Cell signaling

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Definition ***Lec.7***

Cell signaling is part of a complex system of communication that governs basic cellular activities and coordinates cell actions. Where the ability of cells to perceive and correctly respond to their microenvironment is the basic of development, tissue repair, and immunity as well as normal tissue homeostasis.

Scientific terms in cell signaling:

Signaling: Cell-cell communication via signals.

***Signal transduction*:** Process of converting extracellular signals into intra- cellular responses.

Ligand: The signaling molecule.

Receptors: Bind specific ligands, transmit signals to intracellular targets.

Receptors are characterized by:-

1- Usually they are on the cell surface

2- Sometimes they are inside the cell

Extracellular signaling molecules bind to receptors are characterized by:

1- Most bind to receptors on the cell surface

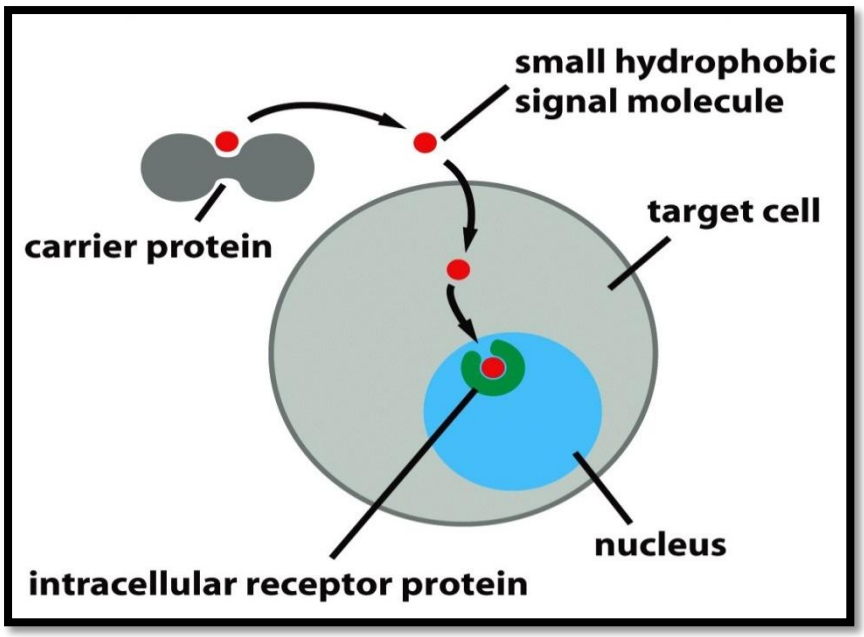
2- Some pass through membranes

3- There are different types of extracellular signaling molecules

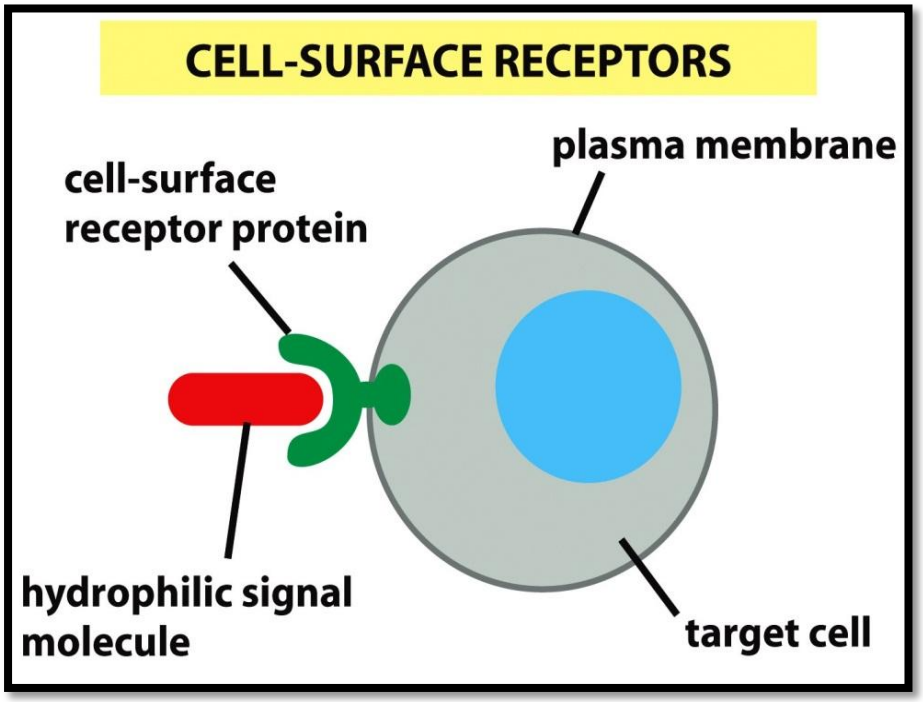
4- Most signaling molecules are secreted by exocytosis

5- Others diffuse through the membrane

6- Others remain bound to the surface.



