
Dye classification
&
Dyeing processes
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Introduction Of Dyes

- Dye: A coloured organic comp. or mixture that may be used for imparting colour to a substrate such as cloth, paper, plastic or leather.

- Requisites of a True Dye:

  - Suitable & attractive colour
  - Able to attach itself.
  - Must be water soluble
  - Substrates being dyes must be affinity to dye.
  - After fixation of dye, it must be fast to washing, cleaning etc.
  - Shade & fastness of a given dye may vary depending on the substrate.

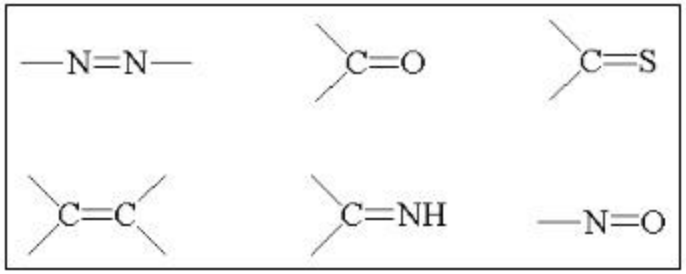
General Introduction To The Chemistry Of Dyes

- ✓ Dyes possess colour because

1) Absorb light in the visible spectrum (400–700 nm)

2) Have at least one chromophore (colour-bearing group),

- Have a conjugated system, i.e. a structure with alternating double and single bonds.
- Most dyes also contain groups known as *auxochromes (colour helpers),* examples of which are carboxylic acid, sulfonic acid, amino, and hydroxyl groups.While these are not responsible for colour, their presence can shift the colour of a colourant and they are most often used to influence dye solubility.

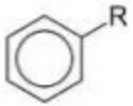


Chromophores

(provides colour – unsaturated grps.)

Chromogens:

(To which chromophore is attached)

