Bioenergetics part 3 AQA Triple Biology

Name: _____

Class: _____

Date: _____

Time: **84 minutes**

Marks: **79 marks**

Comments:

1. This question is about exercise.

(a) During vigorous exercise, anaerobic respiration occurs in a person's body.

Explain **two** effects of anaerobic respiration on the person's body.

1 _____

_____

_____

_____

2 _____

_____

_____

_____

(4)

(b) Design an investigation to show the effect of different types of exercise on the heart rate of athletes.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(6)

Anabolic steroids are drugs.

Anabolic steroids:

- increase muscle mass in humans
- are banned in most competitive sports.

Some athletes take anabolic steroids to improve their performance in sport.

(c) Explain how taking anabolic steroids could improve an athlete's performance.

_____

_____

_____

_____

(2)

Scientists use monoclonal antibodies to test for the presence of anabolic steroids in an athlete's urine.

To produce monoclonal antibodies, a mouse lymphocyte is combined with a tumour cell.

(d) What type of cell is created when a mouse lymphocyte and a tumour cell combine?

Tick (✓) **one** box.

Embryo ☐

Hybridoma ☐

Phagocyte ☐

Stem cell ☐

(1)

(e) Describe how scientists make monoclonal antibodies using the cell created when a mouse lymphocyte and a tumour cell combine.

_____

_____

_____

_____

_____

_____

(3)

(f) What property makes a monoclonal antibody useful in detecting the presence of an anabolic steroid in urine?

Tick (✓) **one** box.

A monoclonal antibody is quick and easy to produce. ☐

A monoclonal antibody is specific to only one person's urine. ☐

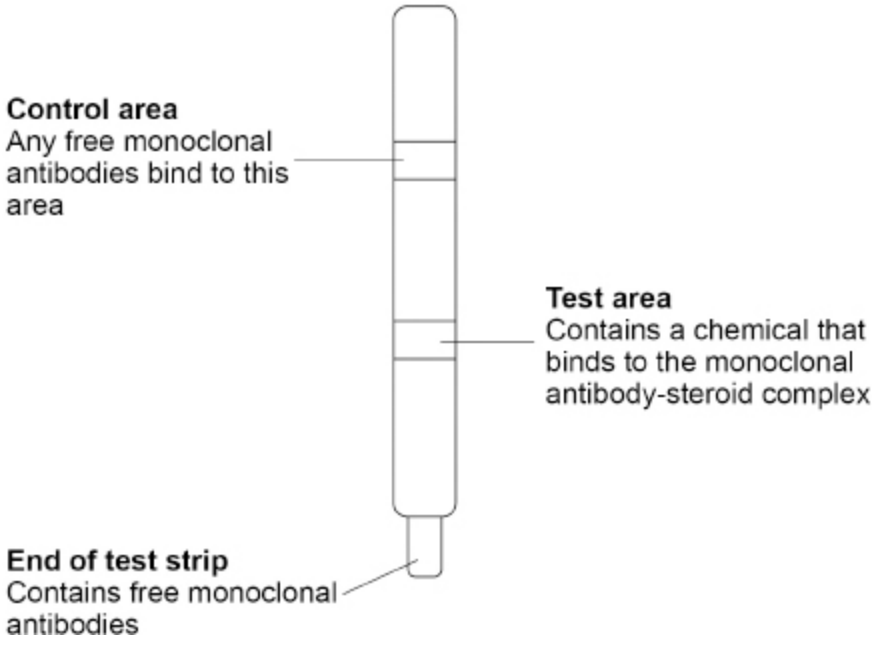
A monoclonal antibody only binds to the anabolic steroid. ☐

A monoclonal antibody can identify many different drugs at the same time. ☐

(1)

Figure 1 shows a test strip that can detect the presence of an anabolic steroid in an athlete's urine.

Figure 1



The end of the test strip is dipped in urine.

The urine moves up through the test strip.

The test area and the control area contain a dye.
The dye turns blue when monoclonal antibodies bind to it.

(g) Suggest the purpose of the control area in the test strip.

