DYE'-STUFFS. The substances used in dyeing as the sources of colouring matter, are derived from the animal, mineral, and vegetable kingdoms, the greatest number from the last mentioned. To the animal kingdom, and to the class of Insects, we are indebted for *Cochineal*—and consequently for *Carmine*—*Kermes*, and *Lac*, and less directly for *Galls*. The *Tyrian purple* of the ancients is also said to have been a product of the animal kingdom, obtained from a mollusc.—The dye-stuffs obtained from the vegetable kingdom are numerous, and in every part of the world there are some in domestic use, which have not become articles of commerce. Such are those dye-stuffs of the Highlands of Scotland, mentioned in the article DYEING. Dye-stuffs are procured from plants of widely different natural families: there are some indeed in which certain colouring matters appear to be extensively prevalent, as in *Rubiaceæ* (madder, &c.), and the genus *Cæsalpinia* (q. v.). They are also obtained from almost all different parts of plants, as the heart-wood (*duramen*) of the stem (Logwood, Brazil-wood, Camwood, Fustic, &c.); the bark (Alder, &c.), the root or its bark (Barberry root, &c.); the leaves and other herbaceous parts (Indigo, &c.); the corolla (Safflower); the fruit (French Berries, Annotta, &c.) The principal dye-stuffs are the following: *Alkanet* (q. v.), useful in dyeing various shades of lilac, lavender, and violet, which are, however, liable to fade on exposure to light. *Aloes*, obtained by evaporating the juice of the aloe, which is grown in the East and West Indies, Sicily, Italy, and Malta. It contains a brown colouring matter named *Aloetin*, which may be employed in the production of a brown tint. *Arnotto* (q. v.), employed in imparting the various shades of yellow, orange, and scarlet, to silk, wool, and cotton. *Archil*, yielding, when infused in water, a crimson dye of great beauty, though fugitive, and used in giving a finish to wool and silk which have been previously dyed. *Barberry root*, imported from the East Indies, and containing a yellow colouring matter called *berberin*. *Brazil-wood*, often called *peach-wood*, containing *brazilin*, which, in contact with the air, yields a rich red colour. *Camwood* (q. v.) or *Barwood*, has a red colour similar to that of Brazil-wood, is generally employed in the form of a coarse powder, and readily imparts its colour to water. *Catechu*, yields a reddish-brown solution in water, and performs an important office in the dyeing of many shades of brown, black, and green. *Chica* (q. v.), employed in the dyeing of wool and cotton of an orange-yellow colour. *Cochineal*, employed directly, or indirectly in the form of carmine (extracted from the cochineal), in imparting the most beautiful red and crimson colours. *French*, *Persian*, *Turkey*, or *Spanish berries*, obtained from several species of *Rhamnus* (see BUCKTHORN), yield a powerful yellow dye. *Fustet*, the finely divided wood of *Rhus cotinus* (see SUMACH), a yellow dye. *Fustic* or *yellow wood*, used for dyeing cloth yellow, and for communicating a good green tint to cloth already rendered blue; as also, in conjunction with other dyes, in imparting various shades of drabs, olives, fawns, &c. *Galls* or *gall-nuts* are employed in dyeing cloth of a dark or black colour. *Indigo* (q. v.), very extensively used in the dyeing of yarn and cloth of a deep blue colour, which may be afterwards rendered green by a yellow dye. *Kermes*, *Kermes grains*, or *Alkermes*, an excellent material for dyeing many shades of red, and one of the most ancient dye-stuffs employed in the colouring of silk. *Lac* (q. v.), *Shell-lac*, or *Stick-lac*, is used in the preparation of red dyes. *Logwood* (q. v.), broken up into small chips, or reduced to powder, is employed in the dyeing of reds, and, when associated with other substances, yields purples, violets, and blues. *Madder* (q. v.), one of the most important of dye-stuffs,

is extensively used in the dyeing of cloth and yarn red, purple, brown, &c. *Munjeet* or *Indian madder* is used in India instead of madder. *Quercitron* yields a rich orange-yellow, or yellow-red dye, capable of being afterwards made a brown; and when used after a blue dye, it changes the latter to a bright green. *Safflower* yields a rich yellow dye. *Sandal-wood*, *Santal* or *Saunders wood*, yields a red colour, which, along with other substances, may be altered to violet, reddish brown, and scarlet. *Sumach*, occasionally called *young fustic*, is employed as a yellow dye, and also for the tannin and gallic acid it contains, which enables decoctions of sumach to be used with great effect for imparting depth or solidity to other colours. *Turmeric*, or *Indian saffron*, is employed as a yellow dye, but is very fugitive. *Weld*, or *Wold*, produces a rich but fugitive yellow. *Woad* is employed as a blue dye for woollen and silk yarn and cloth, either with or without indigo. *Wongshy* is a new yellow dye-stuff procured from the seed-vessels of a plant belonging to the family of *Gentianeæ*, and imported from Batavia.

