

## Signal transduction

*Signal transduction is the process by which a chemical or physical signal is transmitted through a cell as a series of molecular events, which ultimately results in a cellular response*

*Signal transduction relies on proteins known as receptors, which wait for a chemical, physical, or electrical signal.*

*Chemical signals are called ligands, and it can be produced by organisms to control their body or it can be received from the environment. Regardless of which type of signal, it must be transferred throughout the body and across cell membranes. This process is known as signal transduction.*

*In multicellular organisms, growth factors, hormones, neurotransmitters, and extracellular matrix components are the some of the examples of chemical signals which is used by cells. These substances can exert their effects locally, or they might travel over long distances*

*Cells have proteins called receptors that bind to signaling molecules and initiate a physiological response. Receptors are generally transmembrane proteins, which bind to signaling molecules outside the cell and subsequently transmit the signal through a sequence to internal signaling pathways.*

*Broadly, sensory receptors respond to one of four primary stimuli:*

- Chemicals (chemoreceptors)*
- Temperature (thermoreceptors)*
- Pressure (mechanoreceptors)*
- Light (photoreceptors)*

*Receptor proteins receive the signal and normally found on cell surface. These are specialized according to the type of cell they are attached to.*

*Each type of cell receives different signals from the body and environment, and must be specialized so that the body can produce a specific and coordinated response.*

*Each of these specialized proteins has a special method of transferring a signal into the cell*

*. Some proteins activate other molecules, called second messengers, which carry the message to the nucleus or other organelles.*

*Some proteins use the energy from ATP to activate enzymes, which carry out metabolic reactions.*

*The different routes which signal transduction takes to carry a signal are known as signal transduction pathways. (Fig 1 and 3)*

*SIGNAL TRANSDUCTION PATHWAY- It is set of chemical reactions in a cell that occurs when a molecule, such as a hormone, attaches to a receptor on the cell membrane. The pathway is actually a cascade of biochemical reactions inside the cell that eventually reach the target molecule or reaction.*

- A signal may have many components.*
- There is the primary messenger, which may be a chemical signal, electrical pulse, or even physical stimulation.*
- Then, the receptor protein embedded in the cellular membrane must accept the signal*
- Upon receiving the signal, this protein goes through a conformational change.*
- This changes its shape and thus, how it interacts with the molecules around it.*
- many different receptor proteins act in different ways.*
- Cells have proteins called receptors that bind to signaling molecules and initiate a physiological response.*
- Because membrane receptors interact with both extracellular signals and molecules within the cell, they permit signaling molecules to affect cell function without actually entering the cell*
- The majority of signal transduction pathways involve the binding of signaling molecules, known as ligands, to receptors that trigger events inside the cell. The binding of a*

signaling molecule with a receptor causes a change in the conformation of the receptor, known as receptor activation.

- The signal transduction cascade begins when adenylyl cyclase, a membrane-bound-enzyme, is activated by G-protein molecules associated with the adrenergic receptor. Adenylyl cyclase creates multiple cyclic AMP molecules, which fan out and activate protein kinases (PKA, in this example).

- Cyclic adenosine monophosphate (cAMP, cyclic AMP, or 3',5'-cyclic adenosine monophosphate) is a second messenger important in many biological processes. cAMP is a derivative of adenosine triphosphate (ATP) and used for intracellular signal transduction in many different organisms, conveying the cAMP-dependent pathway. • (Fig 4 and/or 5)

*Principles of Signal Transduction* - An environmental signal, such as a hormone, is first received by interaction with a cellular component, most often a cell-surface receptor. Once inside the cell, these molecules can bind to proteins that interact directly with DNA and modulate gene transcription

*Phases of Signal Transduction* - There are three stages in the process of cell signaling or communication-

- *Reception:* A cell detects a signaling molecule from the outside of the cell. A protein at the cell surface detects chemical signals

- *Transduction:* When the signaling molecule binds the receptor it changes the receptor protein in some way. ...

- *Response:* Finally, the signal triggers a specific cellular response.

*Forms of Signaling* - There are four categories of chemical signaling found in multicellular organisms: (a) Paracrine signaling, (b) Endocrine signaling, (c) Autocrine signaling, and (d) Direct signaling across gap junctions.

*Importance of signal transduction*- Signal transduction systems are especially important in multicellular organisms, because of the need to coordinate the activities of

*hundreds to trillions of cells. Also it comprises whole process by which environmental signals are received and responded to by single cells.*

*(Diagrams have been explained during class)*

Dept of Zoology R N College Hajipur