● **Wool** - hair from the fleece of sheep or lambs

● **Specialty wool** – hair from goats, camels, alpacas, llamas, yak

● **Fur fiber** – hair from fur bearing animals such as angora rabbits, minks, beavers, and sheepdogs

● All of the above categories are broadly defined as wool fibers under **Wool Product Labeling Act**
  - Descriptors (e.g., lambs’ wool, cashmere, virgin wool) can be used if fibers meet the requirements

● Fiber length, color, and fineness vary considerably based on animal breed
Sources of Animal Hair Fibers

- Llama
- Angora rabbit
- Alpaca
- Colored Angora goat (Mohair)
- Sheep
Terminology

Wool Product Labeling Act (WPLA)

- **Wool**
  - Fiber from sheep, lamb, Angora goat, Cashmere goat
  - May include specialty fibers from camel, alpaca, llama, vicuna

- **Recycled Wool**
  - Fiber obtained from woven or felted wool, never having been utilized in any way by the ultimate consumer
  - Fiber obtained from spun, woven, knitted, or felted wool product, after having been used in some way by the ultimate consumer.

Source - *U.S.C. 15 Section 68 –Definitions*
**Terminology**

- **Lambs' Wool**
  - Very soft wool from lambs under seven months old
  - Natural tapered tip
  - Very fine diameter

- **Virgin or New**
  - Wool that is used for the first time
  - Not reclaimed or reused

- **Cashmere**
  - From cashmere goat
  - Meets diameter requirements
  - Not all fibers from cashmere goats can be labeled as cashmere
Fiber Structure

- **Surface Contour (longitudinal view)**
  - Surface scales
  - Shape and size of scales vary by breed
  - Hollow medulla running along the interior length of the fiber
  - Visible using a microscope

- **Shape (cross-section)**
  - Round/oval cross-section

*Courtesy CISRO, Australia*
Photomicrographs of Cashmere Wool

longitudinal view

2μm

cross-sectional view

2μm
Color, Crimp, and Luster

- Color depends on breed
  - Sheep and lamb fibers - typically off-white, require bleaching
  - Camel hair – brown
  - Specialty wools and fur fibers - white, gray, brown, or black
  - Naturally colored wool does not require bleaching or dyeing

- Dull; some fibers have a degree of luster

- Natural crimp varies by breed
  - Ranges from fine crimped to almost straight
Wool Performance Highlights

- Low strength
- Low abrasion resistance
- Resilient, very good elastic recovery
- Coarse fibers irritate skin
- High moisture absorption
- Insulating
Wool Performance Highlights

- **Felting Shrinkage**
  - Agitation, moisture and heat
  - Scales entangle into a mat or felt
- **Washable Wool**
  - Scales removed or coated with nylon
Felting Shrinkage in Wool Sweater

Note: The sweater, washed in warm water and tumbled dry, shrank due to felting. The sweater outline was drawn with a red marker prior to washing.
End Uses

- **Apparel**
  - Winter clothing
  - Hats that are molded to shape
  - Men's all-weather and winter suits
- **Textiles for Interiors**
  - Hand-woven area carpets and rugs
  - Upholstered furniture
- **Household & Institutional Textiles**
  - Blankets
- **Technical Textiles**
  - Industrial felts
  - Billiard and pool table covers
Care of Wool

- **Dry clean**
  - To avoid felting shrinkage, except for washable wool
  - Not damaged by dry cleaning solvents
  - Damaged by enzyme spot cleaners

- **Detergents with high alkalinity may damage the fibers**
  - Care instructions should be followed
  - Wash with a mild detergent such as Woolite®

- **Damaged by chlorine bleach**
  - Oxygen-type bleaches may be used
Care of Wool

- **Requires little or no ironing**
  - Steaming preferable
  - Steam-ironed at the recommended temperature, with a damp press cloth placed over the fabric

- **Prone to damage by moths**
  - Use moth balls with caution
  - Some carpets and rugs may be treated with mothproof finishes
Moth Damage – A wool swatch damaged while stored in a box
Silk is the only natural fiber available in filament form.

