8. Respiration

Content

8.1 Aerobic respiration
8.2 Anaerobic respiration
8.3 Human gas exchange

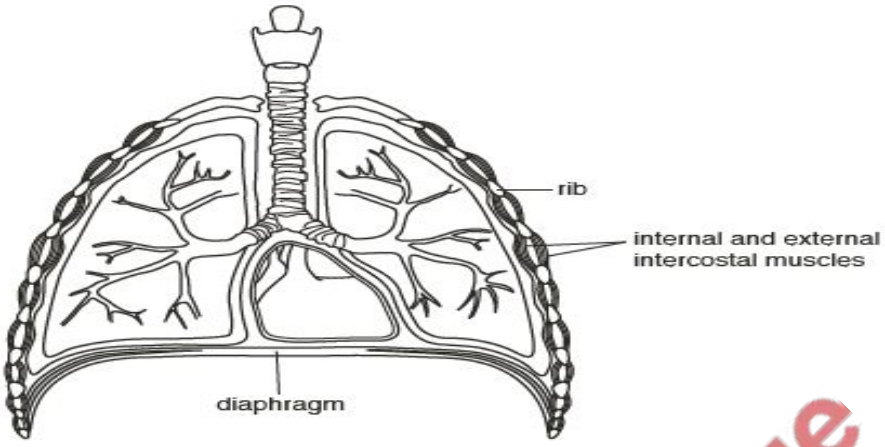
Learning outcomes

Candidates should be able to:

(a) define *respiration* as the release of energy from food substances in all living cells
(b) define *aerobic respiration* as the release of a relatively large amount of energy by the breakdown of food
substances in the presence of oxygen
(c) state the equation (in words or symbols) for aerobic respiration
(d) state the uses of energy in the human body: muscle contraction, protein synthesis, cell division, active
transport, growth, the passage of nerve impulses and the maintenance of a constant body temperature
(e) define *anaerobic respiration* as the release of a relatively small amount of energy by the breakdown of
food substances in the absence of oxygen
(f) state the equation (in words or symbols) for anaerobic respiration in humans and in yeast
(g) describe the effect of lactic acid production in muscles during exercise
(h) know the percentages of the gases in atmospheric air and investigate and state the differences between
inspired and expired air
(i) investigate and state the effect of physical activity on rate and depth of breathing
(j) identify on diagrams and name the larynx, trachea, bronchi, bronchioles, alveoli and associated capillaries
(k) state the characteristics of, and describe the role of, the exchange surface of the alveoli in gas exchange
(l) describe the role of cilia, diaphragm, ribs and intercostal muscles (external and internal) in breathing.

O/N18/21/Q4

The diagram shows the human thorax.



(a) **(i)** Describe how each of the structures named in the diagram is involved when a person takes a single breath **in**.

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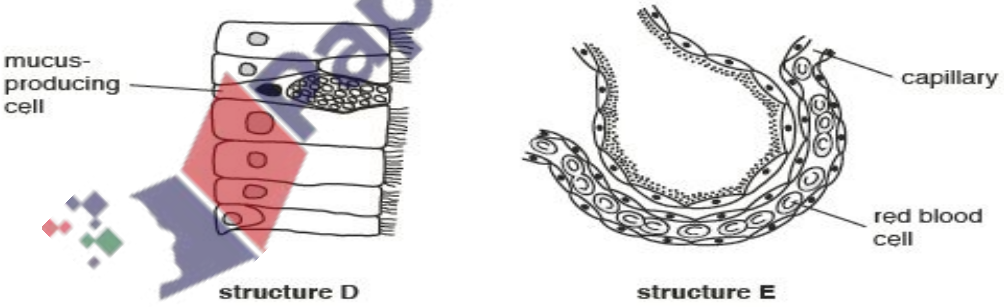
..... [3]

(ii) The diagrams below show two magnified structures, **D** and **E**, from the thorax.



structure D **structure E**

Draw lines labelled **D** and **E** on the diagram of the thorax on page 8 to indicate the positions of **structure D** and **structure E**. [2]

(b) Describe how structure is related to function for each of the following:

a capillary, ...

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a red blood cell. .....

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..... [5]

[Total: 10]

O/N17/22/Q9

(a) Describe and explain the features of a gas exchange surface.

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.....[4]

(b) Explain the effect of exercise on the breathing rate of a person.

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.....[4]

(c) Living at high altitude increases the number of red blood cells in a person's blood.

