



Oral Immunology and Its Roles in Maintaining Oral Health

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Abstract

Oral immunology plays a pivotal role in safeguarding the oral cavity against a broad spectrum of pathogens through coordinated immune responses. The oral cavity, constantly exposed to microbial challenges, relies on an intricate immune system that integrates both innate and adaptive components to preserve local tissue integrity and systemic health. Several anatomical structures, including the stratified squamous epithelium, salivary glands, mucosa-associated lymphoid tissue (MALT), and periodontal tissues, contribute significantly to this defense. Recent studies have highlighted the importance of salivary immune factors such as secretory immunoglobulin A (sIgA), lysozyme, and lactoferrin in preventing microbial adhesion and colonization. Additionally, immune cells like neutrophils and macrophages eliminate pathogens through phagocytosis, while antimicrobial peptides neutralize microbial threats. Dysregulation of these immune mechanisms has been implicated in oral diseases such as dental caries, periodontitis, and candidiasis. Moreover, impaired oral immunity can contribute to systemic complications including cardiovascular disease, diabetes, and respiratory infections. In conclusion, oral Immunity is very vital in maintaining the oral health as it assists in maintaining the oral microbiome Immunity.

Keywords: Oral Immunology, Mucosal Immunity, Oral Health, Gingival Inflammation, Host Defense.

Introduction

The oral cavity serves as both a gateway to the digestive and respiratory tracts and a critical immune interface [1]. Its continuous exposure to microbial agents demands an intricate network of immune defenses that must distinguish between benign residents and harmful intruders to preserve oral and systemic equilibrium [1]. This localized immunological activity hinges on the fine balance between tolerance of commensal flora and activation against pathogens.

Recent advances in mucosal immunology have revealed the dynamic interplay between the structural barriers and cellular components of innate immunity. The oral epithelium, supported by neutrophils, dendritic cells, and antimicrobial peptides, forms a strategic first line of protection [2]. Salivary constituents such as secretory IgA and lysozyme further reinforce defense functions, performing dual roles in hydration and microbial inhibition [3]. In parallel, adaptive immune elements primarily activated T and B lymphocytes—contribute targeted immune responses with immunological memory [4].

A regulated immune environment is vital for the maintenance of a healthy oral microbiome. Dysregulation triggered by genetic predispositions, systemic illness, or external stressors can lead to microbial imbalance and promote pathologies like dental caries, periodontitis, and candidiasis [5,6]. Such conditions are often exacerbated by hyperinflammatory reactions and impaired tissue repair mechanisms.

Moreover, the oral immune system reflects systemic health. Diseases like diabetes, autoimmune disorders, and viral infections including SARS-CoV-2 have been shown to disrupt oral immune function, thereby increasing vulnerability to periodontal damage and opportunistic infections [7]. These links have elevated saliva as a clinical specimen of interest, particularly for its value in detecting inflammatory markers and disease biomarkers non-invasively [8]. Innovative therapeutic strategies, such as pathogen-specific vaccines, microbiota targeted probiotics, and synthetic peptides, hold promise for enhancing oral immunity and reducing reliance on broad-spectrum antimicrobials [9]. As microbial resistance becomes a growing concern, these targeted approaches are essential. A deep understanding of oral immunology equips clinicians to implement tailored interventions and promote oral health as an extension of systemic care [10].

Anatomical and Physiological Basis of the Oral Cavity

The oral cavity serves as the gateway to the digestive and respiratory systems and is uniquely structured to support both mechanical and immune functions. Several anatomical features contribute to its immunological roles are:

- Stratified Squamous Epithelium: Acts as a protective physical barrier against pathogens.
- Salivary Glands: Secrete saliva rich in antimicrobial agents and immune mediators.
- Tonsils (Part of MALT): Positioned at the entrance of the pharynx to detect and respond to ingested or inhaled pathogens.
- Gingival Sulcus and Periodontal Tissues: Key sites for immune surveillance and inflammation in diseases like periodontitis.

These structures form the foundation of the oral immune system by housing immune cells and facilitating the secretion of protective molecules [11].

