AN OVERVIEW ON STEM CELL

Kote Amol P.,[*] Pawar Sanjay D., Dhonde Satish M., Bhawal Ganesh., Sherkar Mahesh R.,Karale Chandrakant K.
E-mail:amolkote22@gmail.com

Department of Pharmacology, S.V.N.H.T'S College of B.Pharmacy, Shrishivajinagar (Rahuri factory), Tal-Rahuri, Dist-Ahmednagar, MS, India-413706.

Summary

Stem cells are the cells by using of this ,whole organism develop from single cell called embryonic stem cell. In adult, damage cells are replaced by healthy cells. Stem cell research and therapy is an emerging field of drug-discovery research and medical science. Stem cells are found in all multi-cellular organisms and have a variety of significant medical applications. All the tissues of the body begin with stem cells. These cells are the template from which all types of cells are derived. As cells die off or are damaged, the hundreds of thousands of stem cells in the human body grow into new tissue. This is due to the ability of stem cells to replicate themselves via mitosis and to generate a various specialized cell types. In recent years stem cells are subject of increasing scientific interest because of their potential utility in numerous biomedical application. stem cells technology provides unprecedented opportunities not only for investigating new ways to prevent and treat a diseases but also for changing the way we identify new molecular targets, discover and develop new drugs, as well as test them for safety.

Key- word: steam cell, Embryonic stem cell, Adult stem cell.

Address of correspondence: **Mr. Kote Amol P.**
Department of Pharmacology, S.V.N.H.T'S College of B.Pharmacy, Shrishivajinagar (Rahuri factory), Tal-Rahuri, Dist-Ahmednagar, MS, India-413706.Email: amolkote@gmail.com

Introduction

Stem cells are cells with the potential to develop into many different types of cells in the body. They serve as a repair system for the body. A cell that has the ability to continuously divides and differentiate (develop) into various other kind of tissues or cells

Stem cells are cells found in most, if not all, multi-cellular organisms. They are characterized by the ability to renew themselves through mitotic cell division and differentiating into a diverse range of specialized cell types.[1,2]

Laboratory studies of stem cells enable scientists to learn about the cells essential properties and what makes them different from specialized cell types. Scientists are already using stem cells in the laboratory to screen new drugs and to develop model systems to study normal growth and identify the causes of birth defects. 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 raises scientific questions as rapidly as it generates new discoveries.[1,2,3,4]

SOURCES OF STEM CELLS

There are numerous sources of stem cells which have been very difficult and interesting to extract. The sources are as follows-

1. Embryo
2. Umbilical cord
3. Haemopoetic cells
4. Amniotic fluid

Embryonic stem cell lines (ES cell lines) are cultures of cells derived from the epiblast tissue of the inner cell mass (ICM) of a blastocyst or earlier morula stage embryos. A blastocyst is an early stage embryo approximately four to five days old in humans and consisting of 50–150 cells. ES cells are pluripotent and give rise during development to all derivatives of the three primary germ layers ectoderm, endoderm and mesoderm. In other words, they can develop into each of the more than 200 cell types of the adult body when given sufficient and necessary stimulation for a specific cell type. They do not contribute to the extra-embryonic membranes or the placenta.[2,5,6,7,8.]

CLASSIFICATION[2,7]

CLASSIFICATION BASED ON THEIR LOCATION

CLASSIFICATION BASED ON THEIR PLASTICITY

CLASSIFICATION BASED ON THEIR LOCATION:

Human stem cells can be classified into following major type s

1. **Embryonic germ cells.**
2. **Fetal stem cells.**
3. **Infant stem cells.**
4. **Adult stem cells**
5. **Eye stem cells.**
6. **Pancreatic stem cells.**
7. **Neuronal stem cells.**
8. **Epidermal stem cells (skin and hair).**
9. **Bone and cartilage stem cells.**
10. **Liver stem cells.**
11. **Gut stem cells.**

1. Embryonic germ cells:

. Human embryonic germ cells have been successfully isolated and characterized. These stem cells are pluripotent and are able to produce cells of all three germ layers.

2. Fetal stem cells:

Fetal neural stem cells found in the fetal brain were shown to differentiate into both neurons and glial cells. Fetal blood, placenta and umbilical cord are rich sources of fetal hematopoietic stem cells.

3. Umbilical cord stem cells:

Umbilical cord blood contains circulating stem cells and the cellular contents of umbilical cord blood appear to be quite distinct from those of bone marrow and adult peripheral blood.[8]

4.Adult stem cells:

Hematopoietic stem cells bone marrow possesses stem cells that are hematopoietic and mesenchymalin origin. Hematopoiesis is the production and maintenance of blood stem cells and their proliferation and differentiation into the cells of peripheral blood. The hematopoietic stem cell is derived early in embryogenesis from mesodermand becomes deposited in very specific hematopoietic sites within the embryo. These sites include the bone marrow, liver, and yolk sac. Hematopoietic stem cells can be purified using monoclonal antibodies, and recently, common lymphoid progenitor and myeloid erythroid progenitor\ cells have been isolated and characterized[9]

5.Gut stem cells:

The gastrointestinal epithelial lining undergoes continuous and rapid renewal throughout life.. Epithelial renewal is sustained with populations of multipotent stem cells residing in distinct anatomic sites governed by niches. A major challenge is to identify these niches, the properties of these stem cells and the molecular mechanisms underlining their fate decisions in appropriate developmental pathways. These answers will provide clues as to why some patients infected with Helicobacter pylori are at risk in developing gastric adeno carcinoma.Epithelial cells migrate from the crypt to a flat surface cuff that surrounds its opening. The stem cell hierarchy in the gut and the fact that stem cells and their progeny are located in well defined anatomic units make the gut an ideal in vivo model for stem cell research.

