

What is a Stem Cell?

Generally speaking, there are two types of stem cells: embryonic stem cells and adult stem cells. Embryonic stem cells are cells extracted from the blastula, the very early embryo, while adult stem cells are stem cells found in the body after birth. The term “adult stem cells” does not refer to a characteristic associated with adulthood, but rather a contrast with the developing embryo.

Stem cells are defined as cells with the unique capacity to self-replicate throughout the entire life of an organism and to differentiate into cells of various tissues. Most cells of the body are committed or specialized and play a well-defined role in the body. For example, brain cells respond to electrical signals and release neurotransmitters, cells of the retina are activated by light and pancreatic β -cells produce insulin. To the contrary, stem cells are primitive cells that remain undifferentiated until they receive a signal prompting them to become specialized cells.

Embryonic Stem Cells (ESC)

Typically, embryonic stem cells (ESC) are derived from the inner cell mass of the blastocyst or blastula, the very early embryo. In nature, ESC last only for a brief time as they only exist in the early embryo. As ESC develop and specialize to form various cell types of the developing fetus, they gradually lose their pluripotency (ability to develop into all types of cells) as they become the various specialized cell types of the developing infant. In vitro, cultured ESC can be maintained and can proliferate almost eternally.



Blastula with the inner cell mass (arrow) where ESC are located.

Although ESC have been studied for a long time as part of the study of embryonic development, it was only in 1998 that human embryonic stem cells were first successfully grown in vitro. The successful culture of human ESC immediately spurred a series of questions: 1) Since ESC can become virtually any cell type of the body,

could injection of ESC lead to improvements in various degenerative diseases? 2) Would it be possible to grow organs in vitro for the purpose of transplant? 3) Could we manipulate the genetic material of embryonic stem cells in order to repair faulty genes in an organ?

But such discussions and efforts became rapidly encumbered by profound ethical considerations. Since the source of human ESC has to be human embryos, central to this issue is the main question: "When is an embryo considered a full human being?" The idea of growing human embryos for the sole purpose of extracting ESC is obviously questionable. Many people believe that the fertilized egg, having the potential of becoming a full human being, is already a legal person. Therefore, with this view, the use of ESC is akin to murder. Supporters of ESC research argue that an embryo is far from a full human being, and if using embryos can save lives and increase quality of life, since they are going to be disposed of anyway, then it is worth it. So far the debate has greatly affected the development of Stem Cell research.

But aside from such ethical considerations, the main issue is that in spite of all the promises of ESC research, nearly 10 years of research have not delivered one successful and safe ESC-based therapeutic approach. Many studies using ESC have shown that although results can at times be remarkable, there is a significant risk of developing tumors.

Adult stem cells (ASC)

ASC are undifferentiated or primitive cells in your body that can self-renew and can differentiate into specialized cells of various tissues. Though ASC are most predominantly found in the bone marrow, they can be isolated from various tissues such as the liver,¹ the intestine,² muscles,³ the brain,⁴ the pancreas,⁵ as well as blood and many other tissues.⁶

The manner with which stem cells have been defined has created a significant bias that has for a long time hindered the development of adult stem cell research. Through the course of scientific investigation, ESC became defined as having the ability to grow many generations in vitro, to maintain their integrity after many generations, and to become cells of virtually any tissue of the body. This concept was applied to all stem cells in general. The technique of growing ESC in vitro has been well developed and many studies have used established ESC lines.

When the same techniques were used with adult stem cells (ASC), very different results were obtained. ASC are very difficult to grow in vitro, they do not maintain their integrity after many generations in vitro, it is difficult to trigger their differentiation in vitro, and injection of ASC under the skin does not lead to a teratoma. Therefore, for a long time ASC have been considered lesser stem cells with very little capability and therapeutic

potential. ASC certainly showed some level of “stemness”, as evidenced by the ability of hematopoietic (blood-related) ASC to become red blood cells, lymphocytes and platelets, but the belief that they were limited in their ability to become other types of cells led to a general lack of investigation into their therapeutic potential.

However, thanks to the work of numerous scientific teams throughout the world, the potential of ASC has been clearly revealed over the past 5 years. A large body of scientific data indicates that ASC have capabilities comparable to ESC, *when studied in a living organism or tissue*. For example, after transplantation, bone marrow and enriched hematopoietic stem cells (HSC) were shown to have the ability to become muscle cells,⁷ heart cells,⁸ endothelium capillary cells,⁹ liver cells,¹⁰ lung,¹¹ gut¹¹ and skin cells,¹² as well as neural cells.¹³ An ASC exposed to brain tissue will rapidly become a neuron or a glial cell,^{14,15} when exposed to liver tissue ASC will rapidly become hepatocytes,^{16,17} and hair follicle stem cells can regenerate a sectioned spinal cord.¹⁸ ASC can virtually become every cell type of the body, opening an entirely new path of research in the field of health and wellness.

