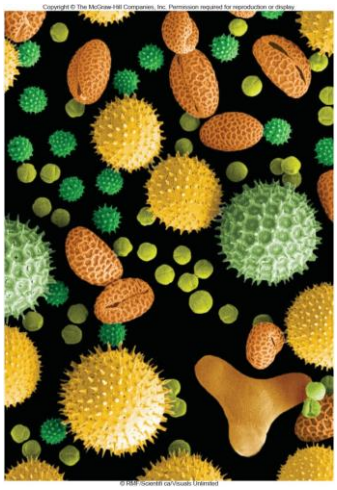
# Cell Communication



# Cell Communication

Communication between cells requires:

**ligand**: the signaling molecule

**receptor protein**: the molecule to which the ligand binds

(may be on the plasma membrane or within the cell)

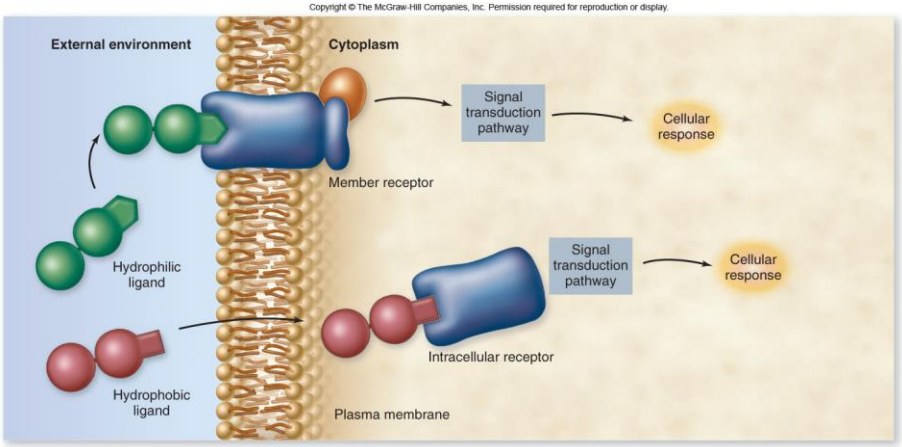



Figure 9.1

# Cell Communication

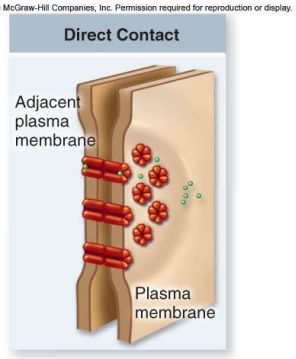
There are four basic mechanisms for cellular communication:

1. direct contact
2. paracrine signaling
3. endocrine signaling
4. synaptic signaling

# Cell Communication

**Direct contact** – molecules on the surface of one cell are recognized by receptors on the adjacent cell



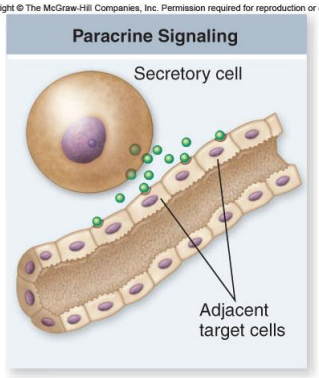



*a.*

# Cell Communication

**Paracrine signaling** – signal released (ligand) from a cell has an effect on neighboring cells



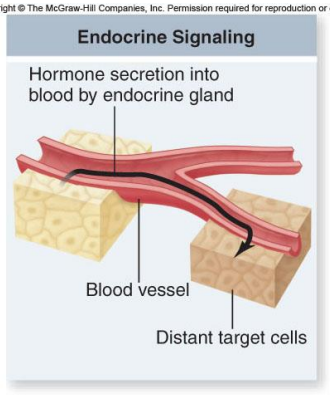



*b.*

# Cell Communication

**Endocrine signaling** – hormones (ligands) released from a cell affect other cells throughout the body



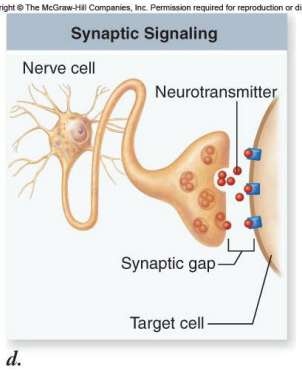



*c.*

# Cell Communication

**Synaptic signaling** – nerve cells release the signal (**neurotransmitter = ligand**) which binds to receptors on nearby cells






