Dental Caries Course

Lecture 5

Oral microorganisms of dental plaque and dental caries

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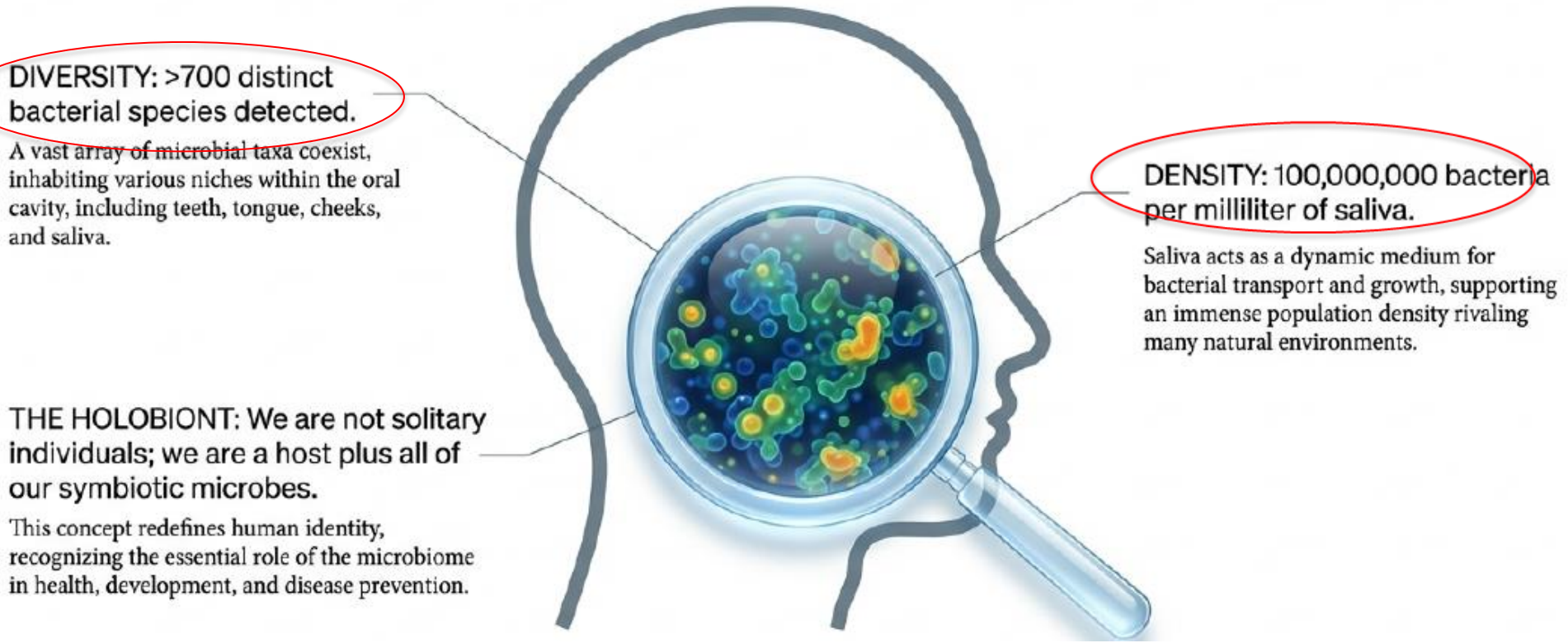
The Mouth is a Planet



- Human mouth not a sterile environment; it's complex habitat.
- Bacteria are the predominant microorganisms; approximately 30 genera.

