



K1E Cells and Organisation: Depth and Practice

AQA AQA KS3 Science - Biology · Calculator allowed · about 75 minutes

Name: _____ Date: ____ / ____ / ____

Answer ALL questions. Show all your working.

1 Which of these organelles is found in plant cells but is never found in animal cells?

- ☐ A) Nucleus
- ☐ B) Mitochondria
- ☐ C) Chloroplast
- ☐ D) Cytoplasm

2 Plants have two types of transport tissue: xylem and phloem.

- (a) State the function of xylem tissue. (1)
- (b) State the function of phloem tissue. (1)
- (c) State the direction in which phloem transports food, compared with xylem's transport of water. (1)

3 Required practical: a student places a fresh celery stick, freshly cut at the base, into a beaker of water coloured with red food dye. She leaves it for 24 hours, then cuts a thin cross-section near the base of the stalk and examines it.

- (a) Predict what the student would observe in the cross-section after 24 hours. (1)
- (b) Name the plant tissue responsible for carrying the coloured water up the celery stalk. (1)
- (c) Explain how the structure of xylem vessels helps them transport water efficiently. (2)
- (d) The student repeats the experiment but places a second celery stick in a beaker of the same dyed water kept in a cold refrigerator. Predict and explain how the results would differ. (2)

4 Two cube-shaped model cells are being compared: cube A has sides of length 1 cm, and cube B has sides of length 2 cm.

- (a) Calculate the surface area and the volume of cube A. (2)
- (b) Calculate the surface area and the volume of cube B. (2)
- (c) Calculate the surface area to volume ratio of cube A and of cube B (in the form X:1), and use your answers to explain which cube would exchange substances with its surroundings more efficiently for its size. (1)

5 Villi are tiny, finger-like projections that line the inside of the small intestine, increasing its surface area for the absorption of digested food.

(a) State two other ways, besides their finger-like shape, that villi are adapted for efficient absorption. (2)

(b) Using your answer to Question 4, explain why many small, finger-like villi provide a much larger surface area than the same amount of tissue would if it were a single flat wall. (2)

6 The trachea (windpipe) is lined with ciliated cells and goblet cells.

(a) State the function of goblet cells in the trachea. (1)

(b) Describe how the structure of a ciliated cell is adapted to its function of keeping the airways clear. (2)

(c) Suggest one effect on the lungs if a person's ciliated cells were damaged, for example by smoking. (1)

7 An egg cell (ovum) is a specialised cell adapted for reproduction.

(a) Describe one adaptation of an egg cell relating to energy or nutrients, and explain its function. (2)

(b) After fertilisation by one sperm cell, the egg cell's membrane changes to prevent any further sperm cells from entering. Explain why this is important. (2)

8 Blood contains red blood cells, white blood cells, platelets and plasma.

(a) State the function of platelets in the blood. (2)

(b) State one other reason why forming a clot quickly at a wound is important for the body. (2)

9 A student calibrates the eyepiece graticule on her microscope using a stage micrometre (a slide with a scale of known real size). At a particular magnification, she finds that 40 small divisions on the eyepiece graticule line up exactly with a length of 500 micrometres on the stage micrometre.

(a) Calculate the real length represented by 1 eyepiece graticule division at this magnification, in micrometres. (2)

(b) The student then measures a plant cell using the same eyepiece graticule and finds it spans 8 graticule divisions. Calculate the real length of the cell, in micrometres. (2)

(c) State why the student must recalibrate the eyepiece graticule if she changes to a different objective lens (a different magnification). (1)

10 The body contains three types of muscle tissue: skeletal, cardiac and smooth.

- (a) State where skeletal muscle is found and give its general function. (1)
 - (b) State where cardiac muscle is found. (1)
 - (c) State one way smooth muscle differs from skeletal muscle in terms of control. (1)
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11 The digestive system is one example of an organ system built from increasing levels of organisation.

- (a) Name one organ found in the digestive system. (1)
- (b) The wall of the small intestine contains muscle tissue and epithelial tissue. State what is meant by the term 'tissue'. (1)
- (c) Explain, using the small intestine as an example, how cells, tissues and organs are related to each other in a hierarchy. (2)

12 Required practical: a student prepares agar cubes containing universal indicator (purple in alkaline agar) and cuts them into cubes of different sizes: 1 cm, 2 cm and 3 cm sides. She drops each cube into a beaker of dilute hydrochloric acid and records the time taken for the acid to diffuse all the way to the centre of each cube, shown by the whole cube turning red. Results: 1 cm cube = 45 s, 2 cm cube = 180 s, 3 cm cube = 400 s.

