

## Dental Pulp Stem Cells: The New Upcoming Advancement in Tooth Regeneration

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Dental pulp cells, new research aspects being conducted in the dental field, are stem cells from the inner nerves (pulp) of a tooth that can be isolated and tested for their usage. In the case of these studies, the pulp cells and other comparative stem cells are used in order to test for regeneration. This regeneration includes tissue regeneration from injury, damage, or depletion, and the start of full tooth structures. Research goes from testing on animals to the testing being conducted on scaffolding outside of animal's bodies, and stem cells from human teeth, animal teeth, and other tissues from other parts of the body. In order to come up with the advancements that scientists have, many studies have been conducted. One has taken cells from two human wisdom teeth to test for growth; others have taken the stem cells from rabbit teeth and done the same research within in and out of the body. In the end, all of the studies are being conducted in order to further the knowledge of stem cells in tissue regeneration and in the future, whole new teeth. Research in this field of study is becoming a huge advancement for the endodontic and periodontal fields to one day change the lives of many more people.

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### Introduction

Dental pulp, the inner portion of a tooth, has very important functions for the life and maintenance of a person's teeth. The pulp is the homeostasis portion of a tooth that maintains a long, healthy life for that tooth. Within the pulp of the tooth are stem cells that have sparked the interest in tooth and tissue regeneration. The increasing interest in this phenomenon comes from the high cost of endodontic treatments and the demand for maintaining pulp vitality (El-Backly). On top of this being a known issue in the dental field, it will always be an issue. People will always have missing teeth or damage to a tooth. Patients have dental work done every day, and there is bound to be some kind of tissue damage. This increasing research in order to discover tissue and tooth regeneration has gone in multiple directions. One of these directions includes taking stem cells from the pulp of a tooth and some from adipose tissue and implanting them into an animal. Another direction is removing pulp stem cells from wisdom teeth and growing them in a gel, and finally pulp stem cells were taken from an animal, grown, and implanted back into the animal to test for growth. The ideas for all of these directions of experiments lead to the

idea of growing normal, functional tissues that can be used in regeneration.

The concepts of regeneration are in order to repair injuries with hard tissue that is as closely identical as the damaged tissue as possible. These injuries could occur from microbial irritation or food-borne microorganisms that were able to get into the pulp area and take over the surrounding tooth structure. Recent experiments have been able to lead to new advancements in this idea of tissue and tooth regeneration, and all are done in different ways with different results. There are many research projects that have shown success when dental pulp has been able to differentiate itself to regenerate dentine and pulp tissue that is very similar to regular physiological tissue found in typical tooth structures (El-Backly). With the following experiments and progress, the industry of tissue injury and repair should continue to advance to discover the unknowns in the close future.

### Recent Progress

Recent progress in this field of research is only going to increase with every experiment or study that is conducted.

Each set of experimenters change where the cells are coming from or where they are tested for when concerned for growth. Science is all about adding to what is already known so the more progress fields have; the more scientists can add to what is known and improve certain processes to benefit the future. In this case, advancement in dental science can improve many aspects. This includes the patient's health, the time and cost of dental treatments down the road, and the ease of a dentist's career. The more knowledge develops, the easier jobs become, and the more successful medical professionals can be when helping their patients. Patient health is the priority for anyone in the healthcare field and that is why the following experiments have such importance in the dental research field.

In one research project, dental pulp cells were isolated from rabbit teeth and placed onto scaffolding or on a porous material and measuring the growth of cells on the particular material to see if it forms tissue. A lower incisor was removed from one of the rabbits and isolated in antibiotics to then isolate the dental pulp stem cells. After growth was found on the scaffolding, each of the four rabbits received scaffolding and a control placed into the dorsal (back) portion of their bodies. Results were taken after time and progress was made in this field of research. The isolated cells shows great diversity in size and shape of cells, and the implanted cells showed even greater results. The implanted cells showed great organization and density, along with the complete healing of the implantation spot with hair growth returning. The skin was said to have completely healed and an increase in the number of blood vessels and capillaries. The scaffold with stem cells compared to the control showed very pronounced differences with areas of regenerated tissues (El-Backly). This is a great progression with tissue regeneration and the use of stem cells implanted somewhere else in a body.

