

# THE CHEMISTRY OF PERMANENT HAIR DYES

There are a number of different types of hair dyes, but the most commonly used are permanent (oxidative) dyes. These dyes have a range of different components that react with each other to produce the desired end colour. In this graphic, we examine some of these chemicals, and how they form dyes.

## 1 PRIMARY INTERMEDIATES



**p-PHENYLENEDIAMINE (PPD) & p-AMINOPHENOL**

All permanent hair dyes contain a 'primary intermediate'; these are often *p*-diamines or *p*-aminophenols. They are oxidised by hydrogen peroxide to give reactive species which then go on to react with couplers to produce dyes. The exact structure of the reactive species produced by oxidation is still the subject of some debate.

## 2 OTHER COMPOUNDS



**HYDROGEN PEROXIDE, AMMONIA, & ETHANOLAMINE**

Hydrogen peroxide is the agent responsible for oxidation of primary intermediates, and also lightens the natural pigments present in the hair, the melanins eumelanin and pheomelanin. The dye-forming reactions are carried out at an alkaline pH, which is why ammonia is also required in the dye mixture. This raised pH causes the hair cuticle to swell, which in turn allows hydrogen peroxide and dye molecules to pass into the cortex. Ethanolamine can be used as an alternative, milder alkaline agent.

## 3 COUPLING AGENTS



**RESORCINOL**  
BROWN YELLOW



**m-AMINOPHENOL**  
LIGHT BROWN



**2,6-DICHLORO-1,4-DIAMINO-BENZENE**  
BROWN



**p-TERPHENYLENEDIAMINE**  
DARK BROWN



**1,4-DIAMINODIPHENYL ETHER**  
PURPLE BLUE



**2,6-DIAMINONAPHTHALENE-1,4-DIOL**  
BLACK Violet



**1,4-DIAMINO-BENZENE**  
BROWN



**1,4-DIAMINOBENZENE**  
DARK BLUE



**m-DICHLOROANILINE**  
DARK BROWN



**p-AMINO-2-NITROPHENOL**  
DARK RED

Coupling agents, also referred to as colour couplers, are the other component in the dye mixture. Independently, they contribute little in the way of colour, but they can react with primary intermediates in the presence of an oxidising agent to produce dye molecules, some examples of which are shown below. Most dyes will contain a mix of different coupling agents, rather than just one. Primary intermediates can, in some cases, couple to themselves to produce colouration. In the end, multiple different dye products are formed from a single formulation of hair dye.



**GREEN INDO DYE**  
INDO-170 & RESORCINOL



**BROWN INDO DYE**  
INDO-170 & m-AMINOPHENOL



**MAGENTA INDO DYE**  
INDO-170 & p-AMINO-2-NITROPHENOL



# Hair Dye Chemical Composition

**Hussin A.Rothana**



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