

**Class Enrichment and Review Activities for April 1--9th      Mrs. Linda Henry- Intro to Forensic Sci.**

**Mrs. Henry can be reached at [lhenry@rockwoodschoools.org](mailto:lhenry@rockwoodschoools.org) OR by calling the school at 814-926- 4688 extension 2201. Mrs. Henry will send you an email to alert you. Take care and stay healthy!!**

**All activities and materials for all classes are on Mrs. Henry's Google Classroom pages and also attached at the bottom of this PDF.**

**This class is every other day on B days only!!!**

April 1 and 3—go over the PDF of hair and fiber notes from Chapter 11 in your textbook...read over carefully....

April 7 and 9—Over 50 multiple choice and short essay review questions about hair and fiber evidence.

**BELOW YOU WILL FIND ATTACHED DOCUMENTS FROM THE ABOVE ASSIGNMENTS FOR APRIL 1 THROUGH APRIL 9TH....**

## **Chapter 11**

# **Trace Evidence I: Hairs and Fibers**



# Introduction

- **Hair is encountered as physical evidence in a wide variety of crimes.**
- **Although it is not yet possible to individualize a human hair to any single head or body through its morphology, it still has value as physical evidence.**

# Introduction

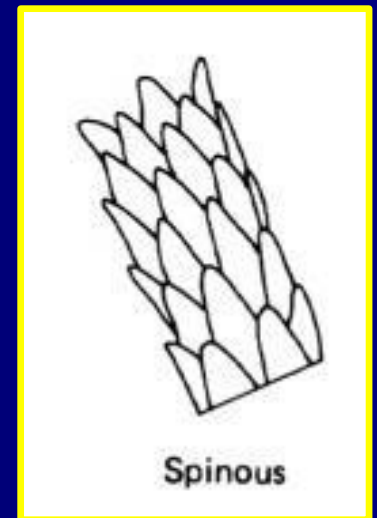
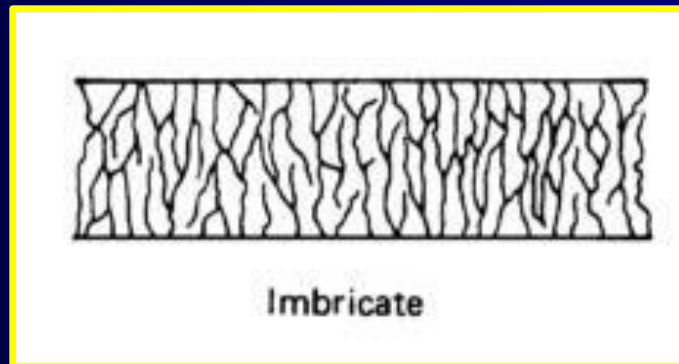
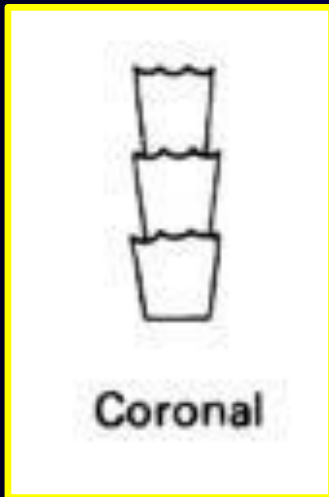
- **When properly collected and submitted to the laboratory accompanied by an adequate number of standard/reference samples, hair can provide strong corroborative evidence for placing an individual at a crime scene.**



- **The length of a hair extends from its root or bulb embedded in the follicle, continues into a shaft, and terminates at a tip end.**
- **It is the shaft, which is composed of three layers—the cuticle, cortex, and medulla—that is subjected to the most intense examination by the forensic scientist.**

# Cuticle and Cortex

- **The cuticle is the scale structure covering the exterior of the hair.**
  - **The scales always point towards the tip of the hair.**
  - **The scale pattern is useful in species identification.**





