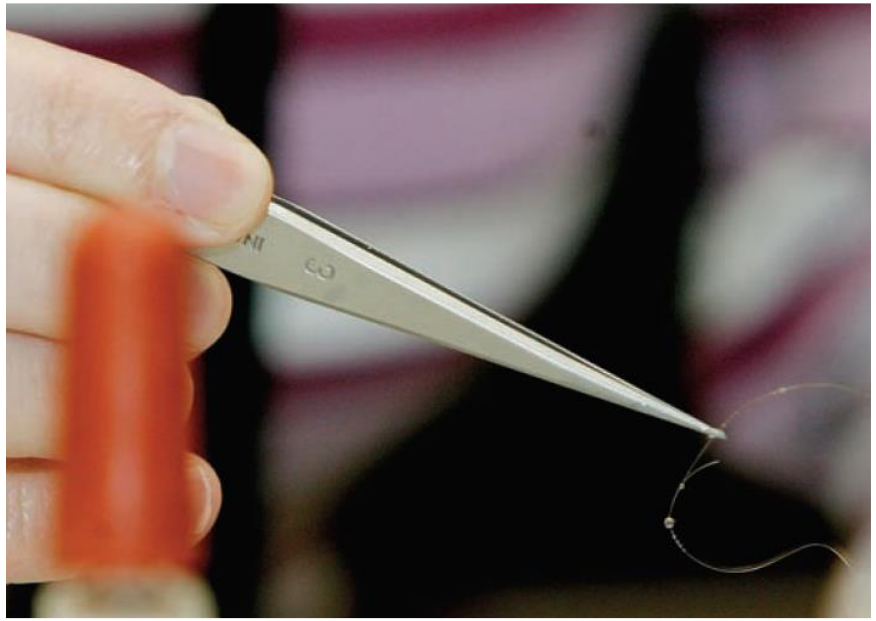
Introduction to Hair analysis in forensic science

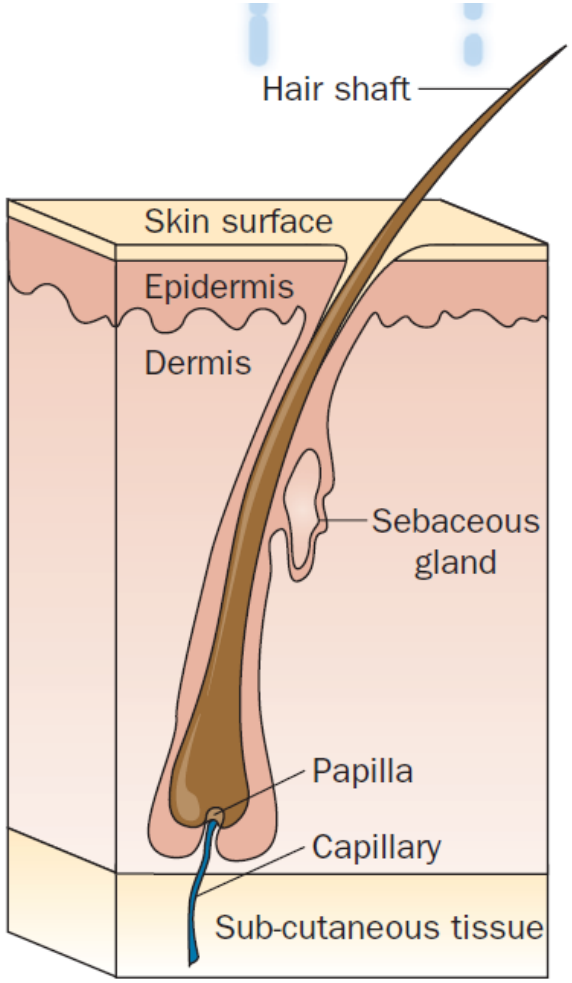


11TH NOVEMBER 2020

https://askinglot.com/open-detail/198926

Hairs

- Hairs grow from the base of the *follicle* upward.
- Hair is made of *keratin*, a tough-protein based material from which nails and horns are made in animals.
- *Sebaceous glands* produce oils that coat hairs, helping to keep them soft and pliable.
- At the end of the follicle is a network of blood vessels that supply nutrients to feed the hair and help it grow. This is called the *papilla*.



