Natural Fibers

NATURAL FIBERS originate from plant and animal sources and include cotton, linen, wool, and silk. Fragments of cotton textiles dated from 5000 BC have been found in Mexico and Pakistan. Wool textiles found in Denmark date back to 1500 BC. Silk was first manufactured in China in the 27th century BC. Pictured here is a close-up of a silkworm's chrysalis cocoon.

Objectives:

1. Identify the origin of natural fibers.
2. Explain natural fiber characteristics, properties, end uses, and care.

Key Terms:

bask	fiber	retting
cellulosic fiber	filaments	sericulture
crimp	hand	staple fiber
felting	recycled wool	virgin wool

Origins of Natural Fibers

Natural fibers are made from plant, animal, and mineral sources. A **fiber** is a small thread-like material from which textiles are made; it may be animal or plant. It can be spun, woven, knitted, matted, or bonded into filaments that are made into textiles. Plant sources include cotton, flax, hemp, sisal, jute, and coconut. Animal sources include wool, silk, angora, mohair, and alpaca. Mineral sources include asbestos and metal fibers.

COTTON

Cotton is one of the most used fibers. It is made from long strands of cellulose lint from the cotton boll and is classified as cellulosic fiber. **Cellulosic fiber** is fiber that contains cellulose

and comes from plants. Natural cotton fiber has been used to make clothing and containers and to insulate and decorate living spaces since ancient times. Its early use has been discovered in ancient China, Egypt, India, Mexico, and Peru. American colonies began growing cotton in the 1600s and 1700s.

Cotton Gin

Throughout time, fibers were separated from seeds by hand until Eli Whitney invented the cotton gin in 1793. This machine pulled the cotton fibers through mesh. The seeds, unable to fit through the mesh, were mechanically separated from the lint fibers. The cotton gin ended a labor-intensive manual process. As a result, spinning and weaving mills sprang up, making the production of cotton yarn and fabric easier, faster, and less expensive. The cotton gin helped launch the Industrial Revolution of the 1800s.

Staple Fiber

A **staple fiber** is a natural fiber twisted to form yarn. Cotton fiber, spun and twisted together, forms yarn used to make fabric. The length of the cotton fiber is also called a staple. For cotton, a long staple fiber is desired because it is easier to spin. In addition, it is finer and stronger. The staple length of cotton is shorter than that of some other natural fibers. For instance, the staple length of cotton used to make fabric is $^{7}/_{8}$ inch to $^{11}/_{14}$ inch. The length to make yarns is $^{1}/_{8}$ inch to $2^{1}/_{2}$ inches. The feel (called **hand**) of the fabric can range from soft to rough. Cotton is used to make many textile products. Yarn—used in crochet and knitting—can be made from cotton.

FIGURE 1. Large bales of raw cotton are ready to be woven into fabric.

LINEN

Linen is made from the stems of the flax plant. It is classified as a cellulosic fiber and is grown throughout the world in a variety of climates. A sticky substance holds the linen fibers together inside the flax stem. The long fibers are desirable in textile production.

Linen is the oldest fiber to be woven into fabric, dating back to 30,000 BC. Flax was grown 8,000 to 9,000 years ago along seacoast regions of modern Denmark and Turkey. It is thought that linen was imported to Egypt from China or India. In Egypt, the ruling class wore linen, and mummies were wrapped in linen for burial as long as 7,000 years ago. Linen is so durable that linen curtains from approximately 3,500 years ago were found intact in the tomb of Tutankhamun (King Tut). Linen was introduced to other countries when Phoenician sailors from the coastline of the Mediterranean Sea opened transportation channels to Greece, Rome, and beyond. Currently, Russia produces the most flax/linen, and Belgium produces the finest linen.

FIGURE 2. Flax plants growing in the field and a farmer holding a sample of flax seed harvested from the field.

Linen has a long staple length similar to that of cotton. Also, linen is produced in relatively small, expensive quantities. Linen is labor-intensive to manufacture, but it is valued in the textile industry because of its cool, clean, and crisp look. In addition, it is comfortable to wear in hot weather.

