

Structure and functions in living organisms

practice questions

100 questions • 333 marks • mark scheme at the back

For Pearson Edexcel International GCSE Biology 4BI1 and Science (Double Award) 4SD0. **Biology only** is not in the Double Award and is only examined on Paper 2.

Name

Total / 333

Cells and levels of organisation Spec 2.1-2.6B

1 Which list shows the levels of organisation in order, from smallest to largest? [1 mark]

- A. ☐ cell, organelle, tissue, organ, system
- B. ☐ organelle, cell, tissue, organ, system
- C. ☐ organelle, tissue, cell, system, organ
- D. ☐ tissue, organelle, cell, organ, system

2 The stomach is an organ in the digestive system. (a) Explain why the stomach is called an organ. (b) Name one other organ in the digestive system. [3 marks]

3 State the function of each of these cell structures. (a) nucleus (b) mitochondria (c) ribosomes (d) cell membrane [4 marks]

8 Complete the table to show the smaller units that make up each large molecule.

[4 marks]

Large molecules and their units	
Large molecule	Smaller units
Starch	
Protein	
Lipid	

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9 A student is given a food sample. Describe how the student could test the sample for (a) protein and (b) starch. Include the result for a positive test in each case. **[4 marks]**

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- State the optimum temperature for this enzyme. (b) Explain why the rate is lower at 50 °C than at 40 °C.

0

- down starch. Describe how the student could carry out the investigation and how they would know when the starch had been broken down.

- A student investigates how pH affects the activity of amylase. (a) State the independent variable. (b) State the dependent variable. (c) Suggest how the student could keep the temperature the same in every test.

- 17** A cell is modelled as a cube with sides of 4 cm. (a) Calculate the surface area of the cube. **[4 marks]**
(b) Calculate the volume of the cube. (c) Calculate the surface area : volume ratio. (d) A smaller cube with sides of 2 cm has a ratio of 3 : 1. State how the surface area : volume ratio changes as the cube gets larger.

Answer =

- 18** Explain how two factors, other than surface area to volume ratio, affect the rate at which oxygen diffuses into a cell. **[4 marks]**

- 19** A student fills a piece of Visking tubing with a mixture of starch and glucose solution and places it in a beaker of water. After 30 minutes the water in the beaker contains glucose but no starch. Explain these results. **[4 marks]**

- 20** A potato cylinder has a mass of 4.00 g. It is placed in a sugar solution for one hour. Its mass is then 4.40 g. Calculate the percentage change in mass and explain what this shows about the solution. **[3 marks]**

Answer =

Nutrition in flowering plants Spec 2.18-2.23

- 21** (a) State the word equation for photosynthesis. (2) (b) Complete the balanced chemical symbol equation for photosynthesis: $\text{...CO}_2 + 6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + \text{...O}_2$ (1) (c) Describe the energy conversion that takes place in photosynthesis. (1) **[4 marks]**

- 22** A student measured the number of bubbles of oxygen released by a water plant in one minute at different light intensities. The temperature and carbon dioxide concentration were the same each time. The results are in the table. (a) State the light intensity at which light stopped being the limiting factor. (1) (b) Name two other factors that could be limiting the rate at light intensities of 30 and above. (2) **[3 marks]**

Bubbles of oxygen released per minute	
Light intensity (arbitrary units)	Bubbles per minute
10	4
20	8
30	12
40	12
50	12

- 23** Explain how two features of a leaf make it well adapted for photosynthesis. **[4 marks]**

- 24** Biology only **[3 marks]**

Explain how the structure of a leaf is adapted for gas exchange.

25 The leaves of a plant growing in poor soil are yellow. Name the mineral ion the plant is likely to be short of and explain why it causes this. **[2 marks]**

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26 A student tests a leaf for starch. Describe the steps she should follow and the result that shows starch is present. **[3 marks]**

27 Describe how you could investigate the effect of light intensity on the rate of photosynthesis of a water plant. Include how you would make the investigation a fair test. **[6 marks]**

[illegible]

Human nutrition Spec 2.24-2.33B

28 Which enzyme completes the digestion of starch to glucose? **[1 mark]**

- A. ☐ Amylase
B. ☐ Maltase
C. ☐ Protease
D. ☐ Lipase

29 (a) Explain why a builder needs more energy from his diet than an office worker of the same age. (2) (b) Explain why a pregnant woman needs more energy than before she was pregnant. (1) **[3 marks]**

30 State one function of each of these in the diet. (i) calcium (ii) iron (iii) vitamin D (iv) dietary fibre **[4 marks]**

31 (a) Name the part of the alimentary canal where most water is absorbed from the remaining food. (1) (b) Describe how food is moved along the gut by peristalsis. (2) **[3 marks]**

32 (a) Name the enzyme that digests lipids and give the products of digestion. (2) (b) Explain how bile helps the digestion of lipids. (2) **[4 marks]**

33

Biology only

[3 marks]

A student burned 0.8 g of a food sample under a boiling tube containing 25 g of water. The temperature of the water rose from 20 °C to 36 °C. Calculate the energy released per gram of the food. The energy needed to raise the temperature of 1 g of water by 1 °C is 4.2 J.

Answer =

[illegible]

34

Explain how the small intestine is adapted for the absorption of the products of digestion. [6 marks]

[illegible]

Respiration Spec 2.34-2.39

Spec 2.34-2.39

35

What does ATP do in a cell?

[1 mark]

- A. ☐ It stores glucose for later use
- B. ☐ It provides energy for cell processes
- C. ☐ It carries oxygen in the blood
- D. ☐ It speeds up chemical reactions as an enzyme

36

Write the word equation for aerobic respiration.