The lower end of hair root

https://askinglot.com/open-detail/198926

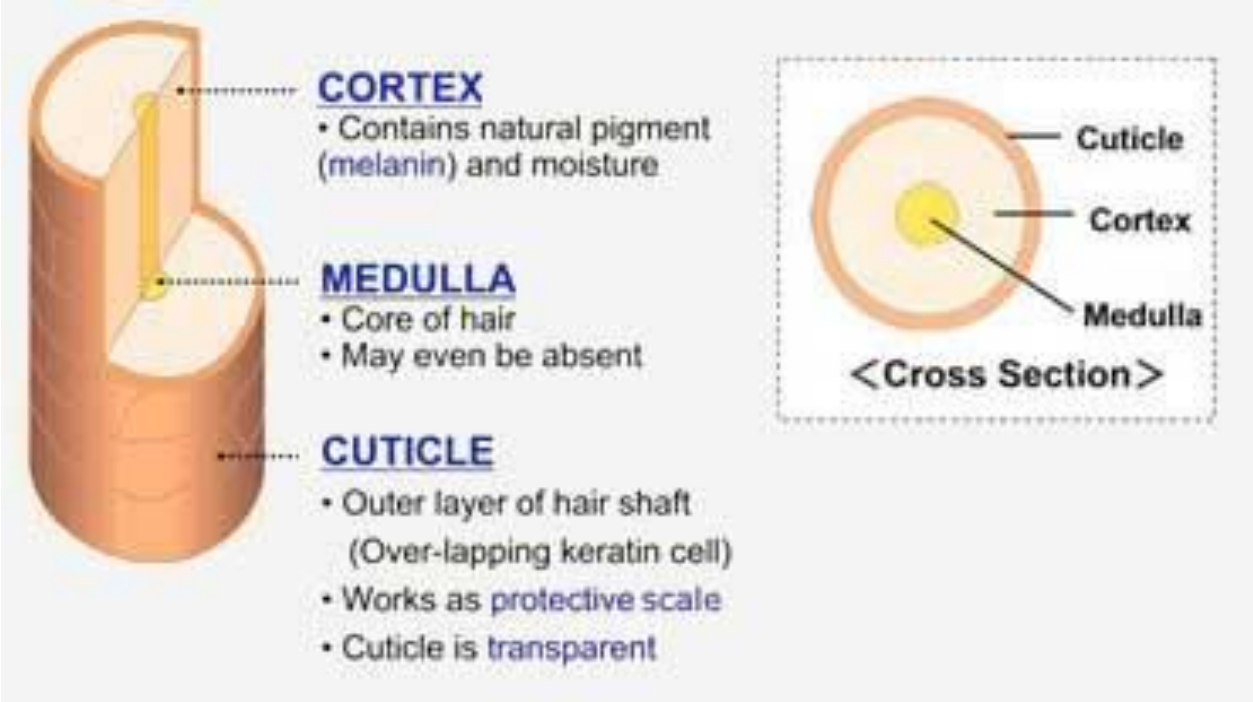
Hair structure

- Generally, a single hair on a macro scale is composed of a root, a shaft, and a tip.
- The **root** is the portion that formerly was in the follicle, the **proximal** (the direction toward the body) most portion of the hair.
- The **shaft** is the main portion of the hair.
- The **tip** is the **distal** (the direction away from the body) most portion of the hair.

https://slideplayer.com/slide/7480900/

Internally structural elements in hairs

- The **cuticle** of a hair is a series of overlapping layers of scales that form a protective covering.
- The **cortex** makes up the bulk of the hair. Pigment granules are found in cortex and dispersed variably throughout the cortex.
- The **medulla** is the inner layer which essentially is an air-filled channel inner layer.



https://sshairartistry.com/thehairblog/2019/1/23/uii2akb9c4cqz88h2tnxfeuppqwrhv

Five different patterns of medulla used in forensic hair analysis

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	

https://askinglot.com/open-detail/198926

Hairs from different parts of the body

The physical characteristics of hairs provide information about which part of the body they came from.

