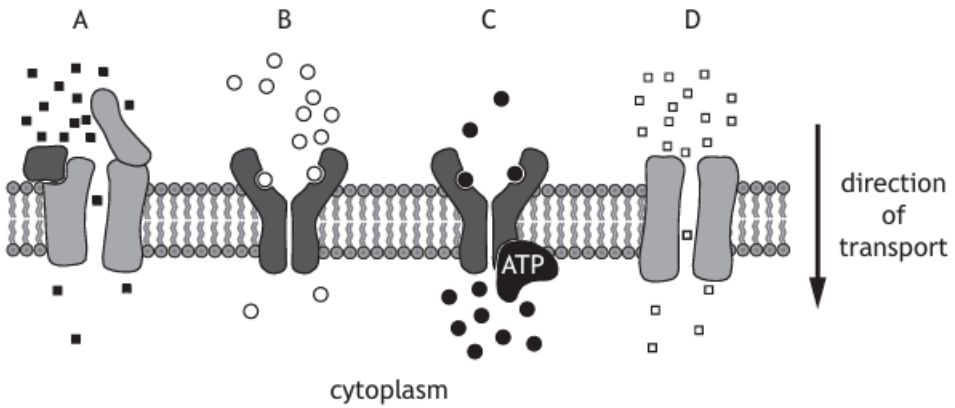
1 The diagram shows the transport of four substances into a cell.

Which substance is transported by facilitated diffusion via a transporter protein?



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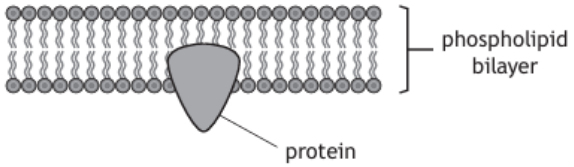
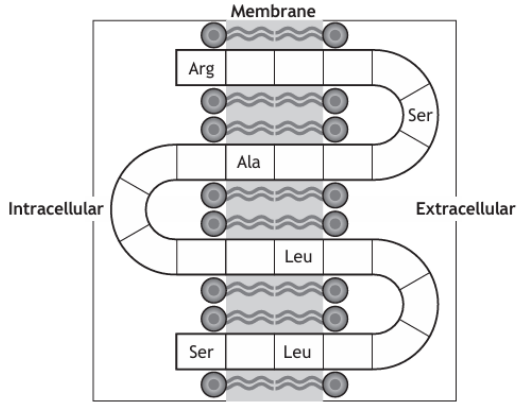


Which row in the table identifies features of this protein?

	Protein type		Nature of R groups on protein surface	
	Integral	Peripheral	Hydrophobic	Hydrophilic
A	✓		✓	
B		✓	✓	✓
C	✓		✓	✓
D		✓		✓

3 The diagram below represents a transmembrane protein. Some of the amino acids in the protein have been identified.



Which row in the table classifies the amino acids shown in this protein?

	Arginine (Arg)	*Alanine* (Ala)	*Leucine* (Leu)	*Serine* (Ser)
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B	hydrophobic	polar	hydrophobic	polar
C	polar	hydrophobic	polar	hydrophobic
D	hydrophobic	polar	polar	hydrophobic

4 Following digestion, the sugar fructose is absorbed from inside the intestine into the cells that line the intestine. Fructose moves from a high concentration to a low concentration into the intestinal cells via a transmembrane protein. Fructose binds directly to the protein causing a conformational change that moves the fructose molecule through the membrane and releases it inside the cell.

Which of the following matches the mechanism of fructose transport described?

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B Active transport via a transporter

C Facilitated diffusion via a transporter

D Facilitated diffusion via a symporter

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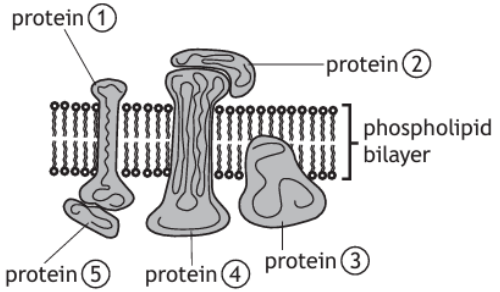


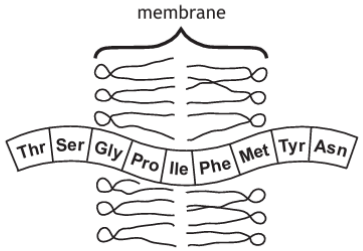
Which row in the table identifies a peripheral and an integral membrane protein?

	Peripheral membrane protein	Integral membrane protein
A	1	5
B	2	1
C	3	4
D	5	2

6 Which line in the table below correctly shows the arrangement of R groups in a globular protein found in the cytoplasm of a cell?

	R groups on surface of protein molecule	*R groups at centre of protein molecule*
A	Hydrophilic	Hydrophilic
B	Hydrophobic	Hydrophilic
C	Hydrophobic	Hydrophobic
D	Hydrophilic	Hydrophobic

7 The following diagram shows a small polypeptide integrated into a membrane.



Which row in the table below classifies amino acids in this polypeptide?

	polar	*non-polar*
A	Thr	Pro
B	Ile	Tyr
C	Asn	Ser
D	Phe	Gly

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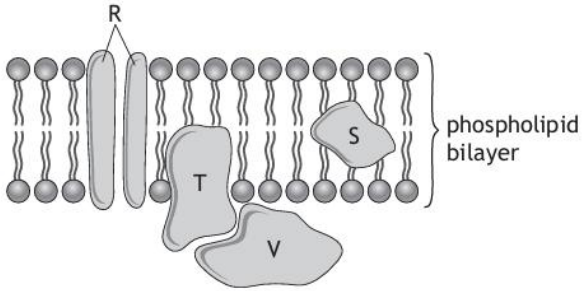
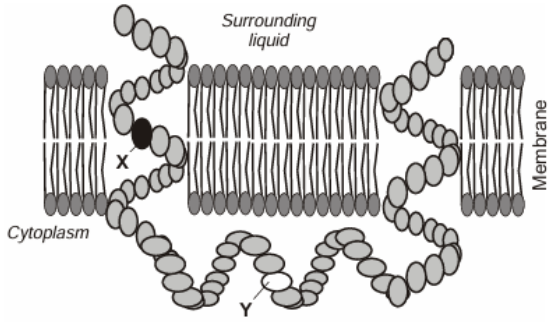


Which of the protein molecules shown are integral membrane proteins?

A S only
B R only
C R, S and T
D R, S, T and V

9 The following diagram represents a transmembrane protein.



Which row in the table is correct for amino acids X and Y?

