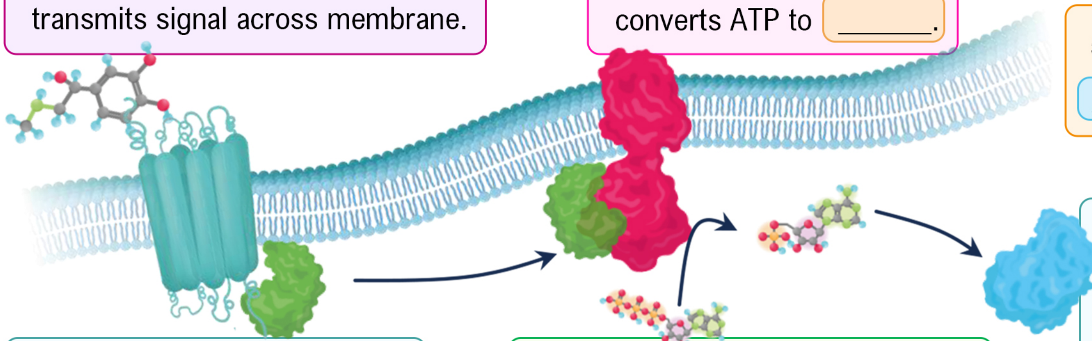
TOPIC: MEMBRANE BOUND RECEPTORS AND SECONDARY MESSENGERS

Second Messenger Systems: G Protein Coupled Receptors

- G protein-coupled receptors (GPCRs): class of membrane-bound receptors that initiate signaling ______________.
  - **Signaling cascade**: chemical messengers linked in ________ - Cyclic AMP (________) is a common example.



1. Hormone binds to ______: transmits signal across membrane.

2. Receptor (GPCR) activates ___________: GTP replaces GDP on G protein.

3. G proteins diffuses along membrane, binds to, and activates the enzyme ___________ _______.

4. Adenylate cyclase converts ATP to ______.

5. cAMP binds to the enzyme __________ __________ ___.

6. Kinase phosphorylates proteins; triggers __________ response.

Holding **R**eally **G**reat **A**ctivities at **cAMP K**inase.

EXAMPLE

The steps of the cascade using cAMP are given below. Write the letter for the appropriate step in the blanks below to put the pathway in order.

a. Protein kinase is activated.

b. ATP is converted to cAMP.

c. G protein is activated.

d. Adenylate cyclase is activated.

Hormone binds extracellular receptor → _______ → _______ → _______ → _______ → Cellular Response.

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PRACTICE

What is the role of G proteins in GPCR signaling?

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a) Catalyzing DNA synthesis.

b) Initiating apoptosis.

c) Transcription of mRNA.

d) Activating downstream effectors.

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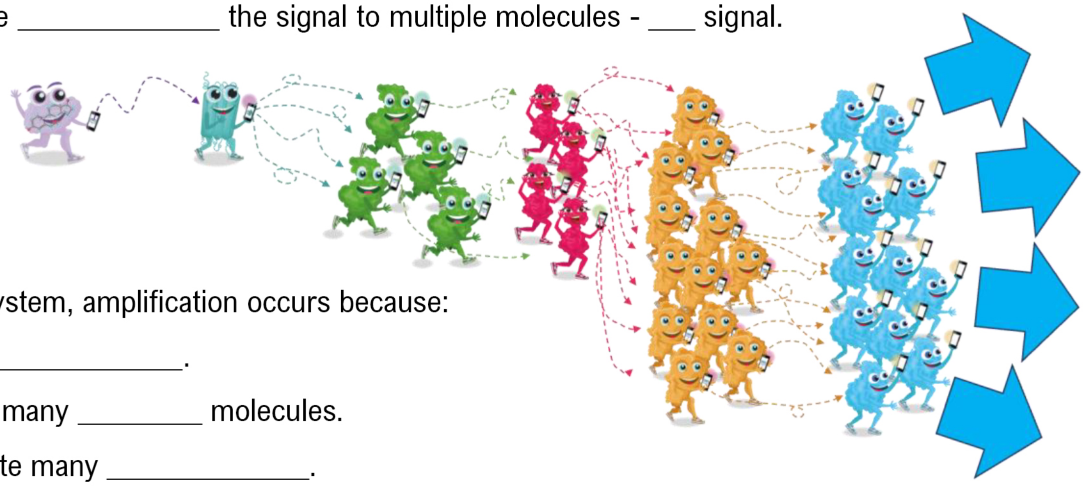
Amplification

