1. (blood flows) twice through the heart / AW**;**
for one circuit / cycle (of the whole body) / AW**; A** *for one heart beat*
ref pulmonary and systemic systems / to lungs and to (rest of) body**;**
R *systematic* max 2

[2]

2. (i) **D** right atrium
E right ventricle
F left ventricle 3

(ii) provides more, force / pressure, to pump blood around body**;**
longer distance compared with distance right ventricle has to pump blood**;**
or right atrium**;**
AVP**;** e.g. detail of pulmonary circulation

accept letters D, E and F if used in place of names of chambers of heart max 3

[6]

3. iron / Fe**;**
four / 4**;**
Bohr, effect / shift**;**
carbonic anhydrase**;**
haemoglobinic acid**; A** *reduced haemoglobin* **A** *HHb*

[5]

4. (a) (i) 5:1; 1

(ii) 7 [× smaller]/AW; 1

(b) 0.5; 1

(c) surface area relative to volume too small/AW;
diffusion too slow/AW; *idea of speed needed*
distance too great/some cells deep in body/not all cells in contact with environment/AW; **R** *large if unqualified*
insufficient/AW, oxygen/(named) nutrient, supplied/(named) waste removed;
idea of linking (named) areas; *look for 'from…' 'to…' with an implication of organs, not just 'all over body'*
(may be,) more (metabolically) active/AW/, homoiothermic;
R *just 'need more energy'* 3 max

[6]

5. **H**;
C/**G**; **A** *either or both*
E;
I;
D;
F; 6

[6]

6. **J** *name* neutrophil/phagocyte;
A *polymorph/granulocyte/eosinophil*
R *monocyte/macrophage/basophile*

function phagocytosis/engulfing/AW;

K *name* lymphocyte/agranulocyte;
A *any named lymphocyte, plus correct role*

function produce/release, antibodies;

error carried forward
if white cells wrongly named, credit function related to given cell
if no names given – credit correct functions for J/K
*if **erythrocyte** given, score **0*** 4

[4]

7. 1 haemoglobin/haem, carries oxygen/AW;

2 detail of no. of oxygen molecules carried;

3 small size/large SA:V ratio, so haemoglobin never far from cell surface/AW;

4 flexible/elastic/stretchy/changes shape/AW;

5 small size/'stretchiness'/AW, allows red cells to, fit/squeeze, into capillaries;

6 biconcave/AW [**A** '*dimpled*'], gives, increased/AW, surface area relative to volume (for diffusion);

7 no nucleus to maximise room for, haemoglobin/oxygen/AW;

8 contain carbonic anhydrase;

9 describe, the reaction catalysed by carbonic anhydrase/role in maintenance of diffusion gradient/AW;

10 transport of carbon dioxide as carbamino-haemoglobin/CO_2 combines with Hb;

11 ref buffering effect;

12 AVP; e.g. further detail of oxygen carriage
variable oxidation state of Fe
idea that small size allows them to be close to tissue or cells
lack of, other/named, named organelles, also increases room for Hb/O_2 max 6

QWC – legible text with accurate spelling, punctuation and grammar; 1

[7]

8. (i) coronary**;** 1

(ii) high concentration of, cholesterol / LDL, in blood;
endothelium / lining damaged;
deposition (fat / cholesterol) in wall of artery**; R** "on artery"
ref to plaque / atherosclerosis / atheroma; max 2

[3]

9. (i) ref to suitable drug; e.g. anticlotting, blood pressure reducing, diuretic
bypass operation**;**
stents fitted**;**
angioplasty / balloon on catheter**;**
AVP**;** e.g. name of drug
extra detail about a named drug or one of above procedures max 2

(ii) avoid, saturated / animal, fats**; A** cholesterol
eat, unsaturated fats / polyunsaturated fats / plant oils / fish oils;
qualified ref to, more / regular, exercise**;**
avoid smoking**;**
avoid stress**;**
eat more, fruit / vegetables / antioxidants; **A** moderate intake of red wine
reduce weight;
reduce alcohol intake;
eat more soluble fibre;
ref to vitamin D production / exposure to sunlight; max 2