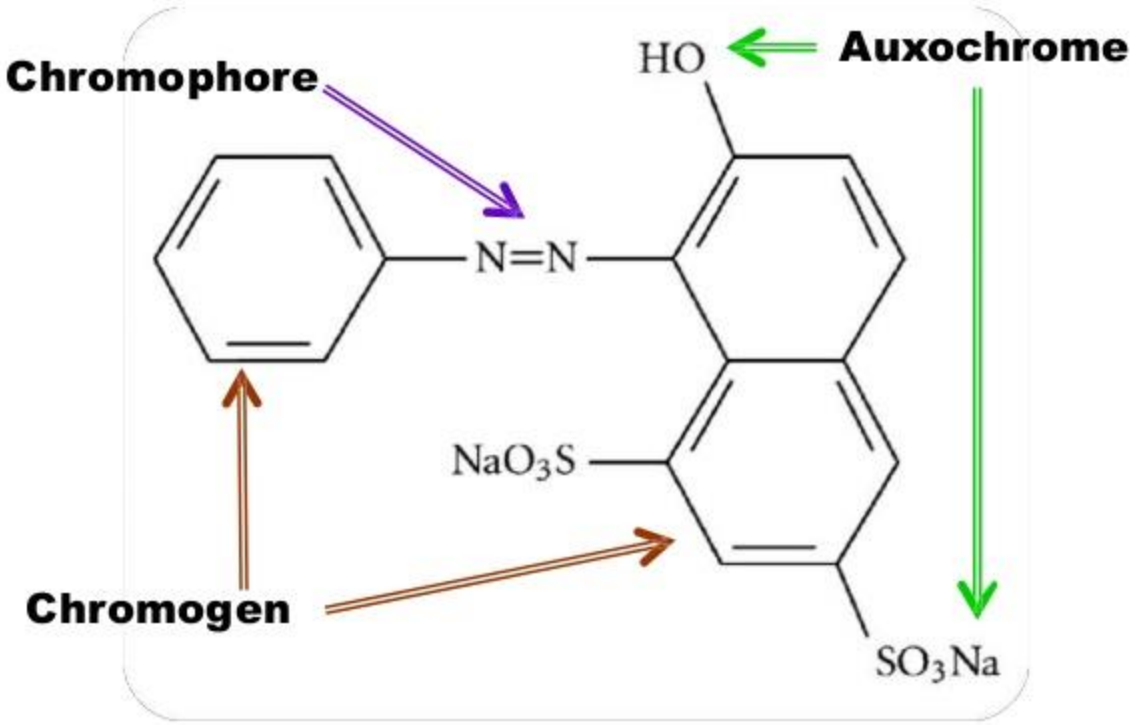


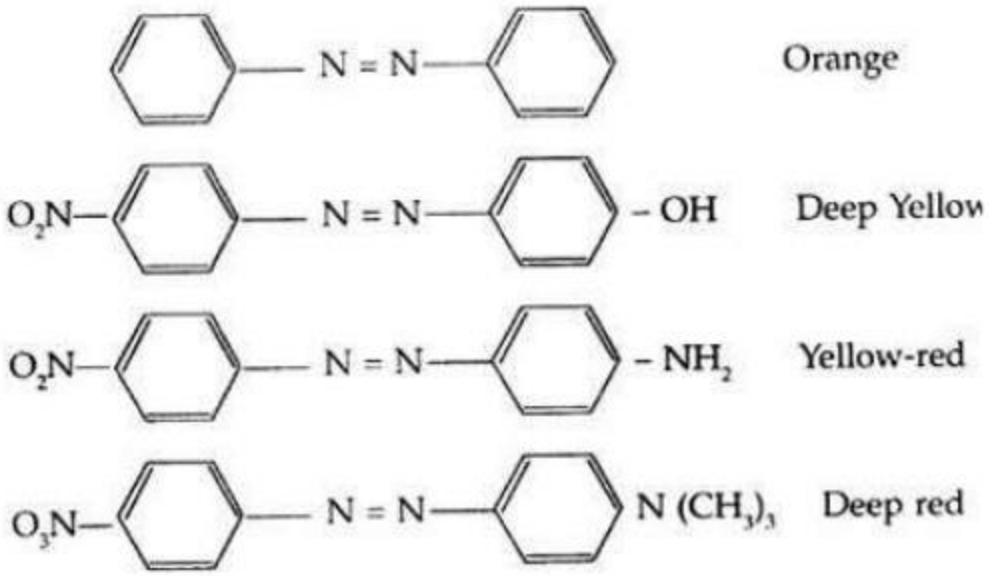
Phenyl, Naphthyl, etc.

Auxochromes:

(Modify the hue / solubility – Saturated functional groups attached to conjugated system)

- ***-NH_2***
- ***-NHR***
- ***-NR_2***
- ***-OH***
- ***-OR***
- ***-SO_3***


Chromophore
HO
Auxochrome
N=N
NaO3S
Chromogen
SO3Na


N = N
Orange
O_2N
N = N
– OH
Deep Yellow
O_2N
N = N
– NH_2
Yellow-red
O_2N
N = N
N $(CH_3)_3$
Deep red

Dyes versus Pigments

- ✓ Solubility : organic colourants fall into two classes, *dyes and pigments*
- ✓ The key distinction is that dyes are soluble in water and/or an organic solvent.
- ✓ Pigments are *insoluble in both types of liquid media.*
- ✓ *Dyes are used* to colour substrates to which they have affinity.
- Pigments can be used to colour any polymeric substrate but by a mechanism quite different from that of dyes.

Classification Systems for Dyes

1. Chemical Classification:

- The most appropriate system for the classification of dyes is by chemical structure. It readily identifies dyes as belonging to a group that has characteristic properties. (ex. Azo dyes)

