Important Announcements

Midsem exam: 21st February 2015 (3PM-5PM)

Syllabus: Lecture 1-9 and Tutorial 1-4

Doubts clarification: Rahul Purwar & TAs: Tuesdays between 2.30 to 5PM (prior email appointment is preferred)

Quiz answer sheet: Schedule: will be posted on Moodle

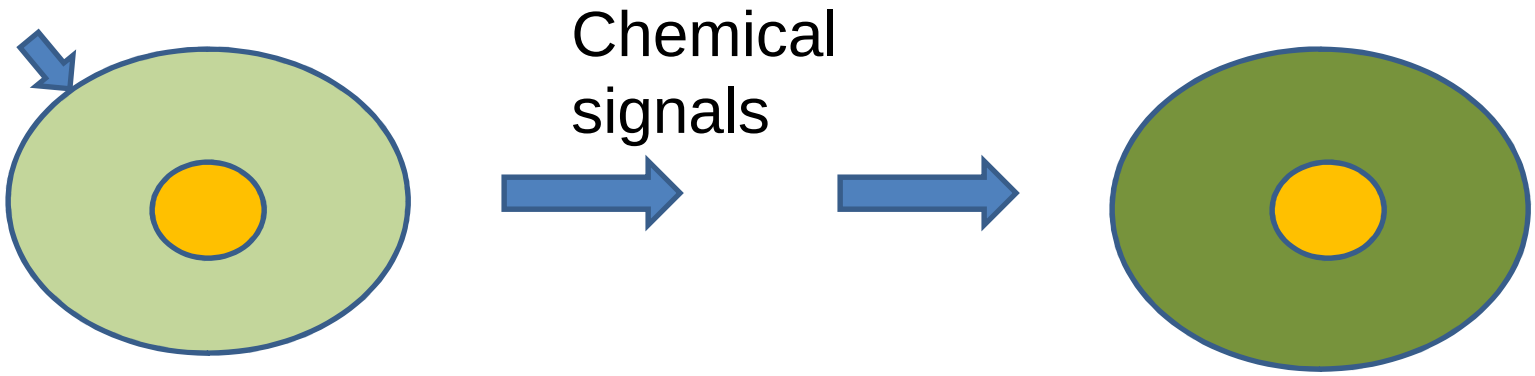
Cell communication

Lecture 9

Reference: Chapters 11_Campbell biology

How do cells communicate?

Cells use chemical signals for communication

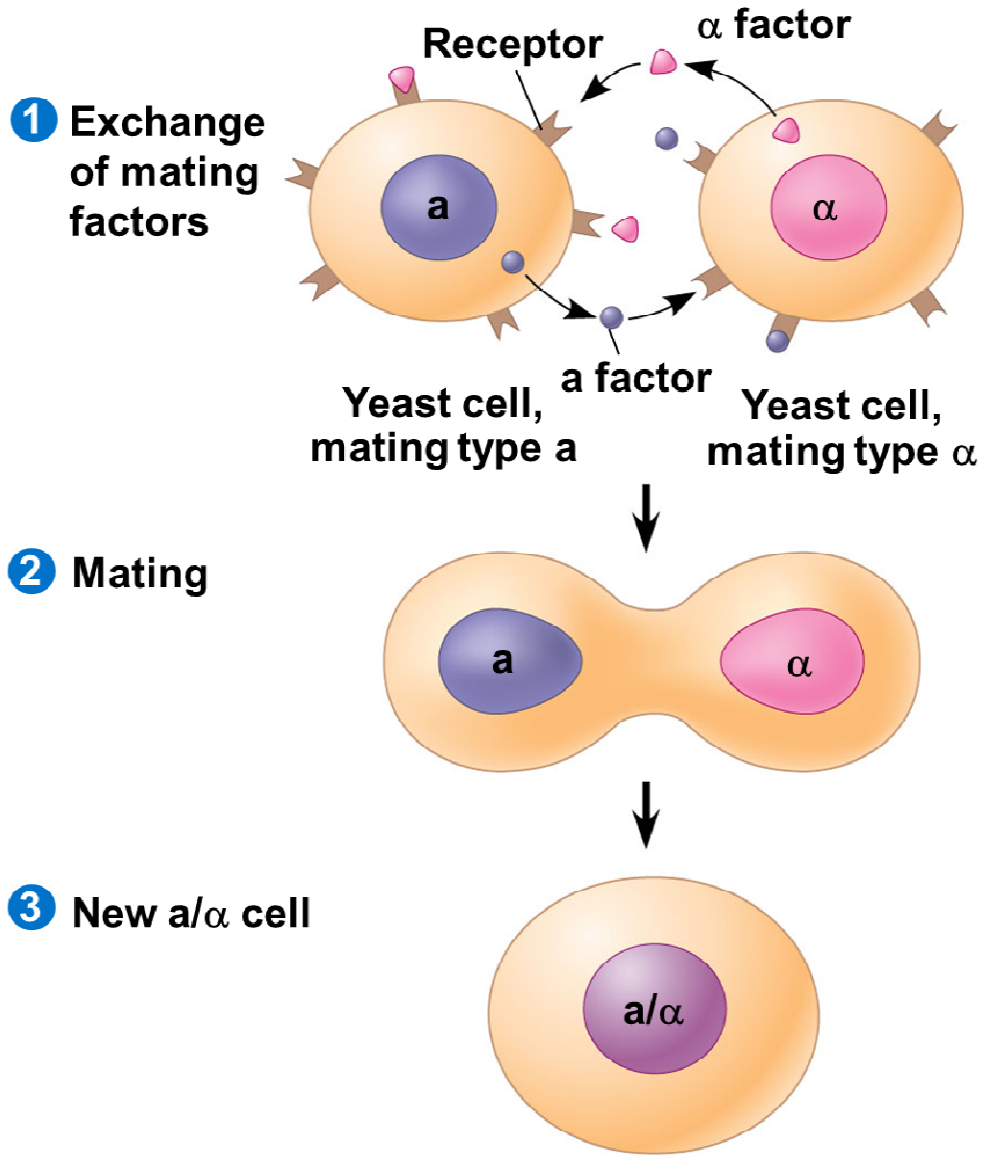


Talking cell or
transmitting cell

Listening cell or
target cell

Signaling transduction pathway

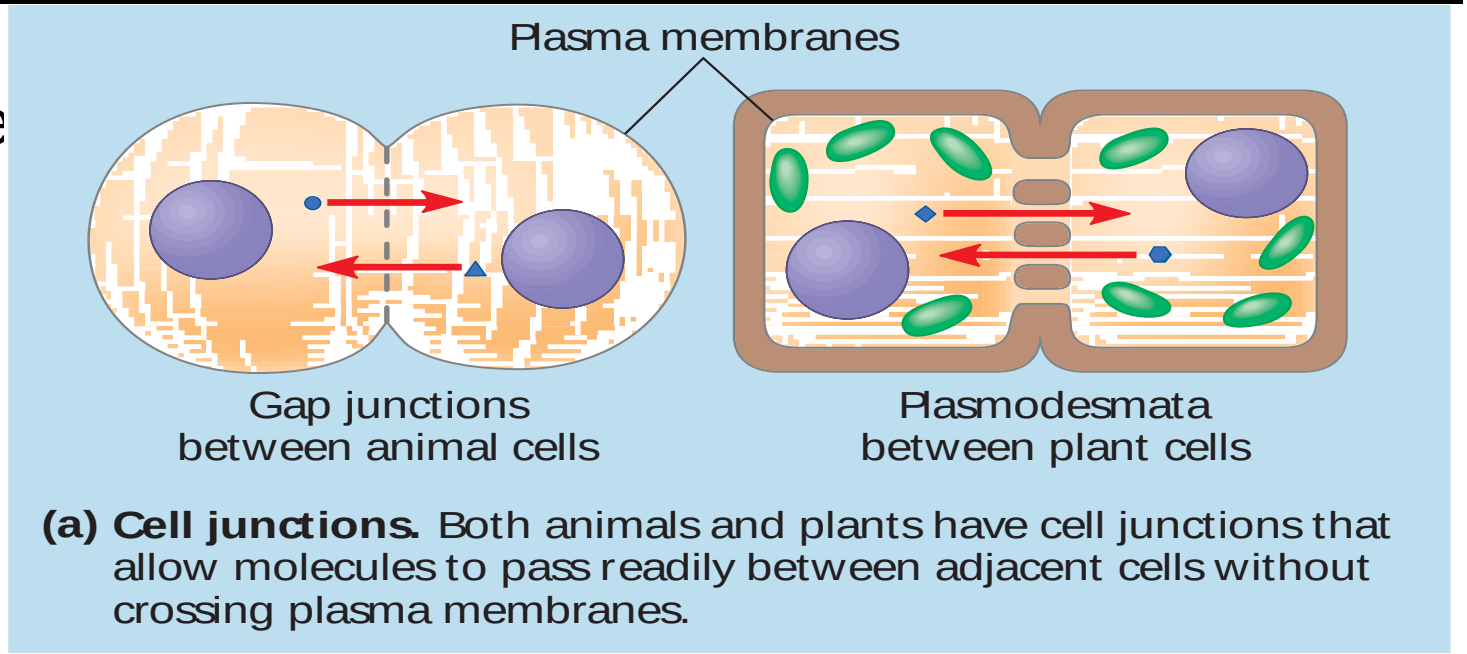
Why do cells communicate?



