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# The Effect of Matrix for Regeneration of Enamel, Dentin and Pulp: A Systematic Review

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**ABSTRACT**

The tooth structure does not have ability to regenerate on it's own until there is introduction of some inducing factors. Several inducing factors present in the form of stem cells, scaffolds and growth factors which thereby, plays role in the formation of enamel, dentin and pulp. In order to stimulate these regenerative factors, certain amount of temperature, pressure and atmospheric humidity should be in control. Specific knowledge of proteins which is present in each of the part of tooth structure (enamel, dentin) is important in order to achieve the final outcome. The present review elaborates about the achievement of tooth structure matrix and organs by usage of specific amount of proteins, growth factors, stem cells.

**KEYWORDS:** Stem cells, Signalling molecules, Growth factors, Enamel matrix, Dentin matrix, Tooth proteins

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## INTRODUCTION

The coronal portion of the tooth which comprises of enamel, dentin and pulp itself is a complex structures. The dentin forms major part of the tooth. Therefore, most of the tooth structure consist of organic matrix and non-collagenous content. The acidic glycoproteins, Gla proteins, serum proteins, proteoglycans etc. forms the remaining part. The dentin matrix consist of similar proteins as that of bone such as dentin phosphoprotein, dentin sialoprotein etc. as well as certain growth factors are also present. Any external disturbance like an infection, trauma, calcium or phosphoric metabolic changes can lead to defective amelogenesis. Mutational changes can lead to defect in dentin. An early diagnosis of any defect can result in an effective treatment plan, thereby, restoring functional and aesthetic features of orofacial dental structures.

In order to maintain the original structure of teeth, it is important to know the structural composition and how to restore it. Therefore, it is important to know different techniques in order to restore defective parts of orodental structures. Tissue engineering is a technique through which biological substitutes can restore, maintain or improve tissue and organ functions simultaneously.[(1)]It consist of stem/progenitor cells, scaffolds and growth factors[(1,2)] to regenerate functionally active biological tissues.

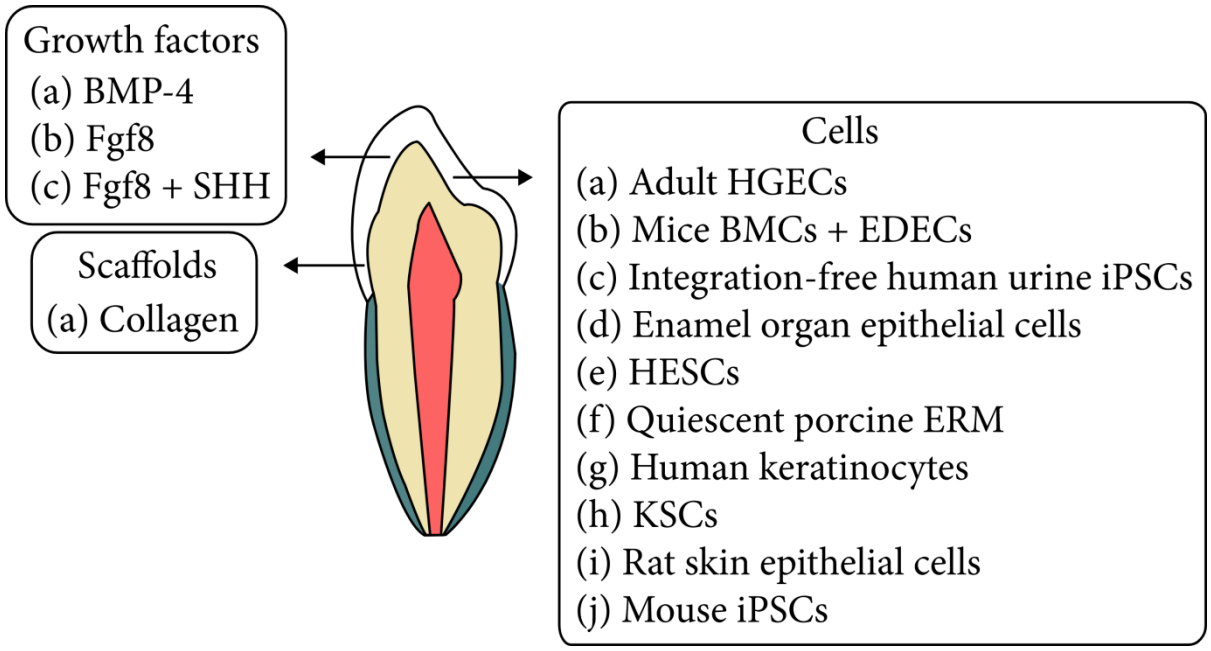
In case of decalcification process, enamel being the hardest but consists of more inorganic material which easily disintegrates as compare to dentin in which organic components of dentin are retained thereby, maintaining it's shape.[(3)]