*d.*

# Cell Communication

Three Stages of Cellular Communication

1. Reception
   a. Ligand binds to a receptor
   b. Receptors are either embedded on plasma membrane or within the cell
2. Transduction
   a. Usually includes a series of steps
   b. Like dominos falling in a circuit
3. Cellular Response
   a. Depends on the cell type

# Receptor Types

Receptors can be defined by their location.

**intracellular receptor** – located within the cell

**cell surface receptor** or **membrane receptor** – located on the plasma membrane to bind a ligand outside the cell

# Receptor Types

There are 4 subclasses of membrane receptors:

1. **Ion channel linked receptors** – ion channel that opens in response to a ligand
2. **Enzymatic receptors** – receptor is an enzyme that is activated by the ligand
3. **G protein-linked (coupled) receptor** – a G-protein (bound to GTP) assists in transmitting the signal

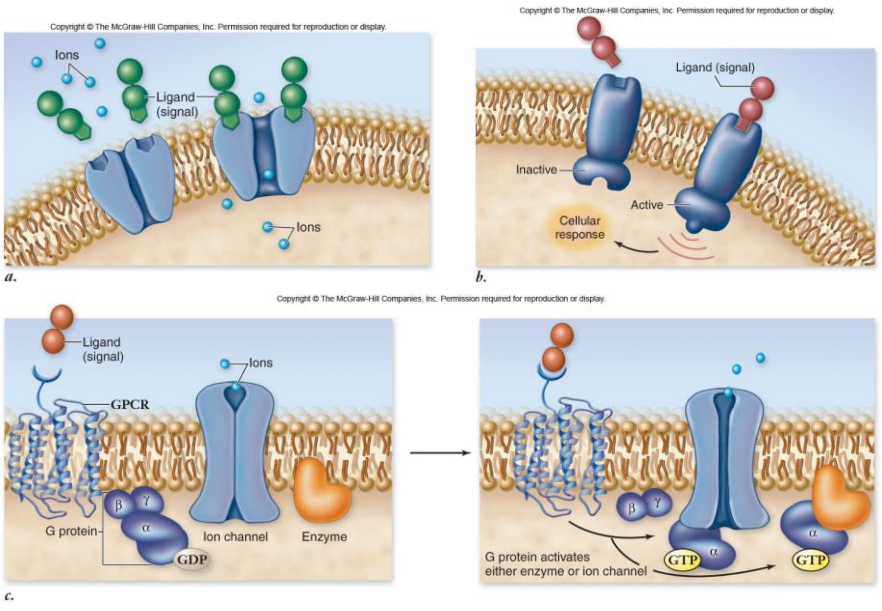



Figure 9.4

# G-Protein Coupled Receptors

**G-protein** – protein bound to GTP

**G-protein-coupled receptor (GPCRs)** – receptors bound to G proteins

-G-protein is a switch turned on by the receptor

-G-protein then activates an effector protein (usually an enzyme)



