DSE-1BT: Developmental aspects of embryo

Stem cell

Stem cells are certain undifferentiated biological cells found in all multicellular organisms. They are in small portion in body mass, but can divide through mitosis to produce some offspring cells that continue as stem cells and some cells that are destined to differentiate (become specialized). Stem cells are an ongoing source of the differentiated cells that make up the tissues and organs of animals and plants.

❖ Characteristics of Stem Cell

All the stem cells found throughout all living systems have three important properties. These properties can be visualized in vitro by a process called clonogenic assays, where a single cell is assessed for its ability to differentiate.

The following are some properties of stem cells:

1) Stem cells, of all origins, are capable of dividing and **renewing** themselves for long periods of time. These cells undergo a period of cell proliferation while preserving the undifferentiated state.
2) All stem cells are **unspecialized or undifferentiated**. These are present as a mass of cells that differentiate later during their period of division.
3) Another essential property of stem cells is their ability to **differentiate** into specialized cells that together make up different tissue types. These cells can be either pluripotent or multipotent.

❖ Application of stem cells

1) Stem Cells and diabetes mellitus

Stem cells have generated incredible interest for repairing failing tissues and organs (Table 1). Stem cell therapy has become a tantalizing idea to provide glucose-responsive insulin-producing cells to Type 1 diabetic patients as an alternative to islet transplantation. Mesenchymal stem cells will grow and differentiate according to their environment. When MSCs injected into the pancreas *in vivo*, it is expected that MSCs will differentiate into pancreatic cells that have both exocrine and endocrine functions. Thus, transplantation of MSCs from bone marrow stem cells can repair the pancreas in its role to provide paracrine effects and other cell differentiation effects.

A beneficial effect of MSC transplantation on diabetes via a direct effect of differentiation to cells capable of producing insulin, or an indirect effect of secretion of immune modulators, which prevent endogenous T cells from eliciting pancreatic β-cell destruction, or other as yet unknown factors, which influence insulin secretion or action.

2) Stem cell therapy and Parkinson's disease

Parkinson's disease (PD) is a widespread neurodegenerative disease that characterized by bradykinesia, rigidity, and tremor. The pathological causes of PD are due to the Decrease of Nigrostriatal Dopamine (DA) neurons, but neuronal degeneration also occurs in non-DA-ergic systems. MSCs are capable of differentiating into tyrosine hydroxylase-positive neurons and can ameliorate motor performance in mice Parkinson's disease model. Moreover, it has been demonstrated that cells with DA-ergic can be produced from both rat and human MSCs, and that transplantation of these cells showed an improvement of motor function in an animal model of PD.

3) Stem cells and heart disease

Physicians of cardiac disease looking forward a remedy for the patients who are suffering from the heart disease. Cardiac transfer of stem and progenitor cells can have an adequate effect on tissue perfusion and contractile performance of the injured heart. Stem cells have the potency to promote myocardial perfusion and contractile performance in patients who are suffering from acute myocardial infarction, advanced coronary artery disease, and chronic heart failure.

4) Autoimmune diseases

Autoimmune diseases are produced as a result of an immune response of the body versus the normal cells and tissues. According to their ability to modulate immune responses, MSCs have also been proposed as a treatment for autoimmune diseases. Patients who are suffering from severe autoimmune diseases do not respond to the standard therapy and often require autologous or allogeneic Hematopoietic Stem Cell Transplantation (HSCT).

5) Liver diseases

Liver failure and cirrhosis occur as a result of a variety of chronic hepatic injuries. MSCs have the potential to be used for the treatment of liver diseases due to their regenerative potential and immunom-odulatory properties. They display sequential and overlapping severe pathogenic processes that include severe inflammation, hepatocyte necrosis, and fibrosis/ cirrhosis, and carry a high mortality rate.

MSCs have been demonstrated to play an immune-modulatory role through producing inhibitory cytokines or inducing the development of regulatory T cells. MSC therapy appears to be effective in regulating the immune response in tissue injury, transplantation, and autoimmunity in both animal models of liver disease and patients in clinical trials. MSCs can also directly inhibit the activation of Hepatic Stellate Cells (HSCs), the main cell source of the extracellular matrix, via MSC-derived IL-10 and TNF-α, and may also induce Hepatic Stellate Cells (HSC) apoptosis via, in part, the Fas/ FasL pathway. Notably, MSCs have the potential to differentiate into myofibroblasts, which act as scar-forming cells within the liver in certain settings.

6) **Kidney disease**

Mesenchymal stem cells can migrate to deteriorate kidney tissue where they can generate an array of anti-inflammatory cytokines and chemokines that can alter the course of the injury. Mesenchymal stem cells are thought to elicit repair through paracrine and/ or endocrine mechanisms that mend the immune response resulting in tissue repair and cellular replacement.