Suggest why athletes sometimes train at high altitude.

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.....[2]

[Total: 10]

M/J17/21/Q6

(a) Describe the role of the cilia in the trachea.

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.....[3]

(b) Fig. 6.1 shows components of the human gas exchange surface and an associated blood vessel.

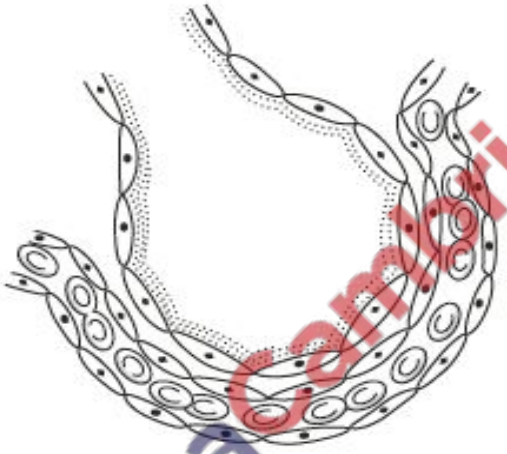

Fig. 6.1

State the characteristics, and describe the roles, of each of the components shown in Fig. 6.1. You should make reference to **named** structures in your answer.

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.....[7]

[Total: 10]

M/J17/21/Q9

Compare each of the following processes:

(a) aerobic respiration and anaerobic respiration

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.....[3]

(b) anaerobic respiration in muscles and anaerobic respiration in yeast

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.....[3]

(c) diffusion and active transport

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[Total: 10]

M/J17/22/Q1

(a) Fig. 1.1 shows the front view of a person's chest and abdomen.

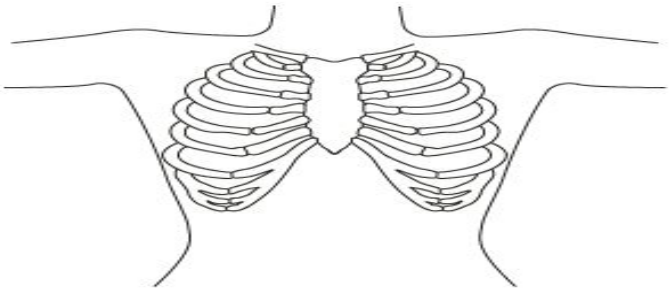

Fig. 1.1

On Fig. 1.1 draw:

- the diaphragm as it would appear immediately after breathing in,
- a circle (O) to show the position of the heart,
- a cross (X) to show the position of the liver. [3]

(b) Fig. 1.2 shows a person about to lift the handle of a bucket from position A to position B.

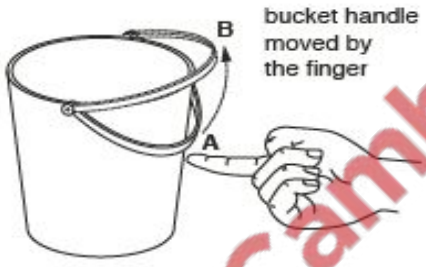

Fig. 1.2

The movement of the bucket handle, as shown, illustrates some features of the movement of a person's chest while breathing in.

(i) State **two similarities** between the movement of a person's chest while breathing in and the movement of the handle.

1 .....

2 .....

[2]

(ii) Explain the **differences** between the movement of a person's chest and the movement of the handle.

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.....[5]

[Total: 10]

M/J17/22/Q6

(a) Describe the journey made by a molecule of carbon dioxide after its production by respiration in a body cell, to the moment it enters the air in the lungs.

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.....[7]

(b) Explain how blood is kept flowing from the foot to the heart.

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[Total: 10]

O/N16/21/Q1

Fig. 1.1 shows a model that a student made to represent the human breathing system.

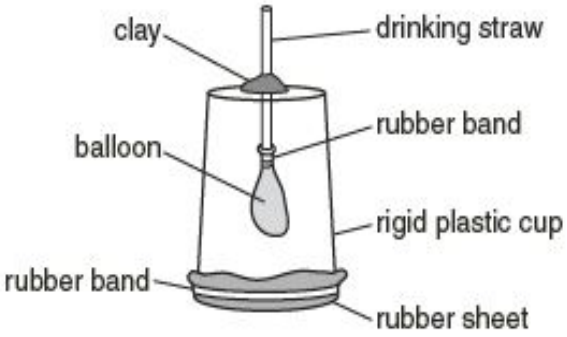

Fig. 1.1

(a) State the part of the model shown in Fig. 1.1 that represents each of the following structures.

the trachea .....

the diaphragm ..... [2]

(b) Describe how this model does **not** accurately represent the human breathing system.

