

# Etiology of Periodontal Diseases(1)

## Periodontal Microbiology: Dental Plaque

*Periodontology I*  
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## Outline

- ◆ Plaque and periodontal diseases:
  - ◆ Role
  - ◆ Microbial specificity of periodontal diseases
  - ◆ Microorganisms in specific periodontal diseases

## Outline

- ◆ Dental plaque:
  - ◆ definition
  - ◆ Macroscopic structure and composition
  - ◆ Formation
  - ◆ Microscopic structure
  - ◆ The biofilm environment

## Overview of Periodontal Diseases

<b>1</b>	<b>2</b>	<b>4</b>
		
<b>Healthy Teeth &amp; Gums</b>	<b>Gingivitis</b>	<b>Moderate Periodontitis</b>
		

## Dental Plaque

- ◆ Definition:
  - ◆ A host-associated biofilm
  - ◆ Consists mainly of a complex ecosystem of bacteria
  - ◆ Forms clear or yellow soft deposits on teeth and other hard surfaces

## Plaque and Periodontal Diseases

- ◆ Role:
  - ◆ Primary etiological factor
  - ◆ Experimental gingivitis studies
  - ◆ Germ-free animals
  - ◆ Clinical studies

## Dental Plaque

- ◆ Microbial Specificity of Periodontal Disease:
  - ◆ Non-specific plaque hypothesis
  - ◆ Specific plaque hypothesis
  - ◆ Ecologic plaque hypothesis

## Dental Plaque

- ◆ Definition:
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## Tooth-Accumulated Materials

- ◆ Plaque: can't be removed with water rinsing.
- ◆ Materia Alba: food debris, can be removed with water rinsing.
- ◆ Calculus: hard deposits



Dental plaque: could be visualized using a plaque disclosing agent



Dental calculus



Materia Alba

### Macroscopic Structure

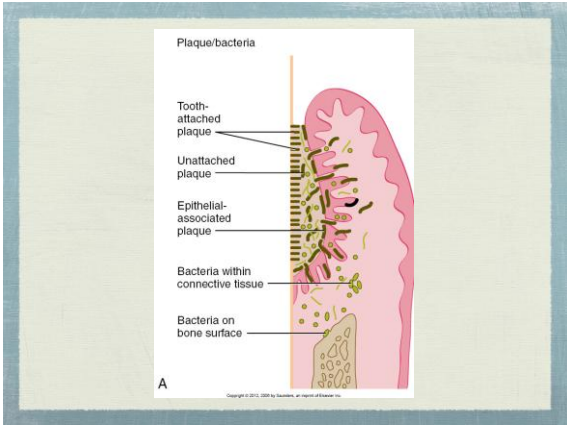
- ◆ Supra-gingival plaque
- ◆ Sub-gingival plaque

### Macroscopic Structure

- ◆ Supra-gingival plaque: found at or above the gingival margin
- ◆ Marginal plaque: supra-gingival plaque in direct contact with the gingival margin

### Macroscopic Structure

- ◆ Sub-gingival plaque: found below the gingival margin, between the tooth and gingival sulcular tissue
- ◆ tooth-associated and tissue-associated regions



### Composition

- ◆ Microorganisms
- ◆ Inter-cellular matrix:
  - ◆ Organic constituents
  - ◆ inorganic constituents
- ◆ Host cells

### Composition

- ◆ Microorganisms: **Bacteria**, Yeast, Protozoa, Viruses, Mycoplasma
- ◆ more than 700 species in the mouth
- ◆ Primary constituent

## Composition

- ◆ Inter-cellular matrix:
  - ◆ 20% - 30% of plaque volume
  - ◆ Organic and inorganic materials
  - ◆ derived from saliva, GCF and bacteria

## Composition

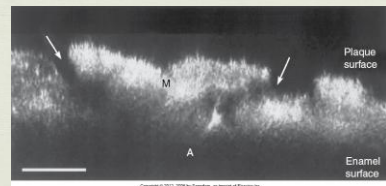
- ◆ Inter-cellular matrix:
  - ◆ Organic:
    - ◆ Glycoproteins: saliva
    - ◆ Mucopolysaccharides: bacteria (dextran)
    - ◆ Proteins: GCF (albumin)
    - ◆ Lipids: disrupted bacterial and host cells

