



Textile raw material types. Wool fiber types. Sheep wool groups

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Meaning of the term “wool”

Wool is hair of animals collected for processing and used to produce fabrics or felts.





Useful properties of wool

- High thermal protection properties
- High felting (spinning) capability
- Wool is light, straight, elastic, supple, plastic, stretchy, and has a certain sheen
- Wool is hygroscopic, hygienic, and long-wearing; wool products have a beautiful appearance
- Wool transmits ultraviolet rays
- Wool protects from radioactive contamination



Types of wool raw materials by source

- **Natural fibers** are fibers that exist in nature in a finished form; they are formed without direct human involvement. This group includes fibers of plant, animal, and mineral origin.
- The main classification features are: chemical composition of fibers and their area of origin.





Natural fibers

- Natural fiber of mineral origin: **Asbestos** (Greek: indestructible) is a collective name for a group of thin-fibered minerals belonging to the class of silicates. In nature, they are aggregates with a spatial structure in the form of fine flexible fibers. It is used in a wide variety of applications such as construction, automotive, and rocket science. By its chemical composition, asbestos represents aqueous silicates of magnesium, iron, and calcium, and is laid down in rocks in the form of veins and streaks.



Natural fibers of plant origin

- Cellulose is the main substance that makes up plant-based fibers. It is a poorly-soluble solid composed of $C_6H_{10}O_5$ links. In addition to cellulose, plant fibers contain waxes, fats, proteins, and dyes.
- Cotton is a natural fiber of plant origin. Cotton is produced from the fibers of the cotton plant seeds. Cotton is used as the base to produce: sateen, batiste, gauze, chintz, flannel, calico, poplin, voile, and other fabrics. The advantages of the cotton fabric are: strength, high wear resistance, resistance to alkali, and elasticity. The fabric is warm, soft, and smooth to the touch; it well absorbs moisture and does not electrify.





Natural fibers of plant origin

- Linen is a natural and environmentally friendly plant-based fiber. Stems of a herbaceous plant called flax are used as the raw material for linen production. Linen fabrics are hygienic, durable, and soft to the touch, with good moisture-permeability and breathability properties. However, linen fabrics, due to the slight stretchability and weak elasticity of the fiber, are extremely wrinkled and poorly ironed, and also shrink after washing. Most often linen fabric products are available in natural colors (from gray to beige). They have a nice sheen.





Natural fibers of animal origin

- **Sheep wool** is the worst conductor of heat, thus the products have high heat-protective properties, good elasticity, and lightness, have the felting capability and well take coloring. It is used to make fabrics for dresses and suits, and to produce velour. The group of woolen fabrics includes: twill, cloth, tweed, woolen suiting, carpetcoat, cheviot, and duvetyn.





Natural fibers of animal origin

- **Goat wool**, unlike sheep wool, has a strong sheen (luster), strength, and less felting ability. It can be in uniform, non-uniform, and fluffy. Goat wool is used to make drapery fabrics, blankets, carpets, and the down is used to make headscarfs and shawls.





Natural fibers of animal origin

- **Camel hair** is yellow-brown in color, similar by properties to non-uniform sheep wool, and has great strength and good elasticity. It is used to make knitwear, and coarse camel hair is also used to make drive belts and engineering products.





Natural fibers of animal origin

- **Cow wool** is short and coarse wool. It has low spinning properties, but is characterized by high spinning ability.
- It is used for the production of sweat-cloth for horse saddles; cow wool is used to produce felting products (shoes and felts) as an addition to other wool types.





Natural fibers of animal origin

- **Horse hair**, when mixed with sheep and cow wool, is used for the production of building insulation materials (ropes for sea vessels).

Handmade saddle-cloth pads are made from the felted wool.

Various technical brushes and scrapers are made of horse hair: painter brushes, art brushes, cosmetic brushes, brushes for cleaning watch movements, grinding rollers for metal, mirrors, and glass, theatrical wigs.





Natural fibers of animal origin

- **Rabbit hair** has low thermal conductivity and poor sound conductivity, with fiber thickness up to 15 micrometers. It is used to make knitted garments.
- It is widely used in the production of knitted and crocheted items. These products are characterized by their elegance and stand on a par with noble materials such as cashmere and alpaca. Compared to them, rabbit hair even has an advantage: it does not require pre-treatment (washing and drying) and is just ready for further processing.