Regardless of the nature of the signal, the target cell responds by means of a receptor protein, which specifically binds the signal molecule and initiates a response.



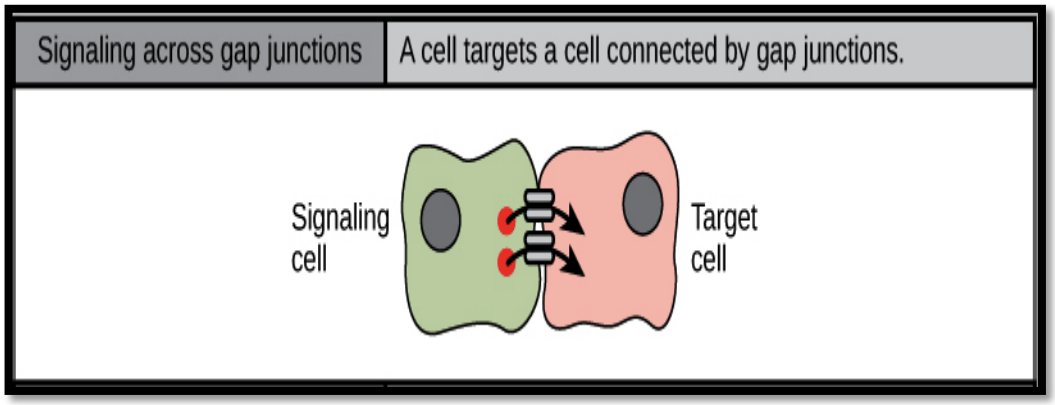
Major types of signaling

There are four types of extracellular signaling:

1- Adjacent or touch signaling

The signaling molecule could either be secreted from the signaling cell or it could stay tightly bound to the cell surface of the signaling cell.

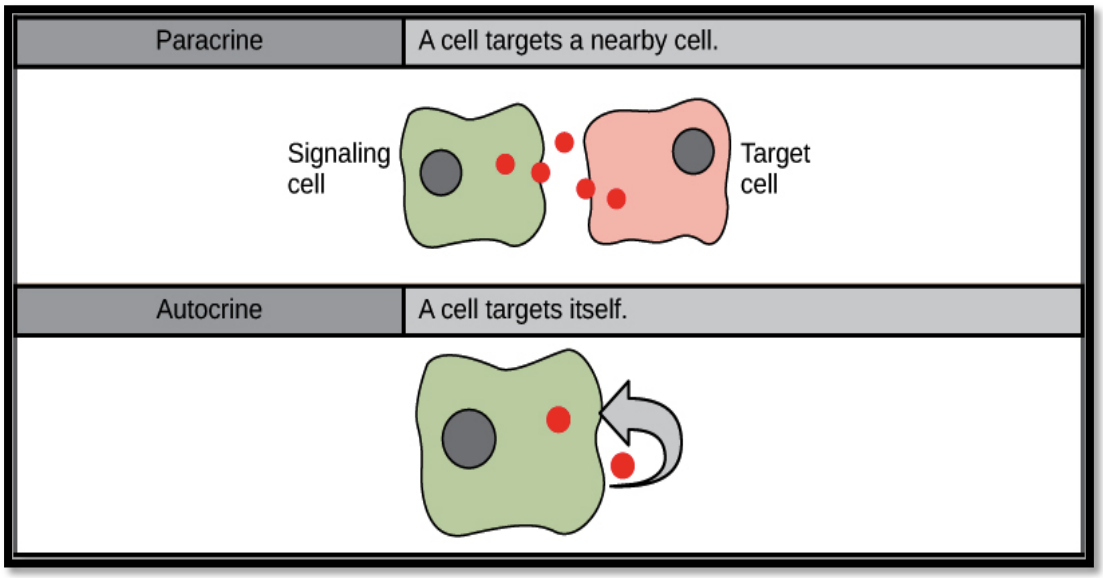
a-via protein in the plasma membrane, also called ***adjacent*** (touching) cells. These signals are transmitted along cell membranes via protein or lipid components integral. Gap junctions in animals are tiny channels that directly connect neighboring cells. These water-filled channels allow small signaling molecules, called ***intracellular mediators***, to diffuse between the two cells. Small molecules, such as calcium ions are able to move between cells, but large molecules like proteins and DNA cannot fit through the channels without special assistance



Cells connected by gap junctions can share small signaling molecules, which is important in cellular development, and in cardiac muscle contractions mode.