## Composition

- ◆ Inter-cellular matrix:
  - ◆ Inorganic:
    - ◆ Calcium and Phosphorus
    - ◆ Sodium, magnesium, potassium, fluoride,...
  - ◆ Source: saliva or GCF

## Composition

- ◆ Inter-cellular matrix:
  - ◆ Complex ecosystem

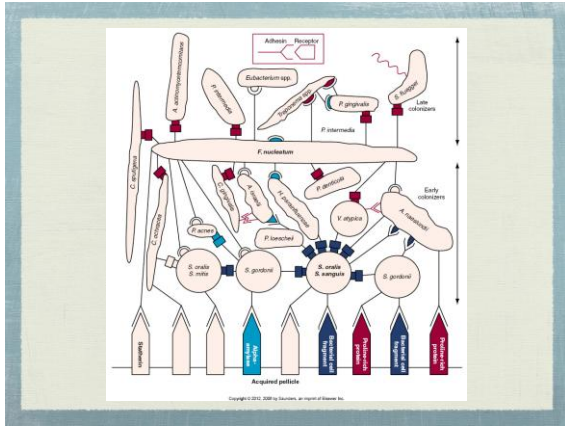


## Formation

- ◆ Bacteria detectable within 3 minutes !
- ◆ Gingival 1/3

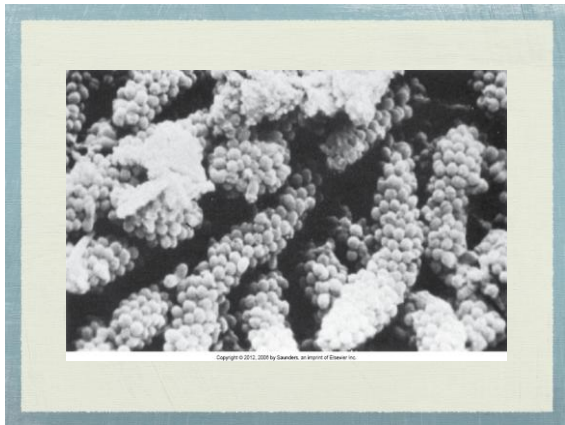
## Formation

- ◆ Stages:
  - ◆ Acquired pellicle
  - ◆ G +ve facultative anaerobes:
  - ◆ G -ve Anaerobes
- ◆ Growth: aggregation, proliferation & matrix



## Microscopic Structure

- ◆ Supra-gingival plaque:
  - ◆ Stratified organization
  - ◆ G+ve cocci and short rods --> G-ve rods, filaments and spirochetes

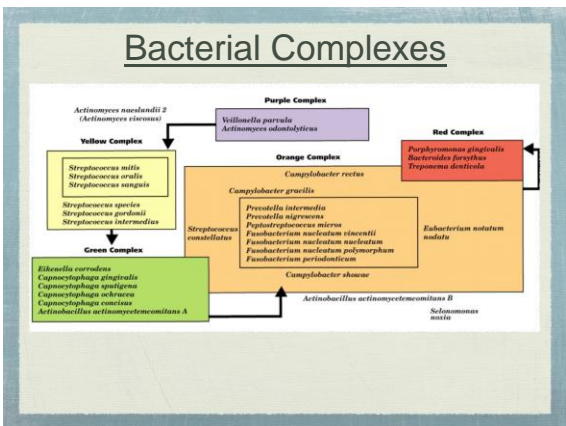


## Microscopic Structure

- ◆ Sub-gingival plaque:
  - ◆ tooth-associated region:
    - ◆ G+ve rods and cocci
  - ◆ tissue-associated regions
    - ◆ G-ve rods & cocci, spirochetes

## The Biofilm Environment

- ◆ Physiologic interaction occur between the different biofilm bacteria
- ◆ Biofilm functions as a barrier
- ◆ Susceptibility to antibiotics



## Microbiology of Specific Periodontal conditions

- ◆ Koch's postulate
- ◆ Perio pathogen must:
  1. increased numbers in diseased sites
  2. decreased numbers in clinical resolution
  3. induce an immune response
  4. causes disease in exp. animal models
  5. demonstrate virulence factors

