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STEM CELLS: A POWERFUL WAY TO SLOW AGING AND TREAT DISEASES

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Stem cells are a type of cell that can reproduce indefinitely and can develop into a wide range of cell types. They are found everywhere inside the human body, and they help to keep us alive and healthy. Scientists have learned how to turn stem cells into whatever cells the body needs, from fibroblasts to neurons. This could help to cure serious diseases like Parkinson's disease or Alzheimer's disease. In this article, we will introduce stem cells, describe their unique capabilities and discuss ways that scientists are using them to cure certain brain diseases.

STEM CELLS

Stem cells are a special type of cells that have two important properties. They are able to make more cells like themselves. That is, they self-renew.

DIFFERENTIATE

Make or become different in the process of growth or development.

Figure 1

Stem cell can differentiate into several other types of cells.

WHAT ARE STEM CELLS?

Many cells in the body have very specific functions. For example, red blood cells deliver oxygen throughout the body and skin cells protect the body from the environment. However, our bodies contain another unique type of cells called **stem cells**, which are different than other cells in that they do not have one specialized function. Instead, stem cells are unique because they can keep reproducing forever and can develop into many other types of cells, like nerve cells, fat cells, muscle cells, or blood cells (Figure 1). You can think of stem cells like seeds that can grow, or **differentiate** into several different kinds of trees.

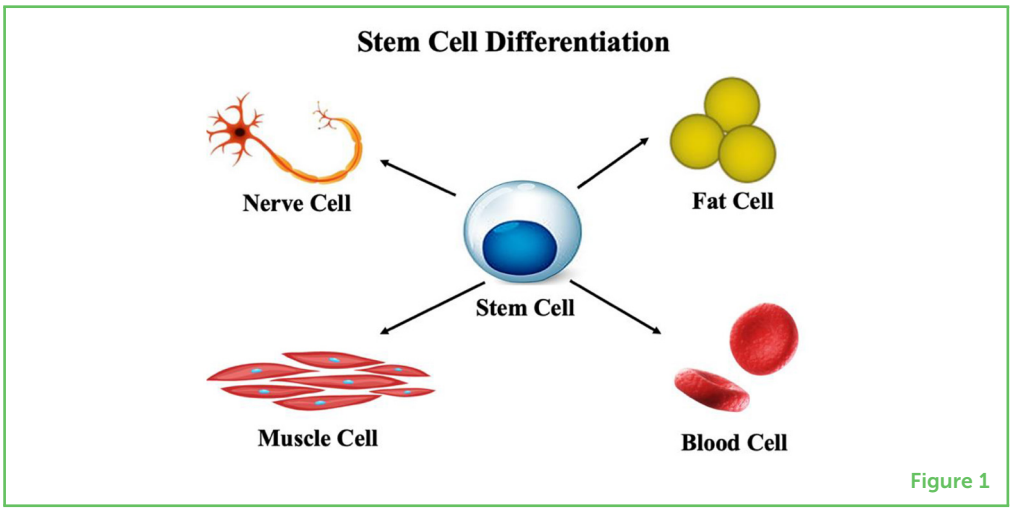

Figure 1

It is important to note that once a stem cell differentiates into a specialized cell, like a muscle cell or a fat cell, it cannot change back into a stem cell or change to a different type of specialized cell.

REGROWING LOST LIMBS—SOME ANIMALS' SUPERPOWER

Have you ever seen a gecko without its tail? Or maybe a crab that is missing a claw? Do not worry! These animals have a kind of superpower, they can regrow their lost body parts. But how exactly do they accomplish this?

MESENCHYMAL STEM CELLS

Mesenchymal stem cells (MSCs) are adult multipotent cells that can differentiate into a variety of cells types, including osteoblasts (bone cells), and adipocytes (fat cells).

Take geckos as an example. Inside a gecko's tail, there are some stem cells called **mesenchymal stem cells**, sleeping soundly. But the minute they detect damage, they wake up and get to work. First, mesenchymal stem cells divide because the original population is not enough to regrow an entire new tail. Once they finish reproducing, they begin to differentiate. Before you know it, the gecko has a brand-new tail!

Although this might sound simple, it is actually a lot more complicated than what we have described. But why is it that humans cannot regrow lost limbs? Most of the cells in human limbs are completely

differentiated, so there are not enough stem cells left to regrow a complex structure like an arm or a leg. Some human organs, like the liver and the skin, can regrow, however. The amazing example of geckos shows the great power of what stem cells can do, and the promising future of what humans can do with stem cells once we learn more about them.

COULD STEM CELLS DELAY AGING?

Mesenchymal stem cells are a type of stem cells that have multiple functions. They serve as the "generals" in the body, giving orders to other "soldier" cells, telling them what to do by sending signals using molecules called **cytokines**. Cytokines can improve skin health and maintain the balance of the immune system. Other than sending signals, mesenchymal stem cells also have navigation and positioning abilities, which means they can locate and find their way to areas in the body where there is damage.

Further, thanks to mesenchymal stem cells, delaying the effects of aging may no longer be just a dream. One thing that happens during aging is that the skin becomes thin and loses its elasticity. This happens because one important cell type in the skin, called **fibroblasts**, grow old and can no longer produce **collagen**—the protein that keeps skin healthy and stretchy. Fibroblasts also play an important role in wound repair [1]. By harnessing mesenchymal stem cells' power of producing cytokines, scientists are beginning to slow down the aging process of fibroblasts. This is often done by injecting mesenchymal stem cells into the skin using a very fine needle. Alternatively, skin care products containing collagen can be used for people who are afraid of needles.