The above list of dye-stuffs comprehends those which are obtained, directly or indirectly, from the vegetable and animal kingdoms; and a more lengthened notice of the substances will be found under their respective names. Other dye-stuffs less generally used are also noticed in the articles devoted to different orders and genera of plants. The metallic salts and compounds employed in dyeing will be specially noticed under the various metals; thus for acetate of lead, see LEAD; sulphate of iron, see IRON; &c.

COAL-TAR COLOURS.—The most recent discovery of importance in dyeing, is the extraction of coloured substances of great beauty from coal-tar, and the application of these to the colouring of cloth. At the present time, these dyes of coal-tar origin are most extensively employed, and give rise to the fashionable colours named Aniline purple, Tyrian purple or Mauve, Violine, Roseine, Fuchsine or Magenta, Solferina, Bleu de Paris, Aniline green or Emeraldine, Azuline, &c. It is only, however, within the last 20 years that these dyes have become practically known, though the preliminary discoveries in connection with their extraction were made in 1826. The condensable product or gas liquor obtained during the destructive distillation of coal in gas-works, consists of aqueous matter holding salts of ammonia in solution, and tar with naphtha. The tar consists of a numerous class of bodies, of which aniline and benzole are two. The aniline is present in minute quantity; and for manufacturing purposes, means are generally resorted to for the conversion of the benzole of gas-tar into aniline. The process followed on the commercial scale is to act upon the benzole by nitric acid, by which it is converted into nitro-benzole, and thereafter, by the action of acetate of the protoxide of iron, it becomes aniline.

Aniline Purple.—In the preparation of the dye known as aniline purple, solutions of equal equivalents of sulphate of aniline and bichromate of potash are mixed together; and when the reaction is complete, a black precipitate is obtained, which is dried, and then digested several times in coal-tar naphtha, to separate all resinous matter. The residue is dissolved by successive quantities of alcohol; and the solution being placed in a retort, the alcohol is distilled off, and the aniline purple is left as a beautiful bronze-coloured substance. Aniline purple is slightly soluble in cold water, more so in hot water, and is readily dissolved by the alcohols and aniline itself. It is nearly insoluble in ether and naphtha.

Roseine is most readily prepared on the commercial scale by adding two equivalents of binoxide of lead to a boiling solution of one equivalent of sulphate of aniline, and boiling the whole for a short time. On filtration, a rose-coloured solution is obtained, which is evaporated down to small bulk, when some resin separates, and the roscine is precipitated by soda or potash, and being collected on a filter, can be washed and dried. This dye is readily soluble in alcohol, and yields a very intense crimson colour, which, on being evaporated to dryness, leaves a dark metallic-looking and brittle residue of roseine. It is soluble in water, but not in naphtha.

Violine is procured by the oxidation of aniline, and the process generally followed is to heat a mixture of two equivalents of sulphuric acid, one equivalent of aniline, and some water, to the boiling-point, then add binoxide of lead, boil for some time, and filter hot. A purple liquid is obtained, which is boiled with potash till the aniline present is volatilised, and the colouring matter is precipitated, when the latter is thrown on a filter, washed with water, and dissolved in a dilute solution of tartaric acid. On filtration, the coloured liquid is evaporated to small bulk, refiltered, reprecipitated by potash and soda, and the precipitate being dissolved in alcohol, yields an alcoholic coloured solution, which on distilling off the alcohol, leaves the violine as a brittle bronze-coloured substance. Violine is very slightly soluble in water, is readily dissolved by alcohol, and is insoluble in ether and naphtha.

Fuchsine or *Magenta* is prepared by adding anhydrous bichloride of tin by degrees to aniline. The materials are constantly stirred during the operation, to keep down the intensity of the action, and the result is, that much heat is evolved, the mixture becomes pasty, then liquid and brown; and as the temperature approaches the boiling-point, it becomes a dark, almost black liquid, which in very thin layers presents a rich crimson colour. This liquid is boiled for some time, much water added, the whole reboiled, so as to volatilise any free aniline, and chloride of sodium (common salt) added till saturation, when the fuchsine or magenta is precipitated as a golden green, semi-solid, pitchy substance. Any resinous matter still remaining may be separated by digestion in benzole. This dye may also be obtained by acting upon aniline with nitrate of mercury. Fuchsine or magenta is sparingly soluble in water, dissolves to some extent in alcohol, and is insoluble in ether and naphtha.

