RESEARCH ARTICLE OPEN ACCESS

HUMAN STEM CELLS: An interpretation and impression on Human Adult Stem cell

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Abstract: An historically, understanding of molecular genetics aspects of human germ cell development has been limited, due to inaccessibility of early stages of human development to trialling.[1]

Human body is a multifarious structure that consists of a number of organ systems working in concert for the sustenance of life. Stem cells are a set of unspecialized cells which enable regeneration or renewal in our body and also can divide in self renewal to produce more of same type of stem cells[1]. Adult stem cells are undifferentiated cells found throughout the body after development that multiply by cell division to replenish dying cells and regenerate damaged tissues. These are also known as somatic stem cells. Germ cells have a unique function in the body. They are not only needed for survival or immediate physiological function of the individual, but also capable of contributing to the next generation. Germ line stem cell is a key to genomic transmission to future generations. Over recent years, there have been numerous insights into the regulatory mechanisms that keep an eye on both germ cell specification and the maintenance of the germ line in adults.[1]

Key words: Adult stem cell, Germ cells, undifferentiated cells, Self renewal

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INTRODUCTION

Our body performs a array of functions vital for its endurance and healthy subsistence which is made possible by the ability of the tissues to undergo renewal or regeneration. The renewal or regeneration of tissues is possible due to the presence of a unique set of unspecialized cells called the stem cells [1] Stem cells are a future promose for treating some diseases that currently have no cure.

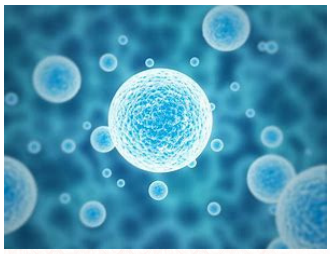

fig 1:Microscopic view of stem cell

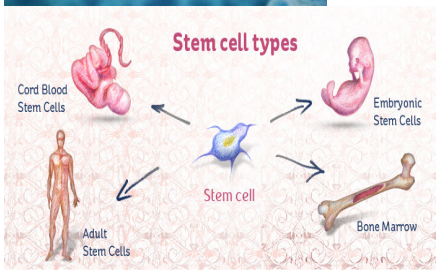

fig 2: Types of stem cell.

CLASSIFICATION OF STEM CELLS

The different types of stem cells are classified based on their capacity for differentiation & tissue of origin :

On their capacity for differentiation, which include [1]

Totipotent cells: Stem cells capable of generating an entire organism; this property is exhibited by embryonic stem cells.

Pluripotent stem cells: Found in embryonic, foetal and to some extent, in adult tissues; they can potentially differentiate into cells of ectodermal, mesodermal, and endodermal origin (germ layers).

Multipotent stem cells: These differentiate into cells of different lineages, usually derived from the same germ layer.

Induced pluripotent cells: These are created by retroviral transcription of genes like Oct4, Nanog, Sox2, Klf4, and c-myc from multipotent stem cells or adult somatic cells; these cells have properties similar to that of pluripotent cells.

Somatic cell nuclear transfer: This is a cloning technique where an adult somatic cell nucleus is introduced into a de-nucleated ovum; this ovum then divides to form the entire organism. This procedure could be used to generate human stem cell lines for therapeutic purposes (therapeutic cloning).

On the tissue of origin as hematopoietic stem cells, umbilical cord blood and stem cells from the dental pulp. Stem cells from the dental pulp exhibit predominantly mesenchymal stem cell (MSC) properties[1].

In mammals, adult stem cells can be classified broadly as: embryonic stem cells, which are isolated from the inner cell mass of blast cysts, and adult stem cells, which are found in various tissues[2].

Stem cells are present inside different types of tissue. Scientists have found stem cells in tissues, including the brain, bone marrow, skeletal muscles skin, liver, blood and blood vessels. They can stay non-dividing and non-specific for years until the body summons them to repair or grow new tissue.

