2018 Cell Signalling MCQ

2018 / H2 / ACJC PRELIM / P1 Q23

1 Nerve cells in the brain communicate by chemical molecules known as neurotransmitters. The following events, in the order shown, describe how binding of a neurotransmitter to a nerve cell will elicit a cellular response.

1 Neurotransmitter binds to a G-protein linked receptor (GPLR) at the cell surface

↓

2 A change in conformation of the GPLR allows the binding of a G protein to its intracellular domain

↓

3 G protein releases a GDP molecule in exchange for GTP

↓

4 The alpha subunit of the G protein dissociates from the other subunits

↓

5 The alpha subunit of the G protein activates adenylyl cyclase, which in turn converts ATP into cyclic AMP (cAMP)

↓

6 cAMP activates protein kinase A (PKA), which in turn phosphorylates transmembrane protein channels

↓

7 Phosphorylated protein channels open, allowing the facilitated diffusion of specific ions into the nerve cell

How many of the events allow for the amplification of signal to occur?

A 3

B 4

C 5

D 6

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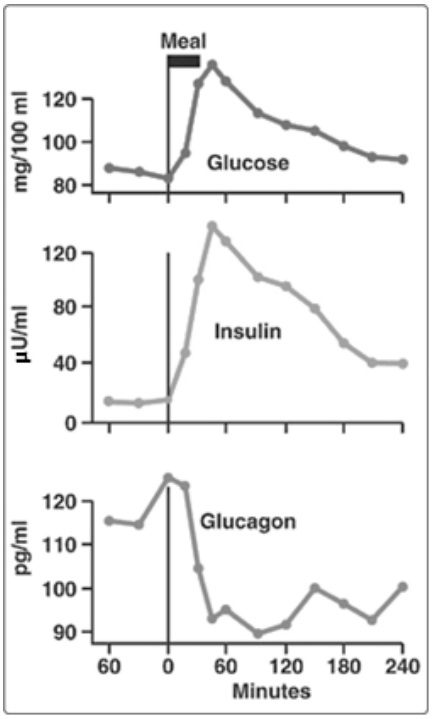
2 The figure shows the levels of glucose, insulin and glucagon found in blood, before and after a carbohydrate-containing meal was ingested.



Which row correctly identifies the events occurring at the respective timings?

	Timing	Events
A	60 minutes before meal	Glucagon results in the activation of glycogen phosphorylase, leading to increased rates of glycogenolysis in liver cells and an increase in blood glucose levels.
B	30 minutes before meal	Glucagon binds to G protein-linked receptors, leading to the activation of G proteins due to the hydrolysis of GTP molecules. Cellular responses lead to the maintenance of blood glucose levels.
C	At the start of meal (0 minutes)	Insulin binds to tyrosine kinase receptors, resulting in the cross-phosphorylation of receptor monomers. Cellular responses lead to a decrease in blood glucose levels.
D	60 minutes after meal	Insulin results in the translocation of glucose transporters to the cell surface, leading to increased rates of glucose uptake in muscle cells and a decrease in blood glucose levels.