Bleu de Paris is prepared by heating 9 parts by weight of bichloride of tin and 16 parts of aniline to a temperature of about 350° F., in a sealed tube, for 30 hours, when a blue product is obtained, which is soluble in alcohol, and crystallises therefrom in fine needles of a lively blue colour. Bleu de Paris is soluble in water, alcohol, wood-spirit, and acetic acid, and insoluble in ether and bisulphuret of carbon.

Aniline Green or *Emeraldine* is obtained by acting upon a hydrochloric acid solution of aniline by chlorate of potash, when the aniline becomes oxidised, and yields a dull green precipitate, which on drying becomes an olive-green residue. It is insoluble in water, alcohol, ether, and benzole, and in the presence of a free acid the green colour improves in appearance, though it returns to its original shade when the free acid is removed.

Quinoline or *Chinoline* is present in coal-tar, and may be employed to yield three colouring matters—a violet, a blue, and a green; but the processes as yet followed in their preparation belong more to the laboratory experiments of the scientific chemist than to the practical operations of the manufacturer.

Picric Acid is obtained by acting upon many organic substances, such as indigo, aniline, carbolic acid, salicin, silk, aloes, gum-resins, &c., by nitric acid. On the commercial scale, carbolic acid is generally employed, and it is first treated with nitric acid of slightly less density than 1300 (water = 1000), and afterwards boiled with stronger acid, when it passes into picric acid, and is precipitated on dilution with water. It can be purified by recrystallisation from boiling water. Pure picric acid crystallises in lamina of a primrose yellow colour.

Azuline is the only other colouring matter of practical importance derived directly or indirectly from coal-tar. It is a brittle, non-crystallisable substance, with a copper-coloured metallic appearance. It is sparingly soluble in water, but is soluble in alcohol, yielding a fine blue solution with a shade of red. Treated with concentrated sulphuric acid, it becomes a fine blood-red liquid, which, on dilution with much water, gives a red precipitate of azuline.

Pittacal is a blue colouring matter obtained from coal-tar.

Dyeing of Silk and Wool by the Coal-tar Colours.—This department of the operations of the dyer is very simple, as the silk and wool fibres possess the power of taking up and fixing the majority of these colouring matters with great rapidity, whenever the yarn or textile fabric is placed in the vessel containing a solution of the colour. In the dyeing of silk with aniline purple, violine, and roseine, the alcoholic solution of the colour is diluted with eight times its volume of hot water acidulated with tartaric acid, and thereafter treated with a larger quantity of cold water. The silk is merely worked in this comparatively weak solution of the dye till the shade of colour is deep enough. The addition of a little sulphate of indigo to the dye-vat assists in bringing out a more decided blue tint. The same result is obtained by first dyeing the goods with Prussian blue before immersion in the coal-tar colour. When silk is to be dyed with fuchsine, picric acid, chinoline blue or chinoline violet, the goods require only to be worked in water-solutions of these colours. A little acetic acid added to the vat containing the fuchsine or picric acid is advantageous, and if a solution of sulphate of indigo is mixed with the solution of picric acid, the goods acquire a fine green colour.

Azuline is attached to silk with more difficulty than any of the preceding colours. The silk requires to be worked first in a solution of azuline acidulated with sulphuric acid, and thereafter the liquid is raised to the boiling-point, and the silk continued to be worked in it. The goods are then washed in water, worked in a bath of soap-lather, rinsed, and finished in a weak acid bath.

Wool is dyed with aniline purple, violine, roseine, fuchsine, and chinoline by merely working the yarn or cloth in a vat containing a water-solution of the colouring matter at a temperature ranging between 112° and 140° F.

Cotton has not the power of firmly attaching, directly, coal-tar colours to its fibre so as to resist the action of soda and of soap. When the cotton, however, is treated with a solution containing much tannin, such as a decoction of sumach, or galls, for an hour or so, then introduced into a dilute solution of alum or stannate of soda, and, lastly, passed into a dilute acid liquid, and washed in water, it acquires a great power of firmly attaching aniline purple, roseine, violine, fuchsine, and chinoline colours, whenever it is worked in a dye-vat containing these colouring matters. This principle of the attachment of these colours to cotton by means of a mordant of tannin and alum, may be applied in printing patterns upon cloth, as in Calico-printing (q. v.). The pattern is printed on the cloth by means of tannin and alum dissolved in water and thickened with gum; and afterwards, when the prepared goods have been introduced into a hot dilute acid solution of the colouring matter, the dye becomes attached to those parts on which only the tannin has been printed, and leaves the other parts uncoloured. Another mode is to mix the dye with albumen or lacterine, print on the cloth, and then subject to the action of steam, which coagulates the albumen or lacterine, and at the same time fixes the colour on the cloth.