Solutions

Each answer shows the steps, then the **result**.

2.1

(a)

- at high partial pressure of oxygen (in the lungs)

(b)

- at low partial pressure of oxygen (in respiring tissues)

2.2

- carbonic anhydrase

3.1 B

- Most CO_2 is carried as hydrogencarbonate ions

3.2 B

- Shifting right means lower affinity, so haemoglobin releases oxygen more readily

3.3

(a)

- $98 - 25 = 73\%$

(b)

- exercising muscle releases more CO_2, lowering pH; this shifts the curve right, so at the same pO_2 haemoglobin is less saturated and releases more oxygen; so more oxygen is delivered exactly where respiration is fastest

3.4

- as HCO_3^- leaves the red cell, chloride ions move in to keep the charge balanced inside the cell

3.5

(a)

- The curve is **S-shaped** (sigmoid). At low partial pressures it is hard for the first oxygen to bind, so the curve rises slowly; binding it changes the shape of the haemoglobin so that the remaining sites are more accessible, and the next molecules bind much more readily — the steep middle section — until the molecule saturates and the curve levels off

(b)

- The **Bohr shift**. Dissolved carbon dioxide forms carbonic acid, which dissociates and lowers the pH; the extra hydrogen ions bind to haemoglobin and change its shape, lowering its affinity for oxygen, so at any given oxygen partial pressure less oxygen is held

(c)

- Exercising muscle respires faster and releases more carbon dioxide; the curve shifts right in exactly those tissues; so haemoglobin unloads more oxygen precisely where the demand is greatest, while the lungs — with low carbon dioxide — still load it fully

(d)

- About 5% dissolves directly in the plasma; most, about 85%, is carried as **hydrogencarbonate ions** in the plasma; $CO_2 + H_2O \rightleftharpoons H_2CO_3 \rightleftharpoons H^+ + HCO_3^-$, catalysed inside the red cell by carbonic anhydrase