STEM CELLS CAN TREAT CERTAIN AGE-RELATED BRAIN DISEASES

Stem cells and stem cell-derived products have also been investigated for treating certain age-related diseases, such as **Parkinson's disease** and **Alzheimer's disease** [2].

Parkinson's disease, for example, causes damage to the brain that results in symptoms including difficulty with movement or problems with certain thinking abilities [3]. Parkinson's happens when a patient's cells no longer produce enough dopamine, a compound that is necessary for controlling movement and coordinating motor functions. The most commonly used medicine for Parkinson's disease is levodopa, the raw material used by the body for making dopamine. But this medicine cannot totally compensate for the lack of dopamine in patients' bodies (Figure 2). Over time, the body's sensitivity to the

CYTOKINES

Cytokines are small proteins that are crucial in controlling the growth and activity of other immune system cells and blood cells.

FIBROBLASTS

Fibroblasts is a type of cell that contributes to the formation of connective tissue, a cellular material that supports and connects other tissues or organs in the body.

COLLAGEN

Collagen is a protein that is the primary building block of your body's skin, muscles, bones, tendons and ligaments, and other connective tissues.

PARKINSON'S DISEASE

Parkinson's disease is a movement disorder of the nervous system that worsens over time.

ALZHEIMER'S DISEASE

Alzheimer's disease is a brain disorder that slowly destroys memory and thinking skills, and eventually, the ability to carry out the simplest tasks.

medicine decreases, and levodopa no longer works as well to treat Parkinson's symptoms.

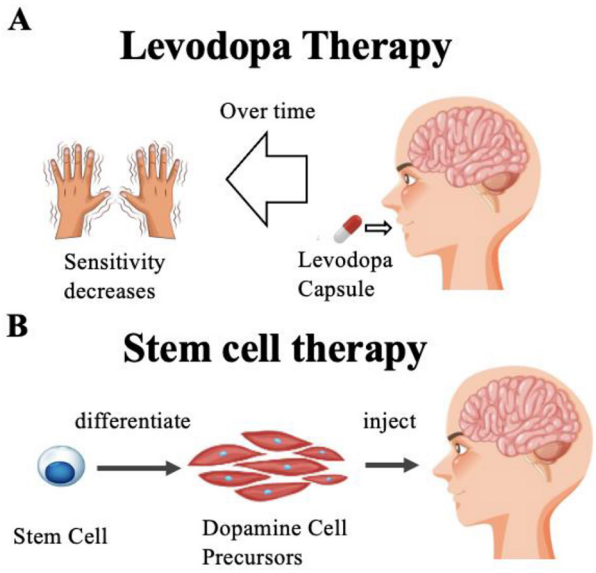

Figure 2

Figure 2

In Parkinson's disease, brain cells stop producing dopamine. **(A)** Currently, many Parkinson's patients take a medicine called levodopa. However, after some time, this medicine is no longer effective. **(B)** Instead, scientists are currently investigating whether it is safe and effective to turn stem cells into dopamine-produce brain cells, which could then be transplanted into patients. These cells can replace the malfunctioned cells and can be a potential cure for Parkinson's disease.

Stem cells now offer us a promising future! If scientists can turn stem cells into dopamine-producing brain cells, they could then transplant these new, healthy brain cells into patients' brains to replace damaged ones. With healthy new cells, the lack of dopamine might be solved once and for all.

Though scientists have not yet found out what exactly caused Alzheimer's disease, research has identified some possible causes of AD (Alzheimer's Disease). Inside an AD patient's brain, there is usually a buildup of two kind of proteins. One is beta-amyloid protein, which form clumps around neurons, damaging nearby neurons and stopping them from communicating. And the other one is tau protein which accumulate inside neurons, causing cell death.

There is currently no cure for AD. Medicines can only manage the symptoms of AD. By implanting stem cells into the patient's brain, they can differentiate into new neurons, so that dead or damaged neurons can be replaced. Then these newly generated neurons can help restore certain brain functions and improve cognitive impairment. Stem cells can not only replace damaged neurons, but also secrete some substance, which help protect the remaining healthy neurons and reduce further neuronal death.

HOPE AMIDST CHALLENGES

Today, expectations for stem cell therapies are higher than they have ever been. However, there are still many challenges that

scientists must overcome [4, 5]. For example, the difficulty in achieving consistent and controlled differentiation of stem cells into the desired cell types, and the complexities of immune rejection when using cells from different sources. All continue to hinder the widespread clinical application of stem cell treatments.

Despite these challenges, scientists are hopeful that stem cells will provide cure for variety of disease. Because advances in technology, such as improved gene editing tools and more precise methods for cell differentiation, are making it increasingly possible to overcome these obstacles and develop safer, more effective therapies. We hope that one day, in the near future, stem cells will improve human lives by delaying aging and helping to fight many important diseases that currently have no cure. Maybe, one day, we will even be able to regrow lost limbs like geckos do, thanks to the power of stem cells!

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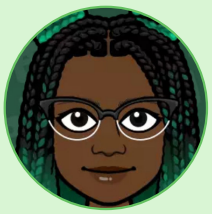
YOUNG REVIEWERS

DAKYUNG, AGE: 15
I have lived and gone to school in California, where squirrels roam in the vast land; Hawaii, where chickens and critters thrive under vivid skies; and my homebase in Seoul, where the cicadas become your alarm clock in the summer. As you can probably tell, biology has always been a cherished part of my life. Also, I love social studies because I can study the relationship of world events, and I enjoy exploring foods from other cultures.



ELISA, AGE: 15
Elisa is a young girl with a curious mind. She is very passionate about science, especially related to health. She hopes that, with her critical thinking, her love for health discoveries and her drive, she will be able to contribute to science through journal review.

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