



DSE-1BT: Developmental aspects of embryo

Gastrulation:

❖ Determination in developmental biology

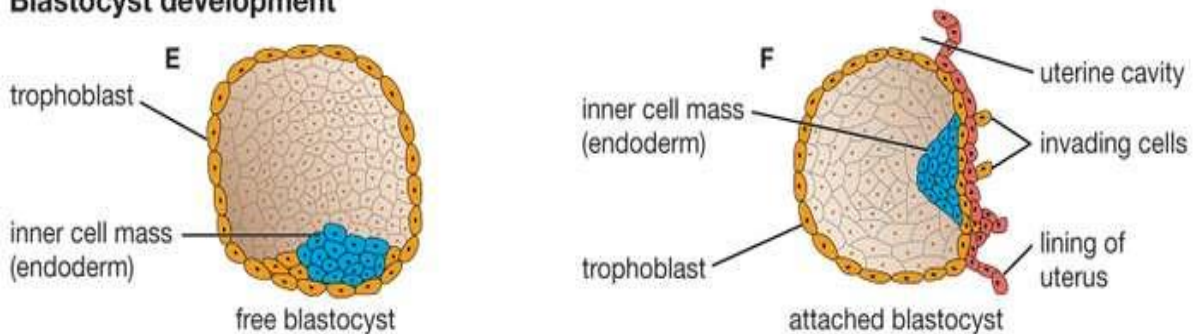
The determination of different cell types (cell fates) involves progressive restrictions in their developmental potentials. When a cell “chooses” a particular fate, it is said to be determined, although it still “looks” just like its undetermined neighbors. Determination implies a stable change - the fate of determined cells does not change.

During the development of an embryo, it is not sufficient for all the cell types found in the fully developed individual simply to be created. Each cell type must form in the right place at the right time and in the correct proportion; otherwise, there would be a jumble of randomly assorted cells in no way resembling an organism. The orderly development of an organism depends on a process called cell determination, in which initially identical cells become committed to different pathways of development. A fundamental part of cell determination is the ability of cells to detect different chemicals within different regions of the embryo. The chemical signals detected by one cell may be different from the signals detected by its neighbour cells. The signals that a cell detects activate a set of genes that tell the cell to differentiate in ways appropriate for its position within the embryo. The set of genes activated in one cell differs from the set of genes activated in the cells around it. The process of cell determination requires an elaborate system of cell-to-cell communication in early embryos.

Cleavage of ovum



Blastocyst development



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Figure: The ovum contains a small collection of cells in the early stages of human development. As cells divide (A–D), they are separated into different regions of the ovum. Each region of the ovum transmits a unique set of chemical signals to nearby cells. Thus, the signals detected by one cell differ from those detected by its neighbour cells. In this process, known as cell determination, cells are individually programmed to direct them toward development into different cell types.

❖ Differentiation in developmental biology

Differentiation follows determination, as the cell elaborates a cell-specific developmental program. Differentiation results in the presence of cell types that have clear-cut identities, such as muscle cells, nerve cells, and skin cells.

Cellular differentiation is the process in which a cell changes from one cell type to another. Usually, the cell changes to a more specialized type. Differentiation occurs numerous times during the development of a multicellular organism as it changes from a simple zygote to a complex system of tissues and cell types. Differentiation continues in adulthood as adult stem cells divide and create fully differentiated daughter cells during tissue repair and during normal cell turnover. Some differentiation occurs in response

to antigen exposure. Differentiation dramatically changes a cell's size, shape, membrane potential, metabolic activity, and responsiveness to signals. These changes are largely due to highly controlled modifications in gene expression and are the study of epigenetics.

Among dividing cells, there are multiple levels of cell potency, the cell's ability to differentiate into other cell types. A greater potency indicates a larger number of cell types that can be derived. A cell that can differentiate into all cell types, including the placental tissue, is known as *totipotent*. In mammals, only the zygote and subsequent blastomeres are totipotent, A cell that can differentiate into all cell types of the adult organism is known as *pluripotent*. Embryonic stem cells in animals are the example of *pluripotent*.

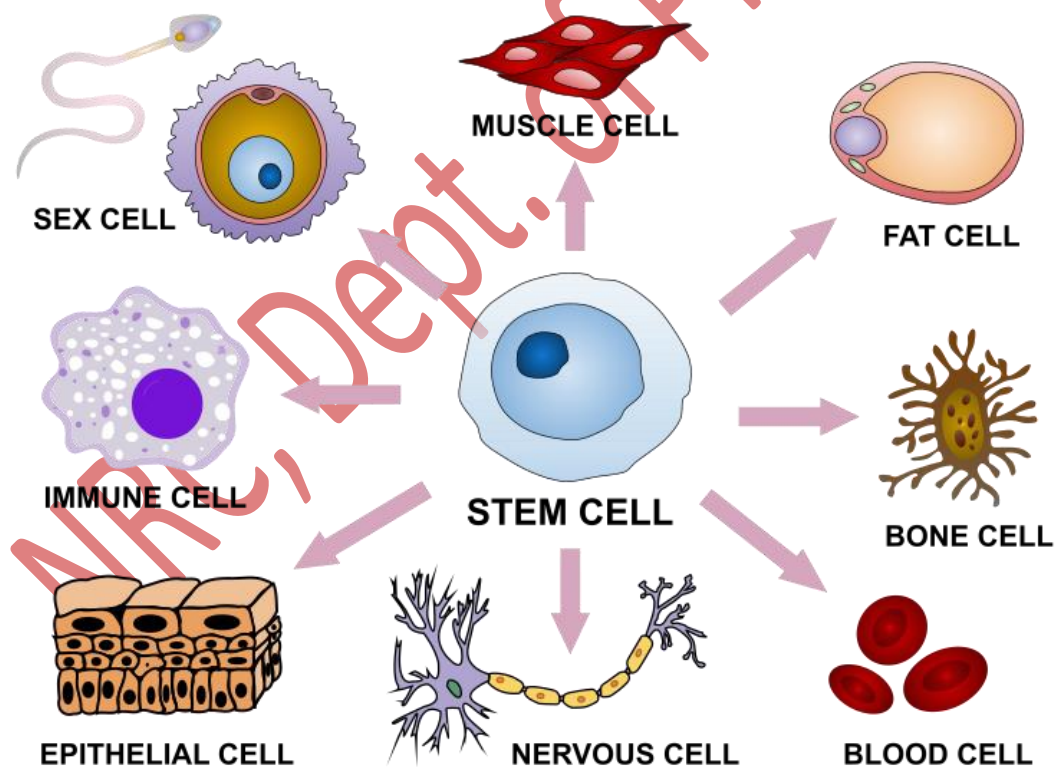


Figure: Stem cell differentiation into various types of tissues