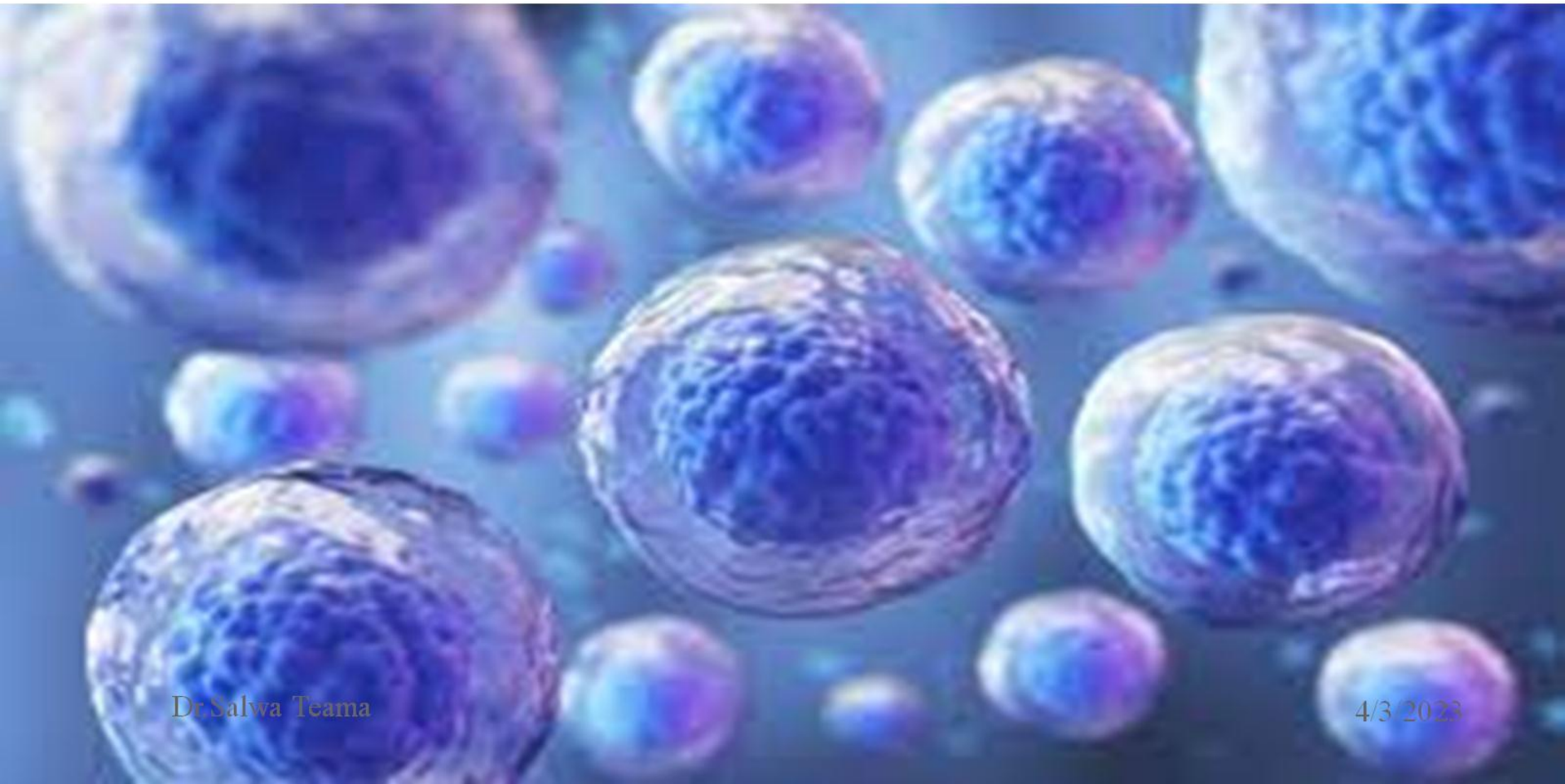


INTRODUCTION TO STEM CELLS

SALWA HASSAN TEAMA



STEM CELL

Stem cells; **Stem cells** are biological cells found in all multicellular organisms that can divide through mitosis and differentiate into various specialized cell types and can self-renew to produce more stem cells.