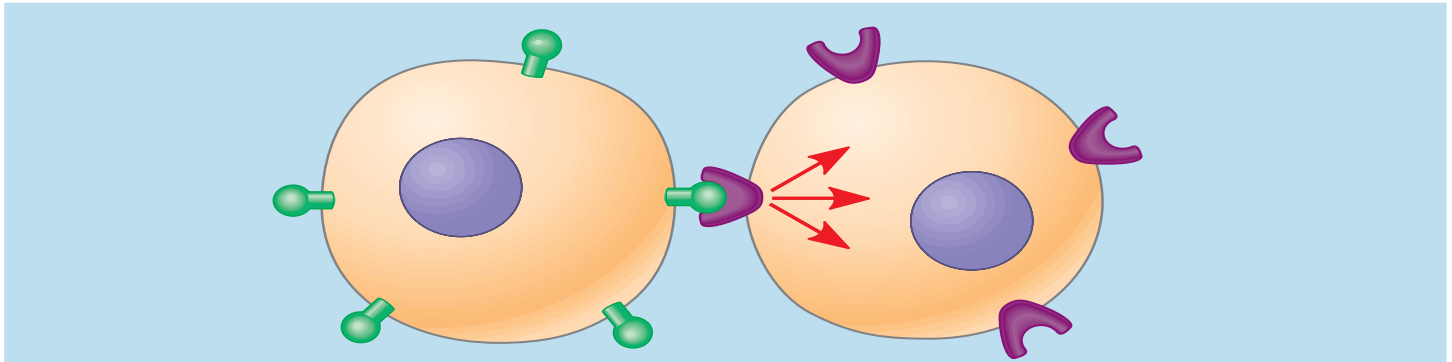
Two different types of yeast cells can signal to each other when they decide to mate!

In a multi-cellular organism: Two types of signaling pathways

- Local signaling: the signal acts on nearby cells



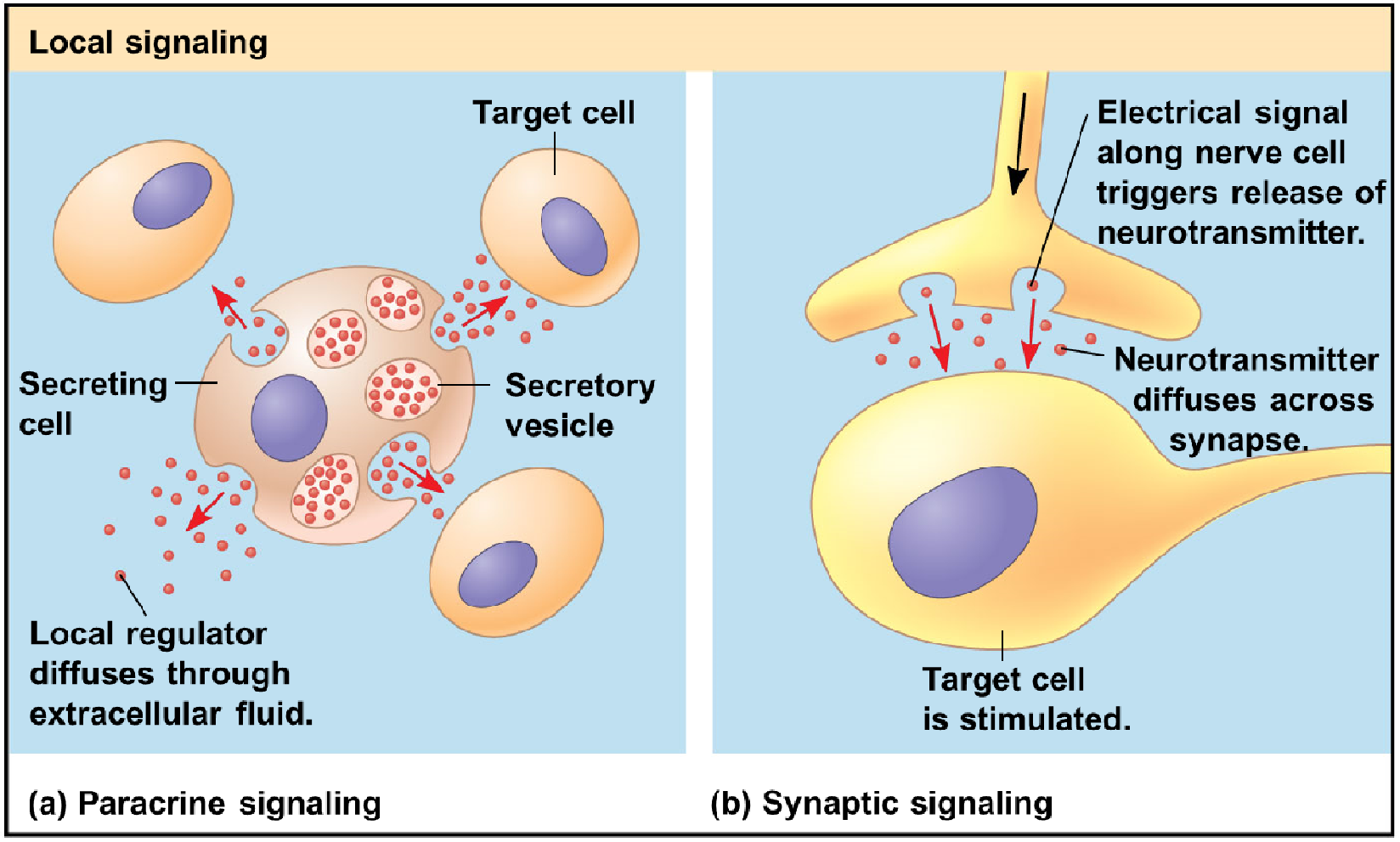
(a) Cell junctions. Both animals and plants have cell junctions that allow molecules to pass readily between adjacent cells without crossing plasma membranes.



(b) Cell-cell recognition. Two cells in an animal may communicate by interaction between molecules protruding from their surfaces.

