Oral Microbiology

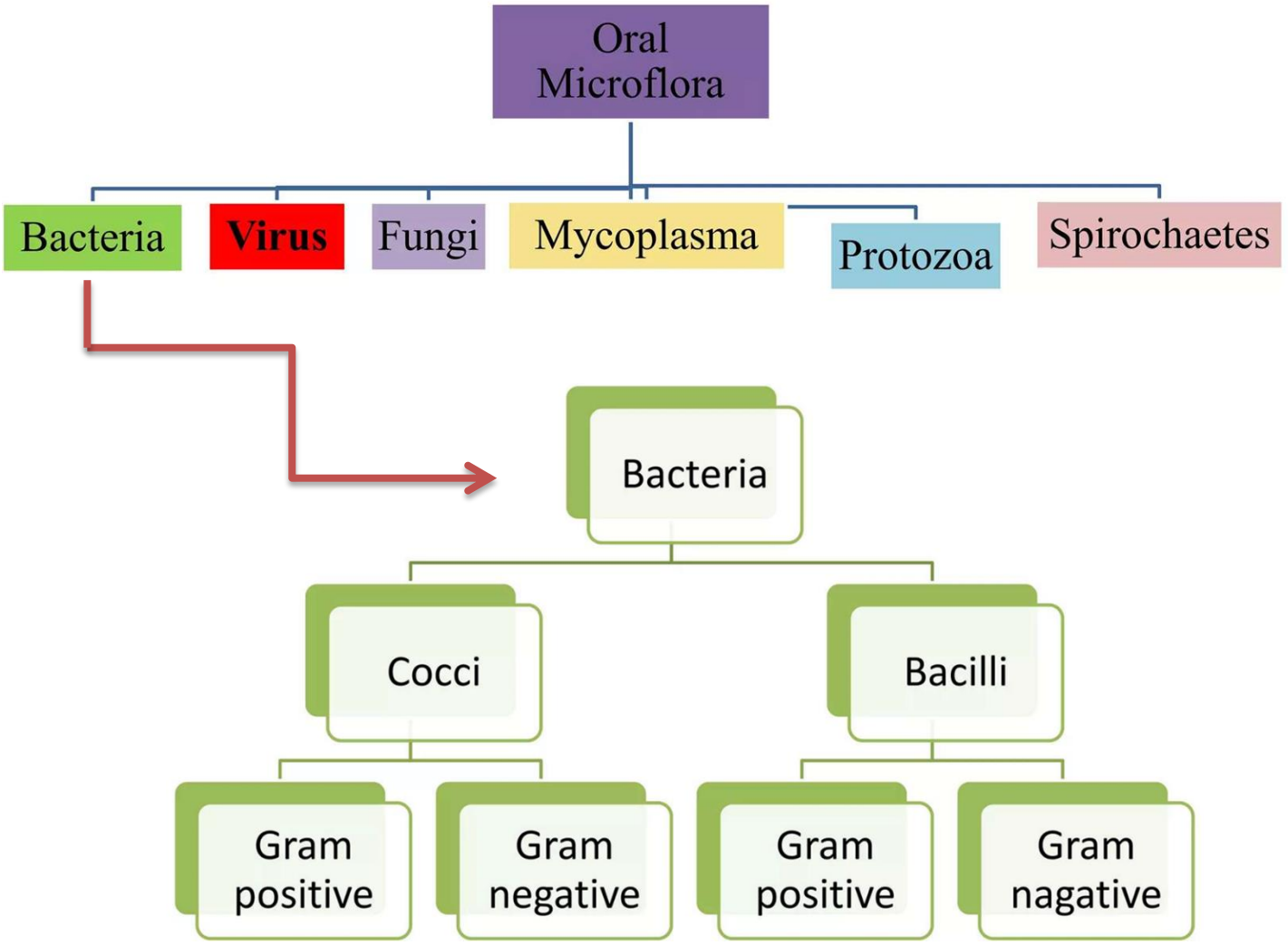
Lecture 19

Dr. Samer Y. Alqaraleh

PhD. Nanobiotechnology (Microbiology)

Faculty of Dentistry

2025-2026


Oral Microflora
Bacteria
Virus
Fungi
Mycoplasma
Protozoa
Spirochaetes
Bacteria
Cocci
Bacilli
Gram positive
Gram negative
Gram positive
Gram nagative

The properties of oral microbiota

Gram-positive cocci

1. Streptococcus

Characteristics:

- Isolated from all sites in the mouth.
- A large proportion of the resident cultivable oral microbiota.
- In general, Alpha-haemolytic (partial haemolysis).
- **Streptococci** can be distinguished from **staphylococci** and **micrococci** by lacking the **enzyme catalase**

Streptococcus groups. *Mutans, Salivarius, Anginosus, Mitis*

S. mutans

- Isolated from carious human teeth.

