Trace Evidence: Fiber
Objective

- SWBAT distinguish and identify different types of fibers.
Agenda

1. Types of Fiber
2. Patterns of Fiber
3. Fiber Analysis Lab
4. Testing & Collection of Evidence
Fibers

- Class evidence
- Have probative value
- Common trace evidence
- Can be characterized based on comparison of both physical and chemical properties
Rub your sleeve against your neighbor’s sleeve. Then answer the following questions:

• Can fibers from one sleeve be detected on the other?
• Do hand lenses or masking tape aid the investigation? How?
Fiber Evidence

• Used in forensic science to create a link between a crime and a suspect.
• Considered to be **CLASS EVIDENCE** because they are *mass produced*.
• Sensitive evidence – 95% of all fibers may be lost within 24 hours.
• Only the fibers you would not expect to find are investigated.
  – Example: pink fibers found all over the victim’s body found on a pink carpet vs. pink fibers found on a suspect’s pants
Fibers

• Fiber evidence properties:
  – color variation, staining, color additives
  – material
  – thickness
  – length
  – degree of twist
  – location
  – number of matching fibers found
Fiber Evidence

Collected by:
• Special vacuums (large areas)
• Sticky tape
• Forceps

Tested by:
• Microscopy – polarizing light, infrared
• Burn test (large quantities only)
Sources

- Fibers can originate from many sources:
  - Carpet
  - Clothing
  - Linen
  - Furniture
  - Insulation
  - Rope/ligature
  - Tape
• Fibers are spun into **yarns** that have specific characteristics
• Yarns are woven, with different patterns, into **textiles**
• Fibers may be **natural** or **synthetic**
Two Types of Fibers

• **Natural**
  – derived from plants or animal hair

• **Synthetic**
  – Man-made
Natural Fibers: Animal Fibers

Sheep’s wool

• most common

• the end use is often determined by coarseness: fine wool fibers are used for clothing, while coarse wool fibers are used in carpeting
Natural Fibers: Animal Fibers

- Goat (mohair, cashmere)
- Camel (wool)
- Llama
- Alpaca (wool)
- Fur fibers from mink, rabbit, beaver, etc.
- Silk (fiber from the cocoon of the silkworm)
Natural Fibers: Plant Fibers

- **Cotton** (ribbon-like shape with irregular twists)
  - *most common*
- **Flax** (Linen)
- **Ramie**
- **Sisal** (often used in rugs)
- **Jute** (used in ropes)
- **Hemp** (the common name for cannabis for industrial or non-drug use; typically used for rope or sack)
- **Kapok** (fiber from kapok tree seed pods; used in pillows and mattress stuffing)
- **Coir** (coconut husks; used in carpet, rugs)
Mineral Fibers

- Asbestos—a natural fiber that has been used in fire-resistant substances
- Rock wool—a manufactured mineral fiber
- Fiberglass—a manufactured inorganic fiber
ASBESTOS

FLAX

JUTE
Synthetic Fibers

More than half of all fibers used in the production of textile materials are manmade.

- **Polyester**
  - Most common
  - Wrinkle resistant, often spun with cotton

- **Nylon**
  - Very common
  - Elastic and strong
  - Lustrous and silk-like when stretched
  - First created by DuPont in 1935
Synthetic (Man-made) Fibers

- Regenerated fibers (modified natural fibers)
  - Rayon
  - Celanese
  - Capron
- Synthetic polymer fibers
  - Polyester
  - Nylon
  - Acrylic
  - Olefins
Synthetic Fibers

• **Acrylics**
  - wool-like, soft and warm
  - quick drying and resistant to moths

• **Rayon**
  - Cellulose-derived
  - thin fiber

• **Acetates**
  - cellulosed-based
  - wrinkle-resistant fiber
Fiber Comparison

Can you tell the difference(s) between the cotton on the left and the rayon on the right?
Cellulose Fibers

- **Cotton**—vegetable fiber; strong, tough, flexible, moisture absorbent, not shape retentive
- **Rayon**—chemically-altered cellulose; soft, lustrous, versatile
- **Cellulose acetate**—cellulose chemically-altered to create an entirely new compound not found in nature.
Special Fibers

• **Kevlar**
  - a light, but strong synthetic fiber developed by DuPont in 1965
  - heat-resistant
  - typically used for bulletproof vests, military applications, racing tires, etc.

