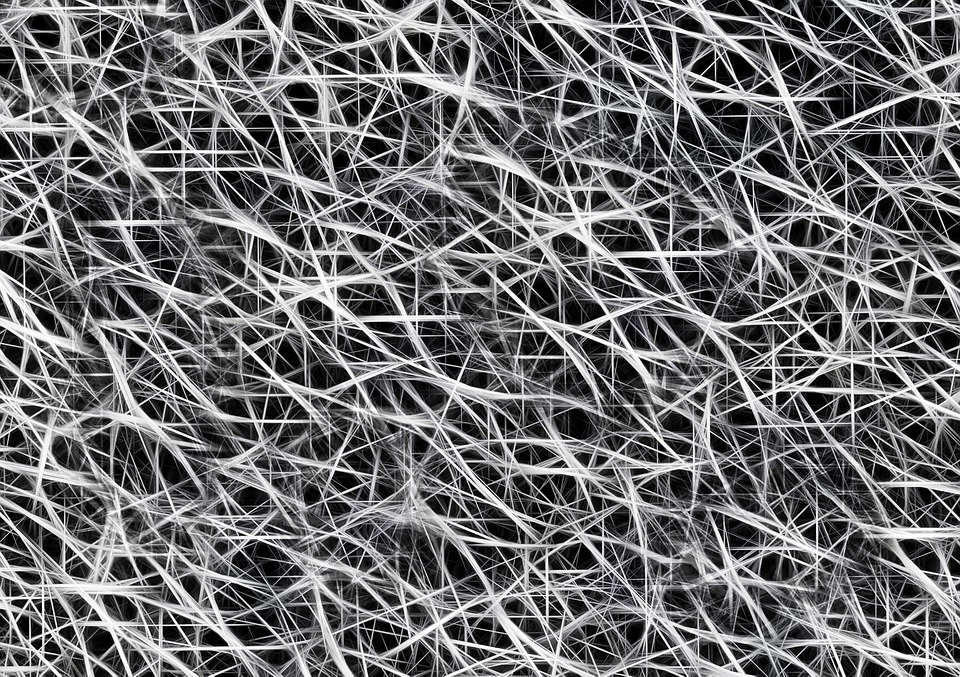
Unit 6: Fiber and Textile Analysis



By the end of this unit, you will be able to:

* Identify and describe common weave patterns of textile samples
* Compare and contrast various types of fibers through physical and chemical analysis
* Describe the principle characteristics used to identify common fibers
* Apply forensics science techniques to analyze fibers

Unit Vocabulary

* Direct transfer:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* Secondary transfer:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* Natural fibers:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* Man-made (synthetic fibers):

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* Polymers:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* Animal fibers:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* Plant fibers:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* Mineral fibers:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* Yarns:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* Thread count:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* Fire burn analysis: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Introduction

* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ are used in forensic science to create a link between \_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Through normal activities
  + We \_\_\_\_\_\_\_\_\_\_\_ fibers
  + We \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ fibers
* Very small fibers are classified as \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Collecting fibers within 24 hours is critical
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ - fibers may be transferred directly from victim to suspect or suspect to victim.
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ - If a victim has fibers on his person that he picked up and then transferred to a suspect

How Forensic Scientists Use Fibers

* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ – composition, uniqueness, and so on.
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ – often key to matching techniques.
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ – usually the more found the easier the match.
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ – can you place the suspect at the scene?
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ – carpet, upholstery, car, and so forth.
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ – several types of fibers can be more conclusive.
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ – can be the key to fiber transfer (possibility of violence)
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ between crime and fiber discovery – passage of time greatly reduces the effectiveness of fiber evidence.

Type of Fibers

* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ are derived in whole from animal or plant sources.
  + Examples include wool, mohair, cashmere, furs, and cotton.
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ fibers are manufactured.
  + Regenerated fibers are manufactured from natural raw materials and include rayon, acetate, and triacetate.
  + Produced solely from synthetic chemicals
  + Examples include nylons, polyesters, and acrylics.
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, or macromolecules, are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ composed of a large number of atoms arranged in repeating units known as monomers.

