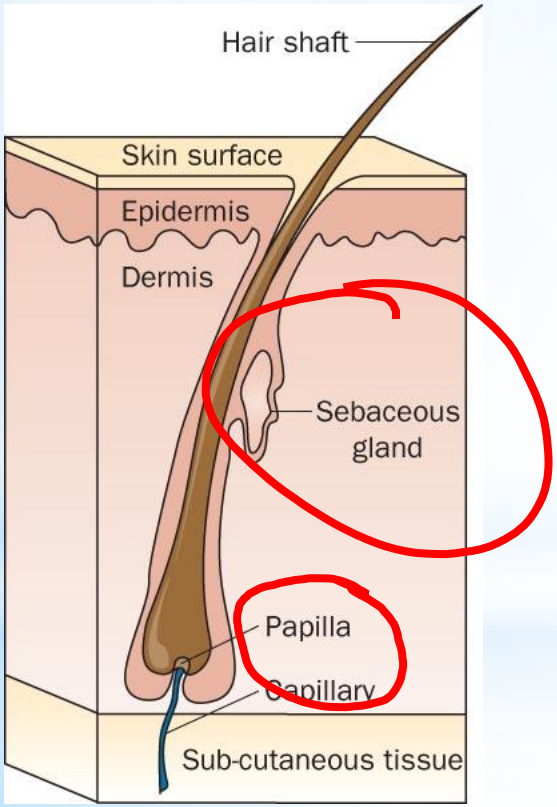
* Hair is a form of class evidence unless the follicle (ROOT) is still attached and DNA can be recovered.
* Good for excluding suspects.
* Transferred very easily.
  * Secondary transfer is common with pet hair

Function of Hair

- Regulates body temperature
- Decreases friction
- Protects against sunlight
- Hair follicles form at five months gestation
- We are born with about 5 million hair follicles which decrease over time.
  - About 2% are on your head.

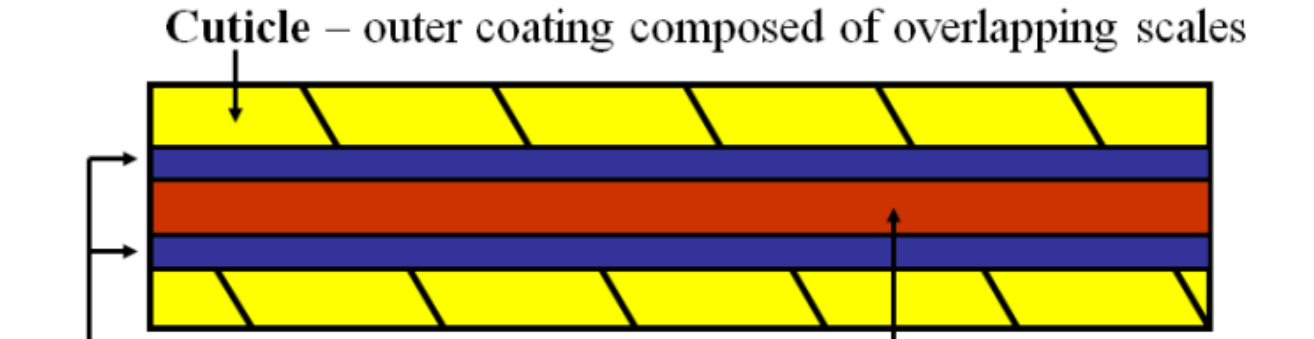
*Hair Structure

* Consists of a follicle and a shaft
* Composed of keratin (a protein) which causes it to be strong and flexible.
  * What are the sebaceous gland and papilla?