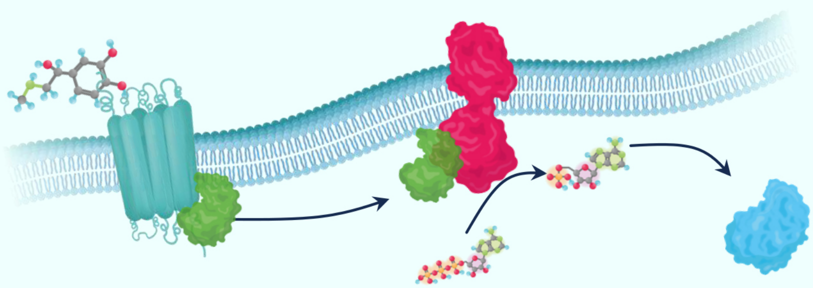
- *Recall*: signaling cascade: series of linked _____________ messengers.
- **Amplification**: when one molecule _____________ the signal to multiple molecules - ___ signal.



- In cAMP secondary messenger system, amplification occurs because:
  1. GPCR will activate multiple _______________.
  2. Adenylate cyclase will produce many ________ molecules.
  3. Protein kinase will phosphorylate many _____________.

EXAMPLE

The image below shows a signaling cascade using cAMP as a second messenger. Circle the places on the image where amplification can happen.



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PRACTICE

Hormones can bring about substantial physiological changes at very low concentrations. How does this relate to the concept of second messenger systems?

a) Second messenger systems act more quickly, creating a larger cellular response.

b) Second messenger systems modify the DNA directly, allowing the hormone to make an impact even at low concentrations.

c) Second messenger systems prevent hormones from being degraded so they can exert their effect for a longer duration.

d) Second messenger systems amplify the original hormone signal, allowing it to work at low concentrations.

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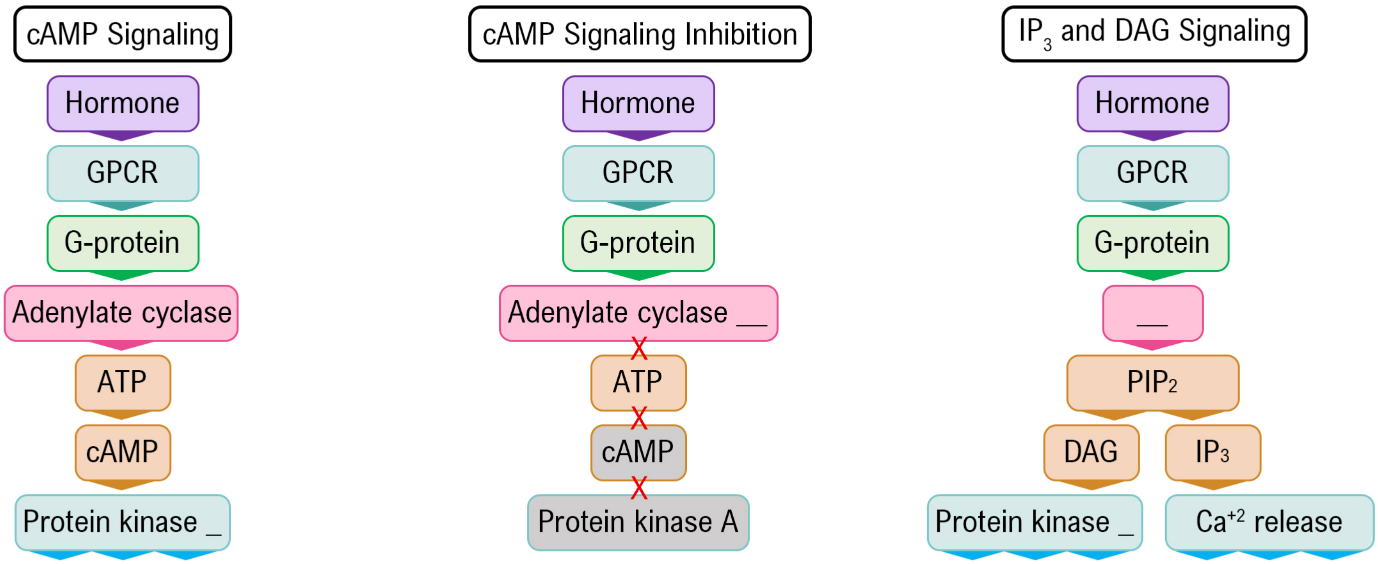
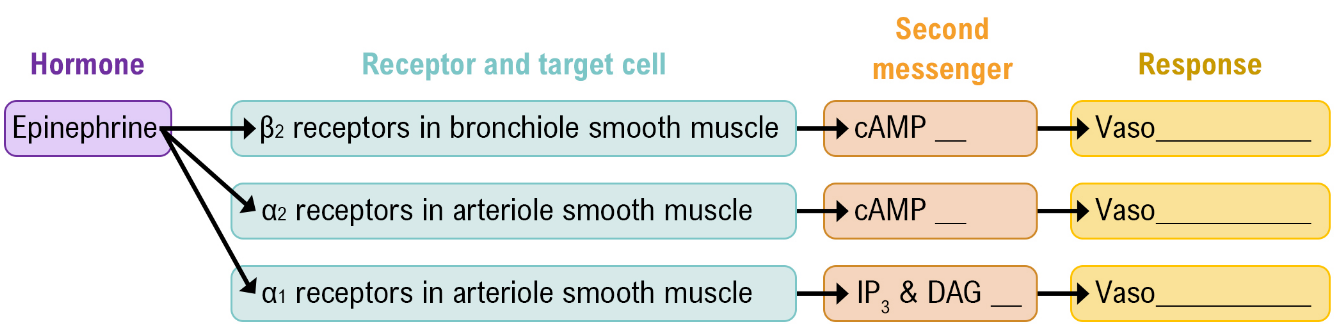
Secondary Messenger Systems: cAMP, DAG, & IP_3