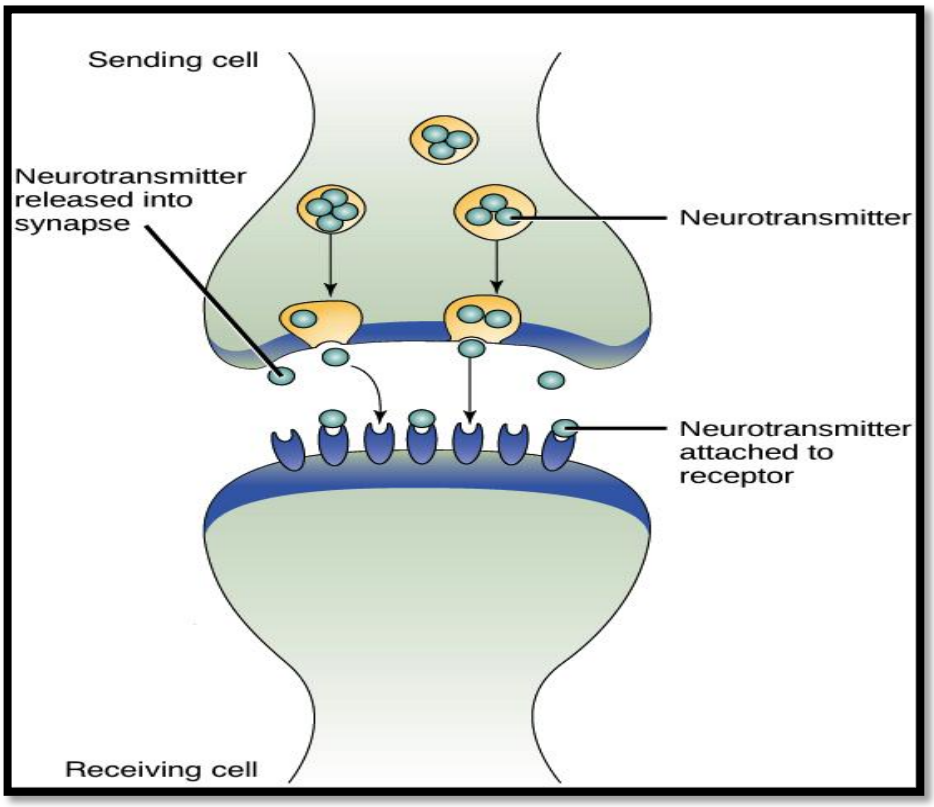
b-Autocrine signaling- via growth factors, cell that releases the signal is also the target. Autocrine cells can target cells close by if they are the same type of cell as the emitting cell, like immune cells. Cellular self-signaling(response of the immune system to foreign antigens and cancer cells).

2- ***Paracrine signaling*** - via neurotransmitters substances and cytokines, action on adjacent target cells. The target cell found in the same tissue, and messenger molecules carried across extra-cellular matrix or through extra-cellular fluid.



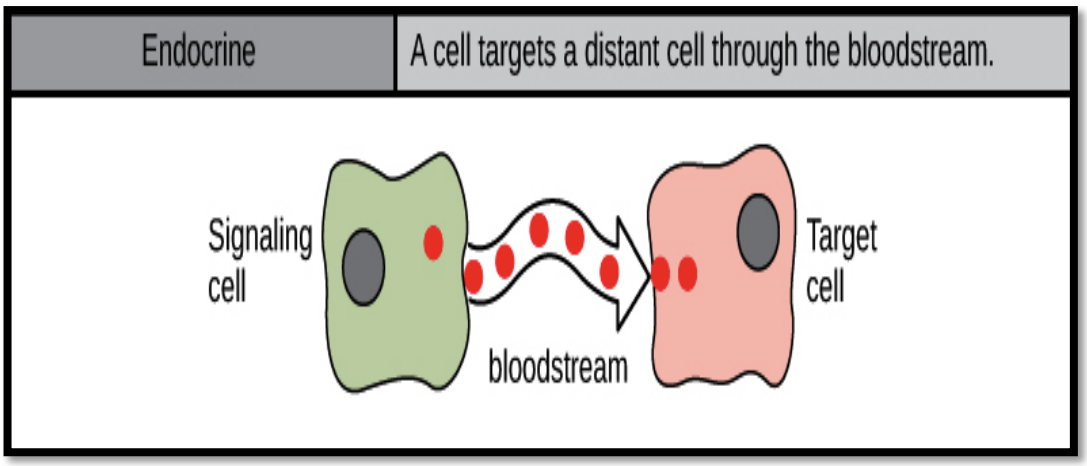
3- ***Synaptic signaling***

Is similar to paracrine signaling but there is a special structure called the synapse between the cell originating and the cell receiving the signal. Synaptic signaling only occurs between cells with the synapse; for example between a neuron and the muscle that is controlled by neural activity. When the impulse reaches the synapse, it triggers the release of ligands called **neurotransmitters**, which quickly cross the small gap between the nerve cells. When the neurotransmitters arrive at the receiving cell, they bind to receptors and cause a chemical change inside of the cell (often, opening ion channels and changing the electrical potential across the membrane).



