The circulatory system

Mark Scheme 5

Level	International A Level
Subject	Biology
Exam Board	CIE
Topic	Transport in mammals
Sub Topic	The circulatory system
Booklet	Theory
Paper Type	Mark Scheme 5

Time Allowed : **60 minutes**

Score : **/ 50**

Percentage : **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 **(a** enzyme **A** uses 'lock and key' **and** enzyme **B** uses induced fit **;**
A enzymes work by 'lock and key' and induced fit
enzyme **A** / lock and key, (shape of) active site is complementary / AW, to (shape of) substrate (molecule) **;**
enzyme **B** / induced fit, has an active site that, moulds around / AW, the substrate **;** [3]

(b) (i) 1 **P** is β-pleated sheet, **Q** is α-helix **;**
accept if P and Q are identified by a description

2 determined by, coiling / folding / sequence, of amino acids / polypeptide **;**
A primary structure for sequence of amino acids

3 stabilised / held / AW, by hydrogen bonds **;**

4 between C = O and H–N (of peptide bonds) **;**
A carbonyl / carboxyl group, and, amine / amino group

5 ref to, parallel / anti-parallel, nature of β-pleated sheet **;** [max 3]

(ii) 1 catalyses reaction between carbon dioxide and water to form carbonic acid **;**
A correct, formulae / equation

2 very fast reaction **;**

3 in (cytoplasm of) red blood cell / erythrocyte **;**

4 (so there are) hydrogen ions / protons, and hydrogencarbonate ions **;**

5 hydrogen ions promotes oxyhaemoglobin dissociation / AW **;**
e.g. reduces affinity of haemoglobin for oxygen / (oxy)haemoglobin gives up oxygen more readily

6 increases supply of oxygen to (respiring) tissues **;**

7 carbon dioxide is transported as hydrogencarbonate ions **;**

8 in the plasma **; A** carbon dioxide diffuses from red blood cell to plasma

9 AVP **;** e.g.
carbonic anhydrase catalyses reverse reaction in the lungs
ref to hydrogencarbonate ions as buffer in plasma (as a consequence of reaction)
R buffering action of haemoglobin in red blood cells [max 4]

[Total: 10]

2 **(a) (i)** **A –** endothelial / squamous / epithelial (cell) **;**
B – nucleus **;** [2]

(ii) 7 (μm) **;;**
award two marks if correct answer given
award one mark if not rounded to nearest whole number
award one mark if given incorrect unit
if no answer given, award one mark if correct measurement (38–41 / 3.8–4.1 / 38000–41000) is divided by 5700 [2]

(iii) *for two marks - one structure and one function*
only two functions = 1 mark
only two structures = 1 mark

1 (capillary) <u>wall</u> is, thin / single layer of cells / one cell thick **;**
A endothelium / epithelium for wall
2 short <u>diffusion</u>, pathway / distance / AW **;**
R 'easy' diffusion
3 (many have) endothelial pores / fenestrations / gaps / spaces / openings **;**
4 to allow named, substance / cell, to leave the blood **;**
A *idea* of separation / selection, of named substance(s) by size
5 small diameter / small lumen / diameter of red blood cells **;**
6 slows down flow of red blood cells / (capillary / blood) close to cells **;**
7 (capillaries have) large, surface area / surface area to volume ratio **;**
8 *idea that* allows more exchange **;**
Ignore faster exchange [max 2]

(b) *white blood cells*
1 (named) white blood cells can, leave capillaries / enter tissue fluid **;**
A diapedesis / (suggestion that some) too large to leave the, blood / capillaries
2 high number in, lymph nodes / thymus / bone marrow / spleen **;**
A stored / produced

g*lucose*
3 small (molecule) **;**
4 filtered / diffuses / leaves / leaks, from blood / from capillaries / into tissue fluid **;**
5 taken up / used, by cells in respiration **;**
Ignore supply

p*rotein*
6 too large to, leave capillaries / enter lymph / enter tissue fluid **;**
7 (in lymph / tissue fluid) antibodies / proteins, from / secreted by, lymphocytes / other cells **;** [max 5]

(c) *accept hydrogen carbonate (ions) / bicarbonate (ions) / HCO_3^- penalise HCO_3 once only*

1 carbon dioxide, reacts / combines, with (terminal amine / **N** terminal, of) haemoglobin **;**
R carried by / reacts with, haem

2 to form carbamino<u></u>haemoglobin **;**

3 carbonic anhydrase catalyses, formation of carbonic acid (H_2CO_3) / reverse reaction described (in the lungs) **;**

4 (carbonic acid dissociates to) HCO_3^- / CHO_3^- / hydrogen carbonate (and H^+) **;**

5 hydrogen carbonate / HCO_3^-, diffuses / moves / AW, out (into plasma) **;** [max 3]

[Total: 14]

3 **(a)** **(i)** haem; R. incorrect spelling
combines/binds with/carries/holds/takes up/transports oxygen; **2**

