Wool

- **Wool** fiber is the animal hair from the fleece of sheep or lambs.

- **Specialty wool** fibers are the hairs of goats, camels, alpacas, llamas, and yak.

- **Fur fibers** are the hairs of bearing animals such as angora rabbits, minks, beavers and sheepdogs.

- The **Wool Product Labeling Act (WPLA)** dictates the labeling of wool products sold in the United States.
  - In WPLA, wool, specialty wool, and fur fibers are broadly defined as wool fibers. Descriptors (e.g., lambs’ wool, cashmere, virgin wool) can be added if the 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 (WPL) definitions:

- The term "wool" means the fiber from the fleece of the sheep or lamb or hair of the Angora or Cashmere goat (and may include the so-called specialty fibers from the hair of the camel, alpaca, llama, and vicuna) which has never been reclaimed from any woven or felted wool product.

- The term "recycled wool" means (1) the resulting fiber when wool has been woven or felted into a wool product which, without ever having been utilized in any way by the ultimate consumer, subsequently has been made into a fibrous state, or (2) the resulting fiber when wool or reprocessed wool has been spun, woven, knitted, or felted into a wool product which, after having been used in any way by the ultimate consumer, subsequently has been made into a fibrous state.

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

- **Lambs' wool** is “very soft wool from lambs under seven months old. The fibers have a natural tapered tip that is lost after the first clipping. It has superior spinning characteristics” (Source – *Dictionary of Fiber & Textile Technology*).

- The terms “**virgin**” or “**new**” can be used as descriptors for wool that is used for the first time; it has not been reclaimed or reused.

- The term “**cashmere**” can be used only for wool fibers that meet the WPLA requirements of fiber source and diameter; not all fibers from cashmere goats can be labeled as cashmere.
Fiber Structure

- **Surface Contour (longitudinal view)**
  - Wool fibers have scales on their surface. The shape and size of scales vary by breed.
  - Coarse wool has a hollow medulla running along the interior length of the fiber. Under a microscope, the medulla appears as a black line in the fiber’s center.

- **Shape (cross-section)**
  - Wool fibers have a round/oval cross-section.
Photomicrographs of Cashmere Wool

longitudinal view

2µm

cross-sectional view

2µm
Color, Crimp, and Luster

- Color depends on breed.
  - Sheep and lamb fibers are typically off-white. Wool requires bleaching before it is dyed.
  - Camel hair is brown; other specialty wools and fur fibers are white, gray, brown, or black. Colored wool does not require bleaching or dyeing; therefore, it is considered eco-friendly.

- Fibers are usually dull; some fibers have a degree of luster.

- Fibers have natural crimp, which varies by breed. Textures range from fine crimped to almost straight. Texture affects fabric hand.
Performance Highlights

- **Low strength**
  - Used for apparel and applications which do not require high strength.

- **Low abrasion resistance**
  - Fiber crimp allows fiber to withstand small amounts of stress by extending when pulled, but fiber cannot withstand moderate or higher stress.
  - Fibers readily break away from yarns and form pills on fabric surface.

- **Resilient, very good elastic recovery**
  - If fabrics are wrinkled in wearing, they return to original shape readily.

- **Coarse fibers irritate skin** causing itching.

- **Highest moisture absorption** of any natural fiber.
  - Contributes to comfort in wearing.

- **Insulating**. Fiber crimp creates bulky yarns and fabrics with air spaces which trap air. Trapped air insulates the body.
Performance Highlights

- Shrinks due to **felting shrinkage**.
  - Agitation (mechanical action), moisture and heat.
  - The surfaces scales of the wool fiber entangle with each other causing irreversible matting.
  - Washable wools are either treated to remove scales, or scales are coated with nylon to prevent them from entangling.
End Uses

- **Apparel**
  - Winter clothing.
  - Wool and wool blends hold the major share for men's all-weather and winter suits.
  - Hats that are molded to shape.

- **Textiles for Interiors**
  - Hand woven area carpets and rugs.
  - Wool blends are used for upholstered furniture and other interior applications. Some products are finished for moth proofing.

- **Household & Institutional Textiles**
  - Commonly used for blankets prior to the introduction of acrylic. Some are still made of wool.