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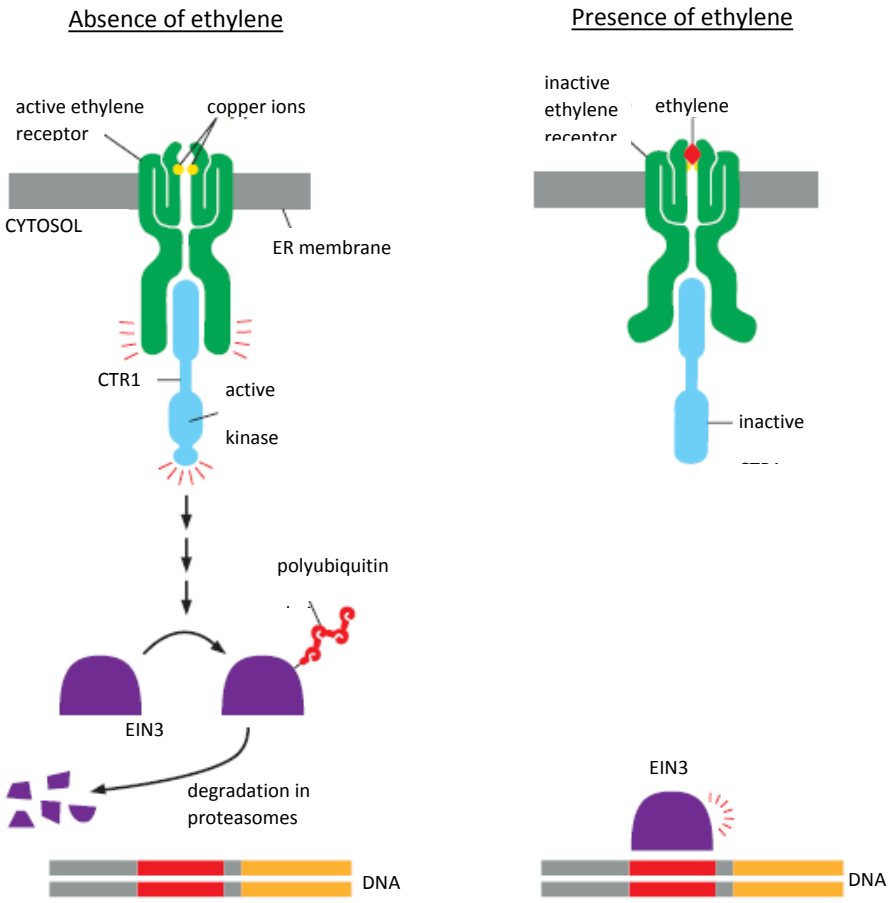
3 Ethylene gas is a plant hormone that regulates plant growth, development and response to environmental stress. It is produced from leaves, roots, stems, flowers and especially ripened fruits.

Plants have various ethylene receptors which are located in the endoplasmic reticulum (ER). The diagram shows the ethylene signalling pathway. Ethylene receptors are dimeric, transmembrane proteins, with a copper-containing ethylene-binding domain and a domain that interacts with a cytoplasmic protein called CTR1.



Which statements provide the most direct evidence that the ethylene gas signalling mechanism functions to mediate gene expression?

1 In the absence of ethylene, active CTR1 stimulates the ubiquitination and degradation in proteasomes of EIN3.

2 In the absence of ethylene, the active ethylene receptors halt transcription of ethylene-responsive genes through degradation of EIN3.

3 In the presence of ethylene, its binding inactivates the receptor, altering their conformation so that they no longer activate CTR1.

4 In the presence of ethylene, the EIN3 protein does not undergo selective degradation and can now activate the transcription of the large number of ethylene-responsive genes.

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

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4 What is the main purpose of the second messengers in signal transduction pathways?

A They allow for long distance signalling between cells by being activated when they bind to extracellular molecules.

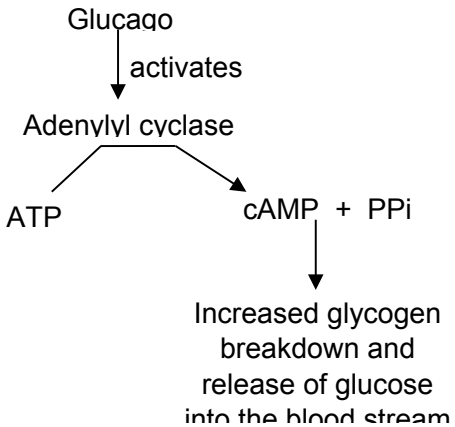
B They amplify the signal without involving protein kinase cascade.

C They can always cross the membranes of the organelles to initiate cellular processes.

D They relay a signal from the plasma membrane to the cytoplasm by sudden increase of their cytosolic concentration.

2018 / H2 / DHS PRELIM / P1 Q12

5 One action of the hormone glucagon is to cause the activation of adenylyl cyclase in liver cells. Adenylyl cyclase is an enzyme that converts ATP into the messenger molecule cyclic AMP (cAMP), the presence of which triggers a cascade of events within the cell that leads to the breakdown of glycogen and the subsequent release of glucose into the blood stream. This pathway is summarised below.



When glucagon is removed, adenylyl cyclase becomes inactive again and ceases to convert ATP to cAMP. The enzyme phosphodiesterase converts cAMP into AMP. The following table summarises an experiment measuring glucose release by liver cell cultures under various conditions.

