Editorial

Stem Cell Technology: A Promising Panacea of 21th Century

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BACKGROUND

Stem cell technology is an advancement of regenerative medicine, and has proven to have infinite potential and can be a single solution of several chronic and incurable diseases.[1] Although there are some ethical issues[2], researches on embryonic stem cell argue that there is possibility of organ transplantation into the diseased person to get rid of the disease permanently.[1] Understanding this fact of possible use of stem cell technology in near future, many countries have already started to preserve umbilical cord,[3,4] even Indian Government had started the service of Cord banking Service since 2014.[5]

History of stem cell research date back to 19th century. Scientists were able to clone Tadpole in 1952, and cloned carp (named Tong Dizhon, was the world's first cloned fish) in 1963. Similarly, Steen Willadsen had cloned Sheep from the early embryonic cells in 1996, and from somatic cells in 1997 (named it Dolly, first cloned mammal). In the same way, scientist had successfully cloned the Rhesus Monkey, Cat, Mule, etc.[6] First cloned water buffalo was Samrupa in 2009 at Karnal National Diary Research Institute in India.[7]

With the evidence from successful cloning even in higher mammals from embryonic as well as somatic cell, scientists were more interested in human stem cell research and became successful to regenerate healthy tissues in diseased organs and thus can revive the person from deadly degenerative diseases.[1] Utilizing the principle of stem cell research, scientists were able to perform bone marrow transplant in 1970. In 1998 researchers first extracted stem cells from human embryo and were successful in transplanting the insulin-making beta cells of pancreas from the stem cell in 1999.[2]

Keywords: Chronic Diseases, Totipotent, Multipotent, Stem Cell, Stem Cell Therapy, Plant stem cell

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What is stem cell, and how it forms?

According to widely accepted cell theory,[8] every living entity whether plant or animal is made up of cell, and cell is derived from pre-existing cell. Human body is made up of around 75 trillions of such cell, which is developed from the zygote; after the fusion of haploid sex cells. After successful fertilization, single celled zygote is formed which is assumed as unicellular human being. Later on it starts dividing and becomes two cells stage, three cell stage, four cell stage, eight cell stage, etc. and subsequently converted into various stages which is called as morula, blastula and blastocyst. Until first week of human embryonic development, the single celled zygote is converted into multicellular, sac like structure (blastocyst) surrounded by a single cell layered membrane and a aggregation of 107 cells inside which is called inner cell mass.[9]

These inner cell mass are undifferentiated and unspecialized in this stage, and later on it will differentiated into about 200 types of different cells, that will form different tissues and ultimately form well differentiated organs, organ systems and organism.[10] Such undifferentiated pluripotent cells in the embryonic stage of human development is called embryonic stem cell.

What are the types of stem cell?

Various researches have established four types of stem cells depending on their ability to differentiate: totipotent, pluripotent, multipotent and unipotent.[1,3,11,13] Totipotent stem cells are found only in early embryos (up to 3 days).[2] Totipotent stem cell have potentiality to form a complete organism like identical twins while pluripotent stem cells exist in the undifferentiated inner cell mass of the blastocyst (4-14 days of embryonic life), can be differentiated into 200 different cell types. Multipotent stem cells in other hand found in fetal tissue, cord blood and adult tissues that can be differentiated into specialized cells of specific tissue type. Although the ability of multipotent adult stem cells is limited to certain range of cells, they already have a track record of success in cell-based therapies. Human stem cells for the therapeutic as well as research purpose can be either obtained from embryo and fetus or from umbilical cord and placenta.

