

Name _____ period _____

Unit 4: Hair and Fibers

Anatomy and Use in Forensic Science

Objectives

You will understand that:

- Hair is _____.
- Hair can be used to back up _____.
- Hair absorbs and adsorbs substances both from within the body and from the external environment.

You will be able to:

- Describe the structure of a hair.
- Explain the difference between human and animal hair.
- Explain which characteristics of hair are important for forensic analysis.
- Assess the probative value of hair samples.

Introduction

Human hair is one of the _____ pieces of evidence at the scene of a violent crime. It can provide a link between the criminal and the crime.

From hair, one can determine:

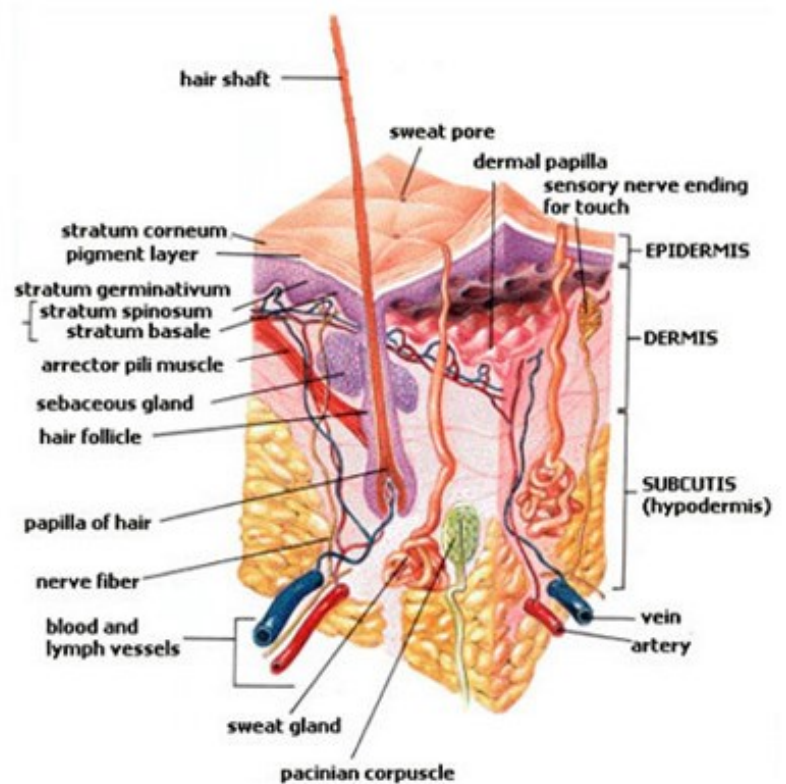
- If the source is _____
- Race (sometimes)
- Origin of the location on the source's body
- Whether the hair was _____
- If the hair has been treated with _____
- If drugs have been ingested

Skin Structure

Hair is composed of:

_____ - hairs grows out of a follicle (has cells with DNA for analysis)

_____ - hair extends from here (in the follicle) has cells with DNA



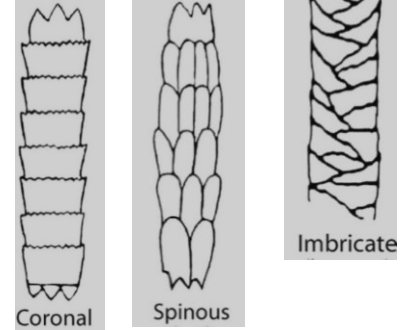
Hair Shaft

Composed of:

- **Cuticle**—outside covering, made of overlapping scales that _____.
Scales are formed from cells that _____ while progressing from the follicle
- _____—inner layer made of keratin and embedded with pigment (give color to hair); also contains air sacs called cortical fusi
- **Medulla**—inside layer running down the _____

The Cuticle

The cuticle is the outermost layer of hair which is covered with scales. The scales point toward the tip of the hair. Scales differ among species of animals and are named based on their appearance. **The three basic patterns are:** _____



Human Scales

In order to visualize the scales:

1. _____.
2. _____.
3. _____.

