Wool and its products

Fibers

Can be characterized based on comparison of both physical and chemical properties

Types of fiber:

Synthetic

Natural

Synthetic	Natural
Rayon	Silk
Nylon	Cotton
Acetate	Wool
Acrylic	Mohair
Spandex	Cashmere
Polyester	

Classification of natural fibers

Natural fibers are classified according to their origin:

1. Vegetable or cellulose
2. Animal or protein
3. Mineral

Animal or protein fibers

Wool— Wool is the fiber from the fleece of domesticated sheep. It is natural, protein, multi-cellular, staple fiber.

Animal fiber coming most often from sheep, but may be goat (mohair), rabbit (angora), camel, alpaca, llama, or vicuña

Difference between Wool & Hair

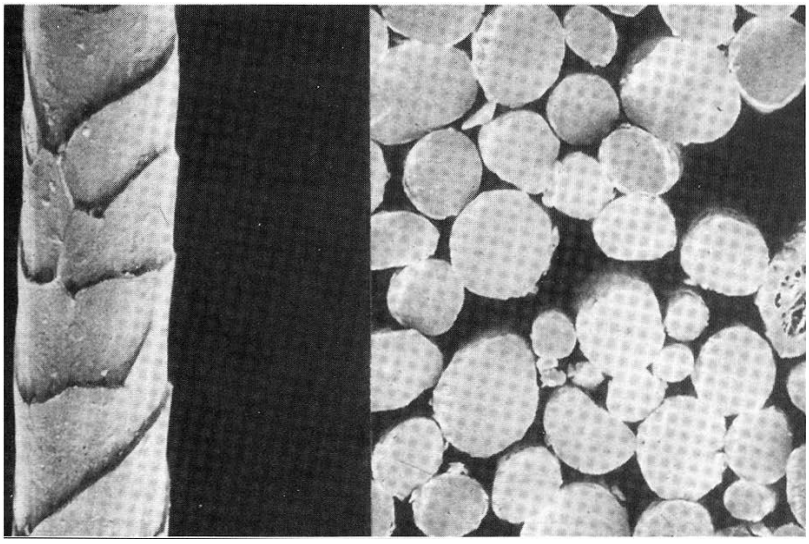
1. The principal animal fiber, wool, has a rough, serrated surface, is curely, or longitudinally wavy, and is disposed on the fleece in locks, technically staples which are composed of a large number of individual fibres.

2. Hair has a smoother surface than wool, is straighter, and is not combined in staples, as each fiber grows individually.

No.	Parameter	Wool	Hair
1	Medulla	Almost absent	Present and pronounced
2	Cuticle	Irregular	Regular and smooth
3	Sides	Scaly projections	Smooth
4	Diameter	Less	More
5	Growth	Continuous if not sheared	Reaches a maximum and then “shed”
6	Softness	More	Less
7	Elasticity	More	Less
8	Heat retention	More	Less
9	Moisture retention	More (12-17%)	Less (7-12%)
10	Dye retention	Permanent	Temporary
11	Inflammability	Less	More

Wool fiber morphology

- Longitudinal appearance of wool is overlapping surface cell structure.
- Cross-section of wool is usually oval in shape.



Wool has a rod-like structure with rough surface of overlapping horny scales. The fiber varies in length from two to eighteen inches and also varies greatly in fineness. The wool fibers are covered with minute scales, which cling to each other and enable the short fibers to be spun into thread.

Longitudinal view of fiber:

1. Rough surface
2. Crimp very evident
3. Scales present
4. More or less circular

Structure of wool

Wool fiber is composed of surface scale, cortex and medulla layer.

- The Microscopic structure of wool has following parts:

