Hair and Fiber

What is hair???

It's an appendage that grows out of an organ known as the *hair follicle* which is found on the skin of mammals. It is an organ found in the epidermis of the skin.

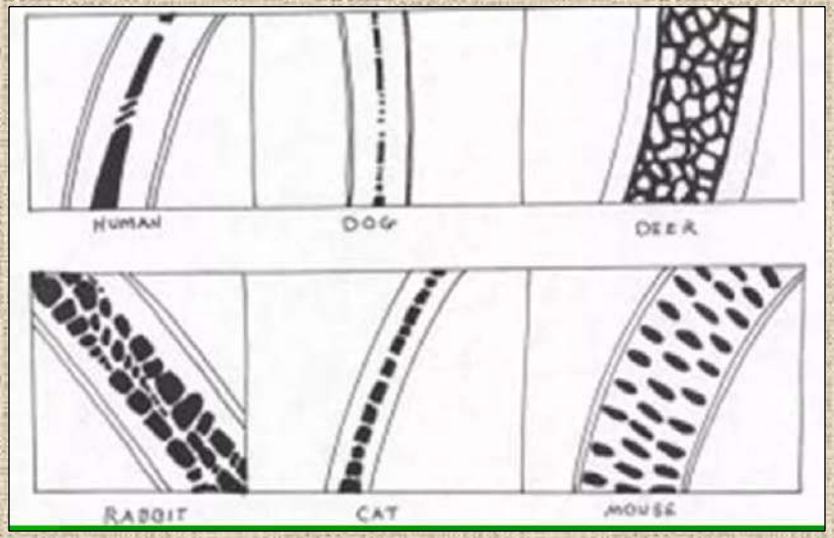
Why do you think we have hair???

How does hair differ?

When hair is observed/compared, there are significant differences between…

***one species and another**

***one individual and another**



Considerations in Hair Examination

Microscopes are use for morphological features.

*Animal vs. human (scale structure, medullary index, medullary shape)

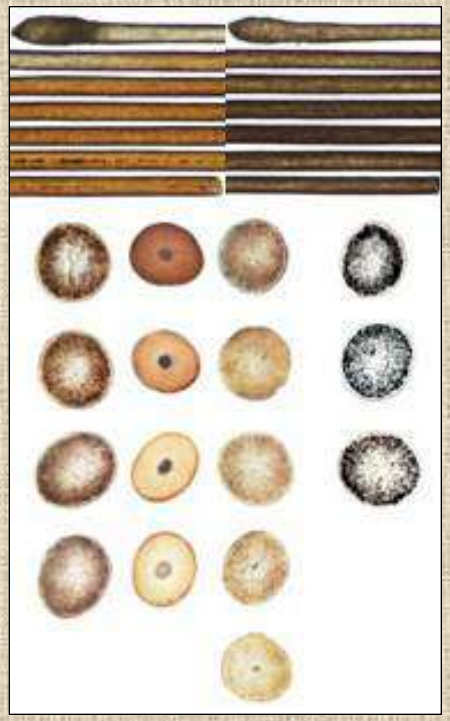
*Comparing color, length and diameter

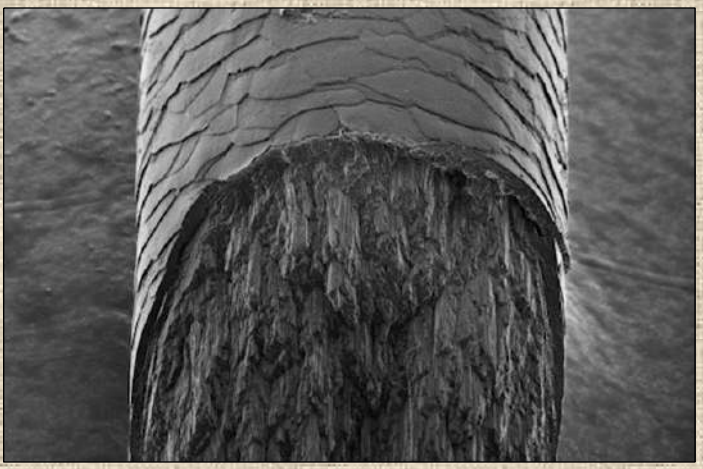
*Medulla pattern or absence of medulla

*Color intensity of pigment granules – dyed/bleached hair.

-Hair grows approximately *one centimeter per month* to determine last dying of hair.

What is in hair & fur???





Mostly composed of protein.

Keratin & Melanin make up 80-90% of a hair's composition.

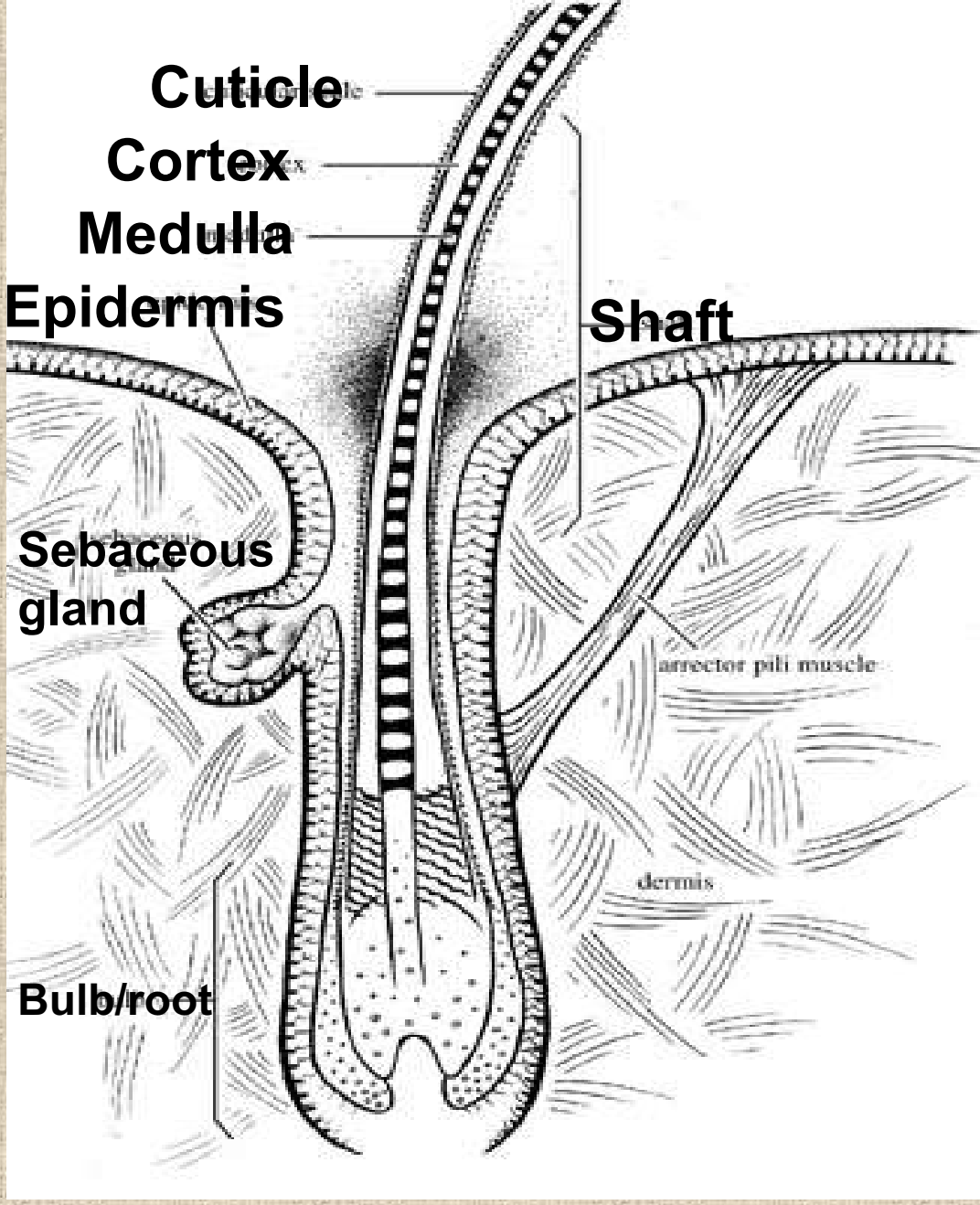
***Keratin is extremely strong, also found in claws, nails, horns.**
***Melanin gives hair it's color.**