Stem cells that retain the ability to divide, generating both new cells either remain a stem cell or become another type of cell with a more specialized function e.g. muscle cell, blood cell, ..

Stem cells act as internal repair system renew tissues so that as the body grows or loses to apoptosis, injury and disease other cells arise to take their place.

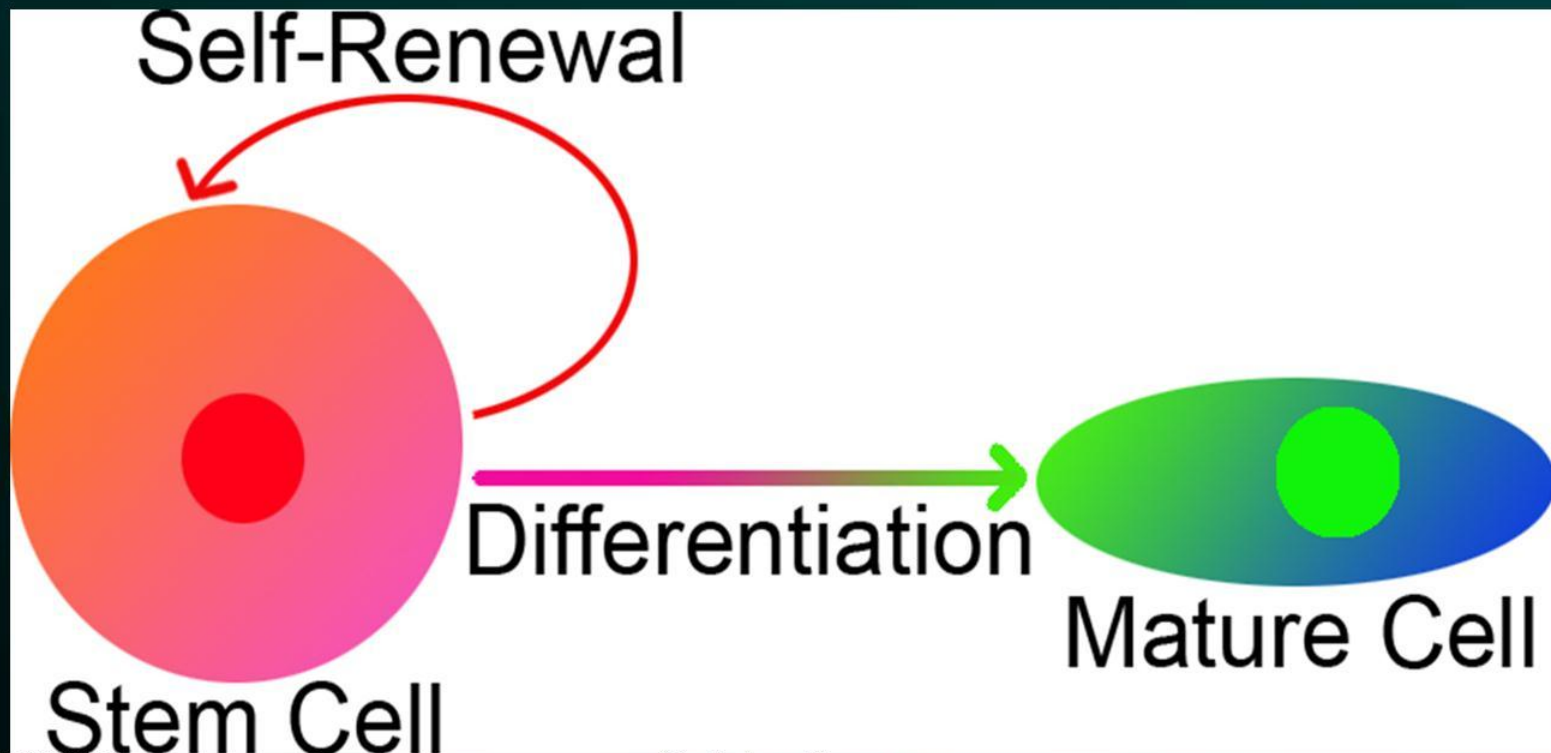
Types of Stem Cell

Embryonic stem cells that found in the inner cell mass of blastocysts, in a developing embryo, stem cells, can differentiate into all the specialized cells, but also maintain the normal turnover of regenerative organs, such as blood, skin, or intestinal tissues,....

Adult stem cells that are found in various tissues. In adult organisms, stem cells and progenitor cells act as a repair system for the body, replenished in adult tissues.

Self renewal

Differentiation



Cell Specialization: Cells is given and shaped with certain duties for a specific job. Mature cells are usually specialized.

Cellular differentiation is the normal consequence to reach cell specialization; it is the process by which a less specialized cell becomes a more specialized cell type. Differentiation dramatically changes a cell's size, shape, membrane potential, metabolic activity, and responsiveness to signals. These changes are due to highly-controlled mechanism in gene expression. With a few exceptions, cellular differentiation almost never involves a change in the DNA sequence itself. Thus, different cells can have very different physical characteristics despite having the same genome