# Cuticle and Cortex

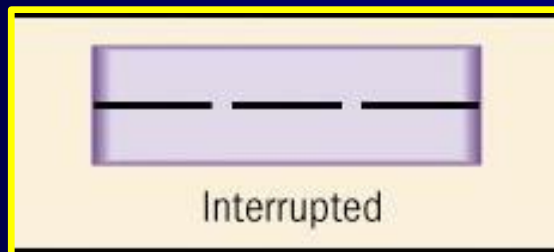
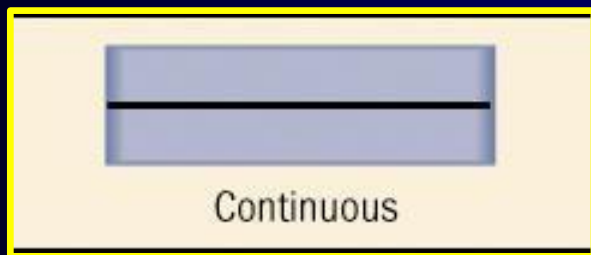
- **The cortex is the main body of the hair shaft.**
  - **Its major forensic importance is the fact that it is embedded with the pigment granules that impart hair with color.**
  - **The color, shape, and distribution of these granules provide the criminalist with important points of comparison among the hairs of different individuals.**

# Medulla

- **The medulla is a cellular column running through the center of the hair.**
  - **The medullary index measures the diameter of the medulla relative to the diameter of the hair shaft.**
  - **For humans, the medulla generally occupies less than one-third the diameter of the shaft, while for animals it is generally one-half or greater.**

# Medulla

- The medulla may be continuous, interrupted, fragmented or absent.



# Medulla

- **The presence of the medulla vary from individual to individual and even among hairs of a given individual.**
- **Medullae also have different shapes, depending the species.**

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- **The root and other surrounding cells in the hair follicle provide the tools necessary to produce hair and continue its growth.**
- **When pulled from the head, some translucent tissue surrounding the hair's shaft near the root may be found. This is called a follicular tag.**
- **By using DNA analysis on the follicular tag, the hair may be individualized.**

# Comparing Strands

- **The comparison microscope is an indispensable tool for comparing the morphological characteristics of hair.**
- **When comparing strands of human hair, the criminalist is particularly interested in matching the color, length, and diameter.**
- **A careful microscopic examination of hair will reveal morphological features that can distinguish human hair from the hair of animals.**

# Comparing Strands

- **Scale structure, medullary index, and medullary shape are particularly important in animal hair identification.**
- **Other important features for comparing human hair are:**
  - **the presence or absence of a medulla.**
  - **the distribution, shape, and color intensity of the pigment granules present in the cortex.**

# Comparing Strands

- **The most common request is to determine whether or not hair recovered at the crime scene compares to hair removed from the suspect.**
- **However, microscopic hair examinations tend to be subjective and highly dependant on the skills and integrity of the analyst.**



# Questions

- **Can the body area from which a hair originated be determined?**
- **Can the racial origin of hair be determined?**
- **Can the age and sex of an individual be determined from a hair sample?**
- **Is it possible to determine if a hair was forcibly removed from the body?**

# Questions

- **Are efforts being made to individualize human hair?**
- **Can DNA individualize a human hair?**

# Hair and DNA

- **Recent major breakthroughs in DNA profiling have extended this technology to the individualization of human hair.**
- **The probability of detecting DNA in hair roots is more likely for hair being examined in its anagen or early growth phase as opposed to its catagen (middle) or telogen (final) phases.**

# Hair and DNA

- **Often, when hair is forcibly removed a follicular tag, a translucent piece of tissue surrounding the hair's shaft near the root may be present.**
- **This has proven to be a rich source of nuclear DNA associated with hair.**

# Hair and Mitochondrial DNA

- **Mitochondrial DNA can be extracted from the hair shaft.**
- **Mitochondrial DNA is found in cellular material located outside of the nucleus and it is transmitted only from the mother to child.**
- **As a rule, all positive microscopic hair comparisons must be confirmed by DNA analysis.**