2. Usage Classification:

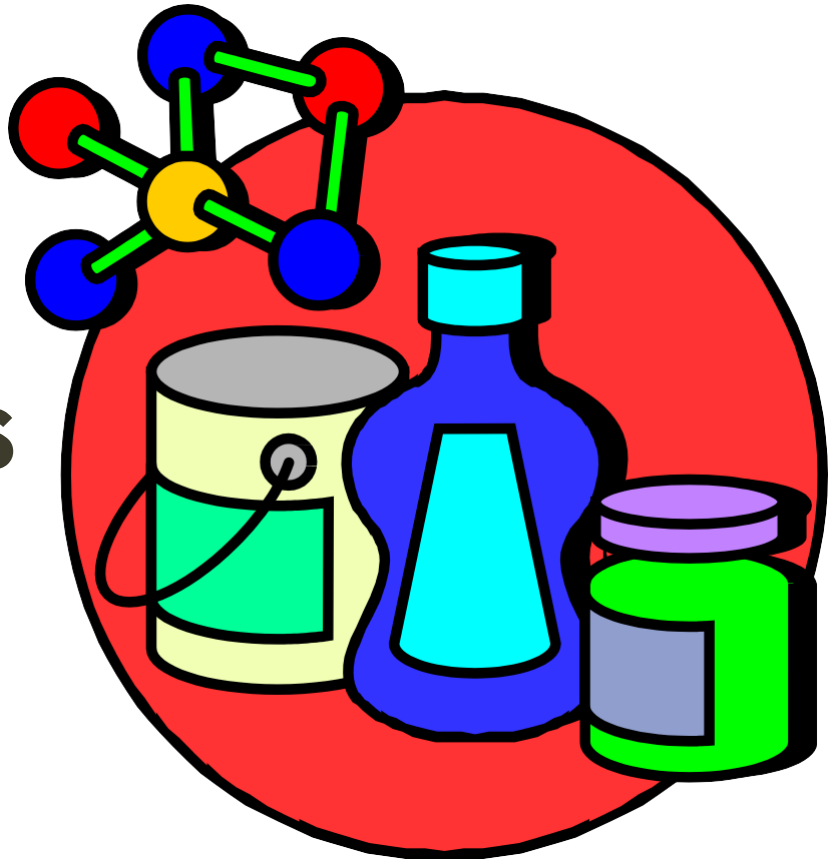
- Classification by usage or application is the principal system adopted by the Colour Index. Because the most important textile fibers are cotton and polyester.
- The most important dye types are those used for dyeing these two fibers, including polyester. cotton blends.

Classification of Dyes

- No single class of dye can dye all fibres.
- A specific class of dye can only be applied to a given type of textile fibre.

Dye for Cellulosic Fibres:

- Direct Dyes
- Azoic Dyes
- Reactive Dyes
- Sulphur dyes
- Vat Dyes



Classification of dyes

Dye Class	General description	Main application
Direct	Simple application; cheap; complete colour range; moderate colour fastness but can be improved by after-treatment with copper salts & cationic.	Mainly used for cellulosic fibres; can also be applied on rayon, silk & wool.

DIRECT DYES

- Direct dyes for Cotton, Viscose, Silk & Nylon
- Easy to dye - require only cooking salt & very hot to boiling water.
- Dyes have a good light fastness but only moderate wash fastness.
- It is possible to improve on wash fastness by after- treatment of dyed article with dye-fixing agent.
- These dyes are principally used for “not so expansive” products or product with fewer washes such as T-shirts, curtains.

DIRECT DYES

Yellow	Pink	Brown	Turquoise
Orange	Red	Violet	Black
Fushia	Grey	Green	Forrest Green
Scarlet	Blue	Wine	China Blue