Culture	Condition(s)	Observation(s)
1	no addition of glucagon and caffeine	minimal glucose release
2	glucagon added and later removed	glucose released into media; rapid reduction in release after glucagon removed
3	caffeine added	minimal glucose release
4	glucagon and caffeine added; glucagon was then removed but caffeine maintained	glucose released into media; slow reduction in release after glucagon removed

Based on these observations, which of the following statement is most likely to be true?

A Caffeine stimulates synthesis of cAMP.

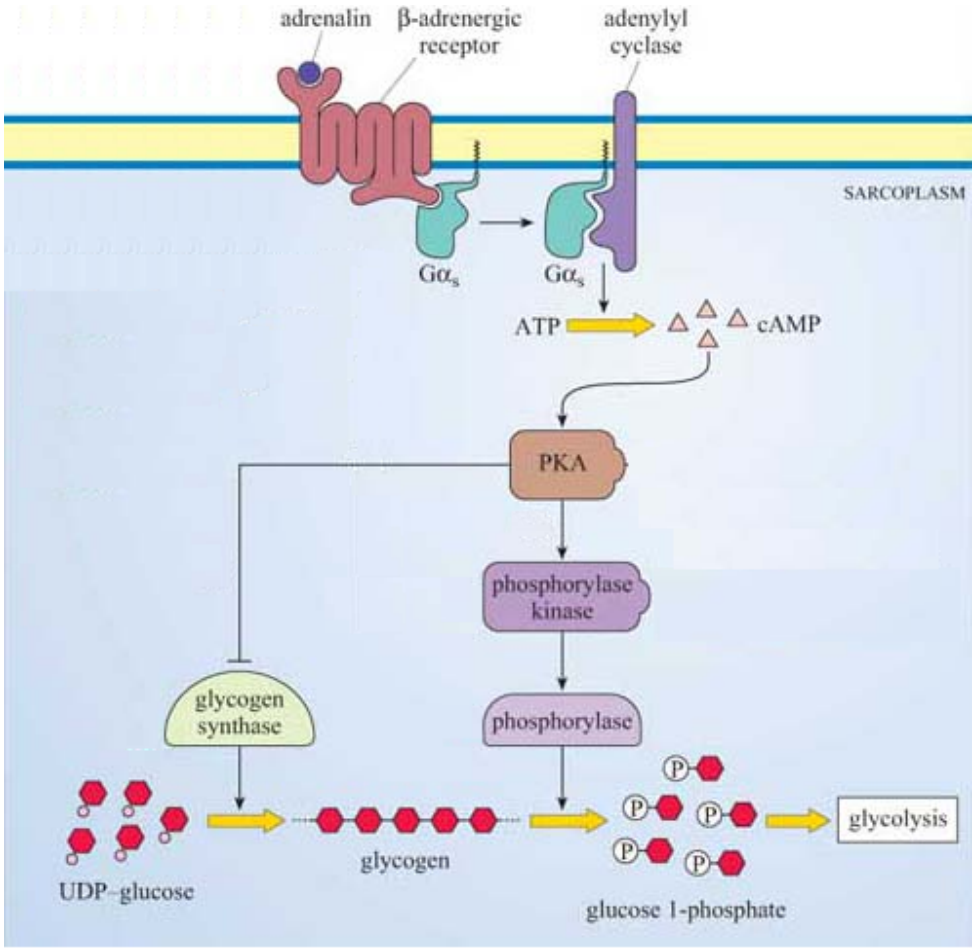
B Caffeine prevents glucagon breakdown.

C Caffeine inhibits the action of phosphodiesterase.

D Caffeine binds the active site of adenylyl cyclase.

2018 / H2 / EJC PRELIM / P1 Q27

6 The β-adrenergic receptor on muscle cells is a G-protein coupled receptor. Details of the cell signalling pathway in the presence of adrenalin is illustrated in the diagram below.



Which of the following is correct?

A Inactivation of G protein occurs when GTP is displaced by GDP.

B Signal amplification occurs at the step where G protein activates adenylyl cyclase.

C During signal transduction, PKA can phosphorylate more than one type of molecule to activate them.

D Muscle cells have decreased rate of glycogenesis and increased rates of glycolysis in the presence of adrenalin.