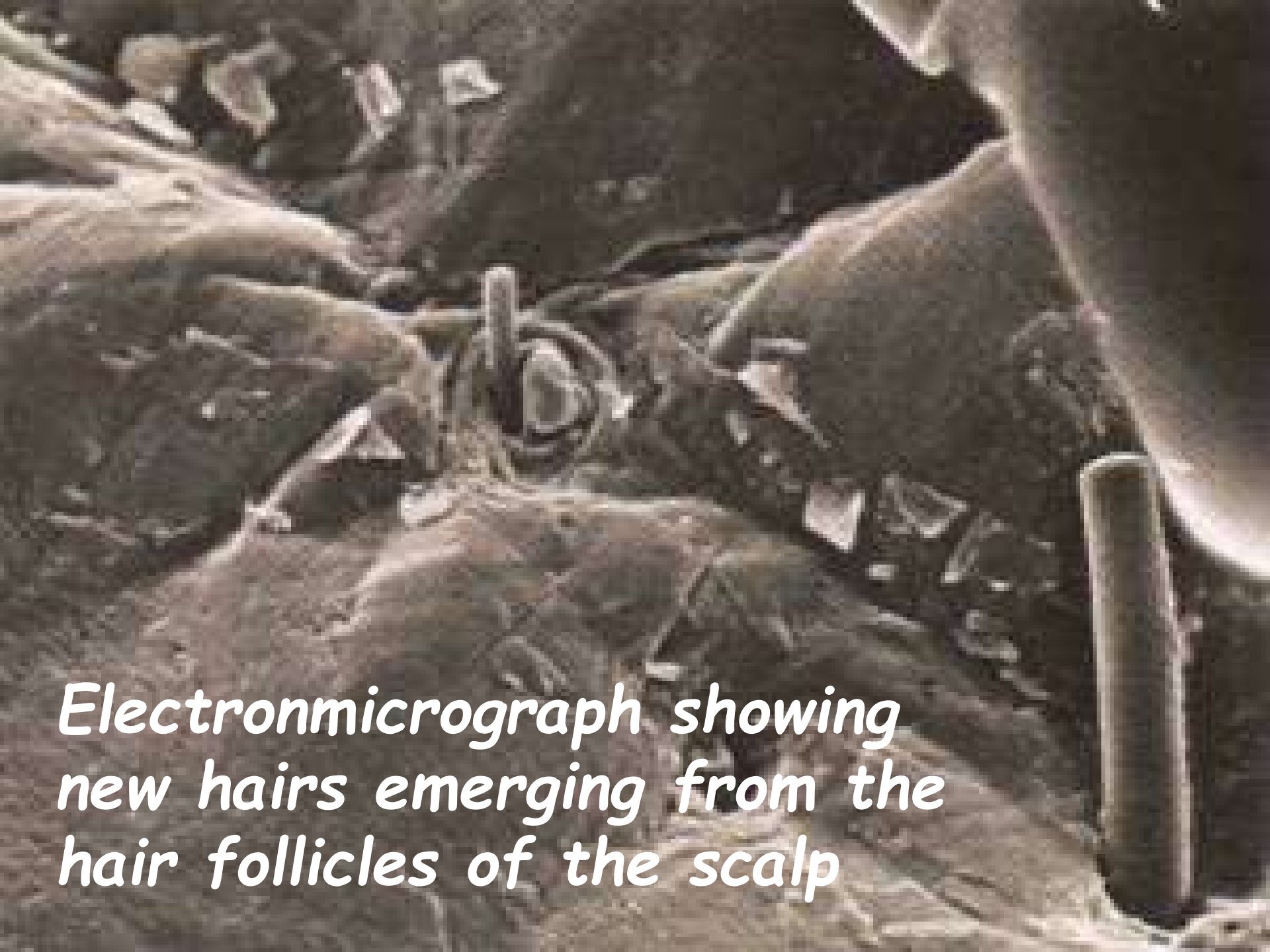
Three Layers

Cuticle: 'scale pattern'. Gives resistance & stability to hair. Scale pattern is different between human & animal.

Cortex: Within the cuticle.
Made up of spindle-shaped arranged parallel to length of hair.
Contains pigment granules.

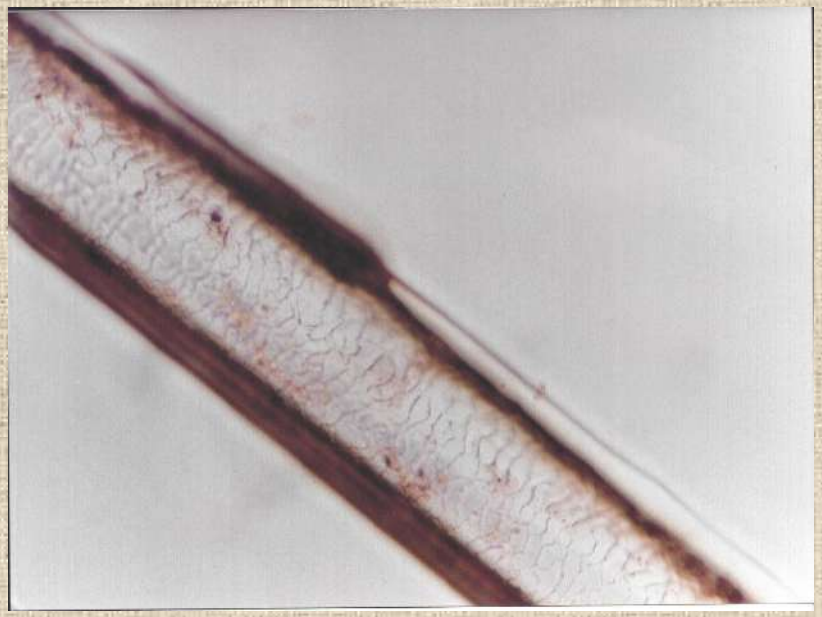
Medulla: Collection of cells running through a hair. The medullary index is used to compare

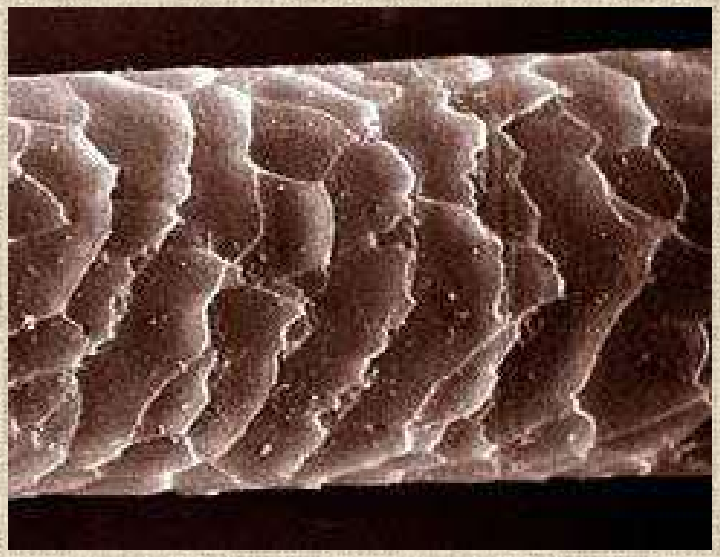




Electronmicrograph showing new hairs emerging from the hair follicles of the scalp

Cuticle Patterns





MEDULLA PATTERNS

Human Hair: Medullas are normally *absent* (not present) or *fragmented* with a medullary index <1/3

Animal Hair: Posses many different patterns of medullas.

*When a medulla is present, a medullary index can be determined.