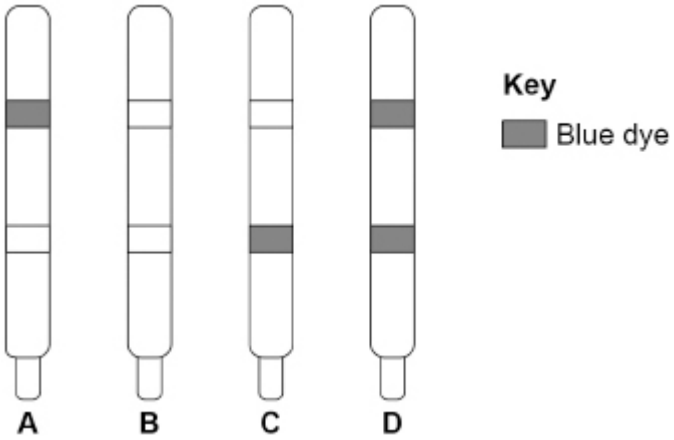
_____

_____

(1)

Figure 2 shows the urine test results of four athletes.

Figure 2



(h) Describe the evidence in **Figure 2** that shows the test for athlete **B** has **not** worked.

Suggest **one** reason why the test did **not** work.

Evidence _____

_____

Reason _____

_____

(2)

(i) Which athlete has tested positive for anabolic steroids in their urine?

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

(1)

(Total 21 marks)

2. A scientist investigated the rate of photosynthesis of one type of tomato plant.

The tomato plants were grown in a greenhouse.

The table below shows the results.

Percentage (%) concentration of carbon dioxide in the air	**Rate of photosynthesis in arbitrary units**
0.00	0
0.02	5
0.04	16
0.06	19
0.08	20
0.10	20
0.12	20

(a) Give **two** control variables the scientist should have used in the investigation.

1 _____

2 _____

(2)

(b) Which range of carbon dioxide concentrations caused the rate of photosynthesis to change the most?

Tick (✓) **one** box.

From 0.00% to 0.02% ☐

From 0.02% to 0.04% ☐

From 0.04% to 0.06% ☐

From 0.06% to 0.08% ☐

(1)

(c) How could the scientist have improved the validity of the results?

Tick (✓) **one** box.

Repeat each reading three times and calculate a mean. ☐

Use concentrations of carbon dioxide above 0.12%. ☐

Use different tomato plants for each concentration. ☐

(1)

(d) Explain the change in the rate of photosynthesis when the concentration of carbon dioxide increased between 0.00% to 0.08%.

_____

_____

_____

_____

(2)

(e) A farmer decided **not** to use a concentration of carbon dioxide higher than 0.08% to grow tomato plants.

Suggest **two** reasons for the farmer's decision.

Use information from above table and your own knowledge.

1 _____

_____

2 _____

_____

(2)

(Total 8 marks)

3. Water and carbon dioxide are exchanged between leaves and the atmosphere through pores called stomata.

(a) Name the cells that control the opening and closing of the stomata.

_____

(1)

Water moves through a plant in the transpiration stream.

(b) Describe **two** differences between the transpiration stream and translocation.

1 _____

_____

2 _____

_____

(2)

(c) Which environmental conditions would cause the rate of transpiration to be greatest in a plant?

Tick (✓) **one** box.

