Dyes

- In the early times the colouring materials were extracted from natural sources like plants and insects.
- Now a days thousands of such substances are synthesised in factories on a large scale.
- Dyes are the organic compounds that are used to impart colour to textiles, foodstuffs, silk, wool and other objects.
- Dyes are capable of getting fixed to the fabrics/objects permanently and are resistant to the action of water, soap, light, acid, and alkalies.
- Every coloured compound cannot be used as a dye.

A good dye must have most of the following properties: 1. It must have a suitable colour. 2. It must be able to fix itself or capable of being fixed to the fabric from the solution. 3. When fixed, it must be fast resistant to the action of light, water, soap, detergents, etc. during washing or to the organic solvents during dry cleaning.

Why do dyes or dyed articles appear to have a characteristic colour ?

If a molecule absorbs light in the visible region (400 nm to 750 nm) corresponding to green colour, then it will appear violet, which is the complementary colour of green. Similarily, if a dye absorbs blue colour, it will appear yellow which is the complementary colour of blue. Thus, the dyes impart colour to fabric by absorbing the complementary colour.

Constitution of Dyes

The colour of a compound is due to the presence of certain groups containing multiple bonds. These groups which impart colour to a compound are called chromophores. Some examples of chromophores are : $–NO_2$ (Nitro), –N = O (nitroso), –N = N – (azo), quinonoid structures, etc. At the same time, there are certain groups which they are not chromophores themselves but they deepen the colour when present with coloured compounds. The groups which deepen the colour of a coloured compound are called auxochromes. Some examples of common auxochromes are : –OH, $–NH_2$, –NHR, $–NR_2$, –Cl, $–CO_2H$, etc.

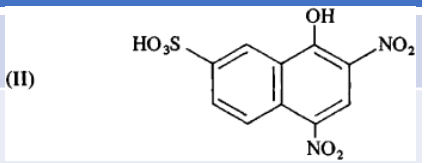
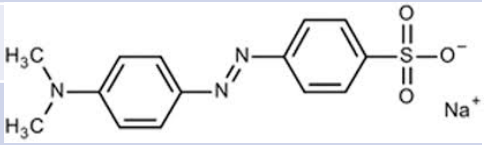
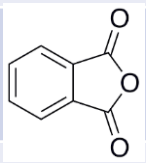
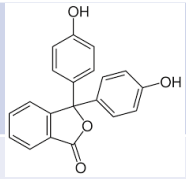
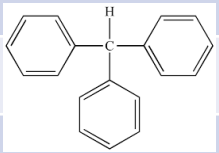
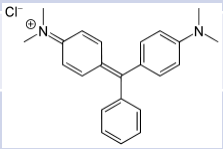
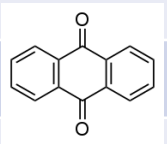
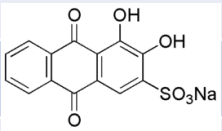
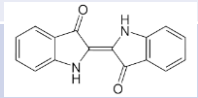
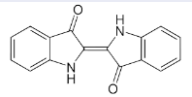
Classification of Dyes

A large number of dyes are used for various purposes. These are classified on the basis of their

(i) Constitution

(ii) Application

Classification based on constitution : Depending upon the characteristic structural units, the dyes, are classified as given in Table:

Dye type	Characteristic Typical examples	Structural unit
(1) Nitro Dye	-NO2	Martius yellow (II) 
(2) Azo Dyes	-N=N-	Methyl orange 
(3) Phthalein dyes		Phenolphthalein 
(4) Triphenyl methane		Malachite green 
(5) Anthraquinone		Alizarin 
(6) Indigoid		Indigo 

Classification of Dyes on the basis of their applications.

Dyes are classified into the following types on the basis of their applications.