Natural fibers of animal origin

- **Alpaca wool.** It has a low weight compared to sheep wool.
- The raw material made from the wool of young alpacas is very warm.
- There is no fat in the thick wool of these animals, thus the products made from it are resistant to contamination.
- It is non-allergenic for both adults and children.
- It has a wide variety of colors.
- The material produced has the only disadvantage of a high price, thus affordable raw materials are sometimes added to the wool fibers used. For example, it can be acryl, viscose, or polyamide. This helps to preserve the unique qualities of the fabric and makes it cheaper to produce.





Artificial fibers (viscose)

- It is obtained by chemical and technological processing of natural high molecular weight compounds of cellulose, a plant fiber (wood, cotton, soybean, etc.).
- Viscose is considered a man-made fiber on one hand, and a follower of natural fibers on the other. It is due to the fact that a natural component, cellulose, is used for its production.
- Viscose is produced by a chemical technique. First, cellulose is extracted from the wood, which is then treated with a sodium hydroxide solution at a temperature range of 45 to 60 °C. The resulting suspension is squeezed, crushed, and placed in carbon sulfide. In this way, a new substance, cellulose xanthogenate, is formed. It is kept in a caustic soda solution for several days until a viscose substance is formed. Subsequently, it is passed through draw dies, after which fibers are created and dried.



Synthetic fibers (capron, lavsan, cremeline, and nylon)

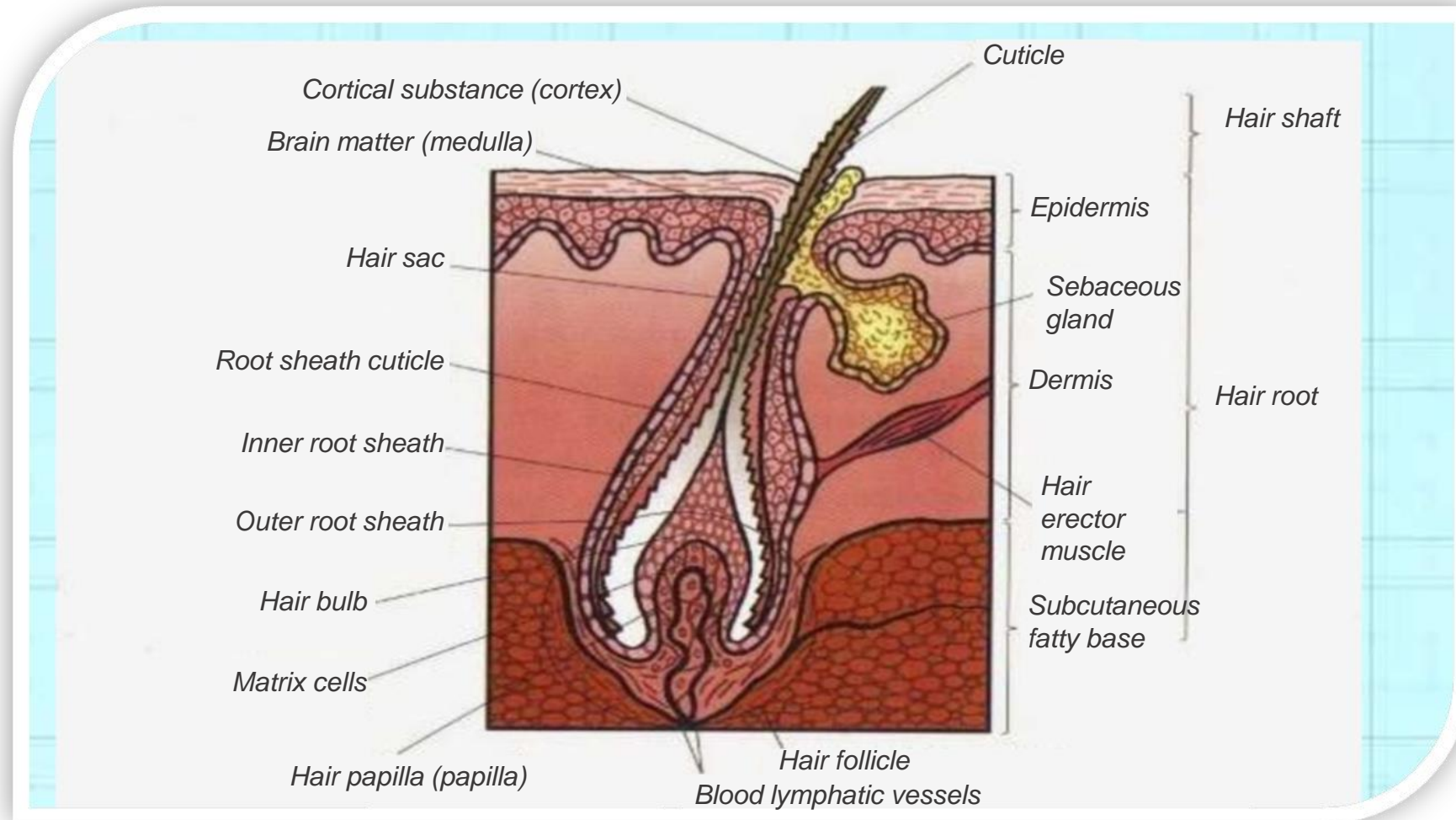
- They are synthesized from the products of coal, oil, and gas processing by a chemical technique. By characteristics, they surpass natural sheep wool, but valuable technological properties and a number of features of wool products cannot be artificially reproduced yet.
- Capron is a synthetic fiber that belongs to polyamide fibers; a fiber made from polyamide resins. It is transparent, wear-resistant, and also resistant to microorganisms. It tends to electrify. It is very durable and form-fitting.



