

# Copper for Life: Haemocyanin

## Haemocyanin

Vertebrates have red blood. The colour comes from a molecule called haemoglobin, which is found in red blood cells. Haemoglobin carries oxygen around the body and it uses iron atoms to hold the oxygen and then release it.

Some invertebrates use a molecule called haemocyanin to carry oxygen around their bodies using copper atoms instead of iron. Snails, lobsters and spiders actually have blue blood (properly called haemolymph). The colour comes from the copper atoms in the haemocyanin molecule, which is blue when it is carrying an oxygen atom. It is dissolved directly into their 'blood' instead of being enclosed in blood cells.

Haemocyanin, like haemoglobin and chlorophyll in green plants, is a metalloprotein. This is a protein that contains metal atoms. Nature has plenty of examples of metalloproteins. In fact, plant and animal life forms have evolved with a basic need for metals.

A haemocyanin molecule contains two copper atoms that bind a single oxygen molecule ( $O_2$ ) and then release it where it is needed. Haemocyanin is a bluish purple colour when it is carrying an oxygen molecule as seen here beneath the carapace of a *Cancer productus* crab. Once haemocyanin releases its oxygen, it is colourless.

## Haemocyanin in medicine

Although haemocyanin comes from a different species to humans (about as different as you can get!) it is not harmful to them. One type of haemocyanin is used as a vaccine carrier and also in research into the human immune system and cancer. It is impossible to make this molecule in the laboratory; it is too large and complicated. The only source is the giant keyhole limpet *Megathura crenulata*. The molecule is called KLH (keyhole limpet haemocyanin).

The giant keyhole limpet is only found along the Pacific coastline from California to Mexico. It is so valuable to medicine that a new industry of keyhole limpet aquaculture has been



*Slugs use copper to transport oxygen.*  
(Wikimedia Commons.)



*Oxygenated haemocyanin in the crab  
Cancer productus.*  
(Wikimedia Commons.)



*Giant keyhole limpets are farmed  
in California. (Courtesy of Stellar  
Biotechnologies.)*

set up to farm it and make sure that enough can be produced reliably and with high purity.

KLH is extracted from the limpets without killing them. They are a resource too rare and precious to waste!

# Questions and Activities

- 1. What is the name for proteins that contain metal atoms?**
- 2. Haemoglobin contains which metal atoms?**
- 3. Haemocyanin contains which metal atoms?**
- 4. Haemocyanin transports which molecules around the bodies of slugs and limpets?**
- 5. What is the equivalent of blood in invertebrates such as snails, crabs and molluscs called?**
- 6. When haemocyanin picks up an oxygen atom we say it is oxygenated. What colour is oxygenated haemocyanin?**
- 7. Which animal does keyhole limpet haemocyanin (KLH) come from?**
- 8. What are the medical uses of KLH?**

[Click here for answers](#)

*Copper Development Association is a non-profit organisation that provides information on copper's properties and applications, its essentiality for health, quality of life and its role in technology. It supports education through a collection of resources spanning biology, chemistry and physics. These materials have been developed in conjunction with the Association for Science Education, and reviewed by teachers.*

*For more resources, visit [www.copperalliance.org.uk/education](http://www.copperalliance.org.uk/education).*