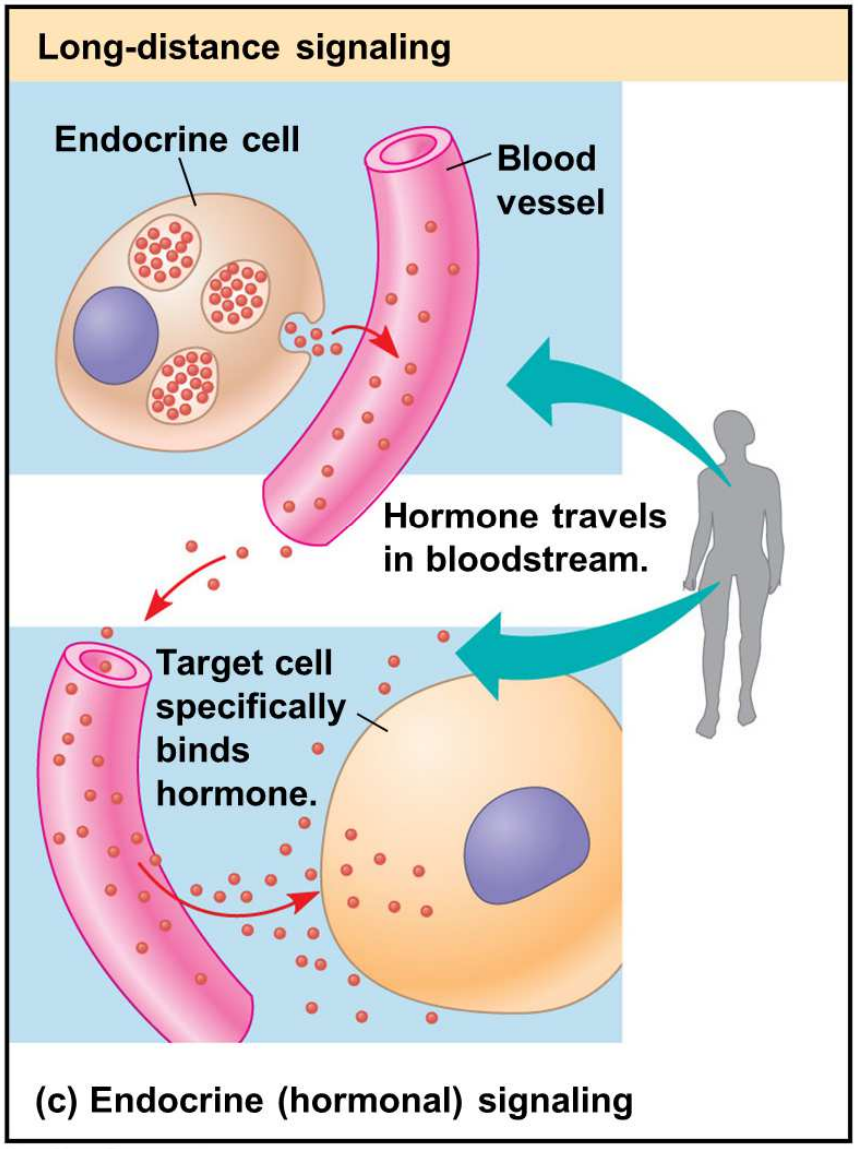
In a multi-cellular organism: Two types of signaling pathways

- Local signaling: the signal acts on nearby cells



Examples: **Scar tissue formation** **Nervous system**

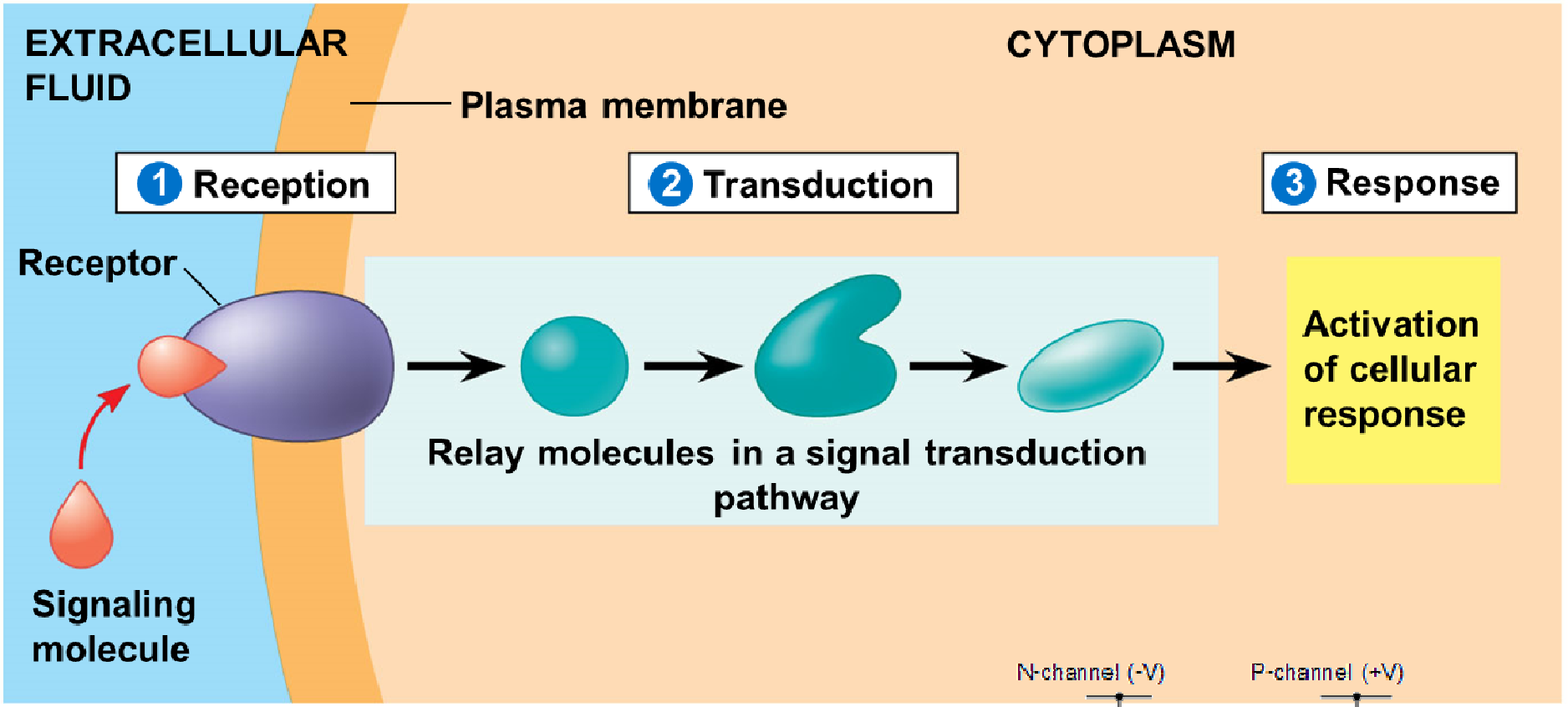
Two types of signaling pathways in multi-cellular organisms



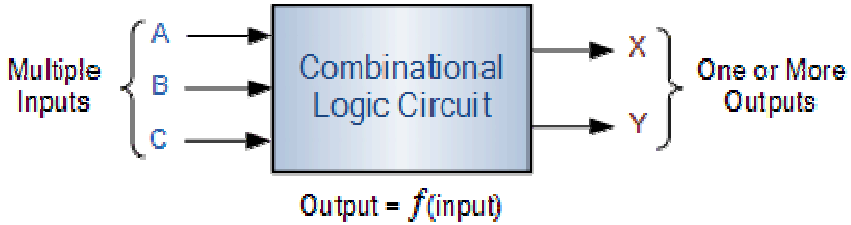
Long distance signaling (hormonal or endocrine signaling)

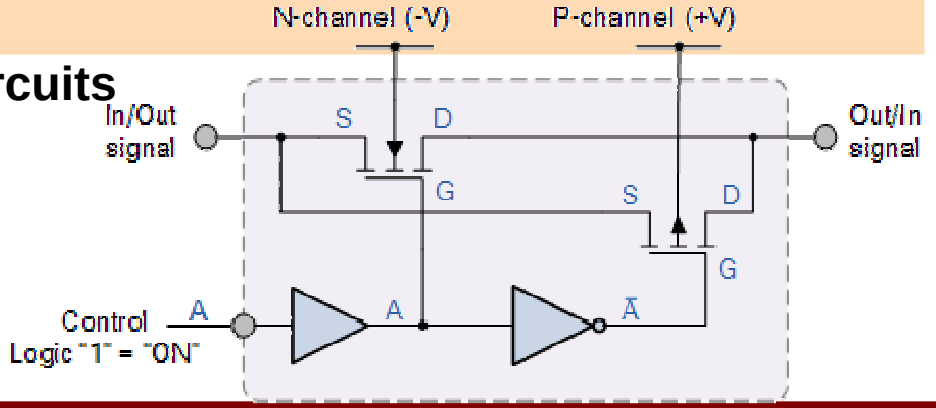
Example: Adrenaline (made by adrenal glands sitting on top of your kidneys makes your heart rate go up when you are stressed

In Single Cells: Three Stages of Cell Signaling



Analogy: circuits





Signal-Receiver (Receptor/ligand)

Interaction of signaling molecule (ligand) with its counterpart (receptor) is needed for cellular response