Classification of dyes

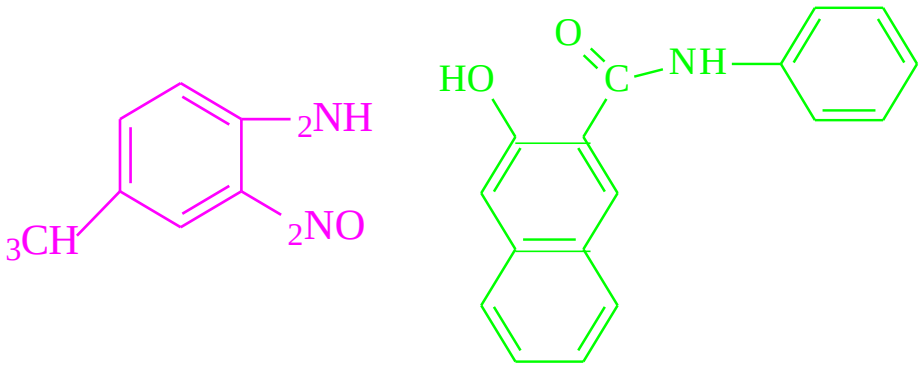
Dye Class	General description	Main application
Azoic (Naphthol)	Complicated application; limited colour range (red, orange, navy among the best); bright shade at moderate cost; generally good wet fastness but moderate to poor dry cleaning & rubbing fastness; also called naphthol dye due to the use of naphthol, or ice colour because of the usage of ice during application.	Mainly applied on cellulosic fibres، especially on brilliant red shade.

Azo Dye Synthesis

- Blue component can be coupled with yellow or green component to form two different dyestuffs.

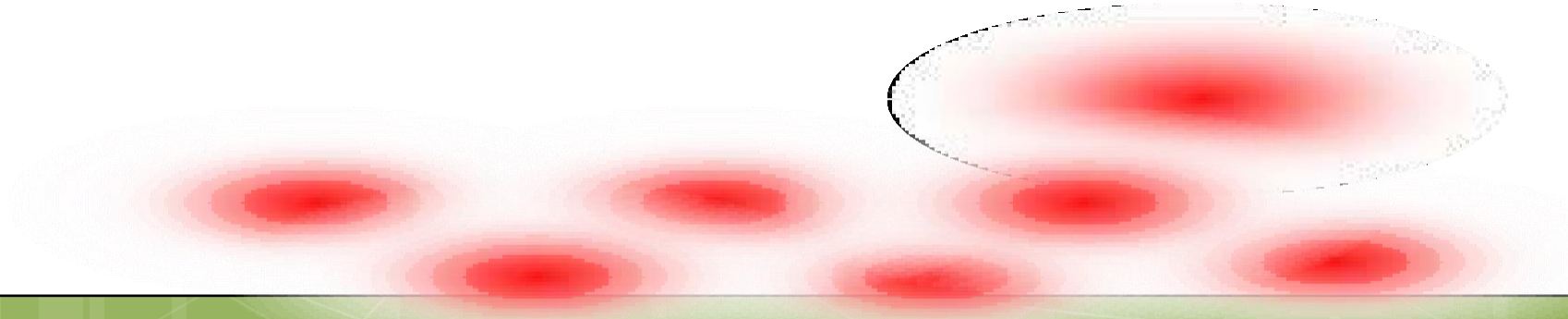
AZOIC DYES

- The word 'Azoic' is the distinguishing name given to insoluble azo dyes that are not applied directly as dyes, but are actually produced within the fibre itself.
- This is done with impregnating the fiber with one component of the dye, followed by treatment in another component, thus forming the dye within the fiber.



AZOIC DYES

- The formation of this insoluble dye within the fabric makes it very fast to washing.
- The deposition of the dye on the surface of the fibre produces poor rub fastness, but once the loose dye is removed by boiling the fabric in soap, the dyeing becomes one of the fastest available.



AZOIC DYES

- Normally it is dyed in **cold** for all natural fibers
- Naphtol dyes are not sold in the form of a "finished dye" but in form of their components (Insoluble azo base & fast colour coupling compound) which combine on the fibre to produce a **water insoluble** azo dye of exceptional fastness properties.
- Only a very limited number of colours can be obtained by using combinations of Naphtol & Diazo.

Classification of dyes

Dye Class	General description	Main application
Vat	Difficult to apply (requires reduction treatment to make soluble in water & oxidation to resume insoluble state after dyeing); most expensive؛ incomplete colour range (strong in blue & green but weak in brilliant red); good all round fastness except indigo & sulphurised vat species; tending to decrease in popularity due to increasing use of reactive dyes.	Commonly used for high quality cotton goods، e.g. towel؛ specially used in the dyeing of denim fabric.