Courtesy, FBI; photos by Sandra Koch & Douglas W. Deedric

Pubic hair showing buckling

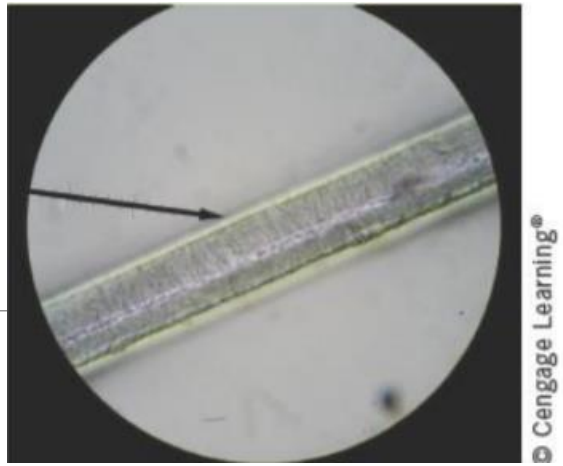
Beard hair with double medulla

Arm or leg hair with blunt, frayed end

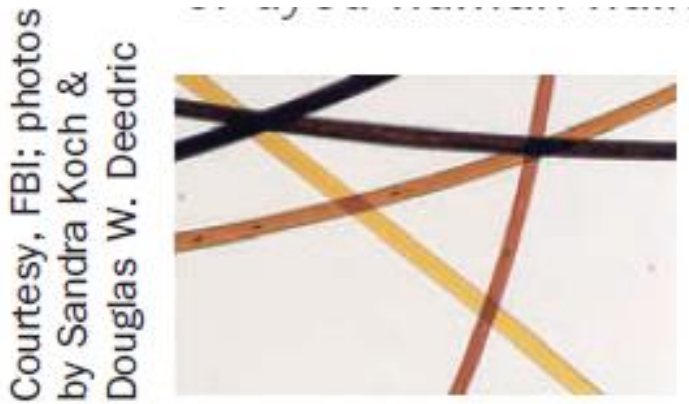
https://askinglot.com/open-detail/198926

Treated hairs

- Hair can be treated in many different ways such as bleaching and dyeing.
- Bleaching disturbs the scales on the cuticle and removes pigments leaving hair brittle and a yellowish color.
- Dyeing colors the cuticle and the cortex of the hair shaft.
- If an entire hair is recovered in an investigation, it is possible to estimate when the hair was last color-treated. The region near the root of the hair will be colored naturally.



Bleached hair lacks pigment in cortex.



Examples of dyed human hair

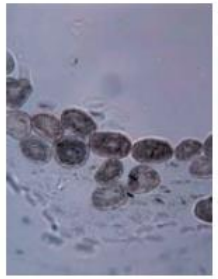
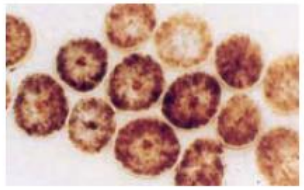
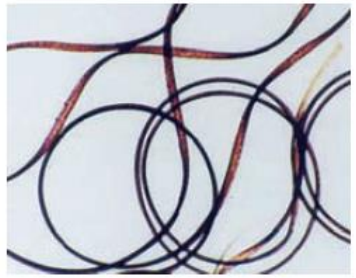
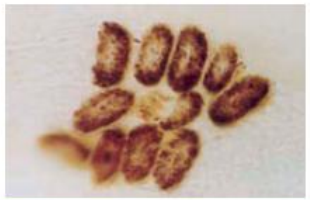
When was the hair last color-treated?

FACT : Human hair grows at a rate of about 1.3 cm per month (approximately 0.44 mm per day).

If an entire hair is recovered and the region near the root of the hair with colored naturally is measured to be 2.5 cm, when was the hair last color-treated?

Racial differences

https://askinglot.com/open-detail/198926

Race	Appearance	Pigment Granules	Cross Section	Other
European	Generally straight or wavy 	Small and evenly distributed	Oval or round of moderate diameter with minimal variation 	Color may be blond, red, brown, or black
Asian	Straight 	Densely distributed	Round with large diameter 	Shaft tends to be coarse and straight Thick cuticle Continuous medulla
African	Kinky, curly, or coiled 	Densely distributed, clumped, may differ in size and shape	Flattened with moderate to small diameter and considerable variation 	

Racial differences

Caucasoid

Oval Cross Section
Shaft Flexible
Colors Vary
Slight Fluctuation in Shaft Diameter

