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Commentary

Cell Signaling in Unicellular and Multicellular Organisms

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DESCRIPTION

Cell signaling is part of a complex system of communication that governs basic cellular activities and coordinates cell actions. The ability of cells to perceive and correctly respond to their microenvironment is the basis of development, tissue repair, and immunity as well as normal tissue homeostasis. Errors in cellular information processing are responsible for diseases such as cancer, autoimmunity, and diabetes. By understanding cell signaling, diseases may be treated effectively and theoretically.

Traditional studies in biology have focused on studying individual parts of cell signaling pathways. Studies in systems biology will help us understand the basic structure of cell signaling networks and how changes in these networks affect the transmission and flow of information. Cell signaling has been most widely studied in the context of human disease and cell-to-cell signaling in a single organism. However, cell signaling can also occur between cells in two different organisms. In many mammals, early germ cells exchange signals with cells in the uterus. In the human gastrointestinal tract, bacteria exchange signals with each other and with human epithelial and immune system cells. In the yeast (*Saccharomyces cerevisiae*), some cells send a peptide signal (mating factor pheromone) to the environment during mating. Mating factor peptides can bind to cell surface receptors in other yeast cells and prepare them for mating. Cell signaling is essential for cell-cell communication. Protozoa use signals to relay environmental or reproductive information. Communication in multicellular organisms allows the development and coordination of specialized cells. Within the cell, signal transduction allows bacteria to respond to environmental stimuli such as nutrient levels. Also, some unicellular organisms release molecules to signal each other. Multicellular organisms need to coordinate many different events with different cell types that can be very far apart from each other. There are four basic categories of chemical signaling in multicellular organisms: paracrine signaling, anticrine signaling, endocrine signaling, and direct contact signaling. In multicellular organisms, cell signaling allows for the specialization of cell groups. For example, bacteria use chemical signals to detect population density (the number of other bacteria in the area) and change their behavior accordingly, while yeast can generate chemical signals to find companions. The cells of multicellular organisms communicate *via* chemical messengers. Both animals and plants have cell connections, and if present, connect directly to the cytoplasm of adjacent cells. Cells communicate by sending and receiving signals. Signals may come from the environment, or they may come from other cells. In order to trigger a response, these signals must be transmitted across the cell membrane. Sometimes the signal itself can cross the membrane cells typically communicate using chemical signals. These chemical signals, which are proteins or other molecules produced by a sending cell, are often secreted from the cell and released into the extracellular space. Not all cells can "hear" a particular chemical message. In order to detect a signal (that is, to be a target cell), a neighbor cell must have the right receptor for that signal.

When a signaling molecule binds to its receptor, it alters the shape or activity of the receptor, triggering a change inside of the cell. The signal can come from the environment or other cells. These signals must be transmitted across the cell membrane to trigger a reaction. The signal itself may pass through the membranes. Cells usually communicates *via* chemical signals. Transduction molecules are often referred to as ligands, which are a general term for molecules that specifically bind to other molecules (such as receptors). The message transmitted by the ligand is often relayed through a chain of chemical messengers in the cell. Ultimately, it causes changes in cells, such as altering gene activity or triggering entire processes such as cell division. Therefore, the original intercellular signal is transformed into the intracellular signal that triggers the response. Yeasts are eukaryotes (fungi), and the components and processes found in yeast signaling are similar to those found in cell surface receptor signaling in multicellular organisms. *Saccharomyces cerevisiae* can participate in processes similar to sexual reproduction. In this process, two haploid cells combine to

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form the next diploid cell (a cell with two sets of each chromosome. Haploid yeast cell ready for mating, *Saccharomyces cerevisiae* secretes a signaling molecule called a mating factor. When mating factors bind to cell surface receptors in other nearby yeast cells, they stop the normal growth cycle and initiate a cellular signaling cascade involving protein kinases and GTP-binding proteins similar to G-proteins.