The Versatility of Stem Cells at Relieving Many Disorders and Illnesses

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Abstract

The topic of stem cells was addressed in this paper. It explores what are stem cells, different types, and potency of each. The paper then focuses more specifically on what current research has deemed most viable type of stem cell which is human embryonic stem cells for regenerative medicine for injuries and/or diseases. The paper states guidelines that researchers should consider when doing this type of experimentation on this type of cell. A final analysis is drawn from the inferences that this research can and will benefit a large amount of individuals with these debilitating conditions.

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It was Memorial Day in 1995 where Christopher Reeves was thrown from his horse to the ground during a riding competition. Hitting his head, he fractured his back and crushed his spinal cord. Reeves, known for his brilliant roles as Superman, became the inspiration for stem cell research for regenerating a damaged spinal cord tissue by implanting a different group of cells that could possibly grow new cells. Why would Reeve want to be the first to experiment with this research idea that thus far has no proven success? One word can sum up everything, "hope." This paper will address the basic of stem cells and what research has been done followed by the intricate detail that is needed on human embryonic stem cells.

Stem cells are defined functionally as cells that have the capability to self-generate while maintaining itself in an undifferentiated state indefinitely (Borowski & Stein, 2011). These cells have the amazing capability to generate daughter cells that are identical to that of the mother, to renew themselves, and produce identical offspring that can differentiate into any cells of the body (Kelly, 2007). In other words, these cells are called stem cells because cells can grow out of them.

Stem cells can form many different cells of an organism. Stem cells, thus, can develop into mature cells that can have characteristic shapes and specialized functions (e.g., heart, skin, or nerve cells) that have the ability to divide for long periods of time. The unique cell can form many different types of cells that make up an organism through a process called differentiation. Differentiation is a technique that stem cells have to divide and form other cell types (class notes).

All animals and plants have these types of cells. Most of the research has been on animals (Kelly, 2007). Research proposed by Kelly says that animal research is good but it cannot

transfer over because humans cannot use stem cells from other animals. This is the case because the DNA molecule of each animal is programmed to work differently in each species (Kelly, 2007). Stem cells can be divided into two main categories; embryonic and adult stem cells. The embryonic stem cell develops from an embryo that has been fertilized in conception or a petri dish. The other form is an adult or somatic stem cell. The somatic stem cell is a differentiated cell with a specific (e.g., brain or peripheral blood) function helping maintain and repair of tissue (Kelly, 2007).

Stem cells are valuable. The first reason is stem cells give rise to specialized cells that can differentiation into any cell of the body. A factor that influences the development of stem cells is physical or tactile, growth factors of each type of cell (class notes). The second reason is under certain conditions stem cells can be induced with certain types of chemicals to become cells with specific functions (e.g., heart muscle or nerve) and can replicate indefinitely through a process of proliferation. The starting line of stem cells can proliferate in a laboratory for months yielding a large amount of cells thus exemplifying the unique trait of self-renewal (Kelly, 2007). Lastly, stem cells can aid in a treatment called regenerative medicine (Kelly, 2007). Regenerative medicine is a cell-based therapy that can be a new field of drug screening and understanding of birth defects (California's Institute for Regenerative Medicine, 2009; class notes).

Stem cells are classified based on plasticity, potency, or versatility. The starting egg is said to be totipotent with a potential to generate into all cells and tissues that make up a mammal and support its development in the uterus. In the first few divisions mammal's cells have this all-encompassing ability to generate into new cells or other structures. This process is called differentiation; a totipotent cell can develop into all 200 cells in a living organism but only for the first few division of a cell. The next stage of development is pluripotent. This is a lot like a

totipotent body that has the ability to differentiate into all the bodies cells (class notes). During the fertilization, an embryo forms two layers that will become the tissue of a developing body (Kelly, 2007). The outer layer will become the placenta with the inner layer becoming any human tissue. The other type is multipotent stem cells. A multipotent cell can be found in humans of any age and are usually further along in the developmental stage that those found in a human embryo (class notes).