6. Liver stem cells:

Mammals are said to survive surgical removal of at least 75% of the liver by regeneration. The original tissue can be restored in 2–3 weeks. This is in contrast to most other organs such as the kidney or pancreas. Recent evidence strongly suggests that different cell types and mechanisms are responsible for organ reconstitution, depending on the type of liver injury. In the case of the liver, regeneration must be distinguished by transplantation (repopulation) with donor cells.

7.Bone and cartilage stem cells:

Mesochymal Stem Cells in bone marrow can differentiate into bone and cartilage under appropriate conditions. However, if bone or cartilage is injured, are there stem cells inherent in bone or cartilage to participate in the repair process? Bone itself has been found to have both uncommitted stem cells as well as committed osteo progenitor cells. In addition, when bone is fractured, there is exposed marrow and abundant bleeding with hematoma formation in the marrow space, which results in good repair potential. In vivo, articular cartilage has a very limited capacity for repair if injured. It is currently not clear whether there is a committed chondrocyte progenitor cell locatedwithin cartilage. In the presence of injury to cartilage, stem cells do participate in the repair process. The numbers, however, are small and the regulatory factors are limited. It is postulated that these cells may be derived from surrounding tissues such as muscle, bone or other non-cartilaginous tissues.

8.Epidermal stem cells (skin and hair):

The human skin comprises the outer epidermis and underlying dermis. Hair and sebaceous glands also make up the epidermis. The most important cell type in the epidermis is the keratinocyte which is an epithelial cell that divides and is housed in the basal layer of the epidermis. Once these cells leave the basal layer they undergo terminal differentiation resulting in a highly specialized cell called a squame which eventually forms either the hair shaft or thelipid filled sebocyte that form an outer skin layer between the harsh environment and underlying living skin cells. The epidermis houses stem cells at the base of the hair follicle and their self-renewing properties allow for the re-growth of hair and skin cells that occurs continuously. New keratinocytes are produced continuously during adult life to replace the squames shed from the outer skin layers and the hairs that are lost. Stem cells differentiate into an intermediate cell called the "transient amplifying cell" which gives rise to the more differentiated cell types inclusive of the keratinocytes and sebocytes.

9.Neuronal stem cells:

It has been suggested that a continuous neurogenic turnover occurs in some limited areas of the central nervous system (CNS). Two neurogenic regions of the adult mammalian CNS are supposed to be involved in this process: the sub ventricular zone (SVZ) of the forebrain and the dental gyrus of the hippocampus which are considered reservoirs of new neural cells.

10..Pancreatic stem cells:

There has been controversy as to whether the pancreas contains true stem cells. It was reported that the endocrine cells of the rat pancreatic islets of Langerhans, including insulin-producing beta-cells, turn over every 40–50 days by processes of apoptosis and the proliferation and differentiation of new islet cells from progenitor epithelial cells located in the pancreatic ducts. The administration to rats of glucose or glucagonlike peptides resulted in the doubling of the islet cell mass, suggesting that islet progenitor cells may reside within the islet themselves.

11.Eye stem cells:

Stem cells have been identified in the adult mouse eye. Single pigmented ciliary margin cells were shown to clonally proliferate *in vitro* to form sphere colonies of cells that can differentiate into retinal-specific cell types, including rod photoreceptors, bipolar neurons and Muller glia. The adult retinal stem cells were localized to the pigmentary ciliary margin and not to the central and peripheral retinal pigmented epithelium.

CLASSIFICATION BASED ON THEIR PLASTICITY:

Stem cell can also be classified according to their plasticity. Different types of stem cells vary in their degree of plasticity or development versatility .Stem cells are perhaps best understood in terms of how committed they are to becoming particular type of cell .

The categories into which they fall include

1. **Unipotent Stem Cells**
2. **Totipotent stem cells**
3. **Pluripotent Stem Cells**
4. **Multipotent Stem Cells**