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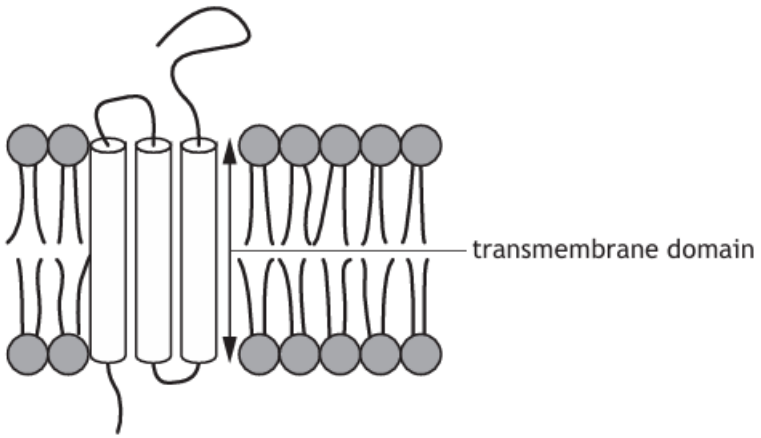
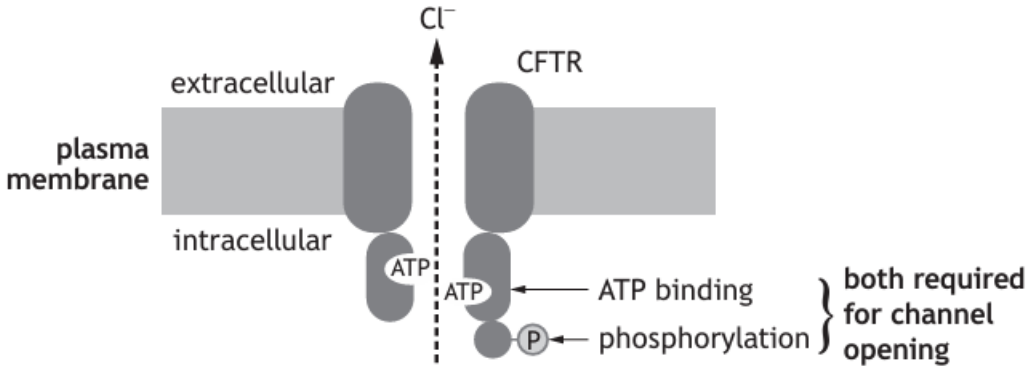
1 Name the class of R-groups that predominate in the transmembrane regions of proteins. 1



2 Describe the interactions that hold an integral transmembrane protein within the phospholipid bilayer. 1

3 Benzalkonium chloride is an antimicrobial compound found in products such as handwashes. It works by disrupting the interactions between the phospholipids of the cell membrane.

Suggest how this disruption could lead to cell death. 1

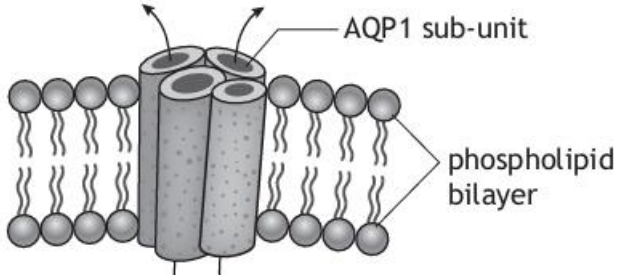


4 Suggest how the binding of ATP results in the opening of the chloride ion channel. 1

5 Region S has some of the R groups in contact with the bilayer.

Predict the class of R groups to which these amino acids belong. 1

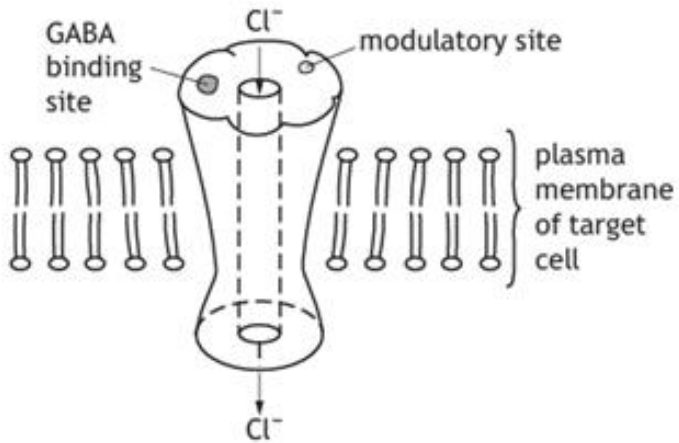
Figure 1: A fragment of membrane containing AQP1



6 Give the term used for proteins such as AQP1 which are embedded into a phospholipid membrane, as shown in **Figure 1**. 1

6 Gamma-aminobutyric acid (GABA) is a neurotransmitter that functions as a signalling molecule in the central nervous system. GABA binds to a receptor protein located in the plasma membrane of target cells as shown in **Figure 1**. Binding of a GABA molecule opens a channel that allows chloride ions (Cl^-) to enter the cell.

Figure 1



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(a) Using the information provided, explain why the GABA receptor is described as a ligand-gated channel. **2**

7a) Explain the meaning of the term electrochemical gradient. **1**

b) Explain why, after the potassium channels open, positive potassium ions move into the cell **against** the concentration gradient. **1**

8 Glucose moves out of liver cells back into the blood by facilitated diffusion.

Describe how facilitated diffusion takes place. **3**

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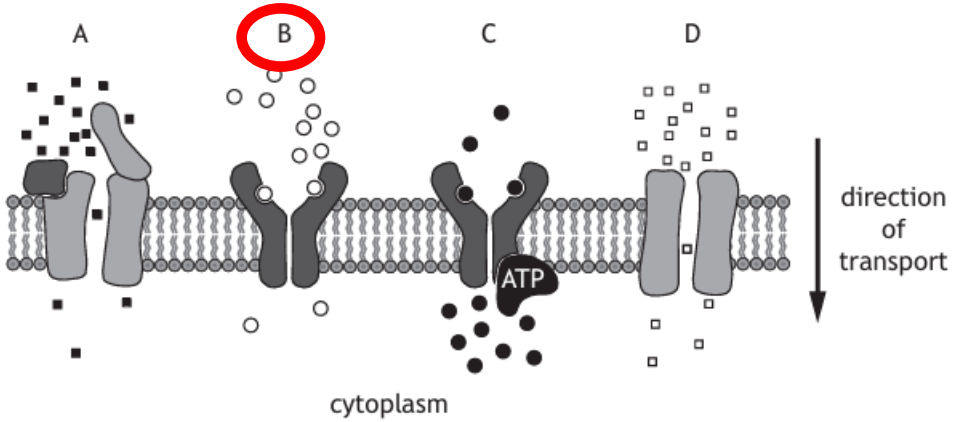

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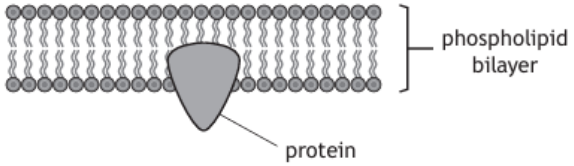