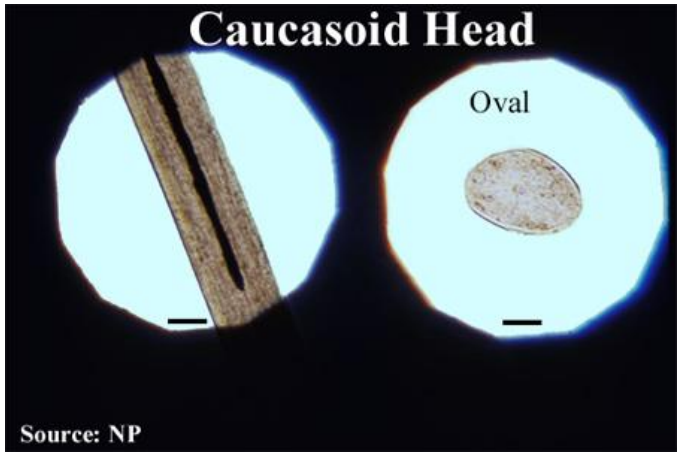
Negroid

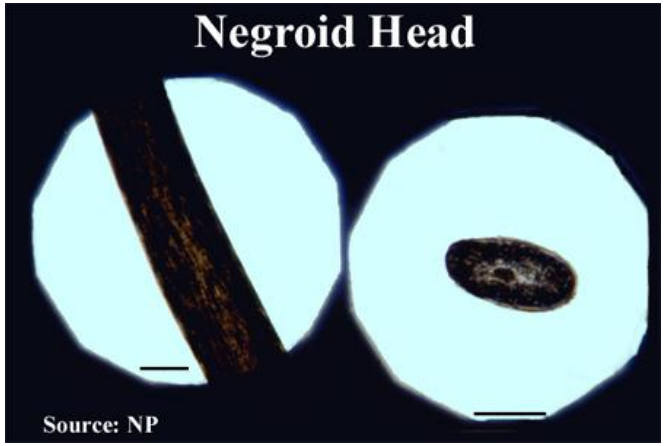
Flat Cross Section
Heavy Pigmentation
Usually Black in Color
Large Diameter Variation along Shaft

Mongoloid

Round Cross Section
Diameter Thick
No Diameter Fluctuation
Color Black

Source: FBI





Human versus animal hairs

An initial analysis is performed using a low-power compound microscope to determine whether the hair is human or animal

- There are 3 main characteristics used to differentiate human and animal hairs
- 1. **medulla thickness and shape**

The ratio of the diameter of the **medulla** to the diameter of the entire hair is known as the **medullary index**. If the **medullary index** is 0.5 or greater, the hair came from an animal. If the **medullary index** is 0.33 or less, the hair is from a human