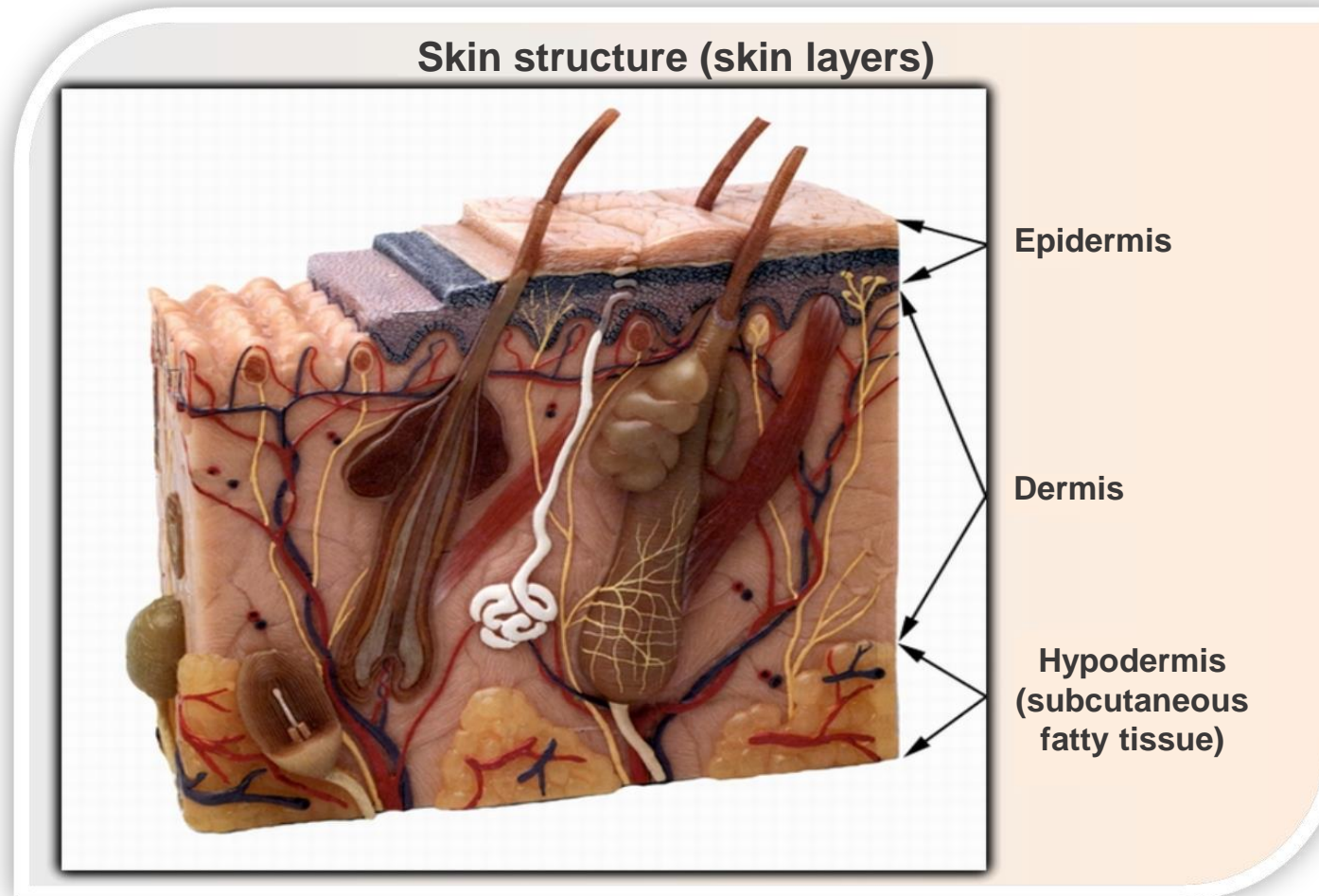
Wool fiber structure

- Morphologically, a single hair consists of a shaft, root, and bulb.
- The shaft is the keratinized part of the wool fiber that is located above the skin surface. Wool, as a raw material, usually consists of shafts cut just at the skin level.
- The root is the living part of the a single hair, located inside the skin, adjoining the shaft on one side (upper) and the bulb on the other. The hair shaft is rarely extracted from the skin together with the root.
- The bulb is the lower part of the hair root located on the papilla. In it, due to the cell multiplication, the wool fiber growth occurs.
