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Stem cells : Prospectus and future

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Key words :

Morph into virtually every kind of tissue, including nerves to replace those destroyed by spinal injuries and cardiac muscle to fill in for cells lost in a heart attack. Scientists see as the key to a new era of regenerative medicine.

This is the saga of the stem cells.

Research on stem cells advancing knowledge about how an organism develops from a single & how healthy cells replace damaged cells in adult organism. This promising area of science is also leading scientists to investigate the possibility of cell-based therapies to treat disease, which is often referred as regenerative/reparative medicine.

Stem cells are one of the most fascinating areas of the biology today. These have two important characteristics that distinguish them from other types of cells:

– they are unspecialized cells that renew themselves foe long periods through cell division

– under certain physiological/experimental conditions, they can be induced to become cells with special functions such as beating cells of heart muscle/ insulin producing cells of the pancreas.

Scientists discovered ways to derive stem cells from early mouse embryos more than 20 yrs ago. Many years of detailed study of the biology of mouse stem cells led to the discovery in 1998, of how to isolate stem cells from human embryos and grow the cells in the lab. These are called human embryonic stem cells. Research in the stem cells grew out of findings by two Canadian scientists Ernest A. McCulloch & James E. Till in the1960s.

The two broad types of mammalian stem cells are:

– embryonic stem cells that are found in blastocysts, and

– adult stem cells that are found in adult tissues.

In a developing embryo, stem cells can differentiate into all of the specialized embryonic tissues. In adult organisms, stem cells and progenitor cells act as a repair system for the body, replenishing specialized cells, but also maintain the normal turnover of regenerative organs, such as blood, skin or intestinal tissues.

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Properties:

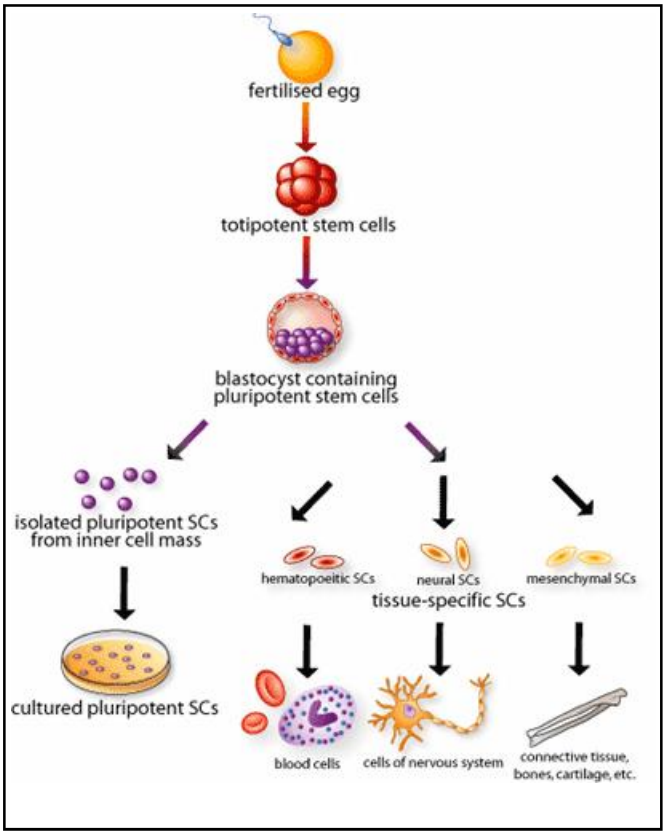
The classical definition of a stem cell requires that it possess two properties:

– *Self-renewal* : the ability to go through numerous cycles of cell division while maintaining the undifferentiated state.

– *Potency* : the capacity to differentiate into specialized cell types.

In the strictest sense, this requires stem cells to be either totipotent or pluripotent – to be able to give rise to any mature cell type, although multipotent or unipotent progenitor cells are sometimes referred to as stem cells.

– *Stem cells give rise to specialized cells*: when unspecialized give rise to the specialized cells, the process is called as differentiation.



Embryonic stem cells:

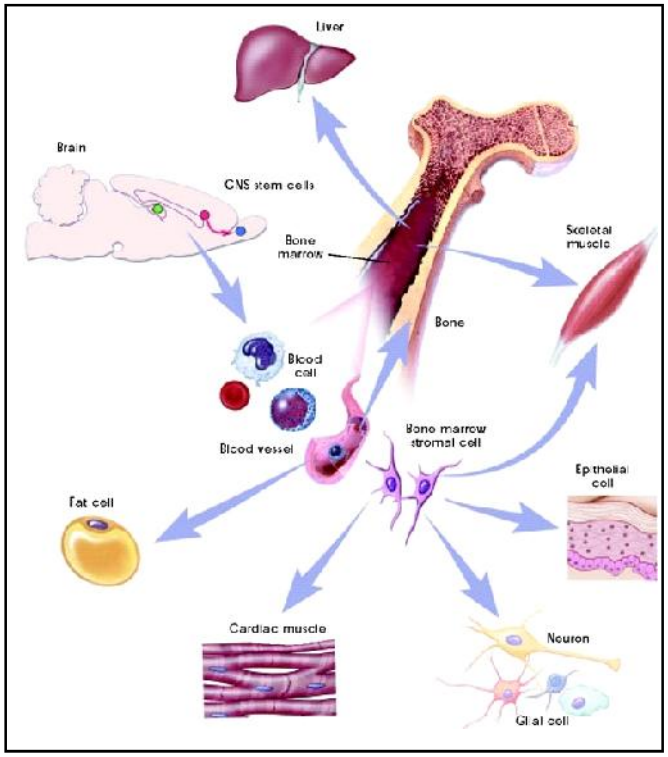
These cells are derived from the epiblast tissue of the inner mass cells of a blastocyst or earlier morula stage embryo. A blastocyst is an early stage embryo-approximately four to five days old in humans and consisting of 50-150 cells. ES cells are pluripotent and give rise during development to all derivatives of the three primary germ layers: ectoderm, mesoderm and endoderm. They can develop into each of the more than 200 cell types of the adult body when given sufficient & necessary stimulation for specific cell type. They do not contribute to the extra-embryonic membranes or the placenta.

Treatment:

No approved treatment or human trials using ES cells

Adult stem cells:

The term adult stem cell refers to any cell which is found in a developed organism that has two properties: the ability to divide and create another cell like itself and also divide and create a cell more differentiated than itself. Also known as somatic (from Greek Σωμματικός, "of the body") stem cells and germline (giving rise to gametes) stem cells, they can be found in children, as well as adults. These can be removed from a baby, child or adult. Most adult stem cells are lineage-restricted (multipotent) and are generally referred to by their tissue origin (mesenchymal_stem_cell, adipose-derived stem cell, endothelial_stem_cell, etc.).



Treatment:

– To treat leukemia & related bone/blood cancers through bone marrow transplant

– in veterinary medicine to treat ligament & tendon injuries in horses.

These both types of the stem cells can be distinguished as follows:

Now, a third type of stem cell has been isolated.

Embryonic stem cells	Adult stem cells
Can develop into all types of body cells *i.e.* more differentiation power	Can develop into limited types of body cells *i.e.* limited differentiation power
Present in large number	Rare in mature tissue
Easily grown in culture	Method to culture them under process
May cause immune rejection	No problem of immune rejection
No approved use in medicines	Approved and used since many years

They can be harvested from amniotic fluid which surrounds the fetus during pregnancy, or from the placenta which is delivered after birth and routinely discarded. These are called as amniotic or placental stem cells. They have advantages that, they do not require the destruction of an embryo, they can apparently be coaxed into developing into a wide range of cell types, they are much easier to obtain than embryonic stem cells, they can double in number every 36 hours, they can divide at least 250 times without mutating and without forming tumors, they have been converted into bone, heart muscle, blood vessels, fat, nerve and liver tissues in lab mice. But unlike embryonic stem cells they cannot reproduce indefinitely.

Stem cells as medicinal miracle:

– Stem cells are widely being used in curing of heart and blood diseases.

– The use of stem cell reduces the chances of host versus graft rejection after transplantation. The cells being our own body cells are not rejected.

– The mechanisms by which stem cells divide and differentiate are under intense investigation. Researchers are working in a number of different models to understand both epigenetic and genomic control of self renewal. ?Blood stem cells represent one of the best characterized systems in stem cell biology and have a history stretching back over 50 years. The volume of new cells made within the bone marrow during an adult's lifetime and accessibility of these cells for analysis have led to many exciting findings and a number of clinical therapies for blood-related

diseases such as leukemia.

– Until recently, researchers thought that the heart was a non-regenerating organ. They believed that scar tissue permanently replaced functioning heart muscle destroyed by disease. Yet new data suggest that primitive stem cells may exist in the heart and can repair damage. The heart's ability to repair itself is quite limited for the most common cardiac insults, such as myocardial infarction; however, there is hope that either adult or embryonic stem cell derivatives may be capable of repairing injured heart muscle.

– Pancreatic cell replacement has been done successfully. Also lung transplant with the lung developed from stem cells has been successful.

– In the future, medical researchers anticipate being able to use technologies derived from stem cell research to treat a wider variety of diseases including cancer, Parkinson's disease, spinal cord injuries, Amyotrophic lateral sclerosis and muscle damage, amongst a number of other impairments and conditions.

The harvesting of stem cells from embryos has become a very hot political, religious and ethical topic. Lots of debates, discussions and conferences are being held on this issue. There still exists a great deal of social and scientific uncertainty surrounding stem cell research, which could possibly be overcome through public debate and future research, and further education of the public.

If researchers could decode how cells develop into tissues and organs, then they will begin to understand the mechanisms of abnormal growth and development which in turn could lead to the discovery of new ways to prevent and treat birth defects and cancer.

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