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**Review Article**

# POTENTIAL APPLICATIONS OF STEM CELL RESEARCH IN DIFFERENT DISORDERS

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## ABSTRACT

Research works are still going on the importance and applications of different types of stem cells. Here are few types of stem cells which have been developed and each of the stem cell is unique in their functions in curing fatal disorders. They also provide a sufficient role in Research engineering and work. The abstract retains the vital information about various fields in stem cell research and the ongoing procedures in the history of the modern science and biological era. Though totipotency is shown by very early embryonic stem cells, the adult stem cells possess multipotency and differential plasticity that can be exploited for future generation of therapeutic options. Fortunately, the regulators of pleuripotency such as oct-4 & nanong protein are discovered and possibility of in vitro regulation of pleuripotency of stem cells is gaining strength. If appropriately investigated it may open a new vistas for future stem cell research & its application.

***Keywords:*** *Stem Cell, Review, Clinical usage, Future prospects.*

## INTRODUCTION

Stem cells have the remarkable potential to develop into many different cell types in the body during early life and growth. In addition, in many tissues they serve as a sort of internal repair system, dividing essentially without limit to replenish other cells as long as the person or animal is still alive. When a stem cell divides, each new cell has the potential either to remain a stem cell or become another type of cell with a more specialized function, such as a muscle cell, a red blood cell, or a brain cell. The regulators of stem cell growth at genomic and proteomic level are identified and we might be able to control stem cell in vitro. In developed countries, stem cell transplant has become a therapeutic option but in developing countries, it is still under trial phase [1].

Research on stem cells continues to advance knowledge about how an organism develops from a single cell and how healthy cells replace damaged cells in adult organisms. Stem cell research is one of the most fascinating areas of contemporary biology, but, as with many expanding fields of scientific inquiry, research on stem cells

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raises scientific questions as rapidly as it generates new discoveries [2,3].

## DIFFERENT DISORDERS OF STEM CELLS

***Blood disorder:*** A gene therapy strategy to improve the condition of a mouse model suffering an inherited blood disorder, beta thalassemia was proposed by researchers at Nationwide Children's Hospital in Columbus, Ohio by using unfertilized eggs from afflicted mice to produce embryonic stem cell lines.

Bone marrow transplants is a successive way for blood disorders like leukaemia, lymphoma, and various genetic blood disorders if a closely matched donor can be found. But bone marrow transplantation is a heroic, toxic therapy that can claim the lives of up to 20 percent of the patient. So another solution is thought by using embryonic stem cell.

At the whitehead institute, researchers made embryonic stem cells from mice with a genetic blood disease causing a severe immune deficiency. Then they used gene therapy to correct the genetic defect. Then they got cells to make blood stem cells that matched the mice genetically. Thus it became possible to build a new healthy blood system. Using this process in Human gives a successive rate to cure blood disorders [4-61].

***Cancer:*** Stem cell transplants from bone marrow or other sources can be effective treatment for people with certain forms of cancer, such as leukaemia and lymphoma. Stem cell transplants used are also used for multiple myeloma and neuroblastomas. The purpose of stem cell transplant is to replenish the body with healthy cells. In some cases, the transplant can have an added benefit; the new blood cells will also attack and destroy any cancer cells that survived the initial treatment [7].

Many research work at various universities show that embryonic stem cell can be used to eliminate oncogenes. The first genome - wide mapping of a DNA modification called 5- hydroxymethyl cytosine (5hmc) in embryonic stem cell was generated by researchers at University of California, Los Angeles. This discovery might prove very important in controlling cancer like diseases where regulation of certain gene play an important role in disease development. Another research at university of Connecticut Stem cell Institute found that after vaccinated mice showed a dramatic decline in tumour growth, compared to the non-vaccinated mice. A study by scientists at University of Minnesota reveals that cancer killing immune cell derived from embryonic stem cell completely eliminated cancerous tumours in 13 of 13 mice tested.

While stem cell transplants may be lifesaving, they're not the right treatment for everyone. The process can be difficult. Some doctors limit stem cell transplants to under age 50 or 70 [8, 9].

