3.16 Biology: Respiration, Digestion and Gas Exchange: 1-hour Pack

Total Marks

ISEB Common Entrance Biology (13+) · Calculator allowed · about 60 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 Aerobic respiration takes place continuously inside almost every living cell in the human body, not only during exercise.

(a) Complete the word equation for aerobic respiration. **(2)**

____ + ____ -> carbon dioxide + ____ (+ energy released)

(b) Name the organelle inside a cell where most aerobic respiration takes place. **(1)**

(c) A pupil says: 'My cells only respire when I am exercising, and stop again once I sit down and rest.' Explain why this statement is incorrect. **(2)**

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2 During very vigorous exercise, a runner's muscles cannot always get enough oxygen from the blood to respire fully aerobically.

(a) Complete the word equation for anaerobic respiration in human muscle cells. **(1)**

glucose -> ____ (+ energy released)

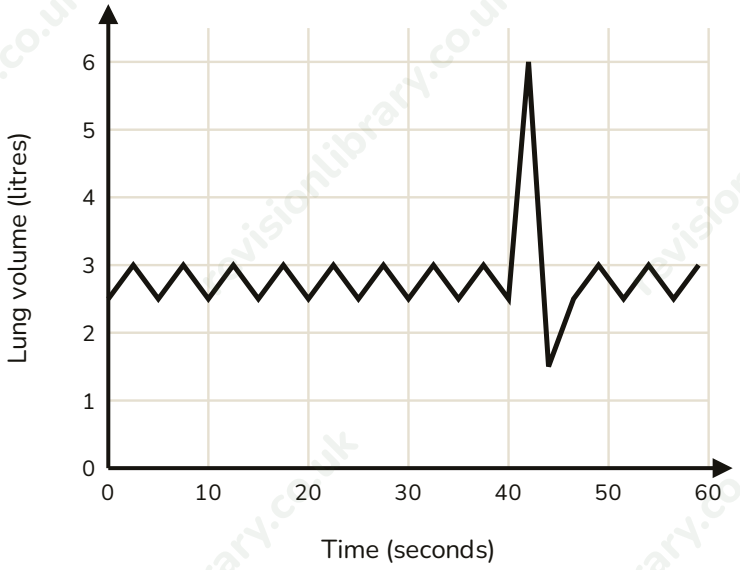
(b) Explain why anaerobic respiration releases much less energy per glucose molecule than aerobic respiration. **(2)**

(c) Define the term 'oxygen debt', and state how it is repaid after exercise finishes. **(2)**

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3 The graph below is a spirometer trace for a resting adult over one minute. The vertical axis shows lung volume (litres) and the horizontal axis shows time (seconds).

For the first 30 seconds, the trace shows regular, evenly-spaced normal breathing cycles between a lung volume of 2.5 litres and 3.0 litres; there are 6 complete breathing cycles in this 30 second period. At 40 seconds, the person then takes one maximal breath in, reaching a peak lung volume of 6.0 litres, before breathing out fully to a minimum lung volume of 1.5 litres. Normal breathing then resumes.



(a) Define 'tidal volume', and state its value from the trace during normal resting breathing. **(2)**

(b) Define 'vital capacity', and calculate its value from the maximal breath shown on the trace. **(2)**

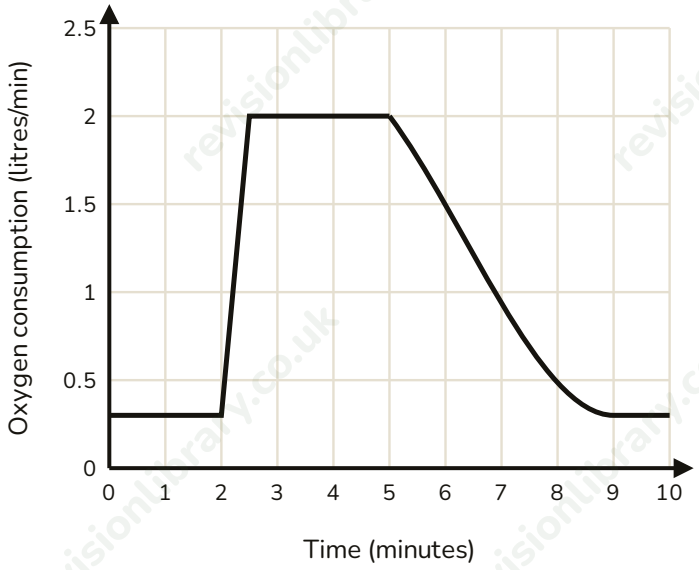
(c) Calculate the person's breathing rate at rest, in breaths per minute, using the number of cycles shown in the first 30 seconds of the trace. **(2)**