Solid Medulla Patterns

Continuous

Interrupted

Fragmented

Human Hair with a medulla

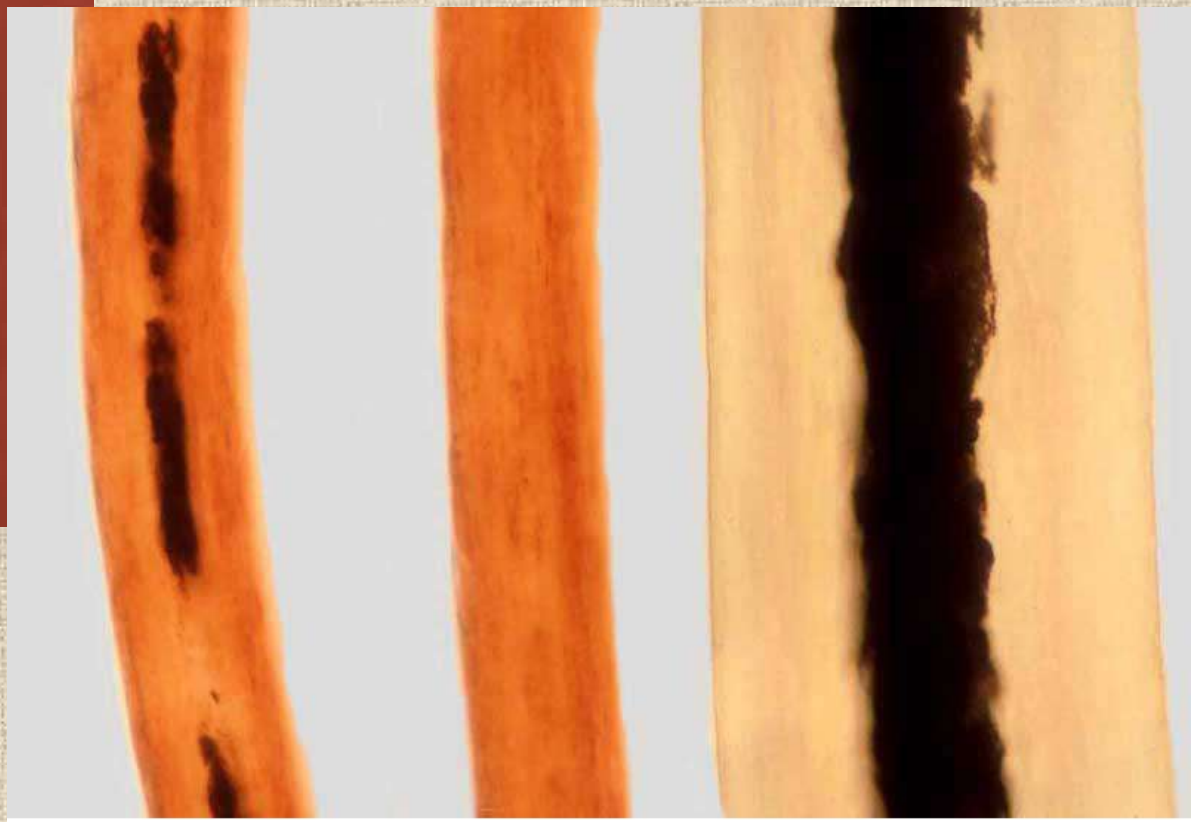
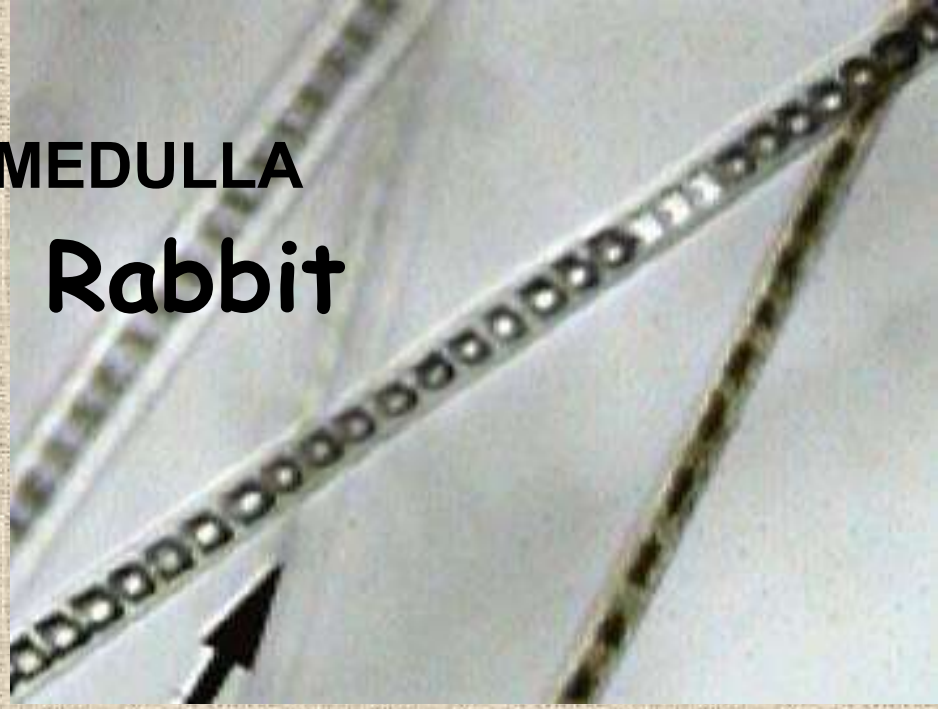
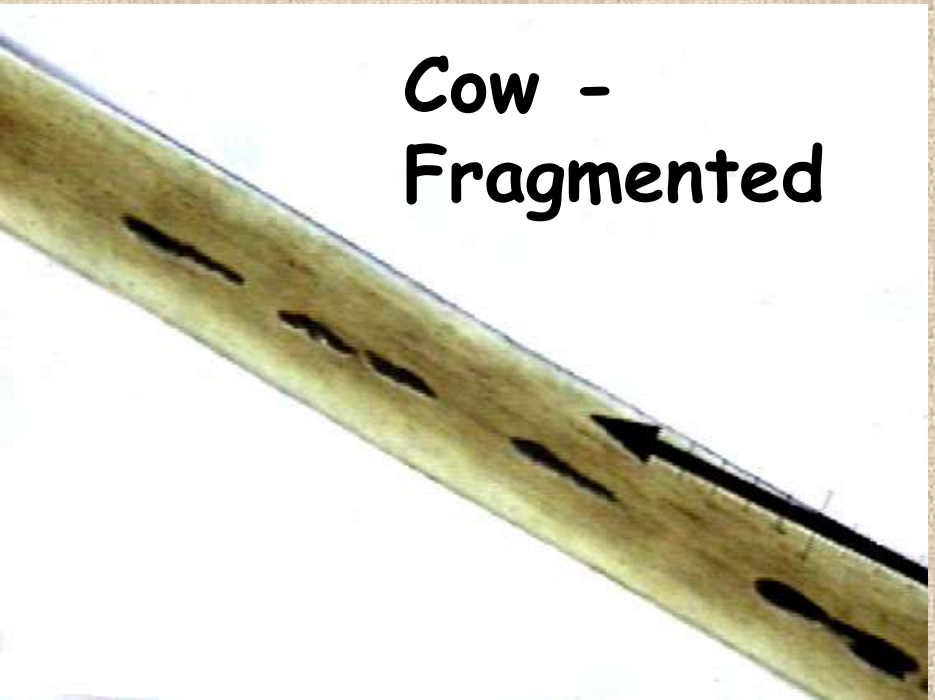
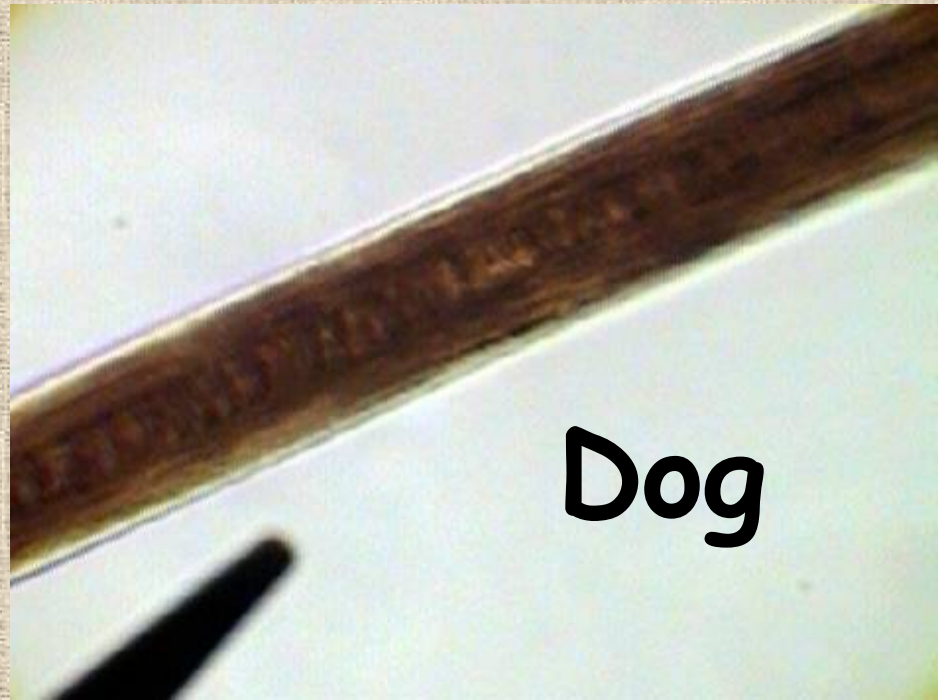


Figure 3. Light micrographs of three human hairs. The left example illustrates dark hair with a typical fragmentary medulla. The middle hair is blond and has no medulla. The right coarser hair is white with a continuous medulla.

