1 A student used a light microscope to observe a blood smear on a microscope slide.

An eyepiece graticule was used to measure the diameter of a white blood cell on the slide. The student recorded that the white blood cell was 5 eyepiece graticule units in diameter.

Which additional information does the student need to determine the diameter of the white blood cell in micrometres?

A calibration of the eyepiece graticule using a stage micrometer only

B calibration of the eyepiece graticule using a stage micrometer and the magnification of the eyepiece lens

C the magnification of the eyepiece lens only

D the magnification of the eyepiece lens and the magnification of the objective lens

2 Which statement explains why it is necessary to use an electron microscope to see the cristae of a mitochondrion?

A The magnification of the electron microscope is greater than that of the light microscope.

B The membranes of the cristae are separated by a distance greater than 200 nm.

C The maximum resolution of a microscope using visible light is too low.

D The wavelength of an electron beam is longer than the wavelength of visible light.

3 Some stains can be used to identify cell structures in living cells.

A dilute solution of one stain causes the whole cell to appear blue.

The blue colour rapidly disappears from most cell structures. Those cell structures that release energy stay blue.

Which type of cell structure is likely to stay blue?

A endoplasmic reticulum

B Golgi body

C lysosome

D mitochondrion

4 When mucus is secreted from a goblet cell, these events take place.

1 addition of carbohydrate to protein

2 fusion of a vesicle with the cell surface membrane

3 extracellular release of a glycoprotein

4 separation of a vesicle from the Golgi body

What is the sequence in which these events take place?

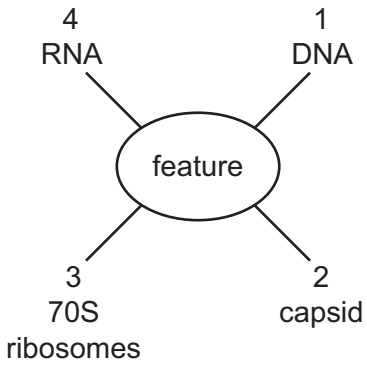
A 1 → 4 → 2 → 3

B 1 → 4 → 3 → 2

C 4 → 1 → 2 → 3

D 4 → 1 → 3 → 2

5 The diagram shows four biological features.



Which biological features are present in typical prokaryotes?

A 1, 2 and 3 **B** 1, 2 and 4 **C** 1, 3 and 4 **D** 2, 3 and 4

6 Which row shows features that occur in dicotyledonous plant cells **and** also in typical bacterial cells?

key

✓ = found in dicotyledonous plant cells **and** also in typical bacterial cells

✗ = **not** found in at least one of these two types of cell

	70S ribosomes	80S ribosomes	centrioles	circular DNA
A	✓	✗	✓	✗
B	✓	✗	✗	✓
C	✗	✓	✓	✗
D	✗	✓	✗	✓

7 Which flow chart outlining the test for non-reducing sugars is correct?

A

add alkaline sodium hydrogencarbonate to sample → neutralise with dilute hydrochloric acid → add Benedict's solution and boil

B

add alkaline sodium hydrogencarbonate to sample → neutralise with dilute hydrochloric acid → add biuret solution and boil

C

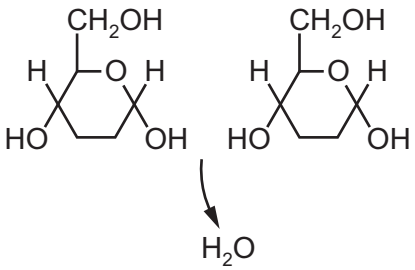
boil sample with dilute hydrochloric acid → neutralise with sodium hydrogencarbonate → add Benedict's solution and boil