[2 marks]

.....

.....

.....

37 Write the balanced chemical symbol equation for aerobic respiration.

[2 marks]

38 Describe the differences between aerobic respiration and anaerobic respiration in animal cells. **[4 marks]**

39 A student investigates the heat released by germinating peas. She puts germinating peas into one vacuum flask and boiled peas into a second flask. She places a thermometer in each flask. (a) Explain why she uses boiled peas. (b) Explain why she rinses both batches of peas in disinfectant. (c) Predict the change in temperature in the flask of germinating peas. **[4 marks]**

40 During a sprint, muscle cells use a lot of ATP. Explain how respiration produces ATP, why muscle cells need ATP, and how respiration in the muscle cells differs when oxygen supply is low. **[6 marks]**

This image shows a full page of primary-ruled notebook paper. It features ten sets of horizontal lines across the page. Each set consists of three lines: a solid top blue line, a dashed middle blue line, and a solid bottom blue line. The lines are evenly spaced and extend from the left margin to the right edge of the page. There are no vertical lines or other markings present.

Gas exchange in flowering plants

41 Biology only [1 mark]

Which cells control the opening and closing of the stomata?

- A. ☐ Palisade cells
B. ☐ Guard cells
C. ☐ Xylem cells
D. ☐ Root hair cells

42 **Biology only** [2 marks]

Carbon dioxide moves from the air into the cells of a leaf during the day. Explain how this happens.

43 Carbon dioxide and oxygen are waste products of metabolism in a leaf. (a) Name the [3 marks]

44

Biology only

[4 marks]

The table shows the net exchange of carbon dioxide by a leaf at different light intensities. A negative value means carbon dioxide is released and a positive value means carbon dioxide is taken in. (a) Explain the value at light intensity 0. (b) Explain why the value is 0 at light intensity 4. (c) Explain the value at light intensity 8.

Net carbon dioxide exchange by a leaf (arbitrary units)

Light intensity	Net carbon dioxide exchange
0	-4
2	-2
4	0
6	+3
8	+5

45

Biology only

[4 marks]

A student puts the same size of leaf into three boiling tubes containing hydrogen-carbonate indicator. Tube A is in bright light, tube B is wrapped in foil and tube C has no leaf and is in bright light. Hydrogen-carbonate indicator is red/orange in normal air, yellow with more carbon dioxide and purple with less. (a) State the colour of the indicator in tube A and tube B after two hours. (b) Explain the result in tube B. (c) State the purpose of tube C.

50 Explain how two features of the alveoli make gas exchange efficient.

[4 marks]

51 A student counts 15 breaths in one minute at rest. Straight after exercise she counts 42 breaths in two minutes. Calculate the percentage increase in her breathing rate after exercise.

[3 marks]

Answer =

52 A student breathes out through limewater before and after exercise. The limewater turns cloudy faster after exercise. Explain this result.

[3 marks]

53 Describe and explain the effects of smoking on the lungs and the circulatory system.

[6 marks]

The need for transport and transport in plants Spec 2.51-2.58B

54 Which statement explains why a unicellular organism can rely on diffusion to move substances in and out of the cell? [1 mark]

- A. ☐ It has a large surface area compared with its volume, so diffusion distances are short
- B. ☐ It has a transport system to carry substances
- C. ☐ It has a small surface area compared with its volume
- D. ☐ It uses active transport for all substances

55 Explain why a large multicellular organism needs a transport system. [3 marks]

56 State what is transported by (a) the xylem and (b) the phloem in a flowering plant. [4 marks]

57 Biology only [3 marks]
Describe how water is absorbed by a root hair cell.

58 Biology only [1 mark]
Which of these is the correct definition of transpiration?

- A. ☐ The movement of sucrose from the leaves to the roots
- B. ☐ The absorption of water by the root hair cells
- C. ☐ The evaporation of water from the surface of a plant
- D. ☐ The movement of water through a partially permeable membrane

59

Biology only

[3 marks]

In a potometer investigation, an air bubble moved 48 mm in 8 minutes along a capillary tube with a cross-sectional area of 0.5 mm^2 . Calculate the volume of water taken up by the shoot per minute.

Answer =

[illegible]

60

Biology only

[6 marks]

A student used a potometer to investigate the transpiration of a leafy shoot in four conditions. The table shows the distance moved by the bubble in 10 minutes. Describe and explain the effect of wind speed, temperature and humidity on the rate of transpiration.

Distance moved by the bubble in 10 minutes	
Condition	Distance moved (mm)
Room temperature, still air	24
Room temperature, fan on	41
Warm room, still air	38
Shoot enclosed in a clear plastic bag	9

[illegible]

Blood and the immune system Spec 2.59-2.64B

61 State the four components of blood.

[4 marks]

62 Plasma transports many substances around the body. Give three substances that are transported by plasma.

[3 marks]

63 Which feature of a red blood cell increases the amount of oxygen it can carry?

[1 mark]

- A. ☐ A large nucleus
- B. ☐ A thick cell wall
- C. ☐ Haemoglobin inside the cell
- D. ☐ Many mitochondria

64 Explain how three adaptations of red blood cells make them suitable for transporting oxygen.

[3 marks]

65 Lymphocytes release antibodies when a pathogen enters the body. Explain why an antibody that works against one pathogen does not work against a different pathogen.

[3 marks]

66

Biology only

[6 marks]

Explain how vaccination protects a person from a disease, and why the person's immune system responds more strongly to a second exposure to the pathogen.