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(d) Suggest why a well-trained athlete would be expected to have a larger vital capacity than a non-athlete of a similar size. **(1)**

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4 The graph shows a person's rate of oxygen consumption (litres per minute) before, during and after a short period of vigorous exercise. Resting oxygen consumption is 0.3 litres per minute. During exercise, oxygen consumption rises to and stays at 2.0 litres per minute. Exercise stops at the 5 minute mark; oxygen consumption then falls gradually, only returning to the resting rate of 0.3 litres per minute at the 9 minute mark.



(a) Define 'oxygen debt'. **(1)**

(b) Explain what happens to the lactic acid built up in the muscles during the recovery period, to repay the oxygen debt. **(2)**

(c) Using the graph, state the time taken for oxygen consumption to return to the resting rate after exercise stopped. **(2)**

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5 In normal blood, 0.3% of red blood cells show abnormality; in anaemic blood, 2.4% show abnormality. Calculate how many times greater the abnormality rate is in anaemic blood.

(1)

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6 Which food type does amylase help to digest?

- ☐ A) starch
- ☐ B) minerals
- ☐ C) fibre
- ☐ D) vitamins
- ☐ E) protein

---

7 Why does the body need iron?

- ☐ A) to insulate the body and store energy
- ☐ B) to make haemoglobin in red blood cells
- ☐ C) to make bones and teeth strong
- ☐ D) to help the body absorb calcium and prevent rickets
- ☐ E) for growth and repair

---

8 Why are the walls of the alveoli very thin?

- ☐ A) so that food can pass through
- ☐ B) so that mucus can escape
- ☐ C) so that gases can diffuse across quickly
- ☐ D) so that they can pump blood
- ☐ E) so that they can hold more air

---

9 Which enzyme digests fat?

- ☐ A) catalase
- ☐ B) amylase
- ☐ C) protease
- ☐ D) lactase
- ☐ E) lipase

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10 Why does the body need proteins?

- ☐ A) to provide a quick source of energy
- ☐ B) to make bones and teeth strong
- ☐ C) to make haemoglobin in red blood cells
- ☐ D) for growth and repair
- ☐ E) to help food move through the gut

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11 Which substance in red blood cells carries oxygen?

- ☐ A) haemoglobin
- ☐ B) insulin
- ☐ C) cellulose
- ☐ D) chlorophyll
- ☐ E) amylase

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12 Plant cells perform photosynthesis and cellular respiration. Name the organelle where most cellular respiration occurs in a plant cell.

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.....

.....

(1)

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13 Which food type does protease help to digest?

- ☐ A) fat
- ☐ B) fibre
- ☐ C) protein
- ☐ D) minerals
- ☐ E) vitamins

---

14 Why does the body need vitamin C?

- ☐ A) to help food move through the gut
- ☐ B) to help the body absorb calcium and prevent rickets
- ☐ C) to make bones and teeth strong
- ☐ D) to prevent scurvy
- ☐ E) to provide a quick source of energy

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15 Which gas is higher in exhaled air than in inhaled air?

- ☐ A) hydrogen
- ☐ B) argon
- ☐ C) nitrogen
- ☐ D) oxygen
- ☐ E) carbon dioxide

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16 A respirometer containing dry yeast cells is set up in the same manner. At 20°C, a coloured drop moves 30 mm in 12 minutes as the cells consume oxygen. Calculate the rate of respiration, in mm of drop movement per minute.

(1)

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17 Which food type does lipase help to digest?

- ☐ A) vitamins
- ☐ B) fat
- ☐ C) minerals
- ☐ D) fibre
- ☐ E) starch

---

18 Why does the body need fibre?

- ☐ A) to provide a quick source of energy
- ☐ B) to insulate the body and store energy
- ☐ C) to help food move through the gut
- ☐ D) for growth and repair
- ☐ E) to make haemoglobin in red blood cells

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19 What happens to the ribcage when you breathe in?