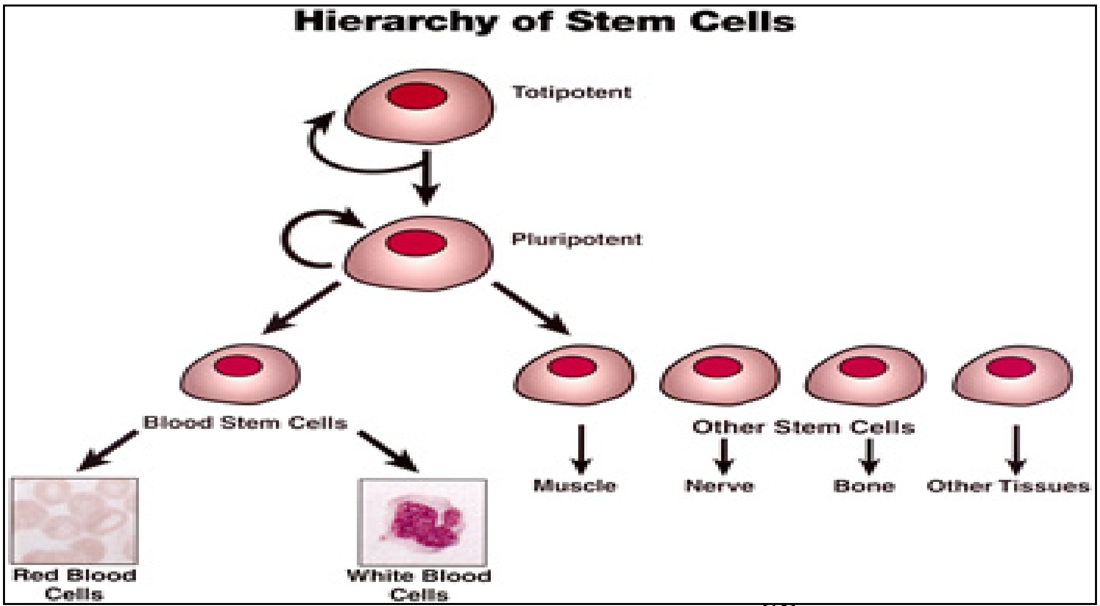

Fig.(2) classification of stem cells[12]

1.Unipotent Stem Cells

Due to interest in totipotent and pluripotent stem cells , unipotent stem cells have not received the same attention and research .They do , however have vast potential to treat health conditions .A unipotent stem cells refer to a cells that can differentiate along one lineage . The word 'uni' itself is derived from the latin word 'unus' meaning one .Found in adult tissues ,a unipotent stem cells, in comparisons with other types of stem cells that gives rise to a broad range of cell types. Although the unipotent adult stem cells in the body's tissues will only give rise to one cell type, they do still have the important property of self-renewal that is shared by all stem cells. Also, despite their differentiation potential being limited, unipotent cells still have vast therapeutic potential to treat injuries and diseases.

1. Totipotent stem cells

Totipotent stem cells are one of the most important stem cells type because they have the potential to develop into any cell found in the human body. In human development, the egg cell in a women and the sperm cell from a man fused together to form a single cell called the zygote. The zygote divides numerous times and forms cells that are the precursors to the trillion of cells that will eventually constitute the human body.

2. Pluripotent Stem Cells:

These cells are like totipotent stem cells in that they can give rise to all tissue types. Unlike totipotent stem cells, however, they can not give rise to an entire organism. On the fourth day of development, the embryo forms into two layers, an outer layer, which will become the placenta, and an inner mass, which will form the tissue of the developing human body. These inner cells, though they can form nearly any human tissue, cannot do so without the outer layer; so are not totipotent, but pluripotent. As these pluripotent cells continue to divide, they begin to specialize further.These are true stem cells, with the potential to make any differentiated cell in the bod. [10, 11.]

Three types of pluripotent stem cells have been found:

- **Embryonic Stem Cells:** these can be isolated from the inner cell mass (ICM) of the blastocyst – the stage of embryonic development when implantation occurs. For humans, excess embryos produced during in vitro fertilization (IVF) procedures are used. Harvesting ES cells from human blastocysts is controversial because it destroys the embryo, which could have been implanted to produce another baby (but often was simply going to be discarded).

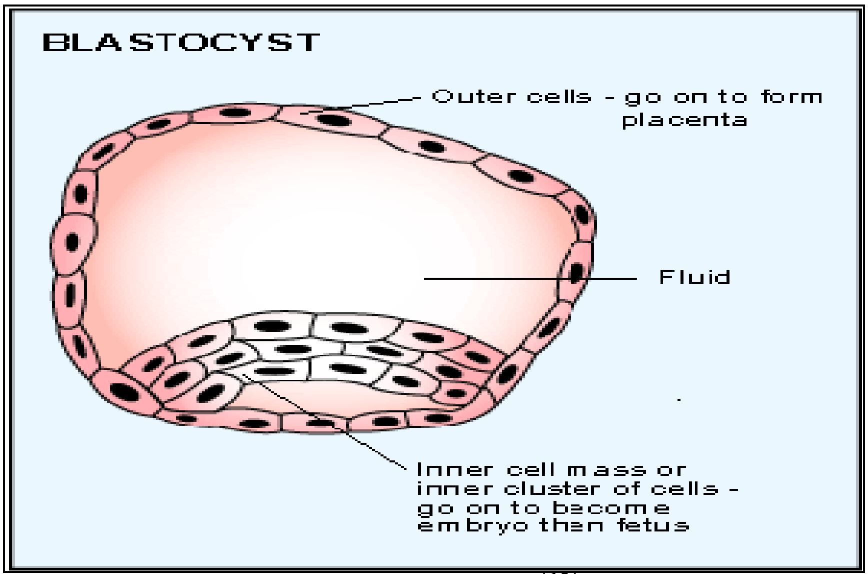

Fig. (3) Blastocytes[12]

- **Embryonic Germ Cells:** These can be isolated from the precursor to gonads in aborted fetuses.

