Solutions

Marking: **M1** a correct method, **A1** the correct answer, **B1** an independent mark.

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

2.1

amino-acid order: primary; α-helix: secondary

whole folded chain: tertiary

four chains together: quaternary

2.2

$15 \times 1.34 = \mathbf{20.1}$ mL/dL

$0.75 \times 20.1 \approx \mathbf{15.1}$ mL/dL

2.3

haemoglobin has four subunits that affect each other; myoglobin has one

each O_2 bound shifts haemoglobin from the low-affinity T state towards the high-affinity R state

so binding is slow at first, then steep: an S shape

2.4

a charged amino acid on the surface becomes hydrophobic

when O_2 is low, these patches stick haemoglobin molecules together into fibres that bend the cell

3.1

(a) capacity 20.1 mL/dL; rest: $20.1 \times 0.23 \approx \mathbf{4.6}$ mL/dL; exercise: $20.1 \times 0.73 \approx \mathbf{14.7}$ mL/dL

(b) working muscle makes more CO_2, acid and heat, which shift the curve right, so Hb releases more O_2 at the same pO_2

(c) 5 L = 50 dL; $50 \times 4.6 \approx \mathbf{230}$ mL O_2 per minute

3.2

(a) $9 \times 1.34 \times 0.98 \approx \mathbf{11.8}$ mL/dL, about 40% less than 19.7

(b) the heart pumps faster and more blood per beat; tissues take more O_2 from each dL, and red cells make more 2,3-BPG

(c) saturation is the share of Hb carrying O_2, not the amount of Hb

3.3

(a) $0.8 \times 20.1 \approx \mathbf{16.1}$ mL/dL

(b) the curve shifts left, so less O_2 is released in the tissues even from the Hb that still carries it

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(c) the clip measures light absorbed, and CO-haemoglobin looks almost the same red as oxyhaemoglobin

(d) give 100% oxygen at once, which pushes CO off Hb several times faster; fit CO alarms and service gas heaters