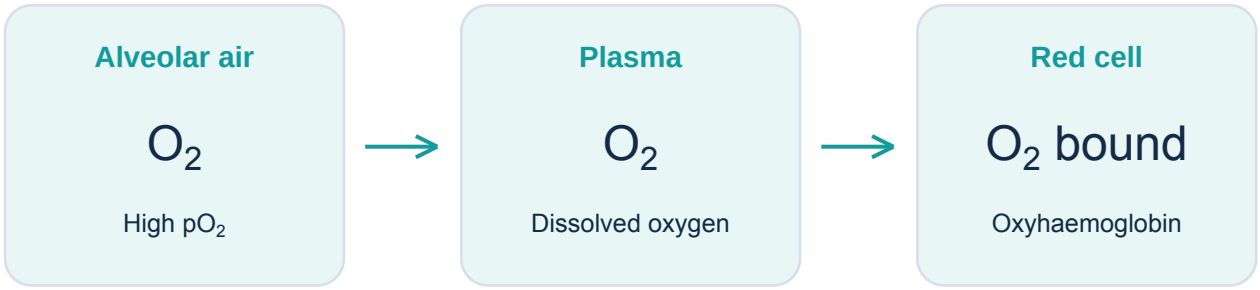
Load oxygen in the lungs

Loading means oxygen binds to haemoglobin to form oxyhaemoglobin. Ventilation maintains relatively high oxygen partial pressure in alveoli, favouring oxygen uptake by arriving blood.

1. OXYGEN ENTERS BLOOD AND BINDS



O_2 crosses the alveolar and capillary walls, passes through plasma, and enters red cells. Hb stays inside the cells. Route schematic; boundaries are omitted.

2. FOLLOW THE PARTIAL-PRESSURE GRADIENT

Blood arriving at lung capillaries has lower pO_2 than alveolar air. Oxygen diffuses into the blood, and haemoglobin binds it. Blood pO_2 and saturation rise as blood passes the alveoli. Binding greatly increases oxygen carriage beyond the small dissolved fraction.

3. THE PLATEAU HELPS PRESERVE LOADING

At high pO_2, most haemoglobin binding sites are occupied. A modest fall in pO_2 within the plateau causes only a small fall in saturation. This gives a margin for variation, but does not protect loading from a very large fall in oxygen availability.

$$\text{haemoglobin} + \text{oxygen} \rightleftharpoons \text{oxyhaemoglobin}$$

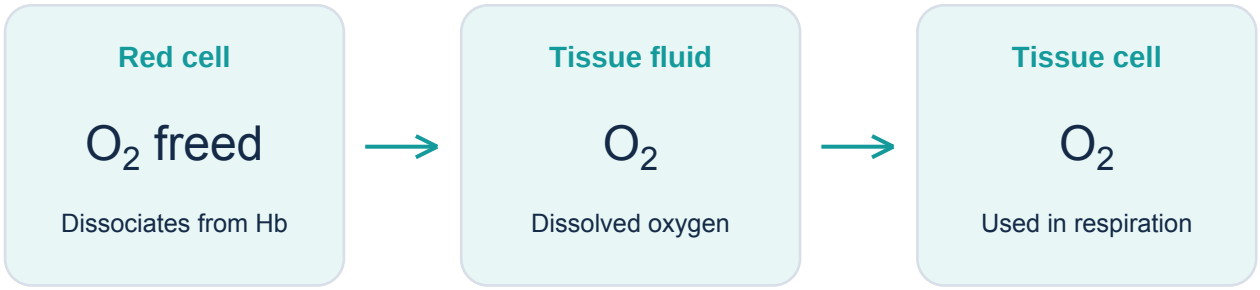
Lung gradient and diffusion route: OpenStax Anatomy & Physiology 2e, section 22.4.
Binding and plateau: OpenStax, section 22.5.

Scope: Cambridge Biology 9700 syllabus, section 8.2, outcome 5, p. 28.

Unload oxygen in respiring tissues

Unloading means oxygen dissociates from oxyhaemoglobin. Cells use oxygen in aerobic respiration, maintaining a lower pO_2 than in the blood supplying them.

1. OXYGEN DISSOCIATES AND DIFFUSES OUT



O_2 crosses the red cell membrane and capillary wall, passes through plasma and tissue fluid, and enters cells. Hb does not leave the red cell. Route schematic; boundaries are omitted.

2. OXYGEN USE MAINTAINS THE GRADIENT

Dissolved oxygen diffuses from blood towards tissue cells. As blood pO_2 falls, oxyhaemoglobin dissociates and supplies more dissolved oxygen for diffusion. Haemoglobin therefore acts as a reversible carrier, not as a pump that pushes oxygen into cells.