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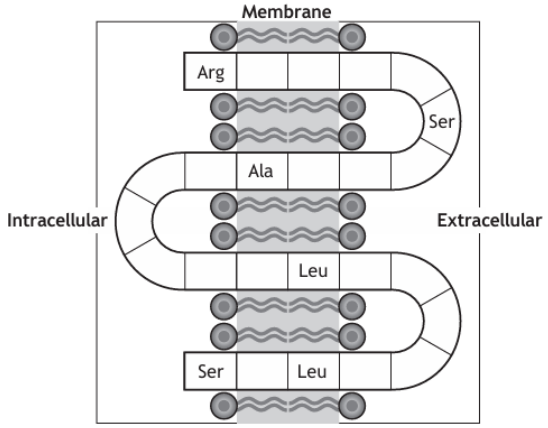

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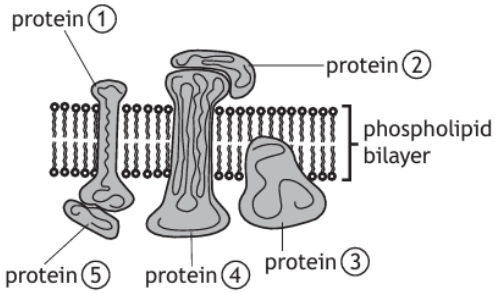

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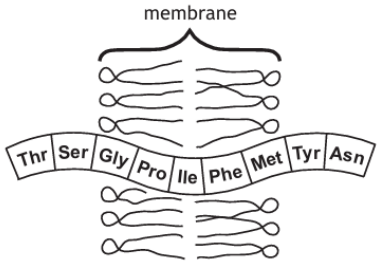

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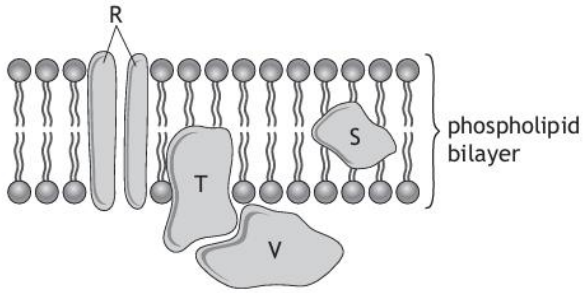

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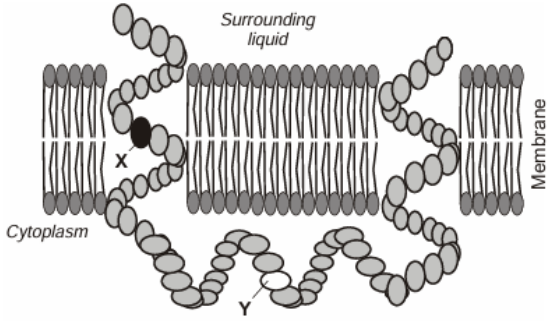

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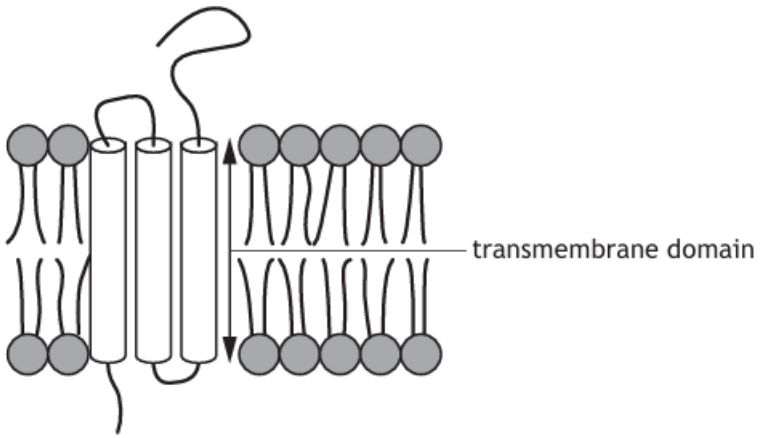


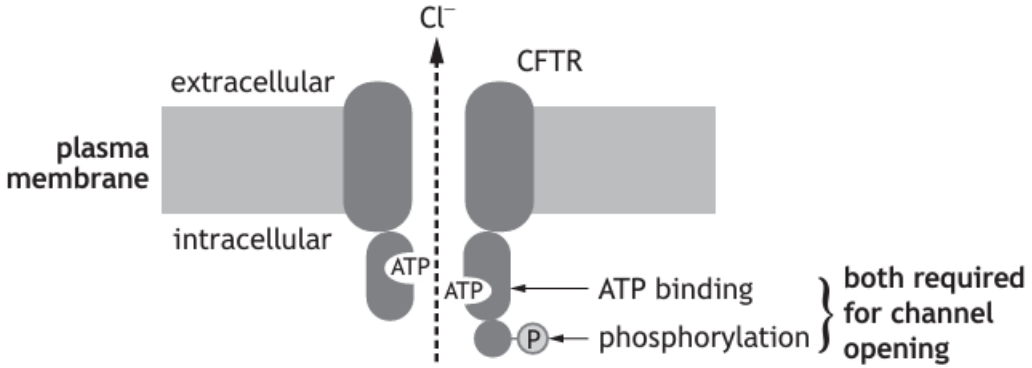
2 Describe the interactions that hold an integral transmembrane protein within the phospholipid bilayer. 1

Hydrophobic R groups interact with hydrophobic tails within the membrane

3 Benzalkonium chloride is an antimicrobial compound found in products such as handwashes. It works by disrupting the interactions between the phospholipids of the cell membrane.

Suggest how this disruption could lead to cell death. 1

would allow leakage of materials into/out of the cell OR Leads to loss of function/structure of membrane proteins.



4 Suggest how the binding of ATP results in the opening of the chloride ion channel. 1

conformational change in ion channel

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Hydrophobic/non-polar

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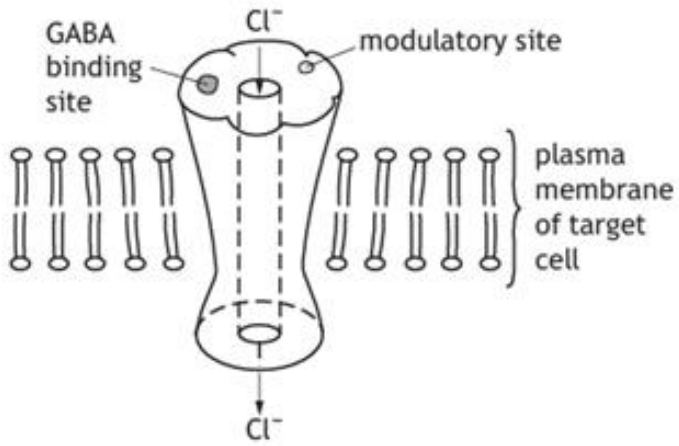

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(a) Using the information provided, explain why the GABA receptor is described as a ligand-gated channel. **2**

GABA is a ligand that can bind to protein (1)
The channel opens in response to ligand binding (1)
Chloride passes through the protein when GABA is bound (1)

7a) Explain the meaning of the term electrochemical gradient. **1**

Combination of concentration gradient & electrical gradient/membrane potential across the plasma membrane.

b) Explain why, after the potassium channels open, positive potassium ions move into the cell **against** the concentration gradient. **1**

Moving down the electrical gradient despite going against the concentration gradient.