- **Nine serotypes** have been recognised (a-h, and k)(*S. mutans, S. sobrinus, S. cricetus*).
- Recovered from teeth or dentures.
- Opportunistic pathogens, being isolated from cases of infective endocarditis.
- Isolated from dental plaque at carious sites, but their prevalence is low on sound enamel.
- The main causative organisms in the enamel and root surface caries.
- Some people harbor more than one species of mutans streptococci in their mouth.

- The antigenic structure of mutans streptococci has been studied in detail. ???

- For the development of a prospective caries vaccine.

- **Antigens**: carbohydrate antigens, lipoteichoic acid, lipoproteins and cell wall or cell wall-associated proteins.

- A major **adhesin** protein involved in the initial adherence of *S. mutans* to the tooth surface are **antigen I/II** (also termed antigen B, Spap or Pac) target for vaccine.

Why is *Streptococcus mutans* are cariogenic?

✓Make extracellular soluble and insoluble polysaccharides (**glucan**, **mutan** and **fructan**) from sucrose that are associated with dental plaque maturation and cariogenicity.

* Glucosyltransferases

* Fructosyltransferases

- glucans and fructans are produced by glucosyltransferases and fructosyltransferases, respectively.

- Mutan is a highly insoluble glucan that is only produced by mutans streptococci.

- These polymers contribute to the characteristic colonial morphology of mutans streptococci when growing on sucrose-containing agar plates. (**Raised colonies**)

- Synthesize intracellular polysaccharides when there is excess sugar act as carbohydrate reserves.
- Scavenge dietary sugars very efficiently and rapidly convert them to acidic fermentation products (mainly lactate).
- Grow and survive under the acidic conditions they generate.
- Can communicate with other mutans streptococci by the release of diffusible signaling molecules that can induce genetic competence acid tolerance.

Salivarius group

- Comprises ***S. salivarius*** and ***S. vestibularis***.
- Commonly isolated from most areas of the mouth.
- Colonize mucosal surfaces, especially the tongue.
- Produces large quantities of an unusual extracellular **fructan** from sucrose.
- *Streptococcus salivarius* also produces extracellular soluble and insoluble glucans from sucrose;
- Some strains have **urease** activity. Generate alkaline condition
- Is not considered a significant opportunistic pathogen.

Streptococcus vestibular

- Isolated mainly from the **vestibular** mucosa of the human mouth.
- **Do not** produce extracellular polysaccharides.
- Produce a urease (ammonia and hence raise the local pH).
- Produce **hydrogen peroxide --** sialoperoxidase system (inhibit the growth of competing bacteria)

Anginosus group

- *Streptococcus constellatus*, *S. intermedius*, *S.anginosus*
- Readily isolated from dental plaque and from mucosal surfaces.
- Causes of serous, purulent disease in humans, including maxillofacial infections.
- Produce a cytotoxin, intermedilysin, which may also interfere with neutrophil function and enable the cell to evade the host defenses during abscess formation.
- Does not make extracellular polysaccharides from sucrose.

Mitis group

- *Streptococcus sanguinis* and *S. gordonii* :
- Early colonizers of the tooth surface,
- Both produce extracellular soluble and insoluble glucans from sucrose.
- Contribute to biofilm formation.
- *S. sanguinis* produces a protease that can cleave **IgA** (IgA protease)

- *S. gordonii* can bind salivary a-amylase (ptyalin) enabling these organisms to breakdown starch.

- Amylase-binding may also **mask** bacterial antigens and allow these bacteria to avoid recognition by the host defenses.

- *S. mitis* and *S. oralis* are able to take up **extracellular DNA**.

- This process is facilitated in biofilms like dental plaque.