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..... [4]

(c) (i) The model can be used to demonstrate the action of breathing.

Describe what the student must do to the model to demonstrate the action of breathing in.

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..... [2]

(ii) State what the student would observe as the model is used to demonstrate the action of breathing in.

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..... [1]

(iii) The model becomes damaged by a hole being made in the side of the rigid plastic cup.

Describe and explain how this damage will change what the student would observe as the model is used to demonstrate the action of breathing in.

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..... [3]

[Total: 12]

O/N16/22/Q7

7 (a) Describe and explain the benefits to a person of the changes that occur in the body during a physical activity such as a 400 m running race.

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(b) Explain why, after this type of physical activity, a person remains out of breath for several minutes.

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.....[2]

[Total: 10]

M/J16/22/Q5

Table 5.1 shows a number of processes that occur in the lungs and thorax (chest cavity).

Table 5.1

process involved	✔
diffusion into red blood cells	
diffusion into the alveoli	
the diaphragm contracts	
the diaphragm relaxes	
the external intercostal muscles contract	
the internal intercostal muscles relax	
the ribs rise	
the ribs fall	
pressure in the thorax increases	
pressure in the thorax decreases	

(a) Carbon dioxide arrives at the lungs in capillaries. Place a tick (✔) in each box against a process involved in removing carbon dioxide from the blood and expelling it to the atmosphere. [4]

(b) Table 5.2 shows the percentage of oxygen in inspired and expired air of three people, J, K and L.

Table 5.2

person	% of oxygen in inspired air	% of oxygen in expired air
J	20.5	15.0
K	20.5	16.5
L	20.5	18.5

Describe the differences shown in Table 5.2 and suggest reasons for them.

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.....[4]

[Total: 8]

M/J15/21/Q2

Table 2.1 shows the volume of blood supplied to parts of the body at rest and during strenuous exercise.

Table 2.1

part of body	volume of blood supplied in cm^3/min	
	at rest	during strenuous exercise
brain	750	750
heart	250	750
skeletal muscle	1200	12500
skin	500	1900
kidneys	1100	.....
digestive organs	1400	600
other	600	400
Total	5800	17500

(a) (I) Calculate the volume of blood that is supplied to the brain **at rest** as a percentage of the total supplied to the whole body.

Show your working in the space below.

..... % [2]

(II) Name the blood vessels that supply each kidney with blood.

..... [1]

(III) Using the information in Table 2.1, calculate the volume of blood supplied to the kidneys during strenuous exercise.

Write your answer in the space provided in Table 2.1. [1]

(b) Use the information in Table 2.1 to name **two** parts of the body that have an increased supply of blood during strenuous exercise.

Explain the advantage to the body of increasing the supply of blood to each of the parts you name.

name of part .....

advantage .....

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name of part .....

advantage .....

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..... [4]

(c) Using the information in Table 2.1, suggest why eating immediately before exercise is not recommended.

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..... [2]

[Total: 10]

M/J15/22/Q5

Table 5.1 shows the mean daily water intake and loss by a person.

Table 5.1

water intake / dm^3		water loss / dm^3	
drinks food	1.50 0.75	faeces sweat urine exhaled air	0.10 0.52 1.50 .....
Total	2.25	**Total**	2.50

(a) (I) Using the information in Table 5.1, calculate the daily loss of water in exhaled air.

..... [1]

(II) Explain why exhaled air contains water.

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..... [2]

(b) Explain why, even though 2.25 dm^3 of water are taken in through the mouth, the faeces contain only 0.10 dm^3 of water.

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..... [3]

(c) Explain the importance of water in urine.

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..... [2]

(d) The difference between water intake and water loss by a person is accounted for by water produced by a metabolic process in the body. Name this metabolic process.

..... [1]

[Total: 9]

O/N14/21/Q4

Fig. 4.1 shows the effect of exercise on the concentration of oxygen in the blood and the concentration of lactic acid in the muscles of a healthy person over a 5-minute period.