8 Glucose moves out of liver cells back into the blood by facilitated diffusion.

Describe how facilitated diffusion takes place. **3**

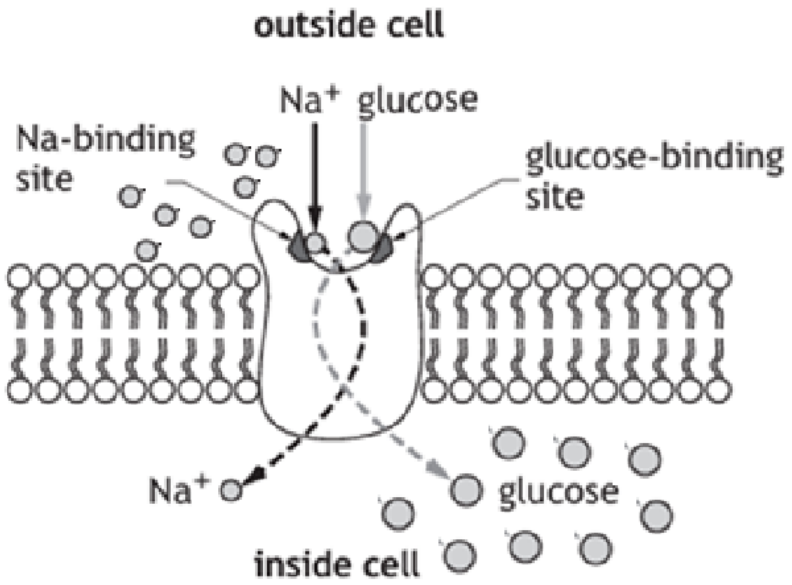
1. Passive transport
2. Down a concentration gradient.
3. Through specific transmembrane proteins.
4. Channel/transporter proteins are the 2 types of transmembrane proteins
5. Binding causes a conformational change in transporters.
6. Channels are multi subunits with water-filled pores

9 What name is given to ion channels that open or close in response to changes in ion concentration? **1**

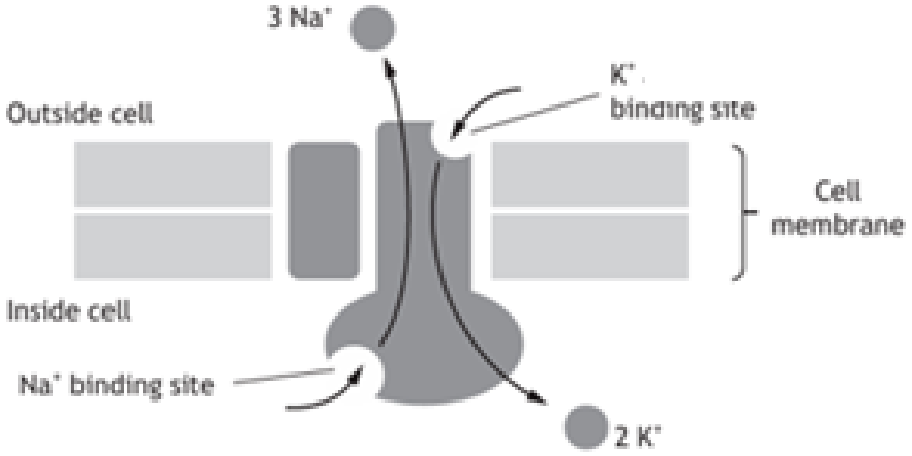
Voltage-gated

Transporters

1. Glucose symporter



2. Na/K ATPase



1. Place the following events for a sodium potassium pump into the correct sequence.

   1 Phosphorylation

   2 Potassium ions released into cell

   3 Transporter protein has high affinity for sodium ions inside the cell

   4 Dephosphorylation

   A 2, 1, 4, 3

   B 3, 4, 2, 1

   C 2, 1, 3, 4

   D 3, 1, 4, 2

2. Which row in the table describes the expected effects of inhibition of the Na/KATPase?

	Intracellular Na ion concentration	Intracellular K ion concentration	Membrane polarity
A	increase	decrease	increase
B	decrease	increase	increase
C	increase	decrease	decrease
D	decrease	increase	decrease

3. A decrease in the activity of glucose symport proteins in the cells lining the small intestine could be caused by an increase in the

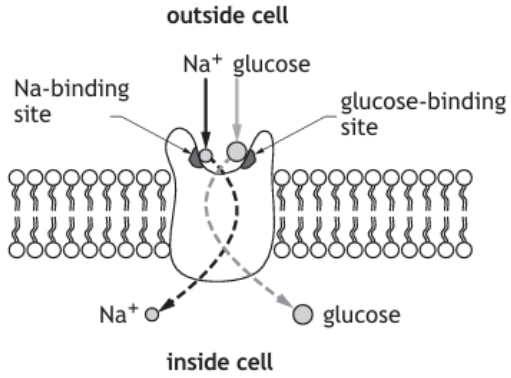
   A glucose concentration inside the small intestine

   B sodium ion concentration in the cells

   C ATP concentration in the cells

   D potassium ion concentration in the cells.

4. The following diagram shows cotransport (symport) of sodium ions (Na^+) and glucose into a cell lining the gut.



Which row in the table below represents the relative concentrations of glucose and Na^+ on the two sides of the plasma membrane when cotransport occurs?

	sodium		*glucose*	
	outside cell	*inside cell*	*outside cell*	*inside cell*
A	high	low	low	high
B	high	low	high	low
C	low	high	low	high
D	low	high	high	low

5. The effect of changing the concentration of extracellular potassium ions on the function of sodium potassium pumps was investigated.

   Starting with an extracellular solution containing no potassium ions, as the concentration of potassium ions is increased the pumps would be expected to

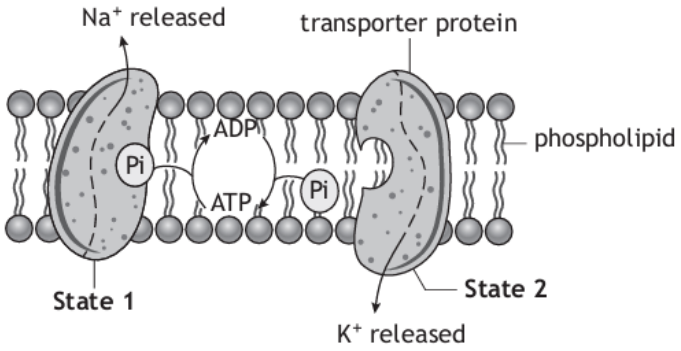
   A pump out potassium ions at a faster rate

   B stay in their phosphorylated conformation for longer

   C pump in sodium ions at a faster rate

   D hydrolyse ATP at a faster rate.

