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# Stem Cells: A Gold Mine in Dental Research and Tissue Engineering

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## Abstract

**The explosion of articles not only in scientific journals, but also in the print media and continuous TV debates, one could easily say the term "stem cells" has become synonym to the word "cure".**

**The extraordinary advances in the prevention, diagnosis, and treatment of human diseases, such as oral health issues, cancer, heart disease, diabetes and diseases of the central and peripheral nervous system, such as Parkinson's disease and Alzheimer's disease, continues to deprive people of health and well-being. Tremendous effort and exceptional research in human developmental biology has led to the identification and discovery of human stem cells.**

**Keywords:** ***Stem cells; Dental research; Tissue engineering; Gold mine***

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## Introduction

### Stem Cells

Stem cells are a class of primitive cells found in almost all multi-cellular organisms and are characterized by their pluripotent and totipotent nature and their ability to differentiate into any mature cell type. The stem cells have the extraordinary potential for regeneration and thus can be used to replace or repair damaged cells of many diseased conditions.

Fundamentally there are 2 main types of stem cells - embryonic and adult stem cells - which are classified according to their origin and ability of differentiation potential [1].

### Mesenchymal Stem Cells (MSCs)

Mesenchymal stem cells (MSCs) are adult stem cells that can be harvested from human and animal sources. Human MSCs (hMSCs) are the non-haemopoietic, multipotent stem cells which can be isolated from bone marrow and other sources such as teeth, umbilical cord, placenta, liver, synovial membrane and amniotic fluid [2]. The role of hMSCs is continuously on rise and become central and indispensable to tissue regeneration and regenerative medicine. Their multipotency and ability to differentiate and develop into various types of tissues such as adipose, cartilage, and bone is center of attraction. They also found their increasing usage in patient-specific gene therapy [2]. One of the most defined and essential characteristics of hMSCs



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is the expression of cell surface marker. According to the International Society for Cellular Therapy standard criteria, cells which are positive for CD73, D90, and CD105 whereas negative expression of CD14, CD34, CD45 and HLA-DR are considered as MSCs.

**MSCs: Application in Bone, Tooth and Tissue Engineering**

Besides other fields of science rejuvenated interest and continued research in stem cells have also found its place in the field of dentistry as it could help in regeneration of vital structures like bone cementum, periodontal ligament fibers, dental pulp and salivary gland. In fact, stem cell research in dentistry gave a major leap and much needed direction to bridge the gap between dental problems and successful patient outcomes. Now it is well believed that stem cells grow rapidly and can develop into specialized dentin, bone, and neuronal cells. These labs grown neuronal cells can be used for various dental therapies and can provide a better treatment options for patients.

The regeneration of bone is a key issue and at the forefront of tissue engineering applications, mainly because of growing use and accessibility of osteoprogenitor cells. The use of natural and synthetic biomaterials as carriers for MSC delivery has shown increasing promise for orthopedic therapeutic applications, especially bone formation. Recent advances in the field of biomaterials have led to a revolutionary transition from non-porous, biologically inert materials to more porous, osteoconductive biomaterials, and the use of cell-matrix composites. Craniofacial structures-such as the mandibular condyle, calvarial bone, and cranial suture have been engineered from mesenchymal stem cells. The growing demand of its usage is not only due to it's readily availability, but it also has uncompromised advantages of its predecessors. Adult mesenchymal stem cells have advantages over embryonic stem cells for tissue engineering of the mandibular condyle, since MSCs can be obtained from the same individual and readily induced to differentiate into both chondrogenic and osteogenic cells [3]. hMSCs have the potential for the regeneration of dental tissues. Bio-engineered teeth can be derived from cultured tooth bud cells. And it consists a well-defined odontoblast, pulp chambers, pre-dentin, and dentin. It also contained a morphologically correct enamel organ composed of stellate reticulum, stratum intermedium, ameloblasts, and dental enamel [3,4].

**Salivary Gland Regeneration**

Salivary glands are (SGs) are one of numerous exocrine organs that have evolved to allow terrestrial living and thus responsible for maintaining the health of the oral cavity.  Saliva secreted out of this gland plays an important and often essential role in survival through its impact on diet. Although functional salivary glands are not essential for humans however SG dysfunction that arises from genetic anomalies [5] or damage from surgery and therapeutic radiation for head and neck cancer [6] or autoimmune diseases such as Sjogren's syndrome [7] impairs oral health, leading to lifelong symptoms of mastication and swallowing difficulties [8] speech impairment mucosal alterations [9], oral and accelerated tooth decay [10]. Despite of these long lasting detrimental and losses, current therapies are limited in its efficacy with no long-term solutions to restore salivary gland function. Consistent with the need to develop regenerative strategies, an increasing interest and focused approach has been devoted on the identification of stem cell populations and their regulators for the repair or regeneration of injured salivary gland. Suddenly genetic lineage tracing has found its place for identification of stem and progenitor cells in a plethora of organs including salivary gland. As only a few genetic lineage-tracing studies have been conducted thus far, we speculate that these approaches are continuing to grow. Besides this, regenerative approaches based on the reactivation of endogenous stem cells or the transplant of exogenous stem cells also hold tremendous potential in restoring the structure and function of these vital organs to improve patient quality of life.

## Conclusion

Tooth loss and salivary gland dysfunction can pose many problems, such as difficulty in chewing and less of saliva formation. Loss of tooth can also be a problem of aesthetics. The current clinical practices for the replacement and restoration of missing tooth, employs implantations and other such classic prosthetic approaches. Tissue engineering and regeneration and dental tissue engineering is a new and promising therapeutic approach that aims to replace the missing tooth or to restore other damaged dental tissue with a bioengineered counterpart. It mainly uses dental stem cells, seeded on the surface of biomaterials that provide the proper stimuli and essential microenvironment to create a bio complexed tissue.

Already a large number of studies have successfully shown the formation of dental tissues in animal models. And a recent clinical trial in humans has demonstrated the potential of adult dental mesenchymal stem cells to regenerate bone of the mandible. These recent findings are promising and prove that dental tissue engineering is soon going to be a reality in clinics.

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## Conflict of Interest

There is no conflict of interest.

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