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Informative

STEM CELLS: HOW FAR CAN WE GO?

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***Abstract*— "Without a doubt, stem cell research will lead to the dramatic improvement in the human condition and will benefit millions of people." - Eli Broad**
The new and emerging field of stem cells has already started providing us with promising results in the provinces of regenerative medicine, drug development, and much more particularly because of their peculiar characteristics. This article sums up the wide applications of stem cells in recent years also taking into consideration the ethical dilemma and the shadow of controversy.

Keywords— **Stem cells, Human Embryonic Stem Cells (HESCs), ethics**

I. INTRODUCTION

Imagine having a peaceful day standing in the garden looking at plants and trees full of foliage, standing erect on their stems. Those stems emerge from the roots and branch at intervals giving rise to even more branches culminating in leaves and flowers. Similarly, branches of our complex being are merged down to Stem Cells. Stem cells were first described by Ernest McCulloch and James Till in the 1960s awarding them the Nobel prize [3]. Ever since the discovery, they have been a boon to researchers studying the development of organisms from the very beginning. However, they have also been a bane by being under the shadow of controversy over the ethical and legal implications.

The seed that is sown has the potential to give rise to an entire plant. Similarly, in humans after fertilization, the fertilized egg undergoes cell division and forms Totipotent stem cells (forming three germ layers - ectoderm, endoderm, and mesoderm- along with the extraembryonic tissue- placenta- of the embryo) which have the potential to give rise to the entire human being [7]. From the totipotent stem cells, arise Pluripotent stem cells (cells giving rise to three germ layers but not the placenta of the embryo) [7]. As we go ahead in the life of the stem cell, its scope to differentiate and give rise to different cell types dwindles and they become more committed to their lineage, forming Multipotent (defining cells of a particular germ layer) and ultimately Unipotent stem cells (cells forming only one type of cells) [7]. Shinya Yamanaka in the year 2006, developed a technology to convert terminally differentiated stem cells by reprogramming them back to their pluripotency. Such stem cells are known as Induced pluripotent stem cells (iPSCs) [10].

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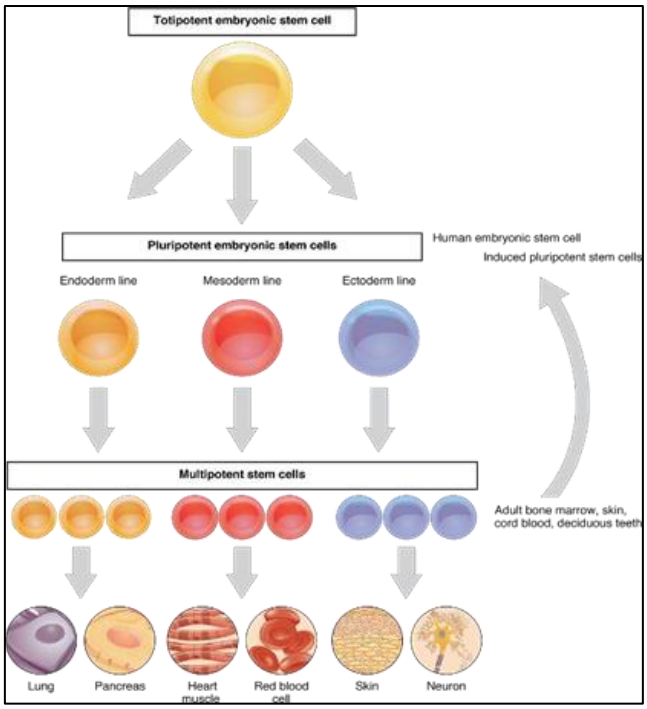

Figure 1: Tree of stem cell differentiation [1].

II. APPLICATIONS OF STEM CELLS

Stem cells have tremendous potential to grow, divide, and differentiate making them special and different from the rest. As the norm goes, one type of cell will produce the same type of progenies, stem cells grow to form two progenies but one of those would differentiate further to give rise to different cell types. Initial stem cells that emerge in the blastomere have the potential to form a complete individual, just the way a single seed can give rise to an entire plant. This is what makes stem cells different from the rest [2].