6. The diagram below shows two conformational states of molecules of the Na/K transporter protein in a cell membrane and the release of Na^+ and K^+ ions from them.



Which line in the table below identifies the affinity for Na^+ ions of each conformational state of this protein?

	State 1	*State 2*
A	low	high
B	low	low
C	high	high
D	high	low

7. Which of the following statements about the sodium-potassium pump is correct?

A The transport protein has an affinity for sodium ions in the cytoplasm.

B It results in a higher concentration of sodium ions inside the cell.

C The transport protein has an affinity for sodium ions in the extracellular fluid.

D It results in a higher concentration of potassium ions outside the cell.

8. The sodium-potassium pump spans the plasma membrane. Various processes involved in the active transport of sodium and potassium ions take place either inside the cell (intracellular) or outside the cell (extracellular).

Which line in the table correctly applies to the binding of potassium ions?

	Binding location of potassium ions	*Conformation of transport protein*
A	intracellular	not phosphorylated
B	extracellular	phosphorylated
C	intracellular	phosphorylated
D	extracellular	not phosphorylated

9. 5 5 Which of the following shows the movement of glucose and sodium ions into intestine cells due to the action of the glucose symport protein?

A Both move down their concentration gradients

B Sodium moves down its concentration gradient and glucose moves against

C Glucose moves down its concentration gradient and sodium moves against

D Both move against their concentration gradients

10. Dephosphorylation of a sodium-potassium pump transport protein results in

A potassium ions being pumped in

B potassium ions being pumped out

C sodium ions being pumped in

D sodium ions being pumped out.

1. Where there is a higher glucose concentration outside the cell, glucose molecules enter via passive transport. This is the case for fat and muscle cells.

Name the glucose transporter that enables glucose transport in these cells. **1**

_____

2. Describe the mechanism of glucose symport. **3**

_____

_____

_____

_____

_____

_____

3. Greenfly are insects that feed on the sugar-rich sap of plants. It has been found that the cells lining the gut of greenfly do not carry out glucose symport. These invertebrates can still successfully transport sugar into the cells lining their gut.

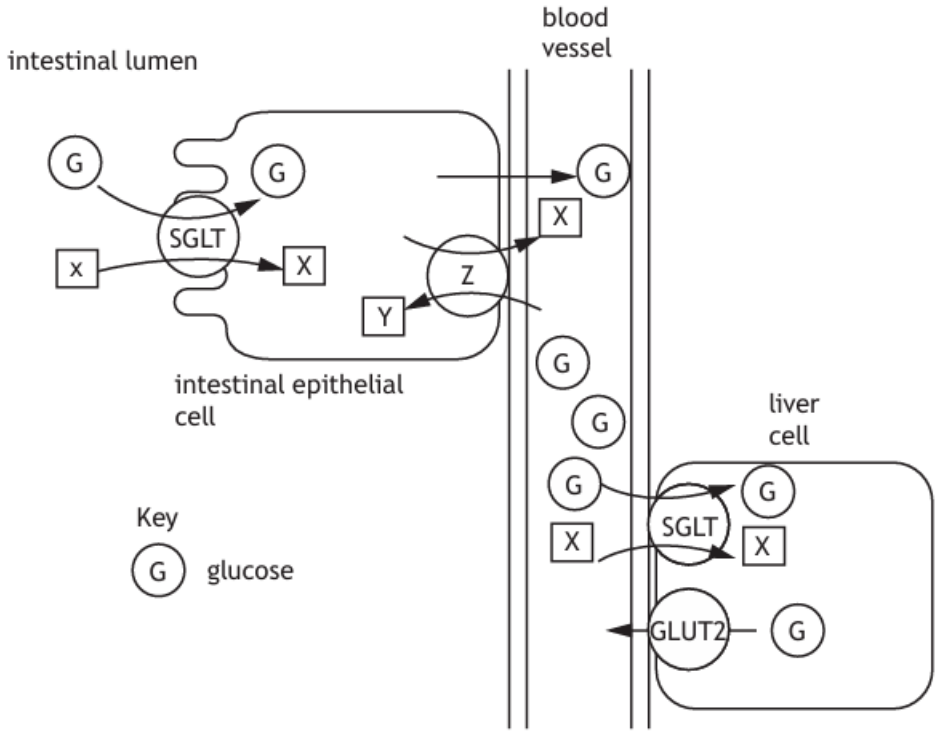
Suggest an explanation for this observation. **2**

_____

_____

_____

4.



During glucose symport, SGLT transports substance X at the same time as the glucose molecules.

Name substance X. **1**

_____

5. Protein Z moves X and Y against their concentration gradients.

Explain how the action of protein Z supplies the energy for the active transport of glucose during symport. **1**