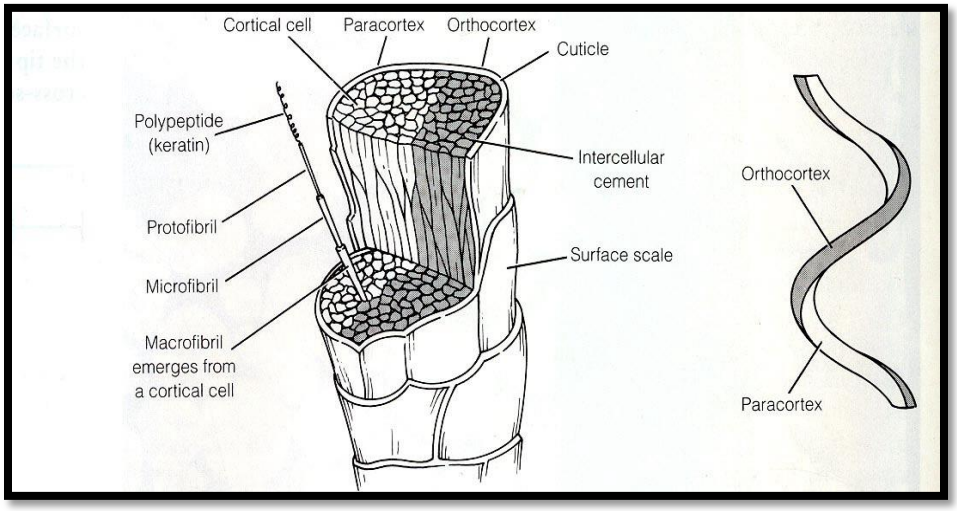
  Cuticle

  Macro Fibril

  Micro Fibril

  Proto Fibril

  Wool Polymer



- Epicuticle- thin outer membrane covering the cuticle
- Cuticle- protective layer of overlapping flattened cells called scales
- Cortex- major component of wool fiber, inner layer
  1. Orthocortex- referred to a soft and has a higher affinity for dyes and is found at the outside of the curve of the fiber.
  2. Paracortex-found on the inside of the curve of the fiber and is referred to a the hard and maintains less affinity for dyes.
- Medulla- the central core found primarily inmedium and coarse wool

Physical properties of wool

- Tenacity: Wool is a weak fibre.
- Elastic-plastic nature: Wool has very good elastic recovery and excellent resilience.
- Hygroscopic nature: very absorbent
- Thermal properties: Poor heat conductivity of wool
- Heat of wetting: Wool is renowned for its ability to give off small but steady amount of heat while absorbing moisture. This is known as Heat of Wetting

Chemical properties of wool

- Effect of acids: Wool is more resistant to acids than to alkalis.
- Effect of alkalis: Wool dissolves readily in alkaline solutions.
- Effect of sunlight and weather: Exposure to sun light and weather tends to yellow white wool textile materials.
- Color-fastness: Wool is easy to dye.

Chemical composition of wool

- Keratin ---------- 33%
- Dust ---------- 26%
- Suint (sweat)---------- 28%
- Fat ---------- 12%
- Mineral Matter --------- 1%

Beneficial properties or virtues of wool

- Insulation: Wool insulates against heat and cold. It is comfortable in both hot and cold weather because it absorbs moisture vapour.

- Fire resistant: A fabric made entirely of wool is difficult to ignite, burns slowly, and has limited ability to sustain a flame. Wool does not melt when burned and so cannot stick to the skin and cause serious burns.
- Water repellent: Although wool can absorb moisture, it repels (oppose) liquids. It is naturally hydrophobic. if wool does eventually get wet it generates heat and keeps the body warm, not cold and clammy.
- Elastic: Wool has greater elasticity than any other plant or animal fibre. Wool can be twisted, turned and stretched and will still return to its natural shape.
- Durable: The interlocking protein molecules in the fibres of wool have the power to elongate, stretch and recover, creating an extremely robust (strong) fabric that will last. Each wool fibre is made up of millions of 'coiled springs' that stretch and give rather than break.
- Static resistant: Wool has very little tendency to collect static electricity because wool naturally absorbs moisture from the air. Wool garments are much less likely to 'spark' or cling (attach) to the body.
- Noise insulation: Wool absorbs noise and reduces noise levels.
- Dirt resistant: Wool's ability to absorb moisture and therefore its low build-up of static electricity means that wool does not attract dust from the air.
- Versatile: Different sheep breeds with their own unique fibre characteristics provide different wools for a wide range of products.
- Dye-ability: Wool is easy to dye. The scales on the surface of the wool fibre diffuse (scatter) light giving less reflection and a softer colour. The proteins in the core of the fibre absorb and combine with a wide variety of dyes and allows the wool to hold its colour.
- Comfort: Wool is comfortable to wear because of its elasticity, and moisture absorbing qualities.
- Fashionable: Wool drapes well, is alive, flexible and tailors easily, making it sought after by fashion designers.

