

# Clinical signs and histopathogenesis of periodontitis

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# Periodontal structures

- Gingiva
  - Periodontal ligament (PDL)
  - Cementum
  - Alveolar bone
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- ◆ **Gingivitis** – affects gingiva only
  - ◆ **Periodontitis** – affects all structures

# Periodontal health



# Gingivitis



# Periodontitis



# Periodontitis



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# Periodontitis – clinical signs

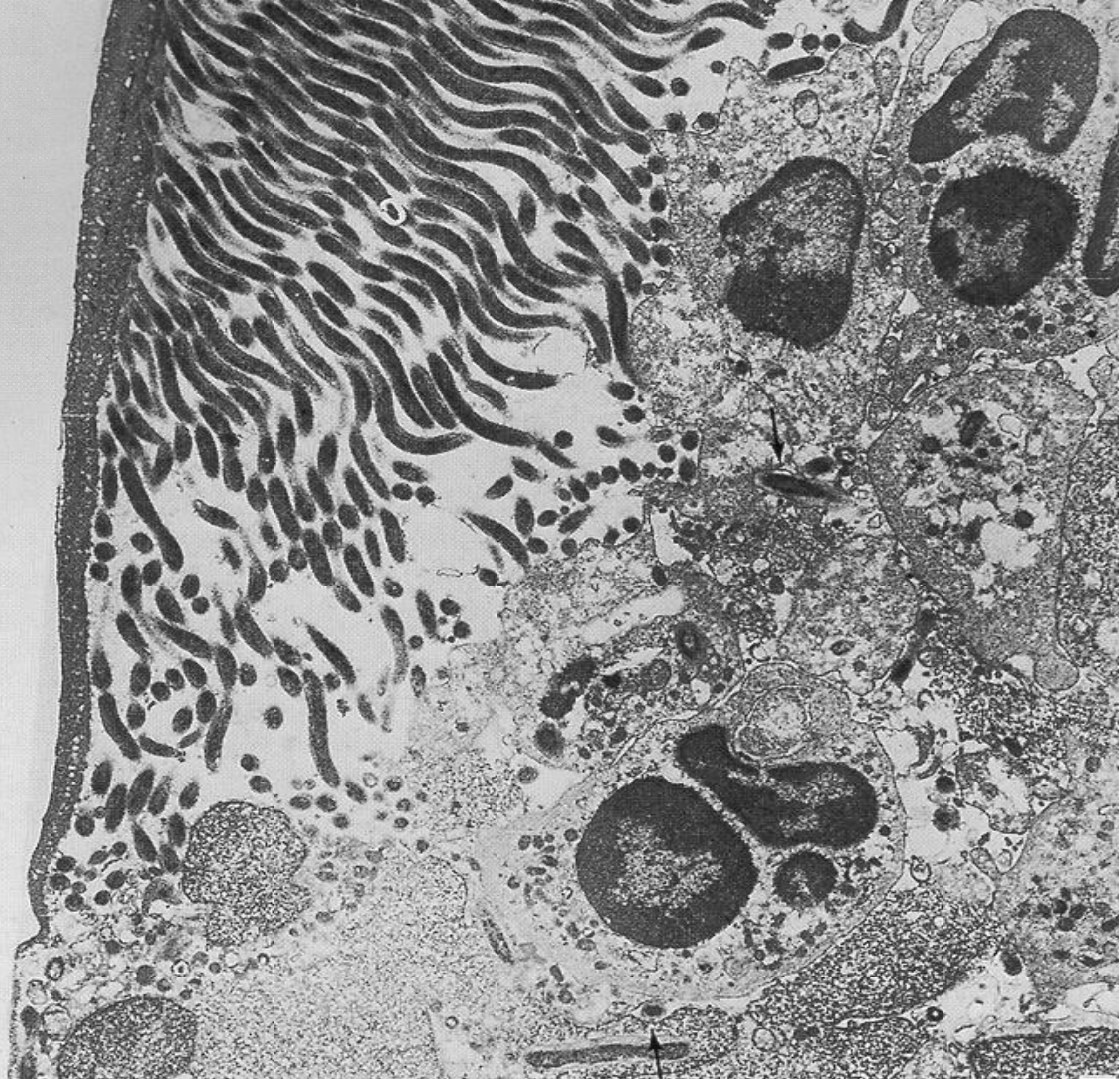
- Gingival inflammation (redness, swelling)
  - Bleeding on probing
  - Pocket formation
  - Gingival recession
  - Mobility and drifting
  - Alveolar bone resorption
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# Features of periodontal inflammation