Cold with low humidity ☐

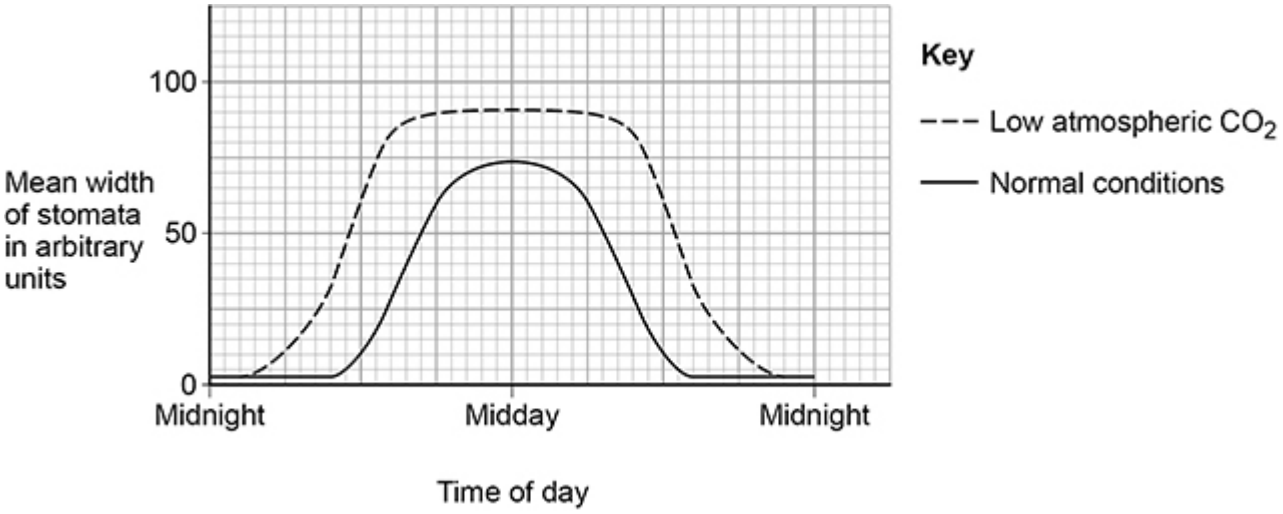
Cold with high humidity ☐

Warm with low humidity ☐

Warm with high humidity ☐

(1)

The figure below shows information about the mean width of the stomata in a plant.



(d) The changes in the mean width of the stomata in **normal conditions** are an advantage to the plant.

Explain how.

(4)

(e) The changes in the mean width of the stomata in low atmospheric carbon dioxide are different from the changes in normal conditions.

Explain how the difference helps the plant to survive in low atmospheric carbon dioxide.

(2)

(Total 10 marks)

4. **Table 1** shows information about five different organisms.

Table 1

Organism	Surface area in m^2	Volume in m^3	Surface area to volume ratio
A	6.04×10^{-8}	1.65×10^{-12}	36606:1
B	3.21×10^{-3}	1.25×10^{-6}	2568:1
C	9.96×10^{-3}	1.35×10^{-4}	**X**:1
D	4.61×10^{-1}	1.57×10^{-2}	29:1
E	1.99×10^{1}	6.12×10^{0}	3:1

(a) Calculate value **X** in **Table 1**.

Give your answer to the nearest whole number.

X (nearest whole number) = _____

(3)

(b) What is the relationship between the size of an organism and its surface area to volume ratio?

Use **Table 1**.

(1)

(c) Organism **B** exchanges gases with the environment directly through its skin.

Organism **D** exchanges gases with the environment using its respiratory system.

Explain why organism **D** requires a respiratory system, but organism **B** does **not** require a respiratory system.

_____

_____

_____

_____

_____

(2)

Table 1 is repeated below.

Table 1

Organism	**Surface area in m^2**	**Volume in m^3**	**Surface area to volume ratio**
A	6.04×10^{-8}	1.65×10^{-12}	36606:1
B	3.21×10^{-3}	1.25×10^{-6}	2568:1
C	9.96×10^{-3}	1.35×10^{-4}	**X**:1
D	4.61×10^{-1}	1.57×10^{-2}	29:1
E	1.99×10^{1}	6.12×10^{0}	3:1

Table 2 shows information about organism **D** and organism **E**.

Table 2

Organism	**Metabolic rate in arbitrary units**
D	890
E	75

(d) Organisms **D** and **E** both keep a constant body temperature (warm-blooded).

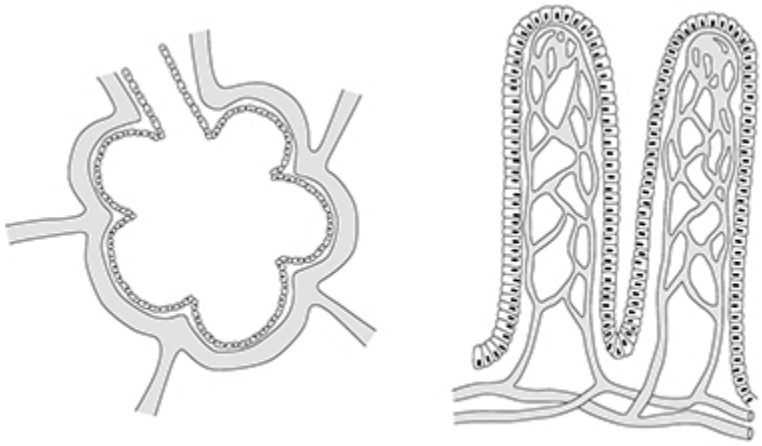
Explain why the metabolic rate of organism **D** is greater than the metabolic rate of organism **E**.

