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INTERNATIONAL EXPERIENCE IN SCIENTIFIC RESEARCH



**PROCEEDINGS OF XI INTERNATIONAL
SCIENTIFIC AND PRACTICAL CONFERENCE
JUNE 11-13, 2026**

**CHICAGO
2026**

INTERNATIONAL EXPERIENCE IN SCIENTIFIC RESEARCH

Proceedings of XI International Scientific and Practical Conference
Chicago, USA
11-13 June 2026

Chicago, USA

2026

UDC 001.1

The 11th International scientific and practical conference “International experience in scientific research” (June 11-13, 2026) BoScience Publisher, Chicago, USA. 2026. 771 p.

ISBN 978-1-73981-121-1

The recommended citation for this publication is:

Ivanov I. Analysis of the phaunistic composition of Ukraine // International experience in scientific research. Proceedings of the 11th International scientific and practical conference. BoScience Publisher. Chicago, USA. 2026. Pp. 21-27. URL: <https://sci-conf.com.ua/xi-mizhnarodna-naukovo-praktichna-konferentsiya-international-experience-in-scientific-research-11-13-06-2026-chikago-ssha-arhiv/>.

Editor

Komarytskyy M.L.

Ph.D. in Economics, Associate Professor

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**THE ROLE OF THE ORAL MICROBIOME IN MAINTAINING HEALTH
AND THE DEVELOPMENT OF SYSTEMIC PATHOLOGIES**

Hostieva Diana Volodymyrivna,

Medical Student, Faculty of Medicine,
Kharkiv National Medical University

Kochnieva Olena Volodymyrivna

Candidate of Medical Sciences,
Associate Professor of Department of Microbiology,
Virology and Immunology named after Prof. D.P. Grynyov
of the Kharkiv National Medical University
of the Ministry of Health of Ukraine.
City of Kharkiv, Ukraine

Abstract:

For a long time, the oral cavity was viewed in clinical practice primarily through the lens of dental diseases. Today, however, the paradigm has shifted. The oral cavity is home to the second most complex and diverse microbiome in the human body after the gut. This intricate ecosystem includes bacteria, fungi, viruses, and archaea, all existing in a state of dynamic equilibrium with the host organism. Current research demonstrates that the oral microbiota is not merely a collection of microorganisms, but a full participant in immune and metabolic processes, exerting a direct influence on both local homeostasis and systemic human health. Under balanced conditions, this ecosystem supports local immunity, provides colonisation resistance, and helps maintain overall physiological stability. Disturbances in the qualitative or quantitative composition of the oral microbiome are associated not only with dental pathologies — specifically caries, periodontitis, and candidiasis — but also with the development or progression of systemic conditions, including cardiovascular, metabolic, autoimmune, and neurodegenerative disorders. Understanding the mechanisms of interaction between the oral microbiome and the host opens new prospects for early diagnosis, prevention, and personalised

therapeutic approaches in clinical practice.

Keywords: oral microbiome, oral dysbiosis, oral–gut axis, systemic pathologies, oncogenesis.

Aim:

The aim of this study was to analyse current literature on the structural and functional characteristics of the oral microbiome and its role in maintaining local and systemic homeostasis, as well as to characterise the mechanisms by which oral dysbiosis contributes to the pathogenesis of dental, inflammatory, metabolic, oncological, and other systemic diseases.

Materials and Methods:

This study was conducted as a narrative analytical review of scientific literature. A comprehensive search, selection, and analysis of current publications were carried out, focusing on the biogeography of the oral microbiome, the mechanisms of dysbiosis formation, the ‘oral–gut axis’, and the relationship between oral microbiota, systemic pathologies, and oncogenesis. The literature search was conducted across international scientometric databases, including PubMed, Scopus, Web of Science, and Google Scholar. The analysis incorporated findings from clinical, experimental, molecular biological, and epidemiological studies, alongside recent review articles. Data systematisation and interpretation were performed using bibliographic, comparative, and analytical methods.

Results and Discussion:

Analysis of current scientific sources indicates that the oral microbiome is a highly organised ecosystem whose structural and functional integrity determines the state of local and systemic homeostasis. The gathered literature allowed us to identify key aspects of oral microbiota organisation, mechanisms of dysbiosis formation, and the primary pathways through which it drives systemic pathological processes.

