Stem cell Technology

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Health Biotechnology

Stem Cell

Can differentiate into other types of cells and can also divide in self renewal to produce more of the same type of stem cells.

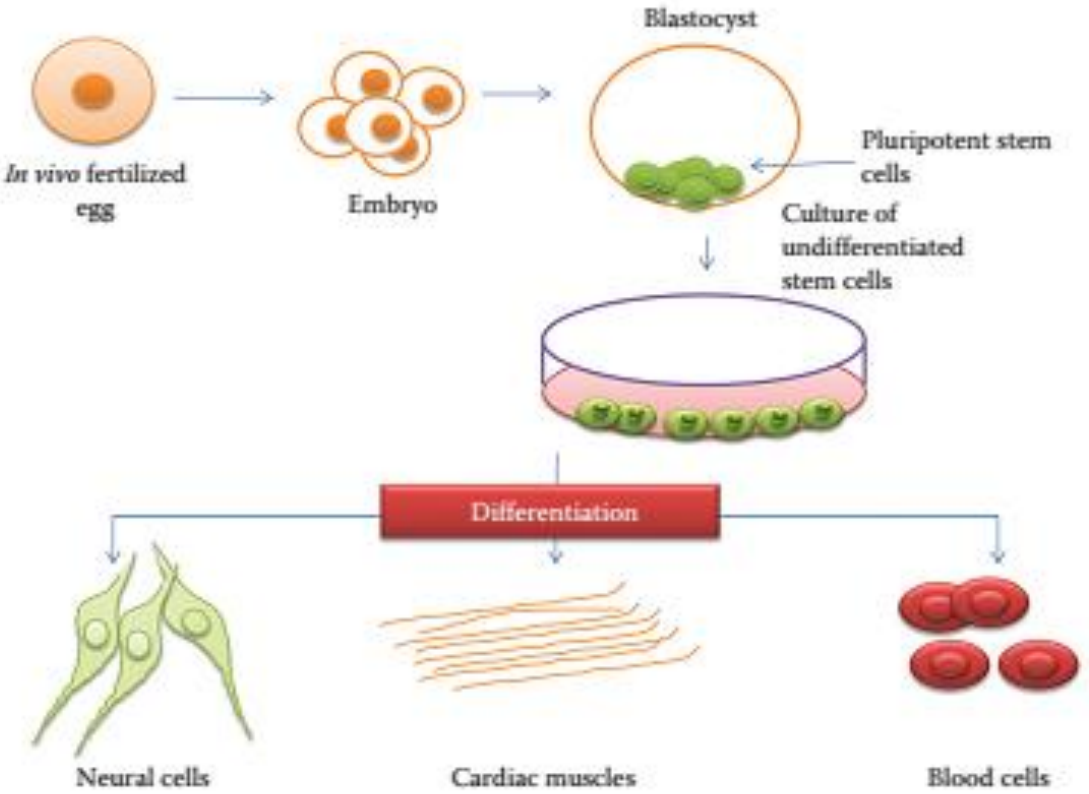

Figure 7.1 Development pathway of stem cells.

Significance of Stem Cell

The main function of stem cells is

- **To serve as internal repair system**
- **To provide new cells to damaged organs as long as person or animal is alive.**
- **When stem cells multiplies, each new cell has potential to either continue as a stem cell(reservior) or become another type of cell of the body such as neural cell, or red blood and muscle cell.**

Interestingly, stem cells are different from other cell types in two ways:

- **First, stem cells are unspecialized cells that are capable of renewing themselves through cell division**
- **second, under special physiological or experimental conditions, they can be differentiated to become tissue or specific type of cells with special functions such as cardiomyocytes and neurons.**

Significance of Stem Cell

- **In some organs, such as gut and bone marrow, stem cells regularly divide to repair and replace damaged tissues in body, whereas in other organs such as pancreas and heart , stem cells only divide under special condtions or requirements.**
- **In principle, there are two types of stem ells in human body, they are ESCs and nonembryonic or somatic or adult stem cells.**