- Members of the mitis group are opportunistic pathogens, particularly in infective endocarditis.

GRAM-POSITIVE RODS AND FILAMENTS

- *Actinomyces*.
- *Eubacterium* AND RELATED GENERA.
- *Lactobacillus.*

Actinomyces

- Form a major portion of the microbiota of dental plaque
- Gingival crevice
- Associated with root surface caries,
- Numbers increase during gingivitis
- Short rods, filamentous, fimbriated
- Most common Gram-positive bacillus in plaque is *Actinomyces naeslundi*,

- Produce an extracellular slime and a fructan from sucrose.
- Levan-like structure monosaccharide sugar, made up from fructose·
- Enzymes that can hydrolyse fructans.
- Produce urease (this enzyme may have a role in modulating pH in plaque).
- Neuraminidase (can modify receptors in the enamel acquired pellicle).

- Two types of fimbriae can be found on the surface, function:
  1.cell-to-cell contact (coaggregation)
  2. cell-to-surface interaction.

- Can cause disease called **actinomycosis** by the opportunistic *Actinomyces israelii*.
- Form granules aid in dissemination into the body.

Eubacterium and related genera

- Obligately anaerobic.
- Filamentous.
- **Asaccharolytic**.
- comprise over 50% of the anaerobic microbiota of periodontal pockets and are common in dentoalveolar abscesses.
- Species were recovered from infected root canals.
- Some species were recovered from periodontal pocket

Lactobacillus

- Commonly isolated fromdental plaque and the tongue.
- Usually comprise less than 1% of the total cultivable microbiota in the healthy mouth.
- Highly **acidogenic** and **acid tolerant**.
- Proportions and prevalence increase in advanced enamel and root surface caries lesions.
- Producing either lactate, or lactate and acetate from glucose.
- *L. casei*, *L. rhamnosus*, *L. fermentum*, *L. acidophilus*,*L. salivarius*, *L. plantarum*, *L. paracasei*, *L. gasseri and L. oris.*
- **Oral probiotic**

GRAM-NEGATIVE COCCI

1) Neisseria.

- Aerobic or facultative anaerobic.
- Gram negative cocci.
- Isolated in low numbers from most sites in the oral cavity.
- Among the earliest colonizers of teeth and make an important contribution to plaque formation by **consuming oxygen** and creating conditions that permit obligate anaerobes to grow.
- Some *Neisseria* species can produce extracellular polysaccharides, and some *streptococcal* strains can metabolize these polymers, effectively using them as external carbohydrate reserves.
- Species opportunistic pathogen

GRAM-NEGATIVE COCCI

2) *Veillonella*

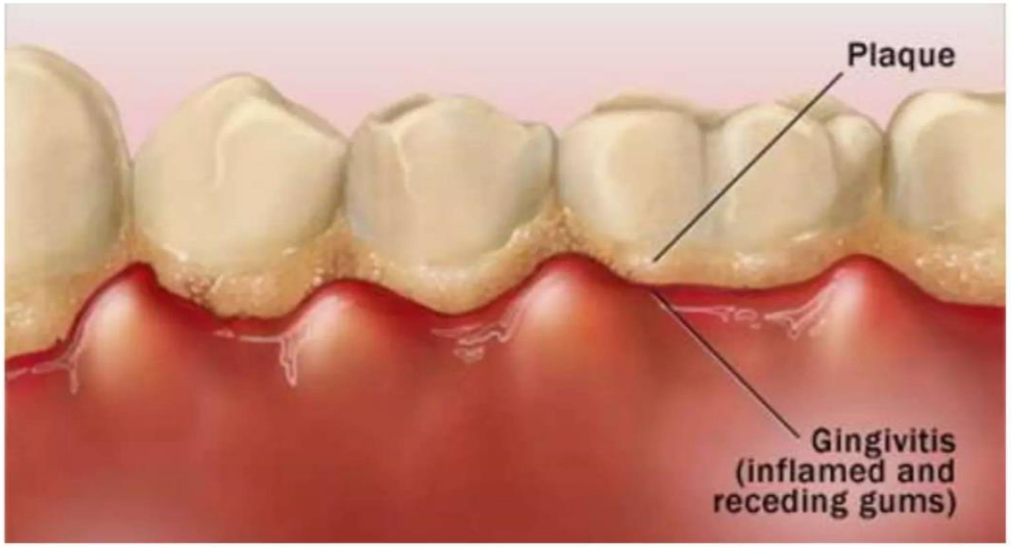
- *Veillonella parvula*, *V. dispar*, *V. atypica*, *V. denticariosi* (more common in carious dentine), *V. rogosae* (more common in caries-free individuals).
- Small, anaerobic Gram-negative cocci.