• **Nomex**
  - a variation of Kevlar
  - fire-resistant
  - used by firemen and disaster response teams
Fiber Configuration

- **Fiber** – a fine, slender piece of thread or filament
- **Yarn** – a twisted aggregate of fibers
- **Textiles** – woven fibers; fabrics
  - Can compare weave patterns. Examples include twill, basket, satin, etc.
Weave Terminology

- **Yarn**—a continuous strand of fibers or filaments, either twisted or not
- **Warp**—lengthwise yarn
- **Weft**—crosswise yarn
- **Blend**—a fabric made up of two or more different types of fiber.
Weave Pattern Examples

The warp (vertical yarns) and the weft (horizontal yarns) are woven together in different ways to produce multiple textile weaves.

Plain
Basket
Satin
Twill
Weave Patterns

plain

satin

twill
Knitted Fabric

- Made by interlocking loops into a specific arrangement
- One continuous thread or a combination
Comparing Fibers

**Microscopic Comparisons** of fibers can examine the following characteristics:

- Color
- Diameter (thickness)
- Surface markings
- Delustering agents
- Cross-sectional shape
Fiber Cross-Sections

- Fibers tend to exhibit different cross-sections depending on their use.
- Carpet is usually tri-lobal.
Filament Cross-Sections

Synthetic fibers are forced out of a nozzle when they are hot, and then they are woven. The holes of the nozzle are not necessarily round; therefore, the fiber filament may have a unique shape in cross-section.
Fiber Comparison Techniques

- **Polarized Light Microscopy** – determines birefringence (difference between two refractive indices) using polarized light

- **Fourier Transform Infrared Spectroscopy (FTIR)** – analysis of a fiber’s chemical composition based on its ability to absorb light at different wavelengths

- **UV-Visible Microspectrophotometry** – distinguishes slight/subtle color differences based on absorption of light at different wavelengths
Testing for Identification

- Microscopic observation
- Burning—observation of how a fiber burns, the odor, color of flame, smoke and the appearance of the residue
- Thermal decomposition—gently heating to break down the fiber to the basic monomers
- Chemical tests—solubility and decomposition
Testing for Identification

- **Density**—mass of object divided by the volume of the object
- **Refractive Index**—measuring the bending of light as it passes from air into a solid or liquid
- **Fluorescence**—used for comparing fibers as well as spotting fibers for collection
Dyes

- Components can be separated and matched to an unknown.
- More than 7000 different dye formulations
- Chromatography
- The way a fabric accepts a particular dye may also be used to identify and compare samples.
Significance of Fiber Evidence

Two Possible Conclusions in Fiber Comparisons:

- The suspect fiber *could have* originated from the known (crime scene) sample.

- The suspect fiber *did not* originate from the known source.

- The number of fibers is directly proportional to the likelihood of actual contact... the greater the number of fibers, the more likely that contact actually occurred.
Matching Fibers

• Finding multiple types of fibers on the suspect and scene increases the likelihood that this did not occur by chance alone.

• Cross-transfer of fibers (the suspect both leaves and takes fibers from the scene) provides more compelling evidence in a case.
Significance of Fiber Evidence

Greater number of fiber types

More unique the material

Greater significance
Collection of Fiber Evidence

- Bag clothing items individually in paper bags. Make sure that different items are not placed on the same surface before being bagged.

- Make tape lifts of exposed skin areas of bodies and any inanimate objects

- Removed fibers should be folded into a small sheet of paper and stored in a paper bag.
Fiber Evidence

- Used to connect the suspect to the victim or to the crime scene.
- In the case of Wayne Williams, fibers weighed heavily on the outcome of the case. Williams was convicted in 1982 based on carpet fibers that were found in his home, car and on several murder victims.
Fiber Review

• Fibers can be from natural or synthetic sources.

• Fibers may support or refute statements from both witnesses and suspects.

• Fibers found on the accused present a compelling argument that the individual was at the crime scene.
Resources