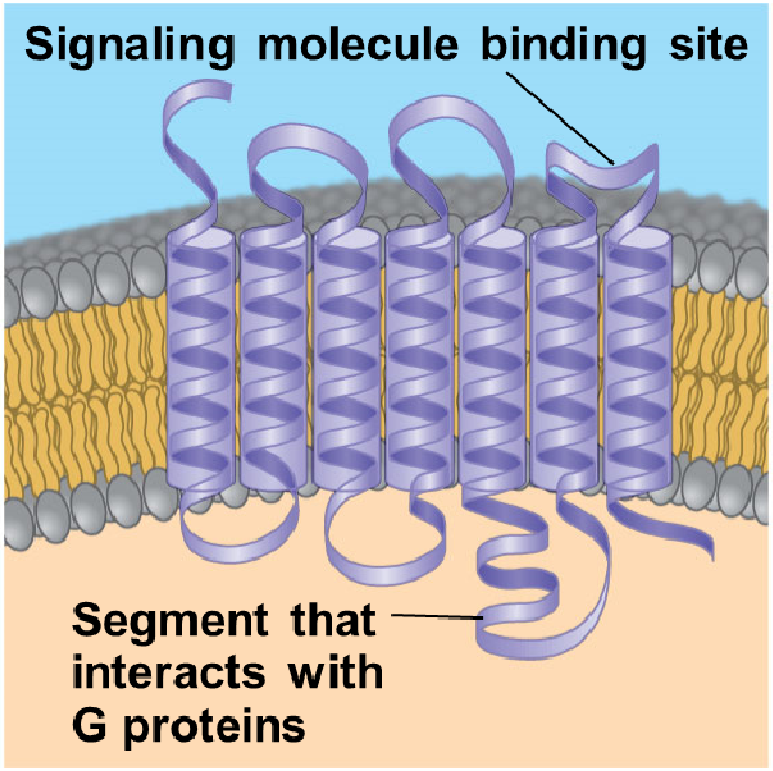
Most signal receptors are plasma membrane proteins for the recognition of ligands:

G-protein coupled receptor

Receptor tyrosine kinases

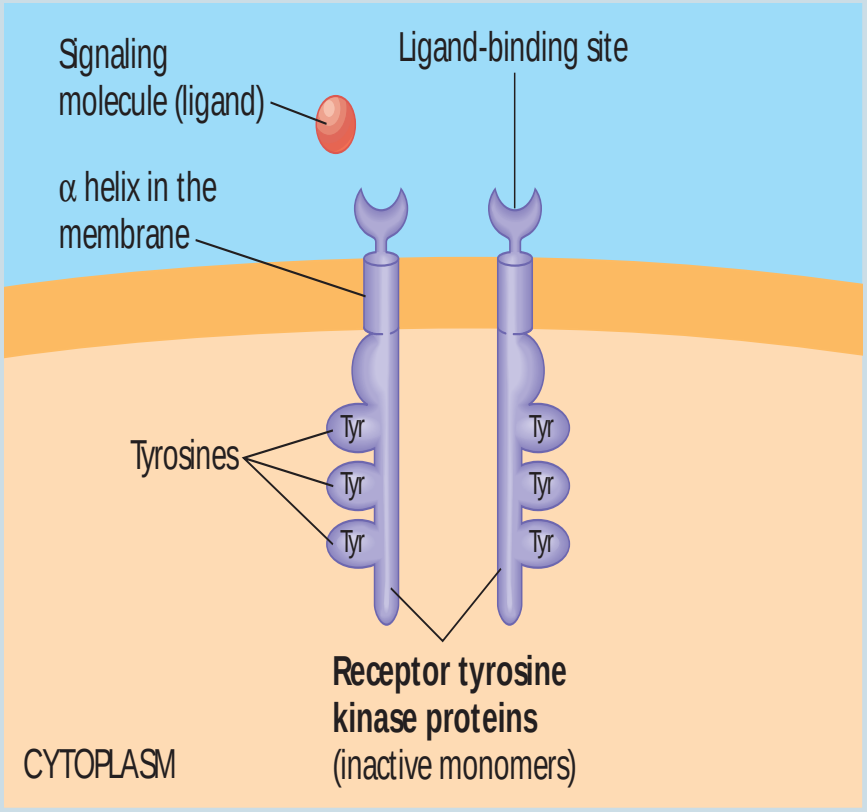
Ion-channel receptor

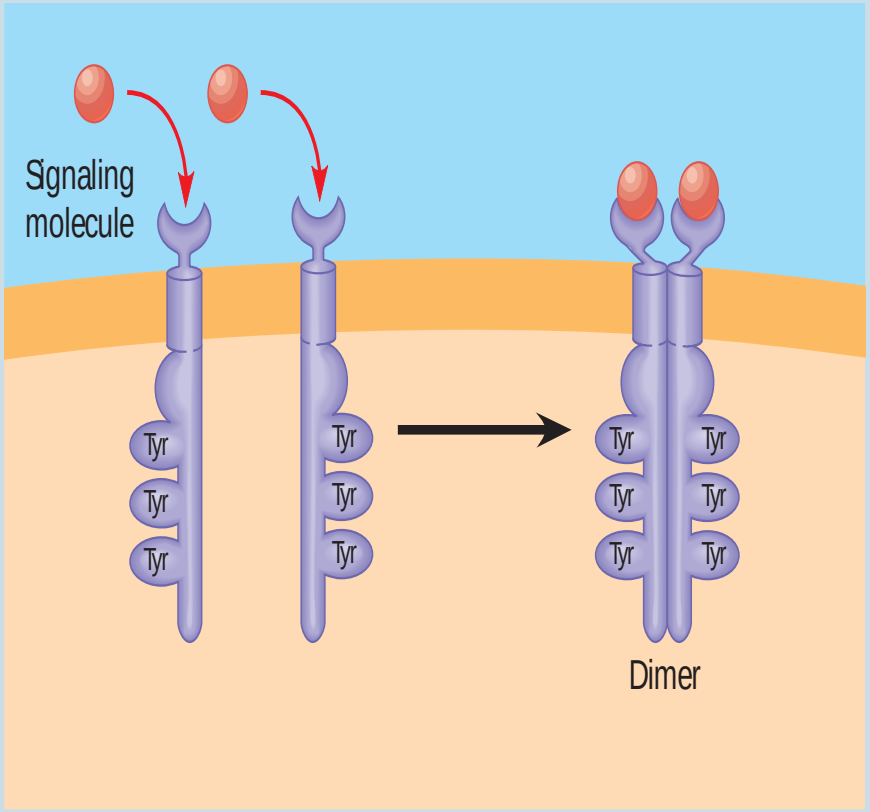
G protein-coupled receptor



- **G-protein-coupled receptor (GPCRs)** are the largest family of cell-surface receptors
- A GPCR is a plasma membrane receptor that works with the help of a **G protein**
- The G protein acts as an on/off switch: If GDP is bound to the G protein, the G protein is inactive

Receptor tyrosine kinases (RTKs)

