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Stem Cells- Introduction, Classification, Applications and Ethical Issues

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ABSTRACT

The unspecialized cells known as stem cells give rise to the specialized cells that comprise the many tissues found in the human body. Their capacity for self-renewal is what makes them unique. via the process of mitotic cell division and developing into a variety of distinct cell kinds. They are essential to the progress, expansion, and upkeep and restoration of our blood, bones, muscles, nerves, and brains organs, including the skin. We are all made of stem cells, from the from the earliest phases of human growth to death. Research on stem cells has great potential to produce new treatments for a variety of dangerous illnesses and wounds. As for stem cells, based therapies have been recognized as the gold standard for therapeutic care. for certain illnesses, such hematopoietic stem cell transplants leukemia, burn treatments utilizing epithelial stem cells, and The range of possible stem cell-based treatments for corneal diseases has increased as a result of recent developments in stem cell research.It's only recently that researchers have gained sufficient understanding of stem cells to explore the possibility of long-term stem cell culture outside of the body. This advancement allows for the conduct of rigorous tests and raises the prospect of controlling these cells to create specific tissues.

Introduction

Cells with the capacity to develop into many cell lineages and exhibit clonogenic and self-renewing properties are referred to as stem cells. All of us, from the earliest phases of human development to the end of life, include stem cells. All multicellular creatures have stem cells, which are basic cells with the ability to differentiate into a variety of adult cells.[1]Totipotency and self-renewal are traits of stem cells. Even though very early embryonic stem cells demonstrate totipotency, adult stem cells have multipotency and differential plasticity that can be used to create new treatment possibilities in the future.[2]Medical research may benefit from the use of all types of stem cells, but each has advantages and disadvantages. [3]

Researchers have been examining the biology of stem cells for decades in an effort to better understand how development occurs and discover novel treatments for various medical conditions.[4.]The goal of modern scientific study and medical practice is to create treatments to replace aged, injured, or missing human body tissues and cells in an effort to bring the fabled idea of regeneration to life[5].

The study of stem cells now has more avenues to explore because to this work. Research on stem cells has great potential to lead to the creation of innovative treatments for numerous severe illnesses and wounds. While stem cell-based therapies have become the accepted clinical standard of care for certain conditions—such as leukemia treated with hematopoietic stem cells and corneal disorders treated with epithelial stem cells—the range of possible stem cell-based therapies has increased recently as a result of developments in stem cell research[6].

Through the process of cell culture, stem cells can now be expanded and developed into specialized cells that have properties similar to those of cells from different tissues, such as muscles or nerves. Medical treatments frequently employ highly plastic adult stem cells derived from bone marrow and umbilical cord blood, among other sources. The types of stem cells, their sources, stem cell research, and future aspects are the main topics of this paper. [7]

Scientists can discover the fundamental characteristics of stem cells and what distinguishes them from other specialized cell types through laboratory investigations of these cells. In the lab, stem cells are already being used by researchers to test novel medications, create model systems for examining typical development, and pinpoint the origins of congenital abnormalities [8].

In the last year, adult stem cells have been utilized alone or in conjunction with other therapies to provide substantial "healthcare benefits" for patients with ailments affecting all human tissues.(Fig-1)[9,10]

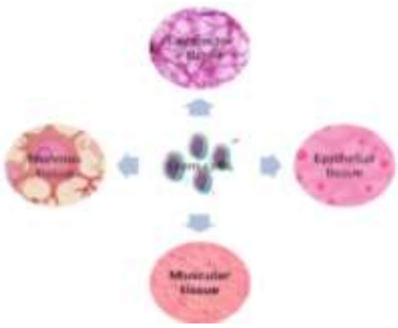

Fig-1. Healthcare benefits for every tissue of human body

Classification: On the basis of potency-

The terms totipotent, pluripotent, multipotent, and unipotent refer to these four basic categories.(Fig-2)

Totipotent

The capacity to differentiate into every sort of cell that could exist . The zygote created during egg fertilization and the initial cells produced by the zygote's division are two examples.

