

# BEYOND THE GERM:

# RETHINKING IMPLANT-RELATED INFECTIONS AS A HOST-MICROBIOTA-BIOMATERIAL ECOSYSTEM

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## Introduction

Infection susceptibility emerges from a dynamic interplay between host biology, microbiota, biomaterials, and environmental factors. The potential **dual role of biofilms** adds another layer of complexity. Systems biology offers a powerful framework to unravel these interactions and transform the management of implant-associated infections.

## Objective

This review integrates insights from immunotoxicology, microbiome science, and biomaterials research to explore how host, microbial, environmental, and biomaterial factors converge to shape infection susceptibility.

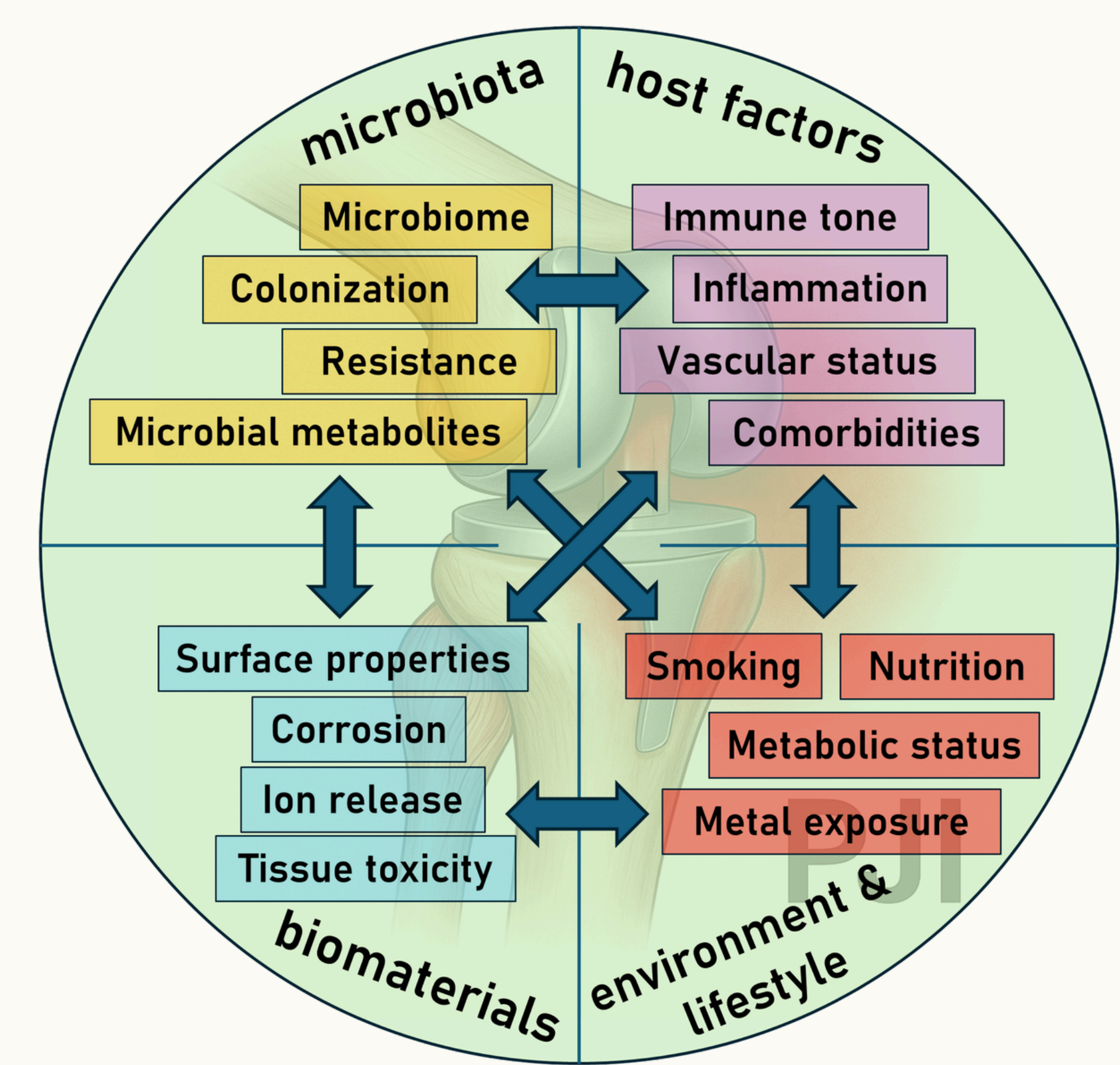
## Methodology

A structured narrative review of PubMed, Web of Science, and Scopus was conducted, with systematic screening in Covidence. Evidence on host-microbiota-biomaterial interactions in implant-related infections was synthesized across four domains: host susceptibility, environmental/lifestyle factors, biomaterial-microbe interactions, and integrative prevention strategies.