- Unique due to the anatomy – i.e. a tooth is partly exposed to the external environment and partly is within the connective tissues
  - Tooth and surrounding tissues can be colonised by bacteria
  - The outer layers of the tooth do not ‘shed’ (like skin), so bacteria can accumulate
  - Bacteria colonise this surface, and are continually in close proximity to the soft tissues
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Bacteria colonising  
base of pocket in  
close proximity to  
host cells



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# Difficulties in identifying which species are important

- Typically, 30-100 species at a site
  - Many species won't grow outside the pocket
  - Not all sites are progressing
  - Many of the suspected pathogens can be found in health
  - The plaque biofilm is a complex structure containing many different bacterial species
  - Different strains of the same pathogens may be more or less virulent
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# And.....

- We all have plaque in our mouth, and yet we don't all have periodontitis
- Some people with very poor OH may develop gingivitis, but don't develop periodontitis
- Other people with good OH have periodontitis

What do you think about these situations?

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# Suspected periodontal pathogens

- **Aggregatibacter actinomycetemcomitans**  
*(old name: Actinobacillus actinomycetemcomitans)*
- **Porphyromonas gingivalis**
- **Tannerella forsythia**  
*(old name: Bacteroides forsythus)*
- **Prevotella intermedia**
- **Fusobacterium nucleatum**
- **Campylobacter rectus**

# Aggregatibacter actinomycetemcomitans

- G-ve rod, capnophilic
- Can invade epithelial cells in the gingiva
- Seen in aggressive periodontitis and chronic periodontitis
- Typically there is an immune response against Aa (elevated serum antibody against Aa)
- Produces leukotoxin

*Aa probably plays a role in chronic periodontitis in some (not all) cases*

# Porphyromonas gingivalis

- G-ve rod, anaerobic
- Produce collagenase, proteases against immunoglobulins,  $\text{NH}_3$ ,  $\text{H}_2\text{S}$ , endotoxin
- Found in low numbers in health, but increasing numbers in sites of disease
- Induces an immune response
- Can invade gingival epithelial cells

*Likely to be strongly implicated in most cases of chronic periodontitis*

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# Tannerella forsythia

- G-ve, anaerobic rod
- Detected in increased numbers at sites of periodontal disease compared to health
- Often found together with *F nucleatum*
- V. common in periodontal pockets
- Can invade epithelial cells

*Presence of Tf is a risk factor for periodontitis*

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# Prevotella intermedia

- G-ve rod, anaerobic
- Elevated numbers at sites of periodontitis
- Results in an immune response
- Possess various virulence properties

*Likely to have a role in periodontitis*

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# Fusobacterium nucleatum

- G-ve rod, anaerobic
  - V. commonly found in subgingival plaque
  - Key structural component of plaque
  - Found in most people
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# Campylobacter rectus

- G-ve, mobile, vibrio
  - Present in higher numbers in disease than in healthy sites
  - Levels are reduced after periodontal treatment
  - Produces a leukotoxin
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# Microbial complexes in plaque

*Streptococcus mitis*

*Streptococcus oralis*

*Streptococcus sanguis*

*Streptococcus intermedius*

*Streptococcus gordonii*

*Veillonella parvula*

*Actinomyces odontolyticus*

*Prevotella intermedia*

*Fusobacterium nucleatum*

*Fusobacterium periodonticum*

*Prevotella nigrescens*

*Peptostreptococcus micros*

*Campylobacter rectus*

*Campylobacter gracilis*

*Campylobacter showae*

*Eubacterium nodatum*

*Porphyromonas gingivalis*

*Bacteroides forsythus*

*Treponema denticola*

*Eikenella corrodens*

*Capnocytophaga gingivalis*

*Capnocytophaga ochracea*

*Capnocytophaga sputigena*

*Campylobacter concisus*

*A. actinomycetem-comitans*

Socransky S S, et al. Microbial complexes in subgingival plaque. J Clin Periodontol 1998; **25**: 134-144