Pluripotent

The capacity to differentiate into nearly any sort of cell. Examples include cells produced from the mesoderm, endoderm, and embryonic stem cells ectoderm germ layers that develop at the outset of the differentiation process of embryonic stem cells.

Multipotent

The capacity to differentiate into a family of cells that are closely related. Hematopoietic (adult) stem cells are one example; these cells can develop into red, white, and platelets.

oligopotent

The capacity to divide into a small number of cells. Adult myeloid or lymphoid stem cells are two examples.

Unipotent

The capacity to differentiate only between cells of their own kind while possessing the self-renewal quality necessary to be classified as stem cells. Muscle stem cells from adults are one example.[11]

Fig-2.

On the basis of their sources-

Two types of stem cells can be distinguished, the simplest being early or embryonic and mature or adult.

Embryonic stem cells

Embryonic stem cells are pluripotent, self-replicating cells with the capacity to be immortal [12]. They are created from embryos that are still in the process of developing before they would typically be inserted into the uterus . Usually four or five days old, the embryos from which human embryonic stem cells are produced are hollow small balls of cells known as blastocyst.[13]After about five days of development, early stem cells, also known as embryonic stem cells, are discovered in the inner cell mass of a blastocyst.

Adult stem cells

Adult stem cells, also known as totipotent or multipotent cells, are undifferentiated cells that proliferate through cell division to replace lost tissue and replenish dead cells throughout the body following embryonic development. (Figure 3). Adult stem cells' major functions in a living thing are to preserve and repair the tissue in which they are located. In contrast to embryonic stem cells, which are identified by their source (the inner cell mass of the blastocyst), research is still ongoing to determine where adult stem cells originate in certain mature tissues.[14]

Source	Type of Cell	Mechanism of action	Effect
Blastula	Embryonic stem cells (ESC)	Differentiation into cardiomyocytes	Direct contribution to contractility
Skin Fibroblasts	ESC		Remodeling of electrical properties
Heart	Cardiac stem cells	Differentiation into endothelial cells	Remodeling of infarcts
Blood	Endothelial progenitor cells (EPC)	Differentiation into smooth muscle cells	Angiogenesis
Bone marrow	EPC & Mesenchymal stem cell (MSC)		Remodeling of the extracellular matrix
Fat cells	MSC	Paracrine effects	Activation of endogenous stem cells

Fig-3.Sources of adult stem cells

Applications

Potential stem cell therapies

With the notable exception of bone marrow transplantation, there are several stem cell therapies available, although the majority are either expensive or in the experimental stage (Fig. 4). Adult and embryonic stem cells are expected to be used in the near future to treat a wide range of conditions, including cardiac failure, cancer, Type 1 diabetes mellitus, Parkinson's disease, Huntington's disease, celiac disease, muscular damage, and neurological problems [15].

One well-known clinical use of stem cell transplantation is bone marrow transplants (BMT). After receiving heavy doses of chemotherapy and/or radiation therapy, BMT can replenish the bone marrow and restore all the different cell types found in blood, which is our primary line of defense against endogenous cancer cells. There are now numerous clinical applications being researched for the extraction of extra stem and progenitor cells. A few are explained here under.

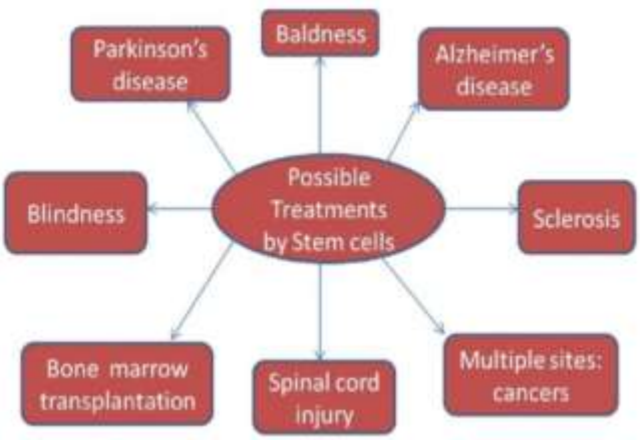

Fig-4. Potential stem cell therapies

Replacement of skin

Thanks to the discovery of stem cells, researchers are now able to create skin from a patient's harvested hair. When a hair is plucked, skin (keratinocyte) stem cells can be extracted from the hair follicle[16]. By cultivating these cells, it is possible to create an epidermal match for the patient's skin, which eliminates the need for tissue rejection in autologous transplants.