Discovered in 1981 murine embryonic stem cells had been found in mice (Boroski & Stein, 2011). It was not until 1998 where James Thomson and his colleagues at University of Wisconsin isolated the first human embryonic stem cells (hESC). Before an egg implants into the uterus a clump of cells are formed and this is where embryonic stem cells are found and where cell bodies are taken (e.g., 4-5) exclusively from this mass of cells.

Since the discovery in 1998 of |embryonic stem cells there has been an estimated 1000 different cell lines have been derived worldwide (Luong, Smith, and Stein, 2011). Researchers like Luong et. al., say that most labs have developed a pluripotent stem cell tailored to their specific research, such as disease-specific induced pluripotent stem cells. An aseptic technique is used to help avoid biological complications (e.g., bacteria, viruses, fungi, and parasites) that protects or shields the hESC culture from contamination because unlike most cultured cells, hESC are maintained without antibiotics (Allaire, Luong, & Smith, 2011).

A researcher needs to address the basic (e.g., temperature, humidity, pH & carbon dioxide) cell culture growth conditions of stem cells but more specifically the unique characteristics of hESC (Allaire et. al., 2011). Successful media maintenance is necessary for hESCs to stay in an undifferentiated state requires the recreation of biochemical and mechanical factors that allow for self-renewal, pluripotency, differentiated, and eliminate apoptosis in vivo.

A standard media of hESC contains a culture enriched with growth factors found in fetal bovine serum (Allaire et. al., 2011). Currently a fibroblast growth factor and serum replacer media are in widespread use to limit the differentiation in an agar dish of hESCs. Research has accepted that certain bone morphogenetic proteins along with the use of inactive mouse embryonic fibroblast feeder layer inhibit differentiation and allow for growth of hESC (Allaire et. al., 2011).

Mouse embryonic fibroblasts are more commonly used with this type of research as a feeder layer to support growth and provide essential nutrients for proliferation as well as preventing differentiation of the hESC culture (Allaire, Luong, & Smith, 2011). This type of media is used because it helps maintain hESC self-renewal and pluripotency. Distantly related house mice are used to help eliminate some of the genetic disorders that are created when kinship are bread together and produce offspring (Saeed, Taipaleenmäki, Aldahmash, Abdallah, Kassem, 2012). Research on mice should be preapproved by an Institutional Animal Care and Use Committee before beginning experiments (Allaire, Luong,, & Smith, 2011, p. 59). However, if necessary precautions are not taken hESC cultures can be contaminated with retroviruses and other pathogens that may alter the hESC biology and genome, as well as risk transmission of pathogens to a patient (Shi, Stencel, & Borowski, 2011).

Once hESCs are cultured with a feeding layer the bodies now can be frozen through a process called cryopreservation. Cryopreservation is where scientists slowly lower the cells temperature to -130°C and -150°C for long term storage (Shi, Borowski, & Stencel, 2011). If this delicate process is not taken into consideration cells can die from dehydration. Even with careful Cryopreservation and thawing, the percentage of cell death is extremely high due to the fragility of hESCs. On average, only 0.1-1% of cells are viable after thawing survive (Shi et. al., 2011, p. 119).

Considering the intricate detail that is needed for hESCs how can this be applicable to humans. In the United States alone, a total of 25.8 million children and adults have diabetes (American Diabetes Association, 2011). As many as 4.5 million individuals suffer from Parkinson's disease and 5.5 million with Alzheimer's disease and 40,000 children are born with congenital heart failure each year (Kelly, 2011; Hoffman & Kaplan, 2002). There is no way to describe how much suffering a person go through but a child afflicted for life with type I diabetes who will eventually become blind and lose his or her limbs (Thill, 2012), or a father who cannot recognize his children or grandchildren because of Alzheimer's, or a mother imprisoned in her own body with Parkinson's disease. A person cannot count the numbers of relatives and friends that live with one of these debilitating illnesses.

In conclusion, the applications of stem cell research are immense. These benefits entail human cell therapies, drug screening, and functional genetics with the use of hESC. Considering the fastidious nature of stem cells it only emphasizes the need for research. This paper has opened my eyes to a different outlook (e.g., political) on life to think that individuals who are not cognizant or aware of the implications or magnitude and are turn a blind eye to these problems that has or is afflicting most of United States citizens is ignorant.

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