* Three layers:
  * Cuticle (outer layer)
  * Cortex (middle layer)
  * Medulla (inner core)

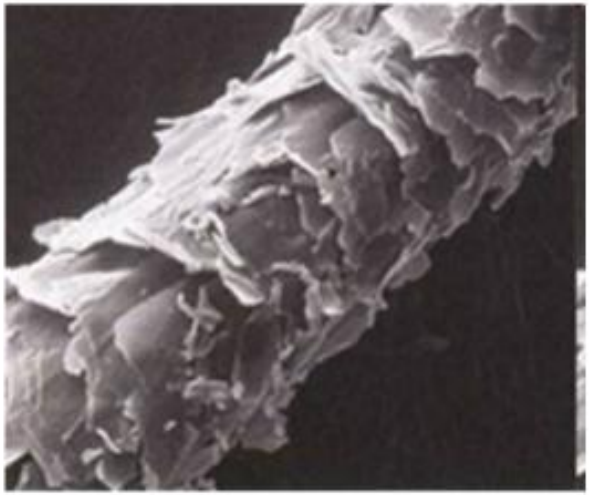
* Shaft composition



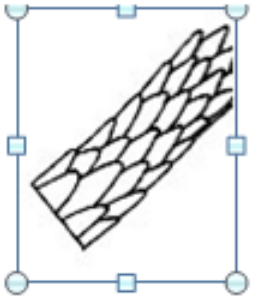
Cuticle

The cuticle varies in:

- Its **scales,**
  - How many there are per centimeter,
  - How much they overlap,
  - Their overall shape, and
  - How much they protrude from the surface
- Its **thickness**, and
- Whether or not it contains **pigment**.



Characteristics of the cuticle may be important in distinguishing between hairs of different **species** but are often not useful in distinguishing between different **people**.