- **Embryonic Carcinoma Cells:** These can be isolated from teratocarcinomas, a tumor that occasionally occurs in gonads of fetus. Unlike the other two, they are usually aneuploid. All three of these types of pluripotent stem cells can only be isolated from embryonic or fetal tissue. They can be grown in culture, but only with special methods to prevent them from differentiating.[12,13]

3.Multipotent Stem Cells:

These are less plastic and more differentiated stem cells. They give rise to a limited range of cells within a tissue type. The offspring of the pluripotent cells become the progenitors of such cell lines as blood cells, skin cells and nerve cells. At this stage, they are Multipotent. They can become one of several types of cells within a given organ. For example, Multipotent blood stem cells can develop into red blood cells, white blood cells or platelets.These are true cells but can only differentiate into a limited number of types. For example, the bone marrow contains Multipotent stem cells that give rise to all the cells of the blood but not to other types of cells.Multipotent stem cells are found in adult animals; perhaps most organs in the body (e.g. brain, liver) contain them where they can replace dead or damaged cells.These adult stem cells may also be the cells that – when one accumulates sufficient mutation – produce a clone of cancer cells.[14,15]

4.0 CELL AND RESEARCH

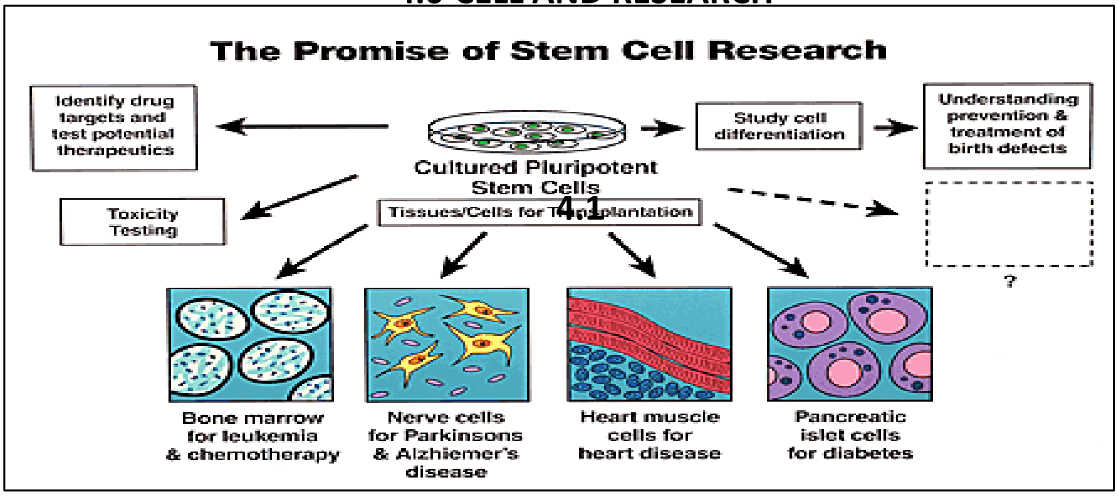

Fig.(4) The promise of stem cell research

Stem cells also hold great potential for usefulness in the area of research.

The following are some of the biological topics, stem cell research might light on:[16,17,18]

1. Developmental human biology:

The studies of this topics is constrained by practical and ethical limitation. Human ES cells may allow the investigation of how early human cells become committed to the major lineages of the body , which form the myriad of functional cell types cell in adult. This knowledge will help may fields. For example, the field of cancer biology will benefit as it is now thought that many cancer originate from abnormalities in the normal developmental processes. Human ES cells will also help in the study of birth defect.

2. Transplantation:

Pluripotent stem cell could be used to generate unlimited supplies of tissues and organs .these stem cell product could theoretically restore function without immune suppression and tissue matching. Stem cells derived transplant of the skin, heart, kidney, and other major organs could make a huge impact on society.

3. Gene therapy:

Genetic material that prompts a necessary biochemical process or encodes a missing protein can be introduced into organ stem cells in order to achieve long term expression and therapeutic effect. The 'immortal' proliferate capacity of stem cells could overcome the problem of loss and insufficient expression of a gene, which gene therapy procedures currently face.

Models of human disease constrained by animal and cell culture models ES cells might provide cell and tissue types to study those pathogenic diseases and viruses such as hepatitis c that grow only in human or chimpanzee cell.

4. Human development:

One reason that stem cells are important is due to human development from stem cell. as such, an understanding of abnormal cell proliferation and differentiation. This means that an understanding of where things go 'wrong.' In stem cell division and thus lead to cancer can help us find ways to prevent the dysfunctional changes or employ effective ways to treat them with targeted drugs.

5. Birth defects:

Stem cell research has the potential to teach us more about how birth defects occur and how these can be prevented or possibly reversed. An understanding of the regulation and chemical triggers of stem cell proliferation and differentiation are key to addressing birth defects.

6. Cell Therapies:

We are also using organ transplants but unfortunately, the number of organs available for transplant is scarce in comparison with those requiring an organ transplant.

Many people suffer endlessly awaiting a transplant and others will die before they are able to receive one. The potential for stem cells to replace damaged cells and tissues is an exciting one for those who will require a transplant during their lifetime. Diseases that it is expected stem cells will treat one day include Alzheimer's and Parkinson's disease as well as those diseases affecting the retina and heart.

7. Heart Disease:

Heart disease is a huge killer in the western world and the quest for effective treatments is an important one. Researchers have shown success in treating disorders of the heart with adult stem cells derived from others tissues. The limits on embryonic stem cell research in many parts of the world have led to intense efforts for research into adult stem cells. After suffering from a heart attack, the damaged heart cells can't regenerate and repair themselves, which severely narrows treatment options for patients. The potential for stem cells to provide a source of healthy, functioning cardiac cells would offer enormous benefit for the millions of people suffering from heart condition.

