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Commentary

Effects of Transferring Signals between Molecules Using Secondary Messengers

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DESCRIPTION

As living organisms, humans are constantly receiving and processing messages from their surroundings, light, heat, odours, and touch are all examples of conveyed signals. Cells in our body are constantly receiving signals from other cells. These signals are useful for keeping cells alive and encouraging life activities such as cell division and differentiation. Signals are frequently discovered in the extracellular fluid that surrounds cells. These chemicals could come from far away (endocrine signalling *via* hormones), nearby cells (paracrine signalling), or even the same cell (autocrine signalling).

Changes in the metabolism of the cell receiving the signal, changes in gene expression (transcription) within the cell's nucleus, or both can be caused by signalling molecules. A cell detects a signalling chemical from outside the cell. A signal is detected when a chemical signal (also known as a ligand) interacts with a receptor protein on the cell's surface or within the cell. When a signal-transmitting chemical binds to a receptor, the receptor protein is changed in some way. Signal transduction is a multi-step process in most cases. Molecules in the signal transduction pathway can influence a single molecule. Finally, the signal triggers a biological response.

Membrane receptors

These receptors operate by binding to signal molecules (ligands) and stimulating the production of a second signal (also known as a second messenger) that causes the cellular response. When a ligand binds to this type of receptor, it changes shape or joins forces with another protein to transport information from the extracellular environment to the cell's interior. Membrane receptors include G Protein-Coupled Receptors (GP-CR) and Receptor Tyrosine Kinases (RTK).

Intracellular receptors

These receptors are found within the cell, either in the cytoplasm or in the nucleus of the target cell (the cell that receives the signal). Hydrophobic or very small chemical messengers (for example, steroid hormones) can pass through the plasma membrane unaided and bind these intracellular receptors. Once bound and triggered by the signal molecule, an activated receptor can promote biological responses such as changes in gene expression.

Transduction

Because signalling systems must respond quickly to small amounts of chemical signals, cells usually adopt a multi-step pathway that delivers the signal quickly while amplifying it to several molecules at each level.

The addition or removal of phosphate groups in the transduction pathway can commonly result in protein activation. Protein kinases are enzymes that help Adenosine Triphosphate (ATP) transfer phosphate groups to proteins. Many signal transduction relay molecules are protein kinases that commonly interact with other protein kinases in the pathway. This frequently leads to a phosphorylation event in which one enzyme phosphorylates another, which phosphorylates another protein, resulting in a chain reaction. Protein phosphatases are a type of protein that is essential in the phosphorylation cascade.

Protein phosphatases are enzymes that rapidly remove phosphate groups from proteins (dephosphorylation), inactivating protein kinases. To ensure that the biological reaction is correctly regulated, the signal transduction pathway must be turned off when the signal is no longer available. The dephosphorylation event can also free up protein kinases, allowing the receptor to be reused and the cell to respond to the new signal received.

Finally, cell signalling governs one or more cellular processes. Cell signalling frequently results in gene expression regulation (the activation or deactivation of specific genes). A signalling pathway may also influence protein activity by opening or closing an ion channel in the plasma membrane or by causing a change in cell metabolism, such as catalyzing glycogen degradation. Signalling routes can also initiate important biological processes such as cell division or apoptosis programmed cell death.

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