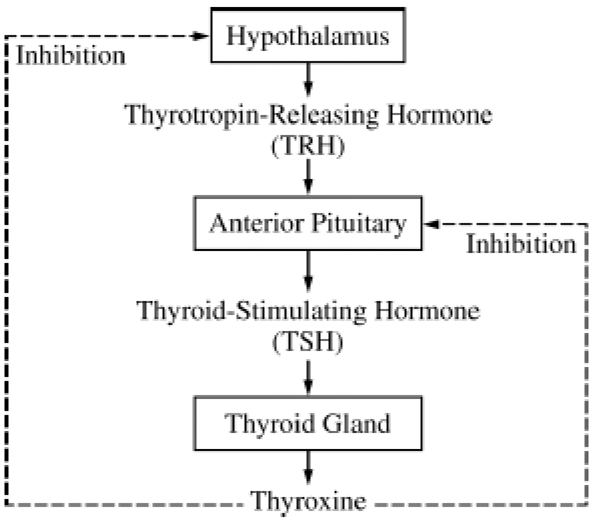


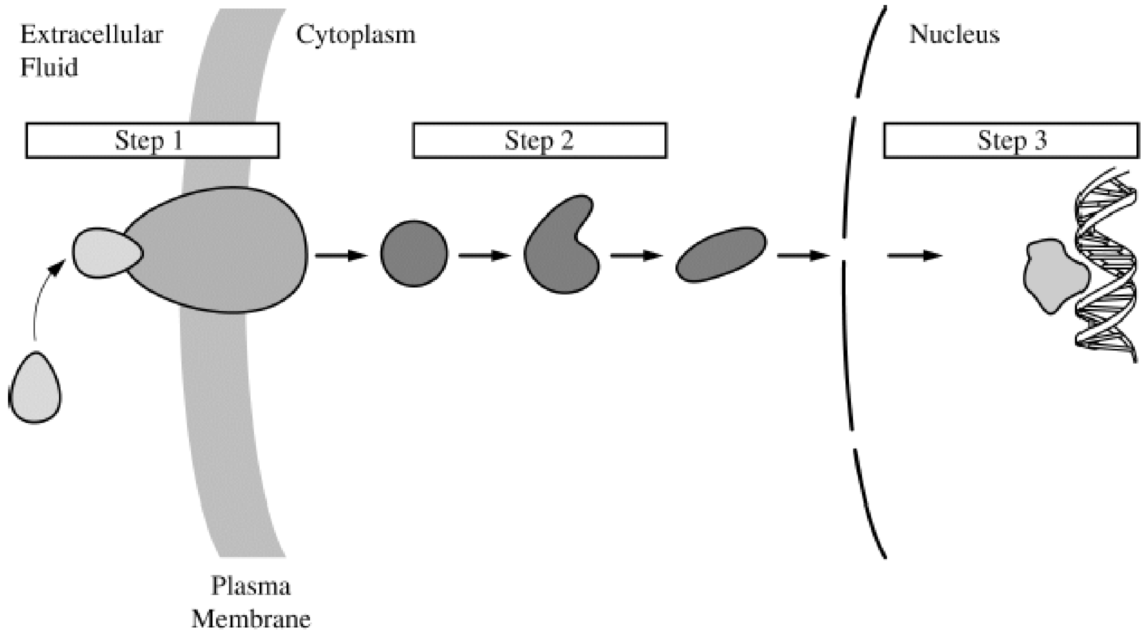
The diagram above illustrates feedback control as exerted by the hormone thyroxine. Following surgical removal of the thyroid gland, the level of TSH in the blood will increase. Which of the following best explains this increase?

(A) Residual blood thyroxine, from prior to thyroid gland removal, will bind to cells in the anterior pituitary, signaling more TSH secretion.

(B) Thyroxine will remain bound to thyroxine receptors on various body cells, and these body cells will secrete additional hormones that stimulate the anterior pituitary to secrete TSH.

(C) Thyroxine that was stored in the anterior pituitary prior to thyroid gland removal will signal more TSH secretion.

(D) A decrease in thyroxine levels means a loss of inhibition to the hypothalamus and anterior pituitary, leading to increased TSH secretion.