_____

_____

6. Describe the chemical reaction that ATPases catalyse. **1**

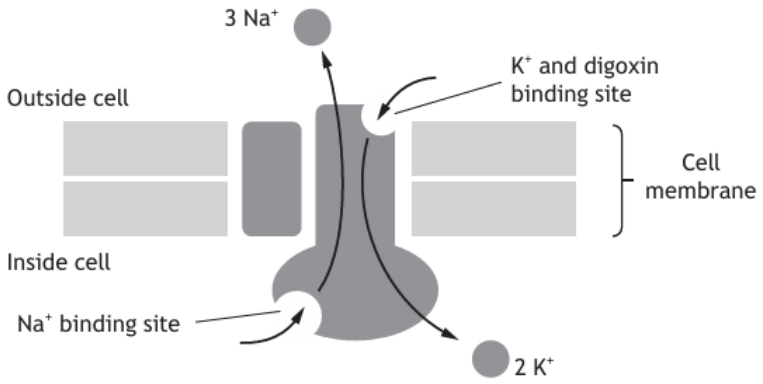
_____

7. The sodium potassium pump (Na/KATPase) is a membrane protein found in animal cells.

(a) Give **one** function of sodium potassium pumps. **1**

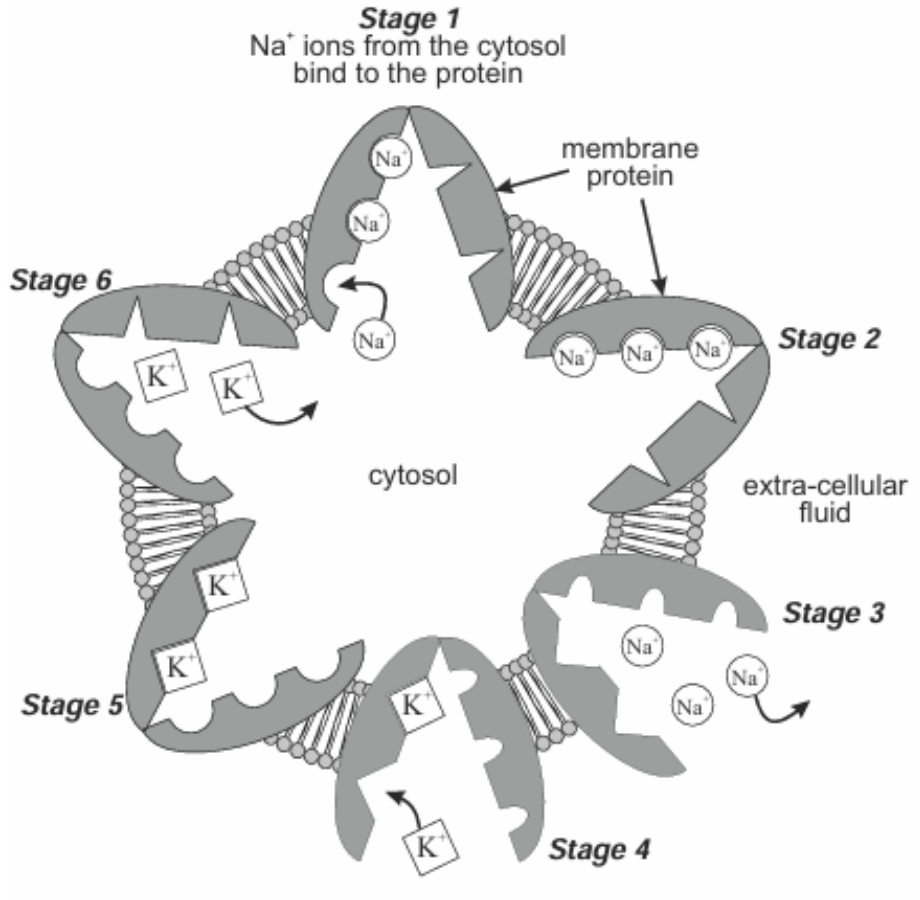
(b) Describe the role of ATP in altering the affinity of the pump for sodium ions (Na^+). **2**

8. Digoxin is a chemical that inhibits the sodium potassium pump by binding to the potassium ion (K^+) binding site as shown in the diagram below.



Explain why binding by digoxin prevents further binding of sodium (Na^+) ions by the pump. **2**

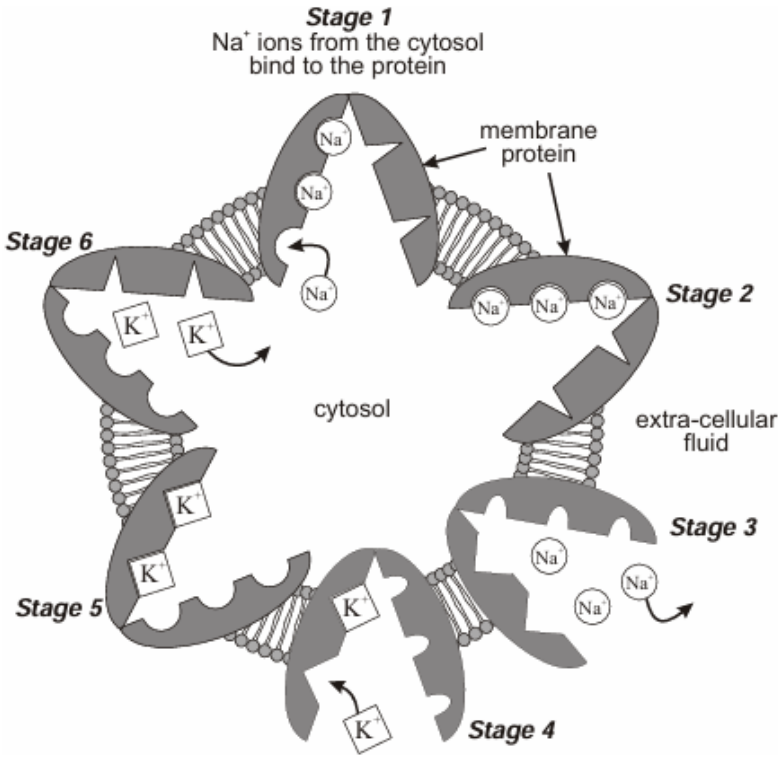
9. The diagram shows stages in the transport across the plasma membrane by a sodium-potassium pump.



Describe the role of ATP in powering the pump between stages 2 and 3.

2

10. The diagram shows stages in the transport of ions across the plasma membrane by a Na^+ / K^+ ATPase pump.



(i) State what happens to change the protein conformation between stages 4 and 5.

_____ **1**

(ii) Na^+ / K^+ ATPase pumps sodium out of gut epithelial cells into the blood. Explain how the glucose symport proteins use these conditions to absorb glucose from the small intestine.

_____

_____

_____ **2**

11. Describe the sequence of events of the Na/K ATPase conformation changes that result in the movement of K^+ ions into the cell.

_____

_____ **2**

12. Explain the role of Na^+ / K^+ ATPase in glucose absorption in the small intestine.

_____

_____

_____ **2**

1. Place the following events for a sodium potassium pump into the correct sequence.

1 Phosphorylation
2 Potassium ions released into cell
3 Transporter protein has high affinity for sodium ions inside the cell
4 Dephosphorylation

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

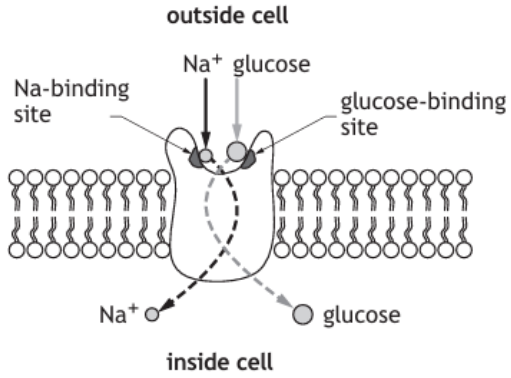
2. Which row in the table describes the expected effects of inhibition of the Na/KATPase?

	Intracellular Na ion concentration	Intracellular K ion concentration	Membrane polarity
A	increase	decrease	increase
B	decrease	increase	increase
C	increase	decrease	decrease
D	decrease	increase	decrease

3. A decrease in the activity of glucose symport proteins in the cells lining the small intestine could be caused by an increase in the

A glucose concentration inside the small intestine
B sodium ion concentration in the cells
C ATP concentration in the cells
D potassium ion concentration in the cells.

4. The following diagram shows cotransport (symport) of sodium ions (Na^+) and glucose into a cell lining the gut.



Which row in the table below represents the relative concentrations of glucose and Na^+ on the two sides of the plasma membrane when cotransport occurs?