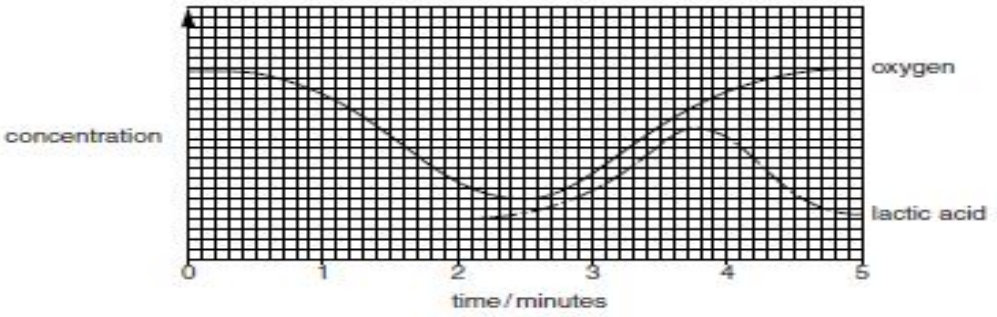

Fig. 4.1

(a) Use Fig. 4.1 to find the time at which the person started to exercise.

..... [1]

(b) Name the process that causes the change in oxygen concentration during the first 2 minutes on Fig. 4.1.

..... [1]

(c) Suggest and explain how each of the two curves on Fig. 4.1 might be different if the person suffered from emphysema.

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..... [5]

[Total: 7]

(d) Suggest why anaerobic respiration does not release as much energy as aerobic respiration for each molecule of the same substrate.

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..... [2]

[Total: 11]

M/J14/22/Q6

(a) Explain the fact that humans breathe while plants do not.

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.....[3]

(b) Explain why the respiration rate of humans is relatively high and constant, while that of plants may vary widely.

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.....[7]

[Total: 10]

O/N12/21/Q3

Atmospheric air contains oxygen and carbon dioxide.

(a) Complete table 3.1 to show the percentage of oxygen and carbon dioxide in inhaled and exhaled air.

Table 3.1

gas	% gas in air	
	inhaled air	exhaled air
oxygen		
carbon dioxide		

[2]

(b) (i) Explain how oxygen is used by a muscle cell.

.....

.....

..... [3]

(ii) Explain what happens in a muscle cell when oxygen is in short supply.

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..... [2]

(c) At high altitudes, oxygen is less available than it is at low altitudes.
Suggest modifications of the circulatory and respiratory systems that might help people that live for many years at high altitude.

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..... [3]

[Total: 10]

O/N11/22/Q8

(a) Describe how anaerobic respiration in muscles differs from anaerobic respiration in yeast.

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.....[3]

(b) Describe the part played by the cells lining the trachea.

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.....[3]

(c) Explain what may happen to the cells lining the trachea in a smoker, and how this may affect the person's health.

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.....[4]

[Total: 10]

M/J11/22/Q5

5 Fig. 5.1(a) and Fig. 5.1(b) show graphs of the pulse and breathing rates of two students, **E** and **F**, during and after one minute's vigorous exercise.