# Collection and Preservation

- **As a general rule, forensic hair comparisons involve either head hair or pubic hair.**
- **The collection of 50 full-length hairs from all areas of the scalp will normally ensure a representative sampling of head hair.**
- **A minimum collection of two dozen full-length pubic hairs should cover the range of characteristics present in pubic hair.**

# Collection and Preservation

- **Hair samples are also collected from the victim of suspicious deaths during an autopsy.**

# Types of Fibers

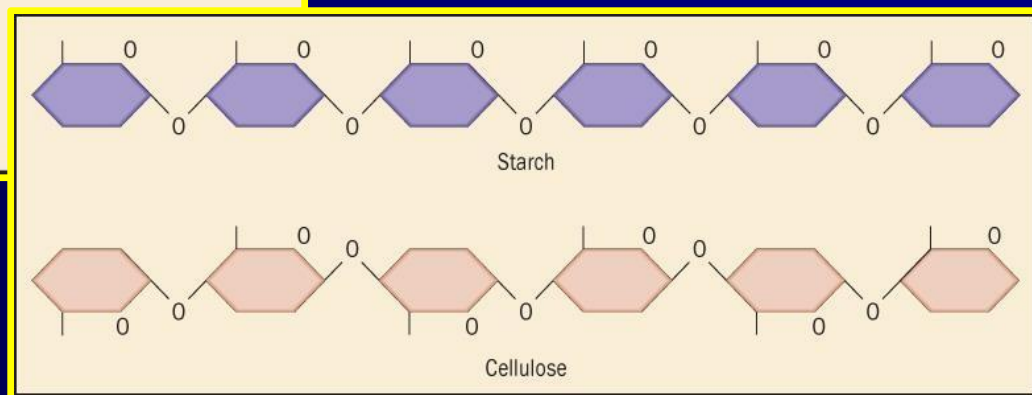
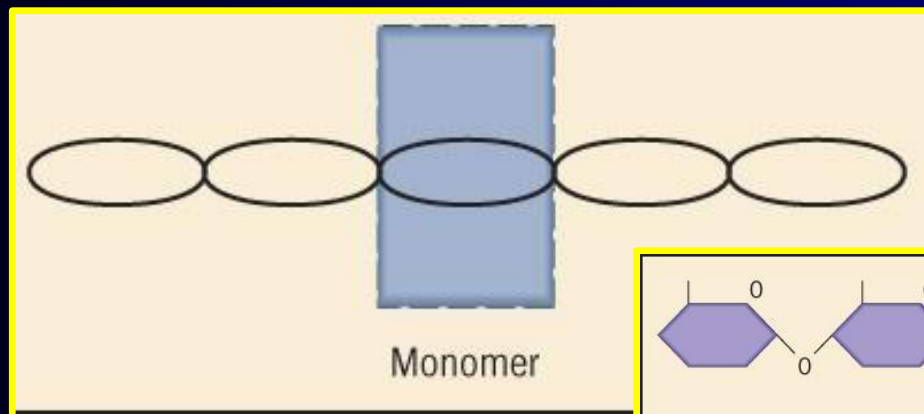
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- **Natural fibers are derived in whole from animal or plant sources.**
  - **Examples: wool, mohair, cashmere, furs, and cotton.**
- **Man-made fibers are manufactured.**
  - **Regenerated fibers are manufactured from natural raw materials and include rayon, acetate, and triacetate.**
  - **Synthetic fibers are produced solely from synthetic chemicals and include nylons, polyesters, and acrylics.**



# Types of Fibers

- **Polymers, or macromolecules, are synthetic fibers composed of a large number of atoms arranged in repeating units known as monomers.**



# Fiber Evidence

- **The quality of the fiber evidence depends on the ability of the criminalist to identify the origin of the fiber or at least be able to narrow the possibilities to a limited number of sources.**
- **Obviously, if the examiner is presented with fabrics that can be exactly fitted together at their torn edges, it is a virtual certainty that the fabrics were of common origin.**