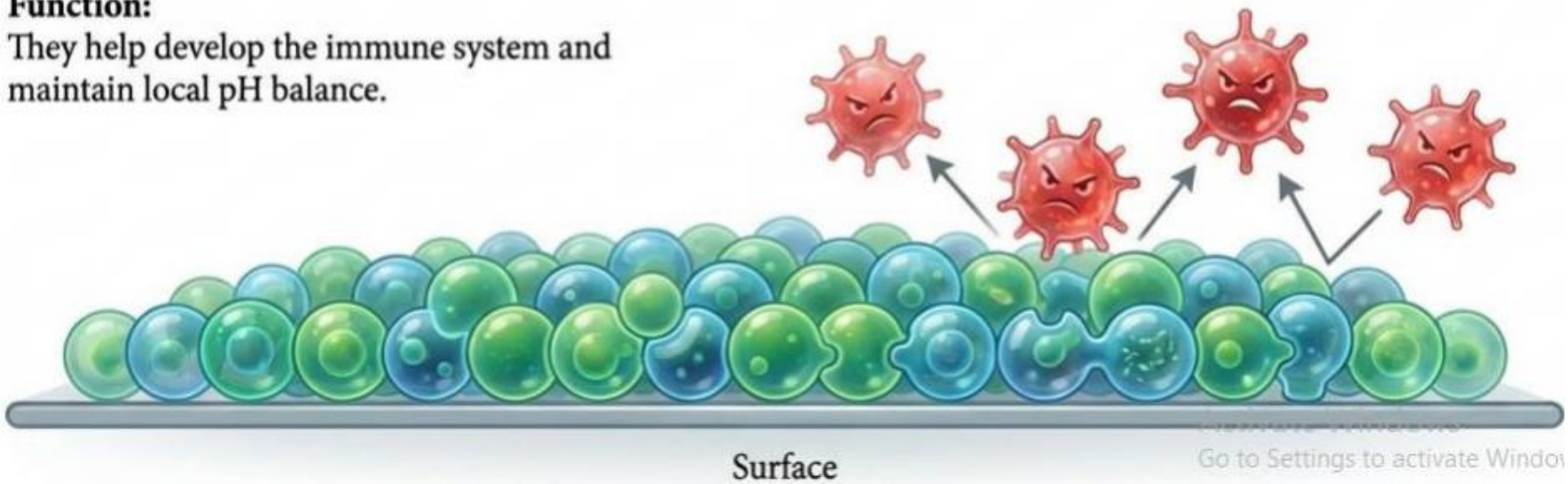
The Guardians of the Gate

- **Commensal Flora**: The resident bacteria that live in **harmony** with the host.

- The Protective Mechanism or called **Colonization Resistance by:**

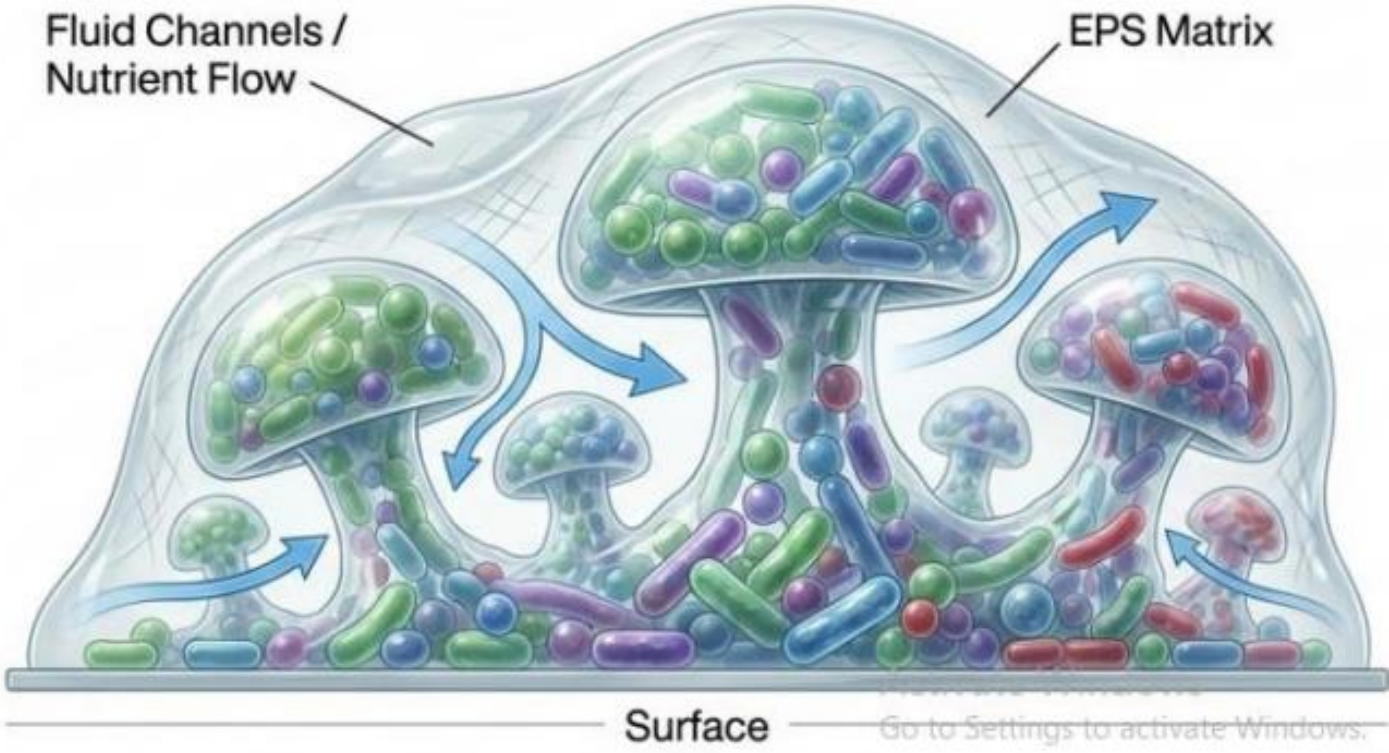
- They **compete for nutrients** (starving pathogens).
- They **block binding sites** (preventing attachment).
- Some even **produce antimicrobial substances** (directly inhibiting invaders).

