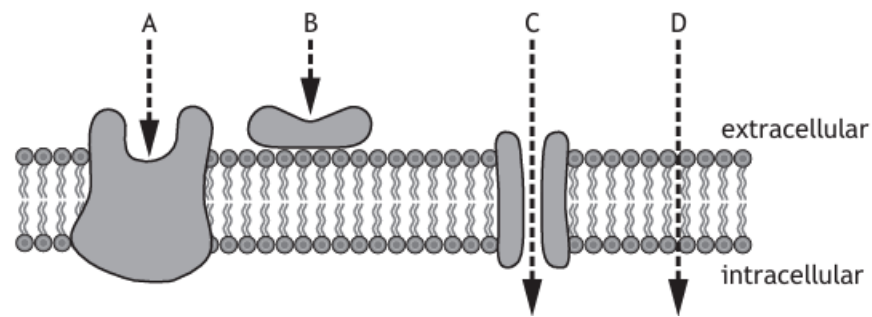


1 Which letter in the diagram represents the first stage in cell signalling for a peptide hormone molecule?



The response to an increase in insulin concentration in the blood involves the following events.

- 1. Recruitment of GLUT 4 to the cell membrane.
- 2. A phosphorylation cascade inside the cell.
- 3. Insulin receptor changes conformation.
- 4. Phosphorylation of the insulin receptor.
- 5. Binding of insulin to its receptor.

The correct sequence of these events is:

- A 5, 4, 3, 1, 2
- B 2, 4, 3, 5, 1
- C 5, 3, 4, 2, 1
- D 5, 3, 1, 2, 4

2 Type 1 diabetes is caused by

- A excessive production of insulin
- B loss of insulin receptor function
- C failure of GLUT4 to respond to insulin binding
- D insufficient production of insulin.

3 The statements refer to steps in signalling pathways.

- 1. The hormone binds to a receptor protein in the cell membrane.
- 2. The hormone binds to a receptor protein in the nucleus or cytoplasm of the cell.
- 3. The hormone-receptor complex binds to DNA.
- 4. The activated receptor results in a G-protein relaying the signal to a target protein.

Which of these statements would refer to a signalling pathway for a steroid hormone?

- A 1 and 3 only
- B 2 and 3 only
- C 1 and 4 only
- D 2 and 4 only

4 Which row in the table describes events in signalling by the hormone insulin?

	Location of insulin binding site	Mechanism of signal transduction
A	intracellular	G-protein activation
B	intracellular	phosphorylation
C	extracellular	G-protein activation
D	extracellular	phosphorylation

5 In multicellular organisms, only target cells respond to a specific signal because

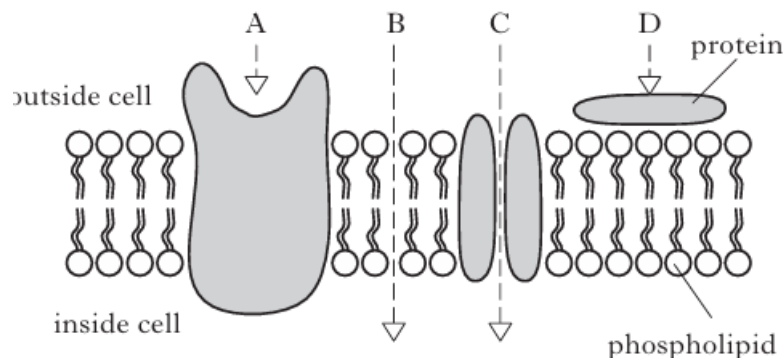
- A signalling molecules only come into contact with target cells
- B only target cells have receptor molecules for the signalling molecule
- C non-target cells do not respond when the signalling molecule binds to its receptor
- D receptor molecules in non-target cells do not change conformation when the signalling molecule binds.

6 A hydrophobic signalling molecule diffuses into a cell through a

- A carrier protein
- B receptor protein
- C phospholipid bilayer
- D transmembrane channel.

7. Cortisol is a steroid hormone.

Which letter in the diagram below shows the first stage in cell signalling for this hormone?



8 To which group of signalling molecules does the sex hormone testosterone belong?

- A Extracellular hydrophilic
- B Extracellular hydrophobic
- C Peptide hormones
- D Neurotransmitters

9 The following list contains examples of extracellular signalling molecules.

1. Neurotransmitters
2. Insulin
3. Oestrogen
4. Testosterone

Which molecules are steroid hormones?