[4]

10. (a) the heart / ventricle / cardiac muscle (involved);
peaks coincides, with, systole / contraction**; R** pump
troughs coincide, with, diastole / relaxation / AW**;**
stretch-recoil effect / AW;
must *link to rise / fall not just a general statement* 2 max

(b) distance (from heart) qualified, e.g. further / around the body / AW**;**
friction / resistance to flow / AW**;**
less / no, stretch-recoil effect / AW**;**
increasing volume of, arterioles / capillaries**;**

A surface area of capillaries / large capillary bed / many capillaries / branching

R large SA:V ratio 3 max

(c) stop damage (to capillaries)**;**
A stop bursting **R '**can't cope' **A '**can't withstand'
lack of (much) elasticity / thin / delicate / fine / one cell thick /
no collagen / no muscle**;** *ora* for artery wall
slows flow rate**;**
allows time (for)**;**
exchange / AW**; A** one named substance moved, but **R** "food"
oedema risk reduced / high pressure might force out more tissue fluid**;** 2 max

(d) valves prevent backflow / AW**;**
action of (skeletal) muscle**; R** if muscle in vein wall implied
residual pressure / AW**;**
large lumen provides little resistance / AW**;**
negative pressure in, chest / thorax / heart**; A** respiratory pump
gravity effect (from areas above heart)**;** 2 max

[9]

11. (a) **F** = sinoatrial node / SAN / pacemaker**;**
G = pulmonary vein**;** 2

(b) (i) atrium / **X**, (only) has to pump, to ventricles / short distance**;**
ora for ventricles **A** ref to gravity effect / negative ventricle pressure

left ventricle / **Y**, has to pump to, body / systemic circulation, and,
right ventricle / **Z**, has to pump, to, lungs / pulmonary system**;**

comparison of Y and Z

left ventricle / **Y**, pumps, further / great(er) pressure**;**
ora right ventricle / **Z A** to all / whole body *idea* as distance

left ventricle / **Y**, pumps against great(er) resistance**;**
ora right ventricle / **Z** 3 max

(ii) (Purkyne fibres) conduct wave of excitation / AW**;**

R *impulse, signal, pulse*
to the, base / apex, of heart**;**
so contraction occurs upwards / AW**;**
both <u>ventricles</u> contract together**;**

ora for answers written in terms of what does not happen 2 max

(c) blood passes to left atrium / deoxygenated and oxygenated blood mixes in <u>atria</u>**; R** 'between atria' – must imply direction in first alternative

not the reverse (due to flap)**;**
(so) blood, in left ventricle / aorta, not fully oxygenated / AW**;**
deoxygenated blood / less oxygen, delivered to brain;
A carbon dioxide build up in brain
reduced (aerobic) respiration in brain / anaerobic respiration**;**
R *no respiration*
(possible link with), lactic acid / lactate, build up**; R** *waste*
oxygen shortage in brain (might) lead to raised blood pressure (causing migraines) / AW**;**
AVP; e.g. ref to oxygen debt 3 max

[10]

12. (a) 78%**; A** 79% 1

(b) (i) **1** fetus gains oxygen, from mother / across placenta**;**

2 partial pressure of oxygen in placenta low**;**

3 2-5 kPa**; A** any figure within range

4 maternal (oxy)<u>haemoglobin</u> releases oxygen**;**
R if stealing / taking oxygen from mother is given

5 fetal <u>haemoglobin</u> has a high(er) affinity for oxygen**;**
A binds more strongly

6 maintains a diffusion gradient / AW**;** *max 4*

(ii) *accept answers written in terms of adult haemoglobin*

7 oxygen would not be released readily enough / AW**;**

8 (because) affinity of fetal haemoglobin would be, too / very / so, high**;**
***only accept** higher/high if linked to oxygen release*