UNISERIAL MEDULLA



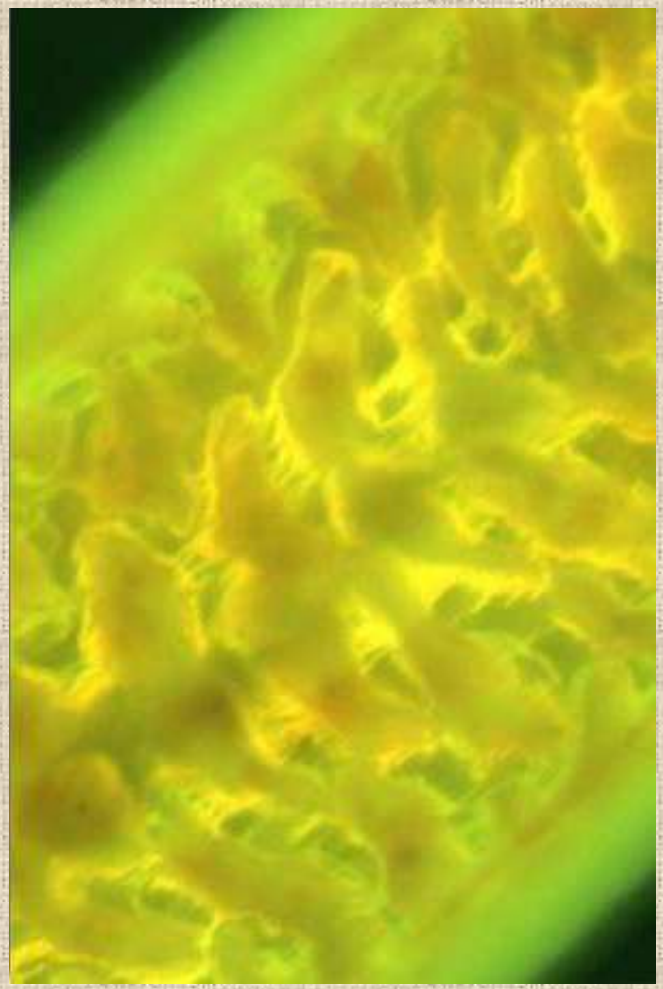




Goat - Vacuolated

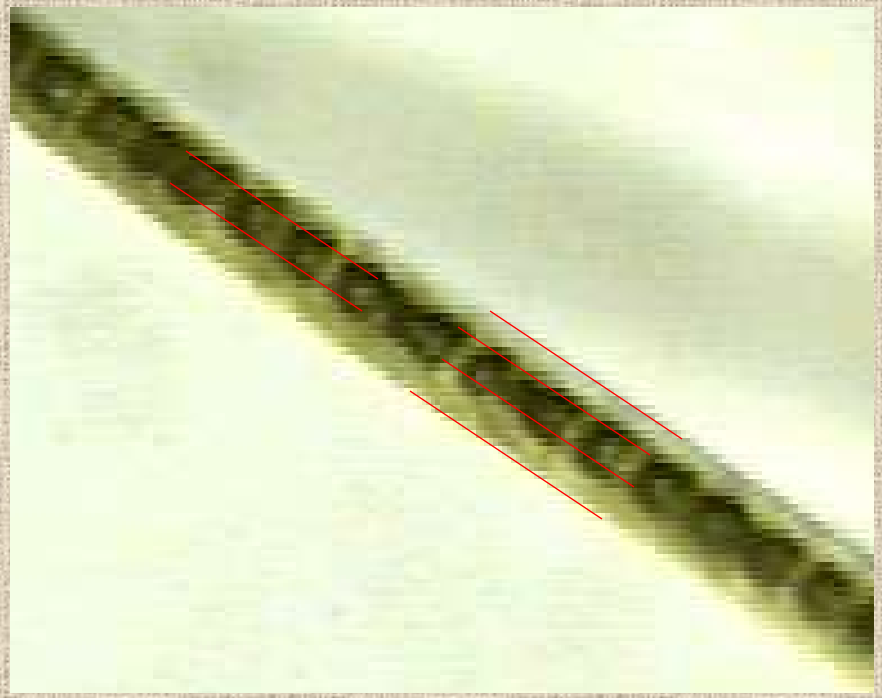
Deer - Lattice

Guinea pig Hair - Vacuolated



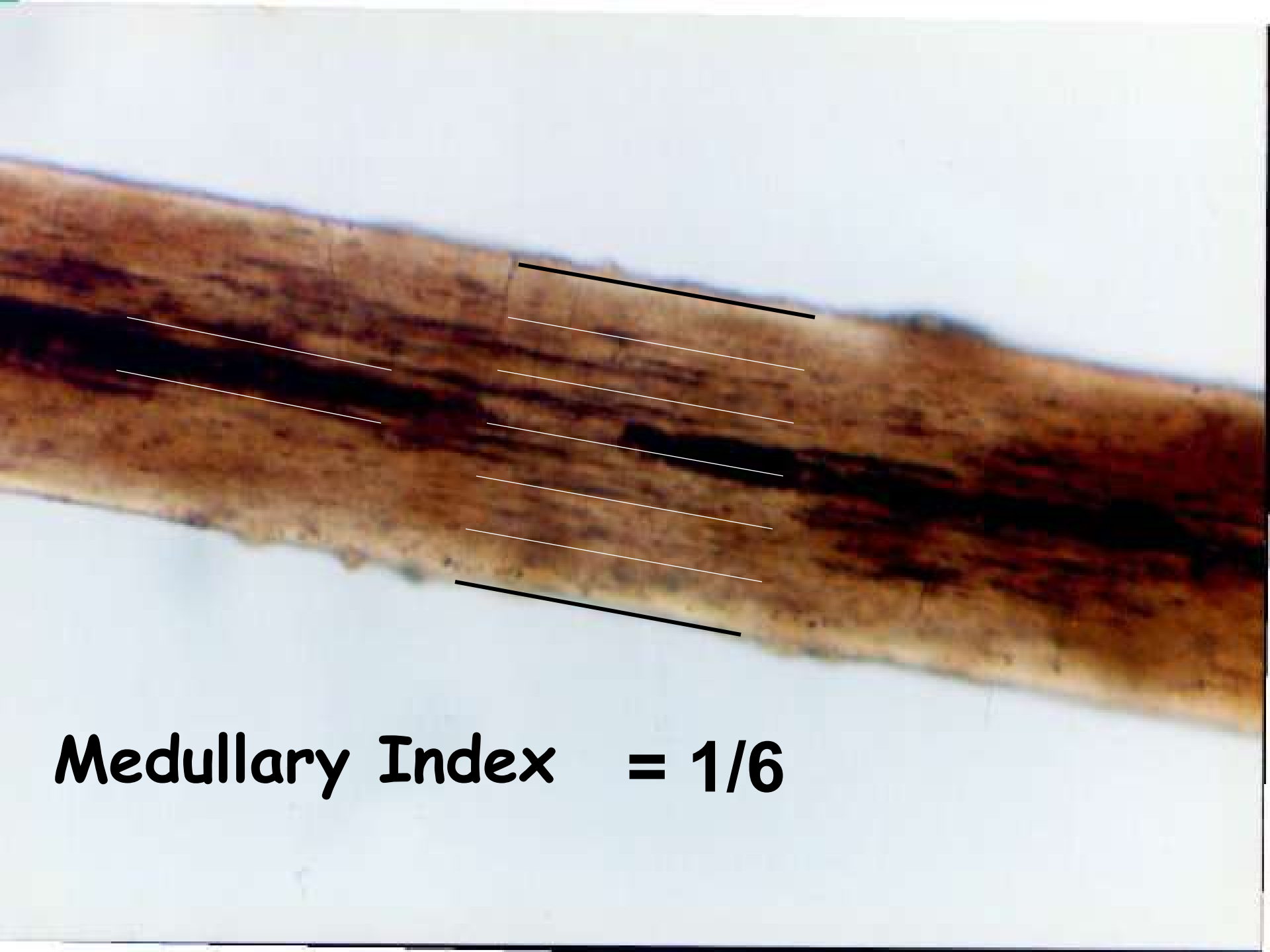
MEDULLARY INDEX

A fraction of the hair's diamter that is occupied by the medulla.



