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Nanotechnology at the Frontier of Oral Health: Emerging Innovations in Diagnostics, Therapy, and Regeneration

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Dear Esteemed Readers and Academic Colleagues,

It is a privilege to introduce **Volume 2, Issue 3 (2025)** of the *Journal of Oral and Dental Health Nexus*, a collection that distinctly advances the conversation on **nanotechnology-driven innovations in oral healthcare**. This themed issue underscores the translational potential of engineered and biogenic nanomaterials in diagnostics, therapeutics, and implantable systems. The six meticulously curated articles reflect the expanding convergence of **materials science**, **bioengineering**, and **clinical dentistry**.

1. Application of Zirconia Nanoparticles in Dentistry and Oral Health

This review presents an in-depth analysis of zirconia nanoparticles, emphasizing their mechanical resilience, bioinertness, aesthetic compatibility, and favorable interactions with soft and hard tissues. Their utility in implant coatings, prosthodontic frameworks, and restorative composites is extensively discussed, alongside insights into their nano-biointerface behavior and resistance to biofilm formation.

2. Biogenic Nanomaterials: A New Frontier in Oral Healthcare

With the global shift toward sustainable technologies, this article explores the synthesis, characterization, and biological activity of nanostructures derived from plant and microbial systems. Their innate antimicrobial and antioxidant profiles, coupled with biocompatibility, make them promising agents in **periodontology**, **oral ulcer management**, and **regenerative procedures** (1).

3. Gold Nanoparticles: A Powerful Biosensor in Oral Medicine and Dentistry

This comprehensive review illustrates how the physicochemical tunability and optical properties of gold nanoparticles enable the development of highly sensitive biosensors. The discussion centers on early detection of **oral cancers**, **bacterial infections**, and **inflammatory biomarkers** through electrochemical and plasmonic modalities—ushering in a new era of **saliva-based point-of-care diagnostics** (2).

4. Graphene-Based Nanocoatings for Dental Implants: Strengthening Performance at the Nanoscale

Implant surface modification remains a critical frontier. This article evaluates the role of graphene and its derivatives (e.g., graphene oxide, reduced graphene oxide) in enhancing **osseointegration**, **antibacterial activity**, and **corrosion resistance** of dental implants. The molecular mechanisms by which graphene facilitates cell adhesion and bone deposition are highlighted.

5. Smart Nanomaterials in Dentistry: A Versatile Landscape in Prevention and Treatment

A paradigm shift toward bioresponsive nanotechnology is captured in this article. It elaborates on **stimuli-responsive nanomaterials** that dynamically interact with the oral environment—releasing antimicrobials (3) in acidic conditions, responding to enzymatic activity, or promoting remineralization. Such systems are explored in the

context of **caries prevention**, **pulp therapy**, and **periodontal regeneration** (4).

6. Smart Nanocarriers for Targeted Drug Delivery in the Treatment of Oral Cancer

Precision oncology in dentistry is rapidly evolving. This article presents state-of-the-art **smart nanocarriers**—functionalized with ligands or antibodies—designed for targeted drug delivery to tumor microenvironments. By enhancing **bioavailability**, **cellular uptake**, and **controlled release**, these systems offer safer and more effective treatment paradigms for **oral squamous cell carcinoma**.

These six contributions collectively underscore the **strategic transformation** underway in oral and dental health sciences, driven by **nano-enabled platforms**. The insights within this issue exemplify how **rational nanomaterial design**, when harmonized with biological imperatives, can yield groundbreaking clinical applications—from **implant stability** to **oncologic precision therapy**.

As we continue to publish cross-disciplinary research of high scientific merit, we reaffirm our mission: to provide a rigorous, dynamic platform for the **translation of emerging technologies** into impactful oral health interventions.

We thank our contributing authors for their intellectual rigor and our reviewers for their critical insights. It is our hope that this issue inspires continued innovation and collaboration within the global dental research community.

With sincere academic regards,

Yasamin Ghahramani, Associate professor of Shiraz University of medical sciences.

Editor-in-Chief

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Declaration of Interest

The author of this article declared no conflict of interest.

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Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

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