FI'BRE (Lat. *fibra*, filament). A term of very common use as applied to objects of a stringy or threadlike character, whether of the animal, vegetable, or mineral kingdom. Minerals are often described as of a fibrous structure or appearance, in which there is, however, no possibility of detaching the apparent fibres from the general mass, or in which they are inflexible, and brittle if detached; but a more perfect example of mineral fibre is found in amiantus, a variety of asbestos. For the scien-

tific use of the term "fibre" with regard to the animal kingdom, see the article MUSCLE AND MUSCULAR TISSUE; for its scientific use with regard to the vegetable kingdom, see VEGETABLE TISSUE; WOOD. In its more popular but perfectly accurate use it includes the hair or wool of quadrupeds, the silken threads of the cocoons of silkworms and other insects, the fibres of the leaves and of the inner bark of plants, and the elongated cells or hairs connected with the seeds of plants, the ordinary materials of cordage, and of textile fabrics.

Of mineral substances, amiantus alone has been used for textile fabrics, and that only to a very limited extent. Animal and vegetable fibres have, from the earliest ages, supplied man with cordage and with cloth. How the invention took place can only be matter of conjecture. It is noted as an interesting fact that the most valuable commercial fibres of to-day were the prominent fibres of ancient times. Cotton, flax, hemp, as well as the common animal fibres, as hair, wool, and silk, were known and used in past ages.

The animal fibres used for textile purposes are chiefly of the two classes already mentioned, (1) the wool or hair of quadrupeds and (2) the silk of the cocoons of insects. To these may be added (3) the byssus of mollusks, but this class contains only the byssus of the pinna (q.v.) of the Mediterranean, an article of ancient and high reputation, but more of curiosity than of use. The skins and intestines of animals, although sometimes twisted or plaited for various uses, can scarcely be reckoned among the fibrous materials afforded by the animal kingdom. For information regarding the fibres obtained from the cocoons of insects, see SILK; SILKWORM. It is to the first class that the greater number of different kinds of animal fibres used for textile purposes belong; and the wool of the sheep far exceeds all the rest in importance. But the wool or hair of other quadrupeds is also to some extent used, as that of the goat, the alpaca, the camel, the musk ox, and the yak, all of which are, like the sheep, ruminants. The hair of comparatively few animals is sufficiently long for textile purposes or can be procured in sufficient abundance to make it of economic importance. The warmth of clothing depends much on the fineness of the hair, and on other characters in which wool particularly excels. See SHEEP; WOOL; GOAT; ANGORA; ALPACA; CAMEL; MUSK OX; YAK.

The useful vegetable fibres are far more numerous and various than are the animal. They are obtained from plants of natural orders very different from each other. They are obtained also from different parts of plants. Wood cells are found in the bark, and are longer, finer, and tougher than those found in the wood. They form the principal part of the fibrous bark or bast layer of cells. These give toughness and flexibility to the structure, and the extracted bundles of cells form the filamentous product known as flax, hemp, and jute, derived from dicotyledonous plants. In monocotyledons the fibrous cells are built up with others into a composite structure known as fibrovascular bundles. Such fibre occurs in the palms and in the fleshy-leaved agaves, the bundles being found, not as in bark, but throughout the stem or leaf forming the supporting structure. These filaments, when separated from the soft cell mass by which they are surrounded, may be known as structural fibre, of which the fibre of sisal hemp is an example. The simple cells produced on the surfaces of the seeds of endogens, such as cotton and coconut, constitute a fibrous material, to which the name "surface fibre" has been given. For illustrations, see Plate of FIBRE PLANTS under article HEMP.

The fibre bundles, therefore, whether occurring as bast fibre or structural fibre, or whether in the form of simple cells, as surface fibre, may be regarded as the spinning units—aggregations of bundles purified and cleansed of all extraneous matter and simply twisted together. The mass of cellular structures separating the fibres is removed in the process of cleaning. The fibres of the leaves of endogens, being parallel to each other, are easily obtained of sufficient length for economical purposes; while the reticulated fibres of leaves of exogens, even if long enough, which is comparatively seldom the case, cannot be separated for use. The best fibres of exogens, however, are often of sufficient length and easily separated. The separation is generally accomplished by steeping in water or by frequent dampening with water so as to cause a partial rotting of the other parts of the bast and of the bark which covers it. Since the fibres of endogens are in general discolored and injured by this damp process to a much greater degree than are those of exogens, mere mechanical means are usually preferred for their separation, such as beating, passing between rollers, and scraping. The fibres of many leaves are separated by scraping alone. The fibres of seeds, as cotton, exist in nature attached to the seed, like the wool or hair of animals, and require merely to be collected and cleaned.