D

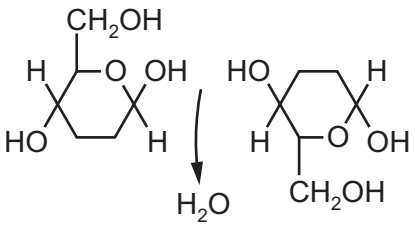
boil sample with dilute hydrochloric acid → neutralise with sodium hydrogencarbonate → add biuret solution and boil

8 Which diagrams show the release of a water molecule during the formation of a glycosidic bond?

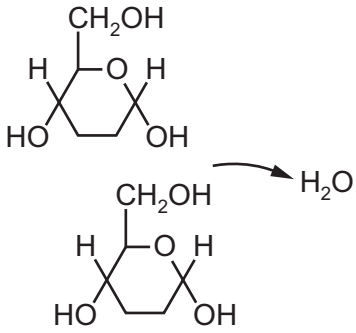
1



2



3



A 1, 2 and 3 **B** 1 only **C** 2 and 3 only **D** 3 only

9 Which molecules have a structural formula that contains C=O bonds?

1 amino acids

2 fatty acids

3 glycerol

4 protein

A 1, 2 and 3 **B** 1, 2 and 4 **C** 1, 3 and 4 **D** 2, 3 and 4

10 Which statement about triglycerides is correct?

A In any triglyceride, all the fatty acids are saturated or all the fatty acids are unsaturated.

B Two triglycerides are joined together by an ester bond.

C Triglycerides are polar hydrophobic molecules.

D Glycerol is joined to each fatty acid by a covalent bond.

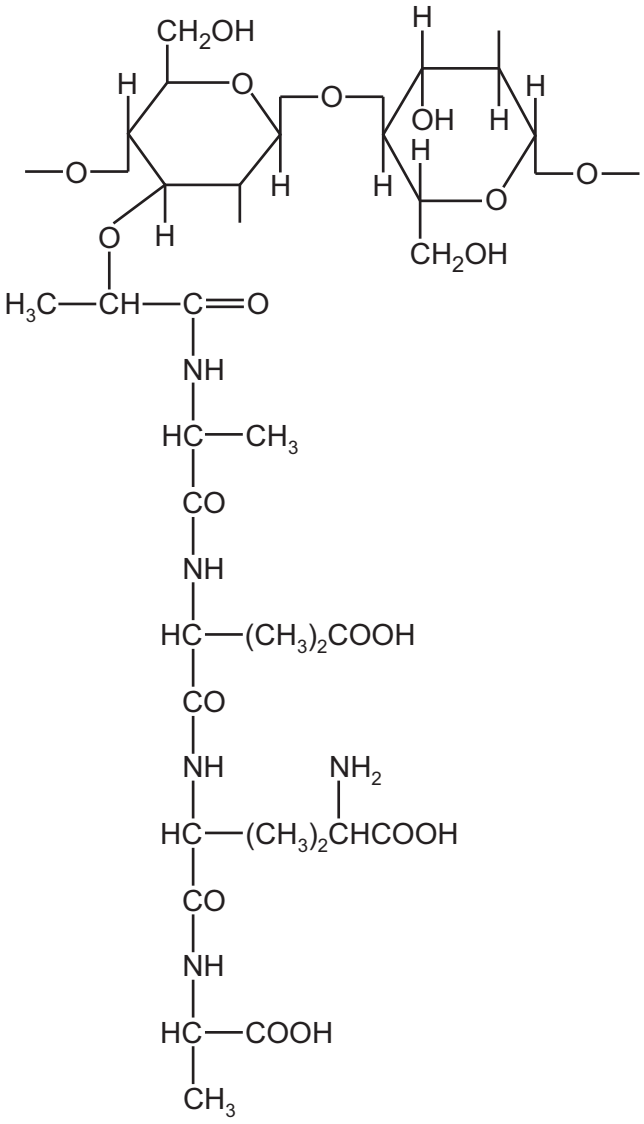
11 Many flowers produce a sweet solution called nectar. Bees provided with nectar use enzyme Q to change the nectar into honey.