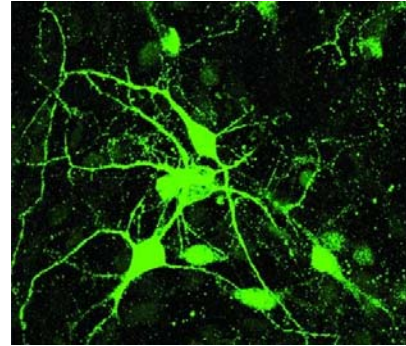
The role of ASC found in tissues is to maintain and repair the tissue in which they are found, however local stem cells appear to be only involved in relatively minor repair of the tissue in which they reside. In case of major injury or degeneration, the need for stem cells far exceeds the number of stem cells available in the tissue and stem cells from the bone marrow (BMSC) are called to contribute to the repair process. In essence, bone marrow stem cells constitute the natural renewal system of the body.

The Natural Renewal System of the Body

In brief, any time there is in the body an injury or a tissue not functioning optimally, the affected tissue releases specific compounds that trigger the release of stem cells from the bone marrow. The affected tissue also secretes SOS molecules that attract stem cells. As stem cells flow in the blood circulation and travel through the capillaries of the affected tissue, the SOS molecules attract stem cells and trigger their migration across the capillary wall into the tissue. When they arrive in the tissue, stem cells multiply and then transform into cells of that tissue. This phenomenon takes place after a heart attack, a broken bone, a stroke, a skin wound... any injury to a tissue, even chronic degenerative process taking place in the body over long periods of time. In this whole process the key parameter was shown to be the number of circulating stem cells; more stem cells in circulation in the blood means that more stem cells are available to migrate in tissues and carry tissue repair.

How Was This Discovery Made?

As with many discoveries in science, significant breakthroughs are made after the development of a tool that allows looking at the world in a different way. Often in science, discoveries are made after the development of a new tool of investigation. For example, how were bacteria discovered? People had been suffering from infectious diseases for centuries, not knowing that the cause of those diseases rested in these minuscule organisms. It wasn't until the invention of the microscope, which revealed the ubiquitous nature of bacteria are, that science could link specific bacteria to the development of specific diseases. Likewise what allowed breakthrough discoveries with stem cells is the development of a protein called Green Fluorescent Protein, isolated from a deep ocean jellyfish. The importance of this development is such that it was awarded the Nobel Prize in Chemistry in 2008. This protein is like a tracking device allowing to follow the movement of cells. Injecting Green Fluorescent Protein into stem cells suddenly made visible a phenomenon that until then had remained invisible. It became possible to literally SEE a stem cell become a liver cell or a pancreatic cell or a heart cell or a brain cell.



Stem cells were injected with Green Fluorescent Protein prior to being exposed to brain tissue. As stem cells transform into brain cells, it is possible to see neurons that are fluorescent.

Adult Stem Cells and Your Health

The discovery that increasing the number of circulating stem cells equates to greater health, coupled with the discovery of a natural compound that supports the release of stem cells from the bone marrow, offers a new strategy in the pursuit of health and wellness. In theory, since BMSC have the ability to become virtually any cell of the body, supporting stem cell release has the potential to support all aspects of human health. BMSC have been shown to support the health of the nervous system,^{19, 20,21} cardiac function,^{22,23,24} liver function,²⁵ pancreatic function,^{26, 27} kidney function,²⁸ lung,²⁹ skin,³⁰ and bone repair.³¹ But more importantly, the discovery of the role of stem cells in the body leads to a broader understanding of health and disease in general, a new paradigm in the way we view health and wellness.

A New Paradigm

The discovery that BMSC constitute the natural renewal system of the body is paving the way to a new paradigm in health and wellness. Once we understand that the role of stem cells is to patrol the body and migrate into areas needing assistance, it becomes

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clear that supporting stem cell physiology is the best strategy to maintain optimal health. Health problems do not begin the day we receive a diagnosis. Health problems begin to develop years if not decades before a disease is diagnosed, as part of the slow natural process of cellular loss.

Supporting the release of stem cells from the bone marrow and increasing the number of circulating stem cells in the early stages of this natural process supports the ability of the body to maintain optimal health. The number of stem cells circulating in the bloodstream has been shown to be a determinant factor for overall health. More stem cells circulating in the blood equates to greater health, as more stem cells are available for the day-to-day natural process of repair throughout the body.

Therefore the discovery of the natural renewal system of the body, along with the discovery of a natural product that supports stem cell release, opens the door to a new way of looking at health. Instead of looking at health as an absence of disease and at any health-promoting strategy as a way to postpone diseases, we can begin to look at health as a natural process, an intrinsic ability of the body. The human body possesses the natural ability to remain healthy, and supporting this natural ability by increasing the number of circulating stem cells logically becomes the best way to enjoy optimal health.

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