Fiber Classification – Natural Fibers

* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (made of proteins):
  + Wool and cashmere from \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
    - Wool is the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ animal fiber
  + Mohair from \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Angora from \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Hair from alpacas, llamas, and camels
  + Silk from \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (longer fiber does not shed easily)
* Plant fibers (made of the polymer \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_):
  + Absorb \_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in water
  + Very \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to damage from harsh chemicals
  + Dissolvable only by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Becomes \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ over time
* Plant fibers:
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ - most common textile plant fiber
  + Coir from coconuts is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Hemp, jute, and flax from \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ grow in bundles
  + Manila and sisal from leaves deteriorate more quickly
* Mineral Fibers:
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ - a fibrous form of glass
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ - a crystalline structure

Fiber Classification – Synthetic Fibers

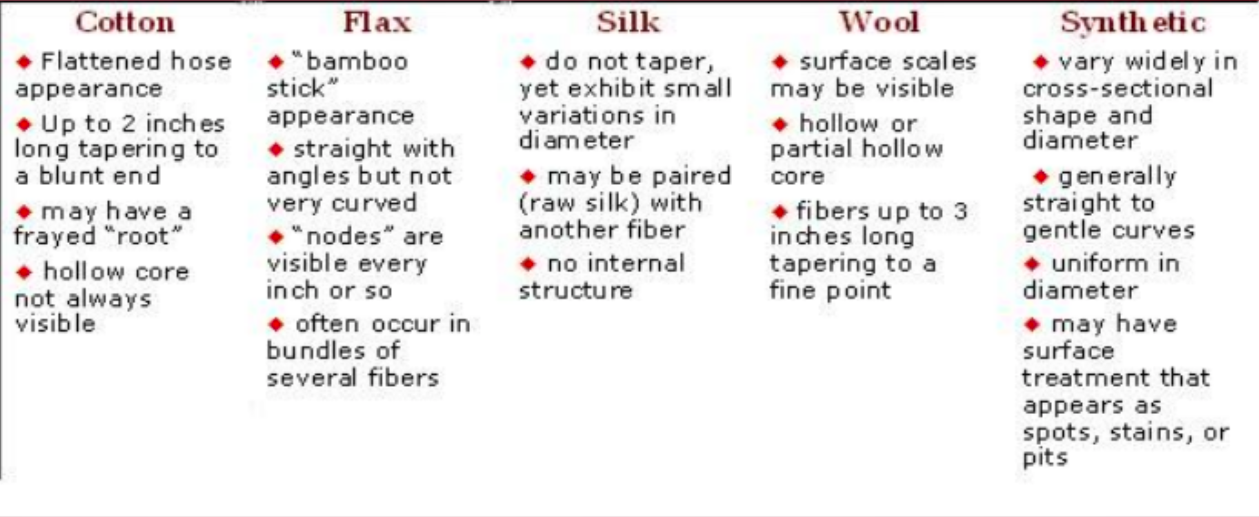
* \_\_\_\_\_\_\_\_\_\_ of fabrics are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ produced
  + Examples:
    - Rayon
    - Acetate
    - Nylon
    - Acrylic
    - Polyester
* Regenerated Fibers (derived from cellulose):
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Most common in this group
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ natural fibers, but \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Celenese®
  + Cellulose chemically combined with acetate
  + Found in many \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Polyamide \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Cellulose combined with three acetate units
  + Breathable and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Used in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ clothing

Fiber Classification – Synthetic Polymer Fibers

* Petroleum base
* Very different from other fibers
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ join to form \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Fibers are spun together into yarns
* No internal structures
* Uniform diameters
* Polyester
  + “Polar fleece”
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + \_\_\_\_\_\_\_\_\_\_\_\_ easily broken down by light or concentrated acid
  + Added to natural fibers for \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Nylon
  + \_\_\_\_\_\_\_\_\_\_\_\_\_ broken down by light and concentrated acid
  + Otherwise similar to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Acrylic
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Tends to “ball” easily
  + Substitute for artificial wool or fur
* Olefins
  + High performance
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Resistant to wear