After testing a sample of nectar for the presence of reducing sugar using standard laboratory reagents, the sample was blue. After testing a sample of honey in the same way, the sample was orange.

Which conclusion about the reaction catalysed by enzyme Q is consistent with these results?

	type of reaction	substrate	product
A	condensation	maltose	glucose
B	condensation	sucrose	fructose
C	hydrolysis	sucrose	fructose
D	hydrolysis	maltose	glucose

12 The diagram shows the structure of part of a peptidoglycan molecule.



Which type of 1,4 linkage and how many peptide bonds are shown in this part of the molecule?

	type of 1,4 linkage	number of peptide bonds
A	α-1,4	3
B	α-1,4	4
C	β-1,4	3
D	β-1,4	4

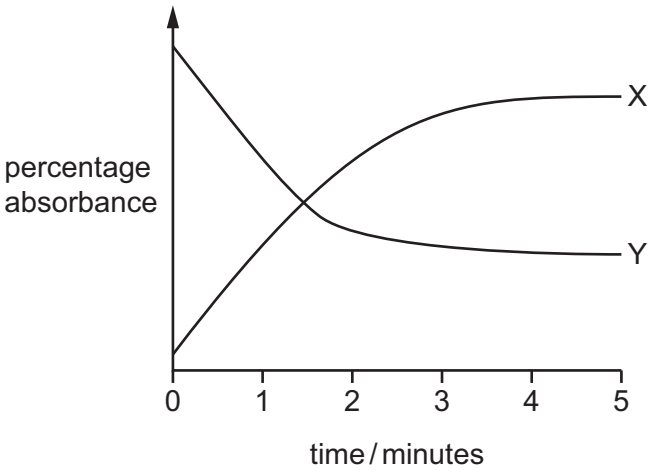
[Turn over

13 A scientist investigated the progress of two enzyme-catalysed reactions in separate test-tubes, X and Y. Both reactions result in colour changes that can be detected using colorimetry.

0.5 cm^3 samples were taken from each test-tube at the start of the investigation and at regular intervals for the next 5 minutes. Copper ions were added to each sample as soon as the sample was collected to inactivate the enzymes and stop the reactions from progressing further.

The absorbance of each sample was measured using a colorimeter.

The graph shows the results of this investigation.



Which statement is consistent with the results shown in the graph?

A The substrate in test-tube X has a higher absorbance than the product.

B The product in test-tube Y has a lower absorbance than the substrate.

C The rate of the reaction in test-tube X increased with time.

D The rate of the reaction in test-tube Y increased with time.

14 A student investigated the hydrolysis of lipid in high-fat milk, using the enzyme lipase.

- 1 cm^3 of enzyme solution was added to 10 cm^3 of high-fat milk.
- The temperature was kept constant.
- The pH of the reaction mixture was recorded at time 0 minutes and every minute for 20 minutes.

Which statements correctly describe the expected results of this investigation?

1 The product forms more slowly as time proceeds because the concentration of the substrate is decreasing.

2 The pH of the reaction mixture increases rapidly in the first few minutes and then increases less rapidly.

3 The increase in the concentration of product eventually causes the lipase molecules to denature.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

15 What is the correct range of measurements for the width of the cell surface membrane?

A 0.5–1.0 nm **B** 5–10 nm **C** 50–100 nm **D** 0.5–1.0 μm

16 Where in the cell surface membrane are the carbohydrate chains of glycoproteins and glycolipids mainly located?

	glycoproteins	glycolipids
A	inner surface	inner surface
B	inner surface	outer surface
C	outer surface	inner surface
D	outer surface	outer surface

17 Sodium ions can enter cells across the cell surface membrane.

Which methods could be used by sodium ions to cross a cell surface membrane and enter a cell?

