The circulatory system

Mark Scheme 3

Level	International A Level
Subject	Biology
Exam Board	CIE
Topic	Transport in mammals
Sub Topic	The circulatory system
Booklet	Theory
Paper Type	Mark Scheme 3

Time Allowed : **62 minutes**

Score : **/ 51**

Percentage : **/100**

Grade Boundaries:

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

Question		Expected Answers	Marks
1	**(a)**	4 polypeptides/4 globins/4 amino acid chains; outwardly pointing hydrophilic (R) groups, maintain solubility/AW; each with a haem group; ref to iron/Fe^{2+} (ion); **R** Fe^{3+}/iron atom temporary attachment to oxygen; **A** readily attaches/binds combines with **R** oxygen binds to haem 4 molecules of oxygen; **A** 4 O_2/8 oxygen atoms **R** 4 oxygens unqualified oxyhaemoglobin; **A** HbO_8 ref to cooperative binding;	**[max 4]**
	(b)	part of the circulation partial pressure of oxygen/kPa % saturation of haemoglobin capillaries in the lungs accept answers between 12 and 14; capillaries in muscle tissue at rest 5; capillaries in muscle tissue during strenuous exercise 20;	**[3]**
	(c)	carbon dioxide reacts with water to form carbonic acid; catalysed by carbonic anhydrase; dissociates to hydrogen carbonate and hydrogen ions; hydrogen ions combine with haemoglobin; **R** hydrogen ions replace oxygen in haemoglobin forms haemoglobinic acid/HHb; so releasing oxygen; ignore ref to Bohr shift (question says 'explain') **A** from equations.	**[max 3]**
			[Total: 10]

Question	Expected Answers	Marks

2 **(a)** one mark per row, do not penalise where crosses are omitted

Statement	plasma	tissue fluid	lymph	cytoplasm of red blood cells
contains haemoglobin	×	×	×	✓
contains water	✓	✓	✓	✓
contains antibodies	✓	✓	✓	×
in direct contact with muscle cells	×	✓	×	×

[4]

(b) increases heart rate;

increases blood pressure;

constricts, arterioles/arteries; **A** narrows diameter/lumen **R** ref to blood vessels

reduces blood flow to, periphery/hands/fingers/AW;

increases 'stickiness' of platelets; **R** blood cells

ref to atheroma, plaque, atherosclerosis, cardiovascular disease, damage to endothelium;

Generally, mark 1st 2 sentences (look for full stops!). However if 2 correct points in 1st sentence allow this. **[max 2]**

(c) mark two parts together

(in every country) the death rate for men is higher than that for women; **R** ref to % of death

in some countries where many people smoke there are low death rates from lung cancer;

data quote to support either part;

Here we need to be very precise! We can accept male or female data quoted in the correct context. R any 'ADDITIVE %s'!/incorrect units. **[max 3]**

(d) age;

how long men have been smoking/age at which start smoking;

how many cigarettes are smoked per day; **A** heavy/light smokers

any 2 risk factors that are linked with lung cancer;;

e.g. Hereditary/running in familie

working environment (pollution/passive smoking/exposure to other carcinogens/radiation);

type of cigarette(tar levels/cigars/cigarettes smoked/brand of cigarette/whether filtered/unfiltered);

depth of inhalation;

R refs to diet/alcohol/lifestyle/stress. **[max 2]**

[Total: 11]

3 **(a** blood is in vessels / blood is in heart, arteries, veins, capillaries **;**
any three

pulmonary and systemic circulations / described
or
blood passes through heart twice for one circuit round the body / **AW ;** [2]

(b) **1** globular (shape) **; A** rounded / spherical **R** circular

2 hydrophilic, amino acids / R-groups, face cytosol
or
hydrophobic, amino acids / R-groups, to the interior **; AW**

3 (so) soluble **or** dissolved in cytoplasm / cytosol **;**

4 *ref. to* haem / prosthetic (group) / porphyrin (ring) / Fe^{2+} / ferrous ion / iron (ion), binding oxygen **; R** forms bonds with

5 four polypeptides / haems / **AW**, so 4 oxygen molecules / 8 oxygen atoms **;**
A four polypeptides, each carrying an oxygen molecule / O_2

6 cooperative binding / allostery / described **;**

7 **AVP ;** e.g. tertiary structure allows association of prosthetic group [max 4]

(c) 13–15% **;;**

one mark for correct data extraction
96 / 97% at sea level and 82 / 83% at altitude [2]

(d) **1** more haemoglobin (molecules) / Hb **;**

2 *idea of* compensation **;** e.g. for decreased saturation of haemoglobin as less oxygen available so more can be taken up / transported so tissues receive same / sufficient concentration of oxygen [2]

(e) **1** reduces (rate of enzyme activity) **;**

2 binds at a site on the enzyme other than at the active site / allosteric site **;**

3 change in tertiary structure **;**

4 change in shape / conformation / configuration of active site **;**

5 substrate unable to bind / product unable to form / ES complexes do not form / fewer ESC **;**

6 **AVP ;** e.g. V_{max} not reached / increasing substrate concentration no effect [max 3]

(f) *accept Hb for haemoglobin throughout*

1 carbon monoxide binds to Hb / Hb has higher affinity for CO than O_2 **;**
A carboxyhaemoglobin forms (heavy smoker)

2 (with CO) Hb reaches lower % saturation / lower percentage saturation (after 3.6–, 4.0–4.2 kPa) **;**
A correct figures quoted
R lower saturation at <u>all</u> partial pressures of oxygen

3 less oxygen taken up, in lungs / at higher partial pressures
or
reduces the volume of oxygen transported **; AW**

4 below 3.6–4.2 kPa (with CO), curve shifts to left / Hb has (relatively) higher saturation **;**

5 less oxygen unloaded at lower partial pressures / in tissues **;**

6 heart rate increases to deliver sufficient oxygen **;**

7 *ref. to* insufficient oxygen to heart muscle and effect on people with CHD **;** [max 3]

[Total: 16]

4 **(a)** **(i)** working **;** e.g. 1st oestrogen peak at day 13, 2nd peak at day 41 / looked at two peaks and calculated number of days in between

28 **;** [2]

(ii) began: day 13 or14 **;**

ended: day 29 or 30 **;** [2]

(iii) (anterior) pituitary (gland) **; R** posterior pituitary [1]

(iv) 1. stimulates follicle **;**

2. to secrete oestrogen **;**

3. surge in LH secreti **;**

4. stimulates ovulation **;**

5. ref. development of corpus luteum / stimulates corpus luteu **;**

6. to secrete progesterone **;** [max 3]

(b) **(i)** 1. ref. reliability **;**

2. ref. to irregularity of cycle **;**

3. *idea that* cannot be sure about menstrual phase on day 22 **;**

4. *idea that* using hormones alone might not identify day of cycle precisely enough **;** [max 2]

(ii) 1. (yes because) oestrogen concentration high on day 22 and low on day 2 ;

2. (but) shows correlation but not necessarily, linked / causal effec ;

3. concentration of progesterone could be affecting performanc ;

4. (progesterone concentration) high at 22 days and low on day ;

5. not LH as concentration low on both day ;

6. ref. to small numbers in investigation / more evidence neede ;

7. ref. to use of statistics to determine if difference in results is significan ; [max 4]

[Total: 14]