

FREQUENTLY ASKED QUESTIONS ON STEM CELLS AND THEIR CLINICAL APPLICATIONS/THERAPY

Basics of Stem Cells

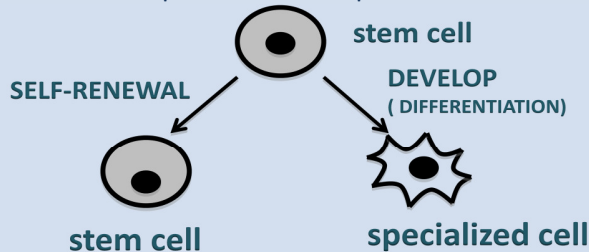
1) What is a cell?

- Cell is the building block of our body. It is the smallest structural and functional unit of the body.
- There are different types of specialized cells that perform different functions.
- Humans have an estimated 100,000,000,000,000 (one hundred trillion) cells and more than 200 different types of cells (liver cells, skin cells, muscle cells, etc.).

2) What is stem cell?

A stem cell is a naïve/immature/unspecialized cell that can

- divide to form similar cells (self renewal) and
- develop into different specialized cells that perform distinct function



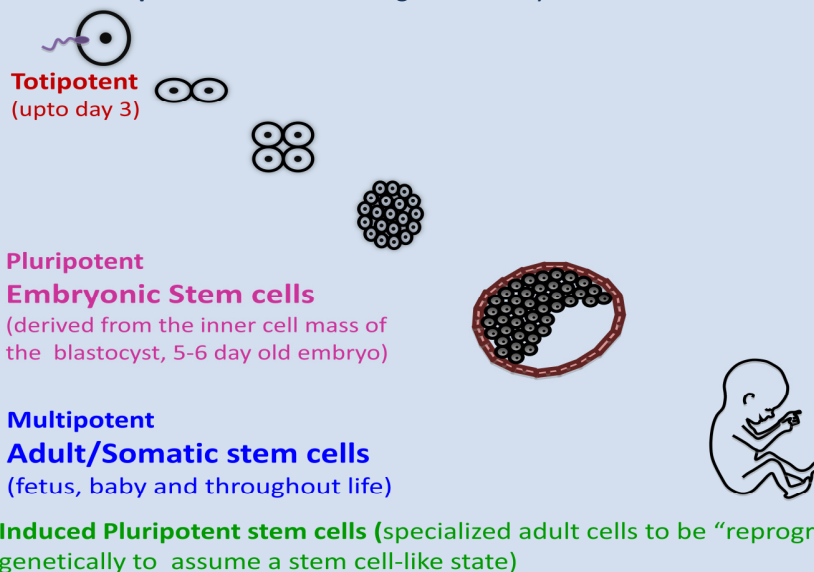
3) Are all the stem cells same? What are the different types of stem cells?

No, all the stem cells are not same. There are many different types of stem cells that come from different places in the body or are formed at different times in our lives. These include

- **Embryonic stem cells (ESCs)** which exist only at the earliest stages of development
- **Adult stem cells** also called somatic stem cells that appear during fetal development and are present in different tissues of our bodies throughout life.
- **Induced pluripotent stem cells or iPSCs** cells are not found in the body but engineered in laboratory from cells of the body, such as those from the skin. The iPSC cells have properties similar to those of embryonic stem cells.

Depending on their ability (potency) to develop into different specialized cells, stem cells can be

- **Totipotent stem cells**- These cells can form all cells of the body including the ones in the extra embryonic membranes (placenta). In humans, the 2 cell staged zygote is totipotent.
- **Pluripotent stem cells** – These stem cells can become virtually any cell in the body except those needed to support and develop a fetus in the womb. ESCs and iPSCs are pluripotent stem cells.
- **Multipotent stem cells** can give rise only to a small number of different cell types



4) What are embryonic stem cells (ESCs)? What is the source of embryos to create ESCs?

- ESCs are pluripotent stem cells that can renew themselves and become virtually any cell in the body except those needed to support and develop a fetus in the womb.

- Eggs fertilized by sperm begin to divide into multiple cells, but do not begin to form organs and tissues for at least two weeks. During this early developmental period, the cells that will ultimately give rise to the developing fetus can be encouraged to grow indefinitely in the laboratory as *stem cells* that are not committed to any particular tissue.
- Human ESCs are derived from the embryos that are 5-6 days old. At this stage, the embryo is a ball of approximately 100 cells called a blastocyst, and is no bigger than a grain of sand. Human embryonic stem cells were isolated in 1998.

Embryos used to generate human ESCs come from several sources:

- ESCs can be derived from donated embryos left after *in vitro* fertilization (IVF).
- IVF embryos analyzed by preimplantation genetic diagnosis can also be used to generate ESCs. An alteration of this technique allows generation of ESCs from single cells removed from embryos in a process similar to preimplantation genetic testing.
- ESCs can be derived from eggs that have been parthenogenetically activated; that is, the eggs are induced to divide without being fertilized by sperm. This new category has received less public debate because it is less common and less well understood.
- Somatic cell nuclear transfer (SCNT) can be used to produce embryos from somatic or adult cells using donated enucleated eggs, and then ESCs can be generated from the resulting embryos.

5) **What are adult stem cells?**

- Adult stem cells or somatic stem cells or tissue specific stem cells- are the reserve supply of cells that can multiply when needed for repair of adult organs and tissues.
- These cells are present in our body in almost all the organs.
- They are multipotent i.e. they can give rise to a limited number of mature cell types, usually corresponding to the tissues in which they reside. Most common example is the blood forming (hematopoietic) stem cells from bone marrow that give rise to the different blood cells in our body.
- Some tissue-specific stem cells can only give rise to one or two mature cell types and are called unipotent and bipotent, respectively. Stem cells found in the skin produce new skin cells, and are example of unipotent stem cells.

6) **What are induced pluripotent stem cells (iPSCs)?**

- These cells are not found in the body but made in laboratory from cells of the body, such as those from the skin. The expression certain genes (*genes are one of the major components that control the fate of the cell*) of adult body cells with specialized function is manipulated to reprogramme the somatic cells back to a pluripotent state.
- The iPSC cells have properties similar to those of embryonic stem cells.
- Human iPSCs were generated in 2007.