[illegible]

67

Biology only

[4 marks]

Describe how platelets help to prevent blood loss and infection when the skin is cut.

[illegible]

The heart and circulation Spec 2.65-2.69

Spec 2.65-2.69

68

What is the effect of adrenaline on the heart?

[1 mark]

- A. ☐ It decreases the heart rate
- B. ☐ It increases the heart rate
- C. ☐ It stops the valves from closing
- D. ☐ It makes the septum thicker

69

Explain why the wall of the left ventricle is thicker than the wall of the right ventricle.

[3 marks]

- 74** Name the blood vessel that (a) carries blood from the aorta to the kidneys, (b) carries blood from the gut to the liver, (c) carries deoxygenated blood from the heart to the lungs, (d) carries blood from the liver to the vena cava. **[4 marks]**

Excretion **Spec 2.71-2.79B**

- 75** Which of these is an excretory product and the organ that excretes it? **[1 mark]**

- A. ☐ Faeces from the large intestine
- B. ☐ Carbon dioxide from the lungs
- C. ☐ Glucose from the kidneys
- D. ☐ Protein from the skin

- 76** Name the excretory product lost from the lungs, and name two substances lost from the skin in sweat. **[3 marks]**

- 77** **Biology only** **[1 mark]**

Which tube carries urine from the kidney to the bladder?

- A. ☐ Renal vein
- B. ☐ Renal artery
- C. ☐ Ureter
- D. ☐ Urethra

78

Biology only

[4 marks]

Describe how ultrafiltration happens in the Bowman's capsule and state what the glomerular filtrate contains.

79

Biology only

[4 marks]

The table shows the concentration of three substances in the blood plasma, the glomerular filtrate and the urine of a healthy person. (a) Explain why there is no protein in the glomerular filtrate. (b) Explain why there is no glucose in the urine. (c) Calculate how many times more concentrated urea is in the urine than in the plasma. Give your answer to the nearest whole number.

Concentration of substances (g per 100 cm ³)			
Substance	Blood plasma	Glomerular filtrate	Urine
Glucose	0.10	0.10	0.00
Protein	7.00	0.00	0.00
Urea	0.03	0.03	2.00

Answer =

84 What is meant by homeostasis? Give two examples of conditions that are controlled by homeostasis. **[3 marks]**

85 A seedling is laid on its side in a dark cupboard. After two days its root and shoot have both changed direction. Describe what happens to the root and to the shoot, and name the response in each case. **[4 marks]**

86 A shoot grows towards a window. This response is called **[1 mark]**

- A. ☐ negative phototropism
- B. ☐ positive phototropism
- C. ☐ positive geotropism
- D. ☐ negative geotropism

87 A student shines a lamp on one side of a young shoot. After a day the shoot has bent towards the lamp. Explain how auxin causes this response. **[6 marks]**

The nervous system and the eye Spec 2.87-2.92

88 What makes up the central nervous system? [1 mark]

- A. ☐ The brain and the nerves
- B. ☐ The brain and the spinal cord
- C. ☐ The spinal cord and the sense organs
- D. ☐ The brain and the sense organs

89 Describe how a sense organ and the central nervous system bring about a rapid response to a stimulus. [3 marks]

90 Explain how an impulse passes from one neurone to the next at a synapse. [4 marks]

91 A person touches a hot object and pulls their finger away. Name the receptor type involved, the neurone that carries impulses to the spinal cord, and the effector. [3 marks]

92 State the function of each of these parts of the eye: (a) cornea (b) retina (c) optic nerve. [3 marks]

93 Explain how the eye changes to focus on a near object.

[4 marks]

94 A person walks out of a dark cinema into bright sunshine. Explain how the iris responds to the change and why this response is a reflex. **[6 marks]**

Hormones and temperature control Spec 2.86, 2.93-2.95B

95 Which of these is a feature of hormonal communication rather than nervous communication?

[1 mark]

- A. ☐ It acts very quickly
- B. ☐ The message is carried by the blood
- C. ☐ The message is an electrical impulse
- D. ☐ The effect is very short-lived

96 Testosterone and progesterone are hormones. State where each is made and give one role of each.

[4 marks]

97 A person is frightened by a loud noise and their body prepares to run away. Explain how adrenaline helps the body to do this. **[4 marks]**

98 Describe how insulin reduces blood glucose concentration after a meal. **[3 marks]**

99 **Biology only** A person has not had a drink for many hours. Explain how ADH helps to keep the water content of the blood steady. **[3 marks]**

100 A person runs a race on a hot day and their body temperature starts to rise. Explain how the skin helps to bring their body temperature back to normal. Then describe how the skin response would differ on a very cold day. **[6 marks]**

Mark scheme

One mark for each point unless a maximum is given. Words in brackets are not needed for the mark.

1. [1]

B B (1)

2. [3]

- it is made of several / different tissues (1)
- that work together to perform a specific function / digest food (1)
- (b) any one from: small intestine / large intestine / oesophagus / pancreas / liver (1) allow other correct organs of the system

3. [4]

- (a) contains the genetic material / DNA and controls the activities of the cell (1)
- (b) (site of) aerobic respiration / releases energy (1)
- (c) (site of) protein synthesis / where proteins are made (1)
- (d) controls the movement of substances into and out of the cell (1)

4. [3]

- cell wall (1)
- chloroplasts (1)
- (large / permanent) vacuole (1)
- allow cellulose cell wall; ignore cell sap on its own

5. [3] **Biology only**

- (differentiation produces) specialised cells / cells with different structures (1)
- each type of cell is adapted to carry out a particular job / function (1)
- specialised cells form tissues / organs that carry out jobs efficiently (1)

6. [6] **Biology only**

Level 3 5-6	A detailed discussion giving at least two advantages and two disadvantages, correctly explained, with a balanced overall judgement. The answer is clear and logically structured.
Level 2 3-4	Gives advantages and disadvantages, with some explanation, but the discussion is not fully balanced or detailed.
Level 1 1-2	Gives one or two simple points with little or no explanation.