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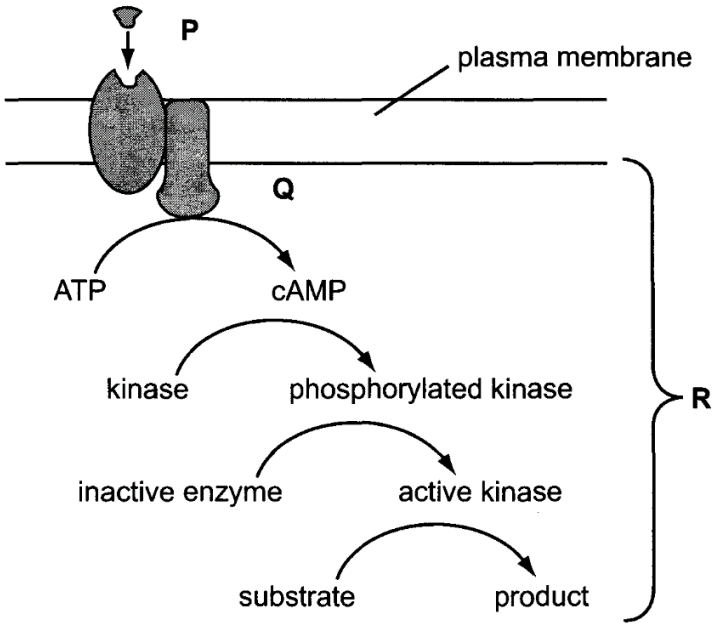
7 The diagram shows an example of cell signalling.



Which processes are shown on the diagram?

	P	Q	R
A	amplification	ligand-receptor interaction	phosphorylation
B	ligand-receptor interaction	amplification	phosphorylation
C	transduction	phosphorylation	amplification
D	ligand-receptor interaction	transduction	amplification

2018 / H2 / JJC PRELIM / P1 Q23

8 What is the correct sequence of events in a cell in response to insulin?

A Hormone binding to receptor → dimerisation of polypeptides → cross phosphorylation → activation of insulin response protein → activation of glycogen phosphorylase

B Hormone binding to receptor → dimerisation of polypeptides → cross phosphorylation → activation of insulin response protein → activation of glycogen synthase

C Hormone binding to receptor → cross phosphorylation → dimerisation of polypeptides → activation of protein kinases → activation of glycogen phosphorylase

D Hormone binding to receptor → cross phosphorylation → dimerisation of polypeptides → activation of insulin response protein → activation of glycogen synthase

2018 / H2 / MJC PRELIM / P1 Q22

QUESTION 9

Which of the following correctly describes the function of second messengers in signal transduction pathway?

A They relay the signal from the outside to the inside of the cell.

B They serve as transcription factors to activate the transcription process.

C They amplify the signal by phosphorylating other proteins.

D They bind to and alter the conformation of other effector proteins.

2018 / H2 / NJC PRELIM / P1 Q26

10 Which enzyme is **not** involved in the regulation of signal transduction pathways?

A GTPase

B kinase

C phosphatase

D phosphorylase

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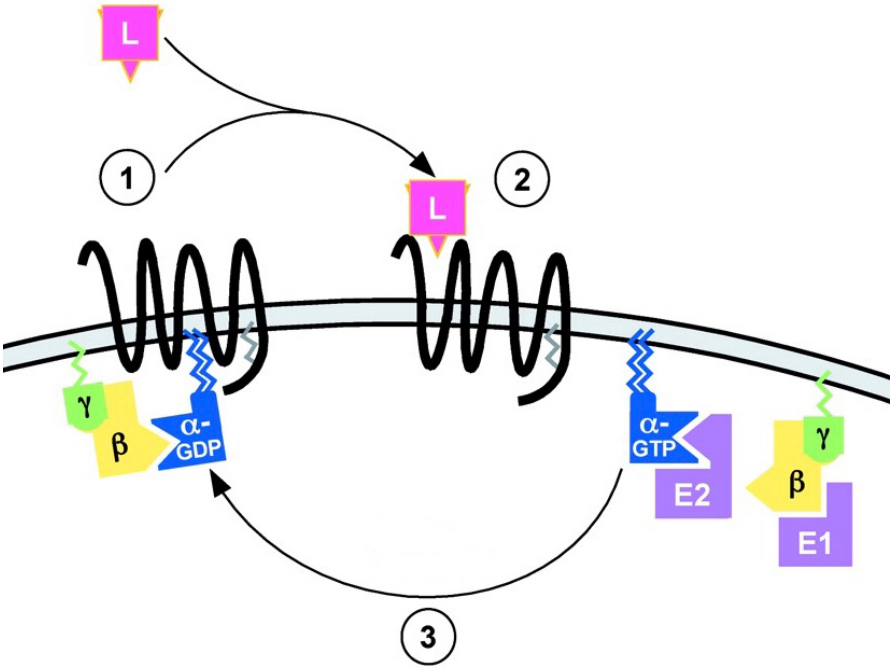
11 The diagram shows part of a cell signalling pathway.