8. Retinal Diseases:

Still has a highly variable success rate and further studies should hopefully refine the standards Embryonic stem cells have been used to treat blindness and other consequences of retinal diseases. Researchers utilize the properties of embryonic stem cells to regenerate vision. By transplanting stem cells in sheets over the damaged retina of patient, the stem cells impart proper function to the eye and restore vision. The procedure and techniques used such that more people who suffer from retinal diseases can benefit from stem cell therapy.

9. Lou Gehrig's disease

Lou Gehrig's disease is a degenerative condition affecting the motor neurons in the brain and spinal chord. Laboratory experiments have found that upon injection of stem cells into the spinal cord of rodents afflicted with a disease similar to Lou Gehrig's, they were able to walk again due to restored functioning of nerve cells.

5. EMBRYONIC STEM CELL:

Embryonic stem cells, as their name suggests, are derived from embryos. Most embryonic stem cells are derived from embryos that develop from eggs that have been fertilized *in vitro*—in an *in vitro fertilisation* clinicand then donated for research purposes with informed consent of the donors. They are *not* derived from eggs fertilized in a woman's body. The embryos from which human embryonic stem cells are derived are typically four or five days old and are a hollow microscopic ball of cells called the blastocyst. The blastocyst includes three structures: the trophoblast, which is the layer of cells that surrounds the blastocoel, a hollow cavity inside the blastocyst; and the inner cell mass, which is a group of cells at one end of the blastocoel that develop into the embryo proper.

Sources of Embryonic Stem Cells:[2,7]

1. In Vitro Fertilization:

The largest potential source of blastocysts for stem cell research is from in vitro fertilization (IVF) clinics. The process of IVF requires the retrieval of a woman's eggs via a surgical procedure after undergoing an intensive regimen of "fertility drugs," which stimulate her ovaries to produce multiple mature eggs. When IVF is used for reproductive purposes, doctors typically fertilize all of the donated eggs in order to maximize their chance of producing a viable blastocyst that can be implanted in the womb. Because not all the fertilized eggs are implanted, this has resulted in a large bank of "excess" blastocysts that are currently stored in freezers around the country. The blastocysts stored in IVF clinics could prove to be a major source of embryo A human blastocyst, which is produced about 5 days after fertilization, is smaller than the period at the end of this sentence.

2. Nuclear Transfer:

The process called nuclear transfer offers another potential way to produce embryonic stem cells. In animals, nuclear transfer has been accomplished by inserting the nucleus of an already differentiated adult cell—for example, a skin cell—into a donated egg that has had its nucleus removed. This egg, which now contains the genetic material of the skin cell, is then stimulated to form a blastocyst from which embryonic stem cells can be derived. The stem cells that are created in this way are therefore copies or "clones" of the original adult cell because their nuclear DNA matches that of the adult cell. As of the summer of 2006, nuclear transfer has not been successful in the production of human embryonic stem cells,1 but progress in animal research suggests that scientists may be able to use this technique to develop human stem cells in the future.

STEM CELLS IDENTIFICATION:

Scientists often use one or more of the following methods to identify adult stem cells: (1) label the cells in a living tissue with molecular markers and then determine the specialized cell types they generate; (2) remove the cells from a living animal, label them in cell culture, and transplant them back into another animal to determine whether the cells replace (or "repopulate") their tissue of origin.

Importantly, it must be demonstrated that a single adult stem cell can generate a line of genetically identical cells that then gives rise to all the appropriate differentiated cell types of the tissue. To confirm experimentally that a putative adult stem cell is indeed a stem cell, scientists tend to show either that the cell can give rise to these genetically identical cells in culture, and/or that a purified population of these candidate stem cells can repopulate or reform the tissue after transplant into an animal.

DIFFERENTIATION OF ADULT STEM CELLS:

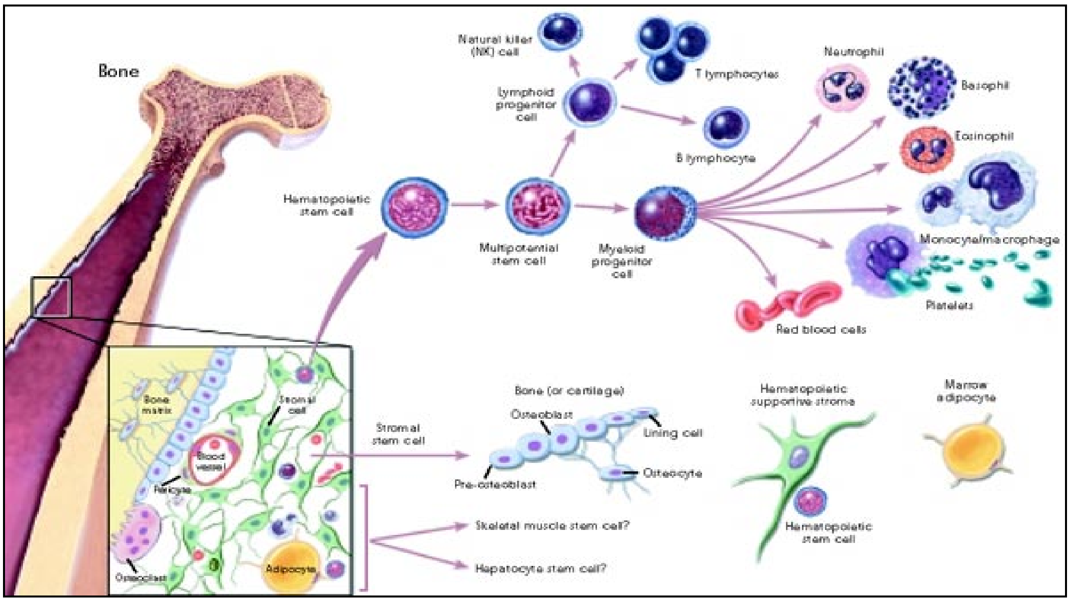

Fig.(6). Hematopoietic and stromal stem cell differentiation.