Retting

Plants are pulled up by hand, or they are machine harvested. The separation of the fibers from the stem occurs in a process called retting. **Retting** is a bacterial rotting process that loosens fibers from the woody portion of the flax stalk. Flax stalks are submerged in pond, stream, or bog water to loosen the sticky gum that holds the fibers together. The moisture and microorganisms cause the woody portion to swell, loosening the **bask** (outer) fibers. Wet flax plants are dried in fields and are then crushed between metal rollers to separate the woody stalk pieces (shives) from the fibers. A combing process straightens and separates the fibers. The outer fibers are spun together, forming yarns to make twine, rope, fabric, and damask.

WOOL

Wool comes from the hair or fur of an animal. Sheep and lambs produce most of the wool used by consumers, but other animals—goats, rabbits, and camels—also produce wool. Cashmere and mohair come from goats, and angora comes from rabbits. Cashmere is extremely soft because of the structure of its fibers. Generally, cashmere has superior insulation properties, without being bulky. Mohair is white, fine, and silky. It is prized for its softness, brightness, and receptiveness to rich-colored dye. Angora wool is silky, white, fine, and soft. Typically, it is used in quality knitwear. Camel hair from Bactrian camels raised in Mongolia is fine and soft.

Fleece is the woolen coat of a sheep or longhaired goat after it is sheared and before it is made into thread or yarn. The quality of wool is calibrated by the fiber's diameter, crimp, yield, color, and staple strength.

Wool fiber is scaled to keep burrs and seeds from the animal's skin. In addition, it is crimped. Sometimes the **crimp** (twisted fibers in wool that make it strong) is more than 20 bends per inch. Crimping is the waviness in the fleece. Scaling and crimping help the fibers cling to each other, making them ideal to spin and felt. These features help wool retain heat trapped in the bends. More crimping in the wool results in finer wool fibers. Typically, wool fibers from Merino sheep are from 3 to 5 inches long and are the softest and finest variety of wool, with up to 100 crimps per inch. Fewer crimps make the hand (feel) coarser. The wool fibers of other breeds of sheep have a staple length of between 2 and $8\frac{1}{2}$ inches. Wool is classified as an animal or protein fiber. Currently, Australia, New Zealand, and China are the largest wool producers.

FIGURE 3. Merino sheep are grazing in a grass pasture in Australia.

Five steps used to process wool for commercial use are shearing, sorting and grading, washing with detergent, carding, and making yarn and fabric.

FIGURE 4. These colorful wool samples are ready to be spun into textiles or yarn.

Felting

Felting is heat, moisture, and pressure applied to wool to cause the scales of the wool fibers to open up, lock together, and shrink. Felting uses heat and steam to shrink wool and make it smaller, stronger, and warmer.

Virgin Wool

Virgin wool is wool fiber that has never been processed, used, or woven. This term is sometimes misunderstood as "higher quality" rather than "unused."

Recycled Wool

Recycled wool is fabric made using scraps of new woven or felted wool that is shredded and reused. Also, recycled wool fabric may be from previously manufactured wool fabric that has been unraveled and re-spun. The recycled wool has shorter fibers and is inferior in quality to the original fibers.

SILK

Silk comes from the larvae of a moth that spins a cocoon of silk thread called **filaments**. Moths are classified as animals, so silk is a protein fiber. Silk was discovered in the 27th century BC. Two legends prevail about the origin of silk. A Chinese empress, named Leizu, is said to have dropped a cocoon into a hot cup of tea. When this happened, the threads began to unravel, thus beginning sericulture. Another Chinese legend has named Lady His-Ling-Shih—wife of the mythical Yellow Emperor—Goddess of Silk, crediting her with introducing silkworm rearing and the invention of the silk spinning loom.

Sericulture

Sericulture is the production of silkworms and silk. The technique of silk production, to prevent the moth from hatching out and to perfect the silkworm diet, was a closely guarded secret in China for 2,000 years. "The Silk Road"—a trade route between Asia, Europe, and Africa—spread the silk industry to the Mediterranean, North Africa, and Europe. Lyon, France, became the center for silk production in the 1700s. However, world wars inhibited silk production in France, China, and Japan. During the late 1970s, China recaptured its status as the world's leading silk producer, followed closely by Japan.

