

Introduction to Signal Transduction

Learning objective 4.2.A Explain how signal transduction allows cells to respond to external signals.

Name:

Date:

Period:

Use the tool **Three Steps In**. Part 1 uses **Which door does it use**, Part 2 uses **Three stages** and Parts 3 and 4 use **Break the chain**. Part 1 is Topic 2.4 again with a different question on the end, so answer it from the rule rather than from memory.

Part 1 · Predict the receptor before you look

For each molecule, fill in the three properties and **predict** where its receptor must be. Then select it in the tool and check.

Signaling molecule	Small?	Non-polar?	Uncharged?	Predicted receptor	Correct?
Epinephrine					
Insulin					
Neurotransmitter					
Testosterone					
Oestrogen					
Nitric oxide					

1. State the rule you used, in one sentence.

2. A neurotransmitter is a small molecule and still cannot cross the membrane. Explain why, and state what that shows about using size alone to answer this question.

3. Testosterone and epinephrine are both hormones carried in the blood. Explain why one is detected inside its target cells and the other at their surface.

Part 2 · The three stages

Switch to **Three stages** and step through them, recording what has actually changed in the cell by the end of each one.

Stage	What happens	What has changed in the cell so far
Reception		
Transduction		
Response		

4. Describe what happens during reception, and explain how information gets from outside the cell to inside it when the signaling molecule never enters.

5. Explain why a pathway has a middle stage at all, rather than the receptor doing the job itself.

Part 3 · Where does the signal stop?

Switch to **Break the chain**. Knock out each component in turn and record what the readouts show. Predict each row before you click.

Knocked out	Steps that still run	Reception occurs?	Response occurs?
Nothing			
Signaling molecule			
Receptor			
First relay protein			
Second relay protein			
Response protein			

6. State what happens to the components upstream of a break, and what happens to those downstream of it.

7. Two of your rows give no response and are not the same situation at all. Name them, and state what is different about the state of the cell in each case.

Part 4 · Diagnose the fault

Each case below describes a cell that does not respond. Use your Part 3 table to say which component is faulty, and give the evidence you used.

What is observed	Which component is faulty	How you know
The signal is present in normal amounts; no relay protein inside the cell is ever activated.		
Both relay proteins are activated normally; the cell still does not respond.		
The receptor binds the signal normally; the first relay protein is never activated.		

8. A researcher finds a cell that does not respond to insulin. Give two different faults that could produce this, and describe an observation that would distinguish them.

9. Some cancers involve a relay protein locked permanently in its active shape. Predict what that cell does in the complete absence of any signal, and explain your prediction.

What the model simplifies

The pathway is drawn with two relay proteins. Real pathways have anywhere from one relay to a dozen, and often branch, so that one signal produces several responses at once and several signals converge on one.

Ligand properties are given as three yes-or-no facts. Real membrane permeability is a matter of degree, and a molecule that is only slightly polar crosses slowly rather than not at all.

The course framework does not require the individual steps, intermediates or enzyme names of any particular pathway, so this tool counts stages and tests dependencies instead of naming molecules.

What it does expect is that you can explain what each stage achieves and predict what happens when one is disrupted.

Receptors are drawn as single proteins that change shape. Many real receptors work as pairs that come together when the ligand binds, and some are ion channels that open rather than relays that change shape. The consequence — a change inside the cell caused by binding outside it — is the same.