- (a) Identify the independent variable and the dependent variable in this investigation. (2)
- (b) Describe the pattern shown by the results. (1)
- (c) Using your understanding of surface area to volume ratio (see Question 4), explain why the larger cubes take much longer for the acid to reach the centre. (3)

13 For each statement, identify whether it is True or False. If a statement is false, give the correct version.

- (a) Xylem transports water and dissolved sugars from the roots to the leaves. (1)
- (b) A tissue is made of two or more different types of organ working together. (1)
- (c) Smaller cells generally have a larger surface area to volume ratio than larger cells of the same shape. (1)
- (d) Egg cells and sperm cells are both examples of specialised cells adapted for reproduction. (1)

- 14** Simple, tiny organisms such as amoeba can absorb all the oxygen and nutrients they need, and remove all their waste, by diffusion alone across their outer surface. Explain why large, multicellular organisms such as humans cannot rely on diffusion alone, and explain how specialised exchange surfaces and transport systems (such as the lungs, small intestine and circulatory system) overcome this problem.

(6)

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- 15** Which of these best defines an organ system?

- ☐ A) A group of similar cells working together
- ☐ B) A structure made of two or more tissues working together for a specific function
- ☐ C) A group of organs working together to perform a major body function
- ☐ D) The basic unit of life

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- 16** The underside of a leaf contains many small pores called stomata, each surrounded by a pair of guard cells.

(a) State the function of stomata. (1)

(b) Explain how guard cells control the size of the stomatal pore. (2)

17 Stem cells in red bone marrow continually divide and differentiate to produce new blood cells.

(a) State what is meant by the term 'differentiate'. (1)

(b) Bone marrow stem cells can differentiate into red blood cells, white blood cells or platelets. Explain why the body needs a continuous supply of new blood cells from stem cells. (2)

18 Fungal cells, like plant cells, have a cell wall, but the cell wall of a fungal cell is made of a different substance.

(a) State what a plant cell wall is made of. (1)

(b) State what a fungal cell wall is made of. (1)

(c) Fungal cells do not contain chloroplasts. State what this tells you about how fungi obtain their food, compared with plants. (1)

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Question 1

- **B1** C cao
- Answer: **C) Chloroplast**

Question 2

- (a) **B1** transports water and dissolved mineral ions from the roots to the rest of the plant, oe
- (a) Answer: **Transports water and dissolved mineral ions from the roots upward through the plant.**
- (b) **B1** transports dissolved food (sugars, e.g. sucrose) made in the leaves to other parts of the plant, oe
- (b) Answer: **Transports dissolved sugars made in the leaves to other parts of the plant.**
- (c) **B1** phloem can transport substances both up and down the plant (in any direction, from source to sink), unlike xylem, which only transports water upward from the roots, oe
- (c) Answer: **Phloem transports food both up and down the plant, whereas xylem only transports water upward.**

Question 3

- (a) **B1** small red dots/rings (a pattern of coloured points) visible around the edge of the cross-section, oe
- (a) Answer: **A ring of small red dots around the edge of the cross-section.**
- (b) **B1** xylem cao
- (b) Answer: **Xylem.**
- (c) **M1** xylem vessels are long, hollow tubes formed from dead cells joined end to end, with no end walls or cell contents in the way
- (c) **A1** this allows water to flow through them easily and continuously up the plant, oe
- (c) Answer: **Xylem vessels are hollow tubes of dead, joined-up cells with no end walls or contents, allowing water to flow through them easily.**
- (d) **M1** in the cold fridge, the dye would rise more slowly, or a shorter distance, in the same time
- (d) **A1** because transpiration (water evaporating from the leaves, drawing water up the xylem) happens more slowly at a lower temperature, reducing the rate of water uptake, oe
- (d) Answer: **The dye would rise more slowly in the fridge, because transpiration (which draws water up the xylem) happens more slowly at lower temperatures.**

Question 4

- (a) **M1** surface area = $6 \times (1 \times 1) = 6 \text{ cm}^2$
- (a) **A1** volume = $1 \times 1 \times 1 = 1 \text{ cm}^3$, both cao
- (a) Answer: **Surface area = 6 cm^2 , volume = 1 cm^3**
- (b) **M1** surface area = $6 \times (2 \times 2) = 24 \text{ cm}^2$
- (b) **A1** volume = $2 \times 2 \times 2 = 8 \text{ cm}^3$, both cao
- (b) Answer: **Surface area = 24 cm^2 , volume = 8 cm^3**
- (c) **B1** cube A ratio = 6:1, cube B ratio = 3:1 (24:8 simplified); cube A (the smaller cube) has the larger surface area to volume ratio, so it can exchange substances more efficiently relative to its size, oe
- (c) Answer: **Cube A = 6:1, cube B = 3:1; cube A has the larger ratio, so it exchanges substances more efficiently for its size.**