In more recent times, experiments have been conducted in order to determine if pulp stem cells can regenerate and what kind of product the regeneration will have. A recent experiment surgically took the pulp from two wisdom teeth from two different people. In addition, they took rat tail collagen and added the extracted cells along with other solutions to well-plates. Some of the solutions showed a decrease in DNA in the stem cells. Other than the solutions that created a decrease in DNA, the other solutions showed cell growth in the gel hinting at chemo tactic cytokines at work. This cell migration mimics the environment by showing the same engineering of tissues and healing wounds (Chen). Unlike other experiments the progress of showing this advancement on a gel culture because of its ability to work with all types of cells, but it also has its drawbacks. Future experiments may show more accurate results without the drawback of

using this particular medium that creates shrinkage among other things.

An even more recent experiment was still testing for regeneration in stem cells; however, the difference is the addition of testing with adipose tissue cells, created a comparison between the effectiveness and the success of the certain cells. For this particular study, many different types of dental stem cells were isolated, including, dental pulp stem cells and mesenchymal stem cells. The idea is to test the potentials these cells have to form dental tissues, but the goal to regenerate a whole tooth has yet to be met. This step in development of the research will surely come with further experiments.

Mesenchymal stem cells come from tissues in the skin, bone marrow, and adipose tissue. These types of stem cells are very readily available in the body and are easy to extract without an invasive procedure. In order to conduct this study to test the different cells, implants were put in place to watch for regeneration of new teeth from different cells. After the placement of the cells from dental tissue and abdominal tissue into the location where the right incisors would generally be, several tooth-like structures appeared over time. Out of the experimental and the control rabbits, the rabbits with the stem cells treated with substances grew tooth-like structures, were as the rabbits without stem cells and just the substance showed no growth. Growth with both the adipose tissue stem cells and the dental stem cells were shown. This creates a huge step in science showing that when placed in the right area different kinds of stem cells can be used to regenerate tissue and structures that have been damaged or destroyed. Further research of the tooth-like structures show the presence of normal tooth structures and looked like the dentin of a real live tooth. The use of rabbit's teeth and their mouths creates an easier, less invasive experiment, and shows the same results it would in a human mouth. The results from this research show that without stem cells, there will be no regeneration of tooth-like structures. Also proven, was the fact that without the stem cells, no structures appeared so the idea that the structures are forming from remaining endogenous host cells, if they exist is false (Chang). This can directly affect the knowledge and benefits of human tooth regeneration further in the future.

There are many ups and downs to these new technological advances. The regeneration process encounters many hurdles such as the commercialization process and not to mention the hurdles in the clinical parts. The cost is extremely excessive including isolation, handling, storage, and shipping. On top of those issues, the possibility of contamination, pathogen invasion and transmission, and tumorigenesis from manipulation, and with the transplant of these cells, risks are involved (Chen).

All three of these experiments have added to the progress that has come to be what we know today. Future research in this field will lead to many new discoveries that may or may not eventually lead to new processes with stem cells. Only time will tell if this will become the new trend in tooth and tissue regeneration.

### Discussion

The results from all of these experiments, whether they be successful or not would have added to the knowledge and understanding of dental pulp stem cells in the long run. Learning what is successful and what is not, allows researchers to add, subtract, or edit parts of an experiment based on those failed or successful attempts. After damage from a root canal or periodontal disease, tooth and tissue regeneration will always be a necessity so the importance behind this research is only growing. After seeing what these researches have done by showing growth of tooth-like structures in animals and stem cell growth into dentin in and out of an animal, there is no doubt that steps have been made in the right direction. All of this recent progress has led to the idea that cell therapy can be used with the dental pulp stem cells in order to cap and protect or replace the dentin beneath an exposed area on a tooth.

These advancements in the understanding of tooth development in the fields of cellular biology has really set the standards for further research in the area of regenerating whole tooth organs (El-Backly). The huge issue and hurdles that must be worked through is coming up with a tooth organ that looks and functions like the original teeth people are born with. This is the future of dental stem cell biology. The more this information becomes available and the process of developing the stem cells becomes easier, the bigger effect it is going to have on the world wide community. Thinking further into future research, this could one day cure a child that was born with missing teeth or be an alternative to getting dentures as an elderly person. The need for this field of dentistry will never go away and if anything, gets bigger and bigger all the time. There will always be a patient that needs tooth regeneration or repair of tissues. Therefore, the research findings from the three experiments will never go to waste because the need for the information will never go away. So many impacts are being made in the dental field using resources that are in everyone's bodies that this could one day be the leading treatment in regeneration.

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