- Hormones may induce different signaling cascades depending on:
  - The presence of a specific ______.
  - The secondary messenger involved.
  - The activity of the ________.



- One hormone; many responses:



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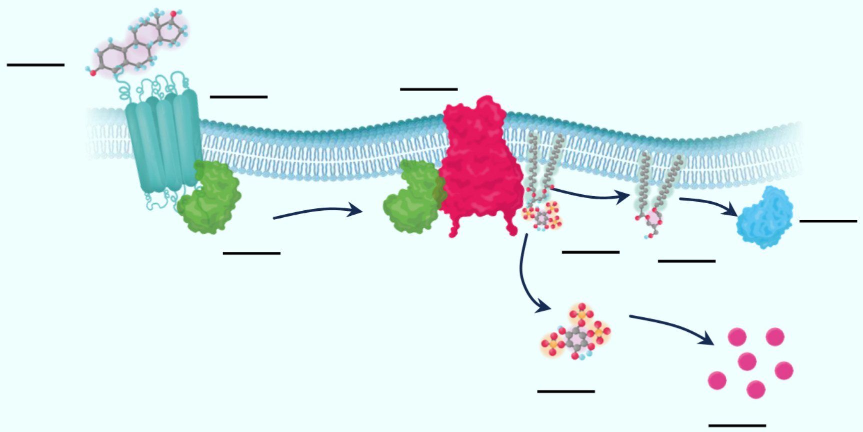
EXAMPLE

The image below shows parts of a signaling cascade that uses IP_3 and DAG as secondary messengers. Label each component and circle the places on the image that are different from a signaling cascade that uses cAMP as a secondary messenger.

a. Phospholipase C
b. G protein
c. PIP_2
d. Kinase
e. Hormone
f. Receptor
g. DAG & IP_3
h. Calcium Ions



PRACTICE

You are studying how a hormone affects a cell and find that when oxytocin binds to the receptor, the intracellular Ca^{+2} concentration increases. Based on this information, what could you logically conclude about this cell and hormone?

a) The cell uses adenylate cyclase as a second messenger.
b) Oxytocin directly interacts with the DNA of the cell.
c) The cell uses IP_3 and DAG as secondary messengers.
d) Both A & B are correct.

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PRACTICE

cAMP, IP_3, and DAG are all molecules that are used as secondary messengers. Which statement below correctly identifies a difference between the pathways in which they are found?

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a) cAMP secondary messenger systems result in the activation of a kinase, while systems that use IP_3 and DAG do not.

b) cAMP and IP_3 are part of the same signaling cascade, while DAG is found in different cascades.

c) Adenylate cyclase produces cAMP while phospholipase C produces IP_3 and DAG.

d) Both A & C are correct.