***Cartilage Damage:*** Recent research on stem cell therapy for osteoarthritis centres on the possibility of stem cell replacing joint replacement as primary care for diseased joint**.** For treatment of cartilage damage treatment such as drilling of bone, osteochondral transplantation and autologous chondrocyte implantation have shown limited results. So, scientists have found mesenchymal stem cells (MSCs) as an alternative. MSCs can modulate the immune response of individuals and influenced positively the microenvironment of the stem cells already present in the disease tissue. MSCs can initiate endogenous regenerative activities in the osteoarthritis joint.

UK based researchers at The University of Manchester and Central Manchester NHS Foundation Trust in great Britain have worked to turn embryonic stem cells into cells that produce cartilage and can be used to repair diseased or damaged joints. They hope that this research work paved their path for further development for joint diseases and other chronic human conditions [10].

***Heart diseases and damage:*** The stem cell helps in various biological events which culminate in healing of the heart muscle. The stem cell therapy will cause new muscle cells to be formed through stimulation of dormant stem cells that are already inside the heart muscle. The adult stem cells used to treat heart failure at the stem cell institute come from human umbilical cord tissue (allogenic mesenchymal).

Using the green fluorescent protein gene from jellyfish researches at Monish University in Australia developed a new technique. They inserted this special protein gene from jellyfish into heart cells derived from other cells in the stem cell culture. This technique was used to isolate and study the heart cells grown from the stem cells of heart patients and model heart disease transforming human embryonic stem into heart cells using a “decellularized”heart as a scaffold was a technique showed by scientists from the institutes of Bioengineering and nanotechnology. The procedure for the study followed was that the scientists separated and removed all cells from heart of a mouse and left only the organs scaffold and replaced them with stem cells. Two different types of cells found in heart were seen to develop from these stem cells. The cell-laden scaffold was then implanted back into the mouse and observed. It shows that the implanted heart developed visible blood vessels, which are necessary for transport of nutrients and oxygen to the heart [8]. The need for electronic pacemaker in human patients was reduced and is arrhythmia achieved its treatment when researchers at Tottoria University, Japan successfully made heart pacemaker cells using the embryonic stem cells of mice. Stem cell therapy for damaged hearts has yet to be proven fully safe and beneficial.

***Diabetes:*** Diabetes researchers have been searching for ways to replace the insulin producing cells of the pancreas that are destroyed by a patient’s own immune system. In theory, embryonic stem cells could be cultivated and coaxed into developing into the insulin – producing islet cell of the pancreas. With a ready supply of cultured stem cells at hand, the theory is that a line of embryonic stem cells could be grown up as needed for anyone requiring a transplant.

The New York stem cell foundation laboratory and Columbia University in New York for the first time derived embryonic stem cells from individual patients by adding the nuclei of adult skin cells from patients with type 1 diabetes to unfertilized donor egg. This achievement proved significant as these patient specific cells potentially can be transplanted to replace damaged or diseased cells in persons with diabetes, Parkinson's, Alzheimer or other disease without rejection by patient's immune system [11].

***Infertility:*** stem cells are responsible for building the ovarian reserve of oocytes in women, as well as the testicular spermatogonial stem cell population in men. Researches is going on for the generation of a germ line cell type form induced pluripotent stem cells that can restore fertility to individuals.

Stem cells could be stimulated in vitro to develop various numbers of specialized cells including male and female gametes suggesting their potential use in reproductive medicine.

Embryonic stem cells prolong proliferation in their pluripotent state, and stable developmental potential to form derivatives of all three embryonic germ layers.

Scientist at Kyoto University in Japan made a development that could help treat infertility in people by using the embryonic stem cells from mice to grow healthy mouse sperm in laboratory. The researchers combined the stem cells into a precursor cell type which was known to grow either into mouse eggs or sperm. These cells were then transplanted into the testis of infertile male mice which produced healthy sperms [12].

***Organ replacement:*** Stem cells have the capacity to proliferate and to differentiate into relatively mature cells of various types. ESCs can become any organ in the body when implanted into a blastocyst so ESCs can be used to replace any organ in the body.

At least two factors limit this possibility. These cells are different genetically from the person to be treated and their use, and derived cells require immunosuppressant. Another limitation is no means are known by these cells can be coaxed to form organs outside of the embryo. So the stem cells require foetal environment.

A step taken by researchers at RIKEN centre for developmental biology in Japan was initially used embryonic stem cells from mice to create a pituitary gland from scratch towards generating viable transplantable human organs [13]. The pituitary gland located at the base of brain is the body's master gland as it produces many hormones. It is especially crucial during early stage of development to better understand the developmental processes working the ability to stimulate the hormone formation in the initial stage was observed in the lab. Next the human stem cells will be used to generate a pituitary gland which will take another three years.