- Isolated from most surfaces of the oral cavity, in highest numbers in dental plaque·
- Lack glucokinase and fructokinase ------- unable to metabolize carbohydrates·

- Utilize several intermediary metabolites, in particular lactate, as energy sources and, consequently, play an important role in the ecology of dental plaque and in the etiology of dental caries. **How??**

- Dissolution of enamel: *Veillonella* can convert lactic acid to weaker acids (predominantly propionic acid) and so ameliorate the potential damage of saccharolytic bacteria, such as streptococci

Microflora of Dental Plaque



Plaque: A sticky, colorless biofilm that builds up on teeth, formed by bacteria, food particles, and saliva.

- **Dental plaque** is the microbial community that develops as a biofilm on the tooth surface, embedded in a matrix of polymers of bacterial and salivary origin.
- Plaque that becomes calcified is referred to as calculus or tartar.

Composition of dental plaque

Bacteria + Intercellular matrix = Dental plaque

- Bacteria -- 70 to 80 per cent of total material.
- Mycoplasma, fungi, protozoa and viruses
- Intercellular matrix:
- Organic components

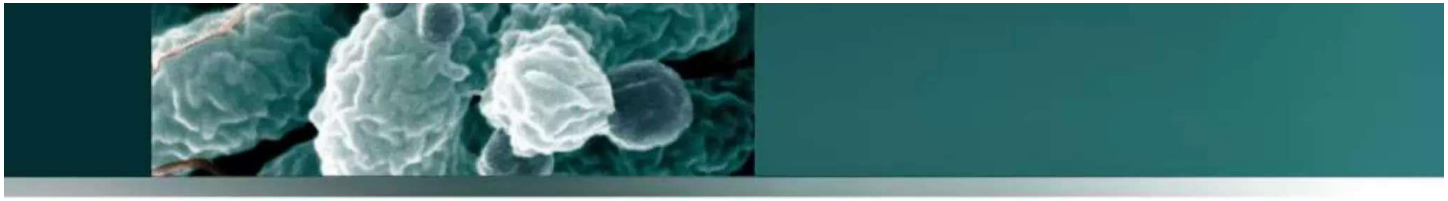
Inorganic components

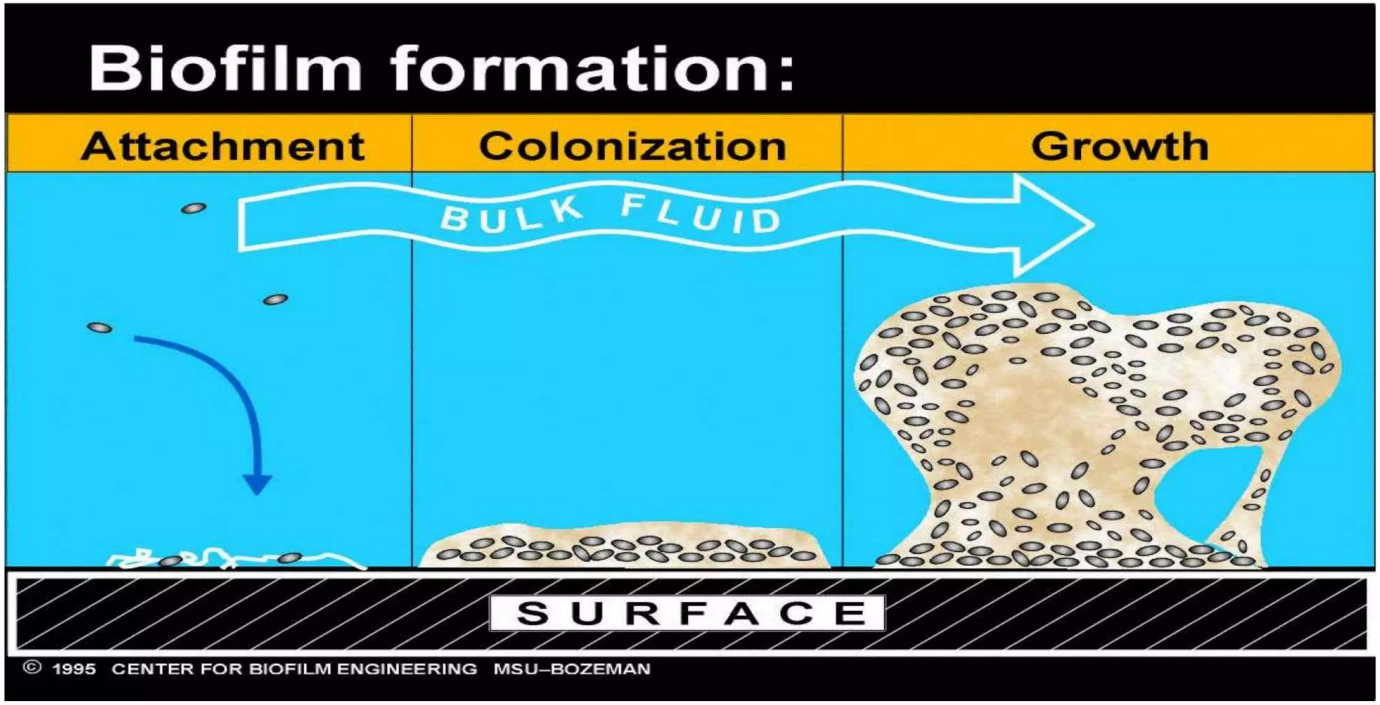
- Carbohydrates:
  Levan
  Glucan
  Galactose
- Glycoproteins