(i) Acid dyes (ii) Basic dyes

(iii) Direct dyes (iv) Disperse dyes

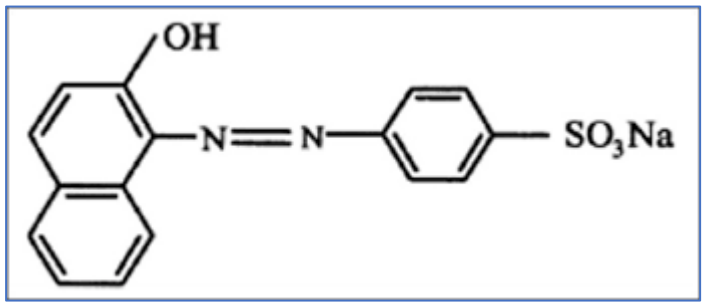
(v) Fibre reactive dyes (vi) Vat dyes

(vii) Insoluble azo dyes (viii) Mordant dyes

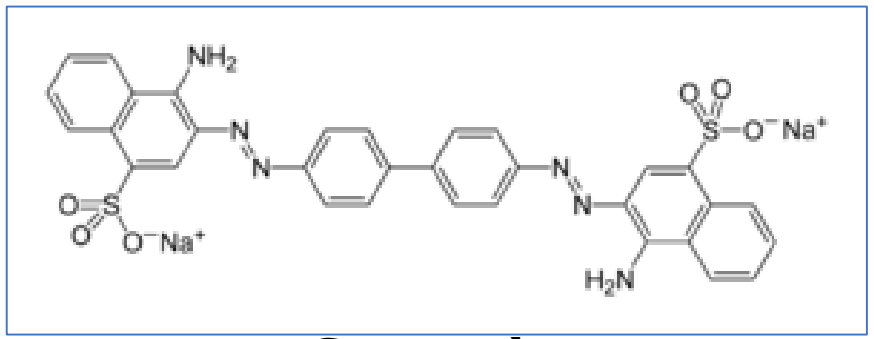
(i) Acid Dyes

These are azodyes used in the form of their sodium salt of sulphonic acid ($–SO_3H$), carboxylic acid (– COOH) or phenol. The dye can be applied to wool, silk and nylon. These do not have much affinity for cotton and therefore, cannot be used to dye cotton.

The common examples of an acid dye are orange – I and congo red.



Orange – I



Congo red

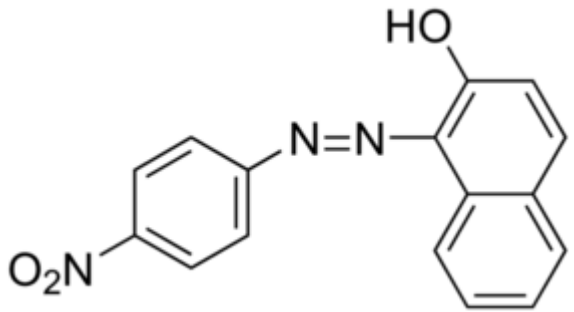
(ii) **Basic Dyes**

These dyes contain basic groups like (-NH_2) group or (-NR_2) group therefore these are called basic dyes. These dyes attack the anionic sites present on the fabrics and get attached to them. These are used to dye modified nylons, polyester, wool, cotton, leather, paper, etc. Aniline yellow, malachite green and crystal violet are the basic dyes.

(iii) **Direct Dyes** As the name suggest these dyes can be directly applied to the fabrics from their aqueous solution. The direct dyes attach to the fibre by means of hydrogen bonding. These are very effective for dying cotton, wool and rayon. Martius yellow and congo red are the common examples of direct dyes.

(iv) Ingrain dyes These dyes are very important because over 60% of the dyes used are azodyes or ingrain dyes. The fabric to be dyed is soaked in an alkaline solution of phenol or napthol and is then treated with a solution of diazotised amine. These are used for cotton, silk, polyster and nylon. The colour is not very fast because the interaction is only on the surface. For example, para-red is an ingrain dye.

Para-red



(v) Disperse Dyes

These dyes are usually applied in the form of a dispersion of finely divided dye. The dyes are disperesed in a soap solution in the presence of phenol, cresol or benzoic acid. These are used for nylon, polyster and polyacrylonitrile. Some common examples of disperse dyes are celliton fast pink B and celliton fast blue B

(vi) Reactive dyes

These dyes attach to the fibre themselves by irreversible chemical reactions. These dyes induce fast colour on the fibres which is retained for a longer time. These dyes are used to dye fibres like cotton, wool or silk. Dyes which are drivatives of 2, 4 dichloro – 1, 3, 5 – triazine are important examples of fibre reactive dyes.

(vii) Vat dyes

Vat dyes are the well-known dyes they are insoluble in water and hence cannot be used directly for dying. Therefore, they are reduced to a colourless soluble form (leuco) in large wooden vats with a reducing agent such as an alkaline solution of sodium hydrogensulphite. Under these conditions, the leuco form develops affinity for the cellulose fibre. Then the fabric is exposed to air which oxidises the leuco (colourless) form to coloured form. Therefore, these dyes are mainly used to dye cotton fibres. Indigo is an important example of this type.

(viii) Mordant Dyes

These dyes require an additional substance (generally a metal ion) for fixing to the fibre. These are used mainly for dyeing wool. The method involves the precipitation of certain mordant material (binding agent) on the fabrics which then combines with the dye to form an insoluble coloured complex called lake. For acid dyes, metal ions are used as mordants but for basic dyes, tannic acid is used as the mordant. For example, alizarin is a mordant dye. It gives a rose red colour with Al^{3+} and a blue colour with Ba^{2+}, a brownish red colour with chromium (Cr^{3+}) and a black violet with iron mordant.