- Histologically, wool fibers of all types consist of scaly and cortical layers, and in transitional fibers, as well as in awns, outer-coat fibers, etc., there is also a medullar layer.

Morpho-histological structure of wool fibers



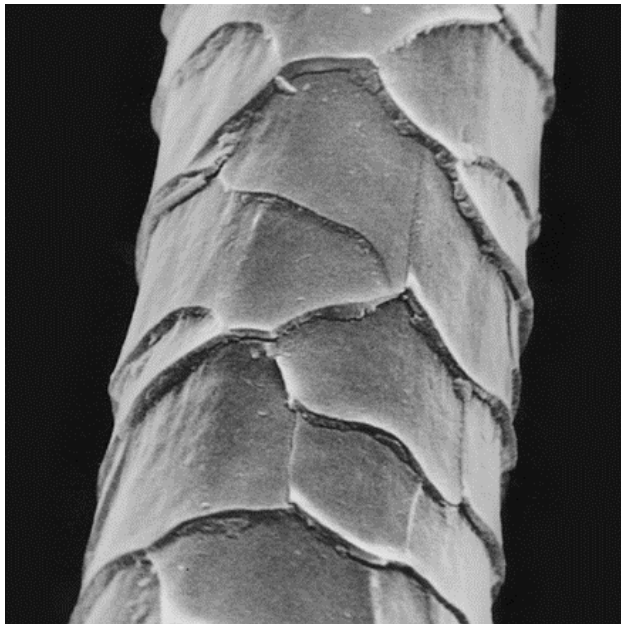
Skin structure





Wool fiber types

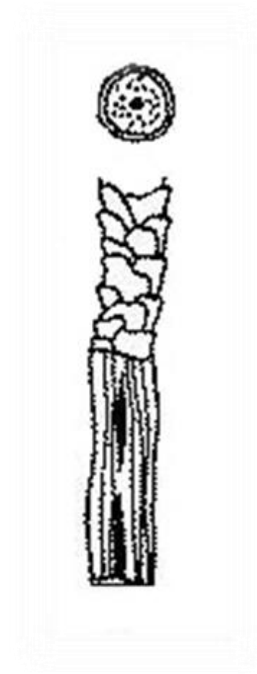
- **Down** is highly tortuous, usually short (except for Romanov sheep) and has the appearance of an undercoat; the finest fibers are without a core. The down protects the sheep body from hypothermia in winter, and falls out in spring (coat changing). Down fibers are used to produce the highest quality yarns.





