Vicky Wong

Chemistry and paint

Girl with a Pearl Earring by Vermeer

Like many other people, I thoroughly enjoyed Tracy Chevalier's book *Girl with a Pearl Earring*, later made into a film. It is an imagining of the story behind a seventeenth century painting by Johannes Vermeer. What fascinated me the most was the description of the artist and his assistants making the paint that he would use. I had never given much thought to what artists used in the days prior to paint being available in little tubes, but there is a lot of chemistry involved in paint-making, which dates back many millennia.

The oldest paintings in the Altamira cave in northern Spain are 35 600 years old, according to radioisotope dating. Early artists used easily available natural substances to make paint, such as iron oxides from the earth – whose colour they changed with fire, charcoal, berry juice, lard, blood, and plant sap.

Key words
pigment
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Painting of a bison in the cave of Altamira, near Santander, Spain

This Egyptian painting, from 1360 BCE, shows the limited range of pigments available at the time.

It was the ancient Egyptians who really developed the use of what we know as paint and it was used for pictures on papyrus, on buildings and in tombs; some of their paintings have survived to this day and can be seen in museums including the British Museum.

What makes paint?

Paint consists of the pigment, which gives it colour, and a binder, which in ancient times was a resin or sap, which surrounds the pigment and holds it in place. These binders were often very thick so a thinner was added to make the paint spreadable.

The Egyptians developed earthy colours such as yellow, orange and red from pigments in the soil. The Romans developed purple, which they made from snails. Thousands of tiny snails had to be found, removed from their shells and left to soak before a liquid was extracted from one of their glands. Placed in sunlight, this changed through a series of colours to produce purple. The process could be stopped at different times to get a range of colours from bright crimson to dark purple.

Cochineal, which was widely used to produce both red and pink colours, was made from the cochineal beetle which was crushed to extract carmic acid. This was mixed with calcium or aluminium salts to produce cochineal or carmine. As the chemical industry developed synthetic pigments, the use of cochineal declined, but has increased again recently as consumers choose natural colours. Cochineal made from beetles is found in some foods and cosmetics.

Other natural pigments included yellow from concentrated cow's urine, green from blackthorn berries and sepia brown from dried squid ink.

Chemical pigments

Alongside the pigments from plants and animals, purely chemical ones were being developed and used by artists. The red colour vermillion comes from mercury sulfide. This compound can be found in nature, but gives a better colour if it is made directly from its elements. This process may have been developed in ancient China, but was certainly used from Roman times. Some artists bought the pigment from alchemists (the early chemists) or apothecaries (the early pharmacists) but others may have made their own. A handbook of art from the twelfth century includes instructions for making it.

To make the paint, the artist or assistants ground up the pigments and mixed them with the binders and thinners. As many of the pigments were very expensive this was a responsible job.

Making paint the traditional way – linseed oil is mixed with ground dried clay earth pigment. The paint takes about 2 days to dry.

From about the 1800s pigments began to be manufactured in larger quantities, making them cheaper and more widely available. One of the earliest pigments to be produced in a factory was lead white. Due to the lead content this was toxic, however, and made many of the factory workers ill. Zinc oxide was found to be a suitable alternative.

Extracting zinc was an important business in the early 1800s and by investigating some of the by-product of the smelting a new element was discovered, cadmium. Cadmium sulfide can give bright pigments in a range of reds, oranges and yellows. Cadmium red is still widely used today although it is toxic. In the nineteenth century a wide range of new pigments were discovered through the use of chemistry – bright greens from arsenic, many colours from chromium, and beautiful blues and purple from cobalt.

Many of these colours are based on the transition elements, those metals in the central block of the periodic table. Many of them can be used to produce a range of colours as they can have many different arrangements of electrons in their outer shells giving rise to different colours.

This new palette of colours meant that artists could paint in shades that previously weren't possible. The work of the impressionists in France was only possible because of the much larger range of pigments which were available.

Colours have changed with time: A Sunday Afternoon on the Island of La Grande Jatte by Georges Seurat.

Off-the-shelf

The use of new pigments was not without problems, however. Georges Seurat in creating his painting A Sunday Afternoon on the Island of La Grande Jatte used the new pigment zinc yellow, zinc chromate ($ZnCrO_4$), to create yellow highlights on the lawn and in mixtures with orange and blue pigments. This pigment darkened to brown, reducing the effect that the painter had in mind. This degradation of colour was not known about as the pigment was so new, but began even in the artist's lifetime. This shows one of the difficulties which can arise with the development of new pigments and materials – knowing how stable they will be over time. In spite of this, most paint continues to be made with synthetic pigments and blended in a factory.

Today, artists buy their paint ready-mixed and very few would even dream of making their own, but whether they realise it or not, painting is all about chemistry.

Vicky Wong is Chemistry editor of Catalyst.

Look here!
For a more detailed article about the relationship between chemistry and paint:
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