Indicative content

- advantage: could replace damaged or diseased cells / tissues
- advantage: could treat conditions that are hard to treat now, such as diabetes or paralysis
- advantage: stem cells can differentiate into many types of cell
- disadvantage: stem cells may divide out of control and form tumours
- disadvantage: viruses in donated cells may be passed to the patient
- disadvantage: the patient's immune system may reject the cells
- disadvantage: ethical or religious objections to using embryos

7. [1]

B B (1)

8. [4]

- starch: (simple) sugars / glucose (1)
- protein: amino acids (1)
- lipid: fatty acids (1)
- lipid: glycerol (1)

9. [4]

- (a) add biuret reagent (1)
- turns from blue to purple / lilac (1) allow violet
- (b) add iodine solution (1)
- turns from orange-brown / yellow-brown to blue-black (1)

10. [4]

- (a) 40 °C (1)
- (b) the enzyme is denatured (1)
- the shape of the active site changes (1)
- the substrate no longer fits / is no longer complementary to the active site (1)

11. [4]

- mix amylase and starch (solution) in a test tube at a set temperature, using a water bath (1)
- repeat at several different temperatures (1)
- keep pH / volumes / concentrations the same (1)
- take samples at regular intervals and add to iodine solution; starch is gone when iodine stays orange-brown / does not turn blue-black (1) allow time recorded for this

12. [3] Biology only

- (a) pH (1)
- (b) time taken for the starch to be broken down / rate of reaction (1)
- (c) use a water bath / thermostatically controlled water bath (1)

13. [6]

Level 3 5-6	A clear, detailed explanation covering both temperature and pH, including the optimum, the increase in rate and the denaturing of the enzyme with the change in shape of the active site.
Level 2 3-4	Explains the effect of one factor in detail, or gives a partial explanation of both, with some correct use of terms such as active site or denatured.
Level 1 1-2	Gives simple statements, for example that temperature or pH changes the rate, with little or no explanation.

Indicative content

- as temperature increases the rate increases because particles have more kinetic energy and collide more often
- there is an optimum temperature where the rate is highest
- above the optimum the shape of the active site changes
- the substrate no longer fits so the enzyme is denatured and the rate falls
- each enzyme has an optimum pH where the rate is highest
- pH higher or lower than the optimum reduces the rate
- extreme pH changes the shape of the active site and denatures the enzyme

14. [1]

C C (1)

15. [3]

- (diffusion / movement) of water (1)
- from a dilute solution to a more concentrated solution (1) allow from a high to a low water concentration
- through a partially permeable membrane (1)

16. [3]

- active transport moves substances against the concentration gradient / from low to high concentration, diffusion moves them down the gradient (1)
- active transport needs energy from respiration, diffusion does not (1)
- mineral ions are at a higher concentration inside the cell than in the soil, so diffusion alone could not take them in (1)

17. [4]

- (a) $6 \times 4 \times 4 = 96 \text{ cm}^2$ (1)
- (b) $4 \times 4 \times 4 = 64 \text{ cm}^3$ (1)
- (c) $96 : 64 = 1.5 : 1$ (1) allow 3 : 2
- (d) it gets smaller / decreases (1)

18. [4]

- steeper / bigger concentration gradient (1)
- faster diffusion because more particles move down the gradient than back (1)
- higher temperature (1)
- faster diffusion because particles have more kinetic energy / move faster (1)
- allow shorter distance (1) for faster diffusion because particles travel a shorter way (1)
- Max 4

19. [4]

- Visking tubing is partially permeable / has tiny pores (1)
- glucose molecules are small (1)
- so they pass through the pores / diffuse out down a concentration gradient (1)
- starch molecules are too large to pass through the pores (1)

20. [3]

- $(4.40 - 4.00) \div 4.00 \times 100$ (1)
- = +10% / 10% increase (1)
- the solution is more dilute than the potato cell contents, so water moved into the potato by osmosis (1)

21. [4]

- carbon dioxide + water (1)
- → glucose + oxygen (1) allow light / chlorophyll written above the arrow; do not accept light as a reactant
- 6 and 6 (both needed for the mark) (1)
- light energy is converted to chemical energy (stored in glucose) (1)

22. [3]

- 30 (arbitrary units) (1)
- carbon dioxide concentration (1)
- temperature (1) allow amount of chlorophyll; ignore water

23. [4]

- thin / flat / large surface area (1) so light is absorbed / gases diffuse a short distance (1)
- palisade cells packed close to the upper surface with many chloroplasts (1) to absorb a lot of light / carry out most photosynthesis (1)
- air spaces in the spongy mesophyll (1) so carbon dioxide diffuses to the cells (1)
- stomata (1) allow carbon dioxide to diffuse in (1)
- transparent upper epidermis (1) lets light through to the palisade cells (1)
- Max 4. Each feature must be matched with a reason. Do not accept 'to absorb light' alone as a feature.

24. [3] Biology only

- thin, so there is a short diffusion distance (1)
- broad / flat, so there is a large surface area (1)
- (many) stomata let carbon dioxide diffuse in and oxygen diffuse out (1) allow guard cells open and close stomata
- air spaces in the spongy mesophyll let gases diffuse (quickly) to and from the cells (1) allow large internal surface area
- moist cell surfaces, so gases dissolve before diffusing into the cells (1)
- Max 3. A feature must be linked to how it helps gas exchange.