Calcium
Phosphorus
Magnesium
Potassium
Sodium

What causes dental plaque in the first place?

- **Biofilms** are communities of microorganisms (like bacteria and fungus), held together by a slimy, glue-like substance.
  - A prime example in humans is dental plaque.
  - It can also be called dental biofilm, oral biofilm, or dental plaque biofilm.
  - In any environment where there is moisture, microorganisms (bacteria, and fungi among others) and a surface (this can be teeth, dentures, crowns, and implants), biofilm can exist.




Biofilm formation:
Attachment
Colonization
Growth
BULK FLUID
SURFACE
© 1995 CENTER FOR BIOFILM ENGINEERING MSU–BOZEMAN

Stage 1 — Adsorption of molecules

- known as dental pellicle forms. This happens within minutes after tooth eruption, teeth cleaning or chewing.
- Involves the adsorption of salivary proteins to apatites surfaces via electrostatic ionic interactions.

Stage 2 — Bacterial adhesion

- Transition between pellicle to plaque is rapid.
- The first constituents are **cocci** with small numbers of epithelial cells and PMNL's which initially adhere via electrostatic interactions.
- Bacteria stick (adhere) to the surfaces, with some species of bacteria adhering better than others. *S. mutans* and *S. Sanguis* produce glycans in the presence of sucrose.

Stage 3 — Cellular growth

The bacteria multiply and the overall biofilm mass grows. The extracellular matrix (the sticky glue-like substance) also increases.

Stage 4 — Maturation

- Detachment of cells from this biofilm into the saliva results in colonization of fresh sites.

Factors which determine the ultimate composition and pathogenicity of plaque

1. Bacterial factors

- ✓ **Extra-cellular products**: eg. glucans produced by *S. mutans* are sticky and help in co- aggregation.

- ✓ **Bacterial interactions**: are important for bacteria that cannot attach directly to the tooth. Eg. *Vellionella* which of incapable of direct attachment accumulates on *A.viscosus*.

2. Host factors:

- ✓ Oral cleansing mechanism such as salivary flow, movements of tongue and cheek control the plaque formation rate.

- ✓ Saliva influences
  - The plaque pH by its buffering action and acid neutralization.
  - Inhibition of adherence by coating the surface receptors.
  - Inhibition of adherence via promotion of bacterial agglutination.

3. Immune response:

Main sources of immune components in oral cavity are:

- ✓ **IgA** and antibodies in saliva which compete with bacterial adherence and influences their metabolism, growth, and accumulation.

- ✓ Gingival Crevicular fluid (GCF) which contains antibodies, leukocytes, complement factors etc.