Two mechanisms exist to ensure that the stem cell population is maintained (**Self-renewal**):

Obligatory asymmetric replication: a stem cell divides into one **parent cell** that is identical to the original stem cell, and another daughter cell that is differentiated.

Stochastic differentiation: when one stem cell develops into two differentiated daughter cells, another stem cell undergoes **mitosis** and produces two stem cells identical to the original.

POTENCY

Potency specifies the differentiation potential

The potential to differentiate into different cell types

- ❑ Totipotent Stem Cells
- ❑ Pluripotent Stem Cells
- ❑ Multipotent Stem Cells
- ❑ Oligopotent Stem Cells
- ❑ Unipotent Stem Cells

Totipotent stem cells can differentiate into embryonic and extraembryonic cell types, it can construct a viable organism. These cells are produced from the fusion of an egg and sperm cell. Cells produced by the first few divisions of the fertilized egg are also totipotent.

Pluripotent stem cells are the descendants of totipotent cells and can differentiate into nearly all cells; i.e. cells derived from any of the three germ layers.

Multipotent adult stem cells and umbilical cord stem cells

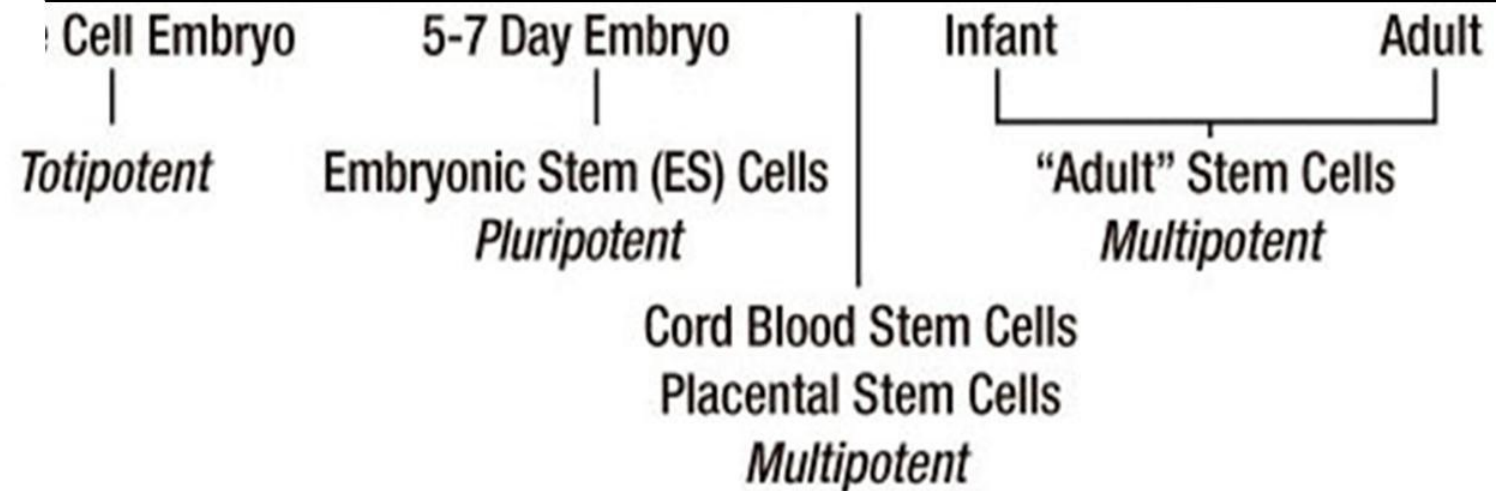
Oligopotent stem cells can differentiate into only a few cells, such as lymphoid or myeloid stem cells.

