Question 31 (Answer: **B**)

- Haemoglobin releases oxygen more readily when carbon dioxide is high and pH is low – the Bohr effect.
- Intense exercise produces the most CO_2 and the lowest pH.
- So the row with pH 7.2 and the highest CO_2 partial pressure gives the greatest dissociation.

Question 33 (Answer: **A**)

- A lymphocyte is small with a very large round nucleus filling almost the whole cell.
- A monocyte is larger with a bean-shaped nucleus, and a neutrophil has a lobed nucleus.
- A red blood cell has no nucleus at all.

Question 34 (Answer: **A**)

- Respiring tissue releases CO_2, which forms carbonic acid in the blood.
- The acid dissociates and the protons bind to haemoglobin, changing its shape.
- That lowers its affinity for oxygen, shifting the curve to the right – the Bohr shift.

Question 32 (Answer: **C**)

- Needing a *higher* oxygen partial pressure for 50% saturation means the curve has shifted right.
- A right shift means haemoglobin's affinity for oxygen has decreased.
- Lower affinity means oxygen is released more readily to the tissues.

Question 33 (Answer: **A**)

- The Bohr shift is the effect of carbon dioxide, and so of pH, on haemoglobin.
- More CO_2 means a lower pH.
- That lowers haemoglobin's affinity for oxygen, so oxygen is released more readily where it is needed.

2(a)	*any **two** from:* (each haem contains) an, iron ion / ferrous ion / Fe^{2+} **;** **A** iron / iron atom (each haem) binds to / AW, an oxygen molecule / two oxygen atoms **;** **A** forms a bond *only if*, iron ion / ferrous ion / Fe^{2+}, stated

2(b)	*any **three** from:* less carbon dioxide diffuses into red blood cells **;** less carbon dioxide reacts with water **;** less carbonic acid is formed **;** less, dissociation of carbonic acid / formation of hydrogen ions and hydrogen carbonate ions **;** less haemoglobinic acid is formed **;** **A** description e.g. H^+ binds to haemoglobin less oxygen (released from haem) diffuses out of red blood cells (to respiring tissues) **;** *ref. to* carbaminohaemoglobin **;** AVP **;** e.g. *ref. to* change in shape of haemoglobin when H^+ binds
2(c)(i)	*idea that* blood vessel **X** carries (oxygenated blood) at high pressure (to body tissues) **;** **A** *ref. to* systemic circulation *any **two** from:* *difference* high proportion of elastic fibres (and low proportion of smooth muscle) **;** *explanation* (elastic fibres allow **X** to) expand / stretch, qualified **;** e.g. to accommodate / AW, blood from ventricular, systole / contraction with, surges / pulses, of blood leaving heart to prevent, bursting / rupture recoil of elastic fibres, detail **;** e.g.to allow surges / pulses, to continue *idea of* allowing continued flow of blood to tissues maintains, onward pressure / high pressure of blood *if no marks gained in this section allow one mark for:* *stretch and recoil with one detail* ***or*** *ref. to two correct details but stretch and recoil not stated*

2(c)(ii)	*allow, impulses / wave of excitation, for electrical impulses* **R** nerve impulses *once and allow **ecf*** *must attempt AVN <u>and</u> Purkyne tissue to gain max* *any **four** from:* both involved in, co-ordination / control, of, systole / contraction, of, heart / heart muscle / cardiac muscle / ventricles **;** *AVN* only pathway for impulses to travel from atria to ventricles **;** AW **A** impulses must pass through AVN for ventricular, contraction / systole allow, a delay **/** 0.1 s, for impulse to pass from atria to ventricles **;** so, ventricles contract after atria contract / ventricular systole occurs after atrial systole **;** allows atria to (fully) empty before, ventricles (begin to) contract / ventricular systole **or** allows blood to fill ventricles before ventricular, contraction / systole **;** *Purkyne tissue* carries / transmits / AW, impulse(s), (down septum), to base of ventricles / through walls of the ventricles **;** for ventricular systole / AW **;** ventricular muscles contract / AW, together / at same time / simultaneously / from the base upwards / from apex of heart **;**

6(a)	• *consider <u>all</u> mps to award if response clearly addresses events in the left side* ○ *mps 1,2,6,7,8 must be in the context of the left side of the heart* • *otherwise allow mp 3, 4, and 5 to max 3 – these mark points are inset to the right* *any **five** from:* **1** blood enters (heart) via / in, pulmonary vein(s) **;** **2** blood exits heart to aorta **;** **R** arota **3** blood flows from atrium to ventricle **;** **4** atrial, systole / contraction, then, ventricular, systole / contraction **;** **A** atrium contracts then ventricle contracts **5** pressure in ventricle, increases / gets higher **;** **I** high pressure unclear attempts / mixed right and left sides **6** bicuspid / (left) atrioventricular valve closes **;** **A** mitral valve **R** *if in context of events in the atrium* **7** semilunar / aortic, valve opens **; ecf** *from arota in mp 2* **R** *if in context of events in the atrium* **8** bicuspid / (left) atrioventricular, valve closes when (blood) pressure in ventricle higher than atrium **or** semilunar / aortic, valve opens when (blood) pressure in ventricle higher than aorta **;** **A** aortic valve
6(b)(i)	*if no marks gained allow one mark for four, polypeptides / polypeptide chains* two, (identical) alpha / α, chains / globins, <u>and</u> two, (identical) beta / β, chains / globins **;** **A** subunits / polypeptides, for chains **R** beta-pleated sheets / globulin *plus **one** from;* each, chain / globin / polypeptide, incorporates / contains / AW, a <u>haem (</u>group) **;** **A** four haem groups **A** molecule for polypeptide if mp1 gained **A** ferrous ion / Fe^{2+} / iron (ion / atom), within porphyrin (ring) for haem group **A** prosthetic group with, ferrous ion / Fe^{2+} / iron (ion / atom) hydrogen bonds / hydrophobic interactions / ionic bonds, between, chains / polypeptides / globins **;** *context is interactions between chains* **R** if disulfide bond also stated
6(b)(ii)	oxygen binds to, iron ion / ferrous ion / Fe^{2+} **;** **A** oxygen bonds / oxygen forms a bond, *only if*, iron ion / ferrous ion / Fe^{2+} stated **A** oxygen binds to, iron / iron atom / haem (group) **R** if more than one oxygen molecule binds to one iron ion detail of saturated **;** e.g. total of 4 oxygen molecules / 8 oxygen atoms (bind per haemoglobin molecule) each, chain / globin / polypeptide, binds one oxygen molecule **R** bonds *ref. to* cooperative binding / allostery **A** description *ref. to* (fully saturated molecule is) in, high partial pressures of oxygen / high concentration of oxygen **;** *ref. to* T / tense, state to, R / relaxed, state