Use information from **Table 1** and **Table 2**.

(4)

(e) Organism **D** and organism **E** both have alveoli in the lungs and villi in the small intestine.

The figure below shows some alveoli and some villi.



Alveoli **Villi**

Describe how the alveoli and the villi are adapted to increase absorption.

(4)

(Total 14 marks)

5. All living organisms respire.

(a) What is the chemical equation for aerobic respiration?

Tick (✓) **one** box.

$6\ O_2 + 6\ CO_2 \rightarrow 6\ H_2O + C_6H_{12}O_6$ ☐

$6\ H_2O + C_6H_{12}O_6 \rightarrow 6\ H_2O + 6\ CO_2$ ☐

$6\ H_2O + 6\ CO_2 \rightarrow 6\ O_2 + C_6H_{12}O_6$ ☐

$6\ O_2 + C_6H_{12}O_6 \rightarrow 6\ H_2O + 6\ CO_2$ ☐

(1)

(b) Name the sub-cellular structures where aerobic respiration takes place.

_____

(1)

(c) Energy is released in respiration.

Give **two** uses of the energy released in respiration.

1 _____

_____

2 _____

_____

(2)

(d) Describe **two** differences between aerobic and anaerobic respiration in humans.

Do **not** refer to oxygen in your answer.

1 _____

_____

2 _____

_____

(2)

(e) What are the **two** products of anaerobic respiration in plant cells?

Tick (✓) **two** boxes.

Carbon dioxide ☐

Ethanol ☐

Glucose ☐

Lactic acid ☐

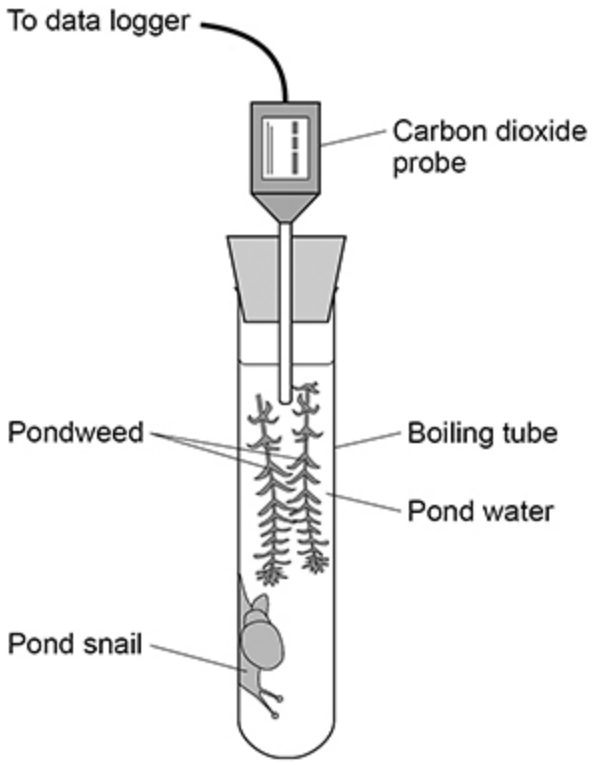
Water ☐

(2)

A scientist investigated respiration and photosynthesis using some pondweed and a pond snail.

Figure 1 shows the apparatus used.

Figure 1



The apparatus was left in a well-lit room for 5 days.