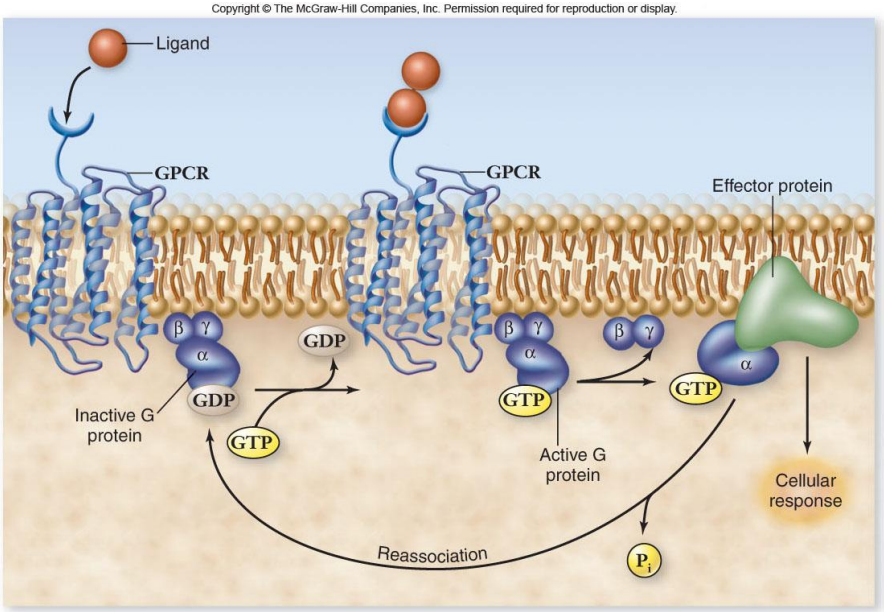



Figure 9.11

# Receptor Kinases

## 4. Tyrosine Kinase Receptors

-membrane receptor

-when bound by ligands, the receptor is activated by dimerization and autophosphorylation (usually from ATP)

-activated receptor adds a phosphate to tyrosine on a response protein

-an example is the insulin receptor

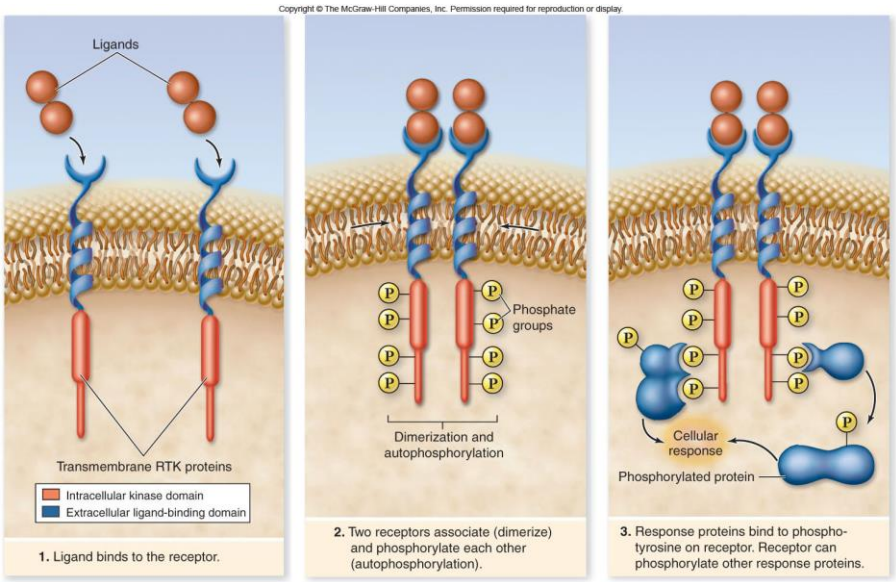



Figure 9.6

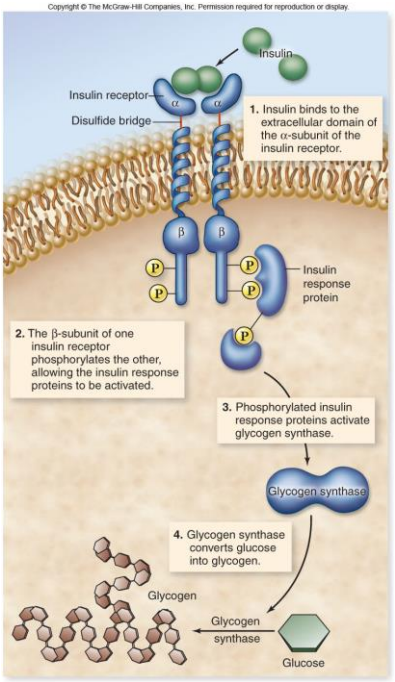



Figure 9.7

# Intracellular Receptors

**steroid hormones**

-have a nonpolar, lipid-soluble structure

-can cross the plasma membrane to a **steroid receptor** (in cytoplasm)

-usually affect regulation of gene expression

An inhibitor blocks the receptor from binding to DNA until the hormone is present.