Referred to as the “queen of fibers,” silk is known for its luxurious appearance.

Silk production, or sericulture, is labor-intensive.

The majority of silk is produced in South and Far East Asia.

The filaments are made of a protein called fibroin; the gum, which is often removed, is called sericin. Silk fabric with sericin is known as raw silk.
Types of Silk

- Silkworms extrude two strands of silk fiber, held together by a natural gum, to form cocoons

- *Bombyx mori* silkworms - **cultivated silk**

- Tussah, Eri, and Muga - **wild silk**

- **Peace silk** and **ahimsa silk** - produced without killing the silkworm
Silk Cocoons - Source for extruded natural protein fibers

Samples courtesy Central Silk Board, India
Silk Grades

- Cocoons unraveled to yield **filament silk**
- **Dupion** or **doupioni** silk - from cocoons that became tangled while they were spun.
  - Variable areas where the yarn is thicker due to the inseparable entangled filaments
- **Spun silk** - filament fibers from cocoons damaged by the emerging silk moth
  - Less expensive and less lustrous than filament silk
- **Waste silk/silk noil** - fibers that cannot be reeled
  - Lower quality, spun silk yarns
Silk Grades

yarn with silk filaments

doupioni silk (entangled fibers from two cocoons)

silk noil and yarn spun with silk noil
Surface Contour and Shape

- **Surface Contour (longitudinal view)**
  - Smooth surface
  - Translucent
  - Variable diameter

- **Shape (cross-section)**
  - Triangular with rounded edges
  - Shape and size varies
Color and Luster

- Cultivated silk - off-white
- Wild silk - off-white to shades of brown
- Filament fibers – lustrous
- Silk noil - dull
Silk Performance Highlights

- Degummed, cultivated silk - soft hand
- Raw and weighted silks – stiff, "scroop" sound when the fabric is moved
- **High strength**
  - Considered to be weak because fibers are so fine
- **Good flat abrasion resistance**
- **Poor flex abrasion resistance**
- **Average resistance to wrinkling**
- **Good dimensional stability**
- **Moderate moisture absorbance**
  - Comfortable to wear in most climates
- **Does not irritate the skin**
- **Damaged by exposure to sunlight,** UV light
Exposure to Sunlight - Degradation of silk curtains

Note: The curtains degraded after approximately five years.
End Uses

- **Apparel**
  - Women's dresses, suits, gowns, blouses, sweaters, lingerie, scarves and other accessories
  - Men's ties, boxer shorts, shirts, and sports jackets

- **Textiles for Interiors**
  - Hand-knotted area rugs, curtains, draperies, wall hangings, wall coverings, cushions, and upholstered furniture

- **Household & Institutional Textiles**
  - Luxury bed linens and comforters
Camisole Made with 93% Silk/7% Spandex Fabric

93% SILK, 7% SPANDEX EXCLUSIVE OF TRIMS
MADE IN CHINA
DRY CLEAN ONLY

Note: Camisole cut on bias
Magnified view
Drapery Fabric Made with Silk

Magnified view
Care of Silk

- **Care instructions differ significantly** based on silk type, fabric construction, and dyes.
  - Does not shrink
  - Washable silks - hand wash or machine wash on the gentle cycle, use mild detergent
  - Rubbing causes chafing, with color loss due to abrasion
  - Dry cleaning recommended for raw silk; washing removes the water-soluble sericin
  - Ironing should be done with care

- **Damaged by chlorine bleach.**

- **Damaged by perspiration**, antiperspirants, and deodorants
  - Garments should be cleaned prior to being stored
Chafing in 68% Silk/32% Nylon Sweater

damage in sweater caused by rubbing to remove food spill

area with no damage

area damaged due to rubbing

Magnified view
## Performance – Comparison of Natural Fibers

<table>
<thead>
<tr>
<th></th>
<th>Cotton</th>
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<td>medium</td>
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<td>Abrasion</td>
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* Wool has the highest absorbency