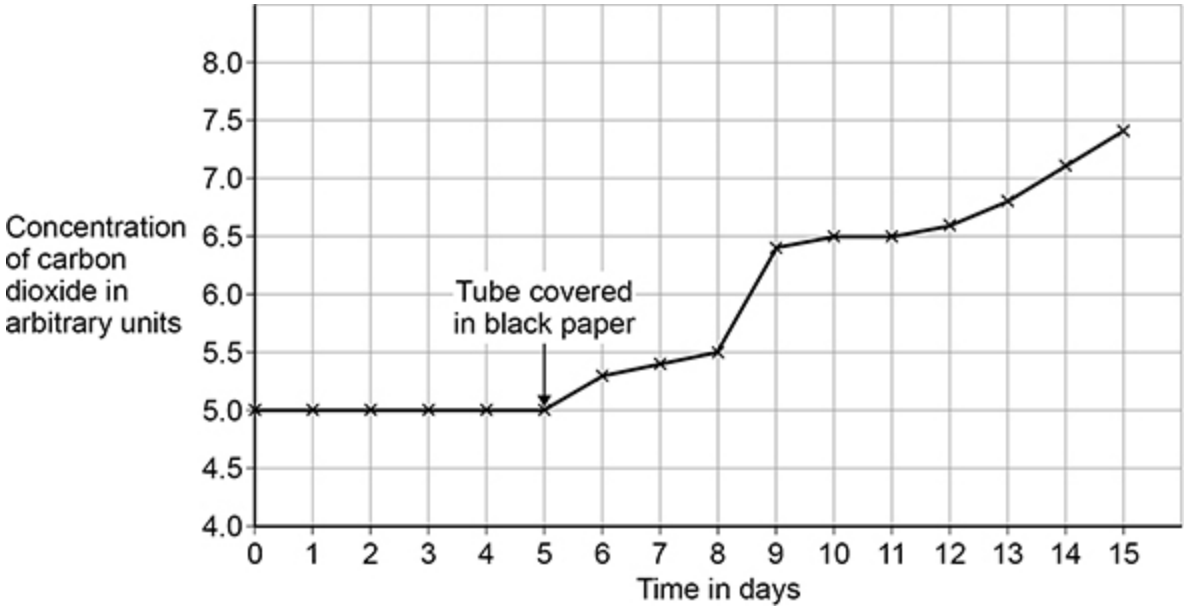
The data logger recorded the concentration of carbon dioxide continuously.

After 5 days, the scientist completely covered the boiling tube with black paper.

The data logger continued to record the concentration of carbon dioxide.

Figure 2 shows the concentration of carbon dioxide inside the boiling tube over 15 days.

Figure 2



(f) Explain why the concentration of carbon dioxide in the tube stayed the same between day 0 and day 5.

_____

_____

_____

_____

(2)

(g) Suggest why the concentration of carbon dioxide increased between day 5 and day 10.

_____

_____

_____

_____

(1)

(h) On day 10, the pond snail died.

Explain why the death of the pond snail caused the concentration of carbon dioxide to increase after day 10.

_____

_____

_____

_____

_____

_____

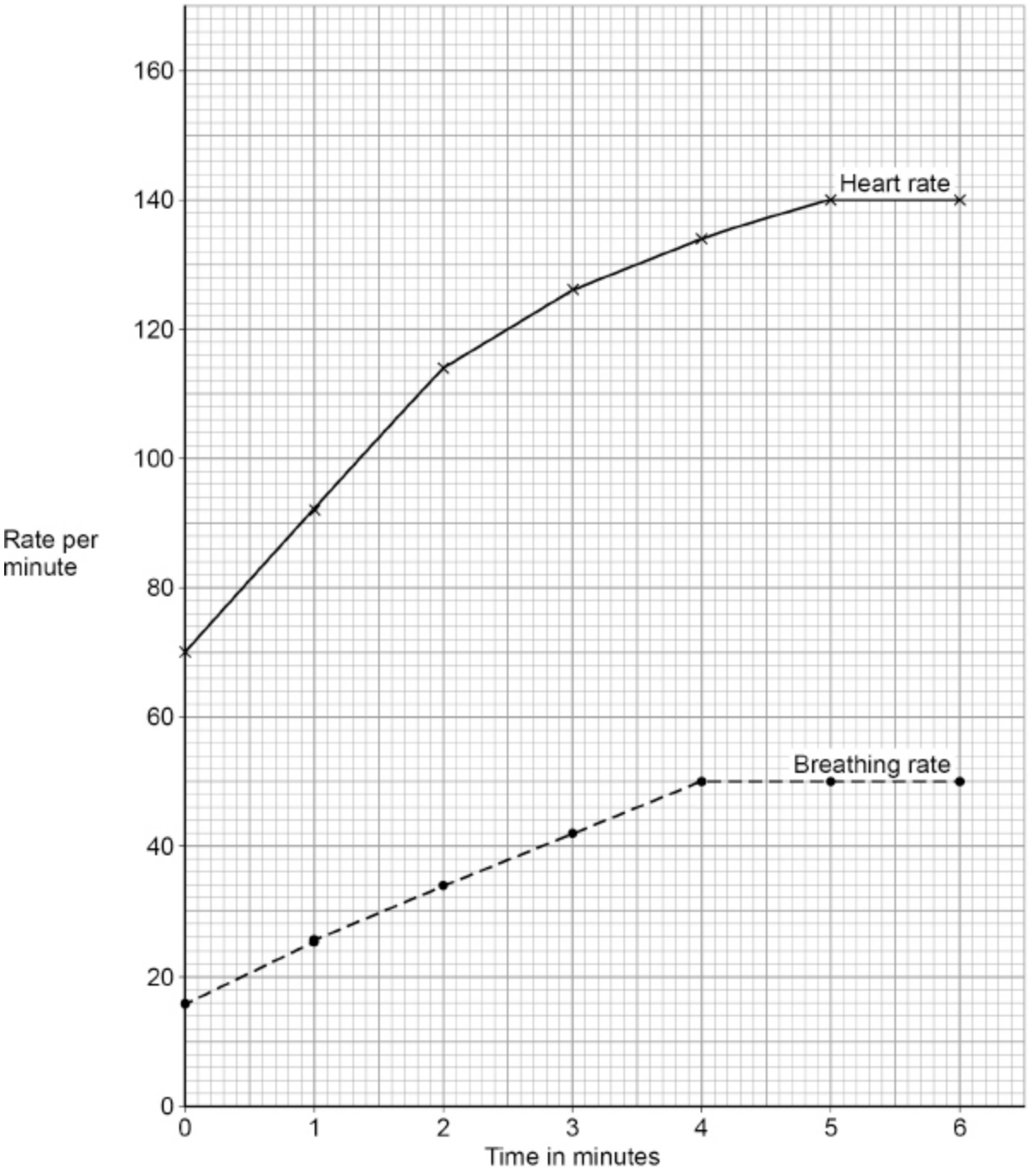
(3)