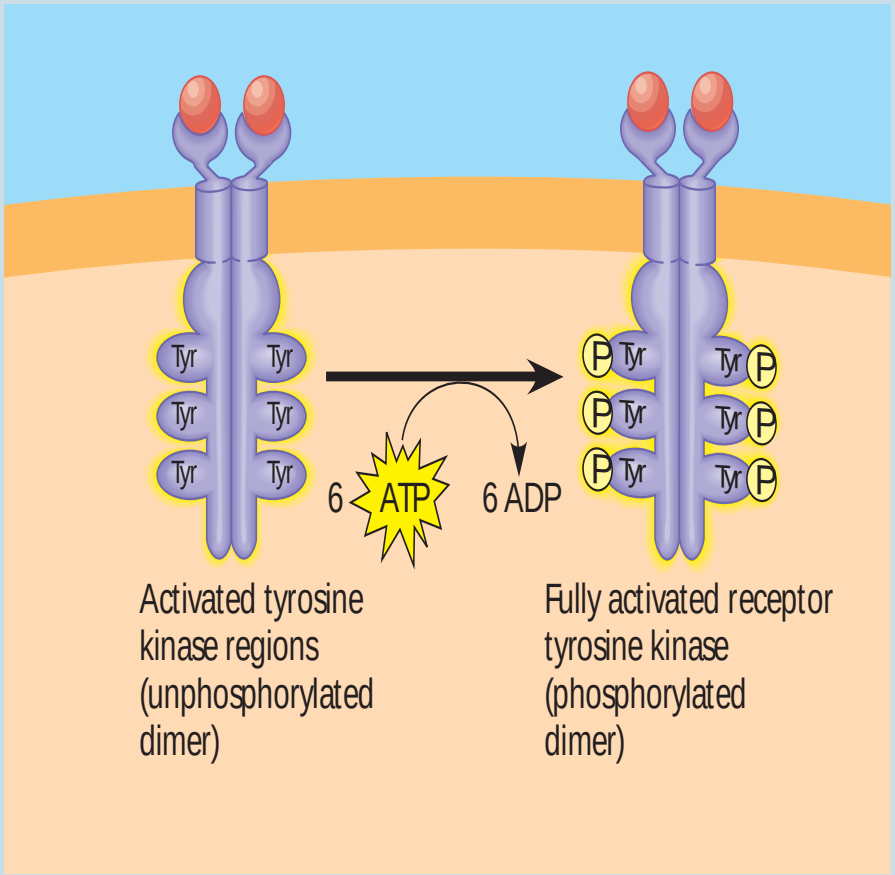


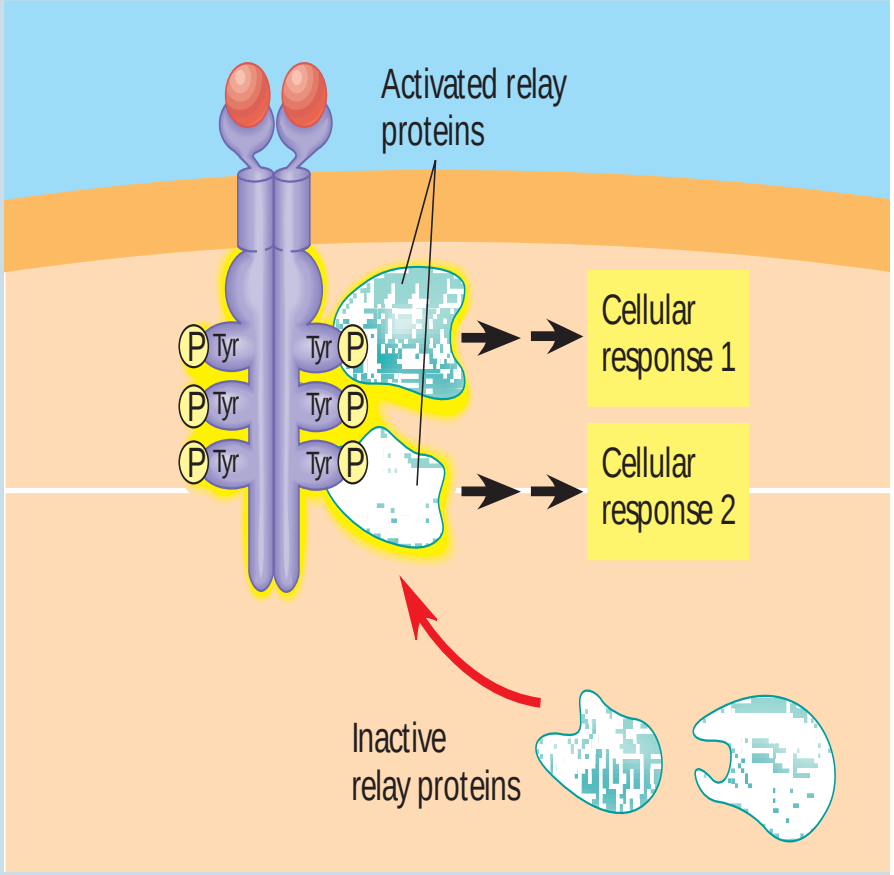


1 Many receptor tyrosine kinases have the structure depicted schematically here. Before the signaling molecule binds, the receptors exist as individual units referred to as monomers. Notice that each has an extracellular ligand-binding site, an α helix spanning the membrane, and an intracellular tail containing multiple tyrosines.

2 The binding of a signaling molecule (such as a gr owth factor) causes two receptor monomers to associate closely with each other, forming a complex known as a dimer (dimerization).

Receptor tyrosine kinases (RTKs)



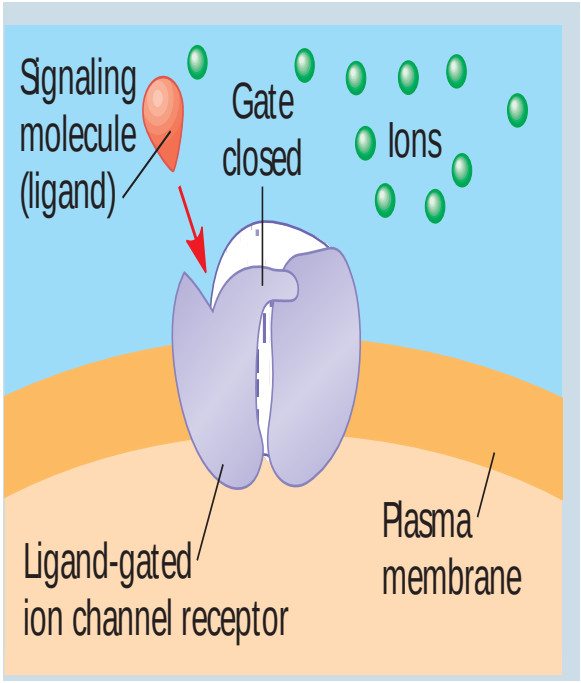


3 Dimerization activates the tyrosine kinase region of each monomer; each tyrosine kinase adds a phosphate from an ATP molecule to a tyrosine on the tail of the other monomer.

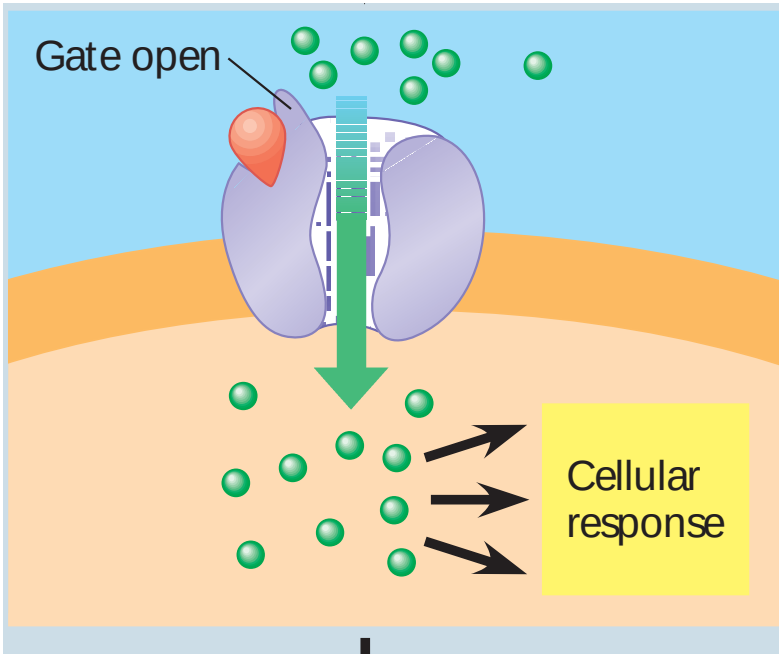
4 Now that the receptor is fully activated, it is recognized by specific relay proteins inside the cell. Each such protein binds to a specific phosphorylated tyrosine, undergoing a resulting structural change that activates the bound protein. Each activated protein triggers a transduction pathway, leading to a cellular response.

Ligand-gated Ion Channel receptors

1 Here we show a ligand-gated ion channel receptor in which the gate remains closed until a ligand binds to the receptor.