VAT DYES

- **INDIGO**, probably the oldest dye known to man, is one of the most important members of this group.
- Natural indigo extracted from the plant 'Indigofera tinctorie' was used by the Egyptians in 200 BC.
- The first synthetic indigo was introduced to the textile trade in 1897 & had the effect of completely replacing the natural product.

- Although the vat dyes may be divided into 3 chemical groups, they are similar in that they are **insoluble in water** & **become water soluble when reduced** in the presence of an **alkali**.
- **After dyeing**, the fabric is **oxidized** & the dye again becomes water **insoluble**.
- Because of the time consuming & costly procedure in reducing vat dye into a water-soluble complex, dye manufacturers have produced a **stabilized water-soluble vat dye**.

VAT DYES

- This dye can be applied to cotton & viscose rayon by the methods used by applying direct cotton dyes.
- After the dyeing, a simple treatment restores the vat dye to its normal insoluble state.

VAT DYES - USE:

- Vat dyes are used in cotton dyeing where high wash & boil fastness required.
- Because of the high alkali concentration in the dye bath, pure vat dyes cannot be used on animal fibres, (wool, natural silk, & various hairs)
- Solubilized vat dyes, not requiring the presence of alkali, can be used for dyeing on animal fibres.

- **When the ultimate in wash & boil fastness is required.**
- Also used to dye over fibre reactive dyes for multi-layered dyeing.

- **Bright red** is absent in vat dye range.

YELLOW	GREEN
ORANGE	OLIVE B
RED	BROWN
BLUE	NAVY
VIOLET	BLACK

Classification of dyes

Dye Class	General description	Main application
Sulphur	Difficult to apply (application similar to vat dyes); cheap particularly for dark shade; poor washing & rubbing fastness & sensitive to chlorine; may cause fabric rendering of cellulose upon storage (aging.)	Mostly used for heavy cellulosic goods in dark shades.

SULPHUR DYES

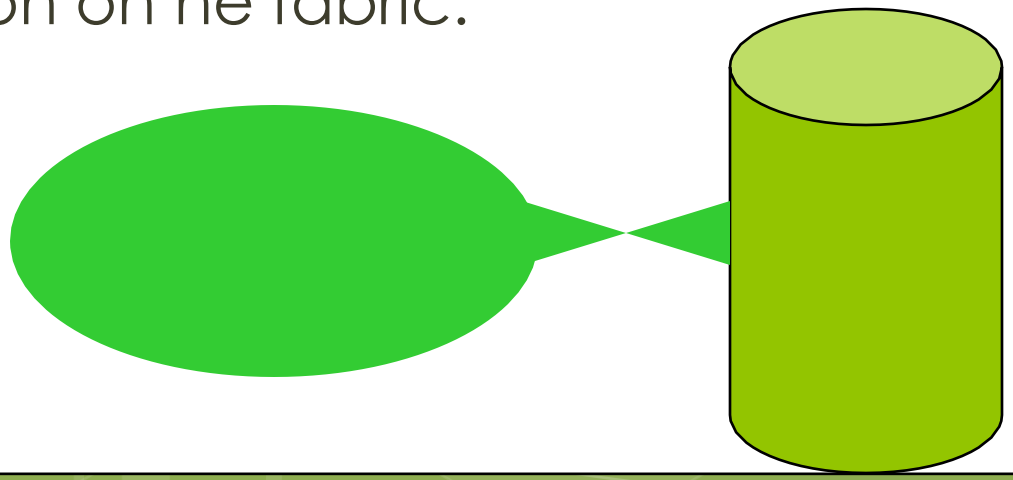
- The general disadvantage of the Sulphur dyes that they produce dull shades & lack a **red**.
- The main advantage lays in their cheapness, ease of application & good wash-fastness.
- In their normal state, Sulphur dyes are insoluble in water but are readily soluble in the solution of Sodium Sulphide.
- It dyes all cellulose fibres, but particularly linen & jute, to a lustrous & deep black with excellent wash & light fastness.
- Sulphur dyes are dyed from a dye bath containing Sodium Sulphide & common or Glaubers Salt, & are oxidized by airing or with some oxidizing agents (Sodium Bichromate or Hydrogen Peroxide) in a fresh bath.