The medulla occupies 1/3 of the hair's diameter.

The medullary index is 1/3



Medullary Index = 1/6

Hair As Evidence

Must have an adequate number of standard/reference samples from the victim & suspect.

*Allows for variation.

Collecting hair from a suspect:

*50 head hairs from all areas of scalp

*24 pubic hairs – combed first for rape cases

Hair are compared – they can only be matched to hairs that have been collected from a crime scene. Must have enough samples to compare.

Questions Concerning Hair Examination

Can the body area of origin be determined?
It is normally easy to determine.
*Scalp – little diameter variation, uniform distribution of pigment.
*Pubic – Short, curly, variation in diameter, usually have a continuous medulla.
*Beard – Coarse, normally triangular cross section, blunt tips acquired from cutting/shaving.

2) Can racial origin be determined?
In many instances, yes.
*Caucasian: Straight or wavy, more even distribution of pigments, oval/round cross section.
*African (Negroid): Tight curls, strong, uneven distribution of pigments, oval cross-section (fairly flat).
*Asian (Mongoloid): Round cross-section, greater diameter, less dense, more straight

CORTEX

Pigment patterns in the cortex for three different ancestries

Compare these cross-sections of three hairs, all of different racial types: (left) Asian, (centre) Caucasoid, (right) African

Questions concerning hair Examination, cont.

3) Can age & sec be determined?
Age – No (except with intact hair)
Sex – No. DNA adhering to hair/root needed.

4) Is it possible to determine if hair was forcibly removed?
It may. Microscopic examination needed.
A follicular tag (tissue) indicates hair that has been pulled out by a person or brushing.

5) How do you individualize human hair?
DNA. And when there isn't enough nuclear DNA, mitochondrial DNA is. Mitochondrial DNA can't individualize.

6)Chemically treated hair – Look for cuticle damage

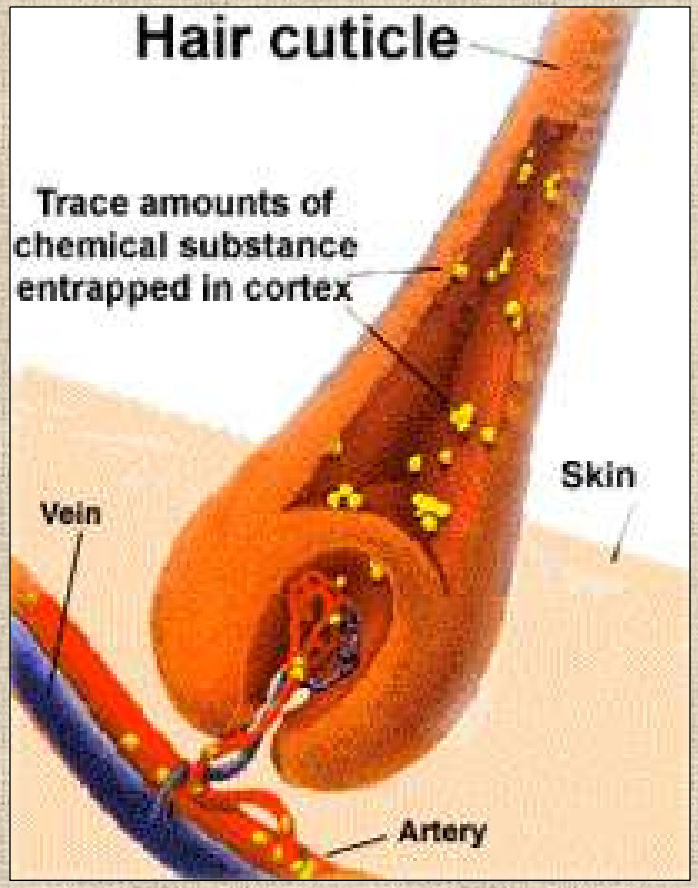
HAIR TOXICOLOGY

Drugs & toxins find their way into a strand of hair through the bloodstream.

*Blood flows into the follicle and these compounds are passed into the hair as it develops.

*Hair growth (1cm – ½ inch per month) provides a ‘timeline’ of drug/poison intake.

Environmental toxins, prolonged alcohol intake can also be measured in hair.



The Root

Provide the tools necessary to produce hair & continue its growth.

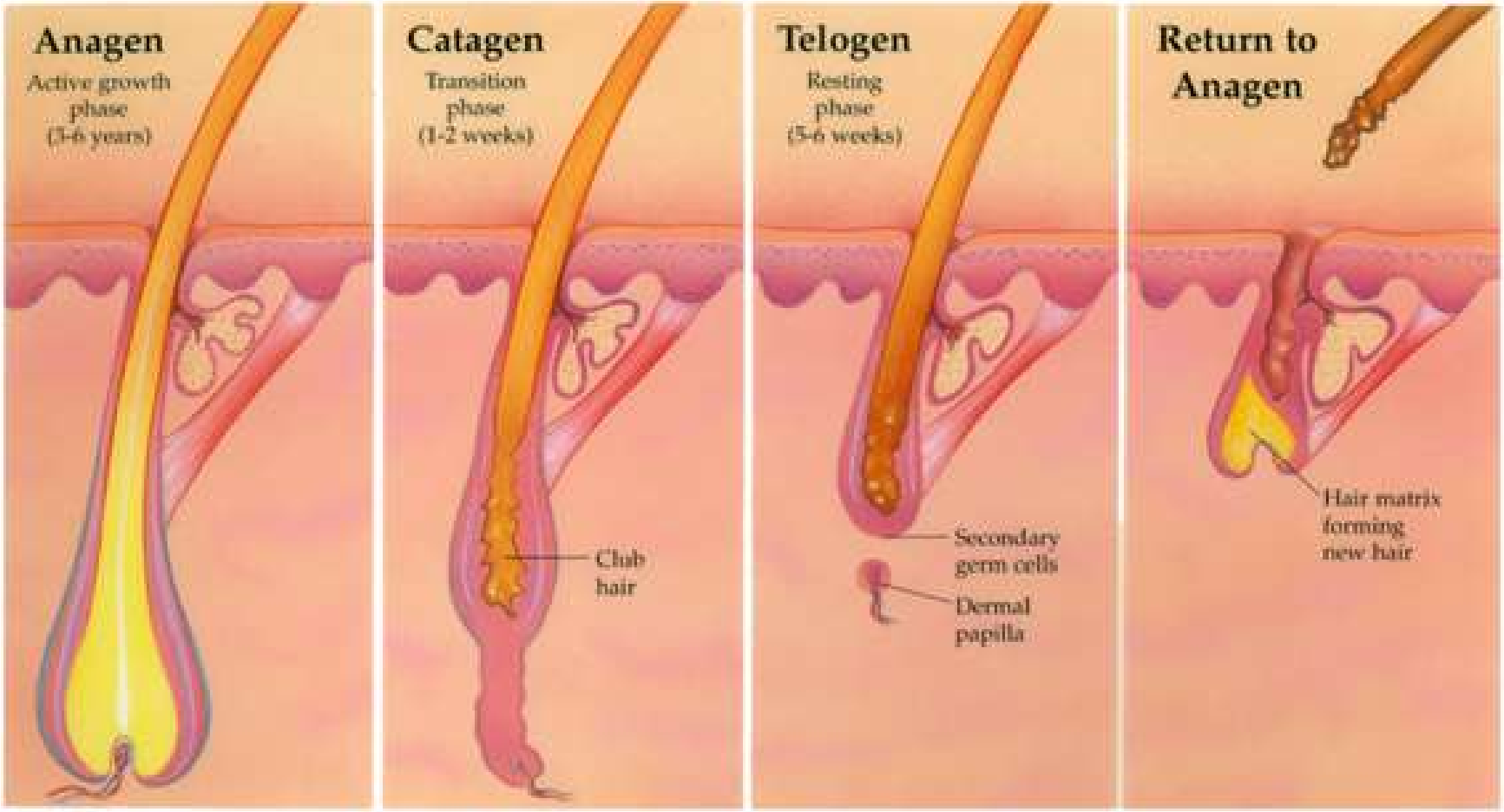
Human hair grows in three phases:

Anagen: Root is attached to the follicle for continued growth (up to 6 years). *A follicular tag* attaches to the root when hair is forcibly removed (DNA)

Catagen: Growth at a decreased rate. Lasts 2-3 weeks. Root elongates and is pushed out of the follicle.