25. [2]

- magnesium (ions) (1)
- needed to make chlorophyll, so less chlorophyll is made (1)

26. [3]

- dip the leaf in boiling water (1)
- boil the leaf in ethanol (in a hot water bath) to remove chlorophyll (1)
- rinse the leaf in water, then add iodine solution; blue-black shows starch is present (1) ignore 'purple' if blue is also given

27. [6]

Level 3 5-6	A detailed, logical method that includes how light intensity is changed, how the rate is measured, repeats and at least two controlled variables, each with a reason. Terms are used accurately.
Level 2 3-4	A method that covers how light intensity is changed and how the rate is measured, with some attempt at controls or repeats. Some detail is missing.
Level 1 1-2	A limited or partly correct method, for example naming the plant and the lamp with no measurement or no control of variables.

Indicative content

- pondweed in water with sodium hydrogencarbonate to supply carbon dioxide
- lamp at measured distances from the plant, for example 10, 20, 30, 40, 50 cm; light intensity changes with distance
- count the bubbles of oxygen released from the cut stem in one minute, or collect the gas and measure its volume
- allow the plant to adjust at each new distance before counting
- repeat at each distance at least three times and calculate a mean
- control temperature (heat shield / water bath / LED lamp), carbon dioxide concentration (same sodium hydrogencarbonate) and the plant used
- plot rate against light intensity or distance

28. [1]**B B (1)****29. [3]**

- the builder is more active / uses his muscles more (1)
- so more respiration is needed to release energy / his muscles contract more (1)
- extra energy is needed for the growth of the fetus (1) allow 'baby' for fetus

30. [4]

- calcium: for strong bones / teeth (1)
- iron: to make haemoglobin (1) allow to make red blood cells; to carry oxygen
- vitamin D: helps absorb calcium (1) allow for strong bones
- dietary fibre: provides bulk / helps food move through the gut / prevents constipation (1) do not accept 'provides energy'

31. [3]

- large intestine / colon (1)
- circular muscles contract behind the food and squeeze it forward (1)
- waves of muscle contraction / contraction and relaxation of muscles move along the gut (1) ignore 'muscles push food' without reference to contraction

32. [4]

- lipase (1)
- fatty acids and glycerol (1)
- bile emulsifies lipid / breaks lipid into small droplets (1) so the surface area is bigger for lipase to work (1)
- allow neutralises stomach acid so the pH is right for lipase (1) as an alternative to either mark in (b), max 2 for (b)

33. [3] Biology only

- temperature change = 16 °C and energy released = $25 \times 4.2 \times 16$ (1)
- = 1680 J (1)
- $1680 \div 0.8 = 2100$ J/g (1) allow 3 marks for the correct final answer. Allow error carried forward from the energy released.

34. [6]

Level 3 5-6	A clear, well-structured explanation covering at least four adaptations, including the structure of a villus, each linked to a reason (surface area, diffusion distance, concentration gradient). Scientific terms are used correctly.
Level 2 3-4	An explanation of at least two adaptations, with reasons given for most. Some links to absorption are incomplete.
Level 1 1-2	A limited answer that names one or two features, such as villi or capillaries, with little or no explanation.

Indicative content

- small intestine is long, and its wall is folded, giving a large surface area
- wall is covered in villi, and villi have microvilli, which increases surface area further
- epithelium of the villus is one cell thick, so there is a short diffusion distance
- network of blood capillaries in each villus carries absorbed glucose and amino acids away
- this keeps a steep concentration gradient so absorption continues by diffusion (and active transport)
- lacteal in the centre of each villus absorbs fatty acids and glycerol

35. [1]**B B** (1)**36. [2]**

- glucose + oxygen (1)
- $\rightarrow$ carbon dioxide + water (1)
- allow reactants and products in either order if correct sides

37. [2]

- $C_6H_{12}O_6 + 6O_2$ (1)
- $\rightarrow 6CO_2 + 6H_2O$ (1)
- allow 1 mark for correct formulae if the equation is not balanced

38. [4]

- aerobic needs oxygen / anaerobic does not need oxygen (1)
- aerobic breaks glucose down completely / anaerobic breaks it down incompletely (1)
- aerobic releases more energy (per glucose) / anaerobic releases less energy (1)
- aerobic produces carbon dioxide and water / anaerobic produces lactic acid (1)

39. [4]

- (a) as a control / to show that the temperature change is caused by living (respiring) seeds (1)
- (b) to kill microorganisms (on the surface of the peas) (1)
- which would also respire and release heat / so only the peas cause the temperature change (1)
- (c) temperature increases / rises (1)

40. [6]

Level 3 5-6	A clear, well-structured explanation that links respiration to ATP production, gives a correct use of ATP in muscle cells and describes the difference between aerobic and anaerobic respiration, using correct scientific terms.
Level 2 3-4	Explains at least two of the three parts correctly, with some use of scientific terms. Some links may be missing or unclear.
Level 1 1-2	Gives one or two simple correct statements about respiration or ATP, with little or no explanation.