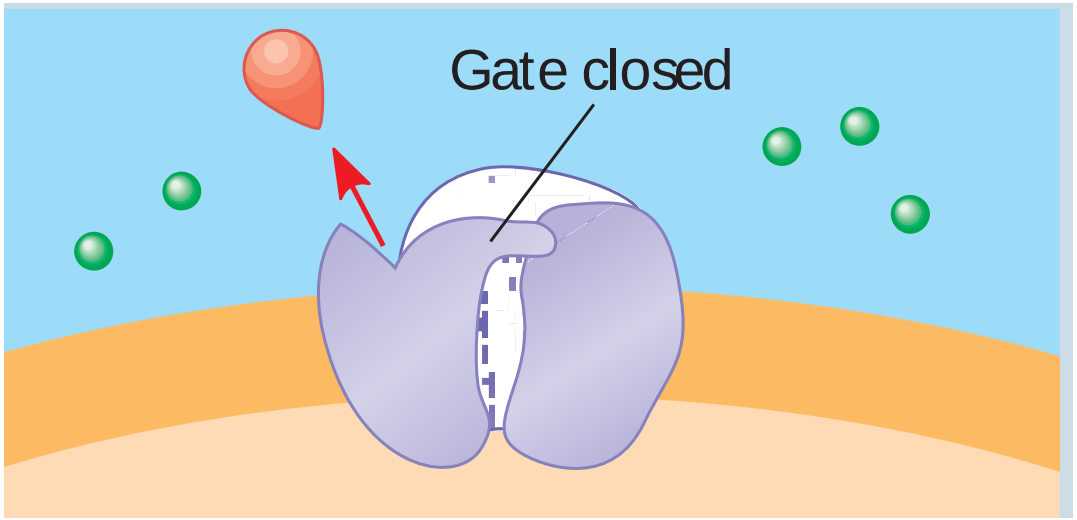


2 When the ligand binds to the receptor and the gate opens, specific ions can flow through the channel and rapidly change the concentration of that particular ion inside the cell. This change may directly affect the activity of the cell in some way.

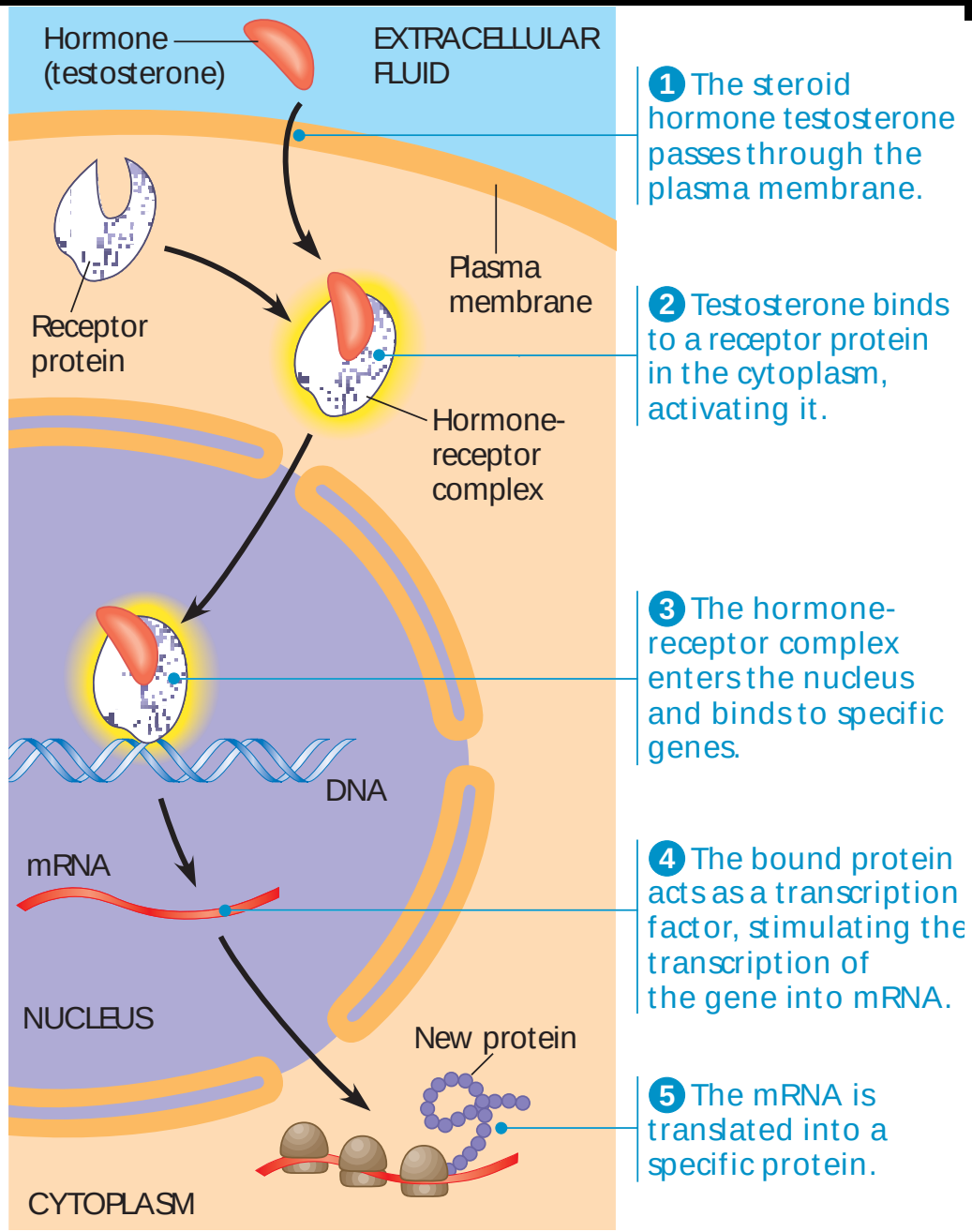


Ligand-gated Ion Channel receptors

3 When the ligand dissociates from this receptor, the gate closes and ions no longer enter the cell.



Intracellular receptors



Transduction

- Relay of the signal from receptor molecule through a cascade of molecular interactions to the target molecules in the cell.

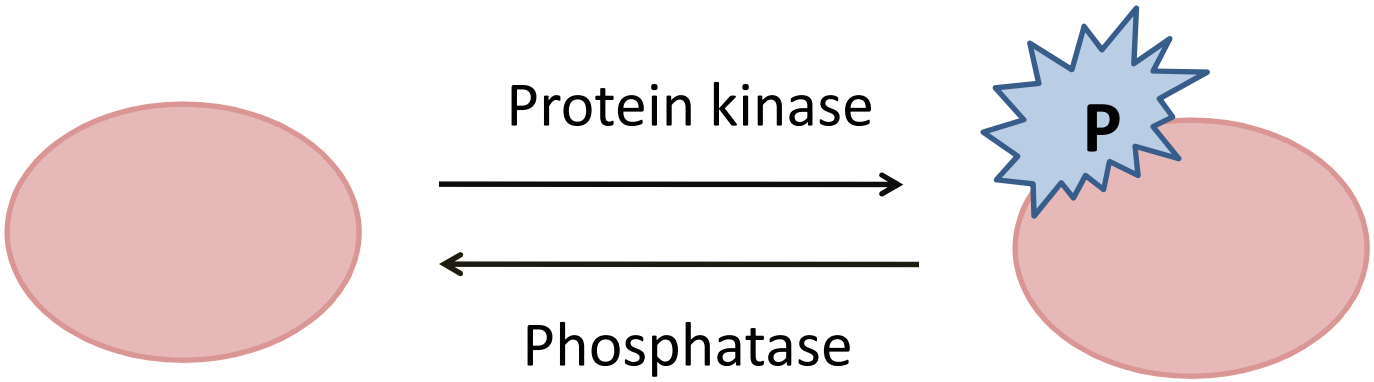
- Involves multiple steps
  - Signal amplification
  - Coordination and regulation of cellular response

- The relay of information is carried by interactions between different proteins which together constitute a signaling pathway.