Telogen: Root take a club-shaped appearance & is pushed out of the follicle. Takes 2-6 months.

Hair Growth Cycle



The Root

The condition of the hair's root can tell officials if…

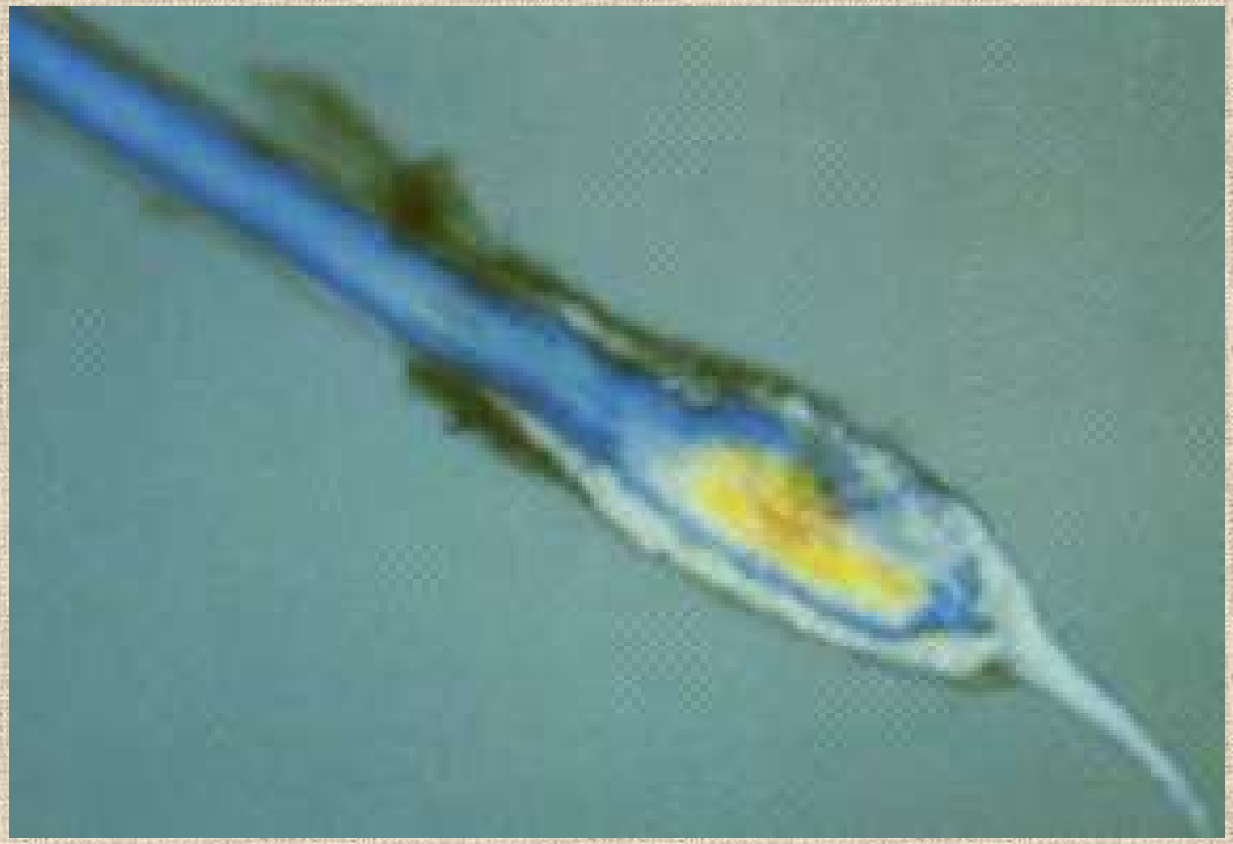
*The hair was naturally shed

*Forcibly removed

If a hair was forcibly removed, skin cells from the follicle will be attached.

Skin cells give us DNA!!!

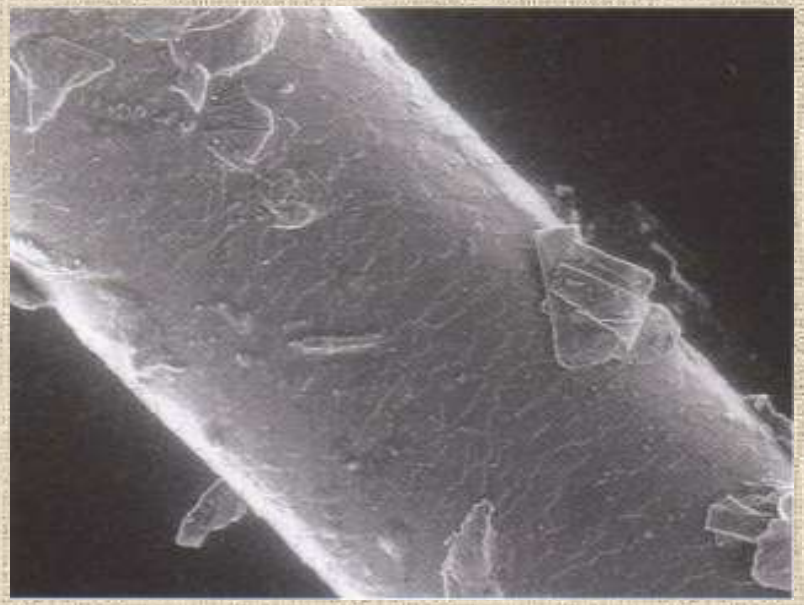
The root of a hair that is *forcibly removed* carries a translucent piece of tissue called the *follicular tag*. This is an anagen hair, one which was not ready to be shed.



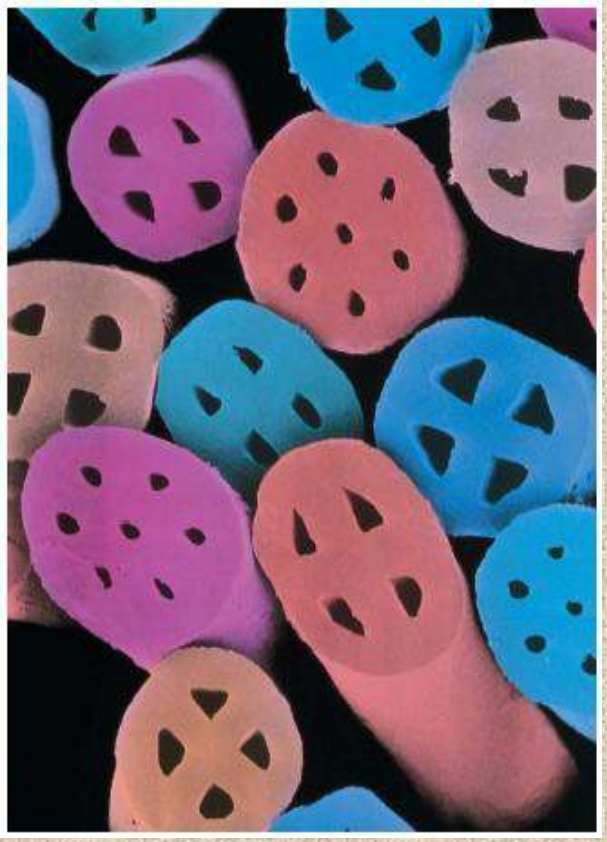
Pulled Human Hair

Tissue attached to root

Stretched and distorted root



FIBERS



Dacron Polyester

Cotton fibers

Cross section of man-made fibers

Cross-sectional views of nylon carpet fibers as seen with a scanning electron microscope (SEM)

Fiber as Evidence

The rarity or commonness of the fiber types found at a crime scene or on a victim or suspect affects their probative value.

*Cotton fibers are the most commonly used plant fibers in textile production. The type of cotton, the fibers' length, and the degree of twist contribute to the diversity found in cotton fibers.