# Fiber Evidence

- **Microscopic comparisons between questioned and standard/reference fibers are initially undertaken for color and diameter characteristics, using a comparison microscope.**
- **Other morphological features that could be important in comparing fibers are:**
  - **Lengthwise striations on the surface of the fiber.**
  - **The presence of delustering particles that reduce shine.**
  - **The cross-sectional shape of the fiber.**

# Fiber Evidence

- **Compositional differences may exist in the dyes that were applied to the fibers during the manufacturing process.**

# Methods for Fiber Comparison

- **The visible light microspectrophotometer is a convenient way for analysts to compare the colors of fibers through spectral patterns.**
- **A more detailed analysis of the fiber's dye composition can be obtained through a chromatographic separation.**

# Methods for Fiber Comparison

- **Infrared spectrophotometry is a rapid and reliable method for identifying the generic class of fibers, as does the polarizing microscope.**
- **Depending on the class of fiber, each polarized plane of light will have a characteristic index of refraction.**

# Collection and Preservation

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- **The investigator’s task of looking for minute strands of fibers often becomes one of identifying and preserving potential “carriers” of fiber evidence.**
- **Relevant articles of clothing should be packaged carefully in separate paper bags.**
- **If it is necessary to remove a fiber from an object, the investigator must use clean forceps, place it in a small sheet of paper, fold and label the paper, and place the paper packet inside another container.**

Chapter 11 on Hair and Fiber Evidence

Name-

\_\_\_\_\_

**MULTIPLE CHOICE.** Choose the one alternative that best completes the statement or answers the question.

- 1) Which of the following is not a layer of the hair shaft?
  - A) cuticle
  - B) follicle
  - C) cortex
- 2) Which part of the hair shaft is most resistant to chemical decomposition?
  - A) cortex
  - B) cuticle
  - C) medulla
  - D) follicle
  - E) root
- 3) Which feature of hair is MOST important in making a species identification?
  - A) scale pattern
  - B) follicle shape
  - C) bulb size
  - D) color
  - E) shaft length
- 4) The number of hair scales pointing towards the tip of the hair is \_\_\_\_\_ the number of hair scales pointing towards the hair follicle.
  - A) greater than
  - B) the same as
  - C) less than
- 5) A cast of a hair surface can be made using:
  - A) an SEM.
  - B) clear nail polish.
  - C) softened vinyl.
  - D) both B and C
  - E) none of the above
- 6) Pigment granules that impart hair with color are found in the:
  - A) cortex.
  - B) medulla.
  - C) cuticle.
  - D) both A and B
  - E) none of the above



- 7) The central canal running through many hairs is known as the:
- A) cuticle.
  - B) root.
  - C) cortex.
  - D) medulla.
  - E) shaft.
- 8) The medullary index of human hair is \_\_\_\_\_ the medullary index for most other animals.
- A) less than
  - B) greater than
  - C) the same as
- 9) Medullae may be classified as being:
- A) interrupted or absent.
  - B) continuous.
  - C) fragmented.
  - D) all of the above
  - E) none of the above
- 10) If a hair does not have a follicular tag, an expert witness is on best scientific footing when stating that:
- A) the hair in question comes from a 21-year-old.
  - B) the hair is useless as evidence in the case.
  - C) his examination reveals that the hair is that of a male.
  - D) a suspect hair comes from a particular animal species.
  - E) the given hair comes from a specific person.
- 11) Which race is most likely to have head hair with continuous medullae?

- A) Icelandic
  - B) Negroid
  - C) Caucasian
  - D) Mongoloid
  - E) Native American
- 12) A hair sample was examined and its medulla appeared to have a pattern described as resembling a string of pearls. It was most likely from a:
- A) cat.
  - B) rabbit.
  - C) dog.
  - D) deer.
  - E) mouse.
- 13) In what stage can a hair most readily be removed from the scalp?
- A) generic
  - B) analgesic
  - C) catagenic
  - D) telogenic
  - E) anagenic