TABLE 6-2  
Evidence Supporting a Role for *A. actinomycetemcomitans* and *P. gingivalis* as Pathogens in Periodontal Disease:  
Socransky's Criteria

Criterion	<i>A. actinomycetemcomitans</i>	<i>P. gingivalis</i>
Association	Increased in localized aggressive periodontitis (LAP) lesions Increased in some chronic periodontitis lesions Detected in the tissues of LAP lesions	Increased in periodontitis lesions Found associated with crevicular epithelium
Elimination	Suppressed or eliminated in successful therapy Found in recurrent lesions	Suppressed or eliminated in successful therapy Found in recurrent lesions
Host response	Increased serum and local antibody levels in LAP	Increased systemic and local antibody levels in periodontitis
Animal studies	Capable of inducing disease in gnotobiotic rats	Found to be important in experimental mixed infections and in periodontitis in the cynomolgus monkey
Virulence factors	Host tissue cell invasion, leukotoxin, collagenase, endotoxin (LPS), epitheliotoxin, fibroblast inhibiting factor, bone resorption-inducing factor	Host tissue cell adherence and invasion, collagenase, trypsin-like enzyme, fibrinolysin, phospholipase A, phosphatases, endotoxin (LPS), H <sub>2</sub> S, NH <sub>3</sub> , fatty acids, factors that affect PMN function

## Microbiology of Specific Periodontal conditions

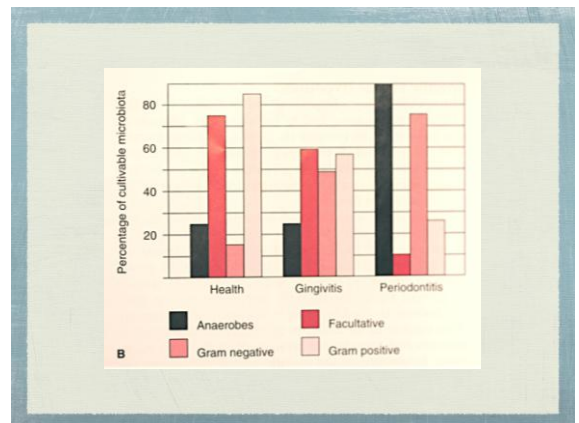
- ◆ Periodontal health:
  - ◆ Primarily G+ve Facultative species
  - ◆ Streptococcus and Actinomyces genera
  - ◆ Small proportions G-ve species

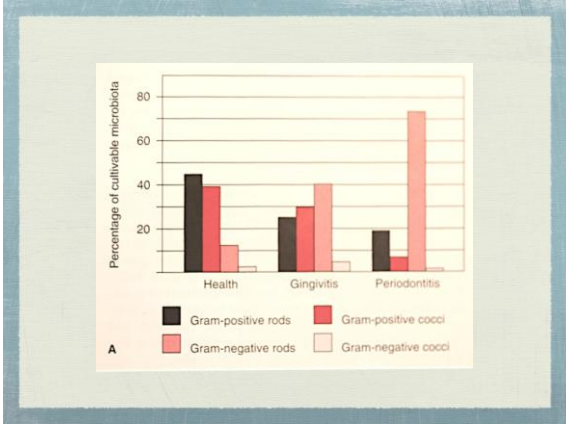
## Microbiology of Specific Periodontal conditions

- ◆ Gingivitis:
  - ◆ Initially --> G+ve cocci and rods & G-ve cocci
  - ◆ Later --> G-ve rods
  - ◆ Equal proportions of G+ve and -ve

## Microbiology of Specific Periodontal conditions

- ◆ Chronic periodontitis:
  - ◆ Anaerobic (90%), G-ve bacteria (75%)
  - ◆ Spirochetes
  - ◆ Pg, Tf, Td, Cr, Pi, Ec, Aa, Fn, Pm





### Microbiology of Specific Periodontal conditions

- ◆ Localized aggressive periodontitis
  - ◆ Capnophilic, Anaerobic
  - ◆ A actinomycetemcomitans
  - ◆ Pg, Cr, Ec, ..