With the outstanding potential of stem cells, they are in the limelight of therapeutics and research. Stem cells are widely used in; studying human development, disease modeling, cloning, drug development, and therapeutics [8, 16, 14]. Human embryonic stem cells are pluripotent in nature. This confers them the ability to self-replicate in culture unlimitedly and also, they can project the ability to differentiate into any cell type in vitro and in vivo. Because of these two properties, they are an important tool in recapitulating human development by studying gene regulation and molecular pathways [17]. Taking into consideration the limitations due to animal models for disease modeling, stem cells have paved a way to model complex human disorders and diseases which couldn't be modeled in animals. Pluripotent stem cells and iPSCs are widely used to model human diseases, increasing our understanding of underlying molecular mechanisms [8, 18]. By using nuclear-transfer embryonic stem cells (ntESC), therapeutic cloning can be used for reproductive medicine and gene therapy in the future [18]. The stem cells are now routinely used for testing the toxicity of several drugs in pharmaceutical industries and also for developing new therapies [17, 19].

They also provide benefits in regenerative medicine, which deals with replacing the damaged tissues and organs in patients who are suffering from severe injuries and chronic diseases [14]. However, it can be difficult to identify and isolate the required tissues of the patients. High rejection rates are also associated with stem cell transplants and patients may suffer from acute or chronic side effects [9]. These challenges and many others are faced during stem cell therapy [15].

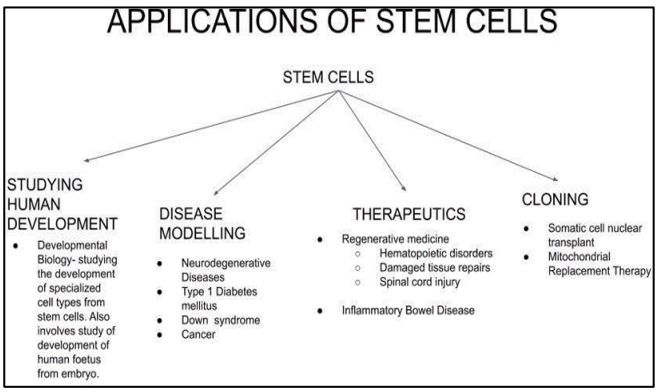

Figure 2: Applications of Stem cells

III. ETHICAL DILEMMA

With developments in stem cell research, moral and ethical implications constitute an important and pressing issue. Human Embryonic Stem Cells (HESCs) are pluripotent and they are derived from the inner cell mass of the human embryo [4]. The human embryos are destroyed during the isolation of HESCs. When it comes to this, the global consensus considers the existence of a one-celled zygote at the stage of fertilization as a human being. Even though each embryo is created to be a potential child, a contradictory view

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is posed by research and therapeutics. If spare embryos are remaining after the fertility treatment, then the individual for whom they were created has the right to decide the fate of the embryo. The worldwide dilemma of using embryos for stem cell research can be questioned [6].

Even though they are an inseparable tool for modern regenerative medicine, stem cell research raises various ethical implications. To address the same, the International Society for Stem Cell Research (ISSCR) in the year 2016, has provided international guidelines to address the issue. These guidelines discuss emerging frontiers in stem cell research along with their applications and also ethical, social, and policy-related challenges [11]. They also provide principles and practices in translational and clinical research. In addition to the guidelines by ISSCR, FDA, EuroStemCell, and WHO along with many other local authorities have imposed various regulations on the extent to which stem cell research can be stretched [12, 13, 14]. Bidding on the morals and ethics for stem cell research, we must decide how far we can go as we as authors believe that the use of ESCs in research will provide promising insights and a basic understanding of our development.

IV. CONCLUSION AND DISCUSSION

Ever since their discovery, stem cells have been an indispensable tool for studying once-obscure features of life. Today, we can save thousands of lives due to the developments in stem cell technologies. However, they are in the shadow of controversies and legal bindings. Even today we are unaware of various hidden potentials that stem cells harbor.

For the time being, we can live by the quote by Eduard Buchner, “We must never, therefore, let ourselves fall into the way of thinking ignoramus but must have every confidence that the day will dawn when those processes of life which are still a puzzle today will cease to be inaccessible by us, natural scientists” [5].

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Conflict of interest: The authors declare no conflict of interest.

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