

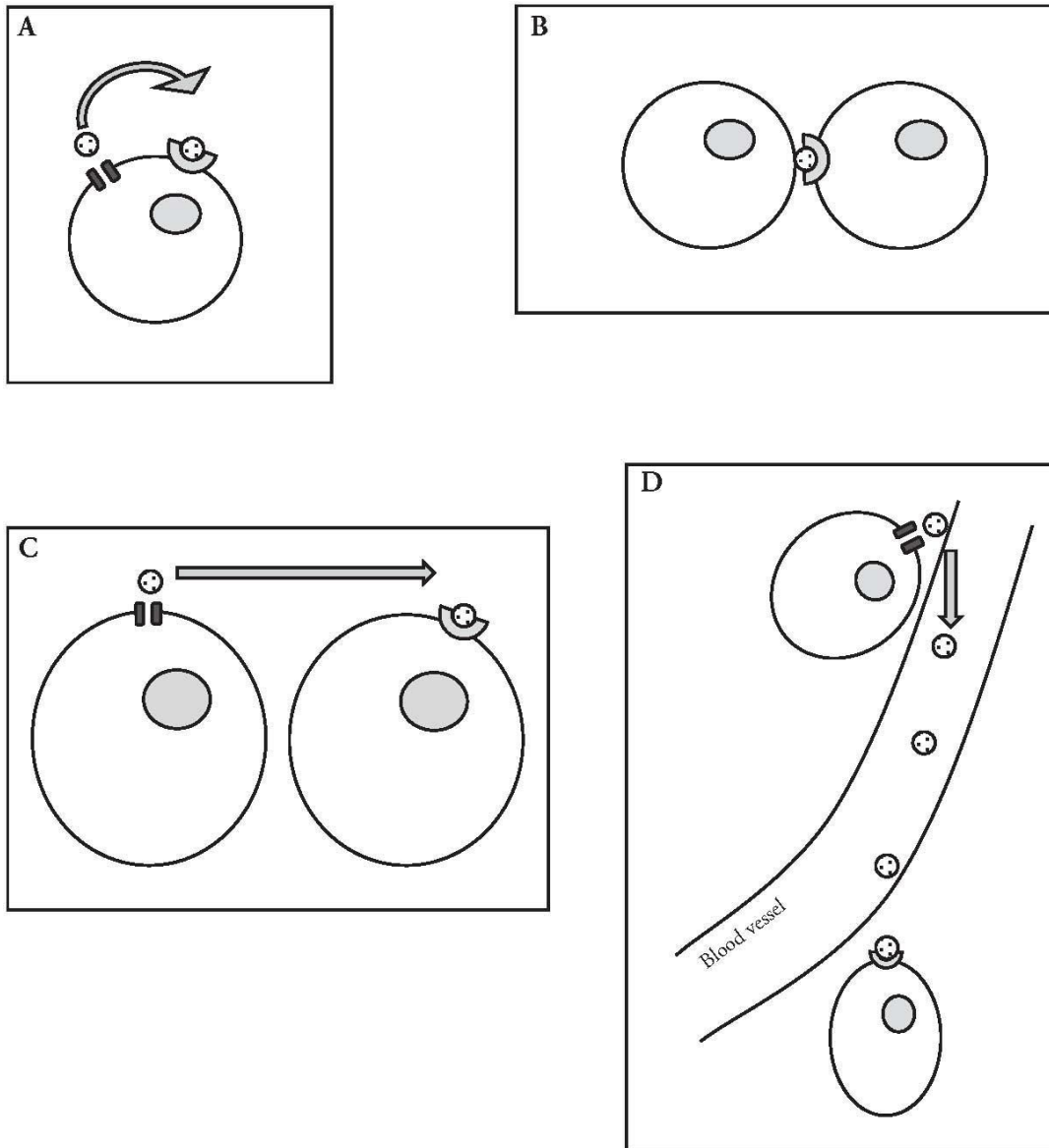
Cellular Communication

How can cells send signals to each other?

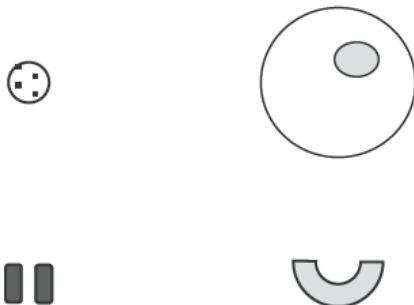
Why?