Steps in Producing Silk

- The silkworm spins a very fine thread and covers itself with a cocoon.
- After the cocoon is steamed and bleached, the thin thread (filament) is unraveled off the cocoon.
- Multiple threads are spun into yarn.

OTHER NATURAL FIBERS

Besides cotton, linen, wool, and silk, other natural fibers—plant or cellulosic fibers and animal or protein fibers—are used in apparel and home furnishing fabrics.

Plant or Cellulosic Fibers: Seed, Bast, Leaf, and Grass

Some seed fibers are coir, kapok, and milkweed.

Coir is extracted from coconut husks and is used to make floor mats, doormats, brushes, mattresses, and upholstery padding. White coir harvested from unripe coconuts is used to make finer brushes, string, fishing nets, and rope.

Kapok fiber is obtained from the seedpods of the ceiba tree and is used for mattress filling, life preservers, sleeping bags, and insulation.

Milkweed has milky white juice and contains alkaloids, latex, and other complex compounds. It is used as a hypoallergenic pillow filling.

Bast fibers are strong and woody. They are obtained from the outer bark or skin of several plants: ramie, hemp, jute, kenaf, and hibiscus.

Leaf fibers are pina, abaca, and sisal. Pina is fiber made from pineapple leaves. It is sometimes combined with silk or polyester to produce textile fabric. Abaca is considered a hard fiber. It is used to make tea bags, filter paper, and banknotes. Sisal is a stiff fiber. It is too coarse

BROADENING AWARENESS...

AMAZING ASPECTS: Health Issues of Natural Fibers vs. Synthetic Materials

For many reasons, natural fibers are more healthful choices than synthetic materials and artificial fibers (e.g., rayon, nylon, acrylic, and polyester). Natural fiber cloth is more comfortable to wear because natural fibers create ventilation by "wicking," which is a process of absorbing perspiration and releasing it. In contrast, synthetic fibers have more compact structures that do not breathe in the same way as natural fibers. This explains why a cotton T-shirt is comfortable on a hot day, but polyester and acrylic garments make you feel hot and clammy in summer heat.

Crimps in wool fiber insulate against hot and cold by trapping air pockets. Wool can absorb liquid up to 35 percent of its own weight. For instance, woolen blankets wick perspiration as you sleep to leave sheets dry should you perspire.

People with sensitive skin who wear cotton and silk clothing are less prone to skin rashes, allergic reactions, and itching than those who wear synthetics. Hemp fabric wicks well and has natural antibacterial properties. Knitted linen has been proven to keep bedridden patients from developing bedsores. Also, underwear made from knitted flax is more hygienic than underwear made from nylon or polyester.

Used in mattresses, furniture, and car seats, the natural fibers coconut and coir remove moisture and provide ventilation far better than plastic foam, which retains body heat and traps perspiration. In addition, coir fibers have a natural resistance to fungus and mites.

to be used for clothing, but it is used to make twine, rope, and dartboards. Sisal is replacing glass fibers in composite materials used to make cars and furniture.

Grass plant fibers include rush, sea grass, maize or cornhusk, palm fiber, wicker, and bamboo. These are used to make apparel and fabric for furnishings. Rush is a grasslike plant used to make chair seats, barstools, and footstools. Currently, sea grass is used to make furniture and is woven like rattan. Cornhusk—the leafy outer covering of ears of maize (corn)—is used in cooking, crafts and toys, medical supplements, and clothing accessories and as rope for braiding purses.

Palm tree fibers are used to make textiles, leather products, and mattresses. Wicker is a hard woven plant fiber used to make furniture and baskets. Bamboo, the largest grass plant, is one of the fastest-growing plants on Earth. An absence of secondary growth wood makes the plant columnar. As a result, bamboo is used in construction.

Animal or Protein Fibers: Mohair, Cashmere, Alpaca, and Spider Silk

Mohair and cashmere wool are made from the hair and fur of goats.