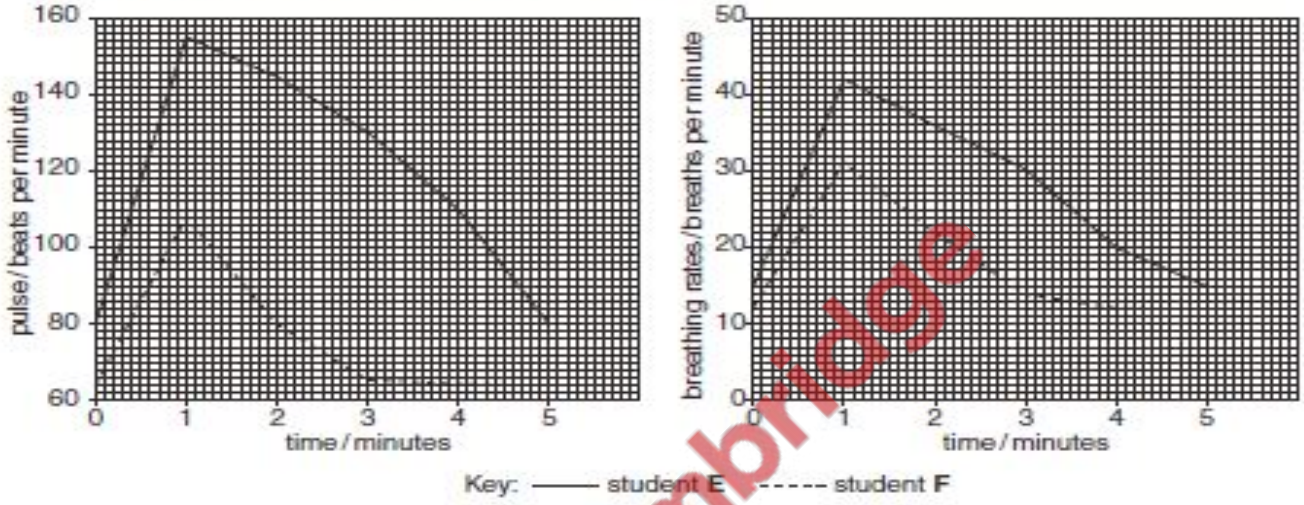

Fig. 5.1(a) **Fig. 5.1(b)**

(a) State how long it took for student F's pulse and breathing rates to return to their original levels after the student had finished exercising.

pulse rate .....

breathing rate ..... [2]

(b) Explain why the pulse and breathing rates of both students increased during exercise.

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.....[4]

(c) Suggest and describe possible reasons for the differences in the effect of vigorous exercise on these two students.

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.....[4]

[Total: 10]

MARK SCHEMES WILL USE THESE ABBREVIATIONS:
; SEPARATES MARKING POINTS
/ ALTERNATIVES
() CONTENTS OF BRACKETS ARE NOT REQUIRED BUT SHOULD BE IMPLIED
R REJECT
A ACCEPT (FOR ANSWERS CORRECTLY CUED BY THE QUESTION, OR GUIDANCE FOR EXAMINERS)
IG IGNORE (FOR INCORRECT BUT IRRELEVANT RESPONSES)
AW ALTERNATIVE WORDING (WHERE RESPONSES VARY MORE THAN USUAL)
AVP ALTERNATIVE VALID POINT (WHERE A GREATER THAN USUAL VARIETY OF RESPONSES IS EXPECTED)
ORA OR REVERSE ARGUMENT
UNDERLINE ACTUAL WORD UNDERLINED MUST BE USED BY CANDIDATE
+ STATEMENTS ON BOTH SIDES OF THE + ARE NEEDED FOR THAT MARK

Mark Scheme

O/N18/22/Q4

4(a)(i) diaphragm **+** contracts **;**
diaphragm **+** moves down **;**
external intercostal muscles **+** contract **;**
internal intercostal muscles **+** relax **;**
ribs move **+** up / out **;**
3 Ig references to volume / pressure
4(a)(ii) **structure D** correctly identified on trachea / bronchus **;**
structure E identified at end of a bronchiole **;**
2 A any method of correct identification
4(b) *(capillary) max 3 marks from*
wall **+** one cell thick **;**
diffusion **;**
example of **named** substance **+** in / out / through wall **;**
branching / network / contacts many cells / large surface area **;**
(red blood cell) max 3 marks from
biconcave **AW ;**
no nucleus **;**
haemoglobin **;**
large surface area **;**
oxygen in / out / carriage **;**
able to squeeze through capillaries / flexible **;**

O/N17/22/Q9

9(a) **1** thin / one cell thick / short distance **;**
2 moist **;**
3 large surface area **;**
4 permeable **;**
5 maximum / more / quick / efficient **+** diffusion / absorption / exchange **;**
6 reference to dissolving / in solution **;**
4
9(b) **1** faster / deeper **+** breathing **;**
2 more **+** oxygen **;**
3 (oxygen) in lungs / inhaled / in blood **;**
4 muscle **;**
5 faster / increased **+** respiration / oxidation of glucose **;**
6 aerobic **;**
7 more energy **+** required / released **;**
8 more **+** carbon dioxide removed **AW ;**
9 delays / prevents **AW +** anaerobic respiration **;**
4
9(c) **1** less oxygen in atmosphere (at high altitude) **;**
2 more **+** haemoglobin **;**
3 oxyhaemoglobin **OR** more **+** oxygen carried / supplied **;**
4 competitive advantage **AW ;**