As indicated above, scientists have reported that adult stem cells occur in many tissues and that they enter normal differentiation pathways to form the specialized cell types of the tissue in which they reside.[12,16,19.]

6. EMBRYONIC Vs ADULT STEM CELLS:

Human embryonic and adult stem cells each have advantages and disadvantages regarding potential use for cell-based regenerative therapies. One major difference between adult and embryonic stem cells is their different abilities in the number and type of differentiated cell types they can become. Embryonic stem cells can become all cell types of the body because they are pluri potent. Adult stem cells are thought to be limited to differentiating into different cell types of their tissue of origin.

Embryonic stem cells can be grown relatively easily in culture. Adult stem cells are rare in mature tissues, so isolating these cells from an adult tissue is challenging, and methods to expand their numbers in cell culture have not yet been worked out. This is an important distinction, as large numbers of cells are needed for stem cell replacement therapies.

Scientists believe that tissues derived from embryonic and adult stem cells may differ in the likelihood of being rejected after transplantation. We don't yet know whether tissues derived from embryonic stem cells would cause transplant rejection, since the first phase 1 clinical trial testing the safety of cells derived from h ESCS has only recently been approved by the United States Food and Drug Administration (FDA).

Adult stem cells, and tissues derived from them, are currently believed less likely to initiate rejection after transplantation. This is because a patient's own cells could be expanded in culture, coaxed into assuming a specific cell type (differentiation), and then reintroduced into the patient. The use of adult stem cells and tissues derived from the patient's own adult stem cells would mean that the cells are less likely to be rejected by the immune system. This represents a significant advantage, as immune rejection can be circumvented only by continuous administration of immunosuppressive drugs, and the drugs themselves may cause deleterious side effects

Embryonic stem cells must be obtained when an embryo is in early development, that is, when the fertilised egg has divided to form about 1000 cells. These cells are separated and maintained in a cell culture dish, thereby halting embryonic development towards creating an individual. This is why embryonic stem cell research is the subject of ethical debates. Utilization of adult stem cells pose less of an ethical dilemma: however, adult stem cells may not have the same potential as those derived from embryos for medical therapeutics.
Embryonic stem cells have advantages and disadvantages for therapy.

7.0 STEM CELL THERAPIES TODAY AND IN THE FUTURE

7.1 STEM CELL THERAPIES TODAY:

Several stem cell therapies are routinely used to treat disease today,
These include:

- Adult Stem Cell Transplant: Bone Marrow Stem Cells
- Adult Stem Cell Transplant: Peripheral Blood Stem Cells
- Umbilical Cord Blood Stem Cell Transplant

Adult Stem Cell Transplant: Bone Marrow Stem Cells

Perhaps the best-known stem cell therapy to date is the bone marrow transplant, which is used to treat leukemia and other types of cancer, as well as various blood disorders.

Why this is stem cell therapy?

Leukemia is a cancer of white blood cells, or leukocytes. Like other blood cells, leukocytes are made in the bone marrow through a process that begins with multi potent adult stem cells. Mature leukocytes are released into the bloodstream, where they work to fight off infections in our bodies.

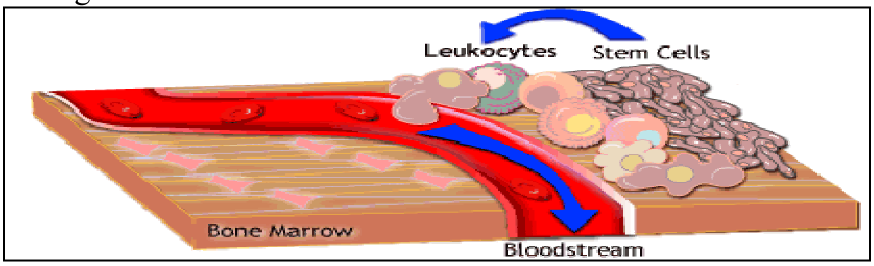

Fig. (7) multi potent adult stem cells (leukocyte)

Leukemia results when leukocytes begin to grow and function abnormally, becoming cancerous. These abnormal cells cannot fight off infection, and they interfere with the functions of other organs.successful treatment for leukemia depends on getting rid of all the abnormal leukocytes in the patient, allowing healthy ones to grow in their place. One way to do this is through chemotherapy, which uses potent drugs to target and kill the abnormal cells. When chemotherapy alone can't eliminate them all, physicians sometimes turn to bone marrow transplants.