Overview and Components of the Oral Immune System

The oral immune system is a specialized defense network that integrates mucosal, cellular, and humoral components to protect the oral cavity from microbial invasion. It is comprised of both innate and adaptive arms that work in concert to maintain homeostasis and prevent disease onset [12]. they are

- Mucosal Immunity: Mucosa-Associated Lymphoid Tissue (MALT): Includes the palatine tonsils and adenoids, which detect inhaled or ingested pathogens. These sites house B cells, T cells, macrophages, and dendritic cells, enabling early immune responses [13].

Oral Epithelium: Functions not only as a barrier but actively secretes antimicrobial peptides like defensins and cathelicidins, which neutralize bacteria and fungi at mucosal surfaces [14].

- Salivary Gland Secretions: Secretory IgA (sIgA): Prevents microbial adhesion to mucosal surfaces.

Lysozyme: Degrades bacterial cell walls.

Lactoferrin: Sequesters iron, starving bacteria of essential nutrients.

Salivary Mucins: Trap and help clear pathogens during swallowing [15].

Types of Oral Immunity are:

- Innate Immunity: Neutrophils & Macrophages: Rapidly respond to infection via phagocytosis. Epithelial Barrier: Blocks microbial invasion and signals immune cells when breached. Complement System: Activates inflammation and destroys pathogens through membrane attack complexes [16].
- Adaptive Immunity: Humoral Immunity: B cells produce sIgA and IgG, neutralizing pathogens and toxins.

Cell-Mediated Immunity: T cells (Th1, Th2, Th17) modulate immune activity and directly kill infected cells.

Immunological Memory: Memory B and T cells ensure faster responses to previously encountered pathogens [17].

Importance of the Oral Immune System

The oral immune system performs essential roles in disease prevention and maintaining oral and systemic health. Its Importance are:

- Pathogen Defense: Prevents colonization by bacteria like *Streptococcus mutans* and fungi such as *Candida albicans*.

- Microbiome Regulation: Maintains microbial balance, preventing dysbiosis that leads to caries and periodontitis [18].
- Wound Healing: Immune cells promote tissue repair following trauma or infection.
- Systemic Link: Chronic oral infections contribute to diseases like cardiovascular disease, diabetes, and adverse pregnancy outcomes [19].

Mechanisms of Action of the Oral Immune System

The oral immune system uses multiple mechanisms to eliminate pathogens, they are.:

- Physical and Chemical Barriers: Epithelial cells and salivary antimicrobials restrict microbial entry.
- Cellular Defense: Phagocytic cells engulf and kill microbes; complement proteins amplify inflammation.
- Antibody Activity: sIgA prevents pathogen adhesion; IgG opsonizes bacteria for phagocytosis.
- Long-Term Immunity: Memory cells enhance future immune responses, reducing reinfection risk [20].

The Roles of the Oral Immune System in Preventing Oral Diseases

The oral immune system employs a multifaceted approach to protect the oral cavity from a range of pathogens, thereby preventing various oral diseases. Its specific roles include:

1. Provision of Physical Barriers / Protection: The epithelial cells lining the oral cavity form a continuous, multi-layered barrier that acts as the first line of defense against microbial invasion. These tightly packed cells are constantly renewed, dislodging potential pathogens before infection can occur [21]. Saliva supports this barrier by mechanically flushing away food particles and microorganisms. This salivary action helps reduce microbial load and prevents colonization of bacteria such as *Streptococcus mutans*, a major contributor to dental caries [22].
2. Prevention of Pathogen Adherence: Secretory immunoglobulin A (sIgA) in saliva binds to bacterial adhesins, preventing pathogens like *Candida albicans* and *Streptococcus mutans* from adhering to oral mucosal surfaces [23]. Salivary proteins such as lysozyme and lactoferrin further assist in this function. Lysozyme lyses bacterial cell walls, while lactoferrin limits bacterial growth by sequestering iron [24, 25].
3. Neutralization of Pathogens: Antimicrobial peptides like defensins and cathelicidins disrupt microbial cell membranes, leading to cell death [26]. For example, defensins produced by oral epithelial cells form pores in bacterial membranes, causing leakage and microbial death, particularly effective in controlling bacteria linked to periodontal disease [27].
4. Elimination of Pathogens through Phagocytosis: Neutrophils and macrophages are frontline immune cells that engulf and digest bacteria via phagocytosis [28]. Neutrophils respond quickly to pathogens like *Porphyromonas gingivalis*, while macrophages clear debris and support healing in the oral mucosa [29].
5. Regulation of Inflammation: Balanced inflammation is key to effective defense and tissue preservation. While inflammation helps eliminate pathogens, its regulation is essential to prevent tissue damage. In conditions like periodontal disease, modulation of cytokines and immune cells prevents excess tissue breakdown [30].
6. Promotion of Tissue Repair: Following oral injury or infection, immune cells clear pathogens and promote tissue regeneration. This ensures the maintenance of the oral mucosa's integrity and function [31].
7. Reduction of Systemic Disease Risk: An efficient oral immune system prevents local infections from contributing to systemic diseases like diabetes, cardiovascular diseases, and respiratory infections [32]. Maintaining a healthy oral immune system also helps reduce chronic inflammation and its systemic consequences, supporting general health and well-being [33].