Yarn and fabric are produced from fibers from camels, yaks, vicuna, alpaca, and musk ox (qiviut—the wool from the belly of musk oxen). Alpaca wool is used to produce high-end luxury knitted and woven fabrics, similar to wool. Alpaca is used to make blankets, sweaters, hats, gloves, socks, coats, bedding, and a variety of textiles. In South America, alpaca is made into ponchos.

Spider silk is a protein fiber spun by spiders. Spiders use their silk to make webs that act as nets to catch other animals or as nests to protect their offspring.

FIGURE 5. An unshorn alpaca is grazing. Alpaca are raised in the United States, Canada, Peru, Bolivia, and Chile. (Courtesy, Johann Dréo, Château-Thierry, France)

Characteristics, Uses, and Care of Natural Fibers

The characteristics, uses, and care of natural fibers vary based on specific aspects, such as strength and breathability.

COTTON

Aesthetics

Cotton is attractive and is easy to dye. It has a matte appearance and can have low or high luster. Longer staples provide a higher luster to the fabric. The hand ranges from soft to stiff and smooth to rough. Cotton is absorbent.

Uses

Cotton is adaptable to all types of garments, from baby clothes (batiste) to jeans (denim). Cotton breathes and is good in hot climates because it does not retain heat. However, cotton does not provide the insulation needed for cold climates.

Cotton is used in apparel, such as socks, underwear, T-shirts, shirts and blouses, and jeans, in fabrics such as terrycloth, corduroy, and seersucker, and in drapery, upholstery, and bed sheets.

Durability

Cotton has a medium-strength fiber and is 30 percent stronger when wet. It has good abrasion resistance and is moderately elastic, but fibers can be stretched only so far before breaking.

Appearance

Cotton wrinkles easily, unless a wrinkle-free finish is applied. Therefore, fabrics can be very formal or very casual in appearance.

Care

Cotton may shrink unless it is preshrunk. It tends to stretch out only slightly. Generally, cotton can be machine-washed or hand-washed in cold water. It can be dried on a line or by machine.

LINEN

Aesthetics

Linen has an excellent luster. The texture ranges from thick to thin. It has a stiff hand that becomes softer with washing. Linen is comfortable for summer clothes because it lets heat escape. Linen washes well and does not hold onto stains.

Uses

Linen is used in a wide variety of furnishing items for the home (e.g., wallpaper, bed and table linens, and upholstery). It is used in high-fashion apparel, as well as in luggage and in sewing thread.

Durability

Linen resists abrasion well. It has poor elasticity and is stiff, so repeated folding breaks the fibers. It is long-lasting with proper care.

Appearance

Linen wrinkles easily and has poor elastic recovery.

Care

Typically, linen can be hand-washed, machine-washed, or dry-cleaned. Furnishings should be dry-cleaned or steam-cleaned. Linen is best pressed with a hot iron.

WOOL

Aesthetics

Wool resists wrinkles; the fabric keeps its shape. It looks dry even when it is wet. Wool fibers absorb moisture, more than $^1/_3$ their own weight.

Uses

Wool is versatile in looks, ranging from a rough to a soft crepe appearance. It can be worn comfortably in hot and cold weather. In addition, wool has numerous uses: clothing, hosiery, gloves, carpets, furniture upholstery, rugs, blankets, and felt.

Durability

Wool loses strength when it is wet. Perspiration weakens the fibers. Wool does not burn easily when a flame is applied. It singes and smells like burnt hair. In contrast, synthetic fabrics melt when exposed to a flame. The crimp determines the fabric strength. Crimping causes wool to insulate against heat and cold. Wool has excellent elastic recovery and elongation, so it stretches.

Appearance

Wool resists and recovers well from wrinkles. It retains its shape and size well when it is dry-cleaned.

Care

It is necessary to follow the detergent instructions when hand-washing wool. Wool can be harmed by certain detergents and may be damaged by chlorine bleach. It must be handled carefully to avoid shrinkage. Also, wool scorches easily and becomes brittle when dry heat is applied. Iron only with a steam iron set on medium heat.

SILK

Aesthetics

Silk dyes easily and accepts brilliant colors. It has a soft luster and, usually, a smooth appearance. Silk has a soft hand.