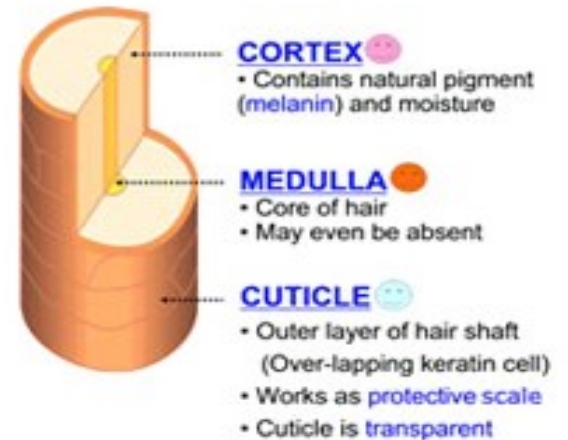
What pattern is seen in this slide?

The Cortex

The cortex gives the hair its _____.

It has two major characteristics:

1. **Melanin**—pigment granules that _____.
2. **Cortical fusi**—_____, usually found near the root but may be found throughout the hair shaft

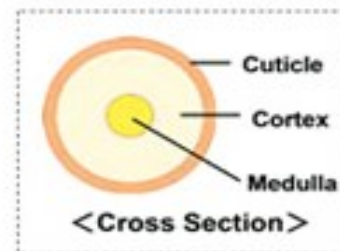


The Medulla

The medulla is the hair core that is not always visible. The medulla comes in _____

Human Medulla

Human medulla may be _____,
_____, or _____.



Medullary Index

Determined by measuring the diameter of the medulla and dividing it by the diameter of the hair.

- Medullary index for human hair is generally _____
- For animal hair, it is usually _____.

Hair Shape

Can be straight, curly, or kinky, _____, which may be round, oval, or crescent-shaped.

Hair Growth

Terminology

Anagen—hair is _____; lasts up to _____ years (85% of head hairs).

Catagen—hair is _____; a resting phase (_____) blood supply is cut off.

Telogen—follicle is getting ready to _____; lasts _____ (10-15% of head hairs)

Grows about _____ per day, or 1 cm per month; approximately one-half inch per month

The Root

Human roots look different based on whether they have been

_____ and have fallen out. Animal roots vary, but in general have a spear shape.

Hair Comparison

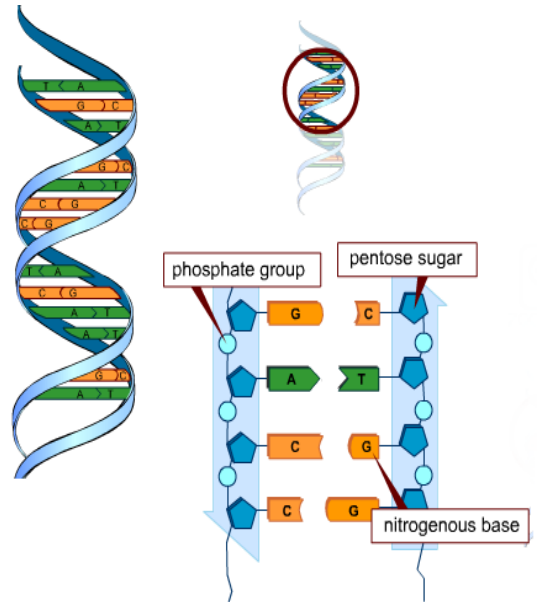
- Color
- Length
- Diameter
- Distribution, shape, and color intensity of pigment granules
 - _____
 - Bleaching removes pigment and _____
- Scale types
- _____ of medulla
- Medullary type
- Medullary pattern
- _____

DNA from Hair

- The root contains _____. If the hair has been forcibly removed, some follicular tissue containing DNA may be attached.
- The hair shaft contains abundant _____, inherited only from the mother. It can be typed by comparing relatives if no DNA from the body is available. This process is more difficult and more costly than using nuclear DNA.