9 ref to idea that adult (females) will need difference with their fetuses in due course**;** 5 max

[6]

13. carbonic anhydrase**;**
carbonic acid / H_2CO_3;
hydrogencarbonate / HCO_3; **A** bicarbonate
haemoglobinic acid**; A** HHb
oxygen / O_2; 5

[5]

14. (a) (i) 6:1**;;**
working. 3.14 divided by 0.52 2

(ii) ratio for B is smaller / decreased / AW**;** *ora*
by two thirds / AW**;**
volume increases more rapidly than area / AW**;** *ora*

ecf if wrong calculation in (a) (i) 2 max

(b) *answers must relate to developing a transport system*

diffusion not adequate / AW / *ora***;**
as not enough area (relative to volume)**;** *ora*
distance too great / cells deep in body / AW**;** *ora* , **R** large unqualified
mass flow system needed**;**
transport / blood (vascular), systems, link, the parts of the body / named parts**;**
e.g. of substance needing to be transported**; R** 'gases' / 'waste' / 'food'
ref to activity / high metabolic rate, of mammals**;** 3 max

(c) alveoli
lung
villi
gut
small intestine **A** intestine
capillary bed / capillaries / AW
skin qualified e.g. elephant's ears
cerebral cortex / brain
kidney (tubule)
liver
AVP**;** 1

[8]

15. **C;**
B;
G;
G;
C / **D; A** *if both put down*
B / **C; A** *if both put down* 6

[6]

16. cardiac**;**
myogenic**;**
sinoatrial node / SAN**; A** pacemaker
stop / prevent / AW**; R** delay
atrio-ventricular node / AVN**;**
bundle of His / Purkyne fibres *or* tissue**;** 6

[6]

17. contractions / heart, not coordinated / irregular / AW**;**
less / no blood, leaves heart / goes to lungs / goes to body**;**
cells / (named) tissue(s) / (named) organ(s) / heart muscle, deprived of oxygen**;**
ref to pressure**;**
AVP**;** e.g. ref to lack of P/R/T on ECG 2 max

[2]

18. (a) (i) Bohr**;** 1

(ii) (steep part) corresponds to pO_2 in, tissues / cells / organs**;**
cells / tissues / organs, need (much) oxygen**;**
change / drop, in pO_2 gives, large change / drop in saturation (of haemoglobin) / much release of oxygen / AW**;**
R refs to increase in pO_2
data from diagram to support**;** 2 max

(iii) ref to (more), H ions / carbonic acid**; A** formula
(forms) haemoglobinic acid**; A** HHb
(haemoglobin), releases more oxygen / has lower affinity for oxygen / has lower saturation of oxygen**;**
at a certain partial pressure of oxygen**;**
data from diagram to support**;** *must be comparative*
AVP**;** e.g. ref to effect of CO_2 on, brain / heart, related to oxygen delivery 2 max

(b) more heat (in exercising muscle) / increase in body temperature / AW**;**
(as) respiration releases some energy as heat / AW**;**
ATP to ADP releases some energy as heat / AW**;**
(muscle) temperature rises, above normal body temperature / to 45 °C**;**
(so) more oxygen release (from haemoglobin / RBCs) / AW**;** 2 max

[7]

19. (a) *award two marks if correct answer (7) is given*
incorrect answer (or no answer) but correct working = 1 mark

7**;;**
max 1 if not to nearest whole number **R** answers in cm

calculation mark for showing division by 12 2

(b) **1** ref to tunica, intima / interna, tunica media and tunica, externa / adventitia**;**

2 thick wall, stops bursting / withstands pressure idea**;**

3 (relatively) narrow lumen to maintain pressure**;**

4 elastic tissue / AW, allowing stretching / AW**;**

5 elastic arteries near heart**;**

6 elastic recoil**;**

7 to even out surges of pressure / to maintain flow / AW**;**
A push idea

8 collagen provides (main) strength / AW**;**

9 (smooth) endothelium (of tunica intima) to reduce friction / AW**;**
A epithelium *or* lumen lining / AW **R** epidermis