Unipotent cells can produce only one cell type, but have the property of selfrenewal which distinguishes them from nonstem cells.

POTENCY

Potency specifies the differentiation potential (the potential to differentiate into different cell types) of the stem cell.

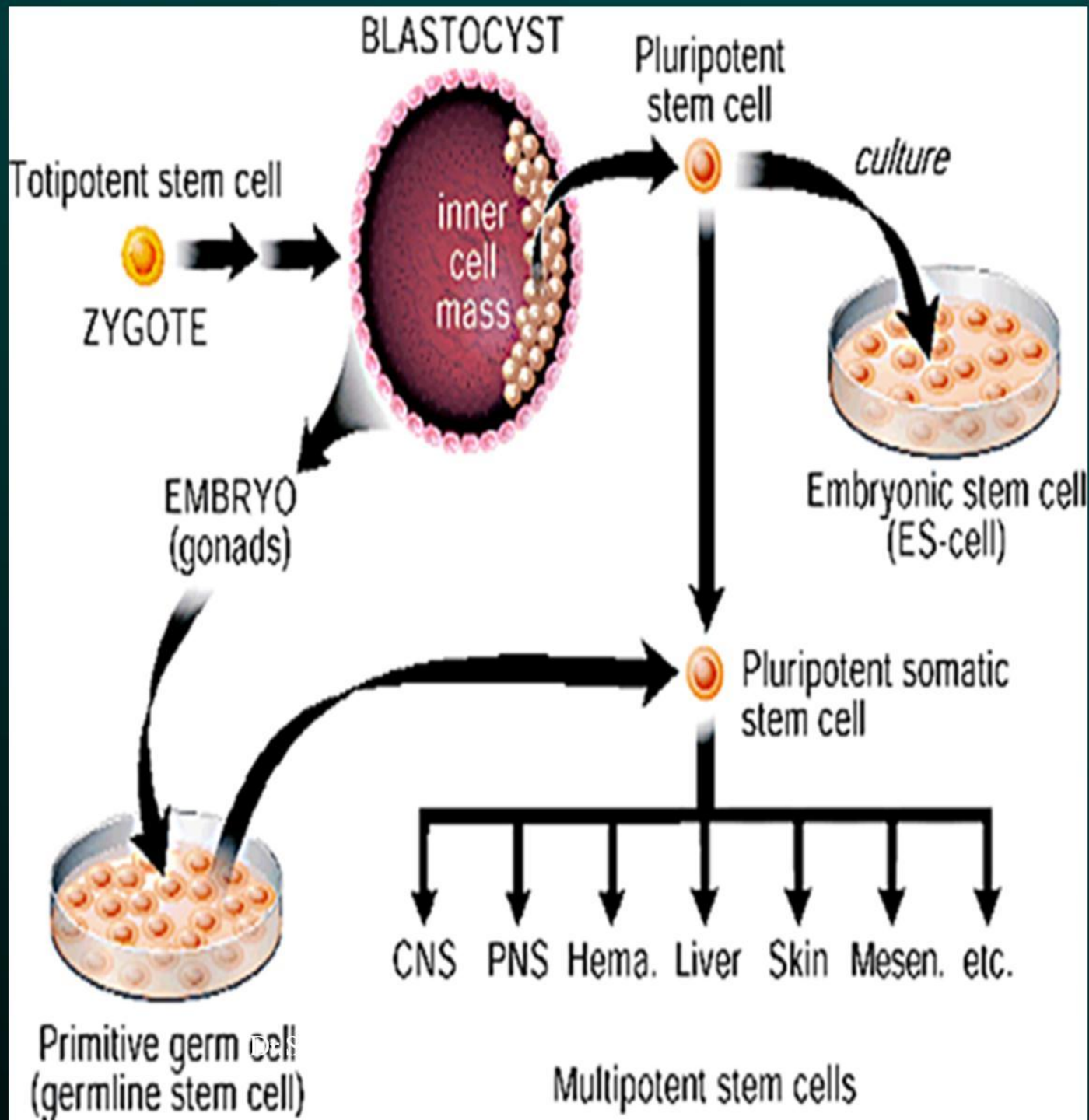
- ❑ Totipotent Stem Cells
- ❑ Pluripotent Stem Cells
- ❑ Multipotent Stem Cells
- ❑ Mesenchymal stem cells
- ❑ Oligopotent Stem Cells