Which of the following correctly describes the numbered steps in the cell signalling pathway?

1 A heterotrimeric G-protein is associated with an active cell surface receptor that has seven transmembrane domains.

2 The binding of ligand L to the G-protein linked receptor is required for the activation of downstream effectors, E1 and E2.

3 A molecule of GDP displaces the GTP on the alpha subunit of the G-protein, causing the alpha subunit to reassociate with the beta-gamma complex.

A 1 only

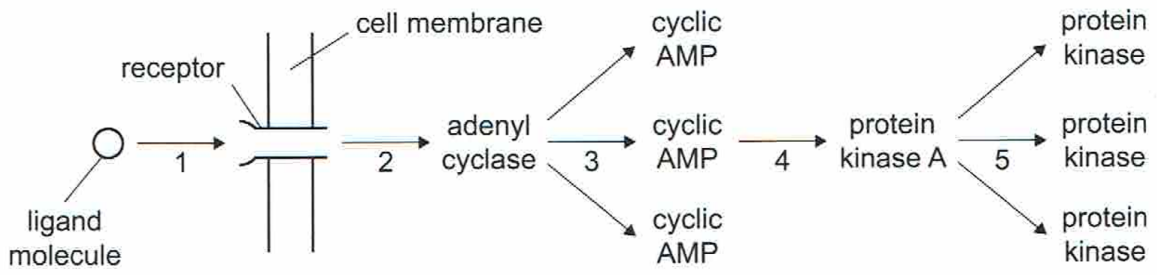
B 2 only

C 1 and 3 only

D 1, 2 and 3

2018 / H2 / NYJC PRELIM / P1 Q19

12 The diagram shows an example of cell signaling.



At how many of the five numbered stages does signal amplification occur in this example?

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

2018 / H2 / PJC PRELIM / P1 Q24

13 Insulin binds to a receptor on a cell surface membrane and, as a result, the activity of an enzyme, E, in the cell is altered by phosphorylation.

Some statements about this example of cell signalling are listed.

1 The concentration of cyclic AMP (cAMP) in the cell increases.
2 A kinase enzyme adds a phosphate group to its substrate.
3 Cyclic AMP (cAMP) activates an enzyme.
4 The enzyme adenyl cyclase is activated.

Which sequence of steps occurs to alter the activity of enzyme E?

A 1 → 4 → 2 → 3

B 2 → 3 → 4 → 1

C 3 → 2 → 1 → 4

D 4 → 1 → 3 → 2

2018 / H2 / RI PRELIM / P1 Q22

14. The diagram below shows the role of an endocrine tissue in controlling blood glucose concentration.

Which of the following statements are true?

1 Small amounts of hormone I and II inducing a large response in liver tissue demonstrates positive feedback.

2 Hormones I and II inducing different responses from the same target tissue is due to the hormones binding to different receptors on the liver cell surface membrane.

3 The binding of hormone I to receptors on liver cell surface membrane leads to the production of second messenger, cAMP.

4 Besides the liver, hormone I will also target muscle tissue to regulate blood glucose concentration.

A 1 and 2

B 2 and 3

C 3 and 4

D 2 and 4

2018 / H2 / RI PRELIM / P1 Q23

15. Which of the following statements is false about cell signalling involving tyrosine kinase receptors?

A Ligand molecules are mostly hydrophilic in nature.

B Different activated relay proteins serve to directly amplify the effects of the ligand.