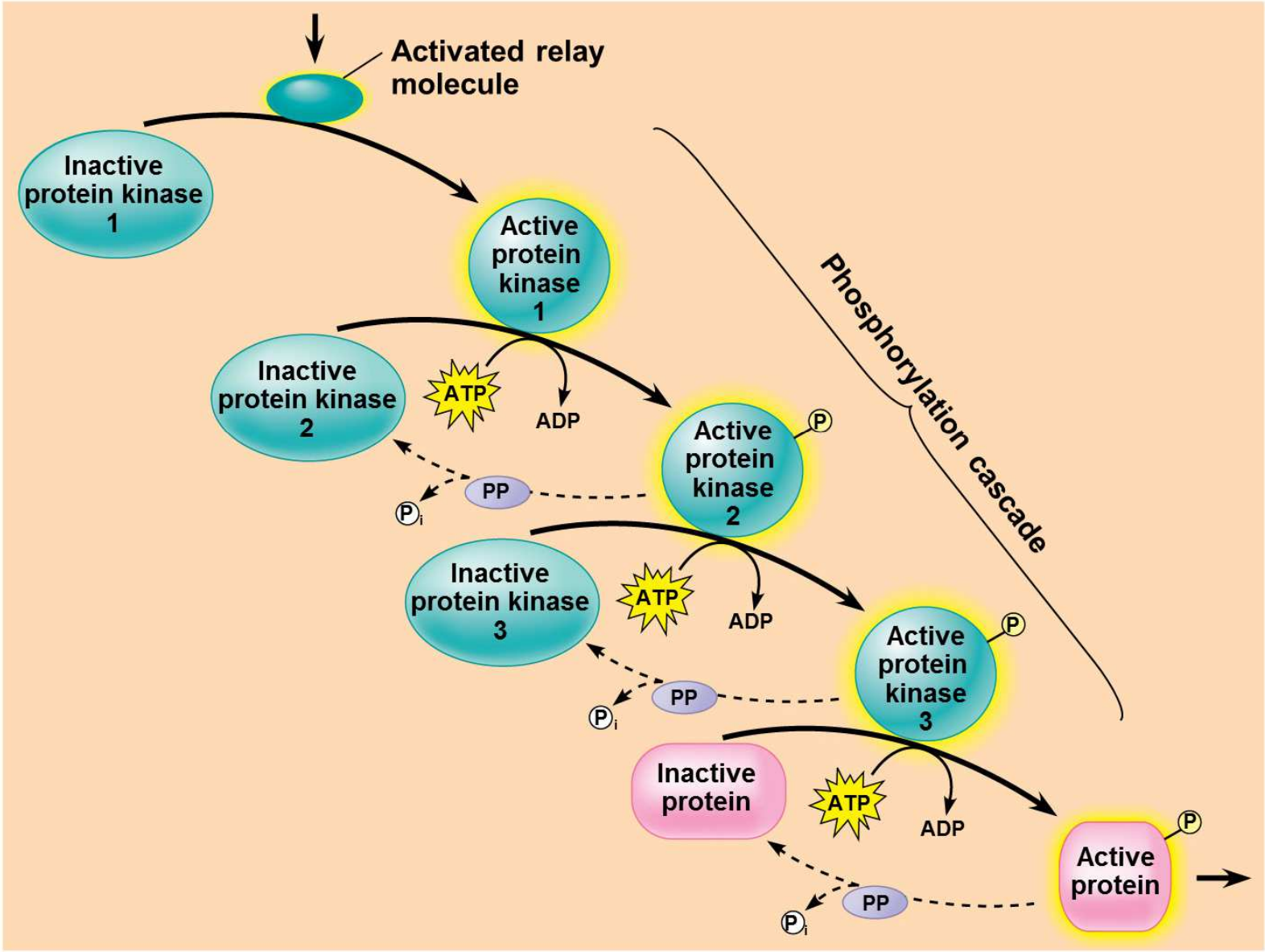
Protein kinases and phosphatases: major relay molecules

Protein Kinases: transfer phosphate group from ATP to the substrate protein

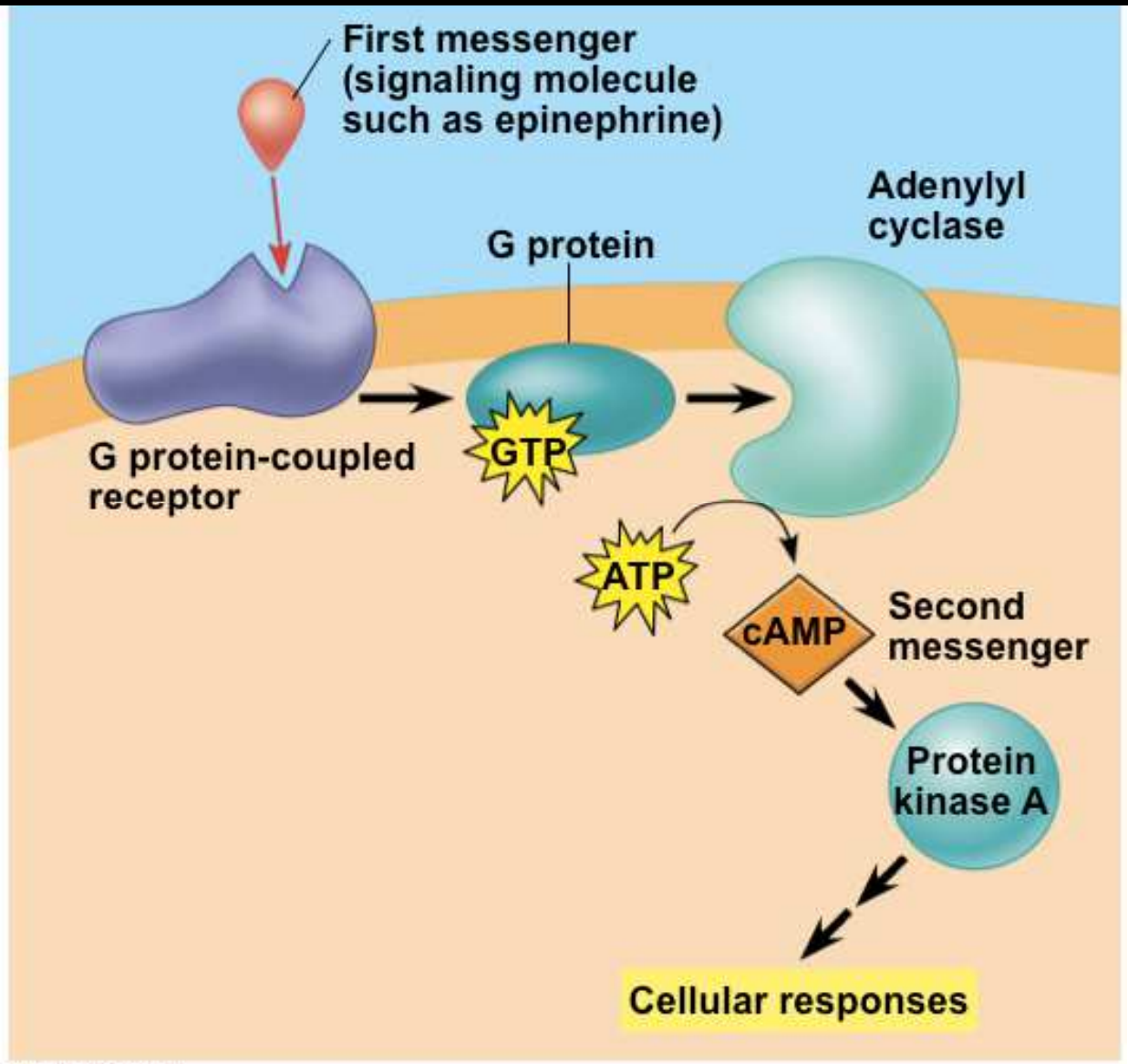
Phosphatases: Remove phosphate from phosphorylated proteins