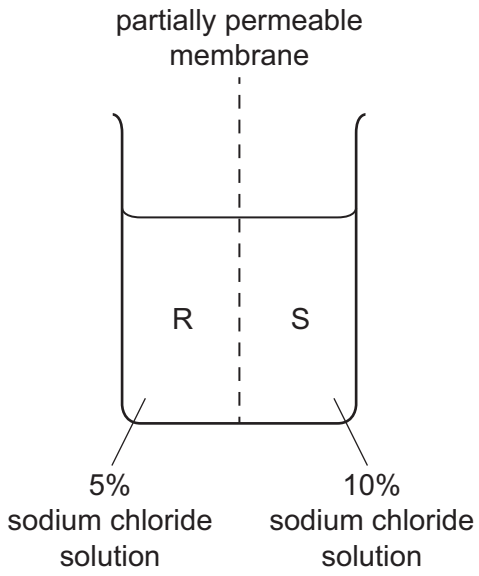
A active transport only

B active transport and facilitated diffusion

C facilitated diffusion and simple diffusion

D simple diffusion only

18 The diagram shows how an artificial partially permeable membrane was used to separate a 5% sodium chloride solution and a 10% sodium chloride solution in a beaker. The two sides of the beaker were labelled R and S.



Which row correctly describes and explains what will happen in the half of the beaker labelled S?

	description of S	explanation
A	volume of solution increases	net movement of water from a higher water potential to a lower water potential
B	volume of solution increases	net movement of water from a lower water potential to a higher water potential
C	volume of solution decreases	net movement of water from a higher water potential to a lower water potential
D	volume of solution decreases	net movement of water from a lower water potential to a higher water potential

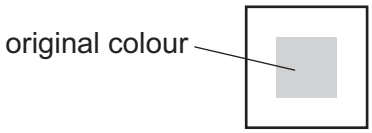
19 Agar cubes can be used to demonstrate the effect on diffusion of changing the surface area to volume ratio.

Three different agar cubes made using a coloured indicator solution were placed into a dilute acid that diffused into the cubes. As the acid diffused into the agar cubes, the colour of the indicator solution changed.

The cubes had volumes of 1 cm^3, 2 cm^3 and 3 cm^3 and were left in the dilute acid for 10 minutes. All other variables were kept the same.

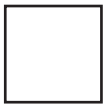
After 10 minutes, the agar cubes were removed from the dilute acid and cut in half. The cut surfaces were observed and the results were recorded as diagrams. All diagrams were drawn to the same scale.

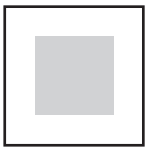
The results for the 2 cm^3 cube are shown.



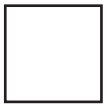
Which diagrams show the results for the 1 cm^3 and the 3 cm^3 cubes?

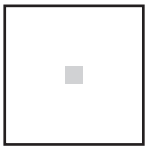
A


1 cm^3


3 cm^3

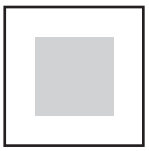
B


1 cm^3


3 cm^3

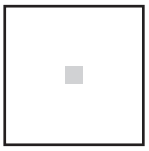
C


1 cm^3


3 cm^3

D


1 cm^3


3 cm^3

20 During sperm formation in mammals, part of the structure of each chromosome is replaced with proteins called protamines. This replacement allows the DNA to be packaged much more densely than would otherwise be possible.

Which part of the chromosome is replaced by protamines?

A centromeres

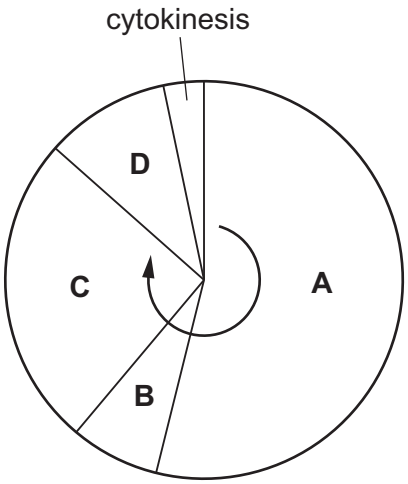
B chromatids

C histones

D telomeres

21 The diagram shows the mitotic cell cycle.

During which phase do chromosomes condense and become visible?