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

10 The stages in cell signalling by a steroid hormone such as oestrogen are listed.

1. Hormone-receptor complex binds to hormone response elements.
2. Oestrogen diffuses through the phospholipid bilayer of the plasma membrane.
3. Transcription of genes.
4. Hormone binds to intracellular receptor.

The sequence in which these events occur is

- A $4 \rightarrow 2 \rightarrow 3 \rightarrow 1$
- B $2 \rightarrow 4 \rightarrow 1 \rightarrow 3$
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11 . Which row in the table gives correct statements about the two types of diabetes?

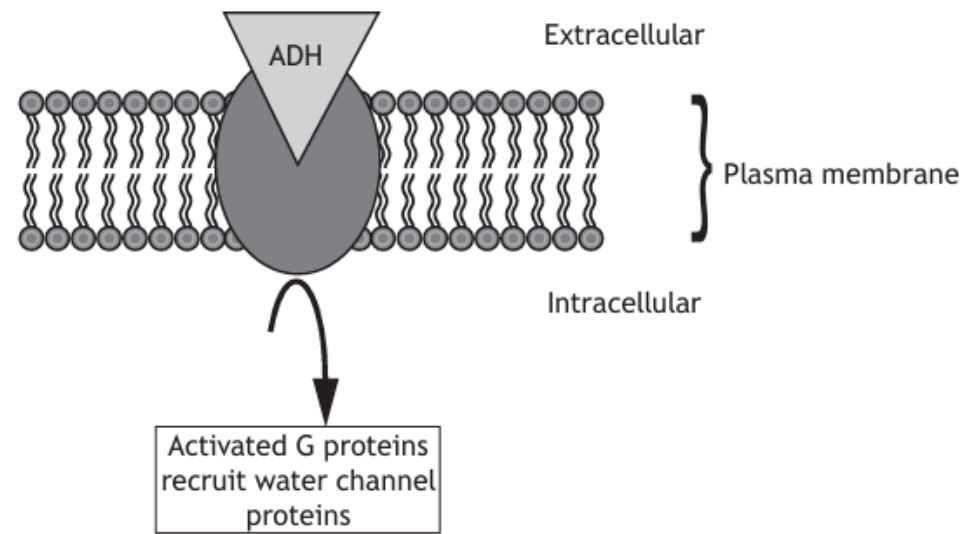
	Type 1	Type 2
A	Can produce insulin	Glucose absorbed by GLUT4 transporter
B	Loss of insulin receptor function	Condition improved by exercise
C	Condition improved by exercise	Loss of insulin receptor function
D	Cannot produce insulin	Associated with obesity

1 Cortisol is a steroid hormone.
Describe the mechanism by which this type of signalling molecule causes an effect within the target cell.

2 Suggest a way in which cortisol might have different effects in different tissues.

3 Explain why this normal response to insulin does not happen in individuals with type 2 diabetes.

4 Binding of antidiuretic hormone (ADH) to its receptor on the plasma membrane of kidney collecting duct cells triggers the recruitment of water channel proteins as shown below.



Name the process by which a response within the cell is triggered by the binding of ADH to its cell surface receptor.

5 State why the treatment regimes for individuals with type 1 diabetes may differ from individuals with type 2 diabetes.

6 What property of the testosterone molecule allows it to pass directly through the membrane? 1

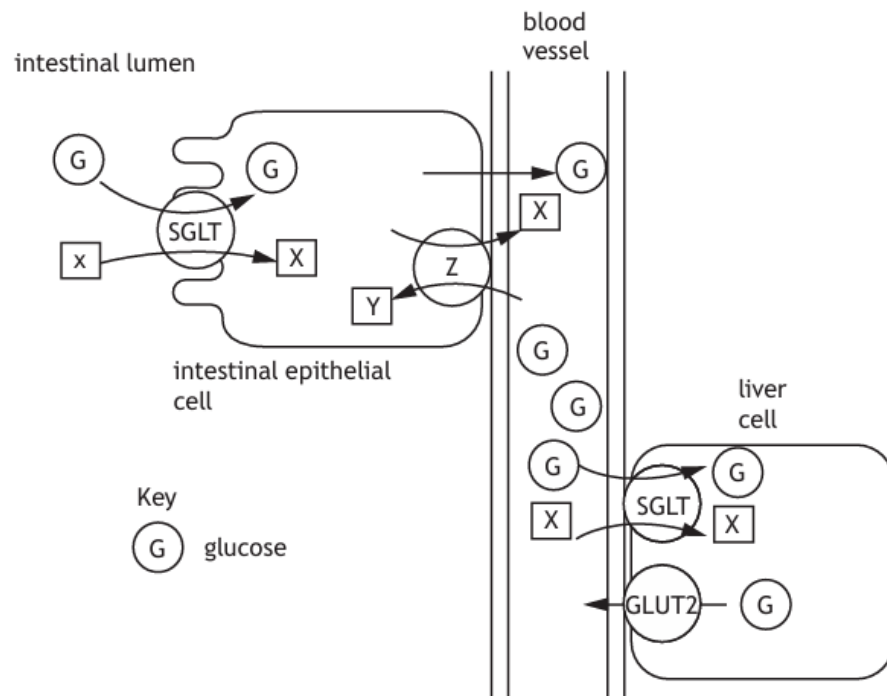
7 Describe how this hormone-receptor complex produces a cellular response. 2