(Total 14 marks)

6. A 45-year-old man exercised on a rowing machine for six minutes.

A fitness monitor recorded his heart rate and breathing rate every minute.

The graph below shows the results.



(a) Describe the trend for breathing rate shown in graph.

Use data from the graph in your answer.

_____

_____

_____

_____

_____

_____

(3)

(b) The safe maximum heart rate for a person exercising can be calculated using the equation:

safe maximum heart rate = 220 – age in years

Calculate the safe maximum heart rate for the man.

_____

Safe maximum heart rate = _____ beats per minute

(1)

(c) What is the man's maximum heart rate?

Use the graph above.

Man's maximum heart rate = _____ beats per minute

(1)

(d) The man concluded that he was exercising at a safe heart rate.

Give the reason for his conclusion.

Use your answers from part (b) and part (c)

_____

_____

(1)

(e) Explain the ways the man's body has responded to the exercise.

Use information from the graph above.

(6)

(Total 12 marks)

1.

(a) any **two** from:

mark as pairs

- *(effect)* muscle fatigue **or** oxygen debt occurs (1)

  allow muscle cramp ignore fatigue / cramp unqualified

  (reason) caused by (build-up of) lactic acid (1)

- *(effect)* (continued) heavy / deep / fast breathing (1)

  (reason) to provide the oxygen needed to break down (built-up) lactic acid (1)

  allow to repay the oxygen debt

- *(effect)* (continued) increased heart rate (1)

  (*reason)* to provide the oxygen needed to break down (built-up) lactic acid (1)

  allow to repay the oxygen debt

- *(effect)* fewer / weaker muscle contractions (1)

  (reason) (because) less energy is released / available (1)

  *do **not** accept energy being produced / made / created*

4

(b) **Level 3:** The method would lead to the production of a valid outcome. The key steps are identified and logically sequenced.

5–6

Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the method is not fully logically sequenced.

3–4

Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.

1–2

No relevant content

0

Indicative content

- test a group of athletes
- use at least two different types / intensities of exercise
- get each athlete to do all exercises **or** have a large (≥30) group doing each exercise

- record heart rate for each athlete before and after exercise **or** calculate increase in heart rate for each athlete after exercise
- calculate the mean increase in heart rates for each type / intensity of exercise
- compare mean increase in heart rates for each type / intensity of exercise

- control variables:
  - same (biological) sex **or** mix of sexes
  - same level of activity / exercise
  - same age
  - same caffeine / drug / medicine intake
  - same length of time for exercise
  - no health issues / illnesses
  - return to resting heart rate before each exercise