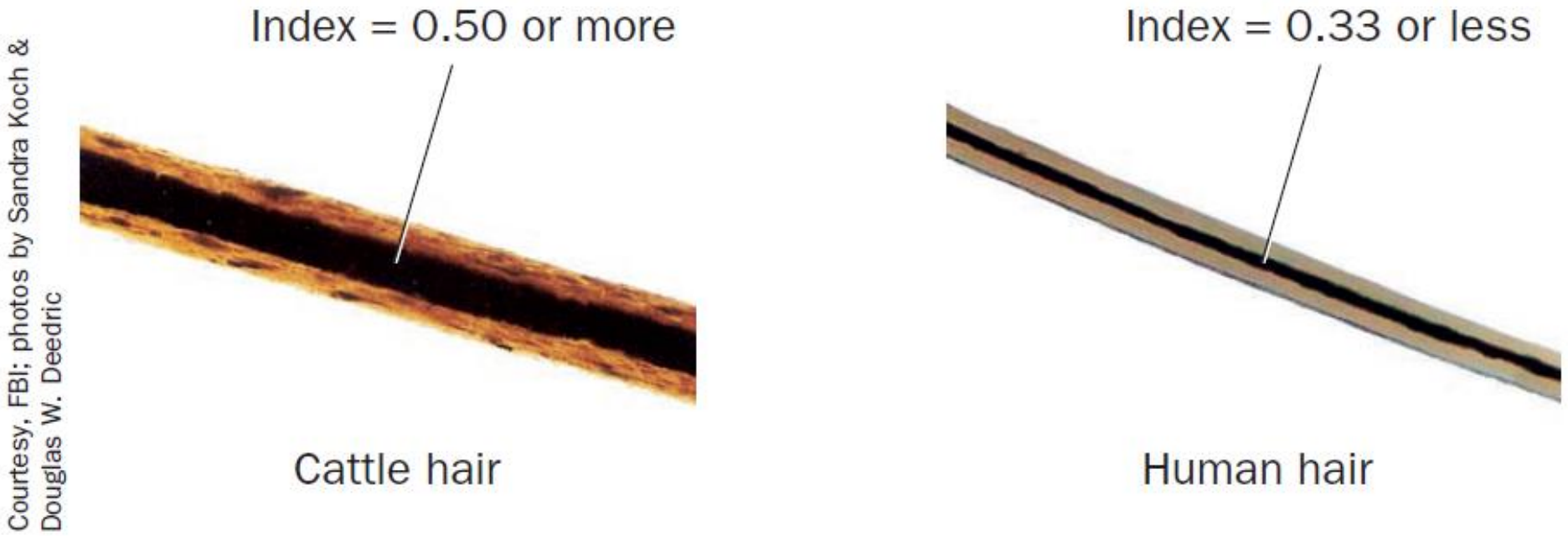
2. **Cuticle shapes**

Human hair has cuticle scales that are flattened and narrow, also called imbricate.

3. **pigment**

Color and pigmentation evenly distribute throughout the human hair shaft. Human hairs are usually one color along the length. Animal hairs can change color abruptly in a banded pattern.

Human vs animal hairs - medulla



The medulla is typically wider and more well defined in animal hairs.

