



Introduction to Signal Transduction

IST-3.C.1

Signal transduction pathways link signal reception with cellular responses.

IST-3.C.2

Many signal transduction pathways include protein modification and phosphorylation



Introduction to Signal Transduction

IST-3.D.1

Signaling begins with the recognition of a chemical messenger—a ligand—by a receptor protein in a target cell—

- a. The ligand-binding domain of a receptor recognizes a specific chemical messenger, which can be a peptide, a small chemical, or protein, in a specific one-to-one relationship.
- b. G protein-coupled receptors are an example of a receptor protein in eukaryotes.



Introduction to Signal Transduction

IST-3.D.2

Signaling cascades relay signals from receptors to cell targets, often amplifying the incoming signals, resulting in the appropriate responses by the cell, which could include cell growth, secretion of molecules, or gene expression—

- a. After the ligand binds, the intracellular domain of a receptor protein changes shape, initiating transduction of the signal.



Introduction to Signal Transduction

IST-3.D.2

Signaling cascades relay signals from receptors to cell targets, often amplifying the incoming signals, resulting in the appropriate responses by the cell, which could include cell growth, secretion of molecules, or gene expression—

- b. Second messengers (such as cyclic AMP) are molecules that relay and amplify the intracellular signal.



Introduction to Signal Transduction

IST-3.D.2

Signaling cascades relay signals from receptors to cell targets, often amplifying the incoming signals, resulting in the appropriate responses by the cell, which could include cell growth, secretion of molecules, or gene expression—

- c. Binding of ligand-to-ligand-gated channels can cause the channel to open or close



**What is the first step of
signal transduction?**

- A. Reception**
- B. Response**
- C. Transduction**

What is the first step of signal transduction?

A. Reception



The first step of the signal transduction pathway is reception. This occurs when the ligand binds to the receptor which leads to a confirmational shape change.

AP BIO INSTA-REVIEW

TOPIC

4.2



**What occurs during the
step of reception?**

**What
occurs during the step
of reception?**



**The signaling molecule binds to
the receptor.**

**The receptor undergoes a
conformational change
(changes shape).**



What is the signaling molecule called?

- A. Activator**
- B. Enhancer**
- C. Ligand**
- D. Repressor**

AP BIO INSTA-REVIEW

TOPIC

4.2

What is the signaling molecule called?

C. Ligand



The signaling molecule is called a ligand. These terms can be used interchangeably.

AP BIO INSTA-REVIEW

TOPIC

4.2



How does the polarity of the ligand affect the location of the receptor?

AP BIO INSTA-REVIEW

TOPIC

4.2

How does the polarity of the ligand affect the location of the receptor?



If the ligand is polar – the receptor will be membrane bound. Polar substances are unable to pass through the membrane.

If the ligand is nonpolar – the receptor will be intracellular. Nonpolar substances are able to pass through the membrane (so the receptor must be inside).

AP BIO INSTA-REVIEW

TOPIC

4.2



The ligand travels through the signal transduction path.

- A. True**
- B. False**

AP BIO INSTA-REVIEW

TOPIC

4.2

The ligand travels through the signal transduction path.

B. False



The ligand binds to the receptor which leads to a conformational shape change. The message is passed along not the signal through the process of transduction.

AP BIO INSTA-REVIEW

TOPIC

4.2



What is the function of transduction?

What is the function of transduction?



To bring the message to its location for response

To amplify the signal/message

To regulate the signal

AP BIO INSTA-REVIEW

TOPIC

4.2



All cells respond to the same ligand with the same response.

- A. True**
- B. False**

AP BIO INSTA-REVIEW

TOPIC

4.2

All cells respond to the same ligand with the same response.

B. False



Every cell is different, so every cell will have different relay proteins leading to a different response from cells.

AP BIO INSTA-REVIEW

TOPIC

4.2



What happens during a phosphorylation cascade?

What happens during a phosphorylation cascade?