(c) (athlete is) faster / stronger

allow description of improved performance

allow reference to increased stamina / endurance

1

(because more muscle mass so) more / stronger muscle contractions

1

(d) hybridoma

1

(e) any **three** from:

- (cell) is cloned

  ignore name of cell

- many (identical) cells are produced

  allow many clones are produced

- all the cells make the same antibody

- the antibody is (collected and) purified

3

(f) a monoclonal antibody only binds to the anabolic steroid

1

(g) to show that the test is working

allow to prevent a false negative (result)

ignore to show there are free / remaining monoclonal antibodies

1

(h) *evidence*
no blue / visible dye (in control area)

allow no line(s) (in control area) allow no colour change (in control area)

1

reason
(because) no (free) monoclonal antibodies bound to control area

allow the (free) monoclonal antibodies did not move up the test strip

allow urine did not move up the test strip

1

or

(because) there were no (free) monoclonal antibodies on the end of the (test) strip

(i) D

1

[21]

2. (a) any **two** from:

- temperature
- size of tomato plants **or** size / number of leaves

  allow age of plant
- light
- (volume of) water

  allow (amount of) water
- (amount / type of) fertiliser / minerals / ions / nutrients (given to plants)

  allow (type of) compost / soil

  allow named example of mineral ion such as nitrate / magnesium
- time before rate readings are taken

  ignore time unqualified

  ignore type of tomato plant

  ignore type of greenhouse

2

(b) from 0.02% to 0.04%

1

(c) repeat each reading three times and calculate a mean

1

(d) (the rate of photosynthesis) increases

ignore values

1

(because) carbon dioxide is needed for photosynthesis

*allow **2** marks for (there is) more carbon dioxide for (more) photosynthesis*

1

(e) any **two** from:

- it would not increase the rate (of photosynthesis)

  allow it would not change the rate (of photosynthesis)

  allow photosynthesis would not increase
- it would not increase the growth of tomatoes
- it would cost more

  allow idea of profit will not increase

  allow reference to avoiding global warming

2

[8]

3. (a) guard (cells)

1

(b) any **two** from:

- transpiration (stream) involves xylem **and** translocation involves phloem

  *allow transpiration (stream) involves dead cells **and** translocation involves living cells*

- transpiration (stream) transports water (and minerals / ions) **and** translocation transports (dissolved) sugars

  *allow transpiration (stream) transports water (and minerals / ions) **and** translocation transports (dissolved) sucrose*

  ignore glucose / ions / minerals in translocation

- transpiration (stream) moves substances upwards **and** translocation moves substances upwards and downwards

  *allow transpiration (stream) moves substances unidirectionally **and** translocation moves substances bidirectionally*

  *allow transpiration (stream) does not require energy (to move substances) **and** translocation does (require energy to move substances)*

2

(c) warm with low humidity

1

(d) stomata (almost) close at (mid)night because there is no / less light for photosynthesis

ignore dark for no / less light

1

(closing stomata) reduces / prevents water loss

1

stomata open wide(st) at midday as maximum light intensity for photosynthesis

allow stomata open wider as light intensity increases throughout the morning for photosynthesis

1

(stomata open wide) to take in most / more carbon dioxide for photosynthesis

ignore (stomata open) to take in carbon dioxide unqualified

1

ignore values for time and width

(e) stomata are open wider **and** for more time

1

(so allows plant) to take in more carbon dioxide for photosynthesis

allow (so allows) plant to take in as much carbon dioxide as in normal conditions for photosynthesis

1

allow descriptions of the area of open stomata for width

[10]

4. (a) $\frac{9.96 \times 10^{-3}}{1.35 \times 10^{-4}}$

allow $\frac{0.00996}{0.000135}$

1

73.77…

1

74 (:1)

allow a correctly derived whole number from an incorrect calculation

*do **not** accept if unit is given*

1

*if no answer in answer space allow answer in **Table 1***

(b) as size increases, (surface area to volume) ratio decreases

*allow they are inversely proportional **or** they are negatively correlated*

allow as one increases, the other decreases

allow as size decreases, (surface area to volume) ratio increases

1

(c) **D** has a smaller surface area to volume ratio (than **B**)

1

(so) diffusion distance is too large (to meet demands of cells / organism)

allow (so) diffusion is too slow (to meet demands of cells / organism)

1

*allow converse for **B** throughout*

(d) **D** has a larger surface area to volume ratio **and** so will lose heat more quickly (per unit volume than **E**)

*allow **D** has a larger surface area to volume ratio **and** so temperature of **D** will drop more quickly*

*ignore **E** loses more heat (overall)*

1

(**D**) requires greater rate of respiration

1

(as) respiration is a (large) part of metabolism

1

(so) need to generate more heat (to keep itself warm)

allow (so) needs to release more heat (to keep itself warm)

*do **not** accept energy produced / made / created*

1

*allow converse for **E** throughout*

(e) **Level 2:** Scientifically relevant facts, events or processes are identified and given in detail to form an accurate account.