8 Testosterone influences both mane colour and length. These traits are controlled by different genes.
Explain how a single signalling molecule such as testosterone is able to influence the expression of multiple genes. 1

9 Hormones such as insulin do not enter the cell and yet influence multiple cellular pathways in a cell.
Describe how insulin is able to activate intracellular signalling pathways. 2

10 Steroid hormones are a type of hydrophobic signalling molecule.
Describe how steroid hormones bring about a response in target cells. 5

11 Diabetes is a condition in which blood glucose concentration is raised.
Describe how failure of insulin signalling leads to diabetes. 3



- 12 Liver cells store glucose as insoluble glycogen. In response to low blood glucose concentrations the liver converts the glycogen back into glucose.

A mutation of the gene coding for GLUT2 protein leads to a failure of its function.

Explain why individuals with the GLUT2 gene mutation may experience hypoglycaemia (very low blood glucose levels) despite having a balanced diet, and not being diabetic.

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- 13 State the term that describes the action of a membrane receptor in which signal binding brings about an effect in the cytoplasm.

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- 14 Insulin is a peptide hormone involved in the regulation of blood glucose in humans.

(a) Describe how insulin is involved in the uptake of glucose into target cells.

2

(b) Adiponectin is a signalling molecule thought to increase the sensitivity of cells to insulin.

In a clinical study, the concentration of adiponectin in the blood of patients with Type 2 diabetes was compared to non-diabetics. The results are shown in **Table 1** below.

Table 1

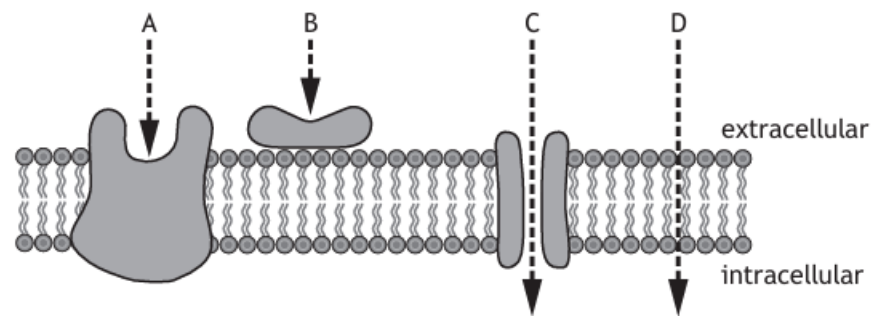
Patient Group	Average concentration of adiponectin in blood plasma ($\mu\text{g cm}^{-3}$)
Type 2 diabetic	6.6 ± 0.4
Non-diabetic	7.9 ± 0.5

Explain how the results in **Table 1** relate to the characteristics of Type 2 diabetes.

2

15 Describe the control of transcription by hydrophobic signal molecules. **5**

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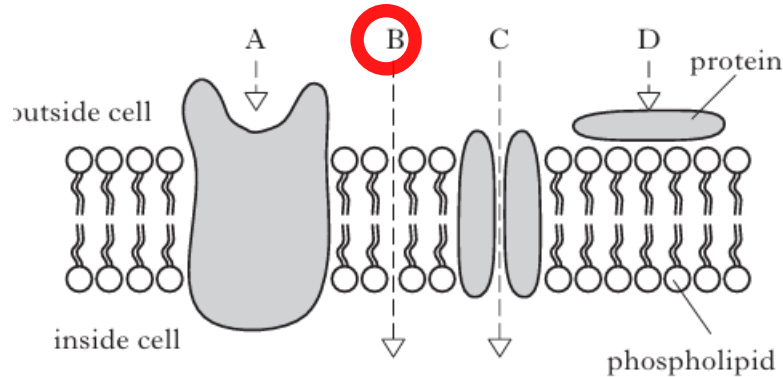
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	Type 1	Type 2
A	Can produce insulin	Glucose absorbed by GLUT4 transporter
B	Loss of insulin receptor function	Condition improved by exercise
C	Condition improved by exercise	Loss of insulin receptor function
D	Cannot produce insulin	Associated with obesity

1 Cortisol is a steroid hormone.
Describe the mechanism by which this type of signalling molecule causes an effect within the target cell. 2

Cortisol diffuses through cell membrane. (1)

Binds to receptor which switches transcription on/off.