Transplanting of brain cells

Dopamine is a substance that is deficient in Parkinson's disease patients and can be supplied by stem cells. It entails the death of dopamine-producing cells in the nervous system. Dopamine release and transplanted cell survival were noted in the first double-blind research on fetal cell transplantation for Parkinson's disease, along with a functional improvement in clinical symptoms [17].

Diabetes treatment

Over millions of individuals worldwide suffer from diabetes, which is brought on by an aberrant insulin metabolism. The pancreatic cellular structures known as the islets of langerhans are normally responsible for the production and secretion of insulin. Recently, mouse stem cells have been used to create insulin-expressing cells[18].

Ethical Issues in the Use of Stem Cells

Epistemology and Ethical Social Approach

Then, ethical concerns about stem cell research are brought up globally. Their study is essential to the discovery of effective and novel treatments for severe illnesses, but it also raises ethical concerns about the use of embryos and the parameters and limitations of such research[19].

There are two primary associated concerns with stem cells extracted from the umbilical cord: (a) when donor consent should be requested for the use of the resulting medical data, and (b) related issues with maintenance and cold storage in certain banks.[20]

Here are two moral difficulties that come up: (a) it is morally unacceptable to destroy, or "kill," fertilized eggs that have the potential to become human beings; and (b) it is morally wrong to employ these "potential" human beings for any purpose. Nevertheless, as a personalized life only starts to emerge after fourteen days of fertilization, medical and biological research states that the fertilized egg of the first fourteen days does not yet contain one [21].

Problems with the Theological Bioethical Approach to the Use of Stem Cells

The Jewish religion holds that after forty days of development, the fetus is partially regarded as a human being deserving of care and protection based on the Old Testament and the Talmud. Since an embryo is "as if it were water" and not a living, breathing being before 40 days, research on embryonic stem cells is morally acceptable. According to Islamic belief, based on the Koran, a fetus begins to develop a personality and identity at the conclusion of the fourth month of pregnancy. Since then, he has been regarded as an individual with rights. Because a fetus cannot be regarded as a complete human being, stem cell research may therefore be permissible if it is [22,23,24,25]

Buddhism places a great deal of emphasis on the use of embryonic stem cells for research intended to improve patient outcomes and promote healing; nevertheless, research conducted for commercial benefit is not permitted. However, Hinduism holds that it is morally wrong to destroy embryos. has no official stance on stem cell research, though. Buddhism's problem is that it denies that any cause of suffering exists in any living thing; nevertheless, since a fetus does not experience pain until after 14 days, we can conclude that research on embryonic stem cells can proceed. [22,23,24,26]

Conclusion

We draw the conclusion that patients who would not typically receive treatment to cure their ailment have hope thanks to continuing research on stem cell therapies. With the promise of stem cell therapy, stem cells have a promising future in

In the form of bone marrow transplants, skin replacements, organ development, and the replacement of lost tissue like hair, teeth, retinas, and cochlear cells, we hope to see new frontiers in therapeutics medicine.

It is obviously necessary to move forward on all fronts given the tremendous potential of stem cells for the innovative treatment of many of the major diseases that impact humans; critics and supporters of adult sources of stem cells, umbilical cord blood, and ES cells are all present. More thorough evidence of clonogenicity and the function of seemingly transdifferentiated cells is likely needed in terms of adult stem cell plasticity[28,29]. Additionally, the "gold standard" of CFU-S-like activity[27]of bone marrow cells in a novel environment has only been persuasively shown in one case.[30]

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