M/J17/21/Q6

6(a) move mucus **;**
(containing) bacteria / pathogens / dust **;**
(moves) up / away from lungs **AW ;**
prevent infection **;**
6(b) reference to diffusion **;**
(for) O_2 / CO_2 **+** exchange **AW ;**
alveolus / air sac **;**
large surface area **;**
one cell thick **+** wall **;**
moist **AW** / mucus **;**
(gases) to dissolve **;**
capillary **;**
one cell thick **+** wall **;**
connect **AW** arteries **+** veins **;**
blood **+** moving **;**
red blood cells / erythrocytes **;**
no nucleus **;**
biconcave **;**
contain haemoglobin **;**
live for 90 / 120 days **OR** 3 / 4 months **;**
carry oxygen **;**
plasma **;**
carriage of carbon dioxide **;**
7

M/J17/21/Q9

9(a) glucose **+** required for both **;**
complete or incomplete breakdown (of glucose) **;**
ref. oxygen requirement **;**
amount of energy released **;**

3 A each point **only** if linked to **either** 'aerobic' **or** 'anaerobic' respiration
9(b) glucose **+** required for both **;**
reference to oxygen debt **AW ;**
lactic acid **;**
carbon dioxide **;**
alcohol / ethanol **;**
3 A each point **only** if linked to **either** 'muscles **or** 'yeast'
9(c) movement of particles / molecules / named molecule **;**
concentration gradient **;**
membrane requirement **;**
living cell requirement **;**
energy requirement **;**
(energy from) respiration **;**
correct example **;**
4 A each point **only** if linked to **either** 'diffusion' **or** 'active transport'
Total: 10

M/J17/22/Q1
1(a) **1** line starts and ends at body wall **+** crosses abdomen below ribs **;**
2 circle with all or part of it touching / on the sternum **;**
3 middle of cross below diaphragm **;**
3
1(b)(i) **1** any reference to up / rises / raised **;**
2 out / forwards **;**
3 reference to muscle **;**
4 (muscle) contract(ion) **;**
5 reference to (requires) energy **;**
2
1(b)(ii) (movement of person's chest)
1 involuntary **AW ;**
2 intercostal (muscles) **;**
3 (muscles) between the ribs / in the chest (wall) **;**
4 (move) bone / ribs / ribcage **;**
5 attached / hinged **+** to vertebrae / backbone / at back **;**
6 ***leads to increase in volume / decrease in pressure **;
(movement of bucket handle)
7 voluntary **AW ;**
8 muscle in arm / finger **OR** reference to bicep(s) **;**
9 external to / not part of **+** the bucket / handle **;**
10 (move) metal / plastic **OR** reference to a single handle **;**
11 attached / hinged **+** to bucket / at side **;**
12 ***does not lead to change in volume / pressure **;
5
*** A** once only for either chest or handle
*** A** once only for either chest or handle

M/J17/22/Q6

6(a) **1** correct reference to (CO_2) diffusion **;**
2 cytoplasm **;**

3 (across) cell membrane **;**
4 tissue fluid **;**
5 * capillary **;**
6 plasma / (red) blood (cell) **;**
7 vein / vena cava **;**
8 heart **+** right (side of heart) **;**
9 reference to atrium / auricle **+** followed by ventricle **;**
10 pulmonary artery / arch **;**
11 * capillary **;**
12 alveolus / alveoli **;**
7
*** A** once only either here or below
Ig inferior / superior vena cava
*** A** once only either here or above
Ig reference to air sac
6(b) **1** (blood is under) pressure **;**
2 (moved) by (contraction of skeletal) muscles **;**
3 reference to veins / correct named vein **;**
4 reference to valves (in veins) **;**
5 (valves) prevent backflow of blood **AW ;**

O/N16/21/Q1

1(a) (drinking) straw **;**
(rubber) sheet **;**
2
1(b) only one lung / balloon **;**
reference to ribs **;**
reference to intercostal muscles **;**
rigid plastic cup doesn't move **;**
no bronchi / bronchioles **;**
no alveoli / blood vessels / capillaries **;**
no cilia / mucus **;**
lung / balloon not attached to cup / thorax wall **;**
rubber sheet doesn't move independently / not muscular / pulled down below diaphragm position / flat at rest, not domed **;**
4 A ORA for all marking points in an answer referring to the human breathing system rather than to the model
1(c)(i) (move) rubber sheet **;**
down **;**
2 R blowing down straw
1(c)(ii) balloon + inflates / expands / gets bigger **AW ; 1**

O/N16/22/Q7

7(a) 1 adrenaline **;**
2 glycogen to glucose **;**
3 liver / muscles (in context of adrenaline effect) **;**
4 boosts blood glucose / sugar levels **;**
5 fast(er) heart beat **;**
6 better / faster circulation **;**

