

STEM CELL BIOLOGY5.1 Definition and characteristics of Stem Cell

Definition - A stem cell is a cell with the unique ability to develop into specialized cell types in the body. In the future they may be used to replace cells and tissues that have been damaged or lost due to disease.

Stem cells are unspecialized cells that develop into specialized cells that make up the different types of tissues in the human body. They are characterized by the ability to renew themselves through mitotic cell division and differentiating into a diverse range of specialized cell types. They are vital to the development, growth, maintenance, and repair of our brains, bones, muscles, nerves, blood, skin and other organs. Stem cells are found in all of us, from the early stages of human development to the end of life.

Stem cells are defined as cells having clonogenic and self-renewing capabilities and differentiate into multiple cell lineages. Stem cells are basic cells of all multicellular organisms having the potency to develop into wide range of adult cells.

Characteristics of Stem Cells -

- 1) Stem cells are unspecialized. One of the fundamental properties of a stem cell is that it does not have any tissue specific structures that allow it to perform specialized functions. However, unspecialized stem cells can give rise to specialized cells including heart muscle cells, blood cells and nerve cells.
- 2) Stem cells are capable of dividing and renewing themselves for long periods, unlike muscle cells.

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blood cells, or nerve cells, which do not normally replicate themselves. Stem cells may replicate many times and the process is called Proliferation. A starting population of stem cells that proliferates for many months in a lab can yield millions of cells, the resulting unspecialized stem cells are capable of long term self renewal.

- 3) The stem cells can remain undifferentiated and unspecialized for a long time in human body and the signals which keep it in this stage is an area of research.
- 4) Stem cells can give rise to specialized cells and the process is called differentiation. Scientists are finding the ways to understand the signals inside and outside cells that trigger stem cell differentiation. The internal signals are controlled by a cell's genes, which are interspersed across long strands of DNA and carry coded instructions for all the structures and functions of a cell. The external signals for cell differentiation include chemicals secreted by other cells, physical contact with neighbouring cells, and certain molecules in the microenvironment.
- 5) Adult stem cells typically generate the cell types of tissues in which they reside. A blood forming adult stem cell in the bone marrow, for example, normally gives rise to many types of blood cells such as red blood cells, white blood cells and platelets. But, it has been found that the blood forming cell in the bone marrow also called hematopoietic stem cell can not give rise to other type of cells. However a

a number of experiments have raised possibility that stem cells from one tissue may be able to give rise to cell type of a completely different tissue a phenomenon called Plasticity. examples of such plasticity includes blood cells becoming neurons, liver cells etc.

Potential uses of stem cells - Since stem cells have the ability to turn into various other types of cells. Scientists believe that they can be useful for treating and understanding diseases. Stem cells can be used to -

- 1) Grow new cells in the laboratory to replace damaged organs or tissues.
- 2) Correct parts of organs that don't work properly.
- 3) Research causes of genetic defects in cells.
- 4) Research how diseases occur or why certain cells develop into cancer cells.
- 5) Test new drugs for safety and effectiveness.

The most remarkable properties of stem cells are - long term self renewal in which they have the ability to make identical copies of themselves and they are able to differentiate into all derivatives of primary germ layers (Pluripotency).

thus we can say that stem cells provide new cells for the body as it grows, and replace specialized cells that are damaged or lost.

History of Stem cell The Key properties of a stem cell was first defined by Ernest McCulloch and James Till in early 1960s. The first therapy of using bone marrow stem cells was done by oncologist George Mathe (1958).

Classification and characteristics of Different types of Stem cells.

on the basis of sources -

1) Embryonic Stem cells are pluripotent cell derived from inner cell mass of the blastocyst, an early stage embryo.

2) Adult Stem Cells - Mesodermal origin - Hematopoietic Scs, Mesenchymal, Mesenchymal precursor Scs, multipotent adult progenitor cells, bone marrow stem cells, fetal somatic stem cells, unrestricted Scs, Cardiac Scs, satellite cells of muscles.

Ectodermal origin - Neural Scs, Skins, Ocular Scs

Endodermal origin - Pulmonary epithelial Scs, Gastrointestinal Scs, Pancreatic Scs, Hepatic oval cells, Mammary and Prostatic gland Scs ovarian and testicular stem cells.

3) Cancer Stem cells - It is of various types such as cancer/tumour tumor as Acute myeloid leukaemia, Scs (CD34+/CD38-) Brain tumor Scs (CD133) Breast cancer Scs (CD44+/CD24-) multiple myeloma Scs (CD138+) colon cancer Scs (CD133+) liver cancer Scs (CD133+) Pancreatic cancer Scs (CD44+/CD24+), lung cancer Scs (CD133+) ovary cancer Scs (CD44+/CD117+) Prostate cancer Scs (CD157/CD44) melanoma Scs (CD4+/CD20+, FoxP3+) Gastric cancer Scs (CD44+)

4) Induced pluripotent Stem cells - A type of Pluripotent stem cell artificially derived from a non pluripotent cell typically an adult somatic cell, by inducing a forced expression of specific genes.

on the basis of cell Potency -

1) Totipotent cells - Zygote, Spore Morula It has the potential to give rise to any and all

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human cells, such as brain, liver, blood or heart cells, It can even give rise to an entire functional organism.

Pluripotent cells - Embryonic stem cells, They can give rise to all tissue types, but cannot give rise to an entire organism.

Multipotent cells - Progenitor cell, such as hematopoietic stem cell and mesenchymal stem cell, They give rise to a limited range of cells within a tissue type.

Unipotent cells - Precursor cell

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