(ii) soluble/polar/hydrophilic (on outside)/compact/spherical/curled/coiled/folded (into a ball)/metabolically active;
4 polypeptides; **2**

(b) iron needed for haem/haem contains iron;
less haemoglobin (made); R. less RBCs
less oxygen transported/supplied/delivered (to cells/tissues);
less respiration/respiration rate decreased;
R.respiration less efficient/effective **max 3**

(c) muscle; A. cardiac/skeletal/involuntary muscle **1**
R. named muscle, e.g. biceps musc

(d) 90%;
25%; A. within range 23-25% R. 23-26%, 22-25%
(N.B. Both % need to be correct for one mark) **1**

(ii) haemoglobin unloads/releases oxygen/dissociates,
easily/readily/at higher ppO_2 (in tissues/cells);
(whilst) myoglobin holds on to oxygen/is very stable/does not dissociate easily/has a higher affinity for oxygen;
(so) providing a store/reservoir/reserve of oxygen;
(so will not) release oxygen until the pp/conc./tension of oxygen is low/during strenuous exercise;
so delaying anaerobic respiration; **max 3**

(e) S-shaped curve to the right of **H**;
(N.B. curve should be S-shaped, start at 0, plateau out at between 90-98% saturation, show 50% plus saturation at pp of 6kpa) **1**

[Total 13]

4 **(a** 1.4 mm ; ;
two marks for the correct answer
A 1.3 / 1.34 / 1.37 / 1.43 / 1.46 / 1.5

tolerance on measurement of 49 mm = ± 2 mm (i.e. 47 to 51 mm)

if answer not given or incorrect allow one mark for correct measurement and correct use of formula (measurement divided by the magnification of 35 ***or*** *showing the rearranged formula)* [2]

(b) 1 large / wide, lumen (relative to thickness of wall) ;
A artery narrow lumen

2 irregular shape ; AW
A flattened / oval / not round(ed) (shape) ;
A artery, round(ed) / regular (shape)
I ref. to (vein) not spherical / artery spherical

3 thin / AW, tunica media / middle layer / (smooth) muscle and elastic layer
or
(proportionately) less, elastic / (smooth) muscle, in, tunica media / middle layer ;

4 (relatively) thin, tunica externa / tunica adventicia / outer layer / fibrous coat / fibrous layer ;
R small(er)

5 tunica intima / tunica interna / inner layer / endothelium, smooth / not 'crinkly' / not wavy / AW ;

alt *if mp 3 not awarded, award 1 mark only for*
thin (smooth) muscle layer / less (smooth) muscle
thin elastic layer / less elastic tissue [max 3]

(c) **(i)** short distance for diffusion (of molecules / ions / named) ;
A reduced distance / thin / short pathway / AW

increased rate / AW, of diffusion (of molecules / ions / named) ;
A fast(er) / (more) efficient
I easy / better [max 1]

(ii) 1 small size allows contact with (many body) cells / AW ;
A *idea of* extending into small spaces

2 red blood cell, close to, (body) cells / tissue for (efficient), diffusion / AW ;
A in contact with / close to, capillary wall / endothelium, for diffusion

3 red blood cells / blood flow, slow(s) down / *idea of* more time,
for (efficient) diffusion / cells to obtain sufficient nutrients / AW ;
treat ref. to lower pressure as neutral

4 (plasma / blood, containing), glucose / nutrients / named nutrient / oxygen,
close to / AW, body cells ; [max 1]

(d) (i) *(produce genetically identical daughter epithelial cells for)*

1 (for tissue) repair ;
R cell repair

2 *idea of* replacing, dead / destroyed / damaged / worn-out / AW, cells ;
A replacement of cells, unqualified *if mp 1 gained*

3 ref. protection of, underlying tissue / muscle and elastic layer / tunica media / AW ;

4 meiosis produces, haploid cells / cells with n chromosomes / cells with one set of chromosomes ;
A cells with half the number of chromosomes

5 meiosis for gamete formation ;
A sex cells
R meiosis in gametes [max 2]

(ii) *ignore ref. to 23/46 chromosomes*

(mitosis to), maintain genetic stability / produce genetically identical cells / produce clones ora
or
meiosis produces genetically different cells ;

(mitosis), ensures cells retain function / cells function as tissue / AW ;
(mitosis) maintains chromosome number ;
A maintains, diploid number / 2n
meiosis produces, haploid cells / cells with n chromosomes / cells with one
A cells with half the number of chromosomes
meiosis for gamete formation ;
A sex cells
R meiosis in gametes [max 2]

(e) *ignore labels*
max 1 if nuclear, membrane / envelope, shown
no marks if chromosomes with two chromatids drawn

1 four separate, chromatids / daughter chromosomes, shown in each half ;

2 all centromeres leading
A 'V' shapes if centromere not obvious *(point of V towards pole)*
or
all centromeres attached to spindle fibres ; [2]

[Total: 13]