Question 5

- (a) **B1** wall is only one cell thick, giving a short diffusion distance for absorbed substances
- (a) **B1** villi have a good/rich blood supply (many capillaries), which maintains a steep concentration gradient for diffusion, oe
- (a) Answer: **A wall only one cell thick (short diffusion distance) and a good blood supply.**
- (b) **M1** splitting the surface into many small projections greatly increases the total surface area for the same overall volume of tissue
- (b) **A1** this gives a much higher surface area to volume ratio, matching the idea that smaller/more divided shapes have a bigger surface area to volume ratio (ft from Q4), oe
- (b) Answer: **Dividing the surface into many small villi greatly increases total surface area without increasing volume much, giving a much higher surface area to volume ratio, similar to how the smaller cube in Question 4 had a bigger ratio.**

Question 6

- (a) **B1** produce/secrete mucus, which traps dust, bacteria and other particles breathed in with the air, oe
- (a) Answer: **They produce mucus, which traps dust, bacteria and other particles.**
- (b) **M1** ciliated cells have hair-like cilia on their surface
- (b) **A1** the cilia beat/wave in a coordinated way to sweep the mucus, with trapped particles, up and away from the lungs toward the throat, oe
- (b) Answer: **Ciliated cells have hair-like cilia that beat in a coordinated way to sweep mucus and trapped particles away from the lungs.**
- (c) **B1** mucus (and trapped particles/bacteria) would build up in the airways/lungs instead of being removed, increasing the risk of infection or irritation, oe
- (c) Answer: **Mucus and trapped particles would build up in the lungs instead of being cleared, increasing the risk of infection.**

Question 7

- (a) **M1** the cytoplasm contains a store of nutrients (food reserves)
- (a) **A1** which provides energy and raw materials for the early stages of development if the egg is fertilised, oe
- (a) Answer: **The cytoplasm contains a store of nutrients, providing energy for early development after fertilisation.**
- (b) **M1** prevents more than one sperm cell fertilising the same egg
- (b) **A1** this ensures the resulting embryo has the correct (normal) number of chromosomes, which is essential for normal development, oe
- (b) Answer: **It stops more than one sperm fertilising the egg, ensuring the embryo has the correct number of chromosomes for normal development.**

Question 8

- (a) **B1** they help blood to clot at a wound/cut
- (a) **B1** this seals the wound to stop further blood loss, oe
- (a) Answer: **Platelets help blood clot at a wound, sealing it to stop further blood loss.**
- (b) **M1** prevents further loss of blood (and a drop in blood pressure)
- (b) **A1** forms a barrier (a scab) that helps prevent pathogens/microorganisms entering the body through the open wound, oe
- (b) Answer: **Clotting prevents further blood loss and forms a barrier that helps stop pathogens entering through the wound.**

Question 9

- (a) **M1** 500 / 40
- (a) **A1** 12.5 micrometres cao
- (a) Answer: **12.5 micrometres**
- (b) **M1** 8 x 12.5, ft from (a)
- (b) **A1** 100 micrometres cao
- (b) Answer: **100 micrometres**
- (c) **B1** the real length represented by one graticule division changes with magnification, so the calibration is only valid at the magnification it was carried out at, oe
- (c) Answer: **The real length per graticule division depends on the magnification used, so calibration is only valid for that magnification.**

Question 10

- (a) **B1** attached to bones (by tendons); contracts to move the skeleton/body, oe
- (a) Answer: **Attached to bones; contracts to move the body.**
- (b) **B1** in the walls of the heart cao
- (b) Answer: **In the walls of the heart.**
- (c) **B1** smooth muscle contracts involuntarily/automatically (e.g. in the walls of the gut or blood vessels), whereas skeletal muscle is under voluntary control, oe
- (c) Answer: **Smooth muscle works involuntarily (automatically), unlike skeletal muscle, which is under voluntary control.**

Question 11

- (a) **B1** any correct organ, e.g. stomach, small intestine, large intestine, liver, pancreas
- (a) Answer: **e.g. Stomach.**
- (b) **B1** a group of similar cells working together to carry out a shared function, oe
- (b) Answer: **A group of similar cells working together to carry out a shared function.**
- (c) **M1** cells (e.g. epithelial cells) group together to form a tissue (e.g. epithelial tissue lining the intestine)
- (c) **A1** different tissues (e.g. epithelial tissue and muscle tissue) work together within the organ (the small intestine) to carry out its overall function of digestion and absorption, oe
- (c) Answer: **Similar cells group to form a tissue (e.g. epithelial tissue); different tissues then work together within the small intestine (the organ) to carry out digestion and absorption.**