ADULT STEM CELL:

Adult stem cells can be extracted from most tissues in the body, including the bone marrow, fat, and peripheral blood. They can also be isolated from human umbilical cords and placental tissue. These cells have a natural ability to repair damaged tissue[3]. Adult stem cells can divide or self-renew indefinitely. This means they can generate various cell types from the originating organ or even regenerate the original organ as a whole. This division and regeneration can be better explained on the skin wound healing process. In the past, scientists believed adult stem cells could only differentiate based on their tissue of origin, but recently some evidence now suggests that they can differentiate to become other cell types.

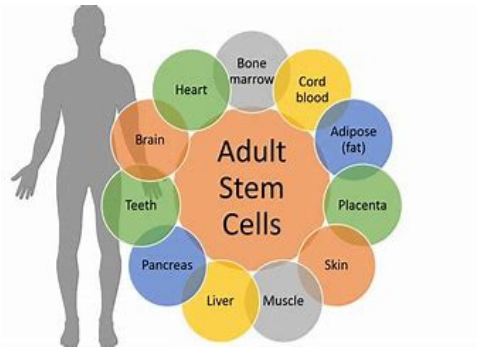

Fig 3: Adult stem cell sources.

Adult stem cells also known as somatic stem cells are undifferentiated cells found throughout the body that divide to replenish dying cells and regenerate damaged tissues. They can be found in children, as well as adults[4].

Research into adult stem cells to be mainly focused on their abilities to divide or self-renew indefinitely and generate all the cell types of the organ from which they originate — potentially regenerating the entire organ from a few cells[5]. More over the use of adult stem cells in research and therapy is not controversial because the production of adult stem cells does not require the destruction of an embryo like in embryonic stem cell. Adult stem cells can be isolated from a tissue sample obtained from an adult. They have mainly been studied in humans and model organisms such as mice and rats[6]. As definition of a stem cell states it possesses two properties: Self-renewal - the ability to go through numerous cycles of cell division while maintaining the undifferentiated state[7].

Multipotency or multi differentiate potential - the ability to generate progeny of several distinct cell types, for example both glial cells and neurons, opposed to unipotency - restriction to a single-cell type[8]. Some researchers do not consider this property essential and believe that unipotent self-renewing stem cells can exist[9-10]. Stem cell treatments are due to its ability to be harvested from the patient, their therapeutic potential is the focus of much research.

Adult stem cells, similar to embryonic stem cells, have the ability to differentiate into more than one cell type, but unlike embryonic stem cells they are often restricted to certain lineages[11].

The ability of a stem cell of one lineage to become another lineage is called trans differentiation.

Different types of adult stem cells are capable of trans differentiation more than others, and for many there is no evidence of its occurrence[13].

Consequently, adult stem therapies require a stem cell source of the specific lineage needed and harvesting and or culturing them up to the numbers required is a challenge.

Adult stem cells are found in skin, digestive system, cornea, umbilical cord, spinal cord, liver, fat, bone marrow, dental pulp, pancreas, brain, peripheral blood, blood vessels, retina, skeletal muscle, skin and digestive system[2].

Adult stem cells can be used to:

- To grow new cells in a laboratory to replace damaged organs or tissues.
- Repair and correct the parts of organs that don't work properly.
- Research causes of genetic defects in cells.
- Research on how diseases occur
- To study upon why certain cells develop into cancer cells.
- To test new drugs for safety and effectiveness.
- Stem cells can be used to study development

Stem cells may help us understand how a complex organism develops from a fertilized egg. Some of the most serious medical conditions, such as cancer and birth defects, are due to abnormal cell division and differentiation[11]. A better understanding of the genetic and molecular controls of these processes may yield information about how such diseases arise and suggest new strategies for therapy. This is an important goal of stem cell research.

1) Stem cells have the ability to replace damaged cells and treat disease : used in the treatment of extensive burns, and to restore the blood system in patients with leukaemia and other blood disorders.