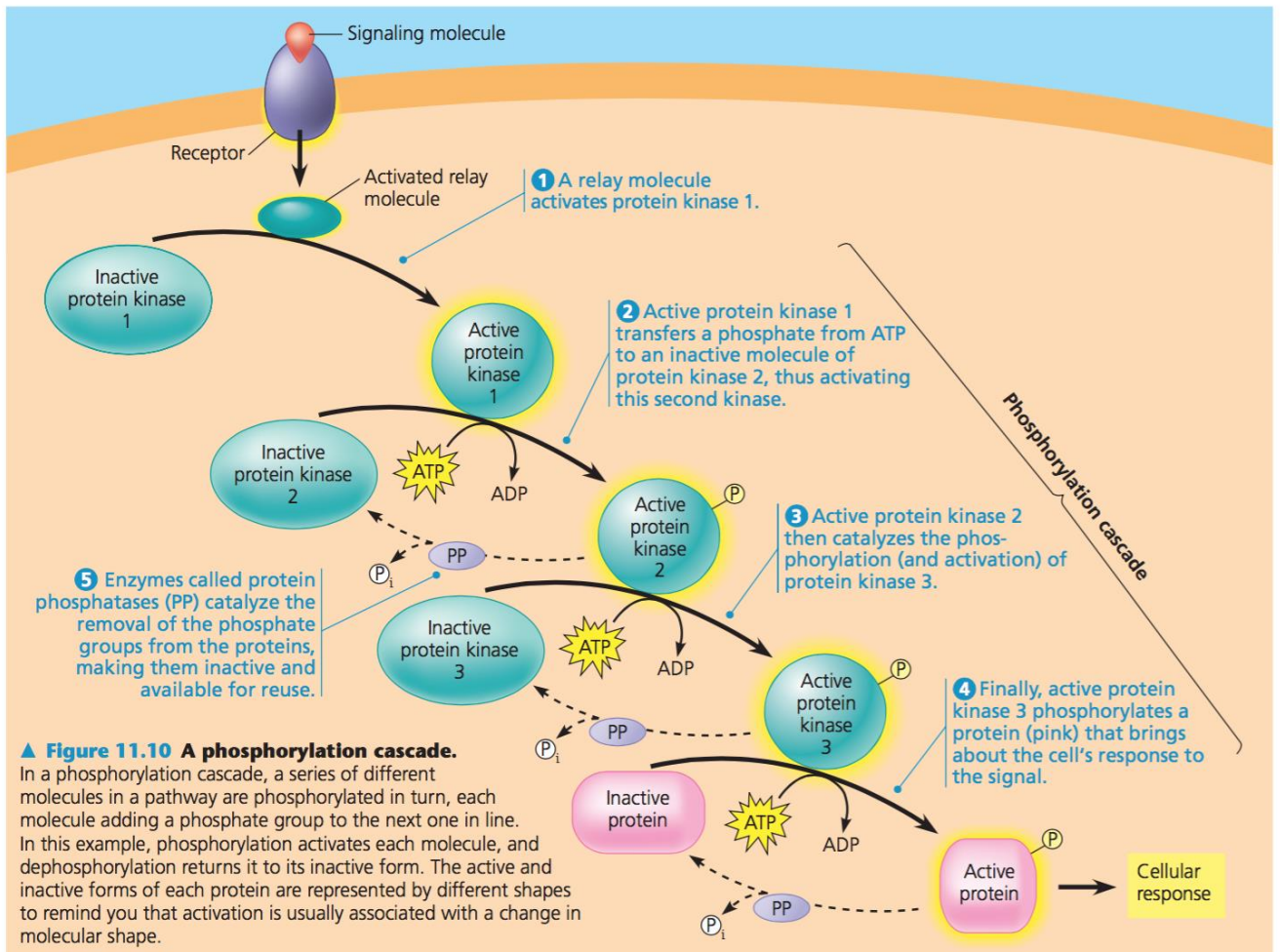


Protein kinase will phosphorylate (add a phosphate to) a relay protein

This activated relay protein will phosphorylate the next relay until the signal reaches the response.



What happens during a phosphorylation cascade?



▲ Figure 11.10 A phosphorylation cascade.

In a phosphorylation cascade, a series of different molecules in a pathway are phosphorylated in turn, each molecule adding a phosphate group to the next one in line. In this example, phosphorylation activates each molecule, and dephosphorylation returns it to its inactive form. The active and inactive forms of each protein are represented by different shapes to remind you that activation is usually associated with a change in molecular shape.