- **Technical Textiles**
  - Industrial felts.
  - Wool/nylon blends used for billiard and pool table felts. Note: These fabrics are woven and then fulled (not true felts).
Wool Felt Hat

Note: Molded hats are commonly made with felted wool. This hat, made with high quality wool felt, was molded and then decorated with feathers and rhinestones.
Hand Woven Rugs Made with Wool Filling Yarns
Care

- **Usually dry cleaned** to avoid felting shrinkage.
  - Not damaged by dry cleaning solvents.
  - Damaged by enzyme spot cleaners.

- Washable wool and some wool products such as sweaters and socks can be **washed**. If laundered, care instructions should be followed carefully.
  - **Detergents with high alkalinity may damage the fibers.** Washing with a mild detergent such as Woolite® is recommended.
  - **Damaged by chlorine bleach;** oxygen-type bleaches can be used with care for garments that can be bleached.

[Image of Machine Washable label]
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.
Care

- **Requires little or no ironing.**
  - Steaming preferable.
  - Should be steam-ironed at the recommended temperature, with a damp press cloth placed over the fabric. The damp cloth prevents the fabric from getting an undesirable shine.

- **Prone to damage by moths.**
  - Use moth balls with caution.
  - Some carpets and rugs may be treated with mothproof finishes.
Silk

- 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 (moth larvae) extrude two strands of silk fiber, held together by a natural gum, to form cocoons. The two strands are later separated.

- *Bombyx mori* silkworms produce **cultivated silk** and are typically raised in a controlled environment.

- Tussah, Eri, and Muga are **wild silk** varieties.
  - Farming silkworms for wild silk varies by species and cultural practices.

- **Peace silk** and **ahimsa silk** are marketed as eco-friendly fibers (produced without killing the silkworm) using wild and cultivated silk cocoons from which the moth has emerged.
Silk Cocoons – Source for extruded natural protein fibers

Samples courtesy Central Silk Board, India
Silk Grades

- Cocoons of cultivated silk and certain wild silk varieties are reeled (unraveled) to produce high-quality **filament silk** yarns.
  - These yarns are too valuable to cut into staple lengths for spun yarns.
  - Fine silk fabrics are more expensive than other fabrics of similar weight and construction.

- **Dupion** or **doupioni** silk is reeled from cocoons that became tangled while they were spun.
  - The yarn produced with entangled filaments has variable areas where the yarn is thicker due to the inseparable entangled filaments.

- **Spun silk** is produced with filament fibers from cocoons damaged by the emerging silk moth.
  - **Waste silk/silk noil** fibers that cannot be reeled produce lower quality, spun silk yarns.
  - Spun silk is less expensive and less lustrous than fine silk.
Silk Grades

yarn with silk filaments

yarn with doupioni silk (entangled fibers from two cocoons)

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

- **Surface Contour (longitudinal view)**
  - Fibers have a smooth surface and translucent appearance.
  - The width of the fiber is not very uniform.

- **Shape (cross-section)**
  - The fiber is triangular with rounded edges.
  - Shape and size of individual fibers vary because each silkworm spins the silk differently.
  - Differences in cross-section depend on variety.
Color and Luster

- Cultivated silk is off-white; color of wild silks range from off-white to different shades of brown. Colored wild silk is not bleached.
- Silk fibers, especially cultivated silk filament fibers, are known for their luster. Silk noil is usually dull.
Performance Highlights

- Degummed, cultivated silk for fine fabrics is soft and has an excellent hand. Raw and weighted silk fabrics are stiffer and produce a rustling sound, known as "scroop," when the fabric is moved.

- **One of the strongest natural fibers**; often considered to be weak because fibers are so fine.

- **Good flat abrasion resistance, but poor flex abrasion resistance.**
  - Overall abrasion resistance is considered moderate.

- **Average resistance to wrinkling**; good dimensional stability.

- **Moderate moisture absorbance.**
  - Comfortable to wear in most climates.

- **Does not irritate the skin**; fibers are very fine.

- **Damaged by exposure to sunlight**, UV light.
  - Window treatments should be lined to reduce damage.
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
Ties Made with Filament Silk Fibers
Care instructions differ significantly based on silk type, fabric construction, and dyes.
- Does not shrink when washed or dry cleaned.
- Washable silks; should be hand washed or machine washed on the gentle cycle using mild detergent.
- Rubbing to remove stains may cause 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.
  - 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
<table>
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* highest absorbency

Comment: Thermal insulation is high for wool.