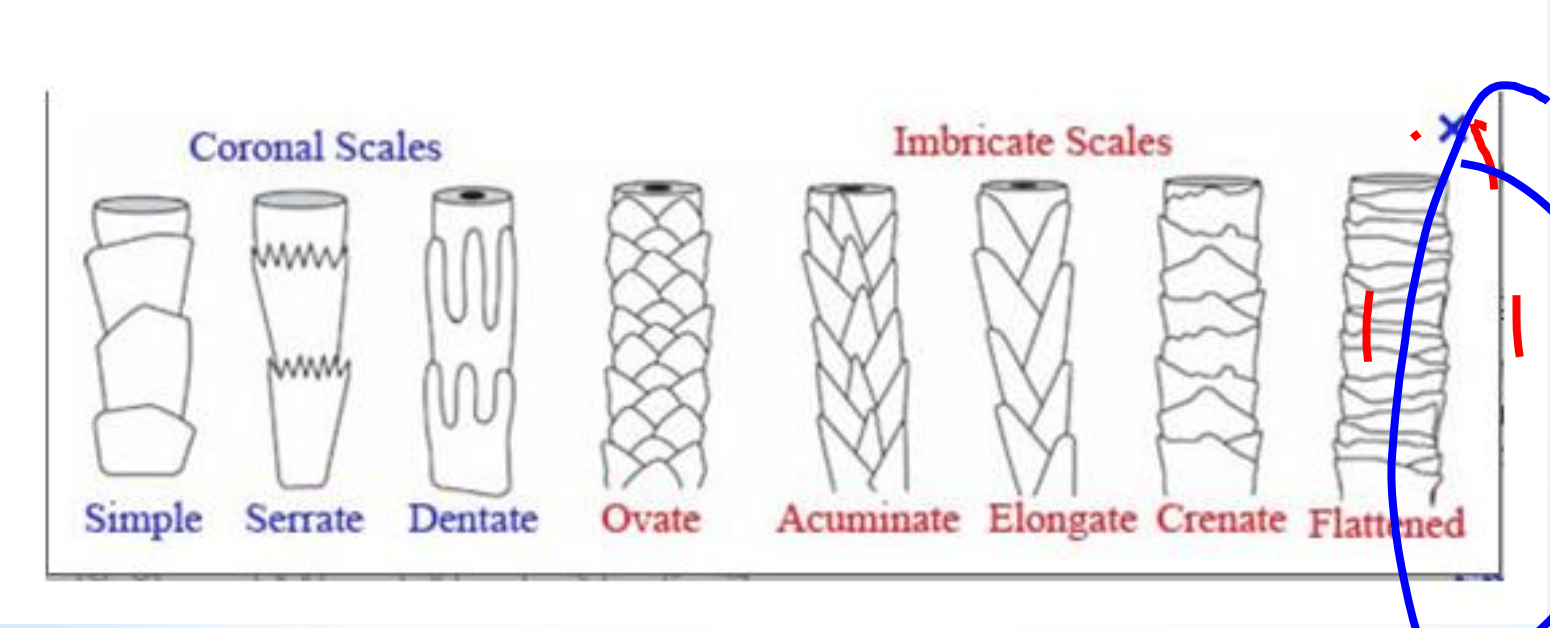


Spinous **Coronal** **Imbricate**

Animals: cuticle scales resemble petals (spinous) or a stack of crowns (coronal)

Humans: commonly flattened and narrow (imbricate)

Humans have imbricate flattened cuticles.

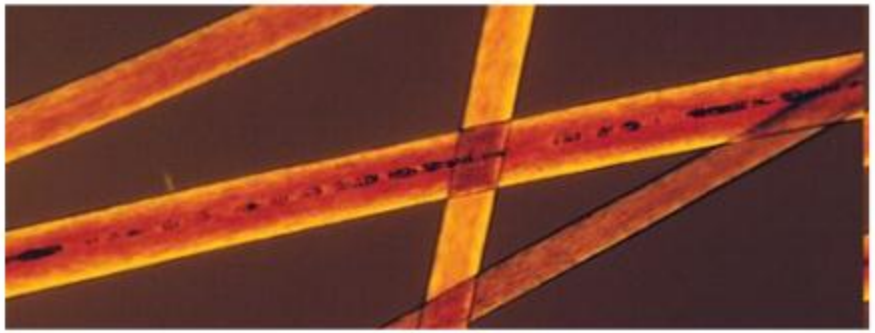


*Cuticle Patterns

Cortex

The cortex varies in:

- **Thickness**
- **Texture**
- **Color**



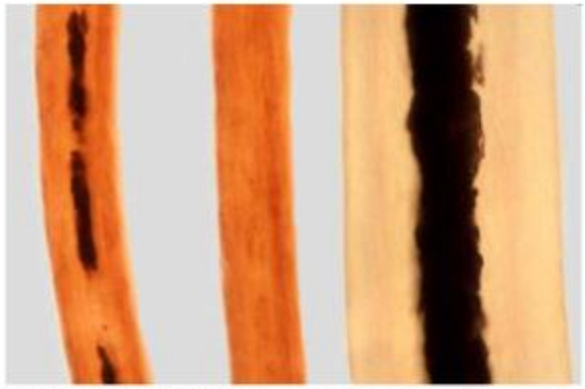
• Distribution of pigment in the cortex is perhaps the most important component in determining from which individual a **human** hair may have come.

• Microscopic examination can also reveal the condition and shape of the **root** and **tip**.

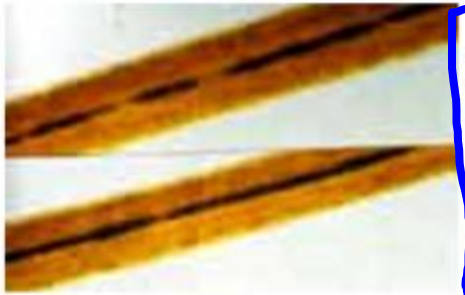
Medulla

The medulla may vary in:

- **Thickness**
- **Continuity** - one continuous structure or broken into pieces
- **Opacity** - how much light is able to pass through it



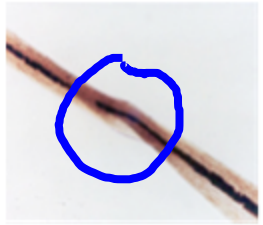
- It may also be **absent** in some species.