Comparison of Natural and Synthetic Fibers

* Visual Diagnostics of Some Common Textile Fibers under Magnification



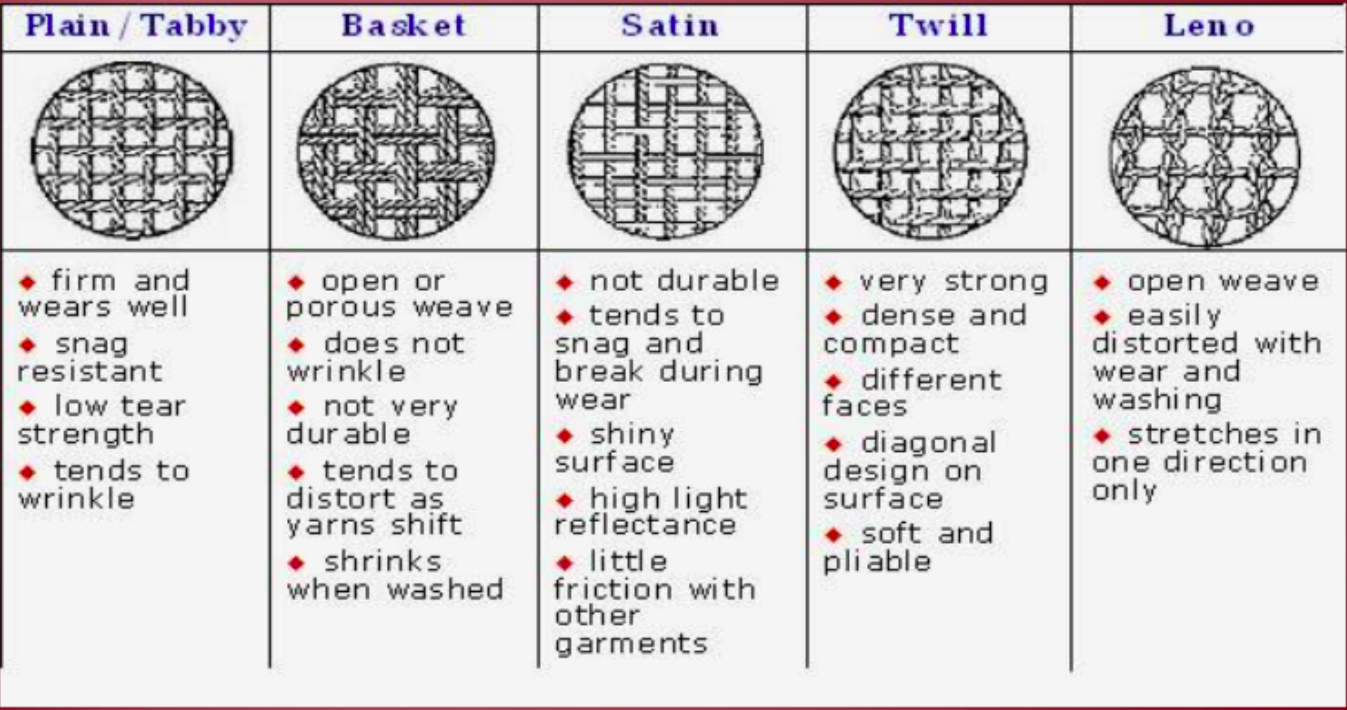
* Under magnification, all synthetic fibers have very \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* Hairs have \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

Yarns, Fabrics, and Textiles Oh My!

* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ - fibers (of any length, thick or thin, loose or tight) twisted or \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Any given yarn will have a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
  + Forensic scientists will identify the twist direction as part of their identification.
* Blending fibers meets different needs (e.g., resistance to wrinkling)
* Fibers are woven into fabrics or textiles
  + Threads are arranged side by side (\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_)
  + More threads (\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_) are woven back and forth crosswise through the warp

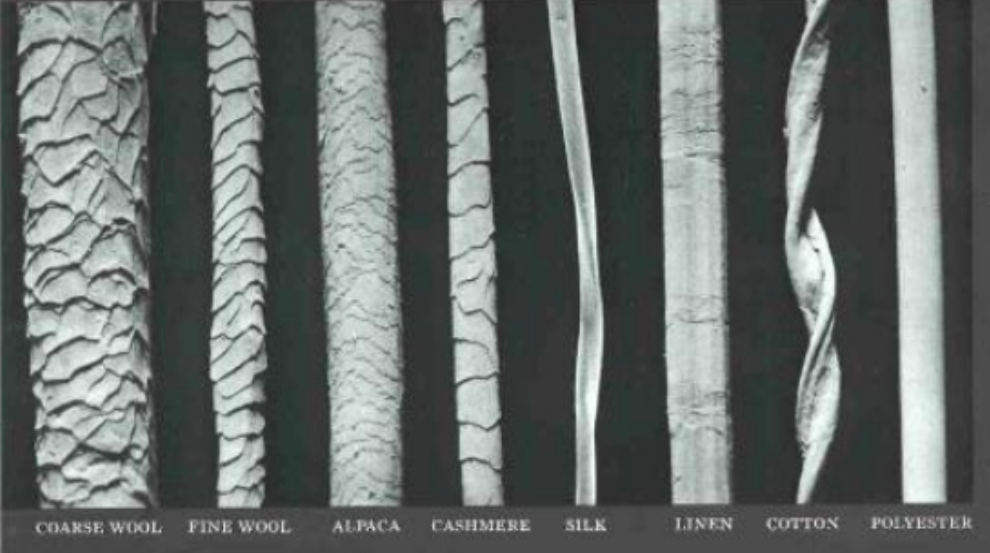
Weave Patters

* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ - The number of threads that are packed together for any given amount of fabric



Fiber Evidence

* Quality depends on the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of the criminalist to identify:
  + the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of the fiber
  + narrow the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to a limited # of sources
* Obviously, if the examiner is presented with fabrics that can be \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ at their torn edges, it is a virtual certainty that the fabrics were of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ comparisons



* + Between questioned and standard/reference fibers
  + Initially taken for \_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ characteristics, using a comparison microscope.
* Other \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 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 \_\_\_\_\_\_\_\_\_\_\_\_\_ of the fiber.
* Compositional \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ may exist in the dyes that were applied to the fibers during the manufacturing process.

Sampling and Testing

* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ evidence
  + Special vacuums
  + Sticky tape
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Nondestructive Analysis
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ – reveal characteristic shapes and markings
  + Polarizing light microscopy – uses specific wavelengths
  + Infrared spectroscopy - reveals \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to differentiate similar fibers
* Destructive Analysis
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ fibers
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ fibers in various liquids
* Compare fibers found on different suspects with those found at the crime scene



Collection and Preservation

* The investigator’s task of looking for minute strands of fibers often becomes one of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ potential “\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_” of fiber evidence.
* Relevant articles of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 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, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, and place the paper packet \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.*

Summary

* Fibers are a form of \_\_\_\_\_\_\_\_\_\_\_\_\_\_ evidence.
* Fibers are a form of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ evidence.
* Fibers are spun into \_\_\_\_\_\_\_\_\_\_\_\_\_ having specific characteristics.
* Yarns are woven, with different \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, into clothing or textiles.
* Fiber \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is gathered using different techniques.
* Fibers are analyzed using \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, tests for \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in different solutions, polarized light microscopy, or infrared spectroscopy.
* Fibers are classified as \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ or \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* Natural fiber \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ include:
  + Animal hair
  + Plant seeds, fruit, stems, or leaves
  + Minerals