AP BIO INSTA-REVIEW

TOPIC

4.2



Identify some possible responses.

AP BIO INSTA-REVIEW

TOPIC

4.2

Identify some possible responses.



Cell growth
Secretion of molecules
Gene expression
Apoptosis



Which is a secondary messenger?

- A. ATP**
- B. Ca^{2+}**
- C. Hormone**
- D. Ligand**

Which is a secondary messenger?

B. Ca^{2+}



Secondary messengers are small molecules that will move within the cell to transfer a signal. Traditionally, we discuss cAMP and Ca^{2+} . These molecules will bind to another receptor as part of the transduction pathway,

AP BIO INSTA-REVIEW

TOPIC

4.2



What happens if the receptor is a ligand gated receptor?

What happens if the receptor is a ligand gated receptor?



Conformational change opens the gate and allows for the specific ions for that channel to flow down their concentration gradient.

AP BIO INSTA-REVIEW

TOPIC

4.2



What are the three steps in signal transduction pathway?

AP BIO INSTA-REVIEW

TOPIC

4.2

**What are the three steps
in signal transduction
pathway?**



**Reception
Transduction
Response**



**What is the signaling molecule
& where does it bind?**

- A. Ligand; Enzyme**
- B. Ligand; Receptor**
- C. Substrate; Enzyme**
- D. Substrate; Receptor**

What is the signaling molecule & where does it bind?

B. Ligand; Receptor



Signaling molecules are called ligands. They will bind to receptors on the membrane or in the target cell. This is part of the reception step of signal transduction pathways.

AP BIO INSTA-REVIEW

TOPIC

4.2



**How are phosphorylation
cascades activated and
deactivated?**

AP BIO INSTA-REVIEW

TOPIC

4.2

How are phosphorylation cascades activated and deactivated?



Once activated, protein kinase will phosphorylate the relay molecule to “prime it to do work”.

To turn off the pathway, the protein phosphatase will remove the phosphates from the relay molecules.



Which of the following act as secondary messengers?

- A. ATP and Ca^{2+}**
- B. Ca^{2+} and cAMP**
- C. cAMP and ligand**
- D. Ligand and ATP**

AP BIO INSTA-REVIEW

TOPIC

4.2



Which of the following act as secondary messengers?

B. Ca^{2+} and cAMP

Secondary messengers are small molecules that will move within the cell to transfer a signal. Traditionally, we discuss cAMP and Ca^{2+} . These molecules will bind to another receptor as part of the transduction pathway,

AP BIO INSTA-REVIEW

TOPIC

4.2



Different cells respond to the signal in the same way.

- A. True**
- B. False**

AP BIO INSTA-REVIEW

TOPIC

4.2

Different cells respond to the signal in the same way.

B. False



Each cell has a different receptor and a different transduction pathway which leads to a different response.

AP BIO INSTA-REVIEW

TOPIC

4.2



What happens when the ligand binds to the receptor?

What happens when the ligand binds to the receptor?



The receptor is a protein, so when the ligand binds this leads to a conformational shape change. This shape change is the first step of transduction.



Muscle contraction occurs when the calcium binds in the muscular cells. Where is the calcium stored in the muscle cells?

- A. Lysosome**
- B. Nucleus**
- C. Smooth ER**
- D. Vacuole**

AP BIO INSTA-REVIEW

TOPIC

4.2

Muscle contraction occurs when the calcium binds in the muscular cells. Where is the calcium stored in the muscle cells?



C. Smooth ER

The smooth ER has a couple different functions including:

- > Detoxification**
- > Synthesis of Lipids**
- > Storage of Ca^{2+} ions**



Calcium is stored in the smooth ER and allows for muscular contractions. How is calcium released from the smooth ER?

- A. Active transport**
- B. Gated ion channel**
- C. Ion channel**
- D. Simple diffusion**

AP BIO INSTA-REVIEW

TOPIC

4.2

Calcium is stored in the smooth ER and allows for muscular contractions. How is calcium released from the smooth ER?



B. Gated ion channel

In this pathway, a secondary messenger binds to the ligand gated ion channel. Once this binds, the receptor protein has a conformational shape change which leads to opening of the ion channel allowing the Ca^{2+} to flow down their gradient.