Wool fiber types

- **The transitional fiber** is by tortuosity and fiber length occupies the middle ground between down and awn. The transitional fiber is characterized by the presence of a discontinuous core. It is mainly used to produce top knitwear.





Wool fiber types

- **Awn fibers** are the longest, sparsely tortuous, or straight fibers, with a fineness of more than 52 micrometers (Romanov breed of sheep, as an exception, has a peculiarity of awn being shorter than down). Wool containing awns is usually coarse, and is used mainly in the felting industry. The awn fibers in the coat are in a mixture with down; there is no coat consisting entirely of awn only. Awn fibers are part of the wool coat of semicoarse-wool and coarse-wool sheep along with other fiber types.
- **Awn** is a fiber that is less technologically valuable compared to down. In different wool types, the awns differ both in their technical properties and in histological structure.





Wool fiber types

- Dry hair is an awn type that results from the wool greasy sweat loss; it is brittle and has less sheen. It is intermediate between awn and dead hair.
- In terms of its histological structure, dry hair occupies an intermediate position between awn and dead hair.
- In the upper part, dry hair resembles dead hair, while in the middle and lower part, found together with the transitional and down fibers, it resembles awn.
- Dry hair is found in the wool of most coarse-wool sheep breeds, being a companion of dead hair (in fat-tail sheep), and in some breeds of sheep a large amount of dry hair is not accompanied by dead hair (Wallachian, Cherkasy).
- In technological terms, dry hair is closer to awn.



Wool fiber types

- **Dead hair** is a type of awn, short, coarse, 75 to 200 micrometers thick, brittle, white, not colored, and forming an acute angle at the bend.
- **Dead hair** is a very coarse, brittle, usually short, almost straight awn fiber.
- In terms of its histological structure, dead hair is close to thick awn. The epidermis layer is non-circular. The dead hair scales have the form of narrow plates, arranged in 6 to 8 scales around the circumference of the fiber.
- **Dead hair** has a strongly developed core. On transverse sections of dead hair fibers, a very thin cortical layer is hardly recognizable. This strong core development serves as one of the main causes for its low tensile strength. Due to its porous medullar layer, dead hair is virtually impossible to take color. In woolen products, dead hair is poorly retained, quickly destroyed, and falls out of the yarn and fabric, as a result of which the product quality is greatly reduced.



Wool fiber types

- **Kemp wool** is lamb hair in fine-wool and semifine-wool sheep, longer and lighter; these are thicker and sparsely tortuous fibers. After the first shearing at one year of age, it disappears.
- **Bristle wool** is distinguished from other fibers by its greater length, thickness, and lower tortuosity. Some lambs are born with these fibers, and later in the first year of life the bristle wool is replaced by typical downy wool fibers. Bristle wool occurs in fine and semifine teg wool (lamb wool) and in wool from young (one year old) fine-wool sheep.



Wool fiber types

- **Kemp** is a special type of fiber found in adult fine-wool and semifine-wool sheep. These are coarse fibers of the awn type that remain in some sheep after the first shearing.





