

Craniofacial Stem Cells in Health and Disease

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Organ regeneration and repair is a holy grail of modern biomedical science. The ability to transplant stem cells into a damaged tissue or to mobilize endogenous stem cells to fight disease offers great hope to modern dentistry and medicine. In addition to the notable clinical advances that have taken place in recent years, the basic science underlying the biology of regeneration has made great strides. The combination of clinical and basic approaches is crucial, as our capacity to deploy stem cells therapeutically will be greatly enhanced by a deep understanding of the basic biology of stem cells. The knowledge gathered through analysis of stem cells in development and tissue regeneration has informed studies that explore the roles of these cells in the pathobiology of diseases such as cancer.

This special issue of the *Journal of Dental Research* encompasses a diverse group of articles that provide a review of important recent advances in craniofacial stem cell biology as well as examples of state-of-the-art research in the field. The issue spans multiple components of the craniofacial complex, from teeth to bones and glands, and it covers both normal development as well as disease processes.

The dental articles have a notable focus on the pulp, including mineral production by dental mesenchymal stem cells (Volponi et al. 2015), regulation of dentinogenesis by growth factors (Sagomyants et al. 2015), and the behavior of pulp cells in ex vivo environments (Smith et al. 2015). In addition, stem cells of the adult human periodontium are explored (Athanasios-Papaefthymiou et al. 2015), and other craniofacial organs covered include the salivary gland (Aure et al. 2015; Maruyama et al. 2015) and the temporomandibular joint (TMJ) (Lu et al. 2015).

The role of stem cells in diseases of the craniofacial complex is reviewed in 2 of the articles (Chai and Zhao 2015; Yin et al. 2015). New discoveries as well as ongoing challenges involving stem cells in head and neck cancer are covered, and interaction between the immune system and stem cells as well as therapeutic opportunities are discussed (Birkeland et al. 2015; Dionne et al. 2015). Another review focuses on papillomavirus infection and its effect on stem cells of the head and neck region (Pulios et al. 2015).

Finally, the issue covers therapeutic strategies in a number of conditions. The current state and future prospects of pulp-dentin regeneration are reviewed (Cao et al. 2015), as is the use of induced pluripotent stem cells in dentistry (Hynes et al.

2015). Original work explores the molecular basis for cell-based therapy of TMJ osteoarthritis (Lu et al. 2015) and possible uses of dental papilla cells in spinal cord injury (De Berdt et al. 2015).

This issue highlights the impressive advances occurring in the craniofacial stem cell field and demonstrates the enormous promise that stem cell-based therapies hold for the future. As a community, we look forward to the day when progenitor and stem cell-based approaches will be a mainstay of curing and preventing craniofacial diseases. We are grateful to all of the wonderful scientists and clinicians who contributed to this issue, and we hope that you as readers will enjoy it!

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References

- Athanassiou-Papaefthymiou M, Papagerakis P, Papagerakis S. 2015. Isolation and characterization of human adult epithelial stem cells from the periodontal ligament. *J Dent Res.* 94(11):1591–1600.
- Aure MH, Arany S, Oviatt CE. 2015. Salivary glands: stem cells, self-duplication, or both? 2015. *J Dent Res.* 94(11):1502–1507.
- Birkeland AC, Owen JH, Prince ME. 2015. Targeting head and neck cancer stem cells: current advances and future challenges. *J Dent Res.* 94(11):1516–1523.
- Cao Y, Song M, Kim E, Shon W, Chugal N, Bogen G, Lin L, Kim RH, Park NH, Kang MK. 2015. Pulp-dentin regeneration: current state and future prospects. *J Dent Res.* 94(11):1544–1551.
- Chai Y, Zhao H. 2015. Stem cells in teeth and craniofacial bones. *J Dent Res.* 94(11):1495–1501.
- De Berdt P, Vanacker J, Ucakar B, Elens L, Diogenes A, Leprince JG, Deumens R, des Rieux A. 2015. Dental apical papilla as therapy for spinal cord injury. *J Dent Res.* 94(11):1575–1581.
- Dionne LK, Driver ER, Wang XJ. 2015. Head and neck cancer stem cells: from identification to tumor immune network. *J Dent Res.* 94(11):1524–1531.
- Hynes K, Menichanin D, Bright R, Ivanovski S, Huttmacher DW, Gronthos S, Bartold PM. 2015. Induced pluripotent stem cells: a new frontier for stem cells in dentistry. *J Dent Res.* 94(11):1508–1515.
- Lu L, Zhang X, Zhang M, Zhang H, Liao L, Yang T, Zhang J, Xian L, Chen D, Wang M. 2015. RANTES and SDF-1 are keys in cell-based therapy of TMJ osteoarthritis. *J Dent Res.* 94(11):1601–1609.
- Maruyama CLM, Leigh NJ, Nelson JW, McCall AD, Mellas RE, Lei P, Andreadis ST, Baker OJ. 2015. Stem cell-soluble signals enhance multilumen formation in SMG cell clusters. *J Dent Res.* 94(11):1610–1617.
- Pullos AN, Castilho RM, Squarize CH. 2015. HPV infection of the head and neck region and its stem cells. *J Dent Res.* 94(11):1532–1543.
- Sagomonyants K, Kalajzic I, Maye P, Mina M. 2015. Enhanced dentinogenesis of pulp progenitors by early exposure to FGF2. *J Dent Res.* 94(11):1582–1590.
- Smith JG, Smith AJ, Shelton RM, Cooper PR. 2015. Dental pulp cell behavior in biomimetic environments. *J Dent Res.* 94(11):1552–1559.
- Volponi AA, Gentleman E, Fatscher R, Pang YWY, Gentleman MM, Sharpe PT. 2015. Composition of mineral produced by dental mesenchymal stem cells. *J Dent Res.* 94(11):1568–1574.
- Yin X, Li J, Salmon B, Huang L, Lim WH, Liu B, Hunter DJ, Ransom RC, Singh G, Gillette M, et al. 2015. Wnt signaling and its contribution to craniofacial tissue homeostasis. *J Dent Res.* 94(11):1487–1494.