Function:
They help develop the immune system and maintain local pH balance.



Dental Plaque – Definition

- Soft, sticky biofilm adhering to tooth surfaces.
- Colorless to pale yellow, Not easily removed by rinsing with water.



Composition of Dental Plaque

- **Plaque**
  - Solid 20-30%
    - **Bacteria 70-80%**
    - -Viruses, Yeast Protozoa, Mycoplasma
    - **Extracellular matrix 20-30%**
      - Organic
        - CHO 30%
        - Proteins 30%
        - Lipids 15%
      - Inorganic
        - Calcium
        - Phosphorous
        - Other minerals (Na, K, F)
  - **Water 70-80%**

Stages of Dental Plaque Formation (Dental Biofilm formation)

1. Acquired pellicle formation.

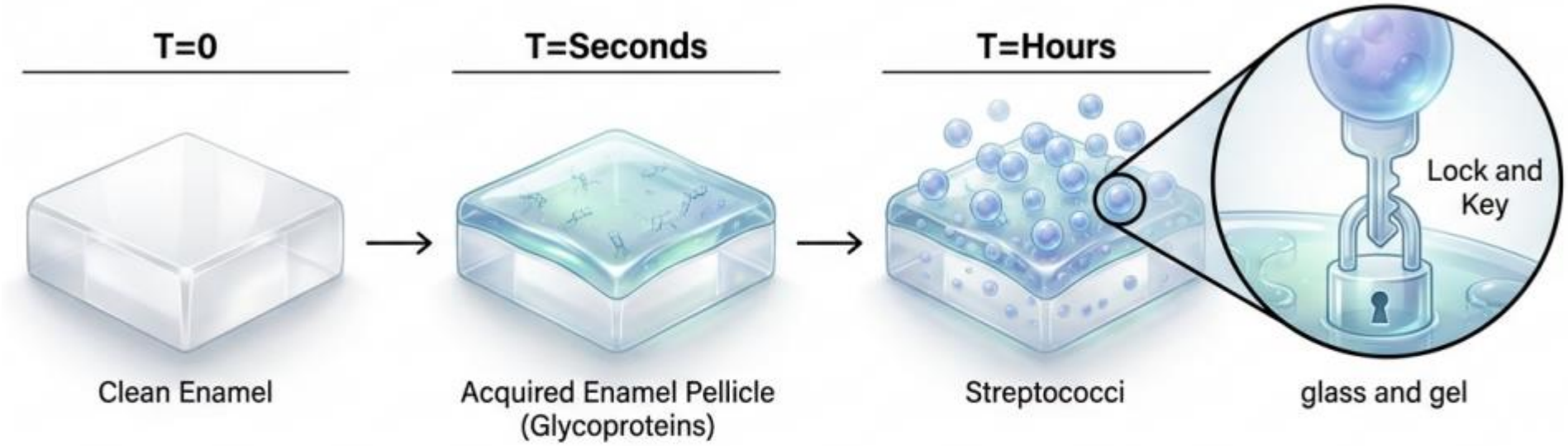
2. Initial bacterial adhesion (early colonizers).

3. Growth and Matrix Production.

4. Co-aggregation and Diversification (Secondary colonizers).

5. Maturation & Dispersion.

The Foundation: Pellicle and Attachment



The Acquired Enamel Pellicle: A thin layer of salivary proteins that instantly coats the tooth. Bacteria do not stick to enamel; they stick to the pellicle.

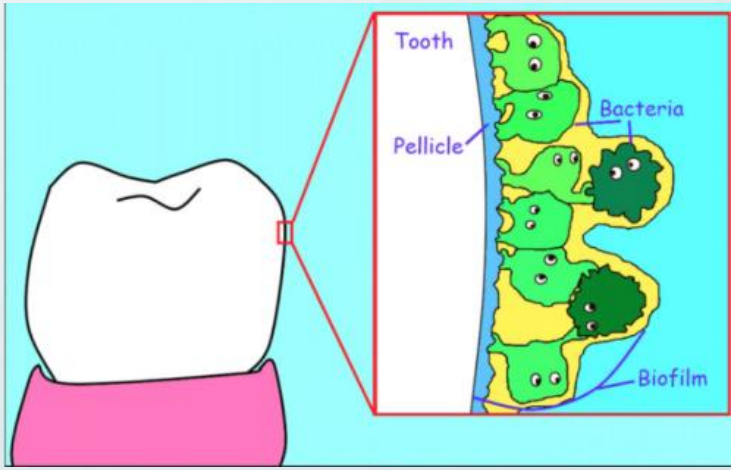
The Pioneer Colonizers: Primarily *Streptococcus* species (e.g., *S. sanguinis*, *S. mitis*).

Adhesion Mechanism: Specific