22 Which statements correctly describe features of stem cells that are essential for their role in cell replacement and tissue repair?

1 After mitosis of stem cells, the daughter cells can either remain as stem cells or follow a developmental pathway that leads to the formation of specialised cells.

2 Stem cells are different to all other body cells because they retain all of the genetic information in their DNA throughout the life of the organism.

3 A small population of stem cells is retained in the body of adults throughout their life time.

4 Stem cells have more telomeres than other body cells and this allows them to undergo an unlimited number of mitotic divisions.

A 1, 2, 3 and 4

B 1, 2 and 3 only

C 1 and 3 only

D 2, 3 and 4 only

23 Which statements are correct for **all** nucleotides?

1 The nitrogen-containing base is always attached to carbon atom 1 of the pentose.

2 The phosphate group is always attached to carbon atom 5 of the pentose.

3 A condensation reaction occurs to join the nitrogen-containing base to the pentose.

4 Nucleotides are linked together by condensation reactions between phosphate groups.

A 1, 2 and 3 **B** 1 and 2 only **C** 1, 3 and 4 **D** 2, 3 and 4

24 How many phosphodiester bonds are present in a circular DNA molecule of 2700 base pairs?

A 2699 **B** 2700 **C** 5398 **D** 5400

25 Which statements about complementary base pairing are correct?

1 Purines and pyrimidines are different sizes.

2 Complementary base pairing occurs during translation.

3 The base pairs are of different lengths.

4 Uracil forms two hydrogen bonds with adenine.

A 1, 2 and 3 **B** 1, 2 and 4 **C** 1, 3 and 4 **D** 2, 3 and 4

26 During the mitotic cell cycle, the chromosomal DNA is replicated. The specific points in DNA molecules where replication is occurring are known as replication forks.

A typical human chromosome has about 150 million base pairs of DNA. It takes about 1 hour to replicate the DNA of a typical human chromosome.

The rate of replication using a single replication fork is approximately 50 base pairs per second.

Approximately how many replication forks must occur in a typical human chromosome during DNA replication?

A 835 **B** 41 700 **C** 50 000 **D** 3 000 000

27 Which molecule has its synthesis directly controlled by DNA?

A amylase

B cholesterol

C glycogen

D phospholipid

28 Which statement correctly describes the association between a companion cell and its sieve tube cell?

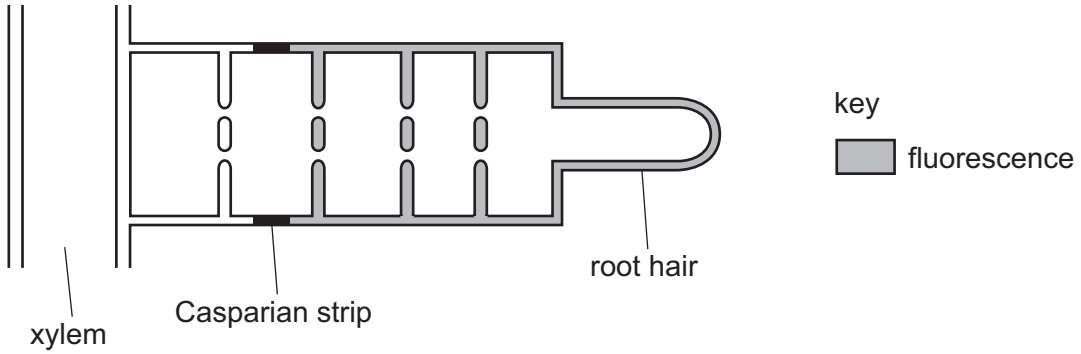
A The companion cell provides all of the ATP used for energy-requiring processes in both types of cell.