Microscopic Evidence and Its Analysis

- Root Characteristics: Removal

Pulled

Forcibly removed

Shed

- Tip Characteristics

Burned

Cut

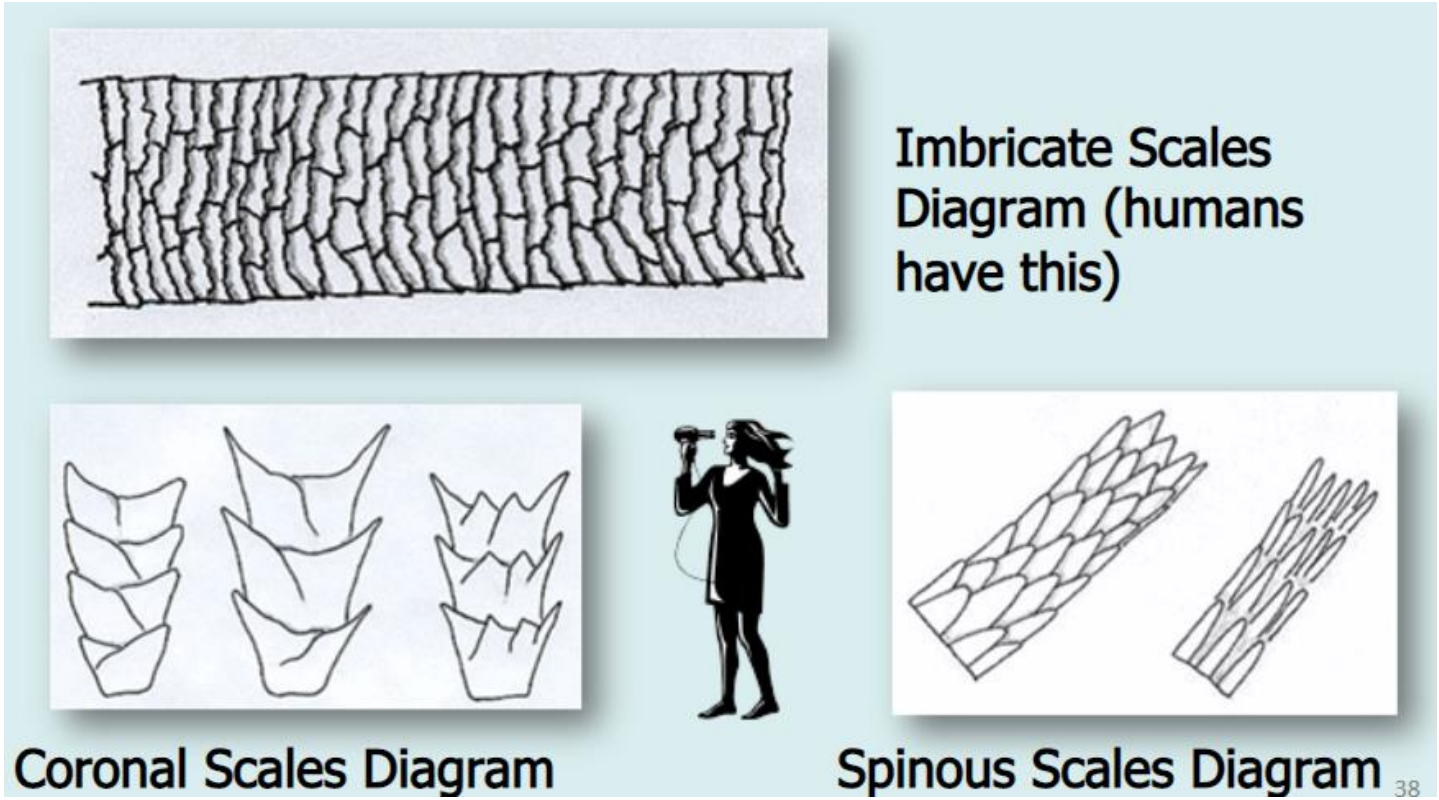
Razored

Split

Human vs animal hairs - medulla

https://slideplayer.com/slide/6518483/

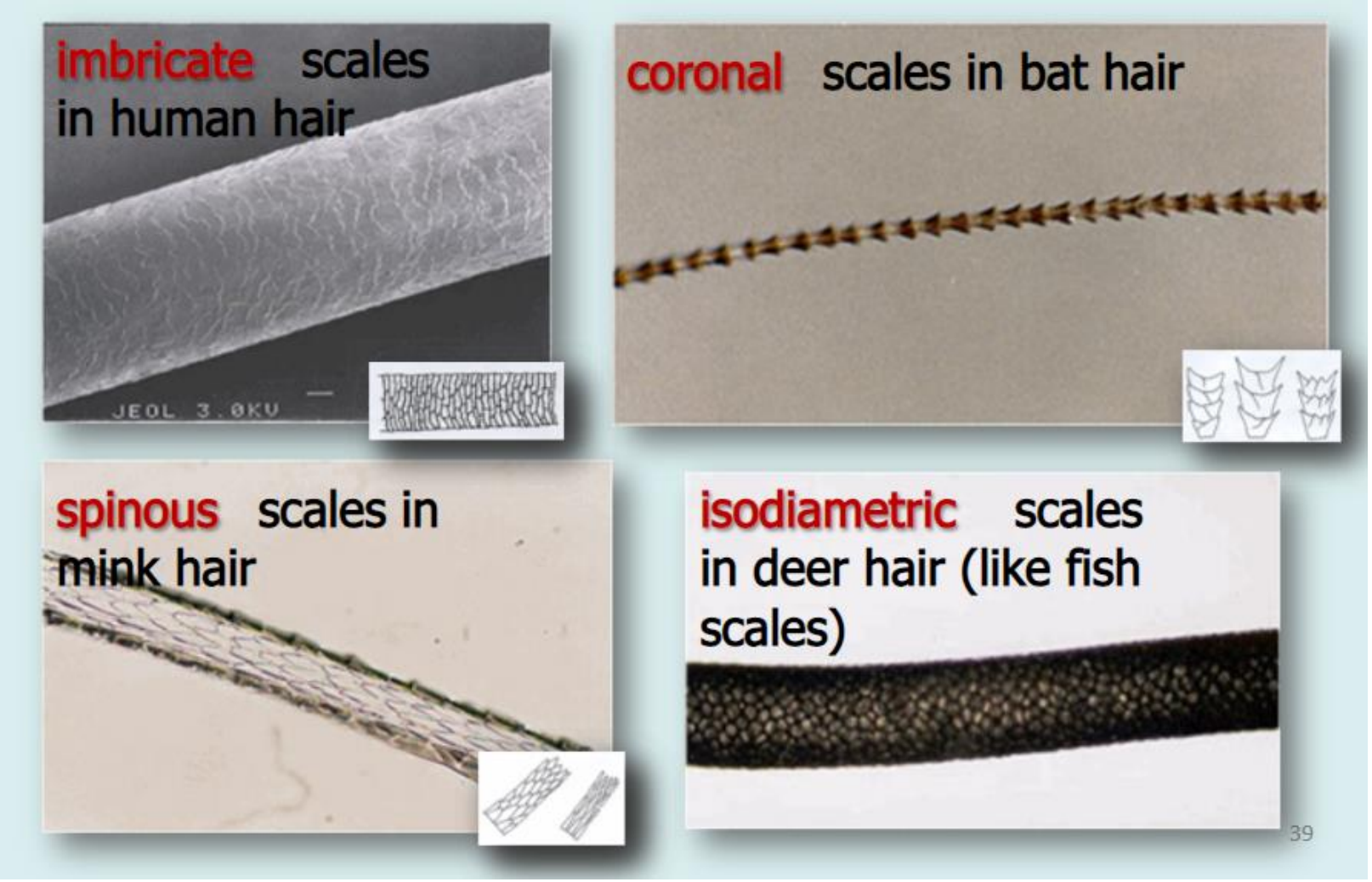
Human vs animal hairs – cuticle scales



- The scales point from the proximal end of the hair to the distal end.
- Human hair has cuticle scales that are flattened and narrow, also called **imbricate**.

