

 جامعة الشارقة  
 UNIVERSITY OF SHARJAH

كلية طب الأسنان  
 COLLEGE OF DENTAL  
 MEDICINE

## Endodontic Microbiology 2




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## Objectives

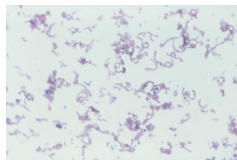
- Type of microorganisms found in endodontic Infections
- Primary endodontic infection
- Secondary endodontic infection
- Biofilms
- Antimicrobial Agents in Endodontics
- Peri-radicular response to infections
- Management of abscesses and cellulitis




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## Type of microorganisms found in endodontic Infections

- **Aerobes**
  - Streptococcus sp.: *S. mitis*, *S. salivarius*
- **Anaerobic**
  - Streptococci : *Pepto streptococcus*
  - Enterococci: *E. faecalis*
  - Bacteroides sp.: *Porphy romonas*, *Prevotella*
  - Actinomyces
- **Fungi**: *Candida albicans*
- **Fusobacteria**
- **Spirochetes**
- **Viruses**



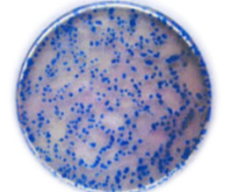


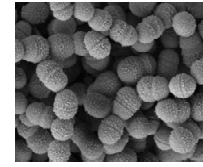
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## Type of microorganisms found in endodontic Infections

### Aerobes (Streptococcus sp.: *S. mitis*, *S. salivarius*)

- Beta hemolytic & non-hemolytic streptococci  
→ Less pathogenic
- *S. mitis* from root canal infection → **bacterial endocarditis**





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## Type of microorganisms found in endodontic Infections

### Anaerobes: Enterococci

- Is facultative bacteria, frequency in endodontic failure
- Common in GI tract
- *Enterococcus faecalis* (Difficult to be removed from the root canal) resistant to antibiotic
- Resistance to benzylpenicillin, ampicillin, clindamycin, metronidazole & tetracycline
- Sensitive to erythromycin & vancomycin
- Treatment with calcium hydroxide + erythromycin & tetracycline (Molander and Dahlen 2003)



## Type of microorganisms found in endodontic Infections

### Anaerobes: Bacteroides

- Is strictly anaerobes, short chain, gram negative rods and coccobacilli, common in dental plaque, non motile, no spore
- Have polysaccharide capsule : it is virulence factor  
→ serious anaerobic infection as sepsis, abscess
- Manufacture endotoxin & proteases



## Type of microorganisms found in endodontic Infections

### Anaerobes: Bacteroides

- Polymicrobial infection  
(facultative anaerobes → reduced oxygen → Bacteroides growth)
- Sensitive to Metronidazole & Clindamycin
- Resistance to penicillin (beta-lactamase)

## Type of microorganisms found in endodontic Infections

### Anaerobes: Bacteroides

- 2 genera the Porphyromonas & Prevotella
- *Porphyromonas* is saccharolytic bacteria, short chain, gram negative rods, non motile, no spore
  - *P. gingivalis* common in subgingival sulcus → periodontal infection
  - *P. endodontalis* (first from root canal infection) common in dental root canal, periodontal pocket, dental plaque → endodontic abscess (Samaranayake 2002)





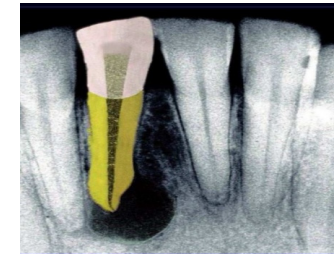
## Type of microorganisms found in endodontic Infections

- The presence of **viruses** in the root canal has been reported only for non-inflamed vital pulps of patients infected with human immunodeficiency virus and herpes viruses where living cells are found in abundance.



## Primary endodontic infection

- Primary infection is caused by microorganisms that **initially invade** and colonize the necrotic tissue.
- Primary infections are characterized by a mixed clostridium composed of **10-30 species** per canal.
- The number of bacterial cells in an infected canals varies from  **$10^3$ - $10^8$  cells**.