Biogeography and spatial organisation of the oral microbiome. The oral cavity is characterised by marked heterogeneity and the spatial organisation of its microbiota, forming a series of unique ecological niches [2]. The hard tissues of the

teeth provide a stable surface for adhesion and the formation of multi-species biofilms, whereas the constantly desquamating epithelium of the mucous membrane requires microorganisms to employ adaptive colonisation mechanisms. Saliva not only performs a transport function but also modulates microbiome composition via antimicrobial peptides and immunoglobulins [2]. Under conditions of eubiosis, strict colonisation resistance is maintained: resident flora competes with pathogens and synthesises the metabolites necessary to preserve the epithelial barrier function. Shifts in pH, hyposalivation, or immunodeficiency states serve as the main triggers for disrupting this balance.

Local dysbiosis as a predictor of systemic pathology. The transformation of microbial symbiosis into dysbiosis is regarded as the primary link in the aetiopathogenesis of caries and periodontal diseases [5]. Concurrently, the consequences of these local inflammatory processes are markedly systemic in nature. Periodontal pockets become an endogenous reservoir for Gram-negative anaerobic bacteria and their endotoxins [5]. The destruction of the periodontal vascular wall facilitates transient bacteraemia and the dissemination of pro-inflammatory mediators into the bloodstream. This explains the epidemiological and pathogenetic links between periodontitis and cardiovascular diseases, rheumatoid arthritis, and obstetric complications [1, 5].

The oral–gut axis. The daily swallowing of approximately 1.5 litres of saliva ensures a continuous supply of oral microflora to the gastrointestinal tract. Although the gastric acid barrier limits bacterial migration, the suppression of gastric secretion or an impaired immune status enables the ectopic colonisation of the gut by oral strains [3]. This phenomenon plays a significant role in the pathogenesis of inflammatory bowel disease (IBD). It has been demonstrated that certain species, notably *Fusobacterium nucleatum* and *Klebsiella* spp., can integrate into the intestinal mucosal microbiome, disrupting the integrity of the epithelial barrier and inducing hyperactivation of the local immune response, thereby contributing to chronic inflammation [3].

The impact of oral dysbiosis on carcinogenesis. Current clinical studies

indicate both the direct and indirect involvement of the oral microbiome in carcinogenic processes [4]. Microbiome-associated carcinogenesis operates through several pathways. Firstly, persistent inflammation induced by periodontal pathogens is accompanied by the chronic release of cytokines and reactive oxygen and nitrogen species, leading to DNA damage in epithelial cells. Secondly, oral microorganisms can locally synthesise carcinogens, particularly acetaldehyde, a by-product of ethanol metabolism. Specific dysbiosis patterns correlate significantly not only with the development of head and neck squamous cell carcinomas but also with extraoral neoplasms, including colorectal and pancreatic cancers [4].

Conclusion:

The oral microbiome is a complex, multi-component ecosystem that plays a vital role in maintaining local immune defence, metabolic balance, and systemic homeostasis. The spatial organisation of the oral microbiota, its biological diversity, and its capacity for dynamic adaptation ensure the stability of this microecological environment under physiological equilibrium. Disruptions to the structure and functional activity of the oral microbiome lead to dysbiosis, which is considered both a key factor in dental pathology and a potential trigger for systemic diseases. Accumulated scientific data confirm that oral dysbiosis is actively involved in driving chronic inflammation, disrupting barrier mechanisms, activating immunopathological reactions, and modulating carcinogenic processes. Of particular importance is the ‘oral–gut axis’, which illustrates the complex cross-system interactions between oral and gut microbiota. Further investigation into the composition, functional properties, and signalling mechanisms of the oral microbiome opens new prospects for introducing advanced diagnostic and therapeutic approaches into clinical practice. Saliva analysis and microbiological profiling of the oral microbiota may soon become promising tools for early non-invasive diagnosis, risk prediction, and the monitoring of systemic pathologies. Simultaneously, targeted modulation of the oral microbiome — specifically through probiotics, prebiotics, and personalised antimicrobial strategies — has the potential to become a crucial component in the prevention and comprehensive treatment of inflammatory, metabolic, and oncological

diseases.

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