INTRODUCTION

Freedom of research, which is necessary for the progress of knowledge, is part of freedom of thought. The applications of research, including applications in biology, genetics and medicine, concerning the human genome, shall seek to offer relief from suffering and improve health of individuals and human kind as a whole (UNESCO Universal Declaration on the Human Genome and Human Rights, 1999).

How does a single cell give rise to a complex, multicellular organism? The question reflects one of the greatest mysteries of life and represents a fundamental challenge in developmental biology. As yet, knowledge about the processes by which a fertilized egg divides, forms a ball of cells (morula), develops a cavity (blastocyst stage) forms the three primary germ layers of cells that will ultimately give rise to all the cell types of the body (gastrula stage) and ultimately generates all the specialized tissues and organs of mature organism.

Little is known about the specific genes that regulate these early events or how interactions among cells or how cellular interactions with other factors in the three-dimensional environment of the early embryo affect development. The process, by which a fertilized egg becomes an embryo, called embryogenesis, include coordinated cell division, cell specialization, cell migration and genetically programmed cell death. (Pelton et al., 1998; Hogan, 1999).

The scope of even the more obvious applications envisioned for human cells is breathtaking: new approaches to the study of human

embryonic development and disorders such as birth defects and embryonal tumors; access to unexplored territories of human embryonic gene expression for modern genomics data mining; new tools for the discovery of polypeptide growth and differentiation factors that might find application in tissue regeneration and repair.

Also new means for creating human disease models in vitro for basic research; drug discovery and toxicology; a potential answer to the issue of the chronic shortage of tissue for transplantation in the treatment of degenerative diseases and an end to the use of immunosuppressive therapy in transplantation if cloning techniques can be used to derive stem cells from a patient's own tissue and finally new delivery systems for gene therapy (Martin et al., 2000).

Major dates in embryonic stem cell research (Trounson et al., 2000):

1878: First reported attempts to fertilize mammalian-eggs outside the body.

1959: First report of animals (rabbits) produced through IVF in the United States.

1968: Edwards and Barister fertilize the first human egg in vitro.

1978: Louise Brown, the first IVF baby born in England.

1980: Candace Reed, the first IVF baby born in Australia.

1981: Elizabeth Carr, the first IVF baby born in the United States.

1981: Evans and Kaufman; and Martin derive mouse embryonic stem cells from the inner cell mass of blastocysts. They establish culture conditions for growing

pluripotent mouse cells in vitro. The embryonic stem cells yield cell lines with normal, diploid karyocytes and generate derivatives of all three primary germ layers as well as primordial germ cells. Injecting the embryonic cells into mice induces the formation of teratomas.

1984-88: Andrews et al., develop pluripotent, genetically identical cells called embryonal carcinoma cells from Tetra-2, a cell line of human testicular teratocarcinoma .Cloned human teratoma cells exposed to retinoic acid differentiate into neuron-like cells and other cell types (Thompson et al., 1984).

1989: Pera et al., derive a clonal line of human embryonal carcinoma cells, which yield tissues from all three primary germ layers. The cells are aneuploid and their potential to differentiate spontaneously in vitro is typically limited.

1995: Non –human primate embryonic stem cells are derived and maintained in vitro from the inner cell mass of rhesus monkeys (Thomson et al., 1995).

1998: Thomson et al., derive human embryonic stem cells from the inner cell mass of normal human blastocysts donated by couples undergoing treatment for infertility.

1998: Gearhart and colleagues derive human embryonic germ cells from the gonadal ridge and mesenchyme of 5-9 week fetal tissue that resulted from elective abortions (Thomson et al., 1998).

Stem cells are unspecialized cells that can differentiate into more mature ones with specialized functions. In humans, they have been identified in the inner cell mass of the early embryo, in some tissues of the fetus, the umbilical cord, the placenta and in several adult organs (Blau et al., 2001).