Stem cells may also hold the key to replacing cells lost in many other devastating diseases for which there are currently no sustainable cures. Stem cells, if they can be directed to differentiate into specific cell types, offer the possibility of a renewable source of replacement cells and tissues to treat diseases including Parkinson's, stroke, heart disease and diabetes[7]. Though the prospect is an exciting, but significant scientific hurdles remain that will only be overcome through years of intensive research[4].

2) Stem cells could be used to study disease but it is difficult to obtain the cells that are damaged in a disease, and to study them in detail. Stem cells, either is the disease gene or engineered to contain disease genes, offer a viable alternative. Scientists in researches could use stem cells to model disease processes in the laboratory. However in people with degenerative diseases they are not released quickly enough to fully repair damaged tissue. In the case of fat stem cells they may not be released at all.

Germ cells are cells that create reproductive cells called gametes. Germ cells are located only in the gonads and are called oogonia in females and spermatogonia in males. In females, they are found in the ovaries and in males, in the testes.

Germ line stem cells, especially from *C. elegans* and *Drosophila*, are among the best understood adult stem cell types, and have provided important models for study of the regulation of adult stem cell behaviour in vivo. The new stem cells, known as human adult germ line stem cells (GSCs), were grown by researchers in Germany and the U.K. by adding special growth factors to spermatogonial cells extracted from testes. Spermatogonial cells are stem cells in the adult testis that normally generate only one type of differentiated cell (sperm) .

The hallmarks of adult stem cells are a committed but relatively undifferentiated state, a long-term ability to proliferate, and an ability to produce both new stem cells (self-renewal) and differentiating progeny. Analysis on the development of GSC has greatly influenced the study of stem cell biology in general and has informed our knowledge of human GSC behaviour. In view of the fact that the early recognition that adult gonads contain a self-renewing stem cell population, much is known about the physical nature of the stem cell compartments and the regulatory networks that keep the balance between self-renewal and differentiation.

The general features of GSC microenvironments in the gonads of some of the best-studied model organisms are illustrated below. Germ cells are only part of the gonad. During development and differentiation into gametes, germ cells undergoes interactions with specialized somatic cells.

causes a delay in GSC division, suggesting the existence of a checkpoint that monitors centrosome orientation prior to mitosis

Adult stem cell lineages are responsible for long-term maintenance and repair of tissues containing highly specialized, short-lived cell types, including blood, skin, and the epithelium of the intestine and colon, as well as sperm. Differentiated cells in many other tissues, including breast, lung, skeletal muscle, bladder, and prostate, are also produced from adult stem cells in response to physiological changes or damage. The mechanisms that regulate

adult stem cell self-renewal and the proliferation and differentiation of stem cell progeny are key not only for harnessing the potential of adult stem cells for regenerative medicine, but also for understanding the developmental origins of cancer. Many common cancers arise in adult stem cell lineages, and there is increasing evidence that defects in the mechanisms that regulate self-renewal, proliferation, and differentiation in adult stem cell lineages can contribute to oncogenesis. Thus, the tremendous recent advances in understanding how the local microenvironment of the stem cell niche regulates self-renewal and differentiation of germline stem cells have important implications for somatic biology as well as for the germline.

Germ cells, through their potential to differentiate into sperm and egg, have the ability to create a new organism. Analysis of the regulatory networks that control germ cell specification, self-renewal, and differentiation may ultimately lead to a better understanding of the control mechanisms that balance the need for genomic fidelity with the opportunity for evolutionary change[15].

CONCLUSION

Adult germ line stem cells exhibit the capacity for unlimited self-renewal and an ability to generate all somatic cell lines. Unlike embryonic stem cell, the adult stem cell research is not controversial so many more interventions can revolutionize the field of biomedical research.

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ACKNOWLGEMENT: BIOLIM STUDY MATERIALS