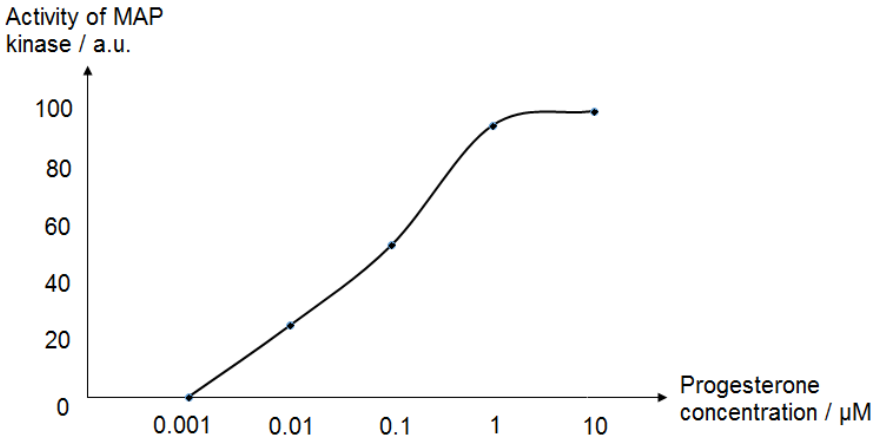
C Dimerisation serves to initiate auto-phosphorylation.

D Receptors are transmembrane proteins that are anchored within the cell surface membrane.

2018 / H2 / RVHS PRELIM / P1 Q25

16 Maturation of frog oocytes (fertilised eggs) results from a series of cell signalling events triggered by the hormone progesterone. Progesterone directly stimulates the translation of mRNA encoding Mos, a protein that sets off a downstream signalling cascade. This cascade leads to the activation of an enzyme called MAP kinase. MAP kinase directly stimulates oocyte maturation.

In an investigation, 16 frog oocytes were treated with six different concentrations of progesterone. The activity of MAP kinase was measured by the proportion of oocytes that have matured. The results are shown in the graph.



Which of the following cannot be concluded from the information above?

1 Progesterone is a lipid-soluble hormone.

2 55 oocytes would have matured in the set-up with 0.1 μM progesterone.

3 The maturation of frog oocytes is activated by phosphorylation.

4 The rate of oocyte maturation is highest at 0.5 μM progesterone.

5 Mos is a second messenger.

6 Signal transduction for maturation of frog oocyte is multistep.

A 2 and 4 only

B 1, 3 and 6 only

C 2, 4 and 5 only

D 3, 5 and 6 only

2018 / H2 / SAJC PRELIM / P1 Q9

17 Arrange the following statements on the signal transduction pathway for insulin in order.

1 Auto-crossphosphorylation
2 Increase in uptake of glucose through facilitated diffusion
3 Relay proteins bind to specific activated tyrosine residues
4 Activated relay proteins activate their respective transduction pathways
5 Insulin binds to receptor tyrosine kinase (RTK) at the receptor site
6 Vesicles containing glucose transporters move to and fuse with the plasma membrane
7 Changes in the 3D conformation activates the tyrosine kinase domain of receptor

A 5, 1, 7, 3, 4, 6, 2
B 5, 7, 1, 3, 4, 6, 2
C 2, 5, 1, 7, 3, 4, 6
D 2, 5, 1, 7, 4, 3, 6

2018 / H2 / TJC PRELIM / P1 Q26

Which of the following statement is true?

	blood glucose concentration	hormone secreted	receptor involved at target cell	cellular effect
A	increase above normal level	insulin	receptor tyrosine kinase	decrease in blood glucose concentration
B	decrease below normal level	glucagon	G-protein coupled receptor	decrease in blood glucose concentration
C	decrease below normal level	insulin	G-protein coupled receptor	increase in blood glucose concentration
D	increase above normal level	glucagon	receptor tyrosine kinase	increase in blood glucose concentration

2018 Cell Signalling MCQ ANS			
Question	**Answer**	**Question**	**Answer**
1	**B**		
2	**D**		
3	**C**		
4	**D**		
5	**C**		
6	**C**		
7	**D**		
8	**B**		
9	**D**		
10	**D**		
11	**B**		
12	**B**		
13	**D**		
14	**B**		
15	**B**		
16	**C**		
17	**B**		
18	**A**		