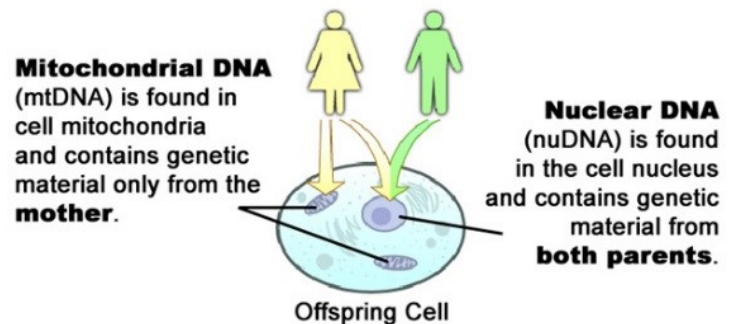
Structure of DNA

- _____.
- Nucleic acids have 3 parts: _____, _____, and a _____.
- The nitrogenous base can be 1 of 4:
 - _____
 - _____
 - _____ or _____.
- Because only the bases can change, it is the order of bases that determines the genetic code.
- Individuals have unique sequences of bases in their DNA (except identical twins), and this information can be used to link _____ samples.



Mitochondrial DNA

- Nuclear DNA makes exact copies of itself through _____.
- Mitochondrial DNA is DNA only found in the _____. This DNA copies itself independently of nuclear DNA.
- Mitochondria are inherited from the _____ with little to no change in sequence from parent to offspring.
- The _____ allows for establishing relationships between people (more similar the mtDNA, more closely related)
- Mitochondrial DNA was admitted into evidence for the first time ever in 1996 during _____.



Collection of Hair

Questioned hairs must be accompanied by an adequate number of control samples.

- From _____
- From possible _____
- From others who may have deposited hair at the scene

Control Sample

- _____ full-length hairs from all areas of scalp
- _____ full-length pubic hairs

Hair Toxicology

Advantages:

- _____
- Is externally available
- Can provide information on the individual's _____ or _____
- Collections must be taken from different locations on the body to get an accurate timeline.

Napoleon died in exile in 1821. By analyzing his hair, some investigators suggest he was poisoned by the deliberate administration of arsenic; others suggest that it was vapors from the dyes in the wallpaper that killed him.

Fibers and Textiles Notes

How forensic scientists use fibers

Fibers are used in forensic science to create a link between crime and suspect

Through normal activities

We shed fibers

We picked up fibers

Very small fibers are classified as _____

Fiber evaluation can show

- Type of fiber
- _____
- Possibility of violence
- _____
- _____

Sampling and Testing

- Shedding—common form of fiber transfer
- Microscopes reveal characteristic _____
- Infrared spectroscopy reveals chemical structures to differentiate similar fibers
- Destructive Testing Methods
 - _____
 - _____
- Compare fibers found on different suspects with those found at the crime scene

Macromolecules

4 Macromolecules:

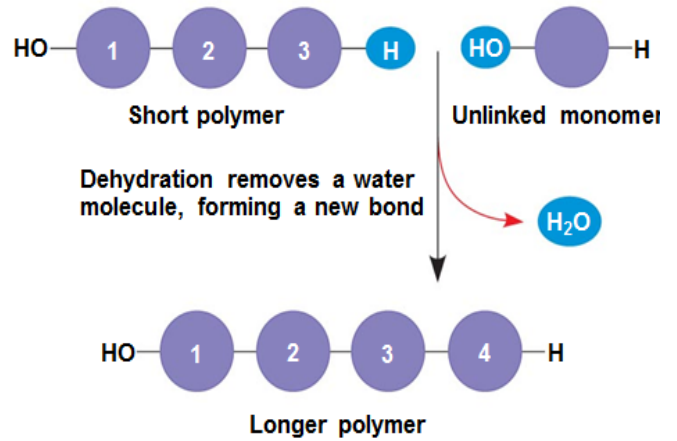
- Lipids (does not form polymers)
- Nucleic Acids
 - Monomers: Nucleotides
 - Polymer: DNA/RNA
 - Function: Hereditary information