Question 12

- (a) **B1** independent variable = size (side length) of the agar cube (oe)
- (a) **B1** dependent variable = time taken for the acid to diffuse to the centre (whole cube to turn red), oe
- (a) Answer: **Independent variable: size of the agar cube. Dependent variable: time for the acid to reach the centre.**
- (b) **B1** as the size (side length) of the cube increases, the time taken for the acid to reach the centre increases, oe
- (b) Answer: **As cube size increases, the time for acid to reach the centre increases.**
- (c) **M1** larger cubes have a smaller surface area to volume ratio than smaller cubes
- (c) **A1** so, relative to their volume, less surface is available for the acid to diffuse in through
- (c) **A1** and the acid must diffuse a greater distance to reach the centre of a larger cube, taking longer, oe
- (c) Answer: **Larger cubes have a smaller surface area to volume ratio, so relatively less surface is available for acid to enter, and the acid must travel further to reach the centre, taking much longer.**

Question 13

- (a) **B1** False; xylem transports water and dissolved mineral ions (not sugars); phloem transports dissolved sugars, oe
- (a) Answer: **False - xylem transports water and mineral ions, not sugars; phloem transports sugars.**
- (b) **B1** False; a tissue is a group of similar cells working together; it is an organ that is made of different tissues working together, oe
- (b) Answer: **False - a tissue is a group of similar cells; an organ is made of different tissues.**
- (c) **B1** True cao
- (c) Answer: **True**
- (d) **B1** True cao
- (d) Answer: **True**

Question 14

- **Level 1** (1-2): Basic, isolated statements about diffusion or about one named system, with little or no reference to surface area to volume ratio or to how the systems work together.
- **Level 2** (3-4): A description linking large size to a reduced surface area to volume ratio, with some reference to at least one exchange surface or transport system, but the explanation of how they overcome the problem may be incomplete.
- **Level 3** (5-6): A clear, logically linked explanation of why a large organism has a much smaller surface area to volume ratio than a small one, making diffusion alone too slow to meet its needs, together with a correct explanation of how specialised exchange surfaces (e.g. lungs, small intestine) with a large surface area, thin walls and good blood supply, combined with a circulatory system to transport substances quickly around the body, overcome this limitation.
- **Indicative content:**
 - As an organism gets larger, its volume increases faster than its surface area, so its surface area to volume ratio gets smaller (as shown by the cube comparison in Question 4).
 - A small surface area to volume ratio means diffusion alone across the outer body surface cannot supply oxygen and nutrients, or remove waste, fast enough for all the cells deep inside a large organism.
 - Specialised exchange surfaces, such as the lungs (alveoli) and small intestine (villi), have adaptations including a large surface area, a wall often only one cell thick (short diffusion distance) and a good blood supply, which maximise the rate of diffusion at these surfaces.
 - A circulatory system (heart, blood vessels, blood) is needed to transport absorbed substances (e.g. oxygen, digested food) quickly to every cell in the body, and to carry away waste products, because diffusion alone would be far too slow over such large distances.
 - Together, the exchange surfaces move substances into (or out of) the blood efficiently, and the transport system distributes them throughout the whole organism, overcoming the limits of diffusion alone.

Question 15

- **B1** C cao
- Answer: **C) A group of organs working together to perform a major body function**

Question 16

- (a) **B1** allow gases (carbon dioxide and oxygen) to move into and out of the leaf, and allow water vapour to escape (transpiration), oe
- (a) Answer: **Allow gas exchange (carbon dioxide and oxygen) and water vapour loss.**
- (b) **M1** guard cells change shape as they gain or lose water, becoming more curved (turgid) when full of water and opening the pore, or straighter (flaccid) when short of water, closing the pore
- (b) **A1** this allows the plant to control gas exchange and reduce water loss when needed, e.g. by closing stomata to conserve water, oe
- (b) Answer: **Guard cells become curved and open the pore when full of water, or straighter and close the pore when short of water, allowing the plant to control gas exchange and water loss.**

Question 17

- (a) **B1** a cell becomes specialised, changing to develop specific structures/functions for a particular job, oe
- (a) Answer: **A cell becomes specialised for a particular job.**
- (b) **M1** blood cells have a limited lifespan and are constantly being lost or worn out
- (b) **A1** so new cells must continually be produced by stem cells dividing and differentiating to replace them, oe
- (b) Answer: **Blood cells wear out and are lost over time, so stem cells must keep dividing and differentiating to replace them.**

Question 18

- (a) **B1** cellulose cao
- (a) Answer: **Cellulose.**
- (b) **B1** chitin cao
- (b) Answer: **Chitin.**
- (c) **B1** fungi cannot photosynthesise/make their own food from light, so they must obtain nutrients from their surroundings (e.g. from dead or living organisms), unlike plants, oe
- (c) Answer: **Fungi cannot photosynthesise, so unlike plants they must absorb nutrients from their surroundings.**