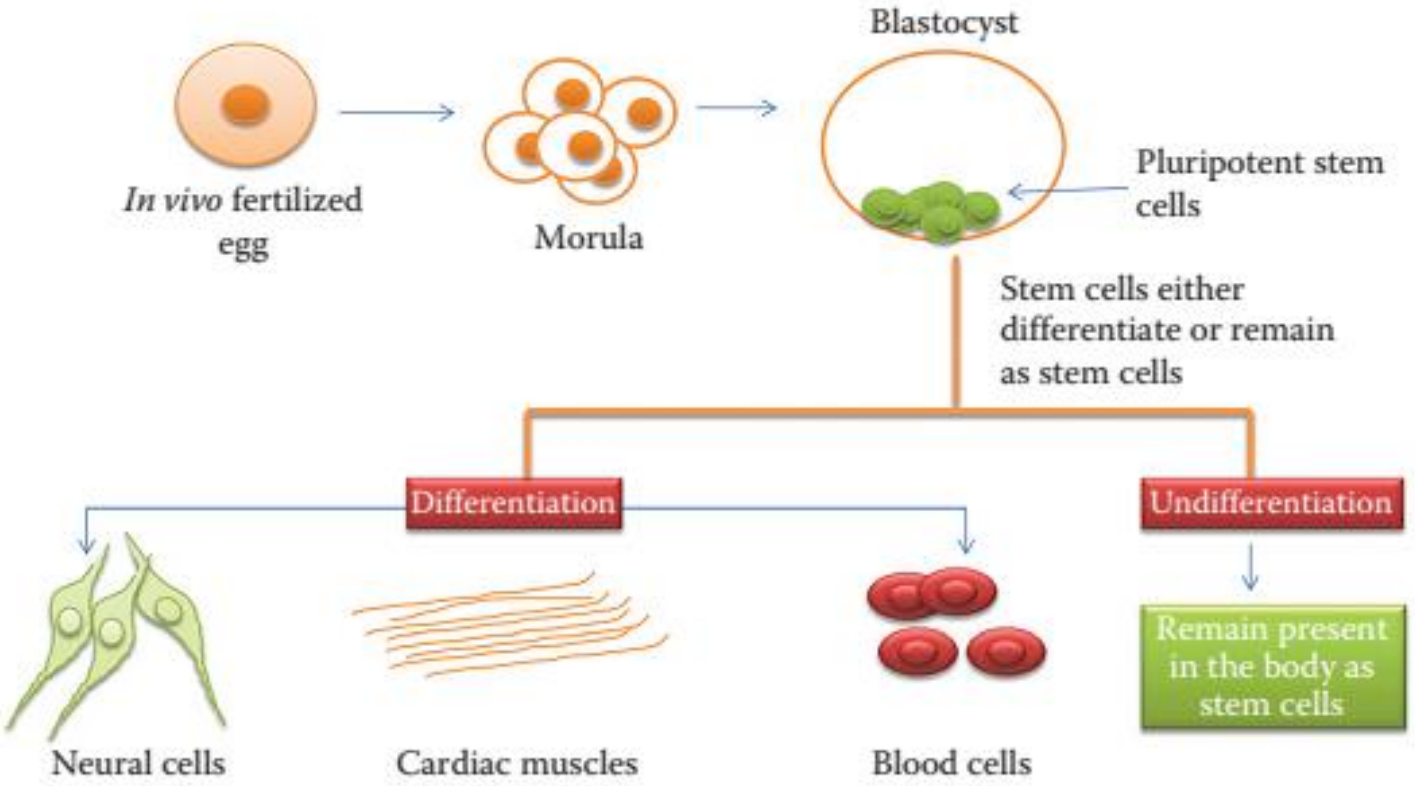

Figure 7.2 Fate of stem cells in the human body.

Significance of Stem Cell

- **In 1981, ESCs were isolated from early mouse embryos, which later led to development of a method to derive stem cells from human embryos which can grow in lab.**
- **Stem cells that are isolated from human embryo are called human ESCs.**
- **Human embryos used in these studies are created for reproduction by using in vitro fertilization procedures.**
- **When these embryos are no longer needed by patients, they can be donated for research with the informed consent of donor.**
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Significance of Stem Cell

- **Moreover, stem cells are important to living organisms form many reasons**
- **The 3-5 day old embryo that is called a blastocyst cotains cells normally referred to as inner cells.**
- **The inner cell mass contains stems cells that give rise to entire body of organism, including many specialized cell types and organs such as skin, sperm, eggs, heart, lung and other tissues.**

Table 7.1 Properties of Stem Cells

Type of stem cells	Properties
Self-renewal	The ability to go through numerous cycles of cell division while maintaining the undifferentiated state.
Totipotent stem cells	These stem cells can differentiate into embryonic and extraembryonic cell types. Such cells can construct a complete, viable, organism. These cells are produced from the fusion of an egg and sperm cell. The cells produced by the first few divisions of the fertilized egg are also totipotent.
Pluripotent stem cells	They are the descendants of totipotent cells and can differentiate into nearly all cells, that is, cells derived from any of the three germ layers.
Multipotent stem cells	They can differentiate into a number of cells, but only those of a closely related family of cells.
Oligopotent stem cells	They can differentiate into only a few cells, such as lymphoid or myeloid stem cells.
Unipotent stem cells	They can produce only one cell type, their own, but have the property of self-renewal that distinguishes them from nonstem cells (e.g., muscle stem cells).