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# Summary of microbiology

- Periodontal disease is not caused by one single bacterial species
  - Initiation of disease results from an interplay between the bacteria present, the local environment and the host response
  - Biofilms must be mechanically disrupted
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# Histopathology of gingivitis and periodontitis

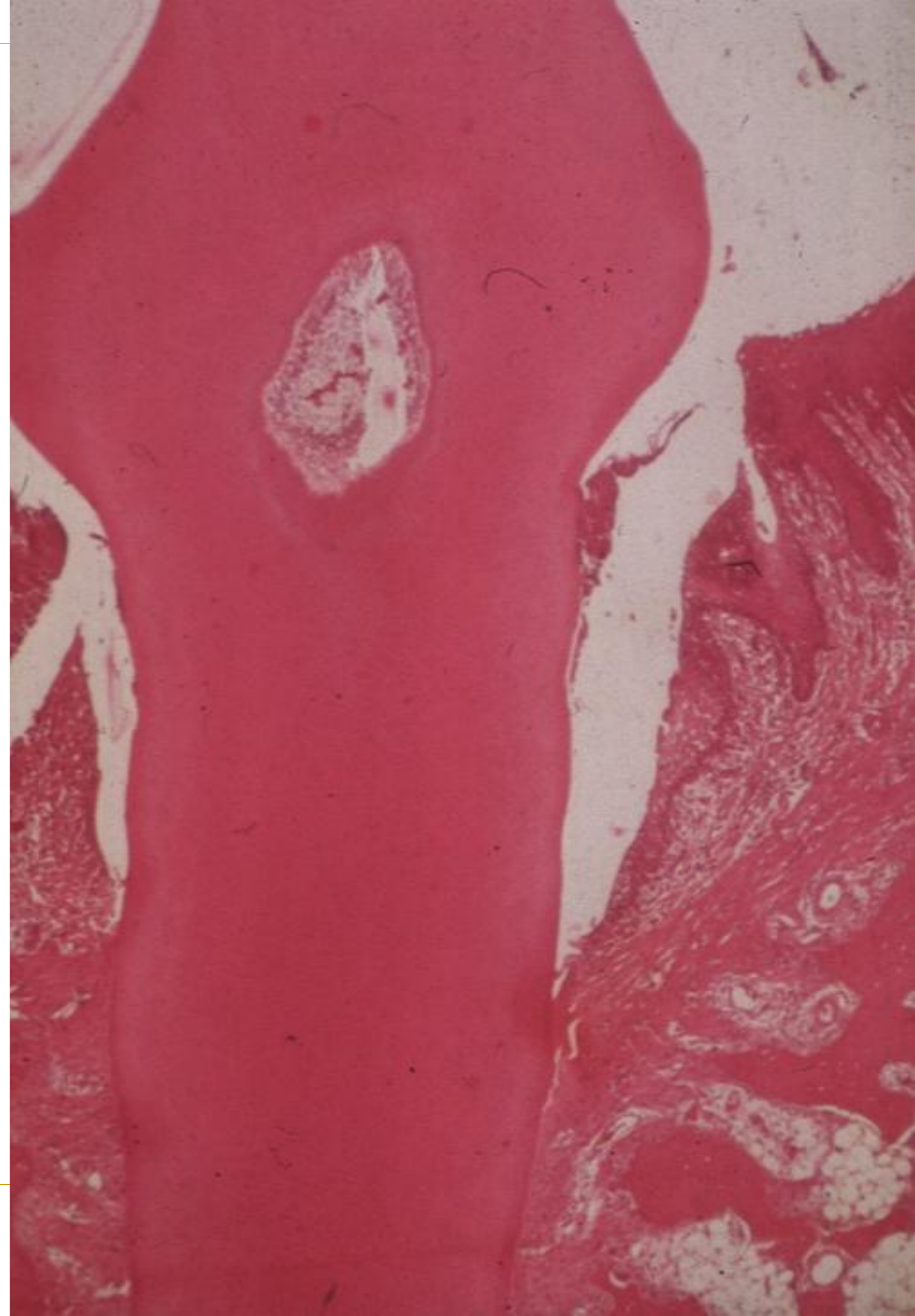
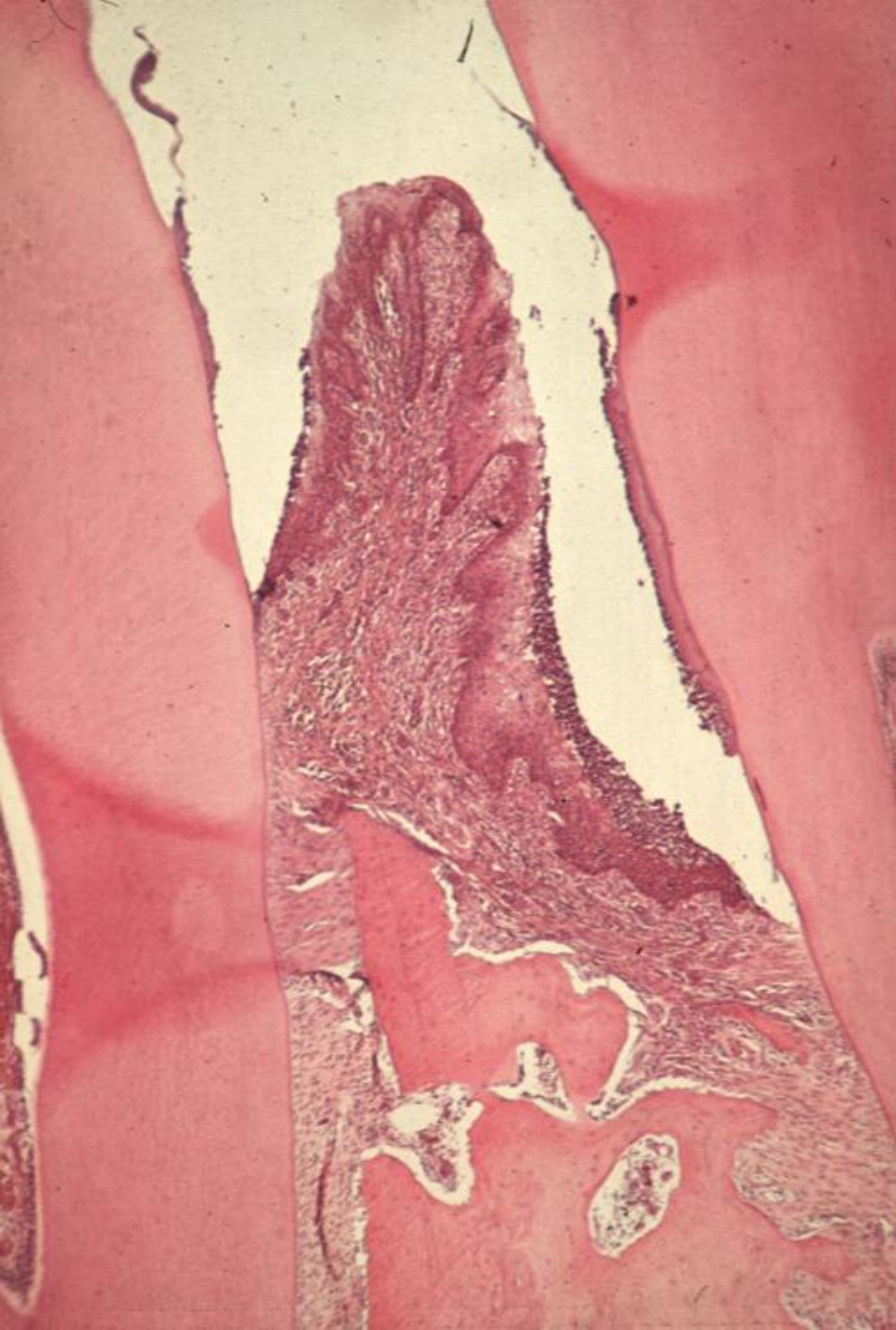
- Divided into stages\*
  - Initial gingival lesion (*gingivitis*)
  - Early gingival lesion (*gingivitis*)
  - Established gingival lesion (*gingivitis*)
  - Advanced lesion (*periodontitis*)