https://slideplayer.com/slide/6518483/

Human vs animal hairs – cuticle scales

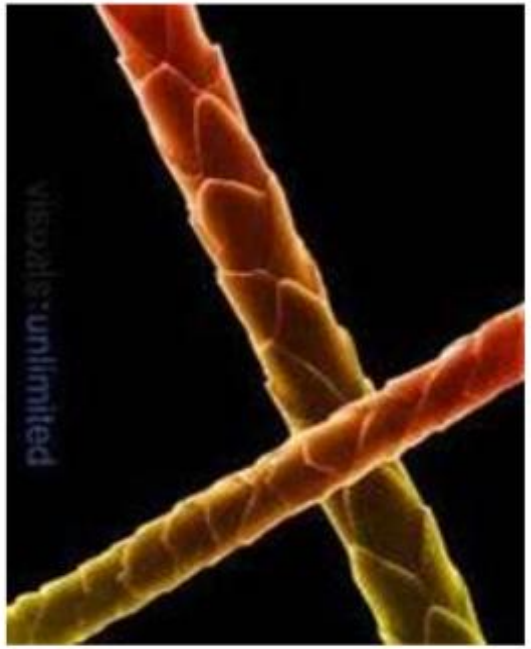


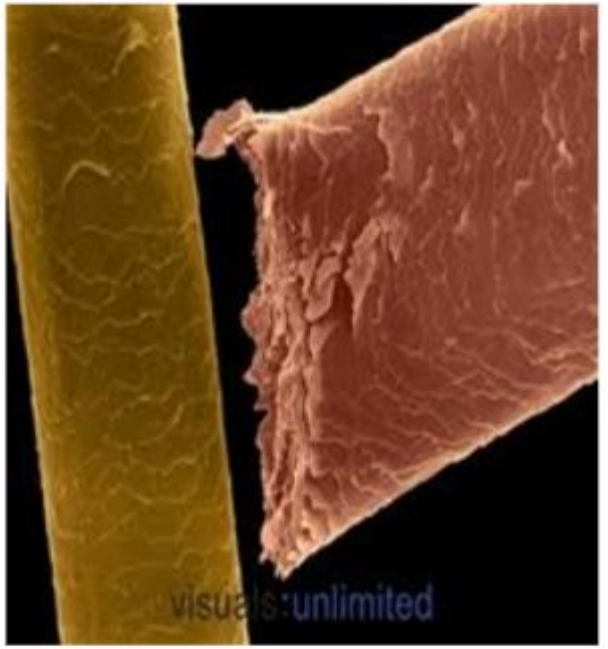
- Rodents and bats have a ***coronal*** cuticle with scales that give the appearance of a stack of crowns.
- Cats, seals, and mink have scales that are called ***spinous*** and resemble petals.
- Human hair has cuticle scales that are flattened and narrow, also called ***imbricate***.

Information provided by a hair examination

- Is it human or animal hairs?
- What is the possible race of the donor?
- What area of the body did it come from?

Which is human Hair ?