Indicative content

- respiration breaks down glucose and releases energy
- the energy released is used to make ATP (from ADP and phosphate)
- ATP is broken down to release energy where it is needed
- muscle cells need ATP for muscle contraction (so movement)
- with enough oxygen, aerobic respiration: glucose + oxygen → carbon dioxide + water, releasing a large amount of energy
- when oxygen is low, anaerobic respiration: glucose → lactic acid
- anaerobic respiration releases much less energy per glucose, so less ATP is made

41. [1] Biology only**B B (1)****42. [2] Biology only**

- by diffusion (1)
- the concentration of carbon dioxide is higher in the air than in the leaf cells (which use it in photosynthesis) / down a concentration gradient (1)

43. [3]

- (a) respiration (1)
- (b) photosynthesis (1)
- (c) (by diffusion) through the stomata (1) allow through stomata without diffusion

44. [4] Biology only

- (a) no light so no photosynthesis (1)
- only respiration happens so carbon dioxide is released (1)
- (b) rate of photosynthesis equals rate of respiration / carbon dioxide made by respiration is used in photosynthesis (1)
- (c) rate of photosynthesis is faster than respiration so there is a net uptake of carbon dioxide (1)

45. [4] Biology only

- (a) A purple (1)
- B yellow (1)
- (b) no light so no photosynthesis, but the leaf still respire and releases carbon dioxide (1)
- (c) control / to show the colour change is caused by the leaf (1)

46. [6] Biology only

Level 3 5-6	Describes and explains the net exchange of both gases in all three conditions, linking each to the relative rates of respiration and photosynthesis.
Level 2 3-4	Describes the net exchange in at least two conditions with some explanation, or explains one condition fully for both gases.
Level 1 1-2	Gives simple statements about one or two gases or conditions, with little explanation.

Indicative content

- respiration happens all the time and uses oxygen and releases carbon dioxide
- photosynthesis happens only in light and uses carbon dioxide and releases oxygen
- bright light: photosynthesis faster than respiration, so net uptake of carbon dioxide and net release of oxygen
- compensation point: photosynthesis equals respiration, so no net exchange of either gas
- darkness: only respiration, so net release of carbon dioxide and net uptake of oxygen
- gases diffuse through the stomata

47. [1]**B B (1)****48. [3]**

- (a) diaphragm (1)
- (b) bronchus / bronchi (1)
- (c) alveoli (1)

49. [4]

- intercostal muscles contract, so ribs move up and out (1)
- diaphragm contracts and flattens (1)
- volume of the thorax increases (1)
- pressure in the thorax decreases (below atmospheric pressure) so air moves in (1)

50. [4]

- walls one cell thick (1) giving a short diffusion distance (1)
- many alveoli (1) giving a large surface area (1)
- good blood supply / many capillaries (1) maintains a steep concentration gradient (1)
- moist lining (1) so gases can dissolve (1)
- Max 4

51. [3]

- breathing rate after exercise = $42 \div 2 = 21$ breaths per minute (1)
- increase = $21 - 15 = 6$ (1)
- percentage increase = $6 \div 15 \times 100 = 40\%$ (1)
- allow full marks for the correct answer with no working

52. [3]

- limewater turns cloudy when carbon dioxide is present (1)
- exercising muscles respire faster / more respiration (1)
- so more carbon dioxide is produced and breathed out (1)

53. [6]

Level 3 5-6	Describes and explains effects on both the lungs and the circulatory system, naming the harmful substances and linking each to its effect, including coronary heart disease.
Level 2 3-4	Describes effects on both systems with some explanation, or explains several effects on one system, with some named substances.
Level 1 1-2	Gives simple statements, such as smoking causes lung cancer or heart disease, with little explanation.

Indicative content

- tar damages / destroys cilia, so mucus and bacteria are not removed, causing infections and bronchitis
- tar contains carcinogens that cause lung cancer
- emphysema: alveoli walls break down, reducing the surface area for gas exchange, so breathlessness
- carbon monoxide combines with haemoglobin, so red blood cells carry less oxygen
- heart has to work harder to deliver oxygen
- nicotine increases heart rate and blood pressure
- chemicals in smoke damage artery walls, so fatty deposits build up / blood clots form more easily
- coronary arteries become narrowed by fatty deposits, so less blood to the heart muscle, causing coronary heart disease and heart attack

54. [1]**A A (1)****55. [3]**

- it has a small surface area : volume ratio (1)
- many cells are deep inside the body / far from the surface, so the diffusion distance is long (1)
- diffusion alone would be too slow to supply oxygen and food / remove waste (1)

56. [4]

- (a) water (1)
- mineral ions (1)
- (b) sucrose (1)
- amino acids (1)

57. [3] Biology only

- the soil water has a higher concentration of water molecules / is more dilute than the cell sap (1) allow higher water potential in the soil
- water moves into the cell by osmosis (1)
- through the partially permeable cell membrane (1)

58. [1] Biology only**C C (1)****59. [3] Biology only**

- distance moved per minute = $48 \div 8 = 6$ mm/min (1)
- volume per minute = cross-sectional area $\times$ distance per minute = 0.5×6 (1)
- $3 \text{ mm}^3/\text{min}$ (1) (allow 24 mm^3 in 8 minutes with correct working for 2 marks)

60. [6] Biology only

Level 3 5-6	A detailed description and explanation covering all three factors, supported by data from the table. Each explanation links the factor to evaporation or the diffusion gradient of water vapour. The answer is logical and uses correct terms.
Level 2 3-4	Describes the effect of at least two factors, with some correct explanation and some use of the data. Some links may be incomplete.
Level 1 1-2	Describes the effect of one or two factors with little or no explanation, or uses the data without explanation.