Classification of dyes

Dye Class	General description	Main application
Reactive	Easy application; moderate price; complete colour range; good fastness due to direct reaction with fibres.	Commonly used for all cellulosic goods; selective dyes can also be applied on wool, silk & rayon; increasingly used in printing due to good fastness.

REACTIVE DYES

- This is an entirely class of dye introduced to the market in .1956
- They react chemically with the fibre being dyed & if correctly applied, cannot be removed by washing or boiling.
- The main feature of the dyestuff is its low affinity to cellulose; therefore large amounts of salt are required to force its deposition on he fabric.

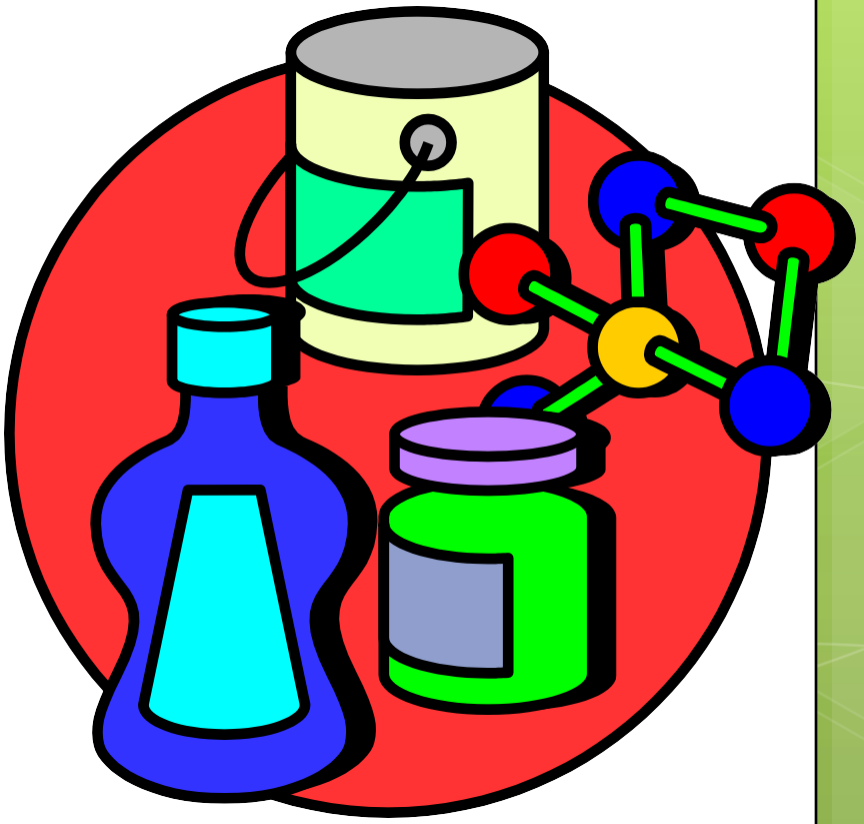


REACTIVE DYES - USE:

- Although some reactive dyestuffs have been specially modified to dye wool, their main usage is in dyeing cotton linen & viscose rayon
- Cold water fibre reactive dyes, suitable for dyeing on cotton, silk, jute, rayon &hessian.
- Cannot be used on synthetics or fabric that has been coated with resin.