In a bone marrow transplant, the patient's bone marrow stem cells are replaced with those from a healthy, matching donor. To do this, all of the patient's existing bone marrow and abnormal leukocytes are first killed using a combination of chemotherapy and radiation. Next, a sample of donor bone marrow containing healthy stem cells is introduced into the patient's blood stream. If the transplant is successful, the stem cells will migrate into the patient's bone marrow and begin producing new, healthy leukocytes to replace the abnormal cells.[14,15]

Adult Stem Cell Transplant: Peripheral Blood Stem Cell Transplant:

While most blood stem cells reside in the bone marrow, a small number are present in the bloodstream. These multi potent peripheral blood stem cells, or PBSCs, can be used just like bone marrow stem cells to treat leukemia, other cancers and various blood disorders. Since they can be obtained from drawn blood, PBSCs are easier to collect than bone marrow stem cells, which must be extracted from within bones. This makes PBSCs a less invasive treatment option than bone marrow stem cells. PBSCs are sparse in the blood stream, however, so collecting enough to perform a transplant can pose a challenge.

Umbilical Cord Blood Stem Cell Transplant:

Newborn infants no longer need their umbilical cords, so they have traditionally been discarded as a by-product of the birth process. In recent years, however, the multi potent-stem-cell-rich blood found in the umbilical cord has proven useful in treating the same types of health problems as those treated using bone m arrow stem cells and PBSCs.

Umbilical cord blood stem cell transplants are less prone to rejection than either bone marrow or peripheral blood stem cells. This is probably because the cells have not yet developed the features that can be recognized and attacked by the recipient's immune system. Also, because umbilical cord blood lacks well-developed immune cells, there is less chance that the transplanted cells will attack the recipient's body, a problem called graft versus host disease. Both the versatility and availability of umbilical cord blood stem cells makes them a potent resource for transplant therapies.[8]

7.2 STEM CELL THERAPIES IN THE FUTURE:

In Stem Cell Therapies future, we saw how stem cells are being used to treat diseases such as leukemia, kidney diseases, eye diseases, pancreatic diseases, spleen diseases etc. Stem cell transplant procedures also show promise for treating neurological disorders such as Parkinson's disease.

What does the future hold for stem cell therapies?

Researchers and physicians are working to design stem cell therapies that

- Are more effective, and
- Reduce the invasiveness and the risk to patients.

Today's stem cell therapies usually rely on cells that are donated by another person. This raises the possibility of donor cell rejection by the patient's immune system. In the future, it may be possible for a person to use a sample of his or her own stem cells to regenerate tissue, which would reduce or even eliminate the danger of rejection. How might this be done? Some possibilities include:

- Collecting healthy adult stem cells from a patient and manipulating them in the laboratory to create new tissue. The tissue would be re-transplanted back into the patient's body, where it would work to restore a lost function.
- Therapeutic cloning, as described in Creating Stem Cells for Research, might enable the creation of embryonic stem cells that are genetically identical to the patient.

- One less invasive way to achieve this goal would be to manipulate existing stem cells within the body to perform therapeutic tasks. For example, scientists might design a drug that would direct a certain type of stem cell to restore a lost function inside the patient's body. This approach would eliminate the need for invasive surgical procedures to harvest and transplant stem cells.

On the surface, the possibilities for stem cell therapy seem limitless. Couldn't we use stem cell technologies to replace any diseased or damaged tissue in the body? To answer this question, researchers must figure out the true potential and limitations of stem cells. Some questions currently being addressed include:

How long will a stem cell therapy last?

- The reason we age is because our cells do. If adult stem cells are used in therapies, will the tissues created from those cells age and malfunction more quickly? Scientists don't yet know how long different stem cell treatments might last.

Can we ensure that stem cell therapies won't form tumors in the body?

- Embryonic stem cells are naturally programmed to divide continuously and remain undifferentiated. To be used successfully in therapies, embryonic stem cells must be directed to differentiate into the desired type of tissue and ultimately stop dividing. Any undifferentiated embryonic stem cells that are placed in the body might continue to divide in an uncontrolled manner, forming tumors.
- Avoiding tumor growth is crucial to the success of stem cell therapies. Let's look at this in more detail. In both embryonic and adult stem cells, improper regulation of genes can lead to uncontrolled cell division and tumor formation. This is a special concern with cells that have been cultured in the laboratory for a period of time, because they may regulate their genes differently than they would in the body.

Why does this happen? Because most cells in our bodies are not meant to divide indefinitely, and none of them are meant to grow in lab dishes. Many tissues, such as blood and skin, rely on a renewal process that directs cells to stop dividing, differentiate and even die after a period of time. Proper direction comes in the form of signals from neighboring cells and the environment in which the cells live.[16,17,18,20.]

8.0APPLICATION:

1. Vision Repair:

Macular degeneration of the eyes is the bane of aging. It is the leading cause of vision loss in people 60 or over. Located in the center of the retina, the macula breaks down with age. Currently there is no cure for this disease and treatment options are only able to slow down the rate of vision loss.

However, recent success by a group of researchers able to reprogram bone marrow stem cells to repair damaged retinas in mice is pointing the direction at new potentials for vision repair.

Researchers at the University of Florida have succeeded in removing blood stem cells from the bone marrow of mice, reprogramming them and then injecting these modified cells into the animals' circulating systems. The modified cells, taking environmental cues from the damaged retinas, replaced the damaged cells. Within 28 days, the retinal function of these mice returned to normal.