Indicative content

- wind speed: bubble moved further with the fan on (41 mm compared with 24 mm), so the rate of transpiration increased
- moving air carries water vapour away from the stomata, keeping a steep concentration gradient, so diffusion is faster
- temperature: bubble moved further in the warm room (38 mm compared with 24 mm), so the rate increased
- water evaporates faster at higher temperature, and water vapour diffuses out faster
- humidity: the bag traps water vapour, so humidity is high and the bubble moved least (9 mm)
- high humidity means a smaller concentration gradient of water vapour between the leaf and the air, so diffusion is slower and the rate decreases
- transpiration is the evaporation of water from the surface of the plant followed by diffusion through the stomata

61. [4]

- red blood cells (1)
- white blood cells (1)
- platelets (1)
- plasma (1)

62. [3]

- carbon dioxide (1)
- digested food / glucose / amino acids (1)
- urea (1)
- hormones (1)
- heat energy (1)
- Max 3

63. [1]

C C (1)

64. [3]

- biconcave shape gives a large surface area for oxygen to diffuse in and out (1)
- no nucleus, so there is more room for haemoglobin (1)
- contains haemoglobin which combines with oxygen (1) allow forms oxyhaemoglobin

65. [3]

- antibodies are specific (1)
- the shape of the antibody fits the antigen on that pathogen only (1)
- a different pathogen has different antigens, so a different antibody is needed (1)

66. [6] **Biology only**

Level 3 5-6	A clear, logical explanation covering the vaccine, the first response, memory cells and all three features of the faster second response (sooner, faster, greater quantity). Scientific terms are used accurately.
Level 2 3-4	Explains most of the sequence, including memory cells and at least one feature of the faster response. Some steps may be missing or unclear.
Level 1 1-2	Some correct points, such as the vaccine contains antigens or antibodies are made, but little explanation of memory cells or the second response.

Indicative content

- a vaccine contains a harmless form of the pathogen (dead or weakened) with its antigens
- the antigens trigger lymphocytes to release antibodies, without the person becoming ill
- memory cells are made and stay in the body
- if the live pathogen enters, memory cells recognise it
- antibody production happens sooner
- antibodies are produced faster and in greater quantity
- the pathogen is destroyed before it can cause the disease

67. [4] **Biology only**

- platelets collect at the wound / release chemicals (1) allow enzymes for chemicals
- soluble fibrinogen is changed into insoluble fibrin (1)
- fibrin forms a mesh that traps red blood cells to form a clot / scab (1) allow net / web for mesh
- the clot prevents blood loss and prevents entry of micro-organisms / pathogens (1)

68. [1]

B B (1)

69. [3]

- the left ventricle pumps blood around the whole body (1)
- the right ventricle pumps blood only to the lungs (1)
- a higher pressure is needed to pump blood around the body, so it needs more muscle (1)

70. [3]

- muscles respire faster / more (1)
- more oxygen and glucose are needed (1) allow more energy needed
- more carbon dioxide is produced and must be removed (1)
- increased heart rate delivers blood to the muscles faster (1)
- Max 3

71. [3]

- resting rate = $20 \times 4 = 80$ beats per minute (1)
- rate after exercise = $38 \times 4 = 152$ beats per minute (1)
- increase = 72 beats per minute (1) (allow ecf from one error)

72. [6]

Level 3 5-6	A detailed explanation of how CHD develops in the coronary arteries and its effect on the heart muscle, with at least three risk factors each linked to how they increase the risk. The answer is well organised and uses scientific terms.
Level 2 3-4	Describes how CHD develops or its effect, and gives at least two risk factors with some explanation of how they increase the risk.
Level 1 1-2	Names one or two risk factors, or states that the arteries are blocked, with little or no explanation.

Indicative content

- fatty material builds up in the coronary arteries, narrowing them
- less blood flows to the heart muscle, so it receives less oxygen and glucose and cannot respire enough
- this can cause chest pain or a heart attack
- a diet high in saturated fat / cholesterol increases the fatty deposits
- smoking damages the artery lining, raises blood pressure and reduces the oxygen carried by the blood
- high blood pressure damages the artery walls
- lack of exercise, obesity and stress are linked to raised blood pressure
- genetic factors (family history) and age also increase the risk

73. [3]

- the wall is one cell thick (1)
- so there is a short diffusion distance (1)
- very narrow and forms a large network, so a large surface area / reaches every cell (1)
- function is to exchange substances between the blood and cells (1)
- Max 3

74. [4]

- (a) renal artery (1)
- (b) hepatic portal vein (1)
- (c) pulmonary artery (1)
- (d) hepatic vein (1)

75. [1]**B B (1)****76. [3]**

- carbon dioxide (1) allow water vapour
- one from: water / salts / ions / urea (1) allow sodium chloride
- a second different one from: water / salts / ions / urea (1)
- Max 3

77. [1] Biology only**C C (1)**

78. [4] Biology only

- blood in the glomerulus is at high pressure (1)
- small molecules are forced out of the blood into the Bowman's capsule (1)
- filtrate contains any two of: water / glucose / urea / ions (1) allow salts for ions
- proteins and blood cells are too large so stay in the blood (1) allow any one named: proteins / blood cells / large molecules

79. [4] Biology only

- (a) protein molecules are too large to pass through (into the Bowman's capsule) (1)
- (b) all the glucose is reabsorbed into the blood (1) allow in the proximal convoluted tubule / by active transport
- (c) $2.00 \div 0.03$ (1)
- = 67 (times) (1) 66.7 or 66.67 (not rounded) scores 1 only; correct answer with no working scores 2

80. [6] Biology only

Level 3 5-6	A clear, logical explanation that links the fall in blood water content to ADH release, the change in collecting duct permeability, the amount of water reabsorbed and the resulting urine. Scientific terms are used accurately.
Level 2 3-4	Some of the sequence is explained, such as ADH being released and more water being reabsorbed, but links between steps are missing or one step is not explained.
Level 1 1-2	Isolated statements, such as more ADH is released or less urine is made, with little or no explanation.