Significance of Stem Cell

- **Interestingly, all stem cells, regardless of their source, normally have three general properties:**

i. They are capable of multiplying and renewing themselves for long periods of time.

ii. They are unspecialized

iii. They can give rise to specialized cells types upon differentiation.

- **Stem cells are unspecialized cells and one of fundamental properties of stem cells is that it does not have any tissue specific structures or morphology that allows it to perform specialized functions.**
- **For instance, a stem cell can not work like adult or somatic cells to pump blood through body and stem cells cannot carry oxygen molecules through blood stream.**

Significance of Stem Cell

- **Nevertheless, these unspecialized stem can give rise to specialized cells through a process called differentiated.**
- **During this process, stem cells usually become specialized somatic cells in several stages.**

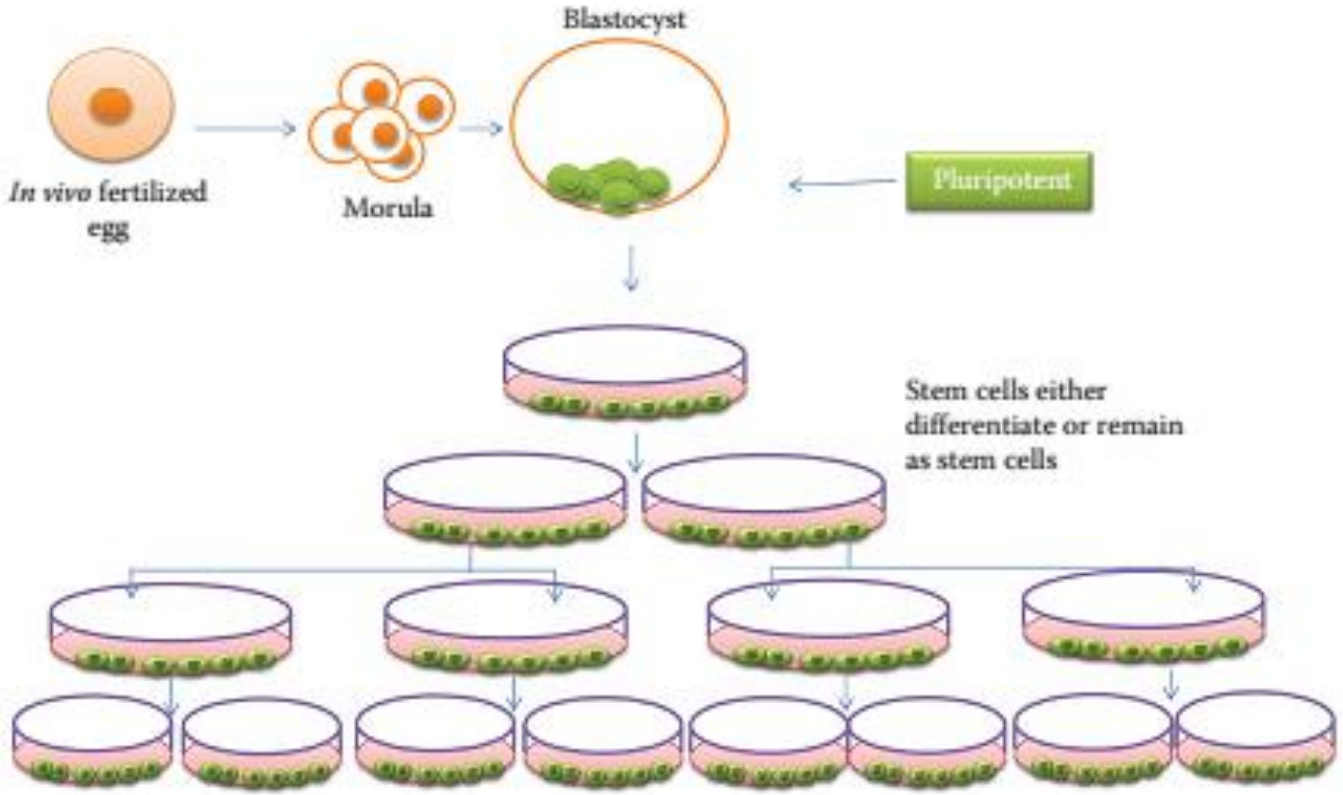

Figure 7.4 Self-renewing properties of stem cells.