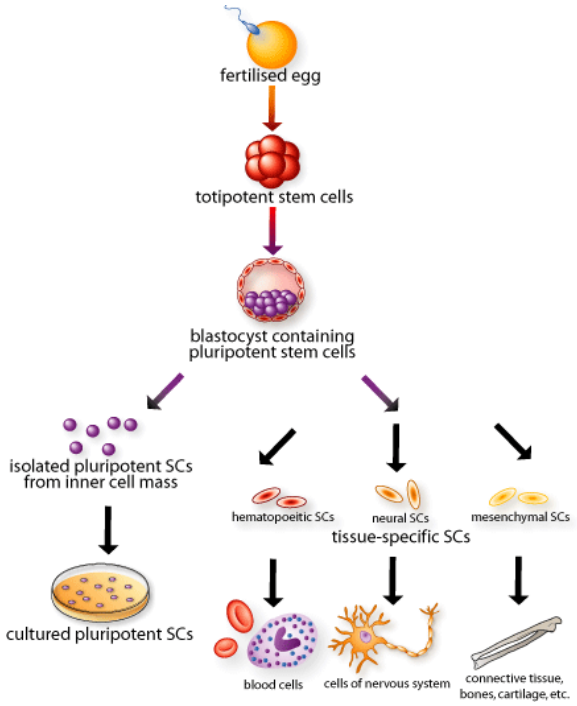

Figure 1: Types of stem cell: totipotent, multipotent and unipotent stem cell[2]

Embryonic stem cells (ESC) are harvested from the inner cell mass of the blastocyst three to fourteen days after fertilization and are totipotent in nature. Fetal stem cells (FSC) are taken from the germline tissues of embryo and fetus after 14 days of fertilization

and has the potential to form every cell type in the body except the placenta and extra-embryonic tissues, and hence are multipotent in nature. Umbilical cord and placenta derived stem cells are obtained from Placenta and umbilical cord blood. The term adult stem cells simply refers to any non-embryonic stem cell taken from various tissues of an adult. Adult stem cells are sometimes referred to as somatic stem cells to differentiate them from human germ cells.

Scope of Stem Cell Therapy

The stem cell therapy also known as regenerative medicine, promotes the repair of diseased, dysfunctional or injured tissue and hence has permanent healing effects. Principally, in stem cell therapy the various progeny of stem cell either embryonic or adult stem cell is taken, and grown up in high-technology laboratory with the help of tissue culture method and transplanted into the diseased person to treat the diseases.[11](figure 2)

Stem cell therapy has been successfully used for the bone marrow transplantation to treat leukemia. Researches have confirmed that unlike ASC, any kinds of adult tissues can be regenerated by using ESC in future if research in ESC is uninterrupted. Researchers have argued that adult Stem Cells may be helpful in jumpstarting repair of eroded cartilage.[12]

Researchers have successfully grown the stem cells in a laboratory which are manipulated to specialize into specific types of cells, such as heart muscle cells, blood cells or nerve cells etc.[13] The specialized cells can then be implanted into a diseased person. For example, if the person has heart disease, the cells could be injected into the heart muscle. The healthy transplanted heart muscle cells could then contribute to repairing defective heart muscle.[14] Similarly, Injections of stem cells have also reduced pancreatic cancers in some patients. Pancreatic cells do not produce insulin and embryonic stems cells might be trained to become pancreatic islets cells needed to secrete insulin.[14] Similarly, diseases like Alzheimer's disease, Parkinson diseases, spinal cord injury, muscular dystrophy, osteoarthritis, rheumatoid arthritis etc. can be permanently recovered[12] and more research is ongoing.

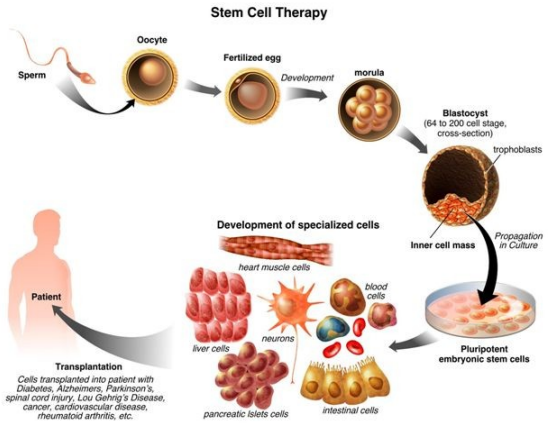

Figure 2: A glimpse of stem cell therapy[2]