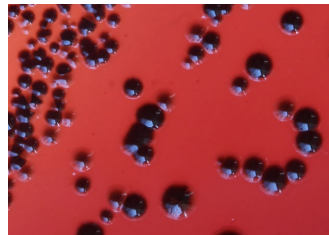
## Primary endodontic infection

### Black pigmented bacteria

In 1980, Griffie et al reported that *B.melaninogenicus* was found to be significantly related to pain, sinus tract formation, and foul odor.

- Prevotella
- Porphyromonas

They seem to play important role in etiology of both symptomatic and asymptomatic apical periodontitis.



## Primary endodontic infection

### *Fusobacterium nucleatum*

- Gram negative obligate nonmotile anaerobe bacteria.
- Most common in symptomatic infection and abscess or exacerbation lesion than asymptomatic infection.

### Spirochete bacteria

- They have been detected in both symptomatic and asymptomatic lesion.

Dewhirst et al 2000  
Baumgartner et al 2007  
Rocas et al 2003

## Secondary endodontic infection

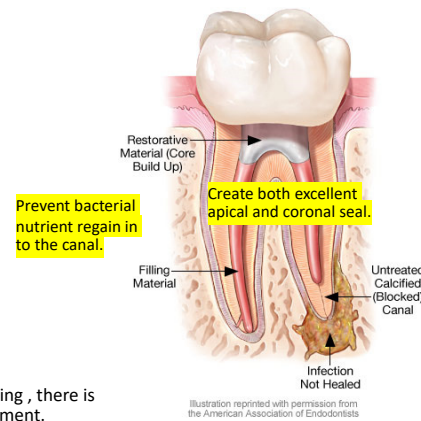
Inadequate treatment or re-infection of the root canal composition similar to the initial infection  
Possible resistant species

- Enterococcus faecalis
- Candida species

Extra-radicular

- Actinomycoses
- Propionibacterium

If microorganisms are allowed to remain at the time of filling, there is increased risk of adverse outcome of the endodontic treatment.



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## Secondary endodontic infection

### Fungi in secondary infection

- The occurrence of yeasts were taken from samples that not responding in favorably to conventional treatment (72% of cases).

*Candida albicans* was the most common species.

- By the new detection technology, *C. albicans* was detected in primary infection in 21% too.
- However the finding indicates that yeasts may be present in low number at the start of treatment, and they may reach higher proportion during root canal procedures.

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## Secondary endodontic infection

### Fungi in secondary infection

- It is also possible that yeasts from oral cavity gain access to root canal as contaminant during endodontic procedures.
- Or they can overgrow after inefficient intracanal antimicrobial procedures, which can cause imbalance in microbiota.

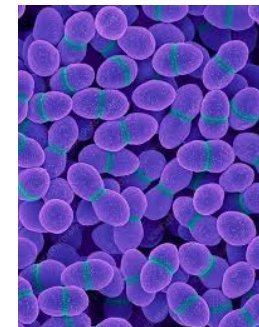
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## Secondary endodontic infection

### *E. faecalis* in secondary infection

Facultative anaerobe, Gram positive coccus.

- This species has been found in low prevalence value in case primary infection and more relate in asymptomatic cases than symptomatic cases.
- *E. faecalis* has been found in root filled teeth with persistent apical periodontitis in prevalence values ranging from 30-90% of the cases.
- This species can be inhibited by other members of mixed bacterial consortium commonly present in primary infection.



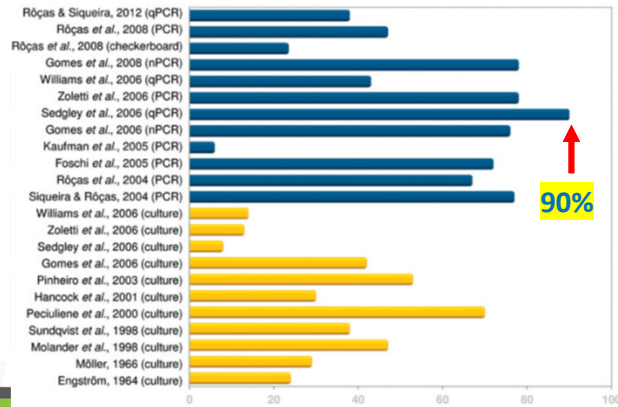
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## Secondary endodontic infection

### *E. faecalis* in secondary infection

Prevalence of *Enterococcus faecalis* in samples from root canal-treated teeth with apical periodontitis. Data from culture (yellow bars) and molecular (blue bars) studies follow.