The number of fibers (or lack of fibers) is considered in crime scenes. This shows contact or lack of contact between people/places at a crime scene.

Locations of fibers on a victim or suspect help recreate the scene.

CLASSES OF FIBERS

1) Natural ~~Fibers: Derived from animal or plant~~ sources.

*Cotton, flax, wool, silk, wool, and furs.

*Most prevalent plant fiber is cotton (white cotton fibers as evidence – almost meaningless)

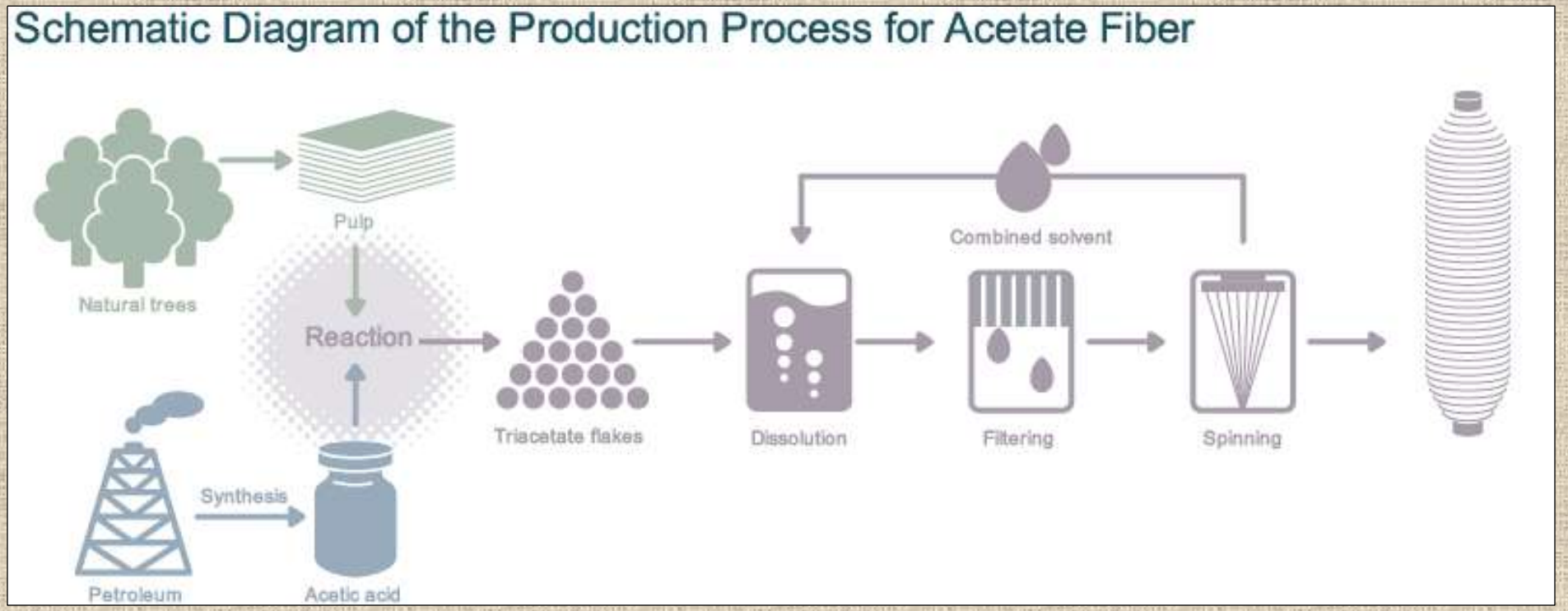
2) Regenerated Fibers: Manufactured from natural raw materials (plant or animal) that have been chemically treated.

-The cellulose is extracted from the natural material (rayon, acetate, triacetate)
-Cellulose is a polysaccharide found in plans

3) Synthetic Fibers: Produced solely from chemical feedstocks (ingredients); Nylon, polyester, acrylics, PVC.
*Polymers – Page 332 in textbook

***Regenerated & Synthetic Fibers* are referred to as 'manufactured'.**

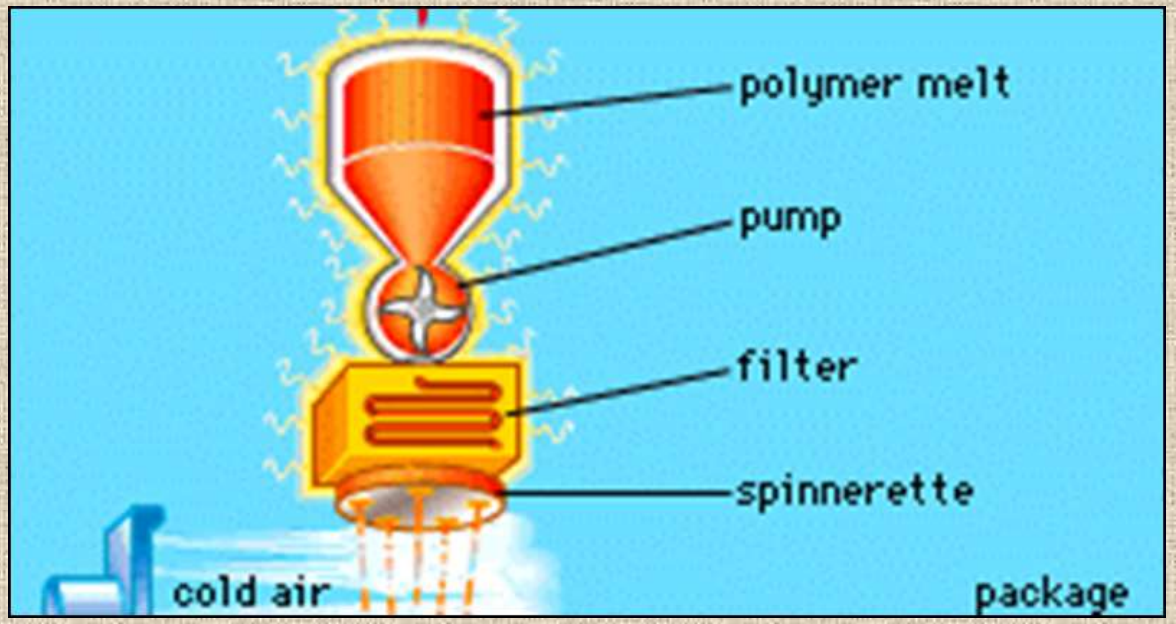
***Cellulose is dissolved/suspended in a solvent**
***The mixture is chemically purified, treated**
***Formed into threads through a spinnerets.**



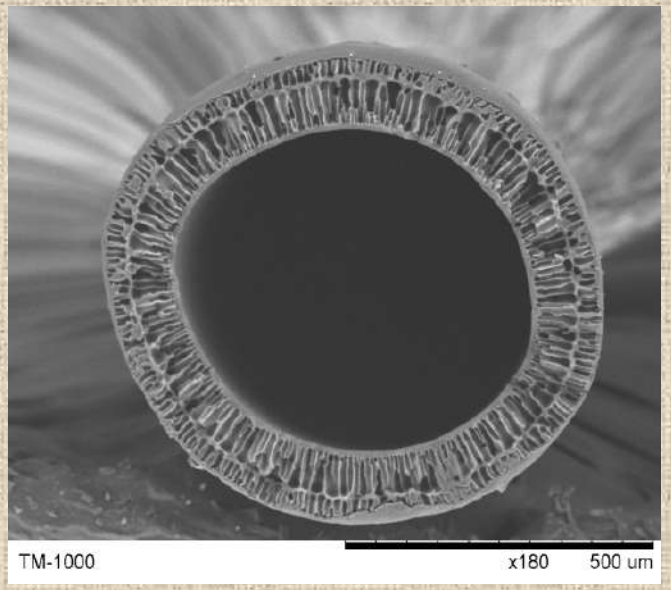
Forming Polymer Fibers

*A polymer in solution or fluid is forced through the small openings of a spinneret.

