



Faculty of Medicine
Histology Department



STEM CELLS & TISSUE RENEWAL

Lecture 20

In

Block 102PMS

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Learning objectives (2nd week/Lecture 10)

After this lecture, students should be able to:

- Define stem cells.
- Recognize the progenitor cells.
- Identify types of stem cells.
- Determine the tissue's potential to regeneration.
- List the tissues with rapidly renewing cell populations.
- Identify the tissues with stable cell populations.
- Define the terminally differentiated cells.

Definition of stem cells:

Stem cells are undifferentiated cells that can differentiate into specialized cells and can divide (through mitosis) to produce more stem cells. Their progenitors would either remain as stem cells or differentiate to be specialized cells.

Types of stem cells:

1- Embryonic stem cells: which are isolated from the inner cell mass of blastocysts. They are pluripotent cells (able to differentiate to all derivatives of the three germ layers: (ectoderm, endoderm, and mesoderm)).

In a developing embryo:

Stem cells can differentiate into all the specialized cells—ectoderm, endoderm and mesoderm but also maintain the normal turnover of regenerative organs, such as blood, skin, or intestinal tissues.

Their clinical use is limited (due to ethical considerations and their liability to form teratomas).

2- Adult stem cells: which are found in various tissues. In adult, stem cells and progenitor cells act as a repair system for the body, replenishing adult tissues.

- They are subdivided into 2 main categories:

A. Hemopoietic stem cells :

They are mainly found in the bone marrow

They are able to differentiate to the different types of blood cells.

B. Mesenchymal stem cells:

➤ They are multipotent cells (can be differentiate into fat cells, muscle cells, cartilage cells, bone cells etc.) according to their surrounding microenvironment.

➤ They are found in the bone marrow, adipose tissue and other sites in the different organs.

➤ Used therapeutically in treating many diseases.
They are able to differentiate to the different types of blood cells.

3- Induced pluripotent stem cells (iPSCs)

These new types of cells are called induced pluripotent stem cells (iPSCs). They can differentiate into all types of specialized cells in the body. To create iPSCs, scientists genetically reprogram the adult stem cells, so they behave like embryonic stem cells.

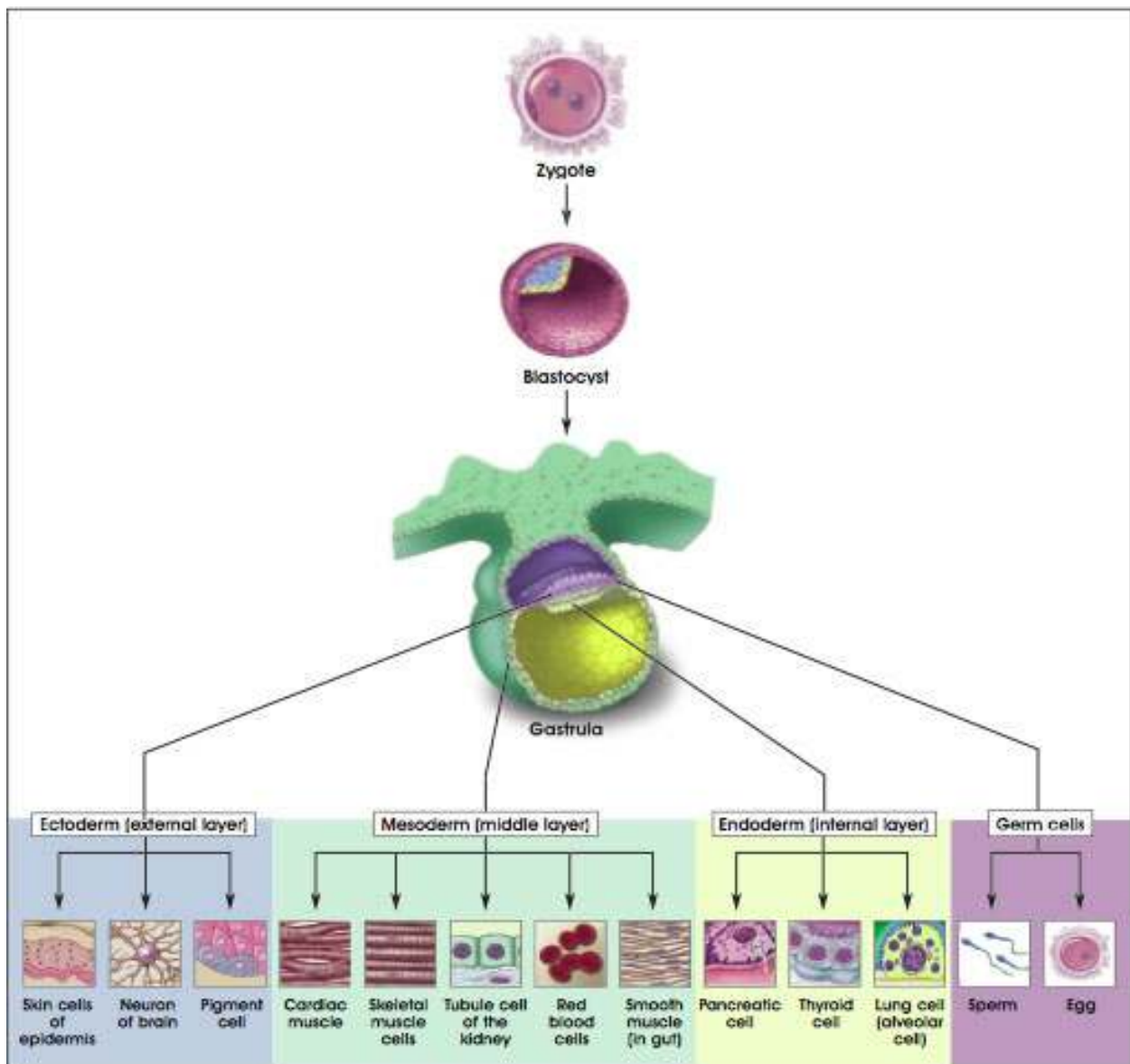
Sources of stem cells:

Stem cells of many tissues are found in specific locations where the microenvironment helps maintain their uniquely undifferentiated properties

- 1. Hematopoietic stem cells:** Obtained from umbilical cord blood (at birth).
- 2. Bone marrow:** Obtained by aspiration of marrow tissue (It contains hematopoietic and mesenchymal stem cells).
- 3. Fetal tissue:** Obtained after termination of pregnancy.
- 4. Adipose connective tissues.**
- 5. Adult tissues:** Such as brain, blood vessels, skin, liver and skeletal muscle.

Differentiation of stem cells is affected by:

- 1- Specific genes.
- 2- Certain molecules in the microenvironment surrounding them (i.e., cytokines secreted by other cells).
- 3- Physical contact with neighboring cells.



Characteristics of stem cells

- 1- Self-renewal:** the ability to go through numerous cycles of cell division while maintaining the undifferentiated state.
- 2- small population**
- 3- Many **stem cells** divide infrequently but the divisions are always asymmetric, that is, one daughter cell remains as a stem cell while the other becomes committed to a path that leads to differentiation.**
- 4- Potency:** the capacity to differentiate into specialized cell types.

Degrees of Potency:

- a. Totipotent or**

b pluripotent: able to give rise to any mature cell type.

c. Multipotent: can differentiate into a number of cell types of a closely related family of cells, e.g. hematopoietic stem cells.

d. Unipotent: cells can produce only one cell type, their own, but have the property of self-renewal.

5- Plasticity of stem cells:

Plasticity of stem cells means that the stem cells can be shifted from one line of differentiation to another, according to the nature of surrounding microenvironment.

Progenitor cells are daughter cells of stem cells

Characters of Progenitor Cells

1. more rapidly dividing progeny committed to differentiation
2. Have reduced potentiality (committed to a single-cell lineage).
3. Cells formed by progenitor cells may become terminally differentiated (meaning that renewed cycling cannot occur)

Clinical uses of mesenchymal stem cells

- Repair of localized tissue defects.
- Repair of ischemic tissue of heart and lower extremities
- Repair of non-healed fractures and bone defects.
- Repair of traumatic cartilage defects and osteoarthritis.
- Systemic cell transplantation for treatment of degenerative diseases.

Tissue regeneration or renewal

- It is the capacity for mitosis within a tissue, either by differentiated cells or by a reserve of stem cells.
- The cell turnover rate is rapid (**rapidly renewing cells**) in the epithelium lining the digestive tract, blood cells and skin cells.
- Stem cells are not readily apparent and differentiated cells appear to undergo slow and episodic division to maintain tissue integrity in (Stable cell populations) such as most connective tissues, smooth muscle,
- Some cells cannot divide nor regenerate as nerve cell and cardiac muscle (permanent cells).

- **Lecture References**

- Kaplan medical. USMLE Step 1 lecture notes 2020;7 book set pdf

- Pathology chapter (tissue repair page 1588

- Junqueira's Basic Histology (Text and Atlas) (2018) 15 th edition.

- Elsevier's Integrated Histology (2007) 1st Edition.

- **Self Assessment of Lecture 20**

- 1- Characters of stem cells include:

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- 2-Types of stem cells

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3- Uses of stem cell
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