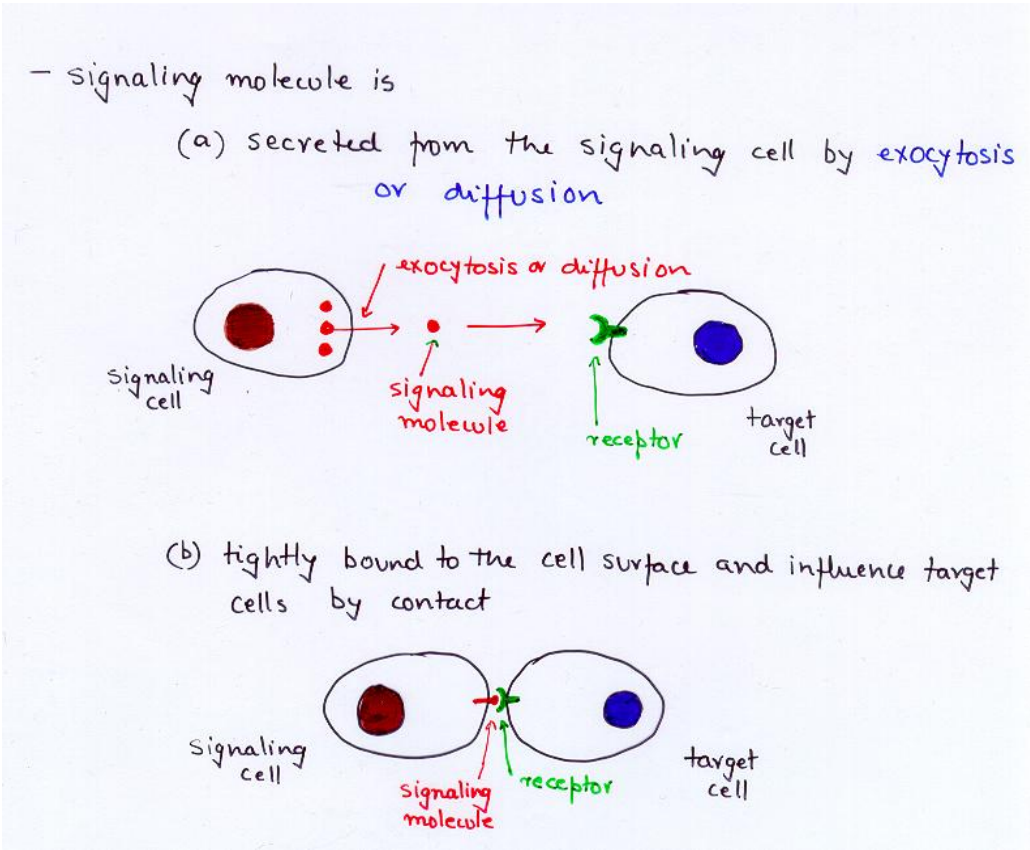
Cellular determination, differentiation & Specialization

Dr. Emad AL-Radhi

PhD. Molecular Cytology

Definition

As the cells continue to divide and develop, their developmental potential begins to decrease and eventually their fate becomes fully determined in a process called ***cell determination***. Cell determination refers to the process by which a given cell chooses a given specific developmental pathway. This means that its cell fate is determined and it will follow a specific set of steps to eventually cell type. These specific set of precursors that are followed by the determined cells to form the specific type of cells (e.g. neuron, skeletal muscle , etc.) is called ***Cell differentiation***. In most cases, cellular determination is due to induction signaling between cells in inductive signaling, one cell produce a ligand (an inducing agent) that then goes onto second cell and stimulates it to follow a specific development pathway.



Types of inductive signaling mechanisms

There are **three** different mechanisms by which inductive signaling can take place:

1-Diffusion: In the first mechanism, a diffusible signal (ligand) is sent through the extracellular space, and is received by a cell-surface receptor, which further transmits the signals by way of second messengers.

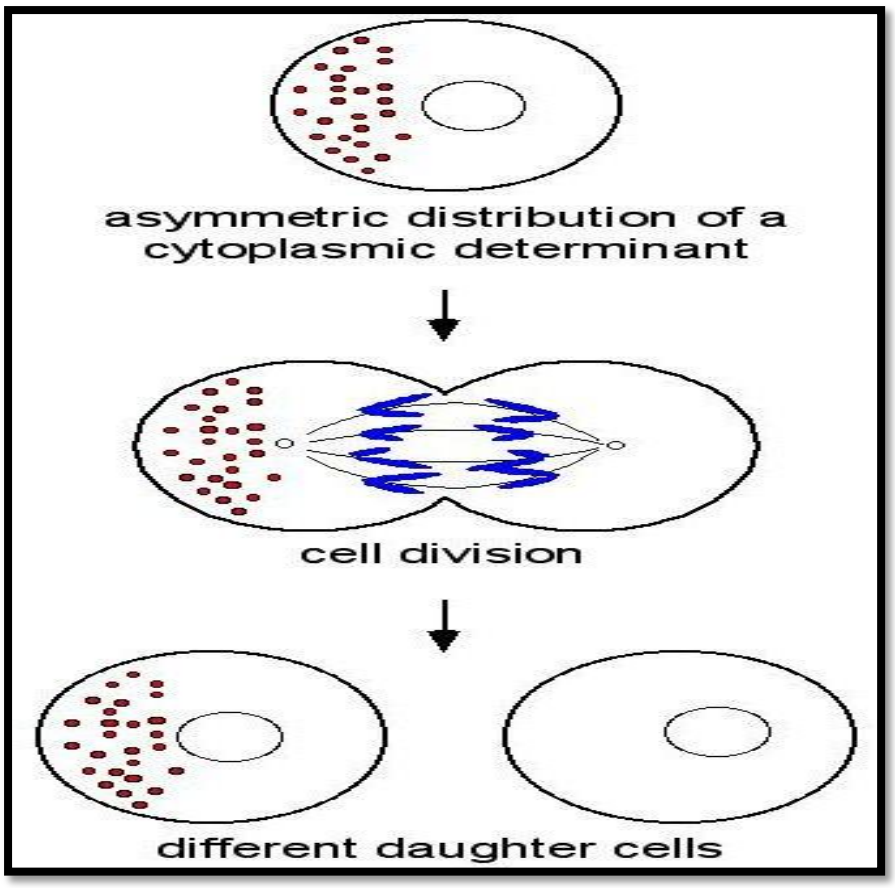
2-Directly contact each other through transmembrane proteins located on their surfaces.