## REVIEW

Enamel fabrication synthetically is a mode through which we can replicate the outer layer of teeth by different modes such as surfactants in which reverse micelles or microemulsions were used to synthesise enamel which simulate the features of enamel proteins.[(3)] It is found that synthesised nanoscale structures may self-assemble into one dimensional building blocks leading to the development of hydroxyapatite nanorods similar to natural enamel crystals which can be used as flowable restorative material. According to Chen et al with the use of nanotechnology, fluorapatite nanorods were

formed under controlled chemical conditions without the use of surfactants, proteins or cells.[4]Amelogenin incorporated crystal with the help of fluoride ions allow synthesis of elongated rod like apatite crystals which is similar to natural enamel.[5]According to several studies it has been observed that fibronectin[6], laminin[7] and ameloblastin[8] which act as mechanical scaffold for cell attachment and survival and also provides microenvironment for guiding cell growth and differentiation.

Signalling molecules released from epithelium induces odontoblasts to release extracellular matrix proteins required for dentin formation.[9] Several studies have shown that application of demineralised dentin powder induces mineralisation as similar to demineralised bone powder on the exposed pulp.[10,11] Bone morphogenetic protein (BMP) helps in formation of reparative dentin which indirectly plays role in regeneration.[8, 11, 12,13]




Several studies have been initiated to prove that enamel like structures can be regenerated with the inclusion of human embryonic stem cells and bone morphogenic protein-4 (BMP-4) specifically explained by Li et al, 2019.[14]Hu et al explained about the role of human keratocyte stem cells with the combination of fibroblast growth factor and Sonic hedgehog which directly induces formation of intact prisms of the regenerated enamel.[15]

Araujo et al explained about the benefits of stem cells derived from human exfoliated deciduous teeth which has been supported by mineral trioxide aggregate(MTA), calcium hydroxide(CH) and biodentine(BD). These three tested materials maintained viability and stimulated proliferation, migration and odontogenic-like phenotype differentiation.[16]

Athirasala et al evaluated human stem cells from apical papilla (human SCAP) in which bioink(printable alginate hydrogels with the soluble and insoluble fractions of dentin matrix) lead to the formation of differentiated odontogenic SCAPs.[17] El Ashiry examined on dental pulp stem cells (DPSCs) which has been carried on Chitosan hydrogel scaffold containing vascular endothelial growth factor(VEGF-2), basic fibroblast growth factor(bFGF), platelet derived growth factor(PDGF), nerve growth factor(NGF), bone morphogenetic protein-7(BMP-7) which helps in periapical radiolucency healing, radicular lenghthening, radicular thickening and apical closure.[18]

According to Meza et al dental pulp stem cells which is in autologous form and carried by leukocyte-platelet-rich fibrin (L-PRF) results in 6 months and 3 years follow-ups showing the periapical index(PAI) score of 1 and cone beam computed tomographic index (CBCT PAI) score of 0.[19]

Several case reports and studies proved by different authors such as Xuan et al and Zu et al shown that with the application of human dental pulpal stem cells (HDPSCs) which is in autologous form and autologous swine dental pulp stem cells(sDPSCs) which is in hydrogel form induces continued root lengthening and apical closure, increase in vascular formation and dentin bridge formation.[20]

## CONCLUSION

With the evolution of new techniques introduced in the branch of dentistry, it is obvious that upcoming methods are more accessible and easier to approach for the development of tooth tissues and organs.Therefore, newer regenerative methods brought upliftment in the branch of dentistry and endodontics.

Conflict of interest:The author declare no conflict of interest.

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