10 tunica media / AW, has (smooth) muscle and elastic tissue**;**
collagen is ***neutral***

11 to prevent bursting / withstands pressure / AW**;**
look for link to tunica media

12 (smooth) muscle maintaining pressure**;**
A ref vasoconstriction / 'blood shunts'
R pumping action

13 AVP**;** e.g. idea that circular cross section allows max blood volume for minimum wall contact / AW 6 max

QWC – clear, well organised using specialist terms; 1

award QWC mark if three of the following are used
tunica (qualified once)
lumen
elastic / elastin
collagen
recoil
smooth muscle
endothelium
vasoconstriction

[9]

20. (a) (i) 4

	blood in aorta	tissue fluid	lymph	blood in vena cava
red blood cells		none**;**		
white blood cells	many / high **;** **R** *some*			
glucose concentration			low**;** **A** *none / some*	
pressure				low**;**

(ii) *glucose*

carried / transported, in the blood**;**
passes through capillary walls to tissue fluid / AW**;**
used up / stored, in tissues / AW (so little in lymph)**;**
ref, respiration / glycogen**;**
high in vena cava as (absorbed) from gut / sent from liver / AW**;** 3 max

pressure

high in aorta as comes from, heart / ventricles / AW**;**
increased, resistance / friction / AW, (causes drop)**;**
increased volume of capillary bed / AW, (causes drop)**;**
lost during formation of tissue fluid / AW**;**
low in, lymph / vena cava as, no mechanism for raising it / long distance from heart**;**
R 'low in veins as it is returning to the heart' 3 max

4 max

(b) carbon dioxide (diffuses) into red blood cells**;** **R** blood only
carbonic anhydrase**;**
carbon dioxide reacts with water**;**
to form, carbonic acid / H_2CO_3 / HCO_3^-**;**
R *if linked with incorrect reaction*
carbonic acid, dissociates / AW, to give HCO_3^-**;**

accept from equations $CO_2 + H_2O \rightarrow H_2CO_3$
$H_2CO_3 \rightarrow H^+ + HCO_3^-$ 3 max

[11]

21. (i) **T** = coronary, artery / arteries**;**
U = right ventricle**;** **A** cardiac muscle 2

(ii) oxygen / glucose, will not reach, (heart / cardiac) muscle**;** **A** less

reduced / no, respiration**;**

(possible) coronary / heart attack / myocardial infarction / (possible) death**;**
A fibrillation / irregular beat / AW 2 max

[4]

22. (i) blood enclosed in vessels / AW**;** 1

(ii) ventricles not separated / one ventricle / partial or no septum /
three chambers / left and right sides not separated**;** *ora* for mammal
single vessel from heart**;** *ora* for mammal **A** aorta
oxygenated and deoxygenated blood not (fully) separated**;**
ora for mammal
blood passes twice through heart for complete circulation /
systemic and pulmonary systems / to lungs and body**;**
If only one animal described max 2 3 max

(iii) blood will not be fully oxygenated / Hb less fully saturated /
deoxygenated and oxygenated blood mixed / AW**;**
still carrying carbon dioxide**;**
lower pressure *or* less, force / push / AW**;** 2 max

[6]

23. (a)

lugworm curve	*human curve*
steeper ;	shallow / gentle / sigmoid ;
higher saturation at, low / same pp oxygen ;	
has max (saturation) at 2 kPa ;	max at 13.5 - 14 kPa ;
reaches 100% (saturation) ;	(only) reaches 98% ;
	(max 1 of above differences)

lugworm haemoglobin has a high affinity for oxygen ;
low oxygen in, lugworm habitat / water / ora ;
lugworm haemoglobin, stores oxygen / only releases oxygen when pp O_2 very low ;
two haemoglobins have different, structures / amino acid sequences ; 2 max