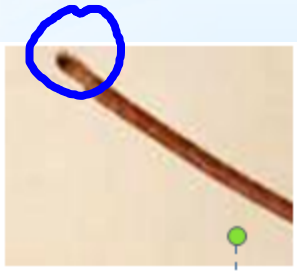


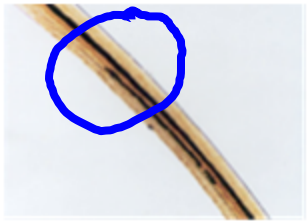
Like the cuticle, the medulla can be important for distinguishing between hairs of different **species**, but often does not lend much important information to the differentiation between hairs from different **people**.

Medulla Pattern	Description	Diagram
Continuous	One unbroken line of color	
Interrupted (Intermittent)	Pigmented line broken at regular intervals	
Fragmented or Segmented	Pigmented line unevenly spaced	
Solid	Pigmented area filling both the medulla and the cortex	
None	No separate pigmentation in the medulla	

*Types of Medullas







Buckled **Blunt** **Double Medulla**

- A cross section: circular, triangular, irregular, or flattened
- Shape: influences the curl of the hair
- Texture: coarse or fine

*Different Hair Types

6 categories of hair

* Head (circular)
* Brows and Lashes (circular with tapering ends)
* Beard and Mustache (thick and triangular; double medulla sometimes)
* Underarm
* Body hair (oval or triangular; usually blunt tip)
* Pubic hair (oval or triangular; with buckling)

*Life Cycle

Hair proceeds through 3 stages as it develops:

- **Anagen** stage:
  - hair actively grows
  - cells around the follicle rapidly divide and deposit materials in the hair
- **Catagen** stage:
  - hair grows and changes
- **Telogen** stage:
  - follicle becomes dormant

- Bleaching
  - disturbs the scales on the cuticle and
  - removes pigment
  - leaves hair brittle and yellowish
- Dyeing colors the cuticle and the cortex

*Treated Hair

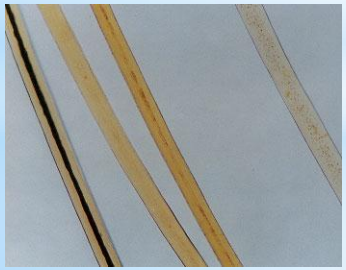
- Pigmentation:
  - animal hair is denser toward the medulla
  - human hair tends to be denser toward the cuticle
- Banded Color Patterns:
  - possible in animals
  - not in humans
- Medulla: much thicker in animals

*Human or Animal

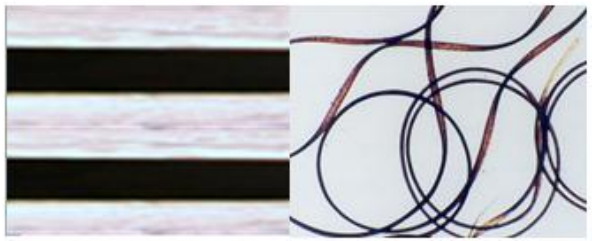
- Broad, racial groups do exhibit some shared physical characteristics
- But NOT applicable to all individuals in these groups

Therefore,

- Individual hairs CANNOT be assigned to any of these groups



*Racial Difference



*Analysis

Macroscopic investigations indicate

- length
- color
- curliness

Phase contrast microscopy shows

- presence of dye or other treatments

Electron microscopes yield yet more detail

Chemical tests

- presence of various substances

Examining a hair shaft

- timeline for exposure to toxins

Neutron Activation Analysis (NAA)

- concentrations of substances

Human hair grows .44mm a day.
The length (in cm) divided by 1.3 cm can give you an estimate of when use occurred in months.

*Analysis

Microscopic assessment

- Cost effective and quick

Blood test

- Determine blood type

DNA analysis

- Identification with a high degree of confidence

*Analysis of follicle