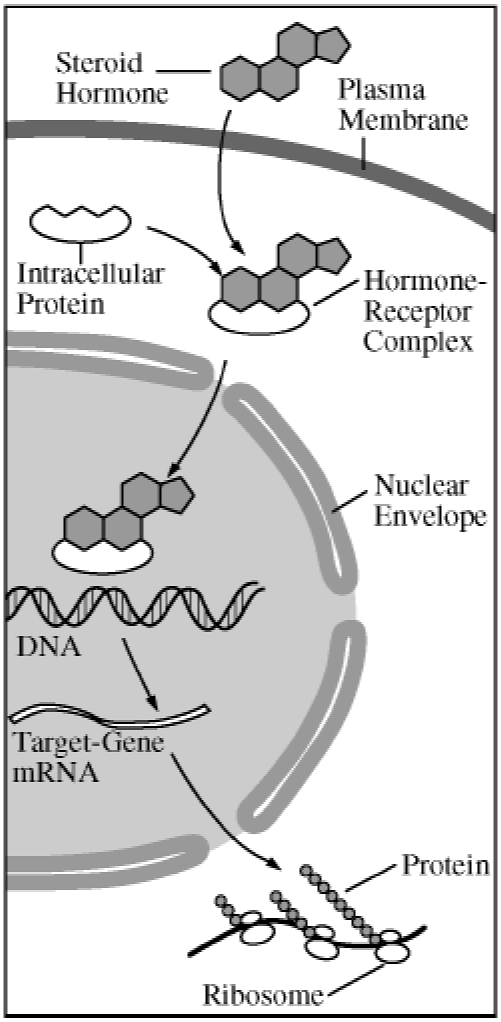
. The figure above represents a generalized hormone-signaling pathway. Briefly **explain** the role of each numbered step in regulating target gene expression.

Epinephrine is a protein hormone found in many animals. Epinephrine stimulates a signaling pathway that results in the breakdown of glycogen to glucose in the liver cells. Which of the following describes the initial steps in the process whereby epinephrine stimulates glycogen breakdown?

(A) Epinephrine binds to a cell-surface receptor; the activated receptor stimulates production of the second messenger, cAMP.
(B) Epinephrine binds to a cell-surface receptor; the activated receptor catalyzes the conversion of glycogen to glucose.
(C) Epinephrine diffuses through the plasma membrane; the hormone dimerizes in the cytosol.
(D) Epinephrine is taken into the cell by endocytosis; glycogen is converted to glucose in the endocytotic vesicle.

Steroid hormones, such as testosterone, pass through the plasma membrane and bind to an intracellular protein, as shown in the diagram below. The hormone-receptor complex then enters the nucleus, where it interacts with DNA to promote transcription of a specific gene.