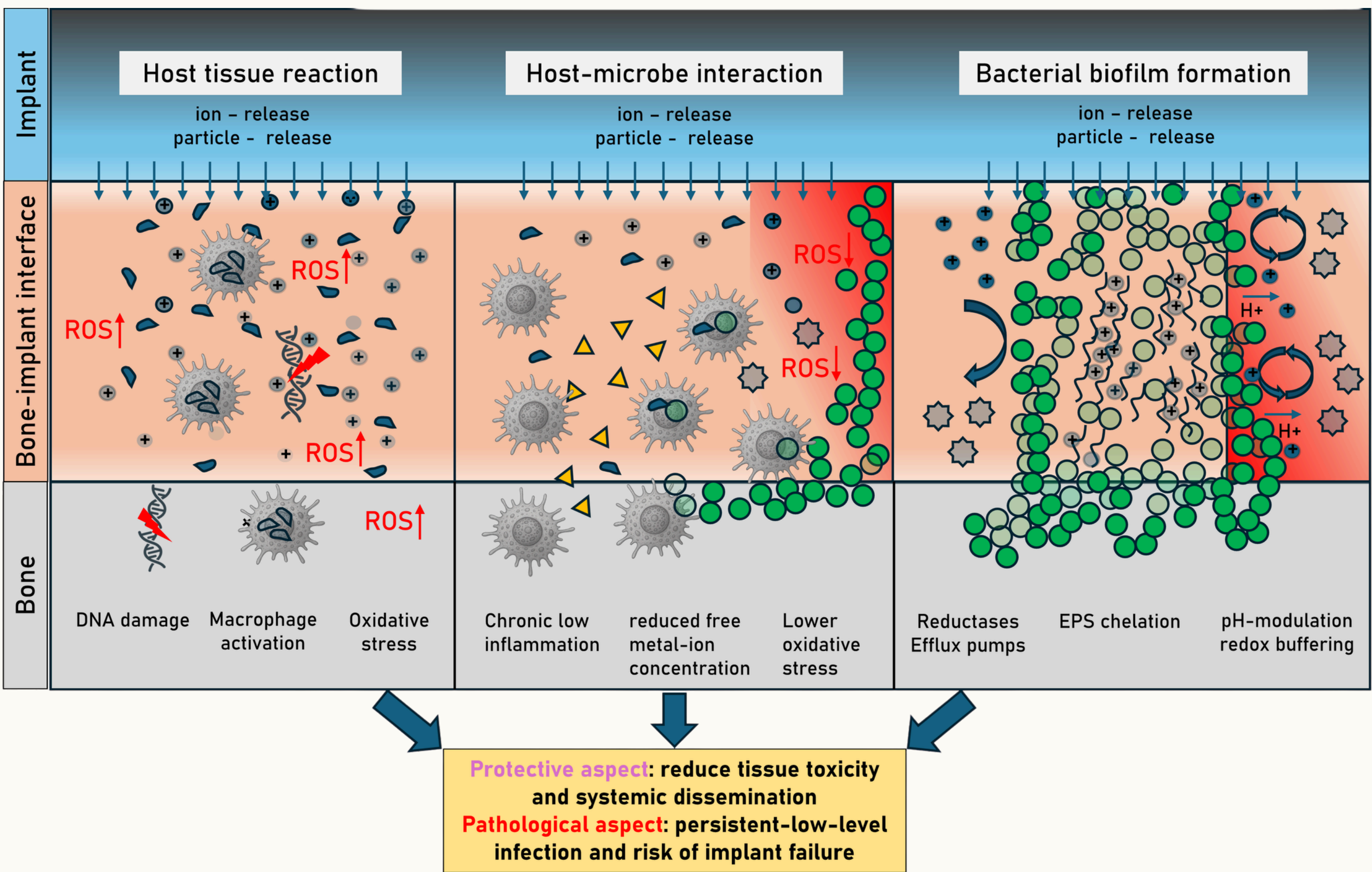
## Conclusion

**Implant-related infection is more than a microbial problem**—it reflects a dynamic host-microbiota-biomaterial ecosystem. Biofilms may represent both a pathogenic threat and an adaptive response to biomaterial-derived stress. Integrating host resilience, microbiome modulation, and smarter biomaterial design could redefine infection prevention and promote long-term host-implant homeostasis.

## Results



**Fig. 1.** Determinants of infection susceptibility in implant surgery: a systems perspective



**Fig. 2.** Biofilm formation as a potential detoxification and containment response at the bone-implant interface.