2. Muscle Regeneration:

Similar to macular degeneration, Duchene Muscular Degeneration (DMD) is characterized by a chronic degeneration of skeletal muscle cells; this degeneration begins by age 3 and leads to progressive muscle weakness; by age 12, children with DMD are usually confined to wheelchairs. Currently, there is no cure for this disease. Recently, however, researchers at the Harvard Stem Cell Institute were successful in transplanting reprogrammed stem cells from normal adult tissue into the diseased muscle of mice that carried a mutated gene similar to human DMD.

3.Organ Reconstruction:

The plasticity of stem cells has created a host of research opportunities aimed at the bioengineering of human body parts. Medical technology is already in place for the regeneration of cartilage, bones and the internal walls of blood vessels. Scientists in Germany have found that the body's own heart muscle stem cells can recreate new heart tissue.

4.Brain damage:

Stroke and traumatic brain injury lead to cell death, characterized by a loss of neurons and oligodendrocytes within the brain. Healthy adult brains contain neural stem cells, these divide and act to maintain general stem cell numbers or become progenitor cells. In healthy adult animals, progenitor cells migrate within the brain and function primarily to maintain neuron populations for olfaction. Interestingly, in pregnancy and after injury, this system appears to be regulated by growth factors and can increase the rate at which new brain matter is formed. In the case of brain injury, although the reparative process appears to initiate, substantial recovery is rarely observed in adults, suggesting a lack of robustness. Stem cells may also be used to treat brain degeneration, such as in Parkinson's and Alzheimer's disease.

5. Cancer:

Research injecting neural (adult) stem cells into the brains of dogs has shown to be very successful in treating cancerous tumors. With traditional techniques brain cancer is almost impossible to treat because it spreads so rapidly. Researchers at the Harvard Medical School induced intracranial tumours in rodents. Then, they injected human neural stem cells. Within days the cells had migrated into the cancerous area and produced cytosine deaminase, an enzyme that converts a non-toxic pro-drug into a chemotheraputic agent. As a result, the injected substance was able to reduce tumor mass by 81 percent. The stem cells neither differentiated nor turned tumorigenic. Some researchers believe that the key to finding a cure for cancer is to inhibit cancer stem cells, where the cancer tumor originates. Currently, cancer treatments are designed to kill all cancer cells, but through this method, researchers would be able to develop drugs to specifically target these stem cells.

6. Spinal cord injury:

A team of Korean researchers reported on November 25, 2003, that they had transplanted multipotent adult stem cells from an umbilical cord blood to a patient suffering from a spinal cord injury and that she can now walk on her own, without difficulty. The patient had not been able stand up for roughly 19 years. For the unprecedented clinical test, the scientists isolated adult stem cells from umbilical cord blood and then injected them into the damaged part of the spinal cord.

Transforming blastocyst stem cells into motor neurons had eluded researchers for decades. The next step will be to test if the newly generated neurons can communicate with other cells when transplanted into a living animal; the first test will be in chicken embryos. Su-Chun said their trial-and-error study helped them learn how motor neuron cells, which are key to the nervous system, develop in the first place. The new cells could be used to treat diseases like Lou Gehrig's disease, muscular dystrophy, and spinal cord injuries.

7 .Heart damage:

Several clinical trials targeting heart disease have shown that adult stem cell therapy is safe and effective, and is equally efficient in old as well as recent infarcts. Adult stem cell therapy for heart disease was commercially available on at least five continents at the last count (2007).
Possible mechanisms are:

- Generation of heart muscle cells
- Stimulation of growth of new blood vessels that repopulate the heart tissue
- Secretion of growth factors, rather than actually incorporating into the heart
- Assistance via some other mechanism

8.Neural and behavioral birth defects:

A team of researchers led by Prof. Joseph Yanai were able to reverse learning deficits in the offspring of pregnant mice who were exposed to heroin and the pesticide organophosphate. This was done by direct neural stem cell transplantation into the brains of the offspring. The recovery was almost 100 percent, as proved in behavioral tests in which the treated animals improved to normal behavior and learning scores after the transplantation. On the molecular level, brain chemistry of the treated animals was also restored to normal. Through the work, which was supported by the US National Institutes of Health, the US-Israel Binational Science Foundation and the Israel anti-drug authorities, the researchers discovered that the stem cells worked even in cases where most of the cells died out in the host brain.

9. Diabetes:

Diabetes patients lose the function of their insulin-producing beta cells of their pancreas. Human embryonic stem cells may be grown in cell culture and stimulated to form insulin-producing cells that can be transplanted into the patient.

However, success depends on developing procedures in all required steps:

- Have the cells proliferate and generate sufficient amount of tissue.
- Differentiation into the right cell type.
- Survival of the cells in the recipient (prevention of transplant rejection).
- Integration with the surrounding tissue in the body.
- Function appropriately in long-term.[2,7,22]

Conclusion

On the basis of above data the stem cells are very important in future aspects like in the treatment of heart disease, retinal disease, human development, birth defects, low Gehrig’s disease, Transplantation , gene therapy. Stem cells have the remarkable potential to develop into many different cell types in body. Serving as a sort of repair system for the body, they can theoretically divide 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 to either 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. These cells are capable of performing three important functions with unique abilities like Plasticity, Homing & Engraftment etc. Experiments using human stem cells for research considered to be important, to improve scientific knowledge in basic research, or to improve medical knowledge of the development of diagnostic, preventive or therapeutic processes for the treatment of human.

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