PEEBEDU

# Cell Signaling Interactive



**Name:** _____ **Period:** _____ **Date:** _____

> Open **peebedu.com** and navigate to **Cell Signaling Interactive**. Read the Introduction popup, which describes three categories of cell signaling: direct contact, short distance, and long distance. Then explore all four simulation tabs: Quorum Sensing, Plasmodesmata, Morphogen Gradient, and Pheromone Guidance.

## Part 1 — Model Evaluation (MAPP Framework)

*Scientific models are simplified representations of complex biological phenomena. Use the MAPP framework below to evaluate the Cell Signaling Interactive as a scientific model.*

### M — Mode

What type of model is the Cell Signaling Interactive? Describe how this computational simulation represents cell communication. In your answer, identify at least three specific simulation elements and explain what each one is designed to show about how cells signal one another.

### A — Accuracy

**(a)** Identify two things this simulation represents **accurately** about cell communication. For each, name the specific simulation feature and explain what aspect of signaling it demonstrates.

**(b)** Identify two things this simulation **oversimplifies or leaves out** about cell signaling. Consider what you cannot observe in the simulation that would be important for a complete molecular-level understanding of signal transduction.

### P — Purpose

What is the learning goal of this simulation? Explain how the Cell Signaling Interactive is designed to help you understand how cells communicate through chemical signaling across different distances. In your answer, connect at least one specific simulation feature to a biological context where that type of signaling is critical for organism function.

### P — Permanency

Could this model change with new scientific evidence? Describe one way that new discoveries might change or improve a simulation like the Cell Signaling Interactive. Explain why scientific models, including computational simulations, are revised as new evidence becomes available.

### Small-Group Discussion

With your group, discuss the following:

- What are the strengths of this simulation as a model for cell communication?
- What are its limitations?
- If you could add one feature to improve this simulation, what would it be and why?
- How does the simulation help you connect the concept of ligand-receptor binding to coordinated cellular responses?

## Part 2 — Free Response Questions

### Conceptual Analysis

### Question 1 — Quorum Sensing and Coordinated Cellular Response

> *Simulation Task: In the Quorum Sensing simulation, set the population density slider to 20 cells and click Start Simulation. Observe the autoinducer concentration on the Global Concentration meter. Then gradually increase the population density slider to 150 cells and observe how the cells change from blue (OFF) to green (ON) and whether biofilm formation occurs.*

**(A)** (1 pt) **Describe** how cells communicate over short distances by using local regulators that target cells in the vicinity of the signal-emitting cell.

**(B)** (1 pt) **Explain** how signaling begins with the recognition of a chemical messenger by a receptor protein in a target cell.

**(C)** (1 pt) **Predict** how the cellular response would change if the receptor proteins on the bacterial cells were mutated so that they could no longer bind autoinducer molecules, even at high population density.

**(D)** (1 pt) **Justify** your prediction using the concept that signaling begins with ligand recognition by a receptor protein and that changes in any component of a signaling pathway can alter downstream cellular responses.

EK 4.1.B.1, 4.2.B.1, 4.2.B.2, 4.3.A.1

## Analyze Model / Visual Representation

### Question 2 — Morphogen Gradients and Cell Fate Determination

> *Simulation Task: Navigate to the Morphogen Gradient (Embryo) simulation. Observe how morphogen molecules diffuse outward from the organizing center and how cells in different zones adopt different fates: purple zone (high morphogen, fate C), blue zone (medium morphogen, fate B), and green zone (low morphogen, fate A).*

**(A)** (1 pt) **Describe** how signal transduction may result in changes in gene expression and cell function, which may alter phenotype.

**(B)** (1 pt) **Explain** the relationship between ligand concentration, receptor activation, and the resulting differential cellular responses in a developing embryo.

**(C)** (1 pt) **Represent** the relationship between morphogen concentration and cell fate determination.

*Draw your diagram here.*

**(D)** (1 pt) **Explain** how the morphogen gradient mechanism connects to the regulation of gene expression during embryonic development, where changes in the expression of developmental genes can establish body plans and determine cell differentiation in organisms.

EK 4.2.A.1, 4.2.B.1, 4.3.A.1