4- ***Endocrine signaling***

In long-distance endocrine signaling, signals are produced by specialized cells and released into the bloodstream, which carries them to target cells in distant parts of the body. Signals that are produced in one part of the body and travel through the circulation to reach far-away targets are known as hormones. For example, the pituitary releases growth hormone (GH), which promotes growth, particularly of the skeleton and cartilage. Like most hormones, GH affects many different types of cells throughout the body. However, cartilage cells provide one example of how GH functions: it binds to receptors on the surface of these cells and encourages them to divide.



Signaling factors

Different types of signals can trigger different effects in a given cell, such as:

1- Differentiation

2- Proliferation

3- Survival

4- Specific cellular functions

And different cells may respond differently to the same signal, which depends on:

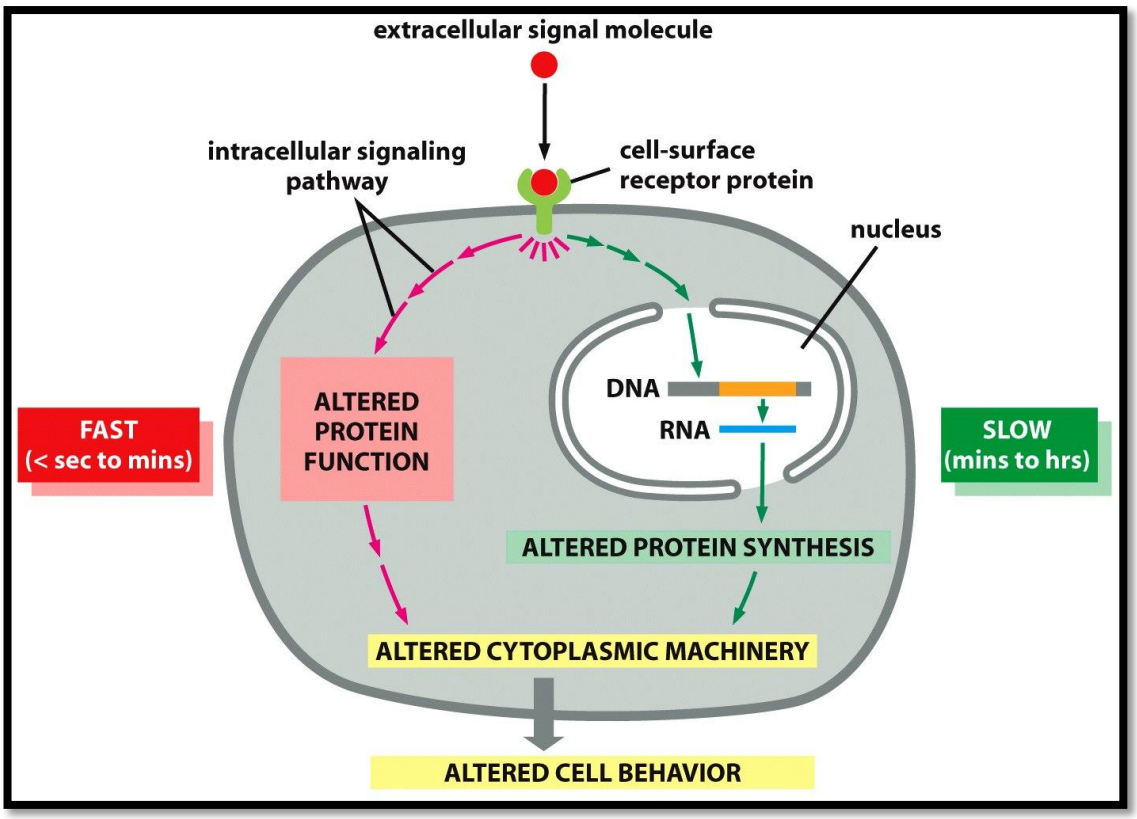
1- Response depends on cell surface receptor

2- Response depends on the environment

3- Intracellular machinery

Example - acetylcholine (a neurotransmitter)

Extracellular signals can act slowly or rapidly to change the behavior of a target cell.



Signaling via intracellular receptors

The signals (ligands) are usually small hydrophobic molecules bind internal receptors, which have many types, cortisol, steroid sex hormones, vitamin D, thyroid hormone, and retinoid . Their receptors in the cytosol (cortisol), DNA (steroids), and nucleus like retinoid.

There are three major classes of cell surface receptors:

1- ***ion channel-linked receptors*** (transmitter gated channels)

2- ***G protein linked receptors*** (the largest family)

The receptor is linked to a trimeric G protein, a ligand binding leads to activation of the G protein which can lead to activation

3- ***Enzyme linked receptors***

The receptors can have enzyme activity themselves, or receptors can be linked to an enzyme and often the enzyme activity is a protein kinase.