7 more oxygen **+** to muscles **;**
7(a) 1 adrenaline **;**

2 glycogen to glucose **;**
3 liver / muscles (in context of adrenaline effect) **;**
4 boosts blood glucose / sugar levels **;**
5 fast(er) heart beat **;**
6 better / faster circulation **;**
7 more oxygen **+** to muscles **;**

M/J16/22/Q5

5 (a) _ diffusion into the alveoli (box 2) ;
_ the diaphragm relaxes (box 4) ;
_ the ribs fall (box 8) ;
_ pressure in the thorax increases (box 9) ;
[4]
(b) 1. any stated difference between inspired and expired % O_2 ;
2. O_2 used in respiration ;
3. Person J – the most / more (than normal) O_2 absorbed / used ;
4. Person J - active / taking exercise / athlete / pregnant / high respiratory rate / high blood cell or red blood cell count AW ;
5. Person K – moderate activity / normal ;
6. Person L – low O_2 absorption / use ;
7. Person L – (named) lung disease / anaemia / smoker / inactive / sleeping / elderly / dying / low respiratory rate / reference to low red blood cell count / carboxyhaemoglobin ;
A any disease that would restrict O_2 uptake
[4]
[Total 8]

M/J15/21/Q2

(a) (i) (750/5800) *100 ;
12.9 / 13 (%) ;
[2]
(ii) renal artery ; [1]
(iii) 600 ;

(b)
heart ;
skeletal muscle ;

for above named parts
ref. supply of more oxygen / glucose ;
ref. increased (aerobic) respiration / prevent anaerobic respiration ;
remove lactic acid (for skeletal muscle only) ;
ref. contract harder / faster ;
skin ;
increased heat loss ;
[max 4]
[1]
[1]
[max 2]
(c) less blood to digestive organs ;
less digestion ;
less / slower absorption of products of digestion ;
A ref. active transport in digestive System

M/J15/22/Q5

5 (a) (i) 0.38 + dm^3 ; [1]
(ii) evaporation / water vapour ;
from (moist lining of) alveoli / lungs ;
Ig other named parts of breathing system
[2]
(b) 1. water is absorbed + blood ;
2. (from) ileum / small intestine / colon / large intestine ;
3. ref need to prevent water loss / importance of water in body (e.g. solvent / transport) ;
4. water lost by other methods / ref. to any named other method of water loss ;
[max 3]
(c) water is a solvent / dissolves ;
any one named solute ;
A salts
[2]
(d) respiration ; if qualified must be aerobic [1]

O/N14/21/Q4

4 (a) 0.3–0.4 minutes ; [1] A 18–24 s
(b) aerobic respiration ; [1]
(c) O_2 curve not as high at start / finish ;
O_2 curve drops more quickly / ORA ;
damage to alveoli ;
less surface area for O_2 absorption ;

less O_2 to blood / muscles ;
lactic acid curve rises sooner / higher / takes longer to return to normal ;
shorter period of aerobic / longer period anaerobic respiration ;
more lactic acid build-up ;
[max. 5]
A uptake / diffusion
[Total: 7]

O/N14/22/Q4

4 (a) glucose / $C_6H_{12}O_6$ (substrate) ;
(yeast) alcohol / ethanol / C_2H_5OH ;
(yeast) carbon dioxide / CO_2 ;
(muscles) lactic acid / lactate / $C_3H_6O_3$;
[4]
(b) (i) food / glucose deficiency / AW ;
(killed) by alcohol ;
poisoned by competing organisms (e.g. bacteria) ;
[max. 2]
(ii) (killed) by heat / baking / high temperature ; [1]
(c) lactic acid removed / broken down / converted ;
by circulation / blood / AW ;
lactic acid not toxic (at concentrations experienced) ;
[max. 2]
(d) substrate / glucose not completely broken down ;
chemical energy ;
still contained within product / lactic acid / alcohol ;
[max. 2]
[Total: 11]

M/J14/22/Q6

6 (a) muscles in humans / no muscles in plants ;
ref. intercostals / diaphragm ;
humans need to keep (constant) supply of O_2 (to blood)
/ remove CO_2 (from blood) / ref. higher metabolic rate / rate of respiration in humans ;
ref. production of (some of their own) oxygen by photosynthesis ;
lungs / no lungs ;
ref. stomata/spongy mesophyll in plants / not in humans / ref. alveoli in humans / no alveoli in plants ;
[3]
(N.B. intercostal ; muscles ; will score 2 marks)