Different types of wool

- Fine Wool
    - Highest quality wool
        - Spanish Merino, Rambouillet, Delaine
- Medium Wool (fine x long)
    - Meat & wool production
        - Southdown, Suffolk, Hampshire, Dorset, Finnsheep
- Long Wool (coarse)
    - Mainly used for meat
        - Largest breeds: Costwold, Lincoln, Romney
- Crossbred (fine x medium)
  Targhee, Corriedale, Columbia
- Carpet (double-coated)
  Scottish Blackface, Karakul, Icelandic

Specialty of hair

- Mohair
- Cashmere
- Camel Hair
- Alpaca
- Llama
- Vicuna
- Angora
- Yak
- Qivuit


camel's hair


angora goat


alpaca


cashmere goat


guanaco


vicuna


llama

Mohair

- Mohair refers to the hair of Angora goat.
- Mohair fiber is approximately 25-45μ in diameter. It is both durable and resilient (elastic). It is notable for its high luster. It also takes dye exceptionally well.

Cashmere

- Cashmere is a type of fiber obtained from the Cashmere goat, or Pashmina.
- cashmere fiber is highly adaptable.
- Cashmere is similar to wool in most properties.

Camel Hair

- Camel-hair are both light in weight and warm; they have a distinctive golden brown colour with a pleasing lustre. The fabrics are soft, comfortable, and good wearing, and they drape (cover) attractively.

Alpaca

- Alpaca offers excellent warmth and insulation. The fibres are strong and glossy and make fabrics similar in appearance to mohair.

Llama

- Llama fibre is soft, strong, and relatively uniform in length and diameter but somewhat weaker than alpaca or camel hair.

Vicuna

- Vicuna is one of the softest fibres in the world. It is fine and lustrous, has a lovely cinnamon brown or light tan colour, and is strong enough to make very desirable fabrics. It is also very light in weight and very warm.

Angora

- hair of angora rabbit
- produced in Europe, Chile, China, & U.S.
- harvested up to 4 times/year—plucking or shearing
- two most common breeds—
    - English—fine, silky fiber

- French—coarser

Yak

- produced by large ox found in Tibet & Central Asia
- collected by combing out during spring molt
- fiber is smooth & lustrous
- often used natively in apparel (clothing), rope, tent covers
- internationally used to blend with cashmere
- coarser than cashmere

Qivuit

- Rare, luxurious fiber
- Wool of domesticated musk ox—6 lbs of wool per year
- can be used just as it comes from animal
- resembles cashmere in hand & texture—much warmer

