



Soap and Cells: Making Molecules 'Stand on Their Heads'

Soap films can be spread on water almost instantly in this experiment.

Dust chalk or talcum powder on to water in a dark-coloured bowl. Pick up the smallest possible drop of liquid soap on a toothpick and touch it to the centre of the powder layer.

In a flash, the powder will be pushed away from the drop to leave a clear circle about 10 cm in diameter.

A grain of solid detergent will do the same if placed on the water.

From the chemical formula of the soap and the size of the drop and circle we can calculate that the long, thin soap molecules are standing on their heads on the water with their tails lined up like grass in a clipped lawn.

A soap film just one molecule thick (a monolayer) has been formed in the circle. The film is invisible because the soap molecules are shorter than the wavelength of light.

The head of each soap molecule has one carbon (C) atom and two oxygen (O) atoms which carry an extra electron. This is attracted to the water and anchors the film.

The upright tail of the molecule is a chain of 15 or 17 C atoms coated with hydrogen (H) atoms. These hydrocarbon chains are also present in oils and fats and make them float since they are less dense than water.

Synthetic detergents also form films on water and have molecules like soap but with phosphorus (P) or sulphur (S) instead of carbon atoms in their heads.

Oil drops from cars make floating rainbows (iridescence) on puddles after a shower. The oil spreads on the puddle in stacked layers to thicknesses matching the wavelengths of sunlight so that the colours are separately reflected to our eyes.

In a soap bubble, inner and outer soap films have water trapped between them. Again the thickness of the bubble is just right to reflect the rainbow colours.

The bubbles burst when water drains out and this can be slowed down to make longer lasting bubbles by adding glycerol (glycerine) to the soapy water.

Sir James Dewar kept a bubble of 32 cm diameter for 108 days.

A soap film folded back on itself so that hydrocarbon layer meets hydrocarbon layer is called a bilayer. Oil and fat dissolve in the inside of the bi-layer and the outside, being all "heads" will dissolve in water. This is how soap helps to wash grease off dishes and clothes.

Soap-like molecules called lipids formed into bi-layers are the outer membranes of living cells. Chemicals imbedded in the membranes provide the extremely sensitive chemical-recognition reactions of immunology, blood grouping and biochemistry.

It is fun to make films and bubbles with all the different washing agents in the house including toothpaste.

Compare the times for circle spreading and bubble life.

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