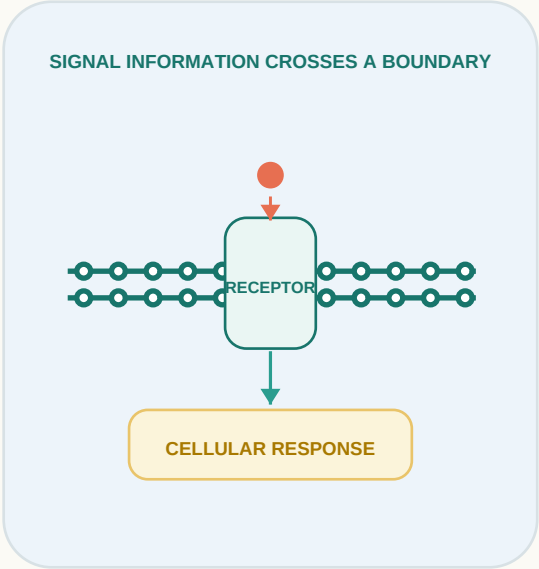
AP BIOLOGY | UNIT 4

# TOPIC 4.2

## Introduction to

## Signal Transduction

Signal transduction converts ligand detection into a specific change in cell activity through reception, transduction, and response.




### THE CORE CAUSAL CHAIN

**LIGAND**
carries information

→

**RECEPTION**
receptor detects

→

**TRANSDUCTION**
signal is relayed

→

**RESPONSE**
cell activity changes

### BY THE END, YOU SHOULD BE ABLE TO...

1. Identify reception, transduction, and response.
2. Compare membrane and intracellular receptors.
3. Explain why the same ligand can produce different responses.

**CENTRAL IDEA**

The ligand carries information. The pathway changes the form of that information so intracellular targets can produce an appropriate response.

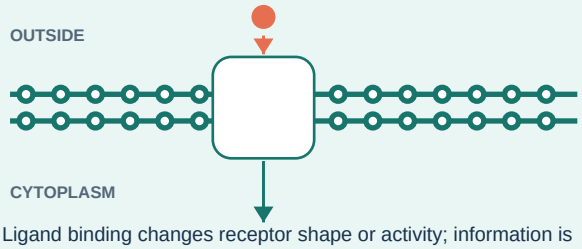
# 1 Reception begins with ligand-receptor binding

Receptor location depends on whether the signal can cross the plasma membrane; binding changes receptor activity and starts the pathway.

## TWO RECEPTOR LOCATIONS

### MEMBRANE RECEPTOR

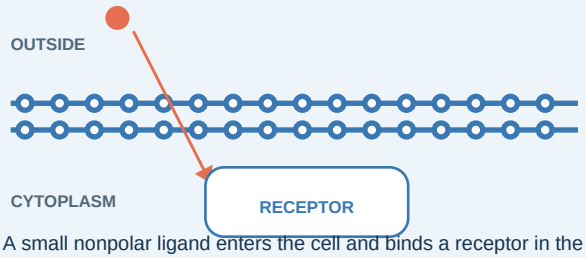
SIGNAL STAYS OUTSIDE




Ligand binding changes receptor shape or activity; information is passed inward.

### INTRACELLULAR RECEPTOR

SIGNAL CROSSES MEMBRANE




A small nonpolar ligand enters the cell and binds a receptor in the cytoplasm or nucleus.

## COMPARE RECEPTION

| FEATURE | MEMBRANE RECEPTOR | INTRACELLULAR RECEPTOR |
|---|---|---|
| RECEPTOR LOCATION | plasma membrane | cytoplasm or nucleus |
| SIGNAL PROPERTY | cannot readily cross | can cross membrane |
| FIRST CHANGE | receptor activates | ligand-receptor complex forms |
| TYPICAL EFFECT | activates internal relay | often changes gene activity |

### RECEPTION STARTS THE PATHWAY

LIGAND FITS → RECEPTOR ACTIVATES → INTERNAL SIGNAL BEGINS

### COMMON ERROR

**For a membrane receptor, the ligand usually remains outside the cell. Information crosses the membrane through a change in receptor activity.**

# 2 One signal can produce different responses

The pathway between receptor and target determines the outcome, so cell type and internal proteins matter as much as the ligand itself.

## THE THREE-STAGE PATHWAY

**1. RECEPTION**
Ligand binds and activates its receptor.

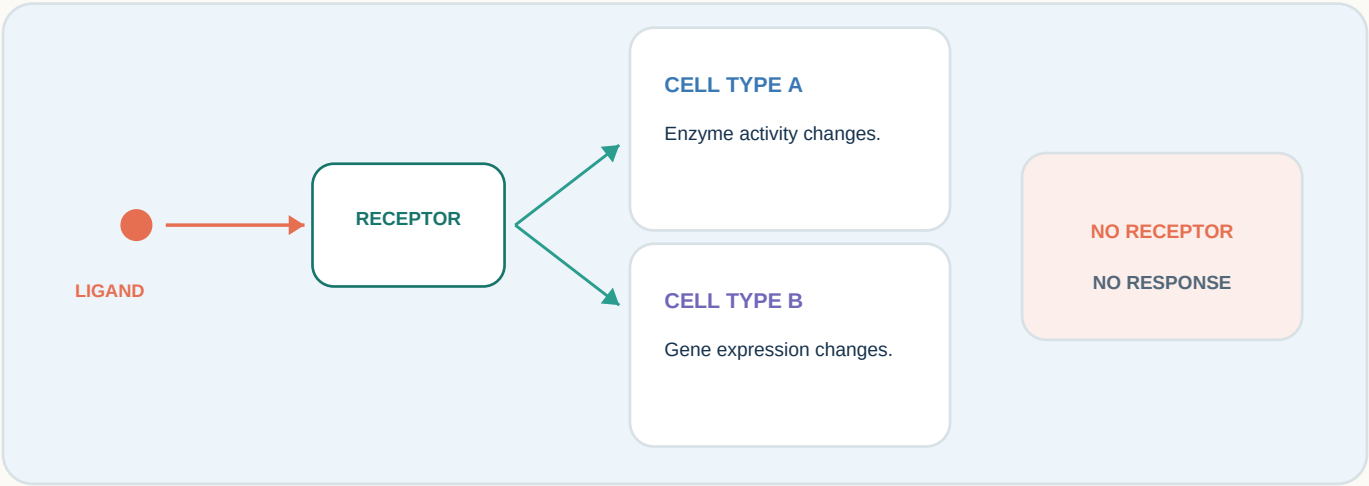
→

**2. TRANSDUCTION**
Information is relayed or converted inside.

→

**3. RESPONSE**
A target protein or gene changes activity.

## SAME LIGAND, DIFFERENT CELLULAR CONTEXT




## WHAT CHANGES THE OUTCOME?

| RECEPTOR | RELAY | TARGET | CELL TYPE |
|---|---|---|---|
| whether the signal is detected | how information moves | which protein or gene changes | which machinery is present |

ENZYME ACTIVITY CAN CHANGE QUICKLY | GENE EXPRESSION OFTEN TAKES LONGER

**KEY IDEA**

**The same ligand can cause different responses in different cells because receptor presence, pathway components, and target molecules differ.**