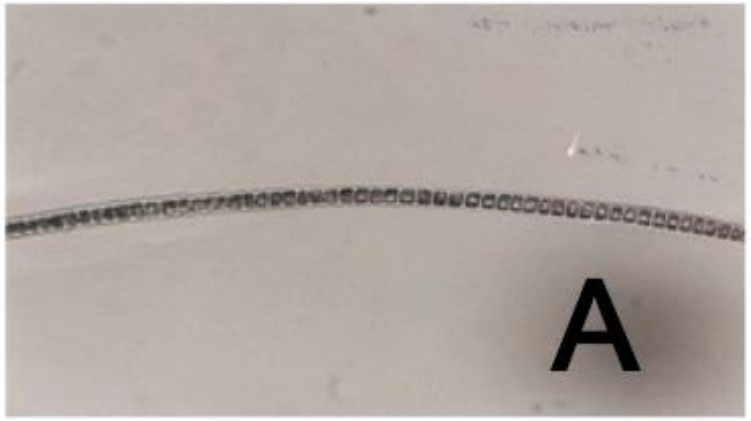




A B C

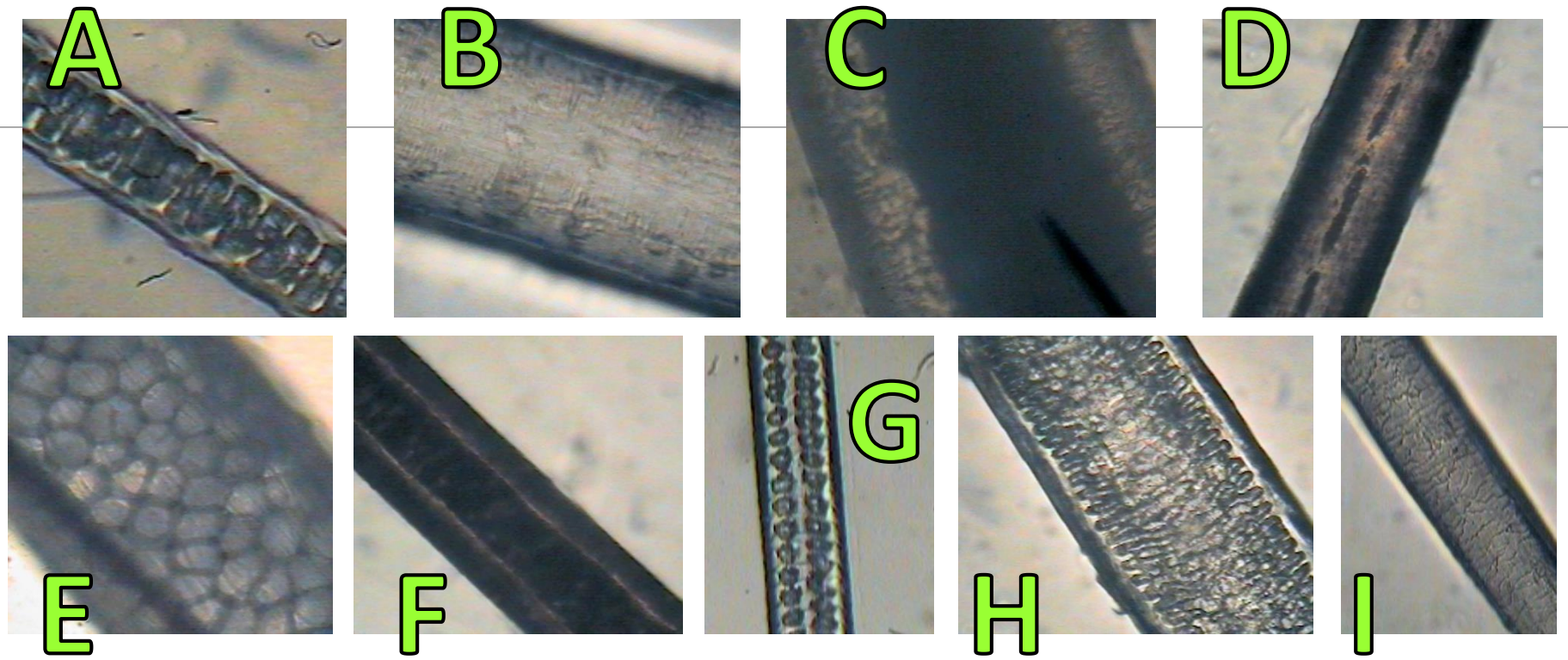
https://slideplayer.com/slide/7480900/

Which is human Hair ?



https://slideplayer.com/slide/7480900/

Can you identify the animal hairs shown?



Think About It …

(1) In which samples are we viewing the cuticle? How do they compare?

(2) In which samples are we viewing the medulla? How do they compare?

(3) What characteristics can be used to identify hair samples?

References

1. M M Houck and J A Siegel, “ Fundamentals of Forensic Science”, 2nd edition, Academic Press (2010).
2. A Langford, J Dean, R Reed, D Holmes, J Weyers and A Jones, ”Practical Skills in Forensic Science”, 2nd edition, Pearson (2010).
3. https://slideplayer.com/slide/6518483/
4. https://askinglot.com/open-detail/198926
5. https://msrobbinspnhs.weebly.com/uploads/1/4/1/6/14166475/fsci_ch_03_final.pdf