(b)

differences (max 5)

D1 ref to lugworm gills **and** mammal, alveoli / lungs ;
D2 ref to internal **and** external, exchange surfaces ;
D3 less oxygen in, water / sand ; **A** ora
D4 lugworm haemoglobin adapted to, water / sand/ low O_2 environment ; **A** ora
D5 lugworm has no red blood cells / ora ;
D6 detail of mammalian red blood cells ;
D7 lung ventilation tidal / lugworm, throughflow / unidirectional / AW ;
D8 AVP ; e.g. ref. water loss from lungs

similarities (max 5)

S1 **both** (gas exchange surfaces have) large surface area ;
S2 **both**, thin / have short diffusion distance ;
S3 **both** well-vascularised ;
S4 **both** moist ;
S5 ref to diffusion of, oxygen / carbon dioxide / gases ;
S6 (blood carries) oxygen to tissues ;
S7 haemoglobin transports oxygen ;
S8 **both** move medium over gas exchange surface ;
S9 AVP ; 7 max

QWC – legible text with accurate spelling, punctuation and grammar ; 1

[10]

24. iron / Fe**; A** Fe^{++}
four / 4**;**
Bohr, effect / shift**;**
carbonic anhydrase**;**
haemoglobinic acid**; A** reduced haemoglobin **A** HHb 5

[5]

25. (i) (blood flows) twice through the heart / AW**;**
for one circuit / cycle (of the whole body) / AW**; A** for one heart beat
ref pulmonary **and** systemic systems / to lungs **and** to (rest of) body**;**
R systematic 2 max

(ii) *read whole answer and look for any two linked ideas from*
- *size*
- *activity*
- *SA:V ratio*

ora if answered in terms of Paramecium

size
(mammals) larger / AW**;**
cells deep in the body**;**
regions requiring materials separated by a distance / need to get materials to all parts / AW**;**

diffusion too slow / AW**;**

activity
(mammals) more (metabolically) active / AW**;**
need more materials / more rapid supply / more removal of wastes**;**

SA:V ratio
(mammals) surface area:volume ratio reduced / AW**;**
diffusion alone not effective / AW**;** *must be linked to SA:V* max 4

[6]

26. *look at and credit any annotations on diagram*
if sequence gets lost do not award the marking points that follow and are directly linked, but give any general ones

1 atrial systole / atria contract**;**

2 blood passes into ventricles**;**

3 veins / blood vessels, entering heart closed / AW**;**

4 atrioventricular / alternative names, valves open**;**

5 ventricular systole / ventricles contract**;**

6 blood to, the arteries / named arteries**;**

7 (via) open, semilunar / AW, valves**;**

8 atrioventricular valves shut to stop backflow**;**

9 relaxation / diastole, of ventricles (and atria)**;**

10 semilunar / AW, valves shut to stop backflow**;**
may be mentioned at X – only credit once

11 ref to **X**,**Y** and **Z;** **X** = 1-4 **Y** = 5-8 **Z** = 9-10 6 max

QWC – legible text with accurate spelling, punctuation and grammar; 1

[7]

27. (a) (i) *award two marks if correct answer (15) is given*

15**;;** ignore signs

if answer incorrect give one mark for indication that 15.5 ***and*** *0.5 read off graph*
if 15 obtained by wrong calculation = 1 2

(ii) qualified ref to distance from heart e.g. further**;**
friction / resistance (to flow)**;**
ref to increasing volume of e.g. capillaries**;**
A surface area of capillaries
idea of dissipation of energy in elastic recoil**;** 2 max

(iii) stop damage to, capillaries / arterioles / AW**;** **A** stops bursting
ref to, lack of (much) elasticity in these vessels / thin walls / AW**;**
ora for nature of artery wall
max one mark if only veins mentioned
slows flow rate**;**
to allow (time for) exchange**;** 2 max