- 14) Beard hairs are coarse and normally \_\_\_\_\_ in cross-section.
- A) triangular
  - B) ribbon-like
  - C) square
  - D) round
  - E) oval
- 15) A human hair in cross-section appeared flat in shape. The racial origin was most likely:
- A) Native American.
  - B) Mongoloid.
  - C) Negroid.
  - D) Indian.
  - E) Caucasian.
- 16) In determining whether a hair sample originated from a male or a female, the MOST important consideration is:
- A) the length of the hair.
  - B) the results of DNA analysis performed on the root structure.
  - C) whether the hair was dyed.
  - D) whether the hair is bleached.
  - E) whether the hair is curly or straight.
- 17) The presence of sheath cells on hair that has been pulled quickly from the head is \_\_\_\_\_ the presence of sheath cells on hairs that have been removed slowly from the scalp.
- A) greater than
  - B) the same as
  - C) less than
- 18) Nuclear DNA typing can be most successfully accomplished on hairs that
- have been removed during which stage of growth?
- A) anxiogenic
  - B) catagenic
  - C) mutagenic
  - D) anagenic
  - E) telogenic
- 19) The conviction of Ennis Cosby's killer was aided by the DNA analysis on a hair that was crucial evidence in the case. This hair:
- A) belonged to the killer and was found in Cosby's car.
  - B) belonged to Cosby and was found clinging to the murderer's jacket.
  - C) belonged to the killer and was found on the body of the victim.
  - D) belonged to Cosby and was found in the suspect's car.
  - E) belonged to the killer and was found in his cap with which he had wrapped the murder weapon before discarding it.
- 20) Which type of crime is LEAST likely to be solved with the use of fiber evidence?
- A) breaking and entering
  - B) hit-and-run
  - C) kidnapping
  - D) sexual assault
  - E) bombing

a camel.

22) By far the most prevalent plant fiber is:

- A) linen.
- B) hemp.
- C) silk.
- D) cotton.
- E) Kapok.

23) A fiber whose microscopic appearance includes being ribbon-like in shape (flat) with twists at irregular intervals is:

- A) silk.
- B) linen.
- C) polyester.
- D) kapok.
- E) cotton.

24) Which was the first man-made fiber?

- A) acetate
- B) Dacrongraphic®
- C) rayon
- D) nylon
- E) polyester

25) Which is NOT a synthetic fiber?

- A) nylon
- B) acrylic
- C) rayon
- D) polyester
- E) all of the above

26) Which is made of natural polymers?

- A) plastic
- B) nylon
- C) starch
- D) sand
- E) paint

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

The following are steps that can be taken in the examination of fibers for the purpose of identification and comparison:

1. examination of dye composition using visible light microspectrophotometer
2. make a cross-sectional view of the fibers
3. microscopic examination for color and diameter of fibers
4. infrared spectrophotometry
5. study of the birefringence of the fibers
6. TLC study of dyes in fibers

- 27) Which step would logically be taken first?
- 28) Which step would achieve separation of the dyes taken from the fibers?
- 29) Which step would involve determining the refractive index of the fibers?
- 30) Which step would produce "fingerprints" of the fibers?

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

- 31) During the collection of fiber evidence, great care should be taken to:
- A) avoid cross-contamination of evidence.

B) send as much potential evidence as possible to the crime lab to ensure that nothing is missed.

C) package all items from each individual together in one bag to avoid later confusion.

D) shake off all garments to be sent for examination before neatly folding them.

E) vacuum each item for trace evidence.

- 32) The rate of human hair growth per month is:

A) 1 inch.

B) 1 dm.

C) 1 cm.

D) 1 mL.

E) so variable as to be forensically worthless.

- 33) The visible light microspectrophotometer is a convenient tool with which to compare the color of fibers because:

A) fibers can be studied right on microscope slide.

B) very small samples can be compared.

C) fibers are not destroyed.