There are many times when communication between cells is advantageous. For multicellular organisms, communication between nearby or even distant cells is critical for the survival of the species. Even single celled organisms like bacteria have an evolutionary advantage when they “talk” with each other. Cells employ a variety of signaling pathways in order to send chemical messages from cell to cell.

Model 1 – Types of Signaling



1. Consider the diagrams in Model 1 of four types of cellular communication. Match each of the shapes below with a label at the right.



Cell

Signaling molecule (ligand)

Receptor

Membrane channel

2. Describe how the shape of the ligand (signaling molecule) and the shape of the receptor are related.

3. Which of the cellular communication methods in Model 1 appear to be for signaling between cells that are in close proximity?

- Which of the cellular communication methods in Model 1 appear to be for signaling between cells in different parts of an organism (long-distance communication)?
- In which of the cellular communication methods would a ligand (signaling molecule) need to have the longest “life”? Explain your reasoning.
- Use the four terms below to label the diagrams in Model 1. Word-part definitions are given to help you determine the meanings of each term.

Autocrine (auto = self)	Paracrine (para = nearby)
Juxtacrine (juxta = beside, next to, touching)	Endocrine (endo = within)
- Cellular communication takes place for a variety of reasons—mating, defense mechanisms, homeostasis, growth, etc. Discuss the following question with your group and make a prediction:
“Do all ligands for cellular communication have the same chemical structure (shape)?”

8. Consider each of the following cellular communication examples. Divide the work among group members. Have each group member determine which type of signaling is being used in their scenario (autocrine, juxtacrine, paracrine or endocrine), and then present their reasoning to the group.
- a. **Quorum sensing*** is used by bacteria to determine the population density of their species in a local area. (Many bacterial functions would be ineffective in small numbers—infected a host organism with a toxin, for example—and would therefore be a waste of energy and resources to the bacteria.) Each bacterium produces a ligand. Once the concentration of that ligand reaches a critical concentration, thus indicating a sufficient population density for the response to be effective, all bacteria will respond simultaneously.

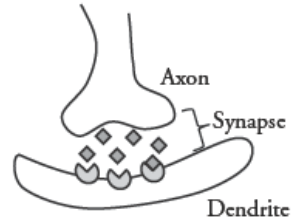
- b. Plants construct channels between cells called **plasmodesmata** that allow ligands to move directly from one cell to another throughout the plant structure.

- c. **Morphogens** are produced in embryos from a central source early in development. They diffuse throughout the tissue creating a concentration gradient that provides a spatial reference for developing cells. Cells far from the morphogen production will develop into one type of tissue while cells close to the source will develop into a different type of tissue. This allows for differentiation of cell structure early in embryonic development.

- d. Cells in the human pancreas release insulin when blood sugar levels are elevated. The insulin signals cells in the liver to begin absorbing glucose and convert it to glycogen for storage.

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- a. **Pheromones** released by a female gamete cell (egg) provide a pathway for the male gamete cell (sperm) to travel, increasing the possibility of fertilization.
- b. Some cancer cells release their own growth hormone rather than relying on growth hormones from the host organism or from other cells. This presents challenges to cancer researchers looking for ways to slow the growth of cancer cells.
- c. **Neurotransmitters** are ligands that are released from the axon of one nerve cell to the dendrite of another nerve cell. This helps to propagate the signal across several cells.



- d. Cells in the pituitary gland produce thyroid stimulating hormone (TSH), which is received by cells in the thyroid. The arrival of TSH in the thyroid triggers production of several hormones, which then travel throughout the body to regulate metabolism.
10. If a medical researcher wanted to prevent communication between cells in order to cure a disease or prevent a malady, how might they achieve that? Propose two or more general methods that could be used to stop a signal transmission from cell to cell.
11. If a medical researcher wanted to enhance communication between cells in order to cure a disease or prevent a malady, how might they achieve that? Propose two or more general methods that could be used to enhance signal transmission from cell to cell.

Extension Questions

11. The examples of cellular communication used in this activity vary from bacteria to plants to vertebrates. However, the mechanisms of cellular communication are similar among varied species. Explain how scientists might use cellular communication systems to show evolutionary relatedness between species.
12. Some hormones such as estrogen and testosterone are lipids and are therefore nonpolar. Explain why a receptor protein would not be needed for this type of ligand to activate a response in a cell.
13. Suggest some stimuli that might cause a cell to release a ligand and begin communication between cells.