Classification of Stem Cells

- **ESCs that isolated from developing embryo known as blastocyst**

- **Adult stem cells that are found in adult tissues or organs.**

1. Embryonic stem cells

- **In humans, ESCs are pluripotent stem cells derived from the inner cell mass of blastocyst(an early stage embryo).**
- **Moreover, human embryos reach the blastocyst stage 4-5 days post fertilization. At that time, they consist of 50-150 cells; these cells are called ESCs.**
- **ESCs are pluripotent stem cells and have the capability to differentiate into all three primary germ layers**

1. Embryonic stem cells

- **Three germ layers later on give rise to more than 220 different cell types in adult body.**
- **ESCs can generate all cell types in the body, whereas adult stem cells are multipotent and can produce an inadequate number of cell types**
- **Furthermore, under well defined conditions, ESCs are capable of propagating themselves for long periods of time without losing their pluripotency.**
- **ESCs can be employed as useful models both for conducting research and as regenerative medicine because ESCs can produce unlimited numbers of cells and can be transplanted into patients.**
- **with the help of ESCs, it is possible to treat various diseases such as genetic diseases, diabetes, Parkinson's disease, blindness, cancers and spinal cord injuries.**

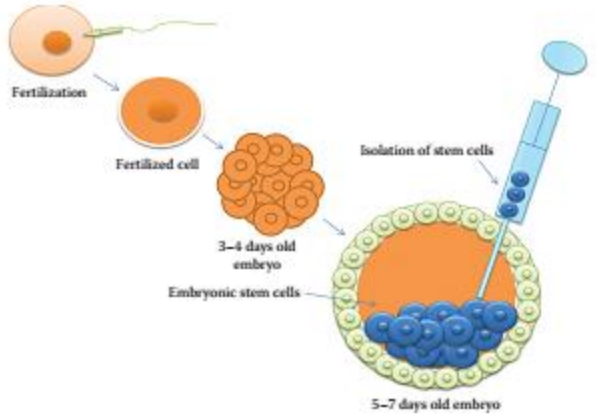

Figure 7.5 Development of human embryonic stem cells.

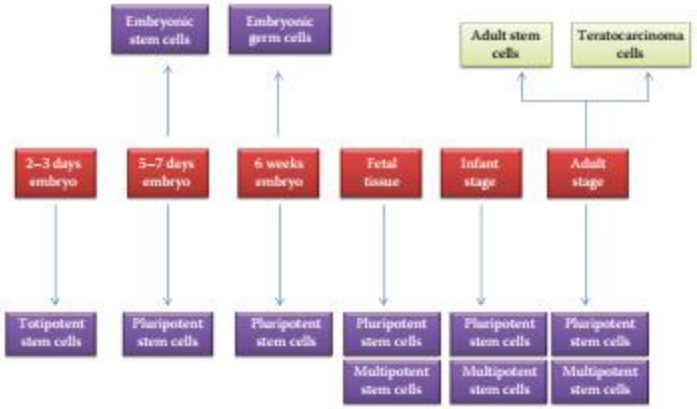

Figure 7.6 Isolation of stem cells in different stages of human life.

Historical perspective of ES cells

- **It is started in 1964 with the research work carried out to isolate a single type of cell from a teratocarcinoma, a tumour now known to be derived from a germ cell.**
- **These specialized cells were isolated from teratocarcinoma, replicated, and grown in cell culture media;**
- **These specialized cells were later named embryonic carcinoma cells.**
- **In 1981, ESCs were derived for the first time from mouse embryos by two research groups.. Martin Evans and his coresearchers and Mathew Kaufman and his co-researchers in their pioneering research, showed for first time a technique to derive ESCs from mouse embryo.**

Historical perspective of ES cells

- **Also, G.R. Martin, showed that embryos could be cultured in lab using in vitro cell culture method.**

- In 1998, a breakthrough occurred when researchers led by James Thomson first developed a technique to isolate and grow human ESCs under lab conditions.

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