- ☐ A) it stays still
- ☐ B) it moves up and in
- ☐ C) it moves down and in
- ☐ D) it moves down and out
- ☐ E) it moves up and out

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20 A student investigates the rate of respiration of germinating sunflower seeds using a respirometer. Soda lime absorbs carbon dioxide, and a coloured drop indicates oxygen uptake. At 25°C, the drop moves 18 mm in 10 minutes. Calculate the rate of respiration of the seeds, in mm of drop movement per minute.

(1)

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21 Why does the body need carbohydrates?

- ☐ A) to help the body absorb calcium and prevent rickets
- ☐ B) to provide a quick source of energy
- ☐ C) to make bones and teeth strong
- ☐ D) for growth and repair
- ☐ E) to make haemoglobin in red blood cells

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22 In which part of the lungs does gas exchange take place?

- ☐ A) alveoli
- ☐ B) trachea
- ☐ C) bronchioles
- ☐ D) diaphragm
- ☐ E) bronchi

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23 Anaerobic respiration takes place in cells during intense exercise when oxygen is scarce. Name the organelle inside a cell where aerobic respiration normally takes place at rest.

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.....

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(1)

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24 Which enzyme digests protein?

- ☐ A) lactase
- ☐ B) amylase
- ☐ C) catalase
- ☐ D) lipase
- ☐ E) protease

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25 Why does the body need vitamin D?

- ☐ A) to insulate the body and store energy
- ☐ B) to help the body absorb calcium and prevent rickets
- ☐ C) to provide a quick source of energy
- ☐ D) for growth and repair
- ☐ E) to make bones and teeth strong

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26 What waste gas is made by respiration?

- ☐ A) argon
- ☐ B) oxygen
- ☐ C) nitrogen
- ☐ D) carbon dioxide
- ☐ E) hydrogen

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27 Hydrogen sulphide in polluted air binds to blood proteins. In a non-polluted area, 0.5% of protein is bound this way; in a heavily polluted area, 4% is bound. Calculate how many times greater the percentage is in the polluted area.

(1)

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28 Why does the body need fats?

- ☐ A) to insulate the body and store energy
- ☐ B) for growth and repair
- ☐ C) to help food move through the gut
- ☐ D) to make haemoglobin in red blood cells
- ☐ E) to make bones and teeth strong

---

29 What happens to the diaphragm when you breathe in?

- ☐ A) it disappears
- ☐ B) it moves up and out
- ☐ C) it contracts and flattens
- ☐ D) it relaxes and curves upwards
- ☐ E) it gets shorter and tighter

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30 Anaerobic respiration occurs in muscles during intense exercise, not requiring oxygen. Name the organelle where aerobic respiration primarily takes place in a muscle cell.

(1)

31 Why does the body need calcium?

- [ ] A) to help food move through the gut
- [ ] B) to make bones and teeth strong
- [ ] C) to help the body absorb calcium and prevent rickets
- [ ] D) to provide a quick source of energy
- [ ] E) for growth and repair

32 Which tubes does the trachea divide into?

- [ ] A) bronchioles
- [ ] B) nostrils
- [ ] C) oesophagi
- [ ] D) bronchi
- [ ] E) alveoli

33 In a respirometer, a liquid drop moves 30 mm in 10 minutes while measuring respiration. Calculate the respiration rate in mm per minute.

(1)

34 Which nutrient does the body need to help food move through the gut?

- [ ] A) vitamin D
- [ ] B) calcium
- [ ] C) proteins
- [ ] D) vitamin C
- [ ] E) fibre

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35 What happens to the volume of the chest when you breathe in?

- ☐ A) it doubles then halves
- ☐ B) it decreases
- ☐ C) it increases
- ☐ D) it stops
- ☐ E) it stays the same

---

36 A respirometer measures seed respiration rate. A drop moves 18 mm in 15 minutes at 20°C. Calculate the rate of respiration in mm per minute.

(1)

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37 Which nutrient does the body need for growth and repair?

- ☐ A) proteins
- ☐ B) calcium
- ☐ C) carbohydrates
- ☐ D) fibre
- ☐ E) fats

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38 Which tube carries air from the throat towards the lungs?

