Unit 4 Progress Check: FRQ

Name

1. Read each question carefully. Write your response in the space provided for each part of each question. Answers must be written out in paragraph form. Outlines, bulleted lists, or diagrams alone are not acceptable and will not be scored.

Growth hormone and insulin are protein hormones that regulate carbohydrate metabolism by hepatocytes (liver cells) through the activation of intracellular signaling pathways. Researchers investigated whether the two hormones trigger the same or different intracellular signaling pathways in hepatocytes. The researchers added either growth hormone or insulin to parallel cultures of hepatocytes. At several time points after the hormone addition, they purified total intracellular protein from the cells and quantified the level of the phosphorylated forms of two proteins involved in two different signaling pathways (Figure 1, **A** and **B**).

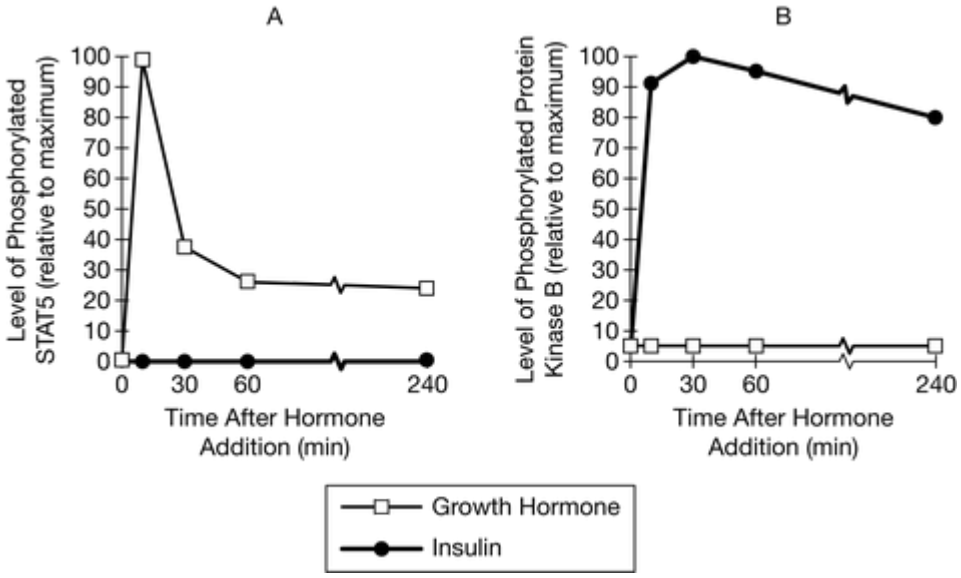


Figure 1. The level of phosphorylated signaling proteins STAT5 (A) and protein kinase B (B) in cells cultured in the presence of growth hormone or insulin

(a) Describe the first interaction that triggers signaling to begin in a target cell.

Please respond on separate paper, following directions from your teacher.

(b) Identify a dependent variable in the experimental design. Identify a negative control for the effects of hormone addition. Identify a likely reason why the researchers continued their

experiment for 240 minutes.

Please respond on separate paper, following directions from your teacher.

(c) Describe the hormone and signaling protein combination that produced the greatest and most prolonged response. For the phosphorylated STAT5 response that reached 100 percent at 10 minutes in Figure 1A , calculate the rate of decrease (percent decrease per minute) in the detected level of phosphorylated STAT5 from 10 to 30 minutes.

Please respond on separate paper, following directions from your teacher.

(d) The researchers claim that the similar regulation of carbohydrate metabolism by hepatocytes when the cells are treated with growth hormone or insulin results from the activation of different signaling pathways. Use the data from the researchers' experiment to support their claim.