90%

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## Secondary endodontic infection

### *E. faecalis* in secondary infection

*E. faecalis* can survive in adverse environmental condition, including starvation. **12 months without nutrients**

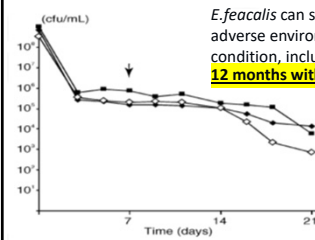
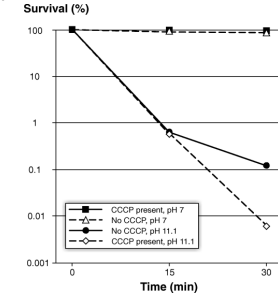


Fig. 5. Effect of inhibition of cell wall and DNA synthesis on starvation-state cells. Starvation of *E. faecalis* strain JH2-2 in water followed by addition of inhibitors on day 7 (□): penicillin G (■), norfloxacin (◇) and water controls (●). Cell densities at onset of starvation (day 0) were  $1.0 \times 10^8$ ,  $3.2 \times 10^8$ ,  $6.9 \times 10^8$ , respectively.

Figdor (2002)

Why *E. faecalis* can survive in root filled teeth?

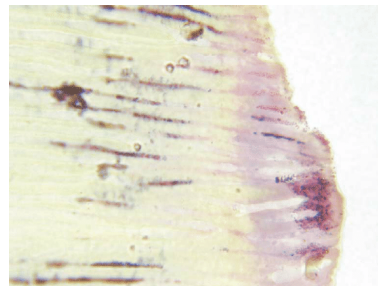


Survival of *E. faecalis* JH2-2 in calcium hydroxide pH 11.1 (and controls, pH 7.0) in the presence or absence of CCCP. Each data point is the average of 3 experiments.

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## Secondary endodontic infection

- Studies have revealed that *E. faecalis* has ability to penetrate far 300microm into dentinal tubules that can escape from intracanal instrumentation and irrigants.
- E. faecalis* has been shown to be able to form biofilms in root canals and this ability can be important for bacterial resistance and persistence in the instrumented canals.

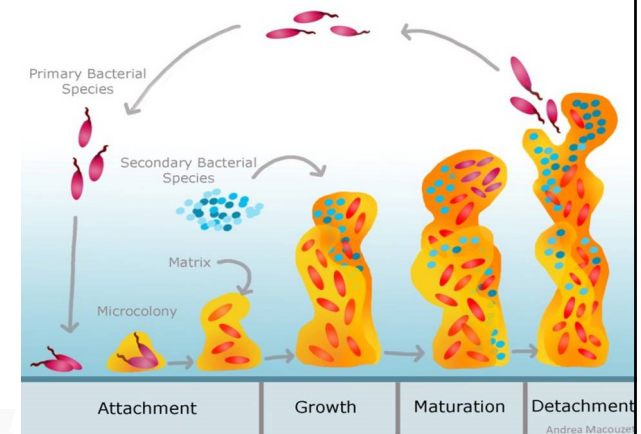


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## Biofilms

### Definition

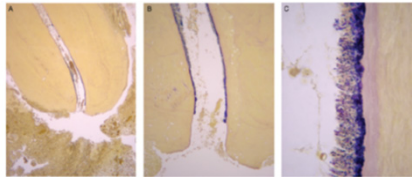
The colonization and proliferation of microorganisms at surface and solution interface; especially problematic in the small-bore water lines of dental unit.