(b) (i) C**;** **R** more than one letter i.e. a 'list' 1

(ii) *feature and role must match. Correct features are stand alone marks. Look at the given role to see if it informs the feature.*

thin wall / single cell layer / AW**;** **R** membrane / thin cell wall
A *statement which gives one cell thick, treating thin cell wall as neutral in this case*
short pathway / ease of access to tissue fluid AW, rapid / easy, diffusion**;**

smooth, (inner) surface / endothelium**;** **A** epithelium
R refs to smooth muscle
reduced friction / smooth flow / reduced turbulence / reduced resistance / AW**;**

(small) gaps / pres / holes, between endothelial cells / in wall / AW**;**
allows nutrients / named nutrients / fluid / AW, out, / (most) cells / proteins cannot pass**;**
R refs to plasma **A** refs to, phagocytes / AW, passing

narrow / small (diameter) / figure quoted / AW**;**
idea of contact with many cells / short diffusion distance / rapid diffusion / reduced rate of flow qualified**;**

large, total surface area / cross-sectional area**;**
allows more exchange / slows flow for exchange / close to all the cells in the body**;**
R easier / more efficient ideas unless qualified 4 max

[11]

28. (a) (i) 29**;** 1

(ii) fetus gains oxygen from, maternal blood / mother / AW**;**
across placenta**;**
partial pressure / AW, of oxygen in placenta is low**;**
2-4 kPa**;**
both in the fetal and maternal parts / AW**;**
maternal haemoglobin releases oxygen**;**
fetal haemoglobin has a high(er) affinity for oxygen**;**
ref to maintaining diffusion gradient**;**
oxygen needed for , respiration / energy release / AW**;**
R energy production 4 max

(b) *accept answer written in terms of adult haemoglobin*

affinity (of fetal haemoglobin) would be too high**;**
would not release oxygen readily enough / AW**;**
ref to idea that adult females will need difference with their fetuses in due course**;**
ref to high partial pressure of oxygen in lungs allowing loading with Hb with lower affinity**;** 2 max

[7]

29. (i) **A** = pulmonary artery**;**
B = bicuspid valve**; A** atrioventricular / AV, valve *mark first on list* **R** 'arterio…' 2

(ii) arrows correctly positioned on left side only**;** 1

(iii)
1 wave of excitation / impulse / AW, stops**;**
2 at the AVN / no transmission to heart apex / AW**;**
3 no ventricular, contraction / systole**;**
4 fibrillation / described e.g. heartbeat, unco-ordinated / irregular / no rhythm**;**
5 blood not squeezed , upwards / out of ventricles / AW**;**
A ref to pressure change
6 atrial contraction continues**;** 2 max

(iv) *credit answers written in context of what would happen if there was a hole*

stops oxygenated and deoxygenated blood mixing**;**
ensures, (fully) oxygenated blood gets to the body / deoxygenated blood to lungs**;**
ref to possible drop in blood pressure if hole present**;**
ref to allowing different pressures being maintained on each side / AW**;**
AVP**;** e.g. prevention of rise in heart rate if two sides not separated 2 max

[7]

30. **S1** three named layers**;**

S2 (tunica intima / inner layer / AW) endothelium**;**
S3 (tunica intima / inner layer / AW)) squamous (epithelial) cells**;**

S4 (tunica media / middle layer / AW), thin / narrow / AW**;**
S5 (tunica media / middle layer / AW), muscle and elastic tissue**;**
R large amounts
refs to collagen neutral
S6 (tunica externa) collagen**; R** if muscle mentioned here

S7 valves**;**
S8 large / wide, lumen**;**
max 4 S marks *credit S marks from labelled diagrams*

F9 smooth , endothelium / epithelium / lining / AW, reduces friction**;**
R if smoothness related to muscle
F10 credit one reference to, thinness / strength , of wall withstanding low pressure**;**
F11 ref to thinness of wall to allow skeletal muscle to squeeze vein**;**
F12 valves to prevent backflow / AW**;**
F13 ref to, wide lumen / walls distending , to accommodate large volume of blood**;**
F14 detail of this e.g. relationship between large volume and slow flow rate**;**
max 3 F marks 6 max

