# Endodontic Microbiology and Pathobiology

## Current State of Knowledge

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**KEYWORDS**

• Endodontic microbiology • Immunology • Stem cells • Healing • Systemic diseases • Genetic polymorphism

**KEY POINTS**

- Greater microbial complexity has recently been revealed in endodontic infections.
- The host response–microbial interactions result in clinical presentation and response to healing.
- The host response is multifactorial and relates to many host factors and disease expression parameters.

### INTRODUCTION

Endodontic disease in the pulp or the periapex results from irritation by a complex array of microorganisms that normally populate the oral cavity. Despite being commensal under normal conditions, the composition of the microflora changes in the necrotic pulp, and many of the microorganisms involved increase in abundance and pathogenicity. The dental pulp, despite exhibiting a robust immunologic response, is clearly compromised in its ability to defend itself against advancing oral microflora, due to its lack of collateral circulation and its enclosure within the mineralized tissues of the tooth. Therefore, the pulp loses its vitality under these conditions at rates that are higher than any other tissue in the body, and a periapical lesion ensues. The periapical lesion has the fundamental biological function of prevention of the spread of infection that would result in osteonecrosis, osteomyelitis, and/or disseminating endodontic infections.

There is a large body of literature that describes the microbial irritants of the pulp and periapical tissues and the microbial-host interactions in these tissues. The intent of this review is to summarize recent advances in this area and provide a perspective

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on the direction of new knowledge in this field, and its direct relationship to potential advances in clinical diagnosis, establishment of the prognosis, and biologically based treatment.

## CONTEMPORARY MICROBIOLOGICAL ANALYSIS

It has long been known that endodontic disease is fundamentally a microbial disease, and that rather than one or several bacterial or fungal species, the disease is initiated and propagated by a complex community of microorganisms that are common members of commensal oral microflora. **Table 1** summarizes the main advantages of different microbial detection methodologies. For decades, the gold standard was to culture bacteria (and to a lesser degree fungi) from infected root canals or periapical abscesses, in order to study their virulence, interactions, and susceptibilities to local and systemic treatment strategies. Although culturing remains the technique of choice for studying the phenotypic characteristics of bacteria and their susceptibility to antimicrobials, it has become clear recently that only about half of oral bacteria are cultivable[1] and that the oral cavity (and presumably the endodontic environment) contains many microorganisms that are not cultivable but may contribute to a significant degree in the pathogenesis of disease and resistance to treatment.[2] Moreover, some bacteria that are ordinarily readily cultivable in the oral environment may be rendered uncultivable despite being viable if the environment contains materials or conditions that interfere with growth in the laboratory. This is especially relevant in the endodontic environment, particularly if bacteria are exposed to some endodontic materials used during treatment and which may temporary interfere with bacterial growth, such as calcium hydroxide or antibiotics.[3,4]

**Table 1**
**Common methods of microbial identification and the information that each provides**

| Culturing | Imaging | Molecular Methods |
|---|---|---|
| Allows the study of microbial virulence | Allows accurate identification of location and density of microorganisms | High sensitivity of microbial detection |
| Allows testing of antibiotic resistance | Higher magnifications allow examination of different microbial forms, shapes and biofilm structure | Accurate taxonomic classification of microorganisms, identification of pathogenic strains, and relative abundance of different taxa |
| Allows in vitro testing and experimentation | Is useful for some fastidious organisms, such as spirochetes being observed with dark-field microscopy | Accurate study of microbial virulence, interactions, and gene expression |
| Easily identifies bacterial load (numbers) | Requires analysis of extracted teeth or smears from patients | Comprehensive analysis of protein expression; approximate estimation of bacterial load |
| Shows microbial viability | Vitality stains allow determination of live and dead forms | Viability can be confirmed with detection of mRNA |