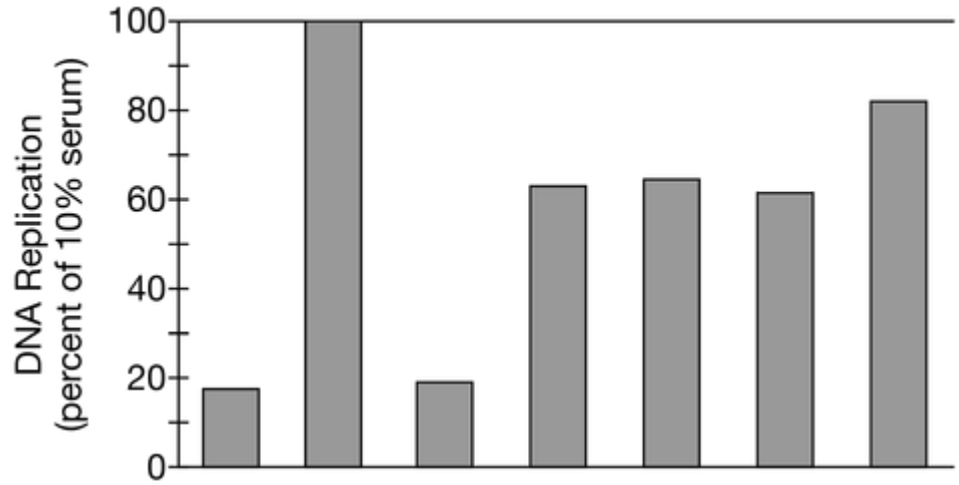
Please respond on separate paper, following directions from your teacher.

2. Read each question carefully. Write your response in the space provided for each part of each question. Answers must be written out in paragraph form. Outlines, bulleted lists, or diagrams alone are not acceptable and will not be scored.

Scientists used cells called fibroblasts to study factors that cause nondividing cells in the G_0 stage of the cell cycle to reenter the cell cycle and undergo mitosis. In a laboratory, fibroblasts typically grow and divide when they are cultured in a growth medium that contains 10% serum (the liquid part of blood that remains after blood clots). If fibroblasts are cultured for 48 hours in the absence of serum (serum-starvation), they stop dividing and enter the G_0 stage of the cell cycle.

The scientists divided serum-starved fibroblasts into groups to which they added no serum, 10% serum, or 0.1% serum. Each of the groups with 0.1% serum was also treated to block the

production of only one or combinations of four proteins (p16, p18, p21, and p27) that are inhibitors of cyclin-dependent kinases. The scientists grew the fibroblasts for 48 hours and then measured the amount of DNA replication taking place to determine whether the cells had reentered the cell cycle. The scientists compared each group of cells to the group cultured with 10% serum and plotted the data (Figure 1).



Serum	0%	10%	0.1%	0.1%	0.1%	0.1%	0.1%
p16	+	+	−	+	+	+	+
p18	+	+	+	+	−	+	−
p21	+	+	+	−	−	−	−
p27	+	+	+	+	+	−	−
Group #	1	2	3	4	5	6	7

Figure 1. DNA replication by treated fibroblasts relative to DNA replication by fibroblasts cultured with 10% serum. The treatment of each group of cells is shown in the table directly under the graph. + means the protein is present; − means the protein is absent.

(a) Based on the data for the groups of cells cultured with 0.1% serum (groups 3 to 7), identify which of the four proteins tested do(does) not appear to play a role in blocking cell cycle entry by fibroblasts.

Please respond on separate paper, following directions from your teacher.

(b) Based on the data for the groups of cells cultured with 0.1% serum (groups 3 to 7), identify

Unit 4 Progress Check: FRQ

the groups(s) most likely to include cells undergoing mitosis.

Please respond on separate paper, following directions from your teacher.

(c) Neurons (nerve cells) of the central nervous system (brain and spinal cord) are in G_0 of the cell cycle and generally do not divide in response to an injury. The scientists predict that they can use the data from this experiment to help them treat individuals who suffer from spinal cord injuries. Provide reasoning to support the scientists' prediction.

Please respond on separate paper, following directions from your teacher.

(d) Interactions between cyclins and cyclin-dependent kinases control the cell cycle. Explain how the presence or absence of inhibitors of cyclin-dependent kinases might play a role in normal cells becoming cancer cells.

Please respond on separate paper, following directions from your teacher.