B The companion cell controls the active transport of molecules through the sieve plates.

C The companion cell prevents side-to-side movement of assimilates between sieve tube cells.

D The companion cell provides a nucleus that controls cellular activities in both types of cell.

29 A maize seedling was grown in soil that contained lanthanum ions labelled with a chemical that fluoresces under ultraviolet light. The diagram represents what was observed when a section of root was examined using a light microscope with ultraviolet illumination.



What is a correct conclusion about the transport of lanthanum ions in maize roots?

A The ions are **not** transported through the apoplast pathway or the symplast pathway.

B The ions are transported through the apoplast pathway only.

C The ions are transported through the apoplast pathway and symplast pathway.

D The ions are transported through the symplast pathway only.

30 Which description of adhesion and cohesion is correct?

A Adhesion refers to the force between the water molecules due to hydrogen bonding. Cohesion refers to the force between water molecules and the xylem vessel walls.

B Adhesion refers to the reduced friction between hydrophobic lignin walls and the water molecules. Cohesion refers to the force between water molecules and the xylem vessel walls.

C Adhesion refers to the reduced friction between hydrophobic lignin walls and the water molecules. Cohesion refers to the force between water molecules due to hydrogen bonding.

D Adhesion refers to the force between the water molecules and the xylem vessel walls. Cohesion refers to the force between water molecules due to hydrogen bonding.

31 Which conditions are needed to allow the mass flow of sucrose in phloem sieve tubes?

	phloem sieve tube in sources	phloem sieve tube in sinks
A	higher hydrostatic pressure higher water potential	lower hydrostatic pressure lower water potential
B	higher hydrostatic pressure lower water potential	lower hydrostatic pressure higher water potential
C	lower hydrostatic pressure higher water potential	higher hydrostatic pressure lower water potential
D	lower hydrostatic pressure lower water potential	higher hydrostatic pressure higher water potential

32 One type of congenital heart defect is where the left and right atria are **not** completely separated. This is called an atrial septal defect (ASD).

ASD usually results in blood moving from the left atrium into the right atrium. This causes increased blood pressure in the right atrium and decreased blood pressure in the left atrium.

Which row describes other effects caused by ASD?

	blood pressure in pulmonary artery	blood pressure in aorta	% oxygenation of blood in pulmonary artery
A	decreased	increased	decreased
B	decreased	increased	increased
C	increased	decreased	decreased
D	increased	decreased	increased

33 Which property of water, related to its role in blood and tissue fluid, is correctly described?

A Water is a solvent for all biological molecules.

B Water is a solvent for most non-polar molecules.

C Water requires little energy to increase its temperature because it has a high specific heat capacity.

D Water cools down slowly because it has a high specific heat capacity.

34 Which statement about tissue fluid formation is correct?

A The hydrostatic pressure of blood decreases from the arteriole end to the venule end of a capillary.

B The water potential is always higher in the blood in the capillaries than in the tissue fluid in the surrounding tissues.

C No cells move out of the blood in the capillaries into the tissue fluid.

D Most tissue fluid formation occurs at the venule end of a capillary.

35 Oxyhaemoglobin, carbaminohaemoglobin, haemoglobinic acid and carbonic anhydrase are found inside red blood cells.

How many of these substances will show an overall decrease in concentration as a red blood cell passes through capillaries in the lungs?

A 1 **B** 2 **C** 3 **D** 4

36 Which of these structures typically contain cartilage and cilia?

1 bronchi

2 bronchioles

3 trachea

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 3 only

37 Which statements about the function of tissues found in the human gas exchange system are correct?

1 Collagen in the bronchi prevents them collapsing.

2 Smooth muscle in the bronchioles can contract to increase the flow of air into the alveoli.

3 Elastic fibres in the alveoli stretch and recoil during breathing.

A 1 and 2 **B** 1 and 3 **C** 2 and 3 **D** 3 only

38 Antibiotic-resistant strains of *Mycobacterium tuberculosis* are a major problem when treating TB. A new antibiotic, teixobactin, could be very effective at killing *M. tuberculosis* with only a small risk that the bacteria will evolve teixobactin resistance.