D) all of the above

E) none of the above

- 34) Generally, the parallel refractive index of a fiber is \_\_\_\_\_ the perpendicular refractive index of the same fiber.
- A) greater than
  - B) the same as
  - C) less than
- 35) What type(s) of evidence may result from hit-and-run accidents?
- A) glass
  - B) fibers
  - C) hair
  - D) blood
  - E) all of the above
- 36) It is a virtual certainty that two fabrics share a common origin if their fibers:
- A) have the same color.
  - B) can be fitted together at their torn edges.
  - C) appear identical in cross-section.
  - D) are of the same fiber type (e.g., rayon, nylon, polyester).
  - E) have the same striations.
- 37) In the Wayne Williams case, the fibers that proved to be the most crucial evidence were made of:
- A) acetate and nylon.
  - B) nylon and silk.
  - C) silk and acetate.
  - D) wool and cotton.
  - E) acrylate and mylar.
- 38) Which is a true statement about the fibers in the Williams case?
- A) They were similar to the clothes Williams was known to wear.
  - B) They were proven to come from Williams' bedroom.
  - C) They were matched to fibers from his car upholstery.
  - D) The investigators did probability calculations to establish the chance of these fibers being found in a particular location.
  - E) They were found on all the victims that were linked to Williams.
- 39) Before the 20th century, all fibers were:
- A) chemically treated.
  - B) regenerated.
  - C) synthetic.
  - D) derived.
  - E) natural.
- 40) A regenerated fiber can be derived from:
- A) acetate.
  - B) polyester.
  - C) isoprene.
  - D) cotton or wood pulp.
  - E) rayon.

- 41) Wayne Williams was convicted of serial murder mainly on the strength of:
- A) DNA studies from bone fragments.
  - B) bite mark comparisons on victims.
  - C) fiber evidence.
  - D) blood analysis.
  - E) paint chips.
- 42) Which of the following properties should NOT be examined when comparing two synthetic fibers?
- A) diameter
  - B) lengthwise striations
  - C) medullary index
  - D) presence or absence of delustering particles
  - E) all of the above
- 43) The monomers involved in the synthesis of proteins are:
- A) lipids.
  - B) sugars.
  - C) amino acids.
  - D) fatty acids.
  - E) starches.
- 44) Cellulose is the basic component of:
- A) sugar.
  - B) wood.
  - C) wool.
  - D) starch.
  - E) all of the above
- 45) The layers of the hair shaft are the \_\_\_\_\_, the \_\_\_\_\_, and the \_\_\_\_\_.
- A) cortex; mitochondria; pigment
  - B) cuticle; cortex; medulla
  - C) pigment; cortex; pigment
  - D) cuticle; root; medulla
  - E) root; medulla; scale pattern
- 46) The stages of hair growth include all of the following except:
- A) catagenic.
  - B) telogenic.
  - C) analgesic.
  - D) anagenic .
  - E) all above are stages of hair growth
- 47) In making hair evaluations, it is best to view the hairs using a(n) \_\_\_\_\_ microscope.
- A) comparison
  - B) scanning electron
  - C) visible light
  - D) stereoscopic
  - E) polarizing

- 48) Microscopic hair comparisons must be regarded by police and courts as:
- A) presumptive
  - B) individualizing
  - C) useless
  - D) classifying
  - E) conclusive
- 49) For standard/reference hair sampling from a victim, the collection of a minimum of \_\_\_\_\_ full-length head hairs and \_\_\_\_\_ full-length pubic hairs is recommended.
- A) 50; 24
  - B) 100; 100
  - C) 5; 16
  - D) 10; none
  - E) 20; 20
- 50) Synthetic fibers display \_\_\_\_\_ because they are crystalline.
- A) high density
  - B) dispersive properties
  - C) infrared reflectance
  - D) flotation
  - E) birefringence
- 53) Explain how a forensic scientist can differentiate between animal and human hair.
- 54) When examining human hair, what features are compared?
- 55) Explain how a forensic scientist would correctly collect, package and preserve a hair sample.
- 56) Describe the correlation between hair analysis and DNA typing.
- 57) Explain the difference between natural and manufactured fibers.
- 58) List and explain the properties of fibers that are most useful for forensic comparison.
- 59) Describe how to properly collect fiber evidence.

ESSAY. Write your answer in the space provided or on a separate sheet of paper.

- 51) Label the cuticle, cortex and medulla on the following hair sample.
- 52) List and explain the three phases of hair growth.

