PEEBEDU Signal Transduction Visualizer

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

> Open **peebedu.com** and navigate to **Signal Transduction Visualizer**. Click **Start Exploring** to dismiss the introduction popup. Read the introduction, which describes how to select pathways, control animations, and highlight components. Begin with the **GPCR/cAMP** pathway selected.

Part 1 — Model Evaluation (MAPP Framework)

Scientific models are simplified representations of complex biological phenomena. Use the MAPP framework below to evaluate the Signal Transduction Visualizer as a scientific model.

M — Mode

What type of model is the Signal Transduction Visualizer? Describe how this computational simulation represents signal transduction pathways. In your answer, identify at least three specific simulation elements and explain what each one is designed to show about cell signaling.

A — Accuracy

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

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

P — Purpose

What is the learning goal of this simulation? Explain how the Signal Transduction Visualizer is designed to help you understand how a ligand binding to a receptor initiates a cascade of molecular interactions that amplify the signal and produce a cellular response. In your answer, connect at least one specific simulation feature to a biological function of signal transduction.

P — Permanency

Could this model change with new scientific evidence? Describe one way that new discoveries might change or improve a simulation like the Signal Transduction Visualizer. 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 signal transduction?
- What are its limitations?
- If you could add one feature to improve this simulation, what would it be and why?
- How does comparing the three pathways help you understand differences in how cells respond to signals?

Part 2 — Free Response Questions

Conceptual Analysis

Question 1 — Signal Amplification Through Phosphorylation Cascades

> *Simulation Task: Select the **GPCR/cAMP** pathway and click **Start Signaling**. Reduce the animation speed to observe each step. Watch the Amplification and Active Molecules counters as the signal moves from the ligand through the G protein, adenylyl cyclase, cAMP, and PKA to the cellular response.*

(A) (1 pt) **Describe** how signal transduction pathways use phosphorylation cascades to relay and amplify an intracellular signal from a single ligand-receptor binding event to a large-scale cellular response.

(B) (1 pt) **Explain** the role of second messengers in amplifying the signal within a transduction pathway, including how the production of multiple second messenger molecules from a single activated enzyme contributes to the overall amplification of the cellular response.

(C) (1 pt) **Predict** how a mutation that prevents the G protein from hydrolyzing GTP back to GDP would affect the duration and intensity of the cellular response in a GPCR-mediated signaling pathway.

(D) (1 pt) **Justify** your prediction by explaining how the inability to inactivate the G protein would alter the downstream components of the signaling cascade and the resulting cellular response.

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

Analyze Model / Visual Representation

Question 2 — Receptor Location and Cellular Response

> *Simulation Task: Select the **GPCR/cAMP** pathway and click **Start Signaling**. Observe the complete pathway. Then switch to the **Steroid Hormone** pathway, reset, and click **Start Signaling** again. Compare where the receptor is located and how the cellular response differs between the two pathways.*

(A) (1 pt) **Describe** how the location of a receptor protein determines the mechanism by which a signaling molecule initiates a cellular response, including the distinction between cell-surface receptors and intracellular receptors.

(B) (1 pt) **Explain** the relationship between the chemical properties of a signaling molecule and the type of receptor it binds, and how this relationship determines whether the cellular response involves a second messenger cascade or direct regulation of gene expression.

(C) (1 pt) **Represent** the steroid hormone signaling pathway from the cell membrane to gene transcription in the nucleus.

Draw your diagram here.

(D) (1 pt) **Explain** how a mutation in the DNA-binding domain of an intracellular receptor could alter gene expression and potentially change the phenotype of the organism, connecting the disrupted signaling pathway to the central dogma of molecular biology.

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