TOTIPOTENT STEM CELLS

Totipotent stem cells have the ability to differentiate into any type of cell in the body.

Totipotent stem cells develop during sexual reproduction when male and female gametes fuse during fertilization to form a zygote, as the zygote continues to divide and mature, its cells develop into more specialized cells called pluripotent stem cells.



PLURIPOTENT STEM CELLS

Pluripotent stem cells have the ability to differentiate into several different types of cells.

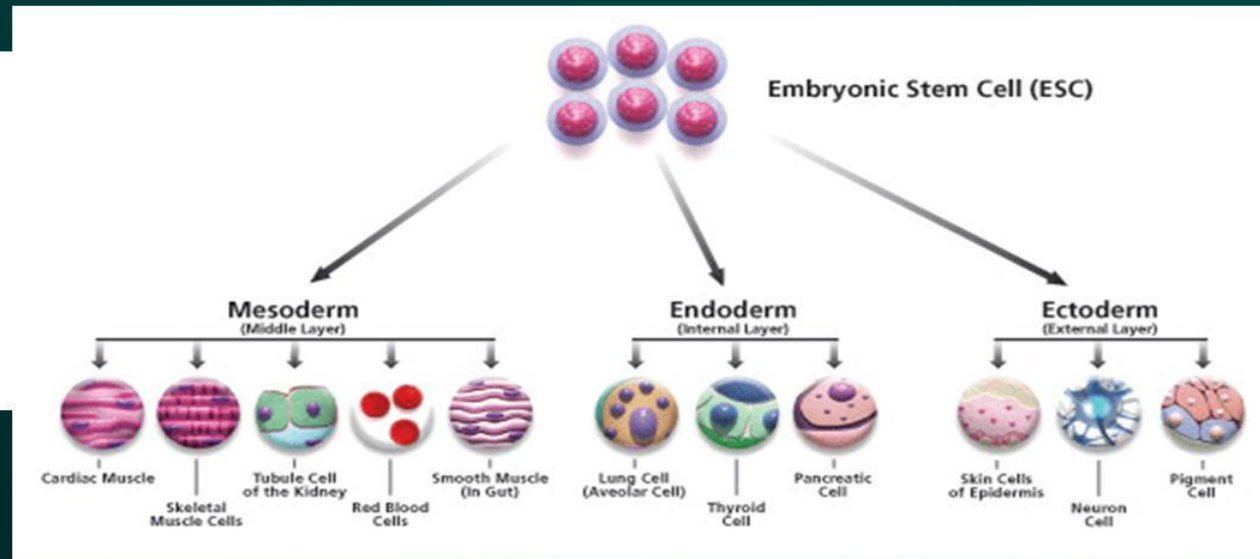
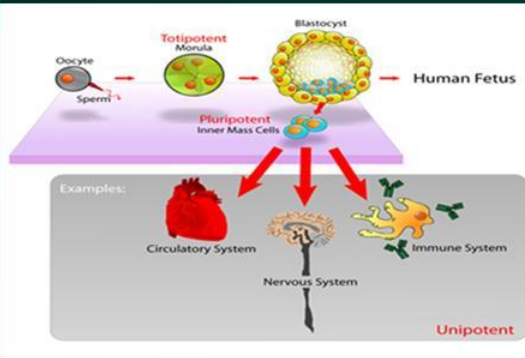
Pluripotent stem cells; Specialization is minimal and therefore they can develop into nearly any type of cell. e.g. Embryonic stem cells and Fetal stem cells.