Indicative content

- sweating lowers the water content of the blood
- the change is detected and the pituitary gland releases more ADH into the blood
- ADH travels in the blood to the kidney
- ADH makes the collecting duct more permeable to water
- more water is reabsorbed from the collecting duct into the blood
- a small volume of concentrated urine is produced
- the water content of the blood rises back to normal

81. [3] Biology only

- large volume of dilute urine (1)
- less ADH is released (1)
- collecting duct is less permeable, so less water is reabsorbed into the blood (1)

82. [1]**B B** (1)**83. [3]**

- stimulus: heat / high temperature / hot pan (1)
- receptor: temperature receptor (in the skin) (1) allow heat receptor
- effector: muscle (in the arm) (1) do not accept brain

84. [3]

- maintenance of a constant internal environment (1) allow keeping conditions inside the body constant
- body water content (1)
- body temperature (1)

85. [4]

- root grows downwards (1) allow towards gravity
- this is positive geotropism / gravitropism (1)
- shoot grows upwards (1) allow away from gravity
- this is negative geotropism / gravitropism (1)

86. [1]

B B (1)

87. [6]

Level 3 5-6	A clear, ordered explanation that states where auxin is made, how its distribution changes, its effect on cell growth, and the resulting bending towards the light. Scientific terms are used accurately.
Level 2 3-4	Some of the explanation is given, such as auxin moving to the shaded side and the cells growing more, but the sequence is incomplete or a link is missing.
Level 1 1-2	Isolated statements, such as auxin is a hormone or the shoot grows towards light, with little or no explanation.

Indicative content

- the response is positive phototropism
- auxin is made in the tip of the shoot
- light from one side causes auxin to move to the shaded side
- auxin makes cells elongate
- the cells on the shaded side elongate more / grow faster than on the lit side
- so the shoot bends towards the light
- this gives the leaves more light for photosynthesis

88. [1]

B B the brain and the spinal cord (1)

89. [3]

- receptors in the sense organ are stimulated (1)
- electrical impulses travel along nerves to the central nervous system (1)
- electrical impulses travel along nerves from the central nervous system to an effector (muscle or gland), which responds (1)

90. [4]

- (electrical) impulse arrives at the end of the first neurone (1)
- neurotransmitter released into the synapse / gap (1)
- neurotransmitter diffuses across the gap (1)
- binds to receptors on the next neurone, which starts a new (electrical) impulse (1)

91. [3]

- temperature (or pain) receptor in the skin (1) allow heat receptor
- sensory neurone (1)
- (arm) muscle (1) do not accept motor neurone

92. [3]

- (a) refracts light (as it enters the eye) (1)
- (b) contains the light receptors (rods and cones) (1)
- (c) carries impulses from the retina to the brain (1)

93. [4]

- ciliary muscles contract (1)
- suspensory ligaments loosen (1)
- lens becomes thicker / more curved (1) allow more convex / fatter
- light is refracted more so is focused on the retina (1)

94. [6]

Level 3 5-6	Explains the change in pupil size in bright light, names both sets of iris muscle and what each does, and links the response to protecting the retina and to the reflex pathway being automatic and fast.
Level 2 3-4	Describes the pupil getting smaller and mentions at least one set of muscles, with some reason for the response or some link to a reflex. Explanation is incomplete.
Level 1 1-2	States that the pupil gets smaller or that it is a reflex, with little or no explanation.

Indicative content

- bright light stimulates receptors in the retina
- impulses sent along neurones to the CNS and then to the iris (effector)
- circular muscles of the iris contract
- radial muscles relax
- pupil gets smaller
- less light enters the eye, protecting the retina from damage
- a reflex is fast and automatic and does not involve conscious thought

95. [1]

B B the message is carried by the blood (1)

96. [4]

- testosterone is made in the testes (1)
- testosterone: development of male secondary sexual characteristics / stimulates sperm production (1)
- progesterone is made in the ovaries (1)
- progesterone maintains the lining of the uterus (1) allow during pregnancy / second half of the menstrual cycle

97. [4]

- adrenaline increases heart rate (1)
- so more blood reaches the muscles (1)
- more oxygen and glucose delivered to muscles (1)
- for respiration to release more energy (1)
- adrenaline stimulates the liver to change glycogen into glucose, raising blood glucose (1)
- Max 4

98. [3]

- pancreas secretes insulin when blood glucose is high (1)
- insulin makes cells take up glucose from the blood / liver takes up glucose (1)
- glucose is converted to glycogen for storage (in the liver) (1)

99. [3] **Biology only**

- more ADH is released from the pituitary gland (1)
- collecting ducts become more permeable to water (1)
- more water reabsorbed into the blood, so a small volume of concentrated urine is made (1)

100. [6]

Level 3 5-6	Explains both sweating and vasodilation in the hot conditions, with the reason each lowers temperature, and describes the opposite skin response (vasoconstriction, reduced sweating) in the cold.
Level 2 3-4	Describes sweating and/or vasodilation with some explanation, and mentions at least one skin response in the cold.
Level 1 1-2	States that the person sweats or that blood vessels change, with little or no explanation.

Indicative content

- sweat glands release sweat onto the skin
- sweat evaporates and takes heat from the skin, cooling the body
- vasodilation: blood vessels supplying the skin surface widen
- more blood flows near the surface so more heat is lost to the surroundings
- in the cold, vasoconstriction: vessels narrow, less blood near the surface, less heat lost
- in the cold, little or no sweating