# Intracellular Receptors

A steroid receptor has 3 functional domains:

1. hormone-binding domain
2. DNA binding domain
3. domain that interacts with coactivators to affect gene expression

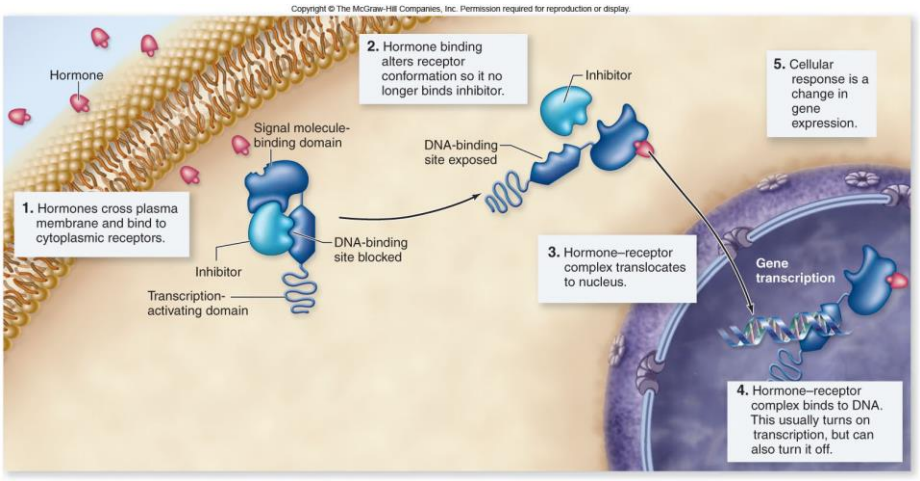



Figure 9.5

## Transduction

Second stage of cell communication = Transduction

When a ligand binds to a receptor protein, the cell has a response.

**signal transduction**: the events within the cell that occur in response to a signal that will eventually lead to the cellular response

Different cell types can respond differently to the same signal.

## Transduction

A cell's response to a signal often involves activating or inactivating proteins.

Phosphorylation is a common way to change the activity of a protein.