EMBRYONIC STEM CELLS

Embryonic stem cells are derived from the **inner cell mass** of the blastocyst at a stage before it would implant in the uterine wall. They are characterized by their ability to differentiate into all derivative cells types of the three primary germ layers, equating to over 200 different cell types in an adult human; These include the muscle cells (gut and cardiac) of the **mesoderm**, lung and pancreatic cells of the **endoderm**, and neuronal and epidermal cells of the **ectoderm**.

Embryonic stem cells; Derived from embryo that develop from eggs that have been fertilized in vitro- in an in vitro fertilization clinic and donated for research purposes with informed consent of the donors. They are not derived from eggs fertilized in a women body.

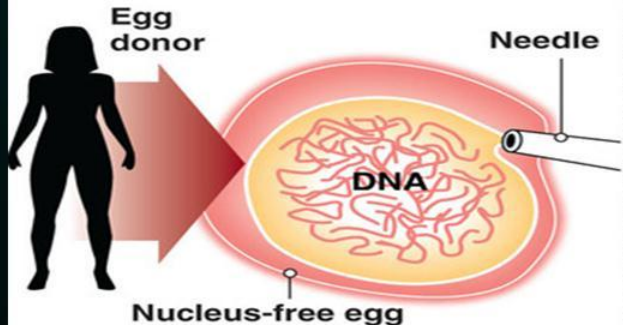
Embryonic stem cell can self-replicate and is **pluripotent**, it can give rise to cells derived from all three germ layers. 4/3/2023 Dr.Salwa Teama



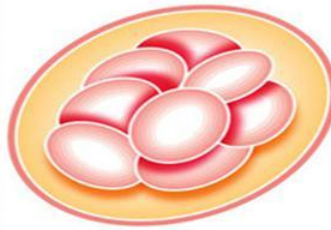
Making embryonic stem cells

Derived from eggs fertilized at an in vitro fertilization clinic, then donated for research purposes.

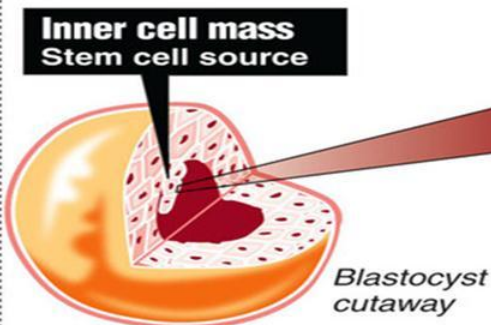
- 1** DNA from adult cell injected into fertilized human egg with no nucleus



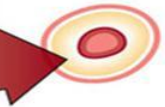
- 2** Egg begins dividing, forming a mass of cells



- 3** After five days it forms a blastocyst, a hollow embryonic ball of cells



- 4** Stem cells are harvested, embryo destroyed



MULTIPOTENT STEM CELLS

Multipotent stem cells have the ability to differentiate into a limited number of specialized cell types.