Controversy of ESC Research

The process of obtaining stem cells leads to the destruction of the embryo from which the cells are taken. Because human life begins at conception, embryo destruction is immoral since it is the destruction of a human being. Even some people who do not believe that human embryos are deserving of full moral status worry about what the effects of normalizing such practices may have on society.[15]

Advocates of ESC research, however, argue that it is unethical to impede potential advances that could heal

disease and relieve the suffering of fully developed human beings. They believe that the moral status of a 150-to-200-cell early human embryo should not take precedence over responsible scientific inquiry.[2]

FUTURE OF STEM CELL RESEARCH

Although ESC research using cells taken from destroyed embryos is illegal in many countries, including Germany, Austria, Ireland, Italy, Portugal and New Zealand and most African and South American countries also have some form of restriction or ban, in the United States there are no restrictions on research and only minimal restrictions on government funding of embryo-destructive research.[2]

In 1995, Congress attached language to an appropriations bill prohibiting the use of any federal funds for research that destroys or seriously endangers human embryos, or creates them for research purposes. However, in 2009, President Barack Obama issued Executive Order that lifted all restrictions against federal funding of stem cell research.[16] The courts ruled that the language of the Dickey Amendment prohibited the use of government funds to directly destroy an embryo, but could not prohibit funding a research project using embryonic stem cells.[17]

CONCEPT OF PLANT STEM CELL

Although scientists have achieved great success in human stem cell research, the success of the human stem cell research had faced many ethical issues all around the world. Unfortunately many countries were compelled to ban the further research in ESC and stop federal funding for the research. As there is increasing conflict regarding the ethical and moral issues on research as well as utilization of human stem cell, many scientists started to utilize the concept of human stem cell research in plant and found an innovative and convincing result. Unlike animal cell, every plant cell has the potency to regenerate new organs e.g., its leaves, stem, flowers and seeds or even the whole plant throughout their whole life. Plant cells can dedifferentiate under certain conditions and become a stem cells at any time of its life span. Understanding such peculiar characteristics of plant cell over animal cell, many scientists started research over plant stem cell to get the benefits of unlimited power of regeneration, and try to transfer that potency into human.[18]

Consequently, the research in plant stem cell started 2006 by a Swiss Biochemist, Dr. Fred Zulli in 2006, started the research in plant stem cell adopting the principle of animal stem research and become successful in transferring the innovation of animal stem cell research into plant stem cell.[18] After his continuous research in the field of plant stem cell, he had established a Mibelle Biochemistry and started to produce plant stem cell from green apple and red grape.[19]

BOTTOM LINES

Until today there are more than 70 conditions like Leukemia, Alzheimer's disease, Parkinson diseases, spinal cord injury, muscular dystrophy etc. are currently being treated with adult stem cells.[1,20] Despite the various degree of restriction, ban and prohibition from the federal funding in ESC research, the plant stem cell has proven to be the best and effective in boosting immunity and at treating various medical conditions. It has been seen that many

government and private funding sources have consistently shown a preference for plant stem cell research. Millions of dollars have been spent on plant stem cell research. The plant stem cell therapy can be used to boost up immunity so as to prevent the infectious diseases and pandemics like ongoing COVID-19 too.

Despite the fact that ESC research still has the same ethical issues, the future of the ESC research cannot be underestimated. Scientists are rigorously involved in the researches in ASC like cord blood, placental stem cell etc. and will find out the permanent solution to treat all sort of diseases and disorders. Future doctors don't practice medicine, and patients need not take lifelong medicine to control chronic diseases, and the medical therapy shall be limited for some sort of infectious diseases only if the researches will succeed.

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