Original Research Paper

Volume - 10 | Issue - 10 | October - 2020 | PRINT ISSN No. 2249 - 555X | DOI : 10.36106/ijar

Zoology

A REPORT ON STEM CELLS AND THEIR APPLICATIONS

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ABSTRACT Stem cells are the building blocks of life. They have remarkable potential to regenerate and develop into many different cell types in the body during early life and growth. They are also a class of undifferentiated cells that are able to be differentiated into specialized cells types. Stem cells are characterized by certain features such as totipotency, pluripotency, multipotency, oligopotent and unipotency. The history of stem cell research had an embryonic beginning in the mid 1800s with the discovery that few cells could generate other cells. In the 1900s the first stem cells were discovered when it was found that cells generate blood cells. Nowadays, stem cell therapy is under research and till now, a very few stem cell therapies have been regarded as safe and successful. It is also found that stem cell therapy cast a number of side effects too. The cost of the procedure too is expensive and is not easily affordable.

KEYWORDS :

Characteristics of stem cells :

1. ***Totipotent*** **-** The ability to differentiate into all possible cell types. Examples are the zygote formed at egg fertilization and the first few cells that result from the division of the zygote.
2. ***Pluripotent*** **-** The ability to differentiate into almost all cell types. Examples include embryonic stem cells that are derived from the mesoderm, endoderm and ectoderm layers that are formed in the beginning stages of embryonic stem cells differentiation.
3. ***Multipotent*** **-** The ability to differentiate into a closely related family of cells. Examples include Hematopoietic (adult) stem cells. That can become red and white blood cells and platelets.
4. ***Oligopotent*** **-** The ability to differentiate into a few cells. Examples include (adult) lymphoid or myeloid stem cells.
5. ***Unipotent*** **-** The ability to only produce cells of their own type but have the property of self renewal required to be labeled a stem cell. Examples include adult muscle stem cells.

Sources of stem cells :

Stem cells come from three main sources :

1. Embryos formed during the blastocyst phase of embryological development (embryonic stem cells).
2. Adult Tissue(adult stem cells).
3. Umbilical cord blood.

Adult stem cells :

Adult or somatic stem cells exist throughout the body after embryonic development and are found inside of different types of tissues. The stem cells have been found in tissues such as the brain.

Bone marrow, blood, blood vessels, skeletal muscles, skin and the liver. They remain in a quiescent or non dividing state for years until activated by disease or tissue injury. Adult stem cells can divide or self renew enabling them to generate a range of cell types from the originating organs or even regenerate the entire original organ. It is generally thought that adult stem cells are limited in their ability to differentiate based on their tissue of origin, but there is some evidence to suggest that they can differentiate to become other cell types.

Embryonic stem cells:

Embryonic stem cells are derived from human embryos that are in the blastocyst phase of development. Sexual reproduction begins when a sperm fertilizes a female ovum to form a single cell called zygote which then begins a series of divisions forming 2,4,8,16 cells etc. This group of cells is called blastocyst. It consists of an inner cell mass (embryo blast) and an outer cell mass (trophoblast). The trophoblast becomes part of the placenta and the embryo blast becomes all the structure of the adult organism. This latter mass is the source of embryonic stem cells to impotent cells.

When extracting embryonic stem cells the blastocyst state signals went to isolate stem cells by placing the “inner cell mass” of the blastocyst into a culture dish containing a nutrient rich broth lacing the necessary stimulation to differentiate, they begin to divide and replicate while maintaining their ability to become any cell type in the human body, eventually, these undifferentiated cells can be stimulated to create specialized cells.

Umbilical cord blood :

Umbilical cord is an important source of stem cells, whether hematopoietic and thus obtainable from placental blood, or mesenchymal easily obtainable from the tissue of the cord itself. Mesenchymal Stem Cells (MSC) are a type of multipotent adult stem cells. MSCs have a good capacity to renew themselves and differentiate continuously into specialized cells of the various human tissues. However, MSCs can be found in more considerable numbers in Wharton's jelly, the matrix of umbilical cord and in placental tissues. The added advantage of Wharton's jelly is that there is no risk in harvesting procedure. The useful phenomenon of multi differentiating capacity has been interpreted as the expression of the “Plasticity” property of the MSCs.

Identification of stem cells :

One way to identify stem cells in a lab and the standard procedure for testing bone marrow or HSC is by transplanting one cell to save an individual without HSCs. If the stem cells produce new blood and immune cells, it demonstrates its potency.

Clonogenic assays (a laboratory procedure) can also be employed in vitro to test whether single cells can differentiate and self renew. Researchers may also inspect cells under a microscope to see if they are healthy and undifferentiated or they may examine chromosomes.

To test whether human embryonic stem cells are pluripotent, scientists allow the cells to differentiate spontaneously in cell culture, manipulate the cells so they will differentiate to form specific cell types, or inject the cells into an immune suppressing mouse to test for the formation of a teratoma.

Stem cells delivery method :

The clinical staff utilize various methods for injecting the stem cells including following injections:

1. Intravenous injection (IV injection)

The IV delivery method is a very simple process. A tubing line with a catheter tip threaded over a needle is placed into the patient's vein. Once proper placement is obtained, the needle portion is removed and the flexible plastic catheter is left in place in the vein with the tubing attached. The stem cell suspension will be administered through the IV after dexamethasone.

2. Intrathecal (IT) injection :

An IT injection is also commonly referred to as a spinal tip. It is a procedure used to access a cerebrospinal fluid(CSF) of the brain and spinal cord, and helps to deliver stem cells directly into the CSF, by passing the blood brain barrier. This is the least invasive method for delivering stem cells directly into CNS.

3. CT Guided intra spinal cord injection:

For patients with spinal cord injuries injection of stem cells will be performed after the spine MRI has been conducted to identify the exact injury locations.

4. Intramuscular injection:

The intramuscular injections of stem cells can assist patients with muscular dystrophy to recover better health gains. These injections are made directly into the muscles of the affected area.

5. ***Intra-vascular Interventional injection :***

Intravascular interventional injection can be applied to place stem cells directly into target organs or tissues using image guidance while the patient is under local anesthesia.

6. ***Intra articular injection :***

Patients with arthritis can be considered to receive stem cells through intra articular injections. This procedure can be performed as a simple injection using a syringe directly into the cavity of the affected joints.

7. Retrobulbar injection :

This injection is given into the soft tissue present behind the eyeball for certain diseases like optic hypoplasia, optic atrophy etc.

Applications of stem cells :

1. Stem cells could be used to replace damaged tissue including heart failure, spinal injuries, diabetes and parkinson's disease.
2. Stem cells could be used to study early events in human development and find out more about how cells differentiate and function.
3. Stem cells grown in the laboratory may be useful for testing drugs and chemicals before they are trailed in people.
4. Stem cells may be used for screening potential toxins in substances such as pesticides before they are used in the environment.
5. Stem cells may prove useful during the development of new methods for gene therapy that may help people suffering from genetic illness.

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