3-Cytoplasm of two cells is connected through gap junctions, allowing the signal to pass directly from one cell to another cell.

cell determination

In some cases, determination results from the asymmetric segregation of cellular determinants. However, in most cases, determination is the result of inductive signaling between cells.

Asymmetric segregation of cellular determinants is based on the asymmetric localization of cytoplasmic molecules (usually proteins or mRNAs) within a cell before it divides. During cell division, one daughter cell receives most or all of the localized molecules, while the other daughter cell receives less (or none) of these molecules. This result in two different daughter cells, which then take on different cell fates based on differences in gene expression. The localized cytoplasmic determinants are often mRNAs encoding transcription factors, or the transcription factors themselves.



Cell differentiation

Is a process by which an undifferentiated cell reaches its specialized function. It is stable and most differentiated cells cannot transform into other cell types it can happen during regeneration. It is usually occurs during histogenesis.

Differentiation dramatically changes a cell's size, shape, membrane potential, metabolic activity, and responsiveness to signals.

Differentiated cells are produced by two methods:

1- Some differentiated cells divide- in **hepatic cells**.

1- Other differentiated cells arise from a pool of **undifferentiated stem cells.**

A complex organism requires two hundreds of different cell types to form structures and carry out specific functions. For example, red blood cells are required to carry oxygen, muscle cells are required for movement, neurons are required to receive and transmit nerve signals. Red blood cells do not express the myosin gene and muscle cells do not express globin genes, these different cell types follow different differentiation programmers.

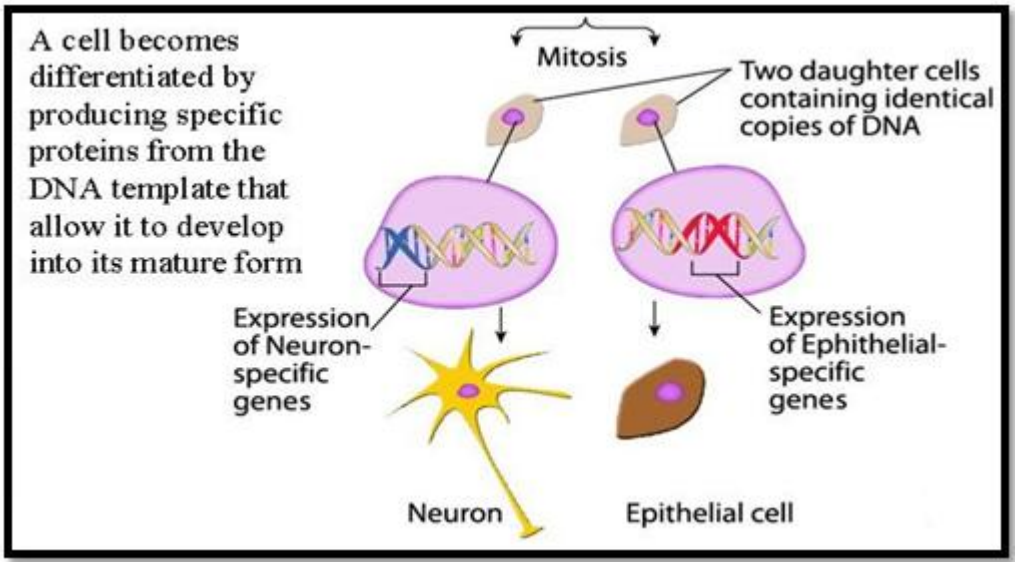
Differential gene expression

Definition

The ability of a given unspecialized cell to express different genes and therefore produce different proteins and structures found within that final specialized cell.

Differential gene expression allows two identical unspecialized cells to follow two different pathways and produce two different cells. These changes are largely due to highly-controlled modifications in gene expression.

Specific regulatory genes are expressed within different differentiating cells that control gene expression thereby assuring that one array of genes is expressed by one kind of cell (e.g., muscle cell) whereas a different array of genes is expressed by a different kind of cell (e.g. adipose cell).



Human body cells arise from a single fertilized egg cell and all contain the same DNA in their nuclei, dividing cells takes different genes expression and regulators with different determined pathways to give a different specialized cells.