3. THE STEEP REGION SUPPORTS GREATER RELEASE

Within the steep part of the curve, a small fall in pO_2 produces a large fall in saturation. If a tissue uses oxygen more rapidly and local pO_2 falls, more oxygen can be unloaded from each passing volume of blood. Delivery also depends on blood flow and haemoglobin concentration.

Deoxygenated does not mean oxygen-free: blood leaving tissues usually still carries oxygen. This lesson considers movement along one curve; changes in pH and the Bohr shift follow in Lesson 8.2.6.

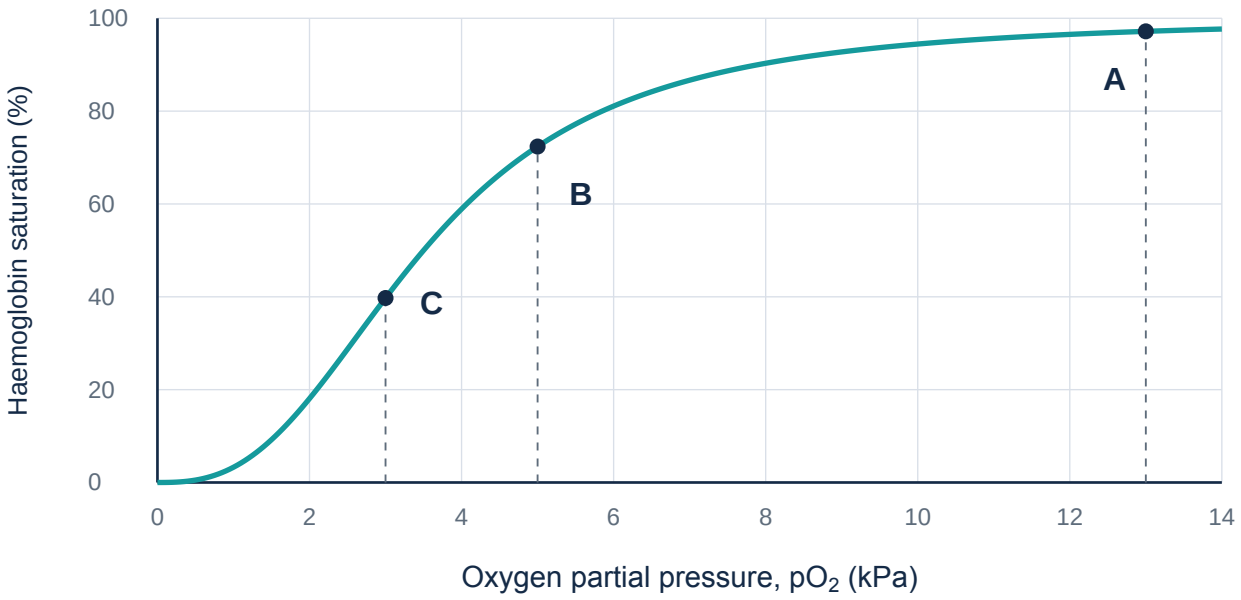
Tissue oxygen use and unloading: OpenStax Anatomy & Physiology 2e, section 22.5.
Steep region and oxygen supply: StatPearls, Oxyhemoglobin Dissociation Curve.

Scope: Cambridge Biology 9700 syllabus, section 8.2, outcome 5, p. 28.

Compare loading and release

Read haemoglobin saturation at the higher and lower oxygen partial pressures. Their difference shows the decrease in bound oxygen as a percentage of haemoglobin's full oxygen-binding capacity.

1. ONE CURVE, THREE ILLUSTRATIVE CONDITIONS



Illustrative Hill model, not patient data: exponent 2.7; half saturation at 3.5 kPa. pH and temperature are held fixed. Tissue examples represent blood equilibrating at lower pO_2.

2. READ THE THREE POINTS

A: lung loading	13 kPa	about 97%
B: tissue unloading	5 kPa	about 72%
C: greater unloading	3 kPa	about 40%

3. SUBTRACT SATURATIONS, NOT PRESSURES

A to B: 97 - 72 = 25 percentage points

A to C: 97 - 40 = 57 percentage points

These are percentages of full binding capacity, not percentages of the starting oxygen load or volumes of oxygen. Use the supplied curve when actual data are given.

Saturation, oxygen content and Hill model: Pittman, Regulation of Tissue Oxygenation, ch. 4.
Physiological interpretation: StatPearls, Oxyhemoglobin Dissociation Curve.

Scope: Cambridge Biology 9700 syllabus, section 8.2, outcome 5, p. 28.