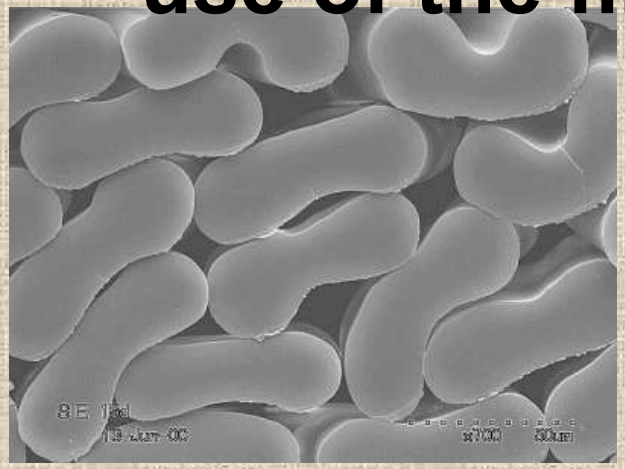
*The spinneret will force the polymers to take on specific shapes, depending on the purpose of the fiber.



Size & shape of man-made fibers determines the use of the fiber.



Round shape

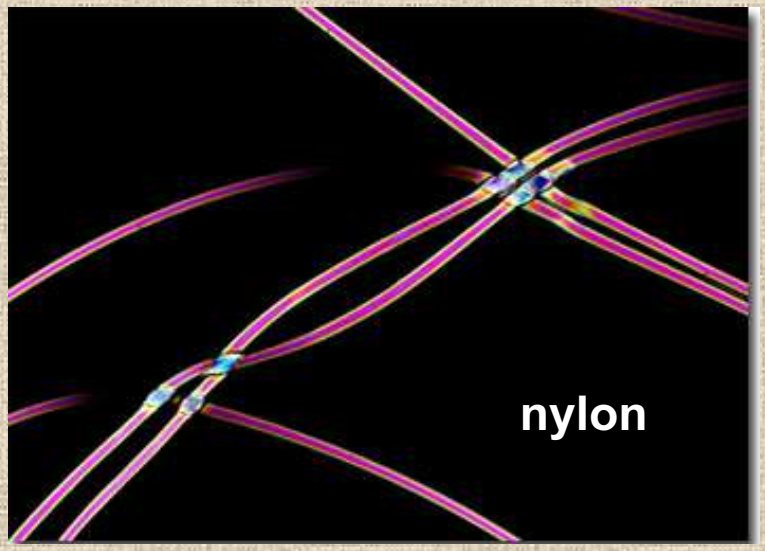


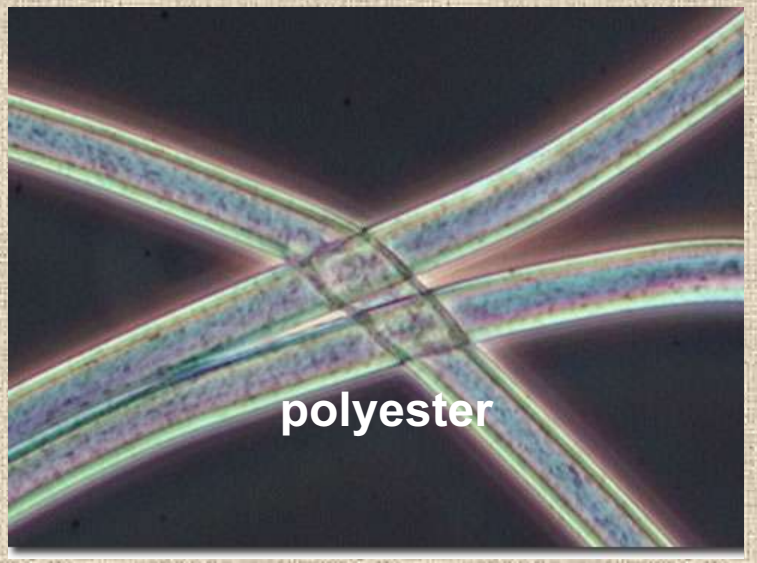
Dumbbell shape

Trilobal Polyester

Antron Nylon

Synthetic Fibers





ID and Comparison of Manufactured Fibers

Evidential value lies in the criminalist's ability to trace the fiber's origin.

*Microscopic comparison for color & diameter using a comparison microscope.

* Lengthwise striations on the surface

*Pitting of fiber's surface with delustering particles (usually titanium dioxide); reduce shine

*Cross-sectional shape (Wayne Williams – Unusual yellow-green fibers)

*Dye composition – microspectrophotometer or or chromatography.

*Chemical Composition – Same broad class of fiber, same subclassification.
-At 4 different types of nylon
-24 different groups of acrylic

*Birefringence – For many manufactured fibers.

Significance of a Match

In reality, no analytical technique finds a definite match to a single garment.
*No database to determine probability

Significance of fiber association increases if the analyst can link two or more different fibers to the same object.

Class evidence – Significance of fiber comparison dictated by circumstances of the case (location, number, nature of fibers)

What are the questions that are asked when analyzing a fiber as evidence?

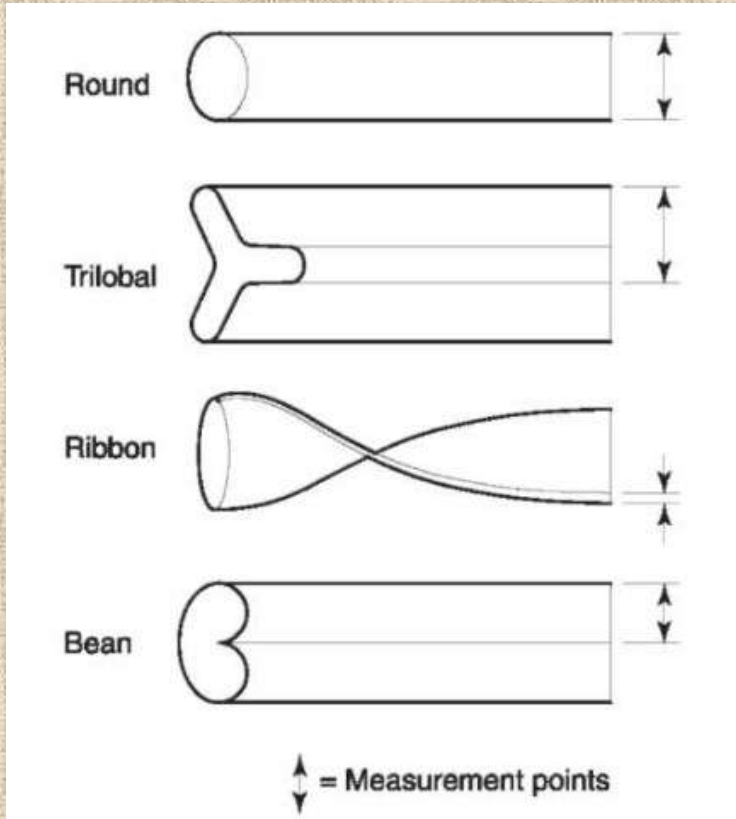
*What is the composition? (what is it made of?)
*What are the physical properties? (color, diameter, length, etc.)
*What is the shape or morphology? (trilobal, twist, etc.)
*Is the fiber part of a large piece of evidence?
*Are there any uniquely identifying features of the fiber? (chemical treatments, unique colors, wear pattern, etc.)

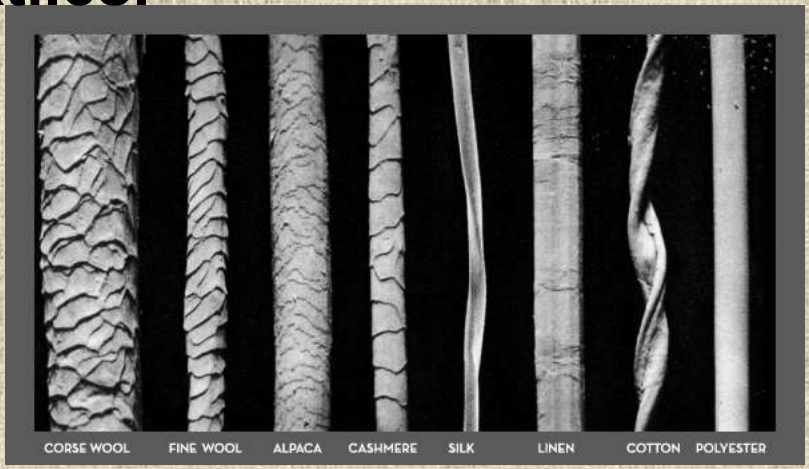
Fibers in Larger Pieces

Textile: Network of fibers shaped into a 2-dimentional piece.

Cloth: Fabric made into a finished piece of clothing.

***Twist pattern differentiates the yarn**
***Weave pattern differentiates textiles.**





Other fiber-containing objects

Rope, cord, paper, fiberboard