Conclusion

The oral immune system plays a central role in defending the oral cavity against microbial invasion, thereby preventing a wide range of oral diseases. Through the interplay of physical barriers, antimicrobial agents, immune cells, and regulatory molecules, the system effectively prevents pathogen adherence, neutralizes threats, modulates inflammation, and promotes tissue repair. These coordinated responses are crucial in maintaining oral homeostasis and reducing the burden of oral infections such as dental caries, periodontitis, and candidiasis. Moreover, an impaired oral immune system may contribute to the onset or worsening of systemic conditions, including diabetes, cardiovascular disease, and respiratory infections. Strengthening the oral immune system through immunomodulatory strategies such as the use of probiotics, salivary enhancers, anti-inflammatory agents, and nutritional interventions may offer new pathways for prevention and management of oral and systemic diseases. Future research into oral immunological mechanisms and therapeutic targeting will further enhance our understanding and management of oral health.

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Author Contributions

Ngwu Justina Nnenna conceptualized the study, conducted the literature review, drafted the manuscript, and approved the final version for submission. Edumson Stanley Minara contributed to the literature search, reviewed and revised the manuscript for intellectual content, and provided critical feedback throughout the writing process.

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Not applicable.

Consent for Publication

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Competing Interests

The authors declared no competing interests.