Dye for Protein Fibres:

- Acid Dyes
- Metal-complex Dyes
- Chrome Dyes

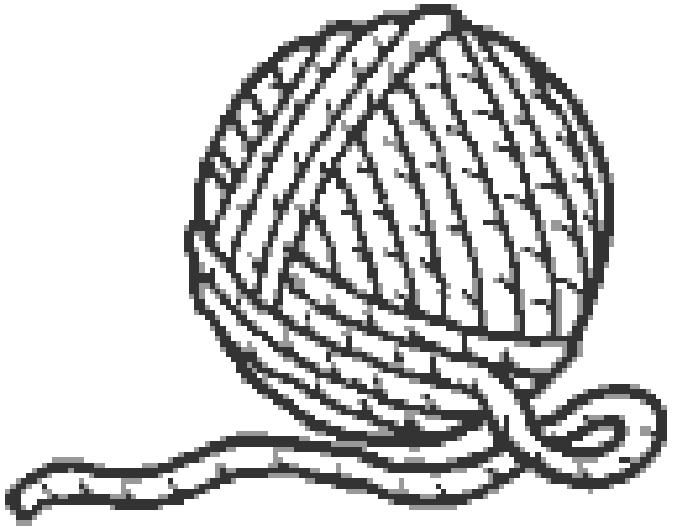


Classification of dyes

Dye Class	General description	Main application
Acid	Easy application; complete colour range with very good bright shades; fastness properties may vary among individual dyes.	Commonly used for wool, silk & nylon.

ACID DYES

- These dyes comprise a large number of dyes used for the dyeing of wool, silk & nylon.
- They vary considerably in their basic chemical structure, but have one common feature - they dye from an acid dye bath.



ACID DYES - USE:

- The family of acid dyes is very large & diverse, varying widely in their methods of dyeing, application & end use of the dyed fabric.
- A choice of dyes should be made considering sometimes-incompatible factors: - level dyeing, fastness, brightness & ease of application.
- Care must be taken to use the appropriate method as prescribed for a given dye.
- A number of acid dyes are also used to dye nylon.

Classification of dyes

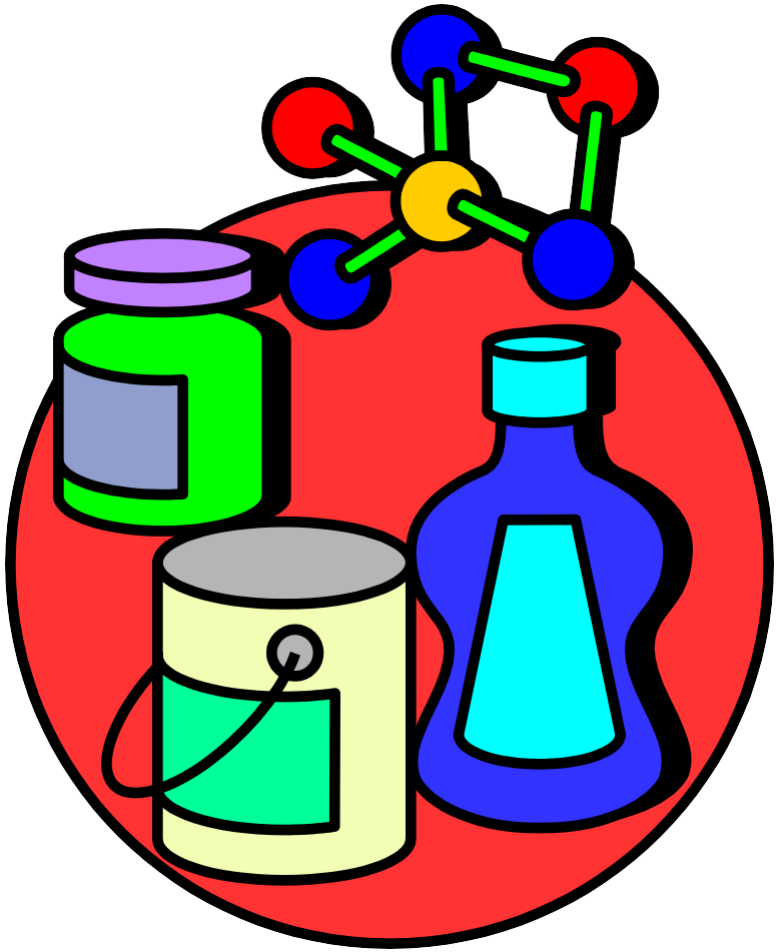
Dye Class	General description	Main application
Metal-complex	Relatively difficult to apply; expensive; complete colour range but duller shade than acid dyes; good fastness due to high molecular size & metal complex structure.	Mainly used for wool& Nylon.