QWC – legible text with accurate spelling, punctuation and grammar; 1

[7]

31. (i) *look for prokaryote feature*

no nucleus / no nuclear membrane / no nucleolus / DNA free (in cytoplasm)**; R** DNA moving
naked DNA / DNA not associated with proteins / no chromosomes**;**
circular / loop **,** DNA**;**
no **,** membrane-bound organelles / e.g.**;**
smaller / 18nm / 70S **,** ribosomes**;**
no ER**;**
cell wall **,** not cellulose / polysaccharide and, amino acids / murein**;**
AVP**;** e.g. mesosomes / plasmids 1 max

(ii) glycosidic (link) and peptide (bonds) (in correct context)**;**
condensation**;**
ref. OH groups**;**
ref. NH_2 and OH group**;**
water **,** removed / produced / by-product**;**
enzyme**;**
AVP**;** e.g. energy required 3 max

(iii) iron / Fe**;** *ignore pluses / minuses* 1

(iv) *treat enzyme as neutral*

nitrogenase**;**
leghaemoglobin**;**
haemoglobin**;** 2 max

(v) (nitrogen) fixation**; A** reduction 1

(vi) type of inhibition (competitive / non-competitive / reversible / irreversible)**;**
basic mode of action (e.g. binds to active site)**;**
detail**;**
consequence (e.g. prevents , substrate / nitrogen , from binding)**;** 2 max

[10]

32. (a) (i)

tissue fluid	*blood*
no red blood cells **R** Hb	red blood cells**;**
few / no, (plasma) proteins	(plasma) proteins**;**
a few white blood cells **R** none	full range / more, white blood cells**;**
no platelets	platelets**;**
always low pressure	pressure higher / variable**;**
some fats	more fats**;**
not in vessels / AW	contained in vessels**;**

qualified ref. to differences in dissolved gas levels**;**

AVP**;** e.g. qualified ref. to, difference in, speed of flow / water potential / ion content
functional difference, such as exchange medium v. transport medium**;** 3 max

(ii) lymphatic / lymph**; A** lacteal 1

(b) **1** pressure high at **R** / AW**;**

2 ref. to heart action causing (hydrostatic) pressure**;**

3 greater than, osmotic effect / water potential effect / AW**;**
A solute potential

4 capillary wall, is leaky / has pores / AW**;**

5 lets, fluid / water / plasma / liquid, through and dissolved substances / named substance(s)**;**

6 red blood cells / proteins / some WBC's, cannot get out because too large**;**

7 pressure low(er) at **S;**

8 ref. to osmotic effect / water potential effect**; A** solute potential

9 due to plasma proteins**;**

10 return of fluid / AW, at **S** / AW**;**

11 valves / pores, at **T** / lymph vessel / AW**; R** semi lunar valve

12 allow, fluid / water / liquid, into lymph vessel / out of tissue fluid**;**

13 allow proteins out of tissue fluid**;** 6 max

QWC – clear, well organised using specialist terms 1

(c) fluid / AW collects**; R** if suggests collection in cells
(tissue) swells / AW**; R** turgid **R** if implies cells swell
oedema**;**
especial danger, in lungs / pulmonary oedema**;**
ref. to build up of proteins (from tissues)**;**
AVP**;** e.g. loss of blood volume 2 max

[13]

33. (i) 10 – 12**;**
1 – 4**;**

if range given, both figures must be within the range 2

(ii) to the left and sigmoid**;**
start and finish at the same points as the maternal curve**;**

if curve drawn on right can still give start and finish points if reasonably sigmoid 2

(iii) to allow, fetus / fetal haemoglobin, to get oxygen (at placenta)**;**
at, low / same, partial pressure of oxygen**;**
maternal haemoglobin releases oxygen / AW**;**
ref. to higher affinity of fetal haemoglobin (allows it to pick oxygen up)**;** 3 max

