

**HANDS-ON LAB**

# Modeling Induction in Embryos

A multicellular organism develops from a single unspecialized cell into millions of specialized cells through *cell differentiation*. Differentiation occurs when chemical signals trigger a response in cells containing the appropriate receptors. For example, the lens in a vertebrate's eye forms with the stimulation of one type of cell by chemical signals from cells that reside just below the forming lens.

A single signal may trigger, or *induce*, different responses in cells according to the type of receptor each possesses. Some signals are contact dependent, requiring the sending and receiving cells to be touching one another, whereas other signals are able to induce responses from a distance. Inducing chemicals that work throughout a developing embryo are spread by diffusion and osmosis. As an inducing chemical spreads, it will form a *concentration gradient*, in which the chemical's concentration starts high at one end of the gradient and steadily decreases as it moves farther from the source.

A cell's distance from the inducer determines the concentration of the chemical that it receives. The concentrations of different inducing chemicals in a cell determine how the cell differentiates into the correct type for its location and function. For example, cells at the bottom of an early-stage animal embryo release inducing chemicals that make cells far from them turn into the outer cell layer, cells near them turn into the inner cell layer, and cells at an in-between distance turn into the middle cell layer.

Studying how inducing chemicals move through an embryo can help a scientist understand embryonic development, although a scientist might want to avoid using embryos in research out of ethical concerns or to limit research cost and time. An alternative is to use models instead of working on actual embryos.

Researchers often work with models in the early stages of their research. These models may be physical constructions, mathematical representations, or computer simulations. Physical models may include laboratory-grown cells or materials that can serve as analogies for living cells and tissues.

**SAFETY**

Do not touch any chemicals. If you get a chemical on your skin or clothing, wash off the chemical at the sink and alert your teacher. Do not taste any chemicals or items used in the laboratory. Never return a used product to its original container. Dispose of chemicals as instructed by your teacher.

**SUGGESTED MATERIALS**

- agar gel, 2-inch cubes
- baking soda
- beaker
- cup, plastic
- metric ruler
- dish detergent, liquid
- drawing paper
- food coloring
- forceps
- gelatin, 2-inch cubes
- graduated cylinder, 100 mL
- hydrochloric acid solution (0.1 M HCl)
- lemon juice
- paper towels
- pen or marker, waterproof
- phenolphthalein pH indicator solution
- Petri dish, plastic
- plastic transfer pipettes
- red cabbage juice pH indicator solution
- rubbing alcohol
- sodium hydroxide solution, (0.1 M NaOH)
- toothpicks
- tray or cookie sheet
- universal pH indicator solution
- vinegar



**PROCEDURE**

1. Brainstorm ideas about materials and methods that can be used to model induction in embryos.
2. Come up with a plan for creating a model of induction in embryos. Consult with your teacher to ensure that conditions you have chosen are appropriate.
3. **As you plan your design, take the following steps:**
  - Decide what methods and/or materials you will use from those provided by your teacher.
  - Decide how you will measure results or determine if a test is successful.
  - Decide what safety procedures are necessary.
4. Have your teacher approve your plan.
5. Obtain the necessary materials and set up any apparatus you will need.
6. Take appropriate safety precautions.
7. Make objective observations.
8. Collect data and organize it.
9. Make a labeled diagram of your design, including any measurements.
10. Share your results with other teams to get feedback on your design.
11. Dispose of chemicals and solutions as instructed by your teacher.

**ANALYZE**

1. Summarize your findings and observations, including an analysis of any data you recorded or graphed.

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Name:

Date:

2. Describe the advantages and disadvantages of the model that you tested.

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3. Share your results with your classmates. Which physical model was best? Why was this model best?

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## **EXPLAIN**

What conclusions can you draw from your results? From your classmates' results?

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## REFINE

Was your design a good physical model of induction in embryos? Explain. How could your model be improved?

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