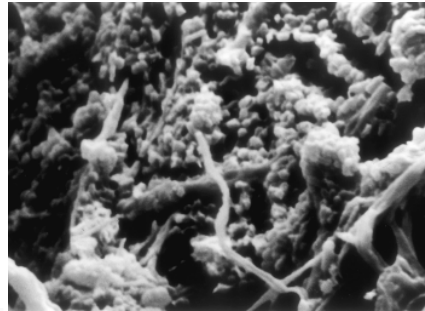
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## Biofilms

### SEM of bacterial cells arranged in a biofilm



Siquera 2001

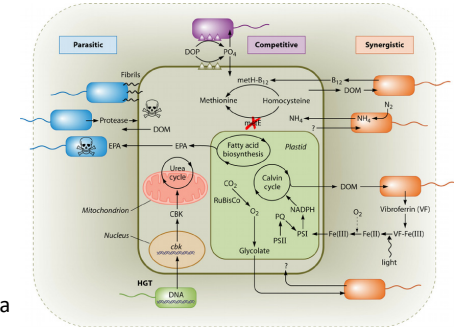


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## Biofilms

### Microbial Interactions

- **Antagonistic**
  - Competition for nutrients
  - Production of toxic metabolites
    - H<sub>2</sub>O<sub>2</sub>, ammonia, sulphur, acids, nitrite.
  - Bacteriocins
- **Synergistic**
  - Consumption of O<sub>2</sub> by facultative anaerobes
  - Production of nutrients for other bacteria
  - Proteolytic degradation of proteins



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## Antimicrobial Agents in Endodontics

- Sodium hypochlorite
- Calcium hydroxide
- Ledermix
- Odontopaste
- EDTA
- Others:
  - CHX,
  - H<sub>2</sub>O<sub>2</sub>,
  - camphorated monochlorophenol (CMCP)
- Er:YAG lasers had an anti-biofilm effect at a low energy and could reduce numbers of species of biofilm-forming cells.



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## Periradicular Response To Infections

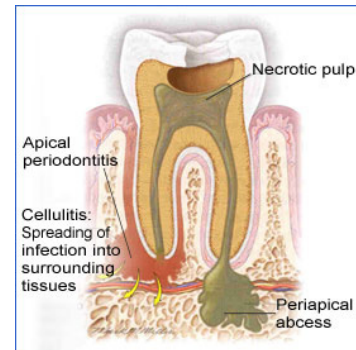
- The peri-radicular inflammatory tissue is capable of an immunologic response to bacteria and bacterial by-products.
- The cells associated with an untreated, infected root canal are **T-lymphocytes**.
- The cells associated with endodontically treated teeth had more **B-lymphocytes** than T-lymphocytes.
- The presence of IgG, IgA, IgM, or IgE have been demonstrated.

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## Periradicular Response To Infections

### Abscess

- It is an accumulation of purulent exudate, consisting of bacteria, bacterial by-products, inflammatory cells (mainly neutrophils), lysed inflammatory cells, and the contents of those cells (e.g., enzymes).
- Abscesses of **periodontal origin** contain **30% to 58% spirochetes**, whereas abscesses of **endodontic origin** contain less than **10% spirochetes**.



## Periradicular Response To Infections

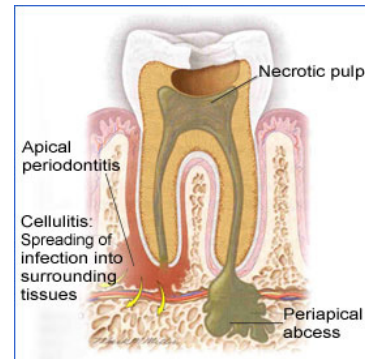
### A cellulitis

- It is defined as a diffuse, erythematous, mucosal or cutaneous infection that may spread to deeper facial spaces and become life threatening.



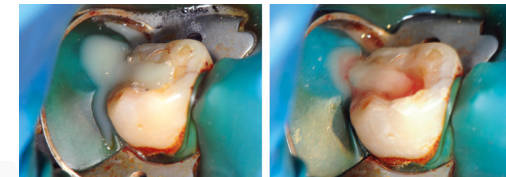
## Periradicular Response To Infections

- Abscesses and cellulitis are the result of bacteria invading and infecting periradicular tissues.
- **Chemotaxis of neutrophils is a nonspecific inflammatory response to the presence of bacteria in normally sterile tissues**
- With accumulation of neutrophils and the resulting purulent exudate, an acute apical inflammatory response develops.



## Management of Abscesses and Cellulitis

- Most endodontic infections can be effectively treated without the use of adjunctive antibiotics.
- The appropriate treatment is removal of the cause of the inflammatory event.







# ***Thank You !***

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**What are the types of microorganisms found in endodontic infection?**

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.