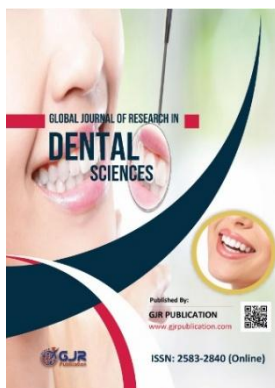
References

1. Belkaid, Y., & Hand, T. W. (2015). Role of the microbiota in immunity and inflammation. *Cell*, 157(1), 121–141.
2. Moutsopoulos, N. M., & Konkel, J. E. (2018). Tissue-specific immunity at the oral mucosal barrier. *Trends in Immunology*, 39(4), 276–287.
3. Dawes, C., Pedersen, A. M., Villa, A., et al. (2015). The functions of human saliva: A review sponsored by the World Workshop on Oral Medicine VI. *Archives of Oral Biology*, 60(6), 863–874.
4. Dutzan, N., Konkel, J. E., Greenwell-Wild, T., & Moutsopoulos, N. M. (2016). Characterization of the human immune cell network at the gingival barrier. *Mucosal Immunology*, 9(5), 1163–1172.
5. Lamont, R. J., Koo, H., & Hajishengallis, G. (2018). The oral microbiota: Dynamic communities and host interactions. *Nature Reviews Microbiology*, 16(12), 745–759.
6. Hajishengallis, G., & Chavakis, T. (2021). Local and systemic mechanisms linking periodontal disease and inflammatory comorbidities. *Nature Reviews Immunology*, 21(7), 426–440.
7. Nazir, M. A. (2017). Prevalence of periodontal disease, its association with systemic diseases and prevention. *International Journal of Health Sciences*, 11(2), 72–80.
8. Javaid, M. A., Ahmed, A. S., Durand, R., & Tran, S. D. (2016). Saliva as a diagnostic tool for oral and systemic diseases. *Journal of Oral Biology and Craniofacial Research*, 6(1), 66–75.
9. Hardy, H., Harris, J., Lyon, E., Beal, J., & Foey, A. D. (2017). Probiotics, prebiotics and immunomodulation of gut mucosal defences: Homeostasis and immunopathology. *Nutrients*, 9(6), 1–24.
10. Hajishengallis, G. (2023). Immune evasion strategies of oral pathogens. *Journal of Dental Research*, 102(1), 10–19.
11. Kumar, P. S., & Mason, M. R. (2019). Mouth as a gateway: The oral microbiome and systemic disease. *Periodontology 2000*, 82(1), 202–212.
12. Groeger, S., & Meyle, J. (2019). Oral mucosal epithelial cells. *Frontiers in Immunology*, 10, 208.
13. Brandtzaeg, P. (2013). Secretory immunity with special reference to the oral cavity. *Journal of Oral Microbiology*, 5(1), 20401.
14. Gorr, S.-U., & Abdolhosseini, M. (2011). Antimicrobial peptides and periodontal disease. *Journal of Clinical Periodontology*, 38(11), 126–141.
15. Marcotte, H., & Lavoie, M. C. (2022). Oral microbial interactions. *Journal of Oral Microbiology*, 14(1), 2022.
16. Hajishengallis, G. (2014). Immunomicrobial pathogenesis of periodontitis: Keystones, pathobionts, and host response. *Trends in Immunology*, 35(1), 3–11.
17. Lamont, R. J., Koo, H., & Hajishengallis, G. (2018). The oral microbiota: Dynamic communities and host interactions. *Nature Reviews Microbiology*, 16(12), 745–759.
18. Marsh, P. D., & Devine, D. A. (2020). How is the development of dental biofilms influenced by the host? *Journal of Clinical Periodontology*, 47(S22), 22–40.
19. Tonetti, M. S., & Jepsen, S. (2013). Impact of the global burden of periodontal diseases. *Journal of Clinical Periodontology*, 40(14), S1–S2.
20. Nanci, A. (2017). *Ten Cate's oral histology: Development, structure, and function* (9th ed.). Elsevier.
21. Marsh, P. D. (2012). Dental plaque as a biofilm and a microbial community—Implications for health and disease. *BMC Oral Health*, 6, S14.
22. Mestecky, J. (2013). Saliva as a mucosal immune secretion. *Annals of the New York Academy of Sciences*, 1098, 1–12.

23. Brandtzaeg, P. (2013). Role of secretory IgA in oral mucosal immunity. *Journal of Oral Microbiology*, 5(1), 20401.
24. Kumar, P. S., Mason, M. R., & Herzberg, M. C. (2019). Inflammation and dysbiosis in the oral cavity and beyond. *Journal of Dental Research*, 98(6), 611–619.
25. Gleeson, M., & Pyne, D. B. (2015). Exercise effects on mucosal immunity. *Immunology and Cell Biology*, 93(3), 225–233.
26. Hirschfeld, J., et al. (2020). Antimicrobial peptides in oral health and disease. *Journal of Clinical Periodontology*, 47(1), 2–12.
27. Berg, R. A., & Shi, J. (2016). Oral epithelial defenses: Defensins and cathelicidins. *Archives of Oral Biology*, 60, 1–12.
28. Genco, R. J., & Van Dyke, T. E. (2013). Host responses in periodontal diseases. *Journal of Periodontology*, 84(4), 455–470.
29. Zhu, J., & Paul, W. E. (2017). CD4 T cells: Fates, functions, and faults. *Blood*, 112(5), 1557–1569.
30. Preshaw, P. M., & Heasman, P. A. (2012). Periodontal inflammation and systemic disease. *Journal of Clinical Periodontology*, 39(4), 25–29.
31. Pihlstrom, B. L., et al. (2005). Periodontal diseases. *The Lancet*, 366(9499), 1809–1820.
32. Han, Y. W., & Wang, X. (2013). Mobile microbiome: Oral bacteria in extra-oral infections and inflammation. *Journal of Dental Research*, 92(6), 485–491.
33. Newman, M. G., Takei, H. H., Klokkevold, P. R., & Carranza, F. A. (Eds.). (2011). *Carranza's clinical periodontology* (11th ed.). Saunders Elsevier. ISBN 978-1437704196.

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