- ☐ A) trachea
- ☐ B) bronchiole
- ☐ C) alveolus
- ☐ D) oesophagus
- ☐ E) diaphragm

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39 In a healthy person, 2% of haemoglobin is damaged; in a person with a condition, 10% is damaged. Calculate how many times greater the damage is in the person with the condition.

(1)

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40 Which nutrient does the body need to prevent scurvy?

- [ ] A) fibre
- [ ] B) vitamin C
- [ ] C) calcium
- [ ] D) vitamin D
- [ ] E) iron

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41 A respirometer's indicator drop moves 36 mm in 12 minutes. Calculate the respiration rate in mm per minute.

(1)

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42 Which nutrient does the body need to make bones and teeth strong?

- [ ] A) fats
- [ ] B) vitamin C
- [ ] C) calcium
- [ ] D) proteins
- [ ] E) fibre

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43 Digestive enzymes are described as being 'specific' to the substrate they break down.

(a) Describe the 'lock and key' model of how an enzyme works. **(2)**

(b) Using the lock and key model, explain why amylase can break down starch but cannot break down protein. **(2)**

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Mark scheme · 3.16 Biology: Respiration, Digestion and Gas Exchange: 1-hour Pack

Question 1

(a) glucose and oxygen on the left-hand side (both needed for the mark) **B1**

(a) water on the right-hand side **B1**

(a) Answer: glucose + oxygen -> carbon dioxide + water (+ energy released)

(b) mitochondria (mitochondrion) cao **B1**

(b) Answer: Mitochondria.

(c) cells respire all the time (continuously), even at rest, to release the energy needed for processes such as keeping warm, cell repair and the activity of internal organs oe **B1**

(c) exercise increases the rate of respiration (more energy is needed for muscle contraction), it does not switch respiration on and off oe **B1**

(c) Answer: Respiration happens continuously in all cells, even at rest, to release energy for essential processes; exercise only increases its rate, it does not start or stop it.

Question 2

(a) lactic acid cao **B1**

(a) Answer: glucose -> lactic acid (+ energy released)

(b) anaerobic respiration only partially (incompletely) breaks down the glucose molecule, into lactic acid, whereas aerobic respiration breaks it down fully oe **B1**

(b) because glucose is not fully broken down, most of the energy stored in it remains locked inside the lactic acid, so much less is released oe **B1**

(b) Answer: Anaerobic respiration only partially breaks glucose down into lactic acid, so most of the energy stored in the glucose is not released.

(c) oxygen debt is the extra oxygen the body needs after exercise, above the normal resting amount, to deal with the lactic acid built up during anaerobic respiration oe **B1**

(c) it is repaid by continuing to breathe faster and deeper after exercise stops, supplying the extra oxygen needed to break down the lactic acid oe **B1**

(c) Answer: Oxygen debt is the extra oxygen needed after exercise to deal with lactic acid build-up; it is repaid by continued fast, deep breathing after exercise stops.

Question 3

(a) tidal volume is the volume of air breathed in or out in one normal (resting) breath oe **B1**

(a) 0.5 litres (3.0 - 2.5) cao **B1**

(a) Answer: Tidal volume is the volume of air moved in one normal breath; from the trace, this is 0.5 litres.

(b) vital capacity is the maximum volume of air that can be breathed out after taking the deepest possible breath in oe **B1**

(b) 4.5 litres (6.0 - 1.5) cao **B1**

(b) Answer: Vital capacity is the maximum volume of air that can be forced out after a maximal breath in; from the trace, this is 4.5 litres.

(c) 6 (cycles in 30 s) x 2 oe **M1**

(c) 12 breaths per minute cao **A1**

(c) Answer: 12 breaths per minute

(d) regular (aerobic) training strengthens the breathing muscles (diaphragm and intercostal muscles) and increases lung development, allowing a greater maximum volume of air to be moved in and out oe **B1**

(d) Answer: Regular training strengthens the breathing muscles and develops the lungs, allowing a greater maximum volume of air to be moved.

Question 4

(a) the extra oxygen needed by the body after exercise, above the normal resting amount, to deal with the lactic acid built up during anaerobic respiration oe **B1**

(a) Answer: The extra oxygen needed after exercise to deal with the lactic acid built up during anaerobic respiration.