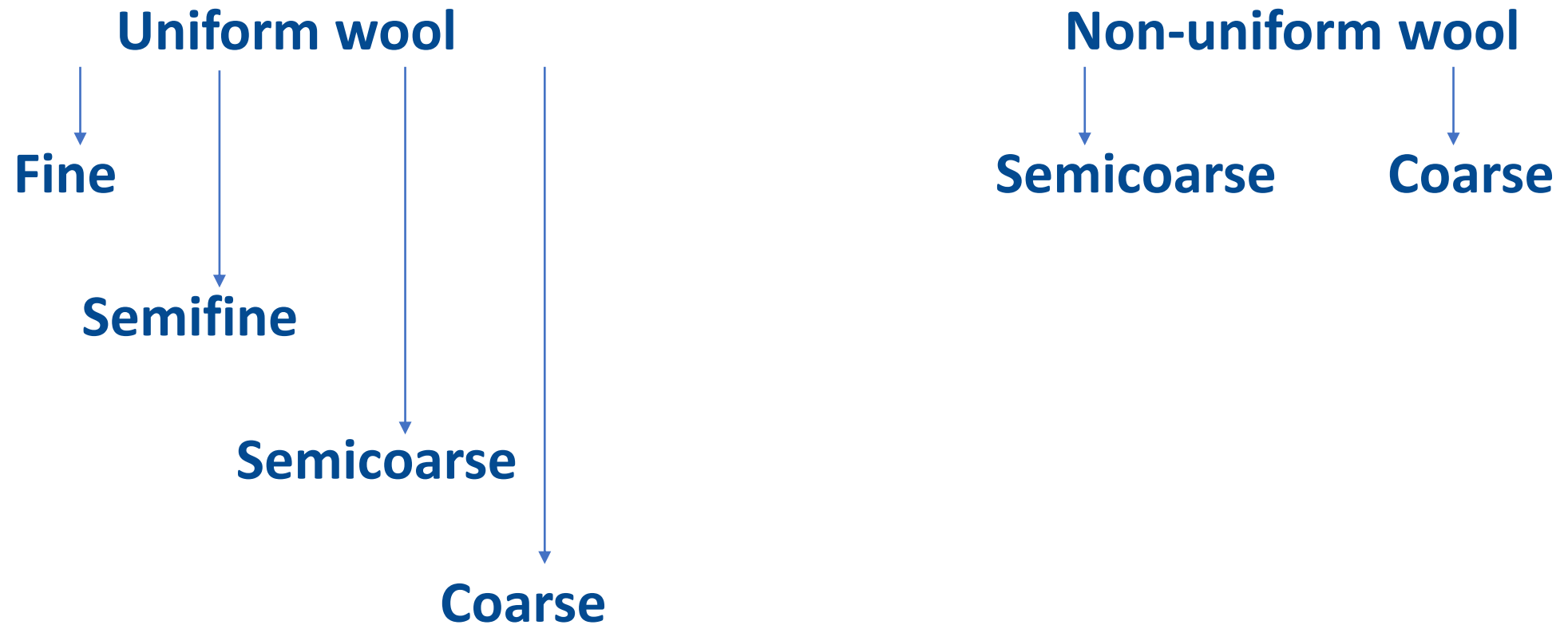
Wool fiber types

- **Outer-coat hair** is short, 3 to 5 cm long, straight, stiff, and by thickness and structure it is close to awn. It grows on the legs and face, as well as on the ears and tail.
- Due to the oblique location of the roots in the skin, outer-coat hair form a kind of coating on its surface, with one hair covering the other like tiles on a roof. That is why it is called “outer-coat” hair. With this arrangement and short length, the outer-coat hair is not sheared.





Sheep wool groups according to the fiber type





Interstate standard for wool

Uniform wool is wool consisting of fibers that are identical in appearance, length, fineness, and other properties.

Non-uniform fine, semifine, semicoarse, and coarse wool types are divided into:

- Merino;
- Crossbred and crossbred type;
- Mixed-bred (fine, semifine);
- Tsigai and the tsigai coarse wool.



Uniform fine wool

- Uniform wool is fine wool, the average fiber fineness of which does not exceed 25 micrometers. Sheep from which fine wool is obtained are called fine-wool sheep. In technological terms, fine wool is the most valuable raw material, which is mainly used for the production of suit fabrics.



Uniform semifine wool

- **Semifine wool** is uniform wool with a fineness of 25.1 to 31.0 micrometers. Sheep from which semifine wool is obtained are called semifine-wool sheep.



Uniform semicoarse wool

- **Uniform semicoarse wool** has a wool fiber fineness of 31.1 to 40.0 micrometers. Such wool is obtained from Tsigai and Russian longhair sheep.



Uniform coarse wool

- **Uniform coarse wool** consists of fine awns in which the core is absent or may occupy a small specific weight; its fineness ranges from 40.1 to 67.0 micrometers.

Sheep of English longhair breeds (Lincoln, Leicester, and Dartmoor), and of their type, give uniform coarse wool.



Thank you!