3–4

Level 1: Facts, events or processes are identified and simply stated but their relevance is not clear.

1–2

No relevant content

0

Indicative content

- **both** have a large surface area
  - to maximise diffusion
- **both** have thin walls **or** have walls that are one cell thick
  - to reduce diffusion distance / time
- **both** are in close proximity to blood supply
  - to reduce diffusion distance / time
- **both** have a good blood supply **or** both have a capillary network
  - to maintain concentration gradient
- villi have microvilli
  - to (further) increase surface area
- cells of villi contain many mitochondria
  - for active transport

For **Level 2** reference to functions of structural details of **both** alveoli and villi is required.

[14]

5. (a) $6O_2 + C_6H_{12}O_6 \rightarrow 6H_2O + 6CO_2$

1

(b) mitochondria / mitochondrion

1

(c) any **two** from:

- movement / muscle contraction
- keeping warm
- active transport
- building larger molecules

ignore reference to metabolism unqualified

allow examples of movement

allow examples of building larger molecules e.g. making (named) proteins / cellulose

allow cell division

ignore growth

2

(d) any **two** from:

- anaerobic produces lactic acid **and** aerobic does not

  *allow anaerobic creates an oxygen debt **and** aerobic does not*
- aerobic produces carbon dioxide **and** anaerobic does not
- aerobic produces water **and** anaerobic does not
- aerobic occurs (mainly) in the mitochondria **and** anaerobic does not

  *allow anaerobic **only** occurs in the cytoplasm*
- anaerobic releases less energy than aerobic

  allow anaerobic releases less ATP (than anaerobic)

  *do **not** accept anaerobic produces / makes / creates less energy*

2

(e) carbon dioxide

1

ethanol

1

(f) pondweed takes in CO_2 for photosynthesis

1

snail **and** pondweed are respiring producing CO_2

*if no other mark awarded allow rate of respiration = rate of photosynthesis for **1** mark*

1

(g) (no light so) no photosynthesis
or
plant is not taking in CO_2

and

snail **and** plant are respiring and so are releasing CO_2

1

(h) snail is being decayed / decomposed / broken down

ignore being fed on

1

(by) decomposers / bacteria (in pond water / snail)

allow fungi / microbes / microorganisms

1

(therefore) respiration (of decomposers / bacteria) releases CO_2

*do **not** accept anaerobic respiration*

1

[14]

6. (a) increased (at first)

1

until 4 minutes **or** 50 breaths per minute

1

(then) stayed constant (from 4 minutes **or** at 50 breaths per minute)

1

(b) 175 (beats per minute)

1

(c) 140 (beats per minute)

1

(d) because his rate is lower than the maximum safe rate

allow ecf for incorrect values in question (b) and question (c)

1

(e) **Level 3:** Relevant points (reasons/causes) are identified, given in detail and logically linked to form a clear account.

5–6

Level 2: Relevant points (reasons/causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.

3–4

Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.

1–2

No relevant content

0

Indicative content

- heart rate increased
  - to increase blood flowing to muscles / lungs
  - to provide more oxygen (to muscles)
  - to provide more glucose (to muscles)
  - to remove carbon dioxide more quickly (from the muscles / blood)
  - to remove lactic acid more quickly (from the muscles)

- breathing rate increased
  - supplies more oxygen / air to lungs
  - so more oxygen to blood
  - more carbon dioxide removed

- more oxygen to muscles
  - needed for (increased) respiration
  - to release / provide energy
  - for muscle contraction

- anaerobic respiration occurs
  - due to lack of oxygen
  - which causes a build-up of lactic acid
  - oxygen debt
  - muscle fatigue / pain

To reach **Level 3**, there must be reference to heart rate, breathing rate and respiration

[12]