(b) the lactic acid is transported, in the blood, to the liver oe **B1**

(b) in the liver it is oxidised (broken down using oxygen) into carbon dioxide and water oe **B1**

(b) Answer: Lactic acid is carried in the blood to the liver, where it is oxidised (broken down using oxygen) into carbon dioxide and water.

(c) identifies exercise stopped at the 5 minute mark and the resting rate was reached again at the 9 minute mark **M1**

(c) 4 minutes cao **A1**

(c) Answer: 4 minutes

Question 5

8 times (x8) (oe) **B1**

Answer: 8 times (x8)

Question 6

A (starch) **B1**

Answer: A) starch

Question 7

B (to make haemoglobin in red blood cells) **B1**

Answer: B) to make haemoglobin in red blood cells

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Question 8

C (so that gases can diffuse across quickly) **B1**

Answer: C) so that gases can diffuse across quickly

Question 9

E (lipase) **B1**

Answer: E) lipase

Question 10

D (for growth and repair) **B1**

Answer: D) for growth and repair

Question 11

A (haemoglobin) **B1**

Answer: A) haemoglobin

Question 12

Mitochondria (oe) **B1**

Answer: Mitochondria

Question 13

C (protein) **B1**

Answer: C) protein

Question 14

D (to prevent scurvy) **B1**

Answer: D) to prevent scurvy

Question 15

E (carbon dioxide) **B1**

Answer: E) carbon dioxide

Question 16

2.5 mm per minute (oe) **B1**

Answer: 2.5 mm per minute

Question 17

B (fat) **B1**

Answer: B) fat

Question 18

C (to help food move through the gut) **B1**

Answer: C) to help food move through the gut

Question 19

E (it moves up and out) **B1**

Answer: E) it moves up and out

Question 20

1.8 mm per minute (oe) **B1**

Answer: 1.8 mm per minute

Question 21

B (to provide a quick source of energy) **B1**

Answer: B) to provide a quick source of energy

Question 22

A (alveoli) **B1**

Answer: A) alveoli

Question 23

Mitochondria (oe) **B1**

Answer: Mitochondria

Question 24

E (protease) **B1**

Answer: E) protease

Question 25

B (to help the body absorb calcium and prevent rickets) **B1**

Answer: B) to help the body absorb calcium and prevent rickets

Question 26

D (carbon dioxide) **B1**

Answer: D) carbon dioxide

Question 27

8 times (x8) (oe) **B1**

Answer: 8 times (x8)

Question 28

A (to insulate the body and store energy) **B1**

Answer: A) to insulate the body and store energy

Question 29

C (it contracts and flattens) **B1**

Answer: C) it contracts and flattens

Question 30

Mitochondria (oe) **B1**

Answer: Mitochondria

Question 31

B (to make bones and teeth strong) **B1**

Answer: B) to make bones and teeth strong

Question 32

D (bronchi) **B1**

Answer: D) bronchi

Question 33

3 mm per minute (oe) **B1**

Answer: 3 mm per minute

Question 34

E (fibre) **B1**

Answer: E) fibre

Question 35

C (it increases) **B1**

Answer: C) it increases

Question 36

1.2 mm per minute (oe) **B1**

Answer: 1.2 mm per minute

Question 37

A (proteins) **B1**

Answer: A) proteins

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Question 38

A (trachea) **B1**

Answer: A) trachea

Question 39

5 times (x5) (oe) **B1**

Answer: 5 times (x5)

Question 40

B (vitamin C) **B1**

Answer: B) vitamin C

Question 41

3 mm per minute (oe) **B1**

Answer: 3 mm per minute

Question 42

C (calcium) **B1**

Answer: C) calcium

Question 43

(a) an enzyme has an active site with a specific shape, which fits (like a lock) only one particular substrate (like a key) oe **B1**

(a) the substrate binds to the active site, allowing the enzyme to catalyse (speed up) the breakdown of that substrate oe **B1**

(a) Answer: An enzyme's active site has a specific shape that only fits one substrate, like a lock and key; the substrate binds there so the enzyme can catalyse its breakdown.

(b) amylase's active site has a shape that is complementary to (fits) starch molecules only oe **B1**

(b) a protein molecule has a different shape, so it does not fit/bind to amylase's active site, meaning amylase cannot catalyse its breakdown oe **B1**

(b) Answer: Amylase's active site shape only fits starch molecules; protein has a different shape that does not fit the active site, so amylase cannot break it down.

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