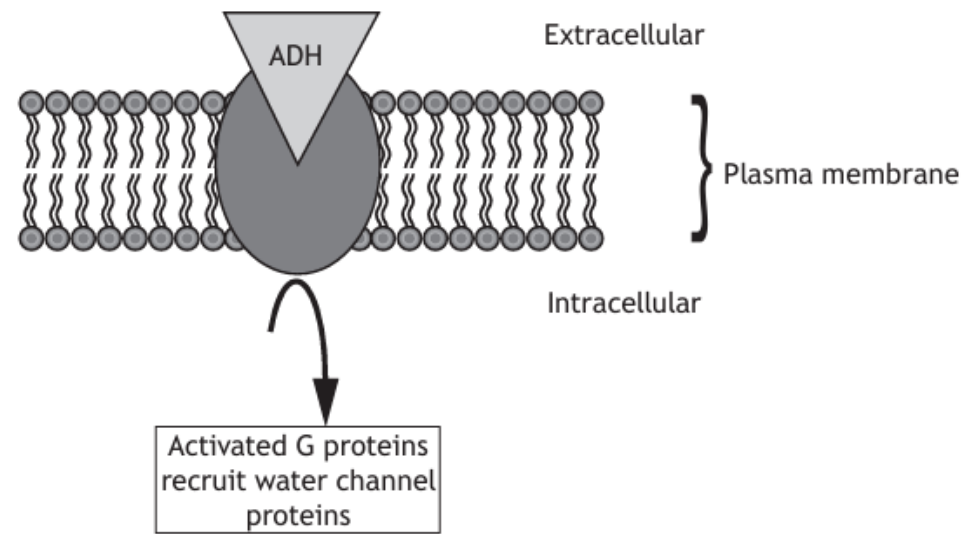
2 Suggest a way in which cortisol might have different effects in different tissues. 1

Different signal transduction pathways.

3 Explain why this normal response to insulin does not happen in individuals with type 2 diabetes. 2

Insulin receptors lose sensitivity (1)
GLUT4 not recruited to membrane (1)

4 Binding of antidiuretic hormone (ADH) to its receptor on the plasma membrane of kidney collecting duct cells triggers the recruitment of water channel proteins as shown below.



Name the process by which a response within the cell is triggered by the binding of ADH to its cell surface receptor. 1

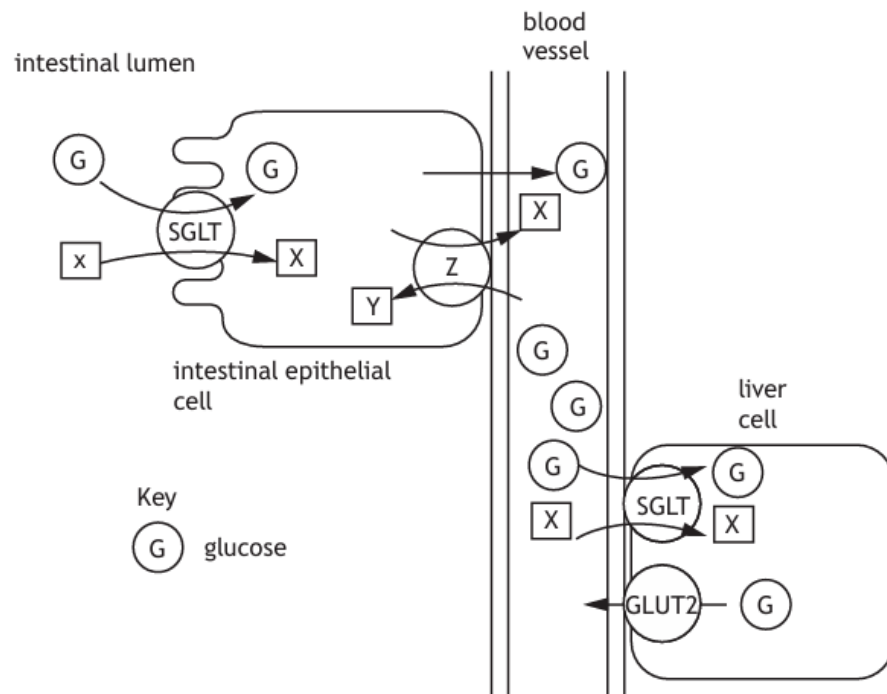
Signal transduction

5 State why the treatment regimes for individuals with type 1 diabetes may differ from individuals with type 2 diabetes. 1

Type 1 cannot produce insulin at pancreas whereas
Type 2 is an issue with insulin liver sensitivity.