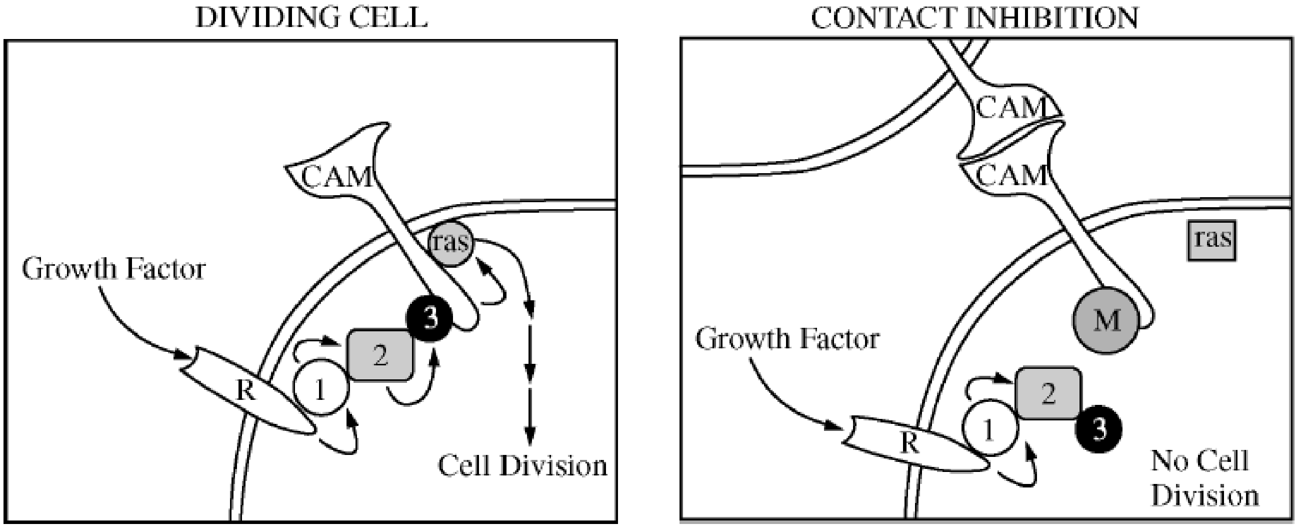
SIGNALING DIAGRAM FOR STEROID HORMONES



Based on the information presented, which of the following will also occur in response to steroid signaling?

(A) Histone protein synthesis will increase because histones maintain the DNA in an optimal conformation for chromosome assembly.
(B) Ribosome production will increase because ribosomes are specific for the mRNA with which they bind during translation.
(C) DNA replication will increase as a result of the binding of the hormone-receptor complex to the DNA.
(D) Production of a specific mRNA will increase as a result of the binding of the hormone-receptor complex to the DNA.

Many human cells can be stimulated to divide by hormonelike growth factors that bind to receptor proteins (R) on the plasma membrane and trigger an internal signal-transduction cascade. In many cases, however, the process of contact inhibition prevents mitosis when cells are in direct contact with one another. Contact inhibition occurs when proteins called cell adhesion molecules (CAMs) interact, causing them to change shape so that the growth-factor signaling proteins that normally associate with CAMs are replaced by another protein, called M. Both pathways are depicted in the figures below.



Which of the following statements accurately uses the information presented to support the hypothesis that interruption of M function in a single body cell can result in cancer?

(A) Protein 3 will be prevented from interacting with CAMs, causing the cell cycle to stop permanently.
(B) The ras protein will remain bound to DNA, blocking expression of genes required for mitosis.
(C) Growth-factor signaling can trigger mitosis in cells that are in direct contact with other cells.
(D) The receptor proteins of body cells will no longer bind to growth-factor proteins.

Some cells release active signaling proteins when membrane-bound precursor proteins are cleaved by proteolytic enzymes. The signaling proteins can then bind to receptors on the surface of a target cell, thereby activating an intracellular signaling pathway and eliciting a response from the target cell.