\* Page and Schroeder, 1976

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## Advanced lesion (= Periodontitis)

- Continued breakdown of collagen in the gingival tissues
- The junctional epithelium grows apically in response to the destructive episodes, in an attempt to maintain epithelial barrier, *thereby creating the pocket*
- Plaque grows down the pocket apically, and anaerobic bacteria flourish
- Inflammatory response spreads apically into the deeper tissues
- Collagen breakdown of PDL fibres continues
- Osteoclasts are stimulated to resorb alveolar bone
- Junctional epithelium continues to migrate apically down the root surface – *pocket gets deeper and harder to clean*



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# Host defence processes

- Physical barriers
  - Outward flow of GCF
  - Increased vascular permeability and vasodilatation
  - Shedding of epithelial surfaces
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# Inflammatory cells - PMNs

- Polymorphonuclear leukocytes
- PMN is the predominant defence cell in the crevice
- Migrate from the vessels into the gingival tissues in response to chemotactic stimuli from plaque bacteria
- First line of defence against plaque bacteria
- If PMNs contain the infection, periodontal destruction is less likely

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# Inflammatory mediators - cytokines

- Cytokines are proteins secreted by cells that transmit signals to other cells (act as messengers)
  - Include INTERLEUKINS (eg IL-1 $\beta$ ) and TUMOUR NECROSIS FACTOR (TNF- $\alpha$ )
  - Secreted by PMNs and macrophages
  - Cause increased inflammation, stimulate bone resorption by osteoclasts, stimulate collagen breakdown by fibroblasts
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# Inflammatory mediators - prostaglandins

- Produced by macrophages
- Includes prostaglandin  $E_2$  -  $PGE_2$
- Cause vasodilatation and stimulate secretion of other inflammatory mediators
- $PGE_2$  stimulates fibroblasts to produce MMPs (which break down collagen)
- $PGE_2$  stimulates osteoclasts to resorb bone

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# Inflammatory mediators - MMPs

- Matrix metalloproteinases are a family of enzymes that break down proteins
  - **COLLAGENASE** is a MMP
  - MMPs are produced by PMNs and fibroblasts, and they break down collagen in the tissues
  - In periodontal disease, levels of MMPs are increased as tissue destruction occurs
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# Pathogenesis 1

- Plaque bacteria and their products cause an inflammatory response in the soft tissues
  - Inflammatory mediators (chemokines, cytokines) are released
  - Defence cells migrate into the area
  - Fluid accumulates in the tissues
- The tissues become red and swollen (*i.e. gingivitis*)
- PMNs, macrophages and lymphocytes migrate into the tissues to combat the bacterial challenge
  - PMNs phagocytose bacteria and kill them
  - PMNs accumulate in the periodontal tissues

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## Pathogenesis 2

- PMNs release their destructive enzymes extra-cellularly
  - Collagen is broken down (PMNs produce collagenases)
  - Epithelium proliferates, and regrows at a more apical location, thereby the pocket is formed
  - As the pocket deepens, plaque bacteria grow further apically, extending the inflammation
  - Inflammatory mediators continue to be released by defence cells and fibroblasts in the area, causing further breakdown of collagen, and stimulating osteoclasts to resorb bone
  - PMNs continue to accumulate, and spill their destructive enzymes into the tissues causing further tissue damage
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# Summary

- Plaque bacteria are necessary to initiate inflammation
  - In response to the presence of bacteria, the host mounts an inflammatory response
  - The majority of the tissue destruction is caused by the inflammatory host response to the plaque bacteria
  - The clinical progress of the disease is influenced by the precise nature of the host response (which varies from person to person), and is influenced by environmental factors like smoking or diabetes
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