- 6 What property of the testosterone molecule allows it to pass directly through the membrane? 1
Hydrophobic/non-polar
-
- 7 Describe how this hormone-receptor complex produces a cellular response. 2
Binds to hormone response element on DNA
Influences rate of transcription.
-
- 8 Testosterone influences both mane colour and length. These traits are controlled by different genes.
Explain how a single signalling molecule such as testosterone is able to influence the expression of multiple genes. 1
Each gene will possess HRE that bind the hormone-receptor complex.
-
- 9 Hormones such as insulin do not enter the cell and yet influence multiple cellular pathways in a cell. 2
Describe how insulin is able to activate intracellular signalling pathways.
Insulin binds to a receptor on the cell's surface
resulting in a phosphorylation cascade
-

- 10 Steroid hormones are a type of hydrophobic signalling molecule. 5
Describe how steroid hormones bring about a response in target cells.
1. Oestrogen/testosterone
2. Diffuse across membrane
3. Bind to specific intracellular in the cytosol/nucleus
4. Receptors are transcription factors
5. Hormone-receptor complex binds to specific target DNA 6.
called hormone response elements/HREs
7. Binding of hormone-receptor complex affects the rate of transcription.
8. Transcription of many genes affected by one hormone.
-
- 11 Diabetes is a condition in which blood glucose concentration is raised. 3
Describe how failure of insulin signalling leads to diabetes.
1. Type 1 diabetes is reduced insulin production at the pancreas
2. No insulin to bind to its receptor at the liver
3. Type 2 diabetes is loss of insulin receptor sensitivity
4. Resulting in lack of recruitment of Glut-4 in fat/ muscle cells
5. impaired glucose uptake into fat/muscle cells
-



14 Insulin is a peptide hormone involved in the regulation of blood glucose in humans.

(a) Describe how insulin is involved in the uptake of glucose into target cells. 2

The binding of insulin to its receptor within the cell membrane changes the conformation of the receptor.

This triggers a phosphorylation kinase cascade.

Results in recruitment of Glut 4 transporters to the membranes of fat/muscle cells.

(b) Adiponectin is a signalling molecule thought to increase the sensitivity of cells to insulin.

In a clinical study, the concentration of adiponectin in the blood of patients with Type 2 diabetes was compared to non-diabetics. The results are shown in **Table 1** below.

Table 1

<i>Patient Group</i>	<i>Average concentration of adiponectin in blood plasma ($\mu\text{g cm}^{-3}$)</i>
Type 2 diabetic	6.6 ± 0.4
Non-diabetic	7.9 ± 0.5

Explain how the results in **Table 1** relate to the characteristics of Type 2 diabetes. 2

Diabetics have lower adiponectin so they aren't as sensitive to insulin (1)

Lowered insulin sensitivity makes cells less able to convert glucose to glycogen (1)

12 Liver cells store glucose as insoluble glycogen. In response to low blood glucose concentrations the liver converts the glycogen back into glucose.

A mutation of the gene coding for GLUT2 protein leads to a failure of its function.

Explain why individuals with the GLUT2 gene mutation may experience hypoglycaemia (very low blood glucose levels) despite having a balanced diet, and not being diabetic.

Glucose cannot diffuse out of the liver into blood.

1

13 State the term that describes the action of a membrane receptor in which signal binding brings about an effect in the cytoplasm.

Signal transduction

1

15 Describe the control of transcription by hydrophobic signal molecules.

5

-
1. Hydrophobic signalling molecules can diffuse directly through the phospholipid bilayers of membranes
 2. Example of hydrophobic signalling molecule e.g. Steroid hormone / oestrogen / testosterone
 3. Steroid hormones bind to receptors in cytosol / nucleus
 4. Receptors are transcription factors
 5. Hormone-receptor complex moves to nucleus
 6. Hormone-receptor complex binds to specific DNA sequences
 7. Specific DNA sequences called hormone response elements / HREs
 8. Binding influences the rate of transcription / can stimulate or inhibit
 9. Each steroid hormone affects the expression / transcription of many genes
-