Classification of dyes

Dye Class	General description	Main application
Chrome Mordant	Complicated application; expensive; complete colour range but very dull shade; good all round fastness.	Mainly used for wool products especially for the end use of carpet.

Dye for Other Fibres:

- Disperse Dyes for Polyester, Acetate
- Cationic Dyes for Acrylic



Classification of dyes

Dye Class	General description	Main application
Disperse	Require skill in application (either by carrier or under high temperature); moderate price; complete colour range; limited solubility in water (normally dispersed in water for application); good fastness after reduction clearing treatment; sublimation property.	Mostly used for polyester &acetate; can also be applied on nylon & Acrylic.

DISPERSE DYES

- The introduction of a new regenerated cellulose acetate fibre in 1920 led to the necessity to develop an entirely new range of dyes.
- It was found that acetate (or Celanese) fibre had hardly any affinity for water-soluble dyes.
- A new dyeing principle was introduced: dyeing with water dispersed coloured organic substances.
- These finely coloured particles are applied in aqueous dispersion to the acetate material & actually dissolved in the fibres.

DISPERSE DYES - USE:

- Basically developed for dyeing of acetate fibres, Disperse dyes are also used for dyeing of polyamide (Nylon) & acrylic (Orlon & Acrylan) fibres.
- With the addition of 'carriers' or swelling agents these dyes are also used in dyeing of Polyester (Terylene, Dacron, etc)

Classification of dyes

Dye Class	General description	Main application
Basic (Cationic)	Careful application required to prevent unlevel dyeing & adverse effect in hand-feel; complete colour range with very good brilliant shades.	Mainly used for acrylic.

CATIONIC & BASIC DYES

- **"Basic dyes"** dye wool & silk from a dye bath containing acid but dye cotton fibres only in the presence of a **mordant** usually a metallic salt that increases affinity of the fabric for the dye.
- Basic dyes include the **most brilliant** of all the synthetic dyes known, but unfortunately they have very poor light & wash fastness.

CATIONIC& BASIC DYES USE:

- Basic dyes will dye wool & silk from an acid bath & are used where brightness is of prime consideration.
- With the introduction of cotton dyes possessing higher fastness properties their use for dyeing cotton has diminished.
- With the introduction of acrylic fibre a new range of 'modified' basic dyes were perfected for dyeing of this material.

YELLOW	BLUE
ORANGE	TURQUOISE
RED	VIOLET
PINK	GREEN
RHODAMINE	BLACK

Colour Fastness

- A good dye must withstand the subsequent treatment (e.g. laundering, dry cleaning, etc.) or environmental wearing (e.g.rubbing,light exposure, etc.).
- The degree to which a dyed material can withstand such treatments & wearing is called colour fastness.
- No dye or pigment is fast in all colour fastness.
- Only a careful selection & formulation of dyes & auxiliaries can result in a desirable dyeing, & conform with the colour fastness requirements.

Dye classes' colour fastness properties

Dye Class	Colour fastness to				
	Washing	Light	Dry cleaning	Perspiration	Rubbing
Direct	Moderate (can be improved after proper after-treatment)	Moderate (can be improved after proper after-treatment)	Good	Good	Good
Azoic	Good	Good	Moderate	Good	Moderate
Vat (except indigo)	Excellent	Excellent	Good	Excellent	Good
Sulphur	Moderate (sensitive to chlorine)	Good	Good	Good	Moderate (poor on dark shades)
Reactive	Good	Good	Excellent	Excellent	Good
Acid	Moderate to poor	Good	Good	Moderate	Good
Metal-complex	Good	Excellent	Good	Good	Good
Chrome Mordant	Excellent	Excellent	Good	Good	Good
Disperse	Good	Good	Good	Good	Good
Basic (Cationic)	Good	Moderate to poor	Good	Good	Good