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 - Monomers: Single sugars/

 - Polymer: polysaccharides
 - Animals: glycogen (energy storage)
 - Plants: Starch (energy storage) and _____ (structural)
 - Function: Energy storage/cell-cell recognition

 - Monomer: amino acids
 - Polymer: polypeptide chain (protein)
 - Function: structural support, storage, transport, cellular communications, movement, and defense against foreign substances,



Polymerization

Macromolecules form long chains (_____) from single building blocks (_____)

- Carbohydrates (cellulose in plants) and proteins (polypeptides from animals) are used to make fibers and textiles

Comparison of Natural and Synthetic Fibers

Visual Diagnostics of Some Common Textile Fibers under Magnification

Yarns, fabrics, and textiles

<ul style="list-style-type: none"> ◆ Flattened hose appearance ◆ Up to 2 inches long tapering to a blunt end ◆ may have a frayed "root" ◆ hollow core not always visible 	<ul style="list-style-type: none"> ◆ "bamboo stick" appearance ◆ straight with angles but not very curved ◆ "nodes" are visible every inch or so ◆ often occur in bundles of several fibers 	<ul style="list-style-type: none"> ◆ do not taper, yet exhibit small variations in diameter ◆ may be paired (raw silk) with another fiber ◆ no internal structure 	<ul style="list-style-type: none"> ◆ surface scales may be visible ◆ hollow or partial hollow core ◆ fibers up to 3 inches long tapering to a fine point 	<ul style="list-style-type: none"> ◆ 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
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Yarns—fibers (of any length, thick or thin, loose or tight) twisted or spun together

Blending fibers meets _____

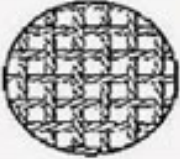
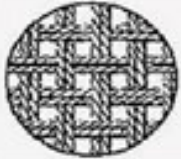
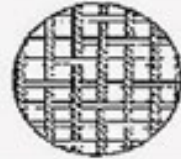


(e.g., resistance to wrinkling)

Fibers are _____

- Threads are arranged side by side (the warp)
- More threads (the weft) are woven back and forth crosswise through the warp

Examples	_____ & cashmere (sheep) mohair (goat) angora (rabbits) alpaca, camels, llamas	Coir Hemp _____ _____, flax manila, sisal	Fiberglass, _____ _____	_____ _____ Polyamide nylon	_____ _____ _____ _____ _____
Character-istics	Resists wrinkling	Absorbs Insoluble in water Resistant to damage from chemicals Dissolvable	_____ _____ Nonflammable Doesn't deteriorate in normal usage	Produced by processing various natural polymers	Petroleum base Very different from other fibers Made from monomers →
Protein/ Cellulose/ Neither?					
Types of Fibers	Animal	Plant	Mineral	Synthetic cellulose (regenerated)	Synthetic polymer fibers
Classification	Natural			Synthetic	

Weave Patterns

				
<ul style="list-style-type: none"> ◆ firm and wears well ◆ snag resistant ◆ low tear strength ◆ tends to wrinkle 	<ul style="list-style-type: none"> ◆ open or porous weave ◆ does not wrinkle ◆ not very durable ◆ tends to distort as yarns shift ◆ shrinks when washed 	<ul style="list-style-type: none"> ◆ not durable ◆ tends to snag and break during wear ◆ shiny surface ◆ high light reflectance ◆ little friction with other garments 	<ul style="list-style-type: none"> ◆ very strong ◆ dense and compact ◆ different faces ◆ diagonal design on surface ◆ soft and pliable 	<ul style="list-style-type: none"> ◆ open weave ◆ easily distorted with wear and washing ◆ stretches in one direction only

Summary

Fibers are a form of _____

Fibers are a form of _____

Fibers are spun into yarns having specific characteristics.

Yarns are woven, with different patterns, into clothing or textiles.

Fiber evidence is gathered using different techniques.

Fibers are analyzed using _____, tests for solubility in different solutions, polarized light microscopy, or infrared spectroscopy.

Fibers are classified as _____.

Natural fiber sources include: Animal hair, Plant seeds, fruit, stems, or leaves, and Minerals.