[7]

34. (i) ref. carbon dioxide (diffusion / AW, from tissues) to red blood cells**;**
carbon dioxide reacts with water**;**
to give carbonic acid**;**
ref. to carbonic anhydrase**;**
carbonic acid, dissociates / AW, releasing, H^+ / hydrogen ions**;**

direct reaction of carbon dioxide to H^+ and HCO_3^- = 2 marks 3 max

(ii) H^+ / hydrogen ions, combine with / AW, haemoglobin**;**
R 'mops up' unqualified
forms haemoglobinic acid / HHb**;**

accept words or symbols throughout 1 max

[4]

35. (a) (i) arrows through correctly**; R** if both sides shown 1

(ii) **X** = vena cava**;**
Y = bicuspid / atrioventricular / AV / mitral (valve)**; R** tricuspid 2

(iii) when ventricle / heart, relaxes**; A** diastole**;**
pressure lower (in ventricle implied)**;** ora
valves stop back flow / AW**; R** incorrect qualification 2 max

(b) (i) A = 2**;**
C = 16**;**
D = 9**;** 3

(ii) A / atrium, only pushes, to ventricle / short distance / AW**;**
A effect of gravity
C / left ventricle, pushes all round body / to systemic system / AW**;**
D / right ventricle (only) pushes to lungs / to pulmonary system / AW**;**

qualification for C **or** D e.g. greater distance / resistance *or* more, force / pressure**;** ora for right ventricle

allow ecf if C & D wrong way round in (b) (i) 3 max

(c) **1** cardiac muscle is myogenic / description**;**
2 SAN / sinoatrial node / pacemaker**;**
3 (in wall of) right atrium**;**
4 wave of electrical activity / impulse / depolarisation / excitation /AW**;**
5 spreads across atria / causes atria to contract**;**
6 stopped / AW (by, fibres / septum), between atria and ventricles**;**
7 delay allows atrial systole to be completed (before ventricular systole)**;**
8 atrioventricular node / AVN**;**
9 impulse passes down / to, Purkyne (Purkinje) fibres / bundle of His**;**
10 contraction from base upwards**;**
11 both ventricles contract together / AW**;**
12 AVP**;** e.g. external nervous control in response to, temp / CO_2 / etc
delay of 0.1 s at AVN
hormone control 6 max

QWC – legible text with accurate spelling, punctuation and grammar; 1

[18]

36. (i) (equivalent to) concentration / AW, of oxygen in, atmosphere / air / tissues**;**
proportion of atmospheric pressure produced by oxygen / AW**;**
at high altitude, atmospheric pressure is lower**;** ora **A** 'air is thinner'
therefore pO_2 is lower / 15 kPa v 21 kPa**;** ora

fourth point can only be given in context of point 2 or 3.
It cannot be given for just stating partial pressure is lower / quoting the figures unqualified 2 max

(ii) haemoglobin / rbc / blood less saturated with oxygen / less oxygen carried in blood / AW**;**
altitude sickness**;**
hypoxia / anoxia**; A** shortage of oxygen to tissues
changes in, breathing pattern / heart rate / pulse rate**;**
dizziness / weakness / disorientation / hallucinations / headaches / AW**;**
(possible) death / coma**;**
brain damage / lung damage / fluid accumulation or oedema in these organs / ref to arteriole / capillary dilation in these organs**;**
AVP**;** e.g. ref to alkalaemia / described / alkaline urine / raised blood pH 4 max

[6]

37. more haemoglobin**;**
get more oxygen round body**;**
more / longer, aerobic respiration (when exercising)**;** ora for anaerobic
reduces, lactate / lactic acid**; A** delays oxygen debt**;**
more, ATP / energy release**; R** producing / making energy
enhanced performance / AW**; A** exercise for longer or harder
increased carbon dioxide removal**;**
ref to indetectability (as a natural product)**;** 2 max

[2]