**protein kinase** – an enzyme that adds a phosphate to a protein (activation)

**phosphatase** – an enzyme that removes a phosphate from a protein (deactivation)

# Transduction

**kinase cascade** – a series of protein kinases that phosphorylate each other in succession

**MAP kinases** are activated by kinase cascades

**Amplification** results because because a few signal molecules can elicit a large cell response

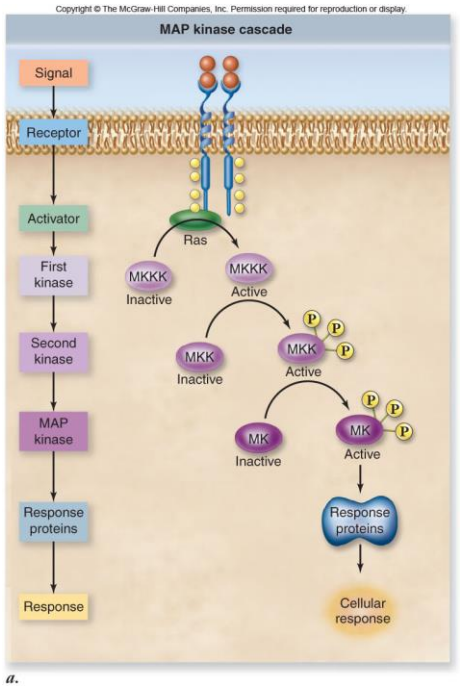
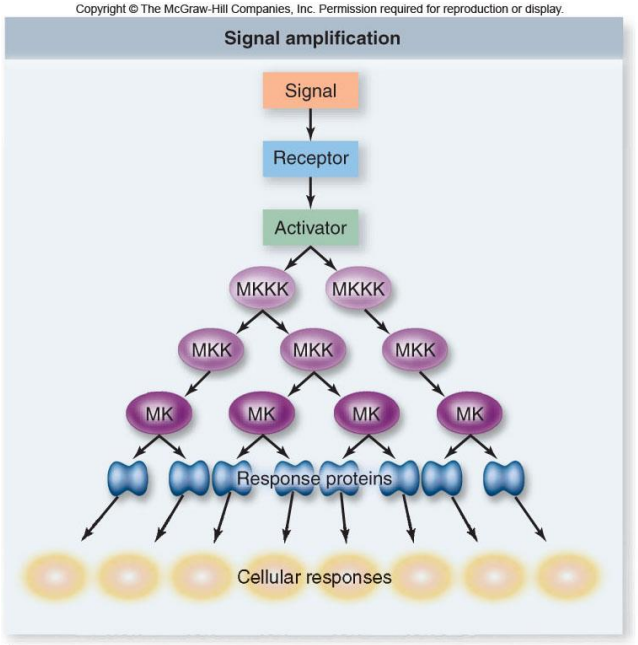



Figure 9.8a




*b.*

Figure 9.8b

# Transduction: Second Messengers

Once activated, the effector protein sometimes produces a **second messenger**.

-second messenger generates the cellular response to the original signal

For example – one common effector protein is **adenylyl cyclase** which produces cAMP as a second messenger.

Other second messengers: **$IP_3$, calcium ions ($Ca^{2+}$)**

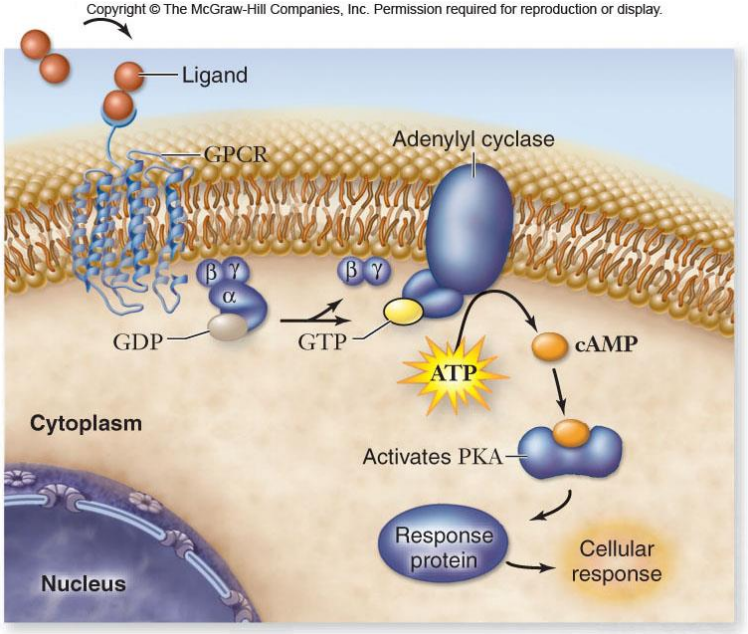



Figure 9.13

# Cellular Response

- Last stage of Cellular Communication
  1. Examples of cellular responses:
     a. Gene expression – turn on transcription/translation
     b. Synthesis or Breakdown of something
     c. Transmission of a stimulus
     d. Body system response – sweating, immune response, hormone release, etc…
  2. Responses vary by:
     a. Type of ligand
     b. Type of receptor
     c. Type of cell
        - Same ligand and receptor may have different cellular response in different types of cells