TRACE EVIDENCE I

HAIR AND FIBERS
Forensic Examination of Hair

Hair is found in many crime scenes.

The more characteristics we understand about hair, the more it can be useful in a crime investigation.
Morphology of Hair

Cuticle
Scale structure covering the exterior of the hair

Cuticle is formed by overlapping scales that always points to the tip of each hair
2 things that make hair good evidence for determining individual identity are a result of the cuticle

The cuticle helps with:

1. Resistance to chemical decomposition
2. Ability to retain structural features over a long period of time
Scale pattern **CAN NOT** be used for **individual** identification

However

Scale pattern **CAN** be used for **species** identification

Human Hair  Cat Hair  Mouse Hair
Cortex

The main body of the hair shaft

Made up of spindle-shaped cortical cells aligned parallel to the length of the hair

Contains the pigment granules that give hair its color
Medulla

Cellular column running through the center of the hair

In many animals, the medulla is the dominate feature

Not all hairs have medullas

Medullas can be classified into 4 groups: continuous, interrupted, fragmented, absent
continuous

interrupted

fragmented

absent
Root

Part located within the hair follicle that helps produce and grow hair

Hair when pulled with the root attached may contain a follicular tag

Follicular tag is a piece of tissue near the root that contains the best source of DNA
Three phases of hair growth

Anagen Phase

Initial growth phase when the hair follicle actively produces hair
Follicular tag present in this phase

Catagen phase

Transition stage between anagen and telogen

Telogen phase

Final phase when hair naturally falls out
Identification and Comparison of Hair

2 main reasons to examine hair evidence

1. Is the hair human or animal?

2. Does the hair compare with hair from a person of interest?
Factors in Comparison of Hair

Easy to distinguish between **human** and **animal** hair based on **characteristics**.

Little difficult to distinguish between **different human hair samples**.
Criminalists look for:

Matching color
Matching length
Matching diameter
Matching medulla

They can also determine if hair had been dyed or bleached
Microscopic Examination of Hair

Comparison Microscope is a great tool that allows you to view the hair samples side by side.
Until DNA analysis started being used on hair samples, microscopic comparison was used. This comparison has been found to have high error rates. Microscopic hair comparison is only used to narrow an investigation.
Questions about Hair Examination
1. Can the Body Area from Which a Hair Originated Be Determined?

Yes

Examples:
Scalp hair has little diameter and pigment variation
Pubic hairs are short and curly with wide variation in diameter and have a continuous medulla
Beard hairs are coarse and have blunt tips from being cut or shaved
2. Can the Racial Origin of Hair Be Determined?

Yes

Examples:
- Caucasian hair is wavy or strain and very fine pigments
- African-American hair is usually more dense with uneven pigment

However there are many exceptions to these examples
3. Can the Age and Sex of an Individual Be Determined from a Hair Sample?

Sometimes

Examples:
Infant hair can be identified because it is fine, short and has fine pigment.

Only DNA recovered from the hair sample can determine sex of individual.
4. Is It Possible to Determine Whether Hair Was Forcible Removed from the Body?

Sometimes

Examples:
A hair root with follicle tissue indicates it was pulled out either by a person or brush

Hairs pulled quickly from the head may have sheath cells present
5. Are Efforts Being Made to Individualize Human Hair?

Yes

Examples:

- Nuclear DNA from the follicular tissue or hair root
- Mitochondrial DNA from the hair cells
6. **Can DNA Individualize a Human Hair?**

Sometimes

Examples:

Nuclear DNA **CAN** identify a person. There is a one in a trillion chance of being wrong.

Mitochondrial DNA **CANNOT** identify a person. It can just exclude portions of the population.
Collection and Preservation of Hair Evidence

Hairs submitted to the lab must always be accompanied by reference samples of the possible suspects and the victims.

Also the reference samples must come from the same part of the body.

Usually either: Head Hair 50 hairs  Or Pubic Hair 24 hairs
Hairs from both the head and the pubic area are combed to remove any foreign particles or hairs.

Both the comb and the hairs are submitted to the lab.

When an autopsy of a suspicious death is performed, hair samples are taken just in case they are needed later.
Who belongs to Who?

Human
Dog
Deer
Rabbit
Cat
Mouse
Forensic Examination of Fibers

Just as hair is important evidence, so are fibers found at a crime scene.
Types of Fibers

1. Natural Fibers

Derived from animal and plant sources

**Animal Fibers** - wool, cashmere, camel, llamas, alpacas

**Fur Fibers** - Mink, rabbit, beaver, muskrat

**Plant Fibers** - cotton
2. Manufactured Fibers

Derived from either natural or synthetic polymers

<table>
<thead>
<tr>
<th>Rayon</th>
<th>Nylon</th>
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<tr>
<td>Spandex</td>
<td>Polyester</td>
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3. Polymers

Basic chemical substance of all synthetic fibers

plastics  paints  adhesives

Synthetic rubber

polymer  Formed by linking a large # of monomers together

= macromolecules
Polymer/macromolecule

monomer
Identification and Comparison of Fibers

Value of evidence relies on ability to determine the origin of the fiber

Microscopic examination
Criminalist first step is to compare

1. Color
2. Diameter

If these do not match it is not a match
Criminalist then will look at:

1. Lengthwise striations
2. Pitting on the surface
3. Composition in the dyes
Analytical Techniques
To analyze fiber's dye composition

The dyes must be separated by chromatography
Chemical Composition

Are the fibers being compared made of the same chemical compounds?

Textile chemists have developed many tests to determine chemical composition.

However

Criminalists only get a single fiber to analyze and they must choose the test they think is necessary.

It may not be the right test!
Birefringence

Each fiber has a unique refractive index like glass. You can identify the fiber based on the disappearance of the Becke line when in liquid.
Infrared Absorption

Each fiber absorbs a unique amount of infrared light.

Using a microscope with an infrared spectrophotometer, you can analyze the amount of infrared light that is absorbed.
Significance of Fiber Evidence

Even if there is a fiber match, it is hard to be certain of the source because there is such a variety of fibers.
Collection and Preservation of Fiber Evidence

Fiber evidence usually **cannot** be seen with the **naked** eye.

It is often **overlooked** at the crime scene.

Investigators **must** collect evidence that can be a "**carrier**" of fibers.
Clothing/carpets/rugs/bedding

Fold carefully
Place in a bag

Items from different people or locations should not come in contact with each other

Larger items: car seats, knives

Cover to protect possible fibers
Some fibers need to be recovered at the scene

Remove with clean forceps

Place on a small sheet of paper

Fold, label and place in container

In the lab:
Searching for fibers is time-consuming and tedious
Check what you know!!!!

1. What characteristics does a criminalist compare first under a microscope?
   Color and Diameter

2. Name two physical characteristics that frequently are used to identify fibers.
   Chemical composition
   Birefringence
   Infrared Absorption
3. What analytical technique is initially used to analyze the dye in fiber?
   Chromatography

4. Describe three analytical techniques for comparing the color of two fibers.
   Visual comparison under microscope
   Disappearance of Becke line in liquid
   Infrared analysis using spectrophotometer