Multipotent stem cells typically develop into any cell of a particular group or type. e.g. Adult stem cells and umbilical cord stem cells

Mesenchymal stem cells are multipotent cells of bone marrow that have the ability to differentiate into several types of specialized cells related to, but not including blood cells. These stem cells give rise to cells that form specialized connective tissues, as well as cells that support the formation of blood.

Adult Stem Cells

Adult Stem Cells; Undifferentiated cells, found among differentiated cells in a tissue or organ that can renew itself and can differentiate to yield some or all of the major specialized cell types of the tissue or organ. The primary role to maintain and repair tissue in which they are found.

Adult Stem Cells; Identified in many organs and tissues, including brain, bone marrow, peripheral blood, blood vessels, skeletal muscle, skin, teeth, heart, gut, liver, ovarian epithelium and testis. Reside in a specific area of each tissue (stem cell niche). May remain quiescent for long time until needed. Found in small number in each tissue, once removed from body capacity to divide is limited, making generation of large quantities is difficult.

Bone Marrow

Adult Stem Cells

Brain



Marrow
Bone
Cartilage
Tendon
Muscle
Fat
Liver
Brain/Nerve
Blood cells
Heart
All Tissues

Peripheral Blood



Bone Marrow
Blood cells
Nerves

Skeletal Muscle



Skeletal muscle
Smooth muscle
Bone
Cartilage
Fat
Heart



Brain
Nerves
Blood cells
Muscle
All Tissues

Hair Follicle



Skin Brain
Smooth Muscle Fat

Gastrointestinal



Esophagus Small Intestine
Stomach Large Intestine/Colon

Placenta



Bone Nerve
Cartilage Muscle Tendon
Bone Marrow Blood vessel

Stem Cells from Fat



Bone
Cartilage
Muscle
Nerves

Umbilical Cord Matrix

CORD BLOOD



Various Tissues

Adult Stem Cell Differentiation

Availability to divide for a long period, when needed and give rise to mature cell types that have characteristic shapes and specialized structure and function of a particular tissue:

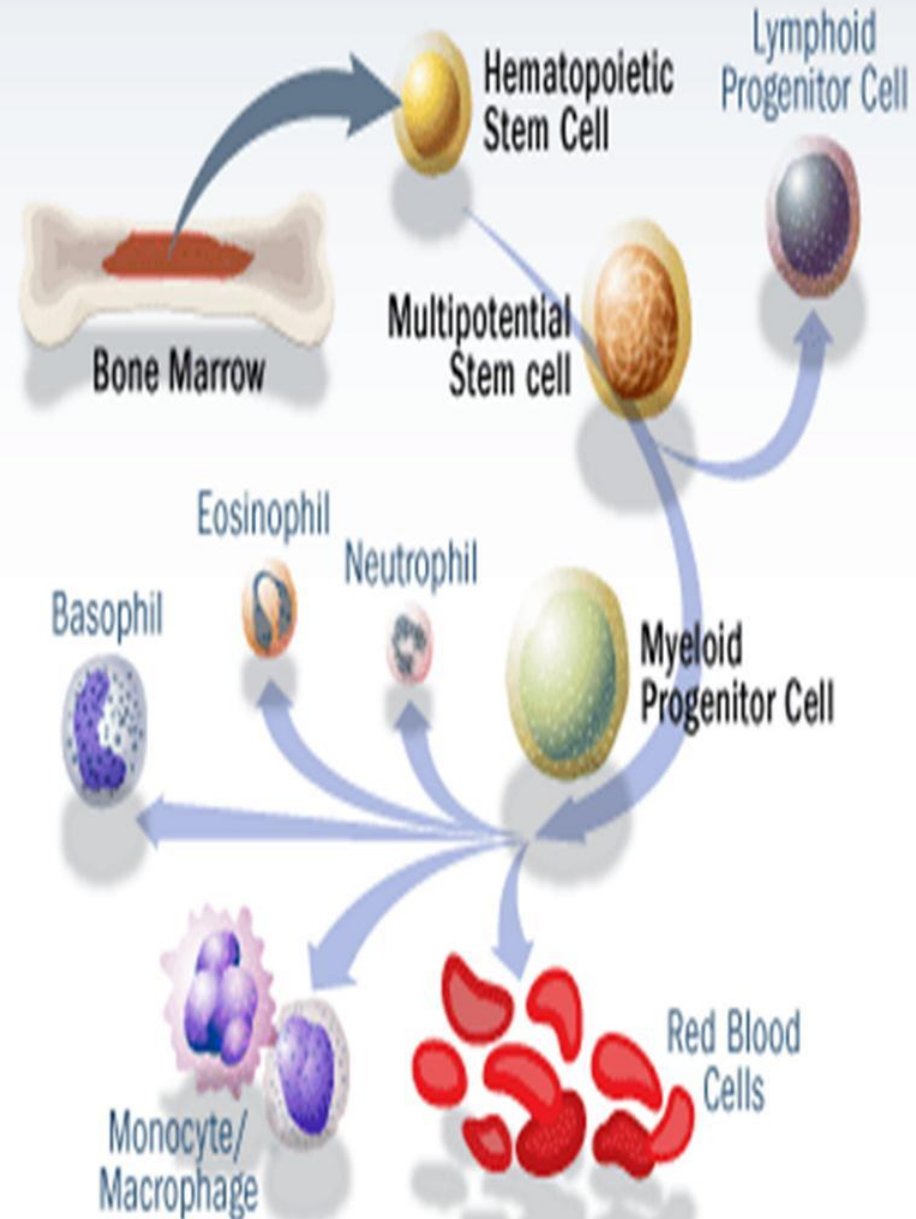
- Hematopoietic stem cell
- Mesenchymal stem cell
- Neural stem cell
- Epithelial stem cell
- Skin stem cell

4/3/2023

Dr.Salwa Teama

Hematopoietic Stem Cells

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OLIGOPOTENT STEM CELLS

These stem cells have the ability to differentiate into just a few types of cells. e.g. lymphoid stem cell can not develop into any type of blood cell as bone marrow stem cells can. They only give rise to blood cells of the lymphatic system, such as T cells.

Unipotent Stem Cells

Unipotent stem cells have unlimited reproductive capabilities, but can only differentiate into a single type of cell or tissue.

Unipotent stem cells are derived from multipotent stem cells and formed in adult tissue. e.g. Skin cells; these cells must readily undergo cell division to replace damaged cells.

Induced pluripotent stem cells (iPS cells)

Adult cells genetically reprogrammed to an embryonic stem cells. Useful tool for drug development and therapeutic.

	Embryonic Stem Cells	Adult Stem Cells	iPS Cells
Found in the Adult Body	No	Yes	No
Able to Self-Renew	Yes	Yes	Yes
Able to Differentiate	Yes	Yes	Yes
Provokes Immune Response	Yes	No	No
Origin	ICM of the blastocyst	Unknown	Differentiated cells in the body
Location	ICM of the blastocyst	Differentiated tissues in the body	N/A
Differentiation Potential	Pluripotent	Multipotent	Pluripotent
Function	Provides the cell source to form cells of the three germs layers during embryo development	Responsible for tissue replacement and repair throughout life	Creation of patient-specific pluripotent stem cells for potential use in regenerative medicine

A bouquet of red roses with green leaves and a red ribbon, set against a dark background with water droplets.

THANK YOU

4/3/2023