Making Wool into Yarn

1. Shearing Sheep

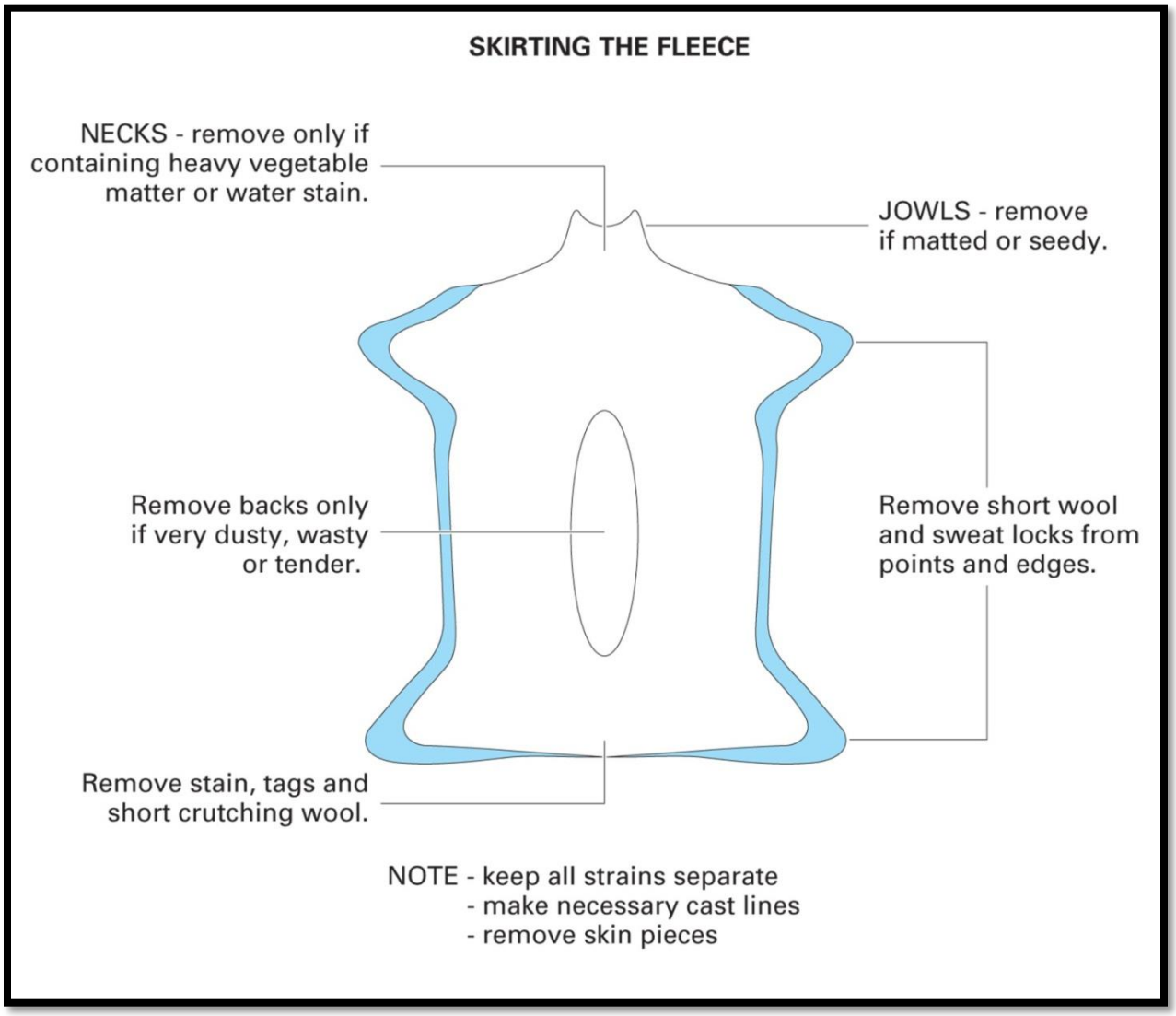
Wool comes from sheep. They grow a wool coat and once a year this wool coat is sheared off the animal. In Wisconsin, this is frequently done in the early spring shortly before they have their lambs. A shorn ewe will be more likely to stay out of the wind and bad weather and protect her new-born lamb if she does not have a thick wool coat on her.

2. Fleece

The shorn wool coat is called a fleece. It is also called "grease wool" because of all the oil and lanolin in the wool. This fleece must be cleaned before it can be processed into wool yarn. There is much vegetable matter, manure and natural oil that must be removed. Sometimes as much as 50% of the weight of the fleece is not wool.

3. Skirting a fleece

The wool from the back end of the sheep, their legs and sometimes their belly is too full of manure to use. These are referred to as "tags" (as in the phrase "tag end"). These are removed first before washing the fleece; this process is called skirting.



4. Washing the wool

The grease must then be removed from the wool. This can be done using soap or detergent and a lot of water or it can be done by submerging the wool in an acid bath which dissolves all the vegetable matter as well as the grease (this is called scouring).

5. Picking

The washed and dried wool is then "teased" or "picked" which is the beginning of the process of opening up the locks of wool and turning it into a consistent web (a net-work of threads).

The wool is put through a picker which opens the locks and blows the fluffy wool into a room. At the same time a special spinning oil is added which helps the wool fibers slide against each other but also helps them stick together as a fine web through the processing.

6. Carding

The wool fibers are then put through a series of combing steps called carding. This can be done with small hand cards that look much like brushes you would use on a dog.

It can also be done on a larger scale with machine driven drums covered with "card cloth" which combs the wool many times by transfering it back and forth from one drum to the other as it is passed down the series of drums. “Woolen“ cards produce a wool web with the fibers coming off in random alignment.

7. Roving

The final step in the carding process divides the web into small strips called pencil rovings. These are collected on large spools on the end of the card. These spools of pencil roving will be placed on the spinning frame to make yarn.

8. Spinning

The roving as it comes off the card has no twist. It is held together by the oil and natural hooks that exist on the surface of the wool fibers. The spinning frame will put the actual twist on the roving and turn it into yarn. This is collected on wooden bobbins. The frame we have is small but it can spin up to 90 threads at one time.