A stem cell is a cell that has the ability to divide for indefinite periods. Under the right conditions, stem cells can give rise to many different cell types that make up the organism. So, stem cells have the potential to develop into mature cells that have characteristic shapes and specialized functions, such as heart cells, skin cells or nerve cells (Slack, 2000).

Stem cell is a cell that has three specific characteristics:

Self renewal, remaining in the undifferentiated state, and differentiation potential to be a specialized cell. Moreover, stem cell can be classified by a hierarchal system into:

1-Totipotent stem cell: is the first stage stem cell that can be found in the zygote. It can develop into both embryonic and extra embryonic tissues.

2-Pluripotent stem cell: is the later stage of totipotent stem cell. This cell type can develop into all kinds of cells of an embryo (except the extra embryonic tissues). Pluripotent stem cell can be found in the embryo, fetus and developing organism.

3-Multipotent stem cell is a stem cell in any specific tissues, organs or systems. This stem cell has more limited differentiation potential. For instance, hematopoietic stem cell has an ability to develop into only cells in the hematological system.

Progenitor cell is not a stem cell itself but is a descendant of a stem cell. It resides in all tissues. Specific characteristics of progenitor and multipotent stem cell are almost alike except for the self renewal ability not found in the progenitor cell (Sorapop et al., 2006).

Human stem cells are pluripotent cells capable of differentiation to any of the three germ cell layers (endoderm, mesoderm and ectoderm).They can under proper circumstances develop into any part of the body. Its maintenance and differentiation will form the basis for significant research in human and development biology and in the clinical application of cell replacement therapy. Due to their inherent capacity for differentiation, the maintenance of undifferentiated cultures is not easy and also being pluripotent may be harmful, as some studies suggest human embryonic stem cells may form teratomas (Tzukerman et al., 2003).

Types:

1- Human embryonic stem cell& human embryonic germ cells.

2- Fetal stem cell.

3- Adult stem cell.

There are three major types of stem cells: embryonic, fetal and adult. Each comes from different sources and has some what different properties. The embryonic stem cells are usually taken from the blastocyst stage. Fetal stem cells usually accumulate in the liver, so fetal liver tissue has been shown to be a rich source of stem cells (Rollini et al., 2004).

Adult stem cell is a stem cell that has developed beyond the embryonic state and usually resides in tissue. It is still in an undeveloped state but has a potential to differentiate into the specific cell type (Sorapop et al., 2006).

After the first discovery of mouse embryonic stem cell in 1981, many medical and biological scientists have greatly appreciated the specific characteristics and specially the potential of stem cell for treatment of various human diseases. Based on current knowledge in stem cell biology, scientists can develop many disease models to study molecular mechanisms of diseases, related genes, intracellular and intercellular communications, early stage of human development and then apply this knowledge into clinical practice (Pederson, 2005).

During the last decade, there has been a new developing medical science branch," Regenerative Medicine". Regenerative medicine applies the basic stem cell knowledge to develop specific cell or tissue to replace the original cell or tissue which have been degenerated, injured or damaged by different processes (Table 1). This is the basic concept of the promising cell and tissue based therapy that would have a potential to make many chronic diseases "curable" such as diabetes mellitus type 1, myocardial infarction (Shufaro et al., 2004).

Table 1. Embryonic germ layers from which differentiated tissues develop (Chandross et al., 2001).

Embryonic Germ Layer	**Differentiated Tissue**
Endoderm	Thymus Thyroid, parathyroid glands Larynx, trachea, lung Urinary bladder, vagina, urethra Gastrointestinal organs Lining of the GIT Lining of the respiratory tract
Mesoderm	Bone marrow (blood) Adrenal cortex Lymphatic tissue Skeletal, smooth, and cardiac muscle Connective tissues (including bone, cartilage) Urogenital system Heart and blood vessels (vascular system)
Ectoderm	Skin Neural tissue (neuroectoderm) Adrenal medulla Pituitary gland Connective tissue of the head and face Eyes, ears