(b) (High respiration rate)
humans active / move / muscle N action (or described) / ORA ;
requires large quantities of / more N energy / ORA ;
high body temperature in humans / ORA ;
activity of enzymes / high metabolic rate / ORA ;
humans complex / named organs, e.g. brain, kidneys, heart ;
(Constant respiration rate)
homeostasis ;
temperature constant in humans / thermoregulation ;
rate dependent on external temperature in plants ;
rate dependent on stage of life cycle, e.g. germination / growing season ;
[7]
R humans are larger
Total [10]

O/N12/21/Q3

3 (a) oxygen 19 – 21% + 14 – 16%;
carbon dioxide 0.03 – 0.045% + 3 – 4.5%; [2]
(b) (i) (aerobic) respiration;
release energy;
from glucose;
for contraction;
lactic acid +ref. oxygen debt AW;
R produce AW energy
A give AW; [max 3]

3 (a) oxygen 19 – 21% + 14 – 16%;
carbon dioxide 0.03 – 0.045% + 3 – 4.5%; [2]
(b) (i) (aerobic) respiration;
release energy;
from glucose;
for contraction;
lactic acid +ref. oxygen debt AW;
R produce AW energy
A give AW; [max 3]

M/J12/21/Q9

9 (a) diaphragm + relaxes;
and moves up / assumes domed shape;
intercostal (if named must be external) muscles relax / internal intercostal muscles contract;
ribs move down / inwards;
volume of thorax / lungs / chest cavity decreases;
pressure in thorax increases; [5]
(b) nitrogen unchanged (A percentage if given 78 – 80%);
(A. 79% in air breathed in + reduced percentage in air breathed out)
not used / produced (in the body / cells / metabolism);
oxygen reduces (A %s from 19 /20 / 21% to 16% +/–);
carbon dioxide increases (A %s - from 0.03 / 0.04% to 4%);
correct ref. aerobic respiration / O_2 / CO_2 diffuse into / out of blood;
ref. water vapour comparison + explanation;

(R waste product of respiration)
ref. temperature comparison + explanation;
ref. comparison of cleanliness of air; [5]
[Total: 10]

O/N11/22/Q8

8 (a) (Accept reverse argument or mix and match answers. A points on equations – identified –
either words or symbols – correctly balanced)
lactic acid / $CH_3CHOHCOOH$ produced;
no alcohol / ethanol / C_2H_5OH produced;
no carbon dioxide / CO_2 produced; [max 3]
(b) produce mucus;
to trap dust;
and bacteria / pathogens (R germs);
cilia;
to move mucus + up AW;
moisten air / warm air; [max 3]
(c) cilia paralysed / destroyed / killed AW;
airways blocked with mucus / mucus builds up / excess mucus produced (A mucus not removed);
narrower airways / breathing difficulty / breathlessness;
(smoker's) cough;
pathogens not removed / enter lungs / bacteria proliferate;
tendency to infection / disease or named caused by pathogen;
lung / tracheal cancer / emphysema;
ref. to the effect of decreased oxygen uptake; [max 4]
[Total: 10]

M/J11/22/Q5

5 (a) 2.5 – 4 + minutes for pulse (A any within range);
3 – 4 + minutes for breathing (A anything within range); [2]
(b) muscles;
For the remaining marks in this part, there must be the use somewhere of a word that indicates enhancement of at least one of the factors (i.e. more / greater, faster etc.). Thus, for example, 'more oxygen' scores, and so, then, would any ref. to CO_2 removal or energy, even if 'more' is not repeated.
more / faster blood;
more oxygen / glucose;
ref. more CO_2 removed / lactic acid;
more energy (R produced, made, manufactured, etc.); [max. 4]
(c) (If they do not indicate which student they are talking about, mark up to 2 max.)
*student F is fitter / exercises regularly AW;
*more efficient muscles / better breakdown of lactic acid;
*more efficient circulation / no or limited cholesterol in blood vessels;
*more efficient lungs / respiratory system;

*exercised less vigorously;
*more haemoglobin / more RBCs;
(*A reverse arguments for Student E)
student E was a smoker, F was not;
student E was obese / overweight AW (R large mass);
emphysema;
suffered from asthma / bronchitis / heart problems / lung infection AW; [max. 4]
[Total: 10]