Uses

Silk is available in many varieties for apparel and accessories. It is used in home furnishings, especially in window treatments and in upholstery of fine furniture.

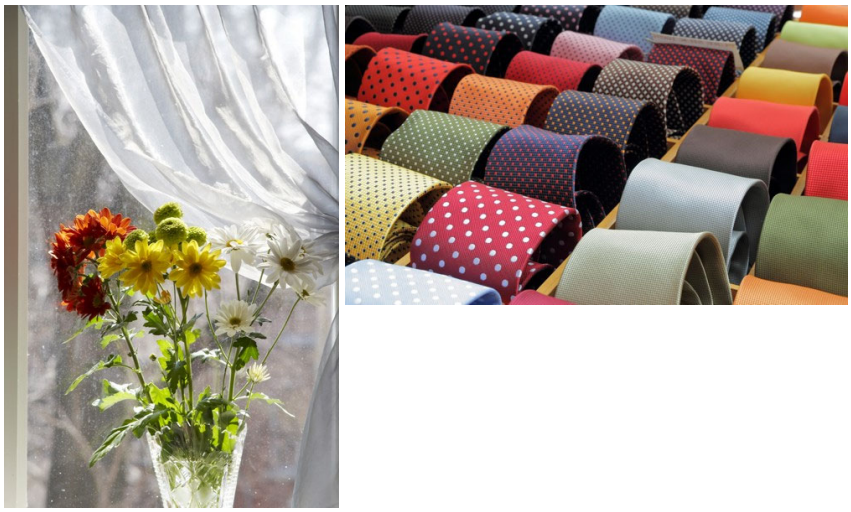

FIGURE 6. Window draperies are commonly made of silk. Silk accepts brilliant colors and is soft enough to be used in men's ties.

Durability

Silk has moderate abrasion resistance. If stretched, it will not return to its original shape.

Appearance

Silk resists wrinkling only moderately. It shrinks only when improperly laundered.

Care

Some silk has a tendency to bleed. It is necessary to dry-clean for the best results. Silk can be hand- or machine-laundered in mild detergent. It is critical to use a damp "press cloth" when ironing.

Summary:

Natural fibers are made from plant and animal sources. Cotton is one of the most used fibers. Cotton fibers, spun and twisted together, make yarn and fabric. In contrast, linen is made from the stems of the flax plant. It is labor-intensive to manufacture, but it is valued in the textile industry because of its comfort and crisp look even in hot weather, as it lets heat escape.

Wool is harvested from sheep, lambs, camels, goats, and rabbits. The fleece from sheep is sheared, graded, washed, and carded to prepare it to be made into yarn and fabric. Silk, however, comes from the larvae of a moth that spins a cocoon of silk thread called filaments. Seeds, bark, and leaves are sources of fibers used in apparel, furnishings, and rope. Goats, camels, yaks, vicuna, alpaca, musk oxen, and spiders are the source of protein fibers used to produce textiles and yarn.

Checking Your Knowledge:

1. List six plant sources of natural fibers and six animal sources of natural fibers.
2. Which natural fibers are the most durable?
3. List sources of wool fiber other than sheep.
4. Explain why wool resists wrinkling.
5. What are the steps in producing silk?

Expanding Your Knowledge:

Identify plant fibers that come from seeds, bark, leaves, or grasses that you can grow yourself. Milkweed seeds, hibiscus bast, and cornhusk grass are fibers that can be cultivated locally. Experiment with growing and harvesting your own natural fibers.

Web Links:

Cotton Fibers
http://www.engr.utk.edu/mse/pages/Textiles/Cotton%20fibers.htm

Wool Products
http://www.madehow.com/Volume-1/Wool.html#b

Silk
http://www.silk-road.com/artl/silkhistory.shtml

Flax/Linen
http://www.textileschool.com/School/Fiber/NaturalCellulosicBast/FlaxLinenFibers.aspx

Natural Fibers
http://www.ehow.com/list_6887650_advantages-disadvantages-natural-fibers.html#page=0

Alpaca Facts
http://www.ilovealpacas.com/facts.shtml