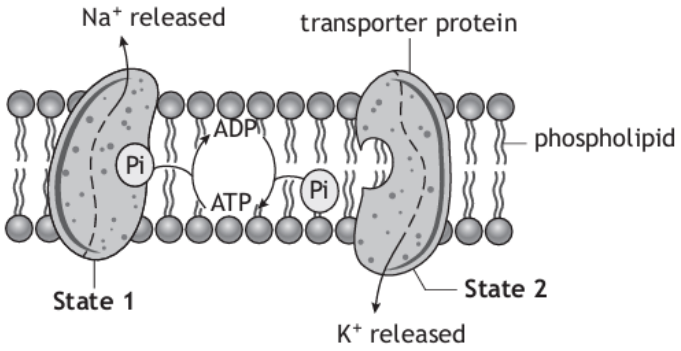
	sodium		*glucose*	
	outside cell	*inside cell*	*outside cell*	*inside cell*
A	high	low	low	high
B	high	low	high	low
C	low	high	low	high
D	low	high	high	low

5. The effect of changing the concentration of extracellular potassium ions on the function of sodium potassium pumps was investigated.

Starting with an extracellular solution containing no potassium ions, as the concentration of potassium ions is increased the pumps would be expected to

A pump out potassium ions at a faster rate
B stay in their phosphorylated conformation for longer
C pump in sodium ions at a faster rate
D hydrolyse ATP at a faster rate.

6. The diagram below shows two conformational states of molecules of the Na/K transporter protein in a cell membrane and the release of Na^+ and K^+ ions from them.



Which line in the table below identifies the affinity for Na^+ ions of each conformational state of this protein?

	State 1	*State 2*
A	low	high
B	low	low
C	high	high
D	high	low

7. Which of the following statements about the sodium-potassium pump is correct?

A The transport protein has an affinity for sodium ions in the cytoplasm.

B It results in a higher concentration of sodium ions inside the cell.

C The transport protein has an affinity for sodium ions in the extracellular fluid.

D It results in a higher concentration of potassium ions outside the cell.

8. The sodium-potassium pump spans the plasma membrane. Various processes involved in the active transport of sodium and potassium ions take place either inside the cell (intracellular) or outside the cell (extracellular).

Which line in the table correctly applies to the binding of potassium ions?

	Binding location of potassium ions	*Conformation of transport protein*
A	intracellular	not phosphorylated
B	extracellular	phosphorylated
C	intracellular	phosphorylated
D	extracellular	not phosphorylated

9. Which of the following shows the movement of glucose and sodium ions into intestine cells due to the action of the glucose symport protein?

A Both move down their concentration gradients

B Sodium moves down its concentration gradient and glucose moves against

C Glucose moves down its concentration gradient and sodium moves against

D Both move against their concentration gradients

10. Dephosphorylation of a sodium-potassium pump transport protein results in

A potassium ions being pumped in

B potassium ions being pumped out

C sodium ions being pumped in

D sodium ions being pumped out.

1. Where there is a higher glucose concentration outside the cell, glucose molecules enter via passive transport. This is the case for fat and muscle cells.

Name the glucose transporter that enables glucose transport in these cells. 1

GLUT4

2. Describe the mechanism of glucose symport. 3

1.Sodium-potassium pump pumps Na+ out of cell

2. Sodium-potassium pump generates lower Na concentration inside creates a steep Na concentration gradient

3. Na moves down its concentration gradient into cell by glucose symporter

4. Alongside glucose which is transported in against its concentration gradient

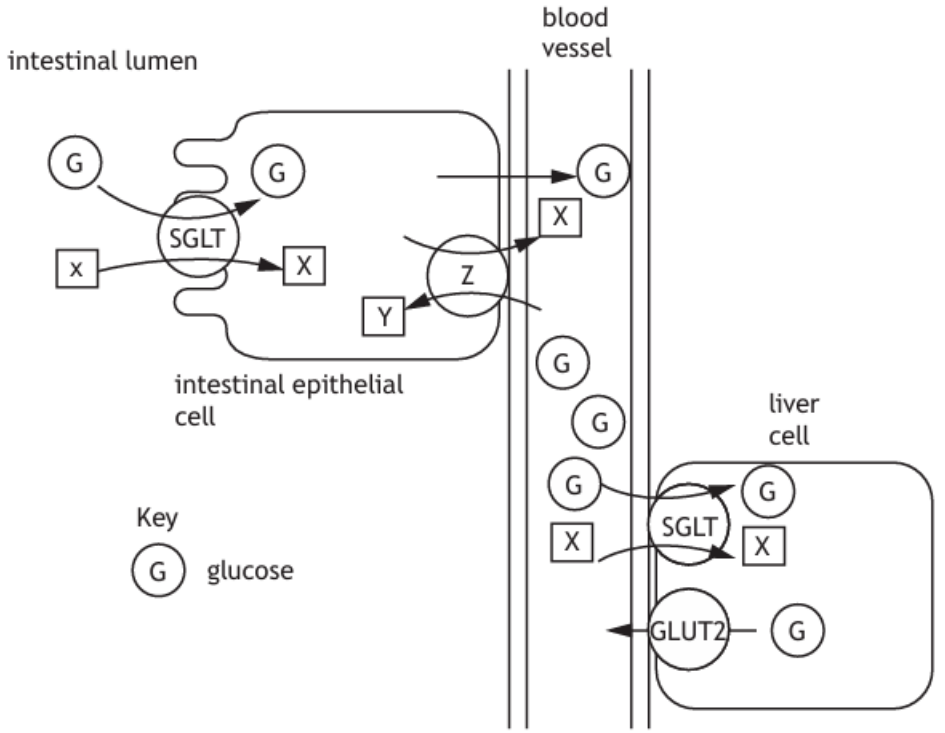
3. Greenfly are insects that feed on the sugar-rich sap of plants. It has been found that the cells lining the gut of greenfly do not carry out glucose symport. These invertebrates can still successfully transport sugar into the cells lining their gut.

Suggest an explanation for this observation. 2

Glucose concentration in the gut higher than that in the cells lining the gut

Glucose transported by facilitated diffusion

4.



During glucose symport, SGLT transports substance X at the same time as the glucose molecules.

Name substance X. 1

Sodium

5. Protein Z moves X and Y against their concentration gradients.

Explain how the action of protein Z supplies the energy for the active transport of glucose during symport. 1

Protein Z is the Na/K pump and maintain the concentration gradient of sodium ions

6. Describe the chemical reaction that ATPases catalyse. 1

Hydrolysis of ATP.

7. The sodium potassium pump (Na/KATPase) is a membrane protein found in animal cells.

(a) Give **one** function of sodium potassium pumps. 1

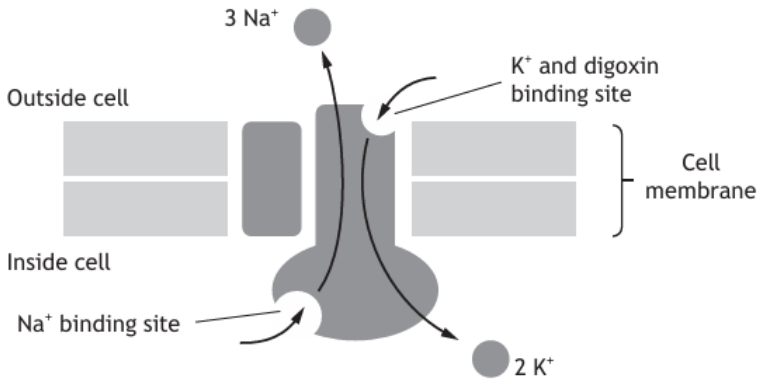
Maintain resting membrane potential

(b) Describe the role of ATP in altering the affinity of the pump for sodium ions (Na^+). 2

Phosphorylation causes a conformational change of pump

Lowers affinity for Na+ ions

8. Digoxin is a chemical that inhibits the sodium potassium pump by binding to the potassium ion (K^+) binding site as shown in the diagram below.