A method of separating animal and vegetable fibres in woven materials is based upon the fact that alkalies destroy the former, and have little effect upon the latter. The alkali used is generally caustic potash of 5 per cent strength. If a wool-cotton or a silk-cotton mixture is boiled in this solution for about 15 minutes, the wool or silk is destroyed and the cotton is little affected. The test may be made quantitative. The most accurate results are obtained by removing dressing or finishing substances from the material before applying the test.

There are two natural groups of fibres—the commercial species and the vast group of the so-called native fibres. Among the uncivilized races many species of fibre plants which civilized man cannot afford to employ commercially have become most useful for utensils, cords, and clothing. While 30 or 40 species of plants supply the world's demand for commercial fibres, hundreds of fibrous plants could readily be enumerated. The list of commercial fibres may be increased from time to time. Of those now important there are six bast fibres, as follows: Flax (*Linum usitatissimum*); China grass (*Bœhmeria nivea*); hemp (*Cannabis sativa*); jute (*Corchorus capsularis* and *Corchorus olitorius*); Sunn hemp (*Crotalaria juncea*); and Cuba bast (*Hibiscus tiliaceus*). There are two surface fibres: Cotton (*Gossypium* spp.) and raffia (*Raphia pedunculata*). The list of structural fibres numbers 15, representing agaves, palms, and grasses as follows: *Cordage fibres*—Sisal hemp (*Agave rigida* var.); Manila hemp (*Musa textilis*); Mauritius flax (*Furcræa gigantea*); New Zealand flax (*Phormium tenax*). *Brush fibres*—Tampico or istle (*Agave*

heretacantha); Bahia piassaba (*Attalea funifera*); Para piassaba (*Leopoldinia piassaba*); Mexican whisk, or broom root (*Epicampes macroura*); cabbage palmetto (*Sabal palmetto*). *Upholstering and matting fibres*—Crin végétal (*Chamærops humilis*); Spanish moss (*Tillandsia usneoides*); saw palmetto (*Serenoa serrulata*); coconut fibre (*Cocos nucifera*). *Paper manufacture*—Esparto grass (*Stipa tenacissima*), a substitute for bath sponges; and vegetable sponge (*Luffa ægyptica*).

The sources of supply of these fibres are as follows: Flax is produced chiefly in Belgium, Russia, Austria-Hungary, Holland, Italy, Great Britain and Ireland, the United States, and Canada; China grass, or ramie, comes from China; hemp is obtained from Russia, United States, France, Belgium, Germany, Austria-Hungary, Italy, and the Netherlands; jute from India and Cuba; bast from the West Indies; cotton is chiefly produced in the United States, Egypt, and Peru; raffia comes from Africa; sisal hemp is produced in Yucatan, Cuba, and the Bahamas; Manila hemp is a product of the Philippine Islands; Mauritius, or aloe, fibre comes from Africa; New Zealand flax from the country indicated by its name; Tampico, or istle, is a Mexican product; Bahía or Pará piassabas, or "bass" fibres, are collected from Brazilian palms, other species of bass from African palms; broom root is a Mexican product; the two palmetto fibres are produced from species of Florida palms; crin végétal is derived from an allied palm, growing in Algeria; vegetable hair from Spanish moss is prepared in South Carolina and the Gulf States; coconut fibre comes from the East Indies; esparto grass is produced in Algeria, Spain, and Portugal; vegetable sponge largely in Japan. Other fibrous substances appear in the form of straw plait from Italy, Japan, and China chiefly. The Eastern floor mattings and basketry are made from various fibres.

The highest use for which fibre may be employed is in the manufacture of cloth or woven fabric. The next higher uses are in the manufacture of threads, twines, cords, and ropes known as cordage. A third use is in the manufacture of brushes and brooms, for which a different class of fibre than either the fabric or cordage fibres is employed. Fourth, fibres are used in the manufacture of many plaited or coarsely woven articles employed in domestic economy, some of which are of commercial importance, while the greater number are "native" productions. A fifth form of utility is the employment of fibres or fibrous substances in mass as filling material, for stuffing pillows, cushions, mattresses, furniture, etc., or as packing substances. A sixth and exceedingly important use is in the manufacture of paper. For further information, consult: Watt, *Dictionary of Economic Products of India* (Calcutta, 1889); Morris, *Commercial Fibres* (London, 1895); "Vegetable Fibres," *Kew Royal Gardens* (ib., 1898); Dodge, "Useful Fibre Plants of the World," *United States Department of Agriculture, Fibre Investigations, Report No. IX* (Washington, 1897); Georgievics, *Chemical Technology of Textile Fibres* (New York, 1902); Matthews, *Textile Fibres* (3d ed., ib., 1913); Mitchell and Prideaux, *Fibres Used in Textiles and Allied Industries* (ib., 1911). See FLAX; JUTE; RAMIE.