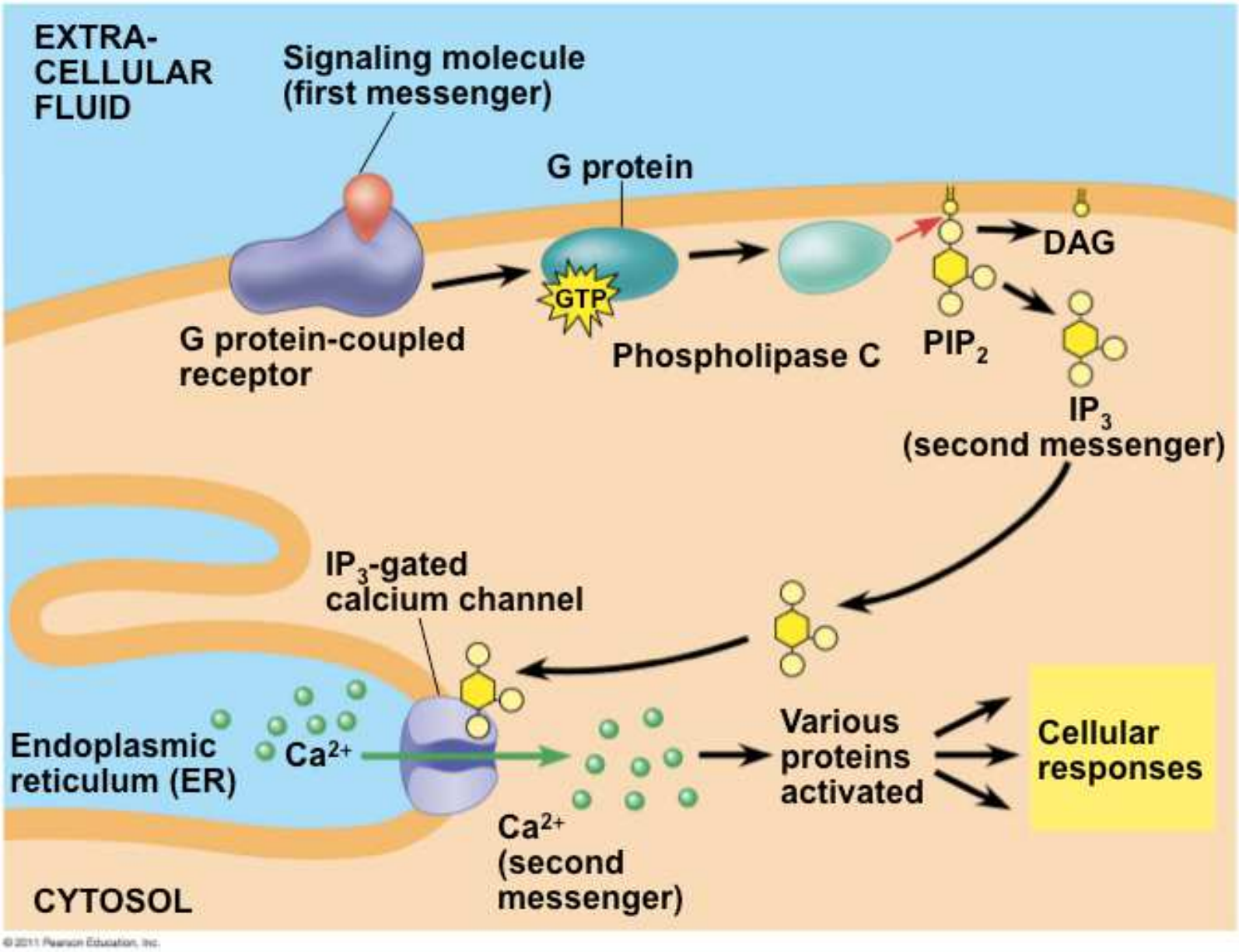
Phosphorylation acting as a signal



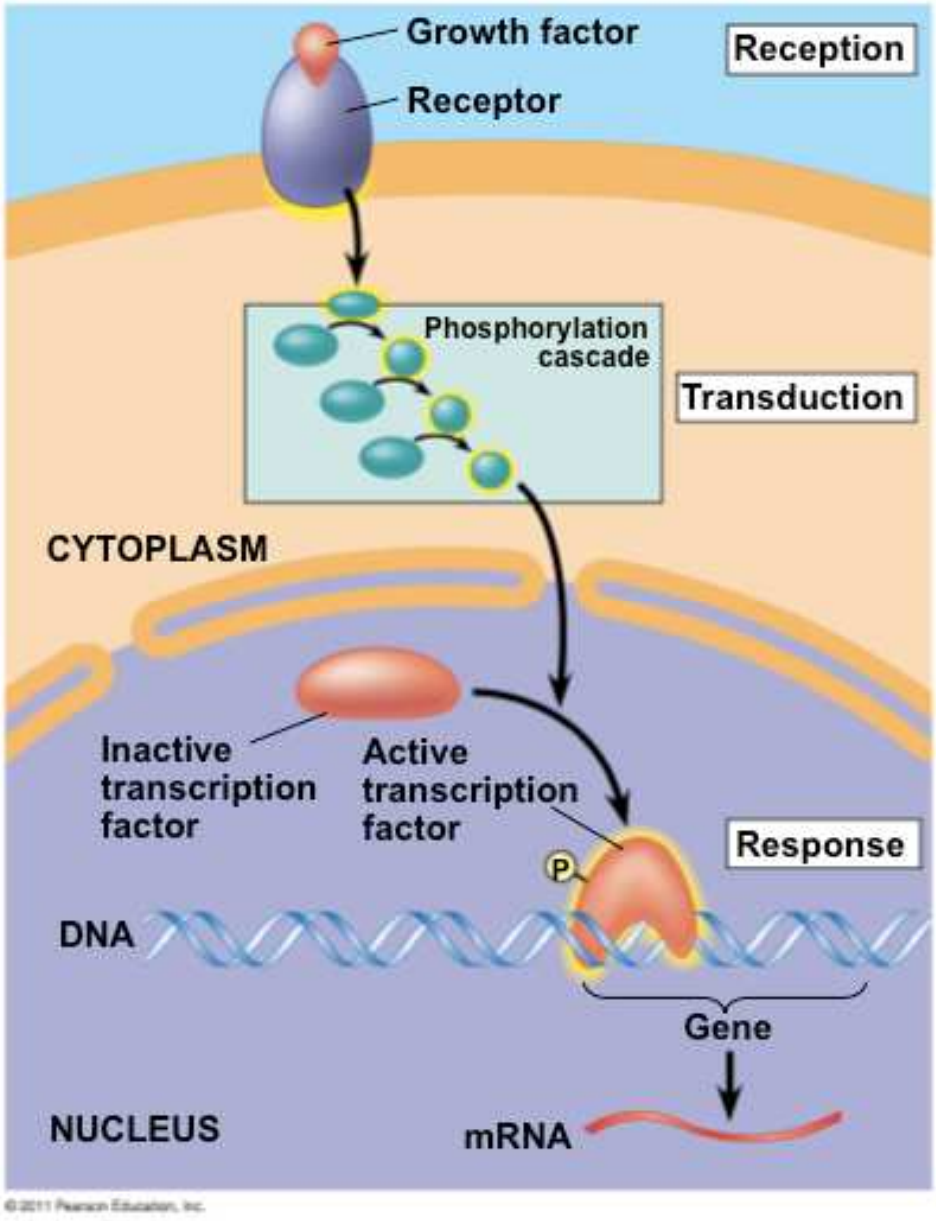
Second messengers: cyclic AMP



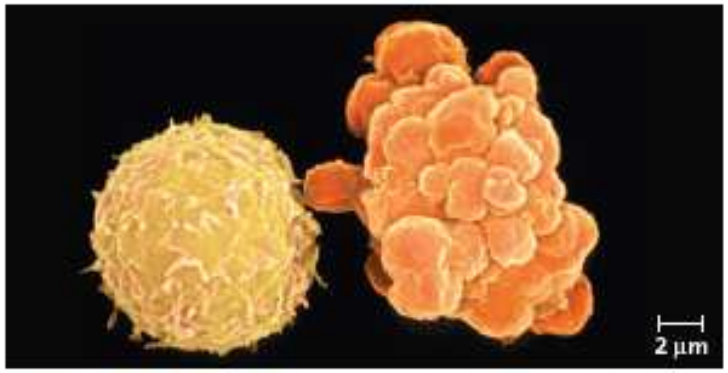
Ca^{+2} as second messenger



Nuclear and Cytoplasmic Responses



An example of signaling pathways: apoptosis or programmed cell death



▲ **Figure 11.20 Apoptosis of a human white blood cell.** We can compare a normal white blood cell (left) with a white blood cell undergoing apoptosis (right). The apoptotic cell is shrinking and forming lobes ("blebs"), which eventually are shed as membrane-bounded cell fragments (colorized SEMs).

Cell death is an integral part of the normal functioning of multi-cellular organisms: immune cells that have done their job undergo cell death to prevent them from attacking our bodies.

Many signal transduction pathways act together to tell the right cell to die at the right time

Thank you!