9. Wind and/or skeining

When the wooden bobbins are full of yarn, they are placed on a cone winder and the yarn is transferred to paper cones for use in weaving and knitting machines. It could also be put into skeins of yarn which are the form that knitters like to use.

10. Finishing

There are many ways of finishing the yarn. It is sometimes necessary to remove the lubricant by washing. Sometimes the wool is woven or knitted directly from the cone and is washed and blocked in its final form (as cloth, socks, sweaters, etc.).

Fineness/Grade : In general, grade refers to the average diameter or thickness of the fibers. Three systems of wool grading are commonly used :

American or Blood system;

English or Spinning Count system; and

Micron system.

American or Blood system

American, defunct but interesting

Theoretical amounts of Merino in a particular breed (half-blood, quarter-blood)

Developed with Merino craze of 1800's

English or Spinning Count system

Indirect correlation between the fiber diameter and count number

Very out of date, but still used by some farmers

Very subjective

Micron system.

Objective measurement

Most technical and accurate

Direct correlation between the fiber diameter and number

Type of Wool	American or Blood Grade	English or Spinning Count Grade	Microns (average fiber diameter)
Fine	Fine	Finer than 80s	Under 17.70
Fine	Fine	80s	17.70 - 19.14
Fine	Fine	70s	19.15 - 20.59
Fine	Fine	64s	20.60 - 22.04
Medium	1/2 Blood	62s	22.05 - 23.49
Medium	1/2 Blood	60s	23.50 - 24.94
Medium	3/8 Blood	58s	24.95 - 26.39
Medium	3/8 Blood	56s	26.40 - 27.84
Medium	1/4 Blood	54s	27.85 - 29.29
Medium	1/4 Blood	50s	29.30 - 30.99
Coarse	Low 1/4 Blood	48s	31.00 - 32.69
Coarse	Low 1/4 Blood	46s	32.70 - 34.39
Coarse	Common	44s	34.40 - 36.19
Very Coarse	Braid	40s	36.20 - 38.09
Very Coarse	Braid	36s	38.10 - 40.20
Very Coarse	Braid	Coarser than 36s	Over 40.20

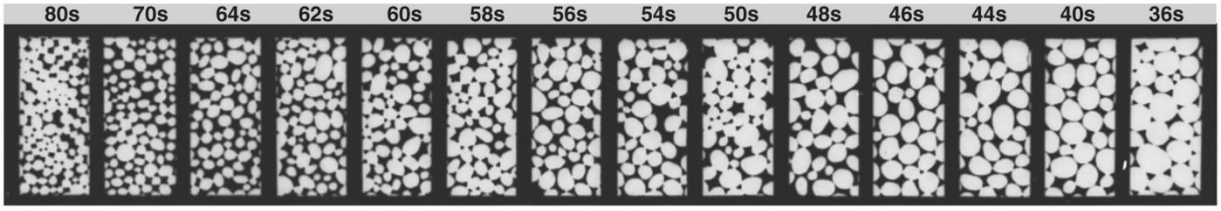


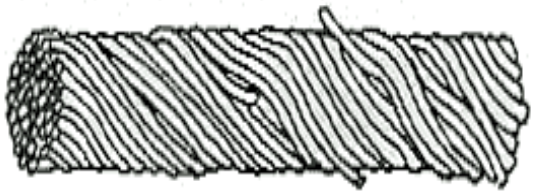
Figure: Cross section of magnified wool fibers demonstrating the wool grades based on fiber diameter measured in microns. Courtesy of USDA.

Types of Wool Yarn

There are two types of wool yarn

1. Woollens
2. Worsteds.

woolen yarn
is spun after carding



worsted yarn
is not only carded but is given extra combing to remove shorter fibers

Woollens

Woolens is a general term describing various fabrics woven from woollen yarn that is spun from the shorter wool fibres. These shorter fibres are not combed to lie flat as in the worsted yarn. This results in soft surface textures and finishes and the weave of individual yarns does not show as clearly as in worsted fabrics.

Worsteds

Worsted is a general term for fabrics woven from worsted yarns that contain longer fibres spun from combed wool. Worsted wool refers to tightly woven, smooth, clear finished goods in a variety of twill and other stronger weaves.

Application of Wool

Wool is used in the manufacture of various products

- Boots
- Carpet
- Blankets
- Sweaters
- Coats
- Seat covers
- Bed sheets
- Cushion covers
- Socks
- Curtain
- Shawl
- scarf