Penicillin and similar antibiotics bind to a single protein, but teixobactin binds to two lipids that are needed for the formation of the bacterial cell wall. Teixobactin binds to regions of the two lipids that do **not** vary across many different species of bacteria.

Which statements help to explain why the use of teixobactin is thought to be less likely to lead to the evolution of antibiotic resistance than the use of many other antibiotics, such as penicillin?

1 A single mutation can result in bacteria that are resistant to penicillin and similar antibiotics but at least two mutations are required to produce teixobactin-resistant bacteria.

2 Mutations can affect the structure of proteins but **cannot** affect the structure of lipids because only proteins are made of amino acids.

3 The lack of variation across many species of bacteria in the two lipids that bind to teixobactin suggest that the particular structure of these lipids is essential for successful bacterial cell wall formation.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

39 Monoclonal antibodies are now being used to treat some human diseases.

What explains why monoclonal antibodies are suitable for this purpose?

1 They can divide by mitosis to produce the large numbers of antibodies required for treatment.

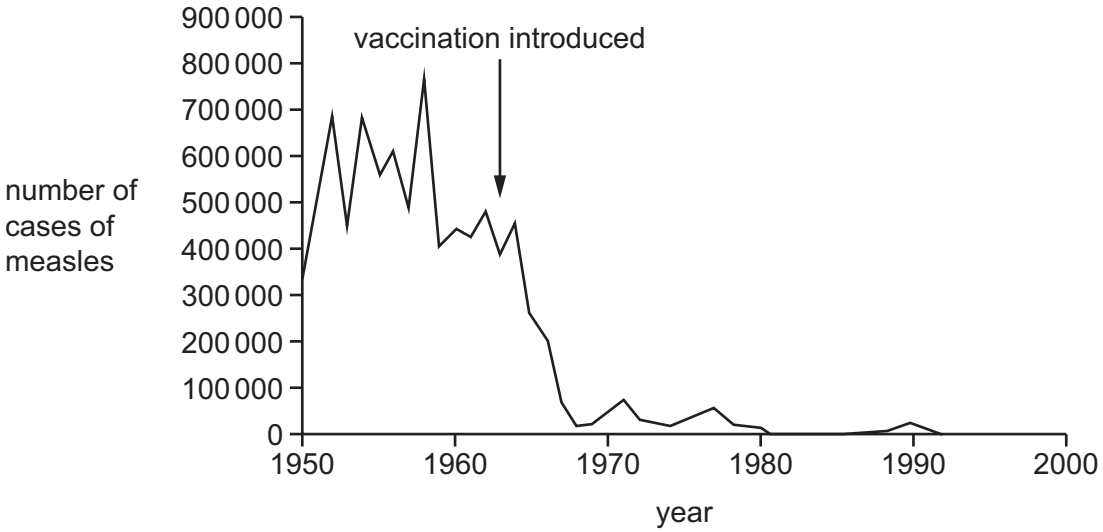
2 They are specific to a particular antigen.

3 They can be modified so that they do **not** act as antigens themselves.

A 1, 2 and 3 **B** 1 only **C** 2 and 3 only **D** 2 only

40 Measles is an infectious disease caused by a virus.

The graph shows the number of cases of measles each year in a country before and after a vaccine was introduced.



What could have caused the decrease in the number of cases of measles after vaccination was introduced?

	vaccines provided artificial active immunity in people	vaccines provided artificial passive immunity in people	fewer people are able to act as hosts for the virus
A	✓	✗	✓
B	✗	✓	✓
C	✗	✓	✗
D	✓	✗	✗

key

✓ = yes

✗ = no