Explain why binding by digoxin prevents further binding of sodium (Na^+) ions by the pump. 2

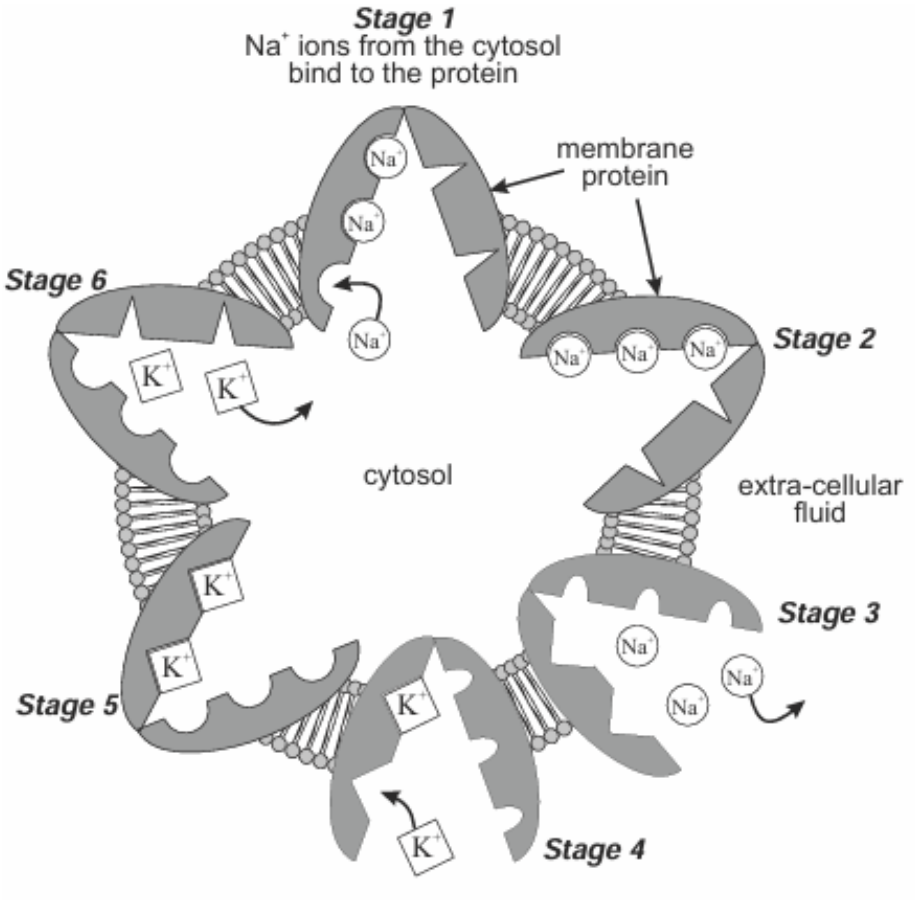
Prevents binding of K+ ions (1)

Preventing de-phosphorylation

OR Prevents reversal of conformational change

OR Affinity for Na+ ions low

9. The diagram shows stages in the transport across the plasma membrane by a sodium-potassium pump.



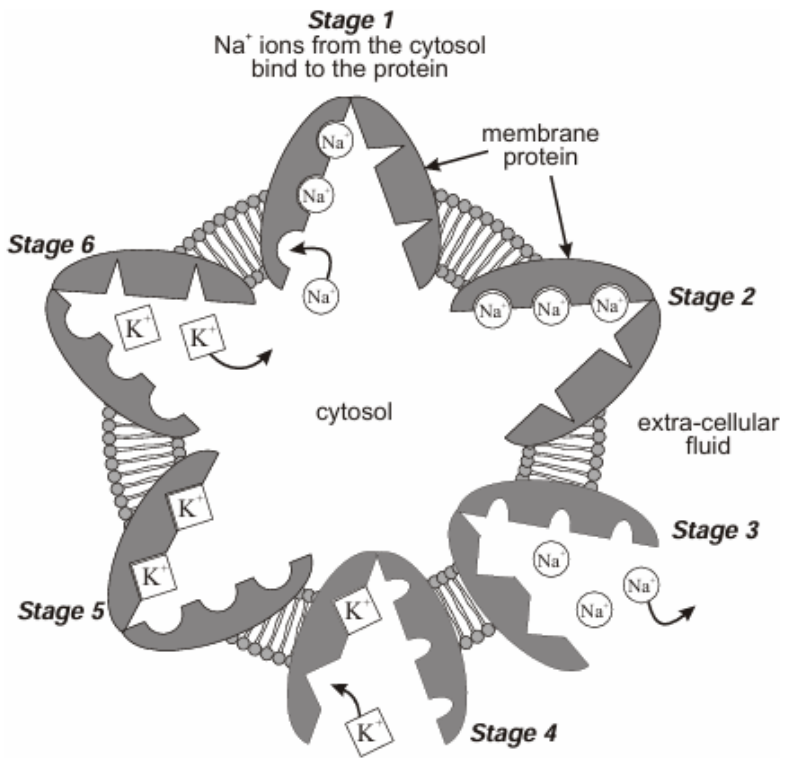
Describe the role of ATP in powering the pump between stages 2 and 3.

ATP phosphorylates the Na/K pump

Protein changes conformation releasing Na outside the cell.

2

10. The diagram shows stages in the transport of ions across the plasma membrane by a Na^+ / K^+ ATPase pump.



(i) State what happens to change the protein conformation between stages 4 and 5.

dephosphorylation

1

(ii) Na^+ / K^+ ATPase pumps sodium out of gut epithelial cells into the blood. Explain how the glucose symport proteins use these conditions to absorb glucose from the small intestine.

Na moves in down concentration gradient/diffuses IN

Glucoses goes in against concentration gradient/moves IN by active transport

2

11. Describe the sequence of events of the Na/K ATPase conformation changes that result in the movement of K^+ ions into the cell.

Phosphorylation of pump changes conformation to have high affinity for K outside of cell

Dephosphorylation of pump changes conformation to now have low affinity for K

2

12. Explain the role of Na^+ / K^+ ATPase in glucose absorption in the small intestine.

Pumps sodium out of cell

Sodium diffuses in down a (steep) concentration gradient

Linked to glucose moving up it's concentration gradient Through a symport

2