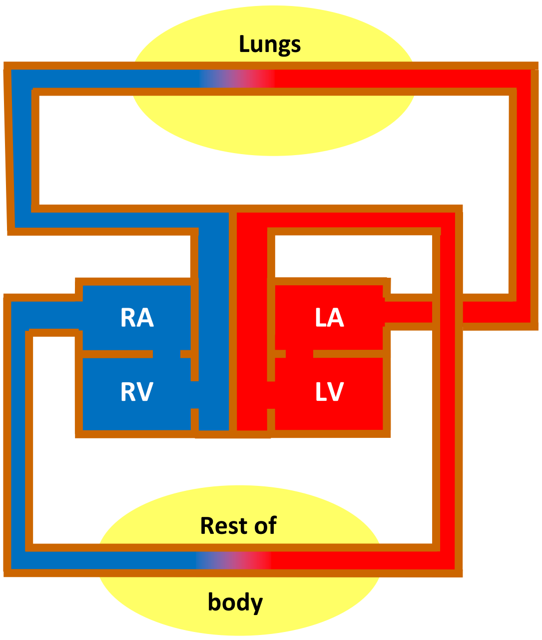
2.8 Haemoglobin

The role of haemoglobin in the carriage of oxygen within the body

Oxygen is transported around the body within **erythrocytes** (red blood cells), which contain the protein **haemoglobin** (**Hb**). When haemoglobin binds (reversibly) with oxygen, it becomes **oxyhaemoglobin**.

haemoglobin + oxygen ⇌ oxyhaemoglobin

Haemoglobin consists of four subunits, each composed of a **polypeptide** (protein) chain and a **haem** (non-protein) group. The haem group contains a single iron ion (Fe^{2+}) which can attract and hold an oxygen molecule (it has an **affinity**, or attraction, to the oxygen molecule). Each haemoglobin molecule can therefore hold four oxygen molecules.



The diagram shows where oxygen is absorbed (the lungs), and delivered to (the rest of the body). In the lungs, the molecules of oxygen diffuse into the blood plasma and enter the erythrocytes where they are picked up by haemoglobin. Body tissues require the oxygen to respire, so oxyhaemoglobin must be able to release the oxygen – this is called **dissociation**.

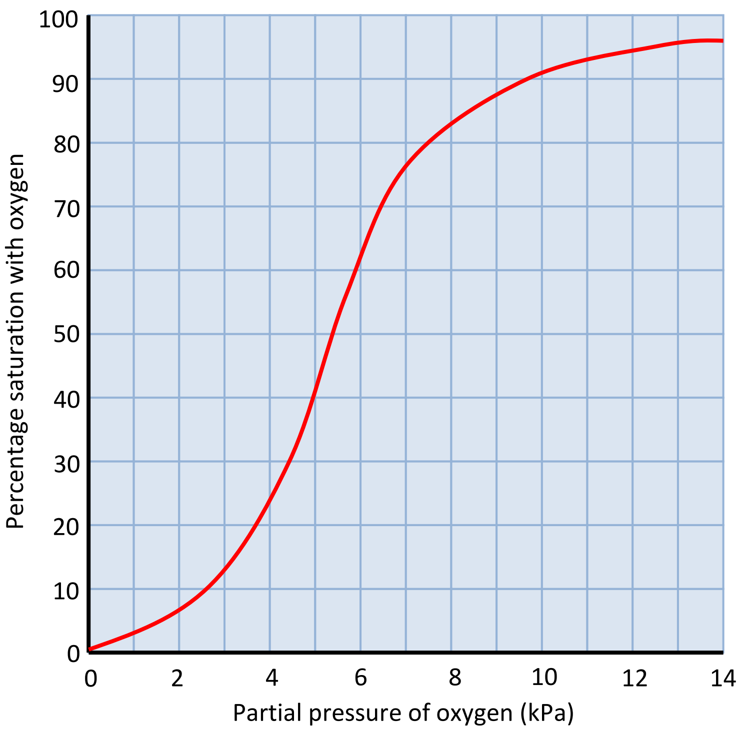
The ability for haemoglobin to take up and release oxygen is dependent on the amount of oxygen in surrounding tissues. The amount of oxygen is measured by its relative *pressure* it contributes to a mixture of gases. This is called the **partial pressure** (pO_2).

If you were to plot the partial pressure of oxygen against the percentage saturation with oxygen, you would get an S-shaped (**sigmoid**) curve, not a straight line. This is because at a low pressure, haemoglobin will not bind with oxygen as readily, so there is a low affinity for oxygen. The steepness of the sigmoid comes from the increase in pressure causing an increase in affinity for oxygen, and it eventually levels off when a haemoglobin molecule has three oxygen molecules, because it then becomes more difficult to attract the fourth.

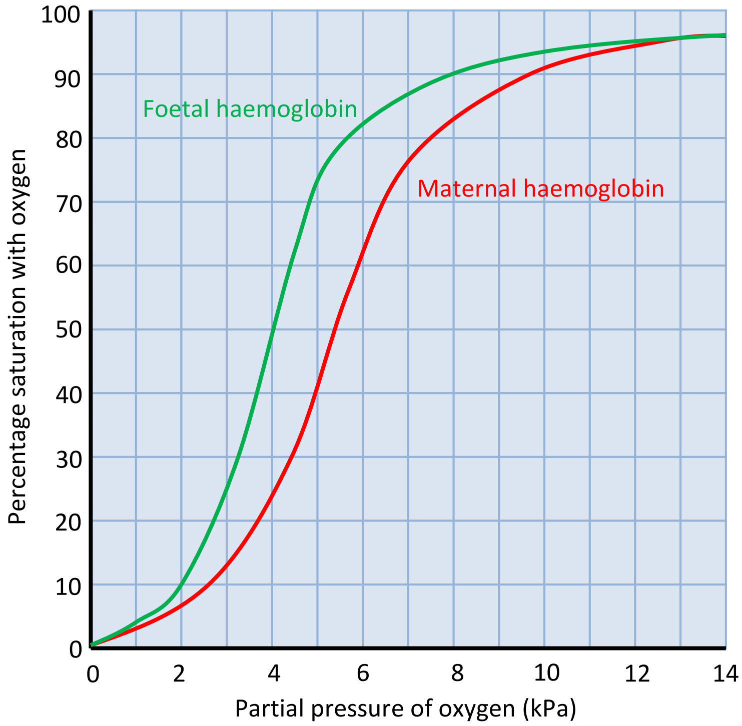
Mammalian haemoglobin is well adapted to transporting oxygen around the body. The partial pressure of oxygen (also called **oxygen tension**) in the lungs is sufficient enough to achieve almost 100% saturation.

The oxygen tension in the respiring tissues around the body is sufficiently low, which causes oxygen to dissociate readily from the haemoglobin.

The graph to the right shows the relationship between partial pressure of oxygen and the percentage saturation, and its sigmoid curve. The graph is given the name of the **oxygen dissociation curve**.



FOETAL HAEMOGLOBIN



A mammalian foetus does not have functioning lungs, and so the haemoglobin of a foetus must have a *higher* affinity for oxygen so that it can absorb oxygen from an environment where adult haemoglobin will release it.

In the placenta, **foetal haemoglobin** must absorb oxygen from the mother's blood. This reduces the partial pressure of oxygen, which causes the **maternal haemoglobin** to release oxygen.

Because foetal haemoglobin has a higher affinity for oxygen than maternal, the curve is slightly to the left, as shown in the graph.