***Spinal cord injury:*** **s**tem cells hold potential for treating spinal cord injuries. Transplantation studies in animals have shown that a transplantation of stem cells may contribute to spinal cord repair by: replacing the nerve cells that have died as a result of the injury generating new supporting cells that will re-form the insulating nerve sheath (myelin) and act as a bridge across the injury to stimulate re-growth of damaged axons which is protecting the cells from damage by releasing protective substances.

Neuralstem's NSI-566 neural stem cells could provide a neuron rich substrate to the injured spinal cord segments, possibly promoting and supporting repair, regeneration and reorganization. In preclinical work, rats with ischemia-induced spinal cord injury recovered a significant amount of motor function after transplantation with neuralstem cells [14].

***Parkinson's disease:*** induced pluripotent stem (iPS) cells represent an important development in stem cell research to treat diseases like Parkinson's disease. Scientists could use cells from people living with Parkinson's disease to create iPS cell models of the disease that have the same intrinsic cellular machinery of a Parkinson's patient. Researchers could use these cell models to evaluate genetic and environmental factors implicated in Parkinson's disease [11].

Researchers from Lund University took human embryonic stem cells from in vitro fertilization embryos and grew them into motor neurons. The neurons were transplanted into the brains of rats with Parkinson's disease, and in five months, their dopamine levels raise back to normal.

## IMPORTANCE AND APPLICATIONS OF STEM CELL

***Embryonic stem cell****:* These stem cells are found in the early stage of the embryo, usually known as the blastocyst. It can produce different type of cells in our body. Embryonic stem cells divides and increases its cell number from 4 to 6 then 8 and increases henceforth forming a fully grown baby with millions of cells, a research work on this speciality of embryonic stem cells to divide and multiply is being done. These cells have the potential to divide and form into any type of body tissue. The early stage trial is being carried out in laboratories by scientists in treating eye disorders [15].

***Tissue stem cells:*** This Stem Cell is found in the tissue of the adult body. They can make only the cell that belongs to only their own tissue. Tissue stem cells are required for skin grafts and bone marrow transplantation which have been used for a number of years. Treatments for blood diseases, severe burns and some types of corneal damage have been proven; no other treatments are yet proven. Still research is going on for heart development [16].

***Umbilical cord blood cell:*** It is found in the umbilical cord after the birth of a baby. It can make the different types of cell present in the blood. It is used for treating blood disorder of children sometime adult. But its use is limited because a small number of cells obtained from umbilical cord. Cord blood must be matched to the patient to avoid rejection or Graft versus Host (GvH) Disease, although GvH appears to be less of a risk with cord blood than for bone marrow transplants [12].

***Mescenchymal stem cell:*** It is found in the bone marrow. It makes the cells in bone and cartilage and different types of blood stem cells. It is proven that it can repair bone and cartilage damage and also the blood vessels after heart attack. MSCs can be used for efficient generation of skeletal tissues in the body [17].

***Induced pluripotent stem cell:*** It is made in the laboratory from adult cells like skin cells. It behaves like embryonic stem cells. It can be made from patients and used to produce cells that act as a model "disease in the laboratory" for studying diseases and testing new drugs [18].

***Blindness:*** Using the potential of embryonic stem cell researchers at University of Wisconsin-Madison have been generating retina like tissue which could be one day used to develop and test therapies for blinding eye disease by isolating early retinal structures from other cell groups and grew them separately in batches in laboratory. There researchers could also spot major retinal cells including photoreceptors and retinal pigment epithelium (RPE). These cells gave appropriate respond in normal retinal function which is valuable not only for studying but also for working of the face of disease [19].

## CONCLUSION

Stem cells pose a bright future for the therapeutic world by promising treatment options for the diseases which are considered as noncurable now a days. However, because of significant pre and post-transplant morbidity and mortality further research and trials are required to refine and optimize conditioning regimens and modalities of supportive care. By virtue of funding of stem cell research, we hope to see new horizon of therapeutics in the form of organ development and replacement of lost tissue such as hairs, tooth, retina and cochlear cells. If appropriately investigated it may open a new vistas for future stem cell research & its application.

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