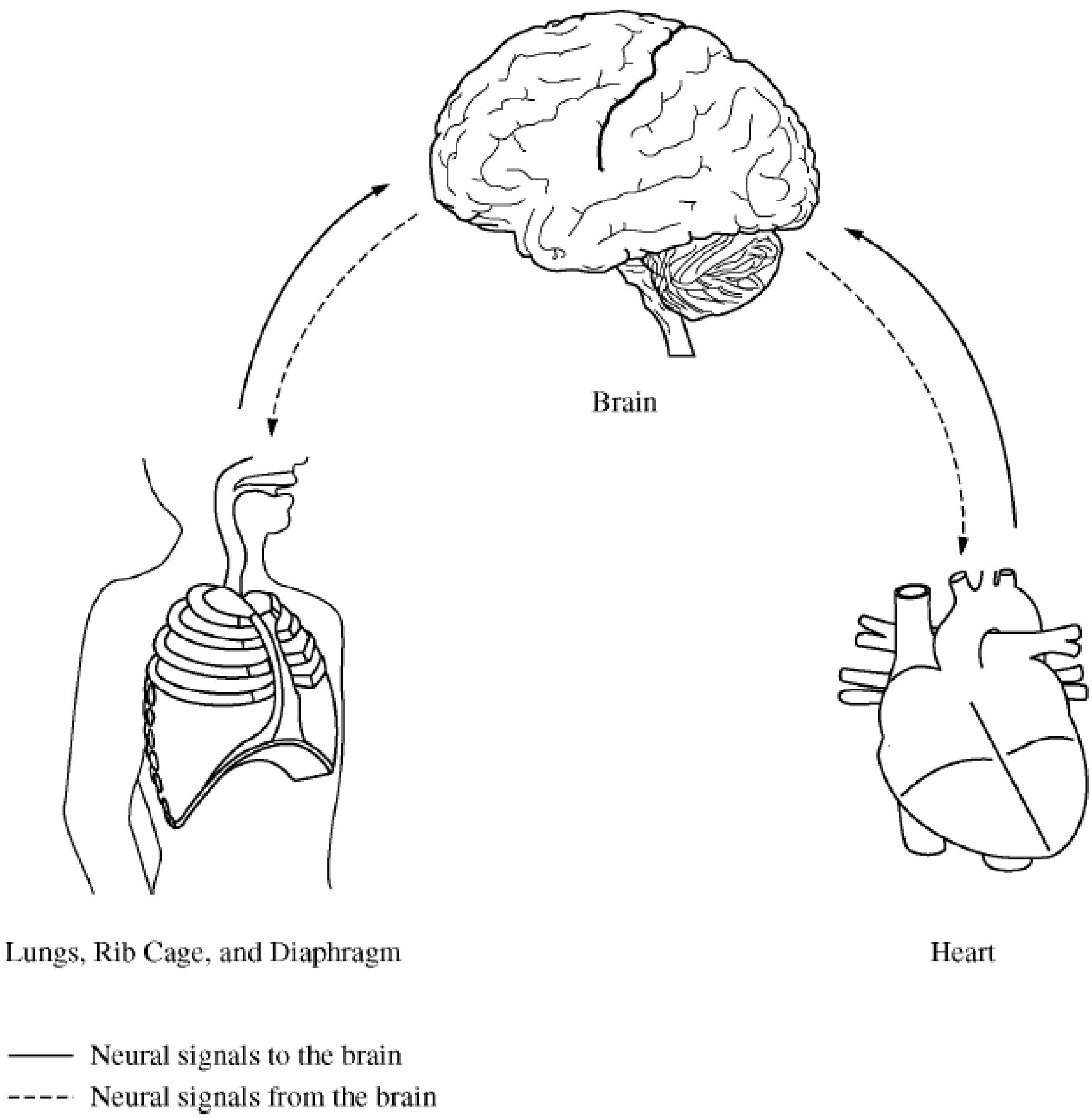
This mechanism of activating receptor-binding signaling proteins has been observed in a variety of organisms from bacteria to humans. Many of the enzymes responsible for proteolysis of membrane-bound precursor proteins have been isolated and characterized.

Which of the following questions would be most appropriate to investigate whether the proteolytic enzymes are evolutionarily conserved among species?

(A) Are the genes encoding the proteolytic enzymes expressed in the same cell types in all species?
(B) Once the precursor proteins of different species are cleaved, do the active signaling proteins bind to the same receptors on different target cells?
(C) If a proteolytic enzyme from one species is incubated with a precursor protein from another species, does correct cleavage occur?
(D) Are the proteolytic enzymes synthesized in the rough endoplasmic reticulum of all species?

Cell communication is critical for the function of both unicellular and multicellular eukaryotes. Which of the following is likely true of cell signaling?

(A) Cell signaling uses the highest molecular weight molecules found in living cells.
(B) Cell signaling has largely been replaced by other cell functions in higher mammals.
(C) Similar cell signaling pathways in diverse eukaryotes are evidence of conserved evolutionary processes.
(D) Cell signaling functions mainly during early developmental stages.



The brain coordinates the circulatory and respiratory systems of the human body. The control of breathing, for example, involves neural pathways among the structures represented in the figure above. One important stimulus in the control of breathing is an increase in blood CO_2 concentration, which is detected as a decrease in blood pH. Which of the following best describes the physiological response to an overall increase in cellular respiration in the body?

(A) In response to depleted blood CO_2 levels, the pH sensors send signals directly to the rib muscles, resulting in an increase in the rate of CO_2 uptake by the lungs and a decrease in CO_2 utilization by the brain.

(B) In response to low blood pH, the pH sensors send a signal to the brain, which then sends a signal to the diaphragm, resulting in an increased rate of breathing to help eliminate excess blood CO_2.

(C) In response to high blood pH, the pH sensors send a signal directly to the lungs, resulting in a slower rate of breathing, and the lungs send a signal back to the heart once CO_2 availability has been restored.

(D) In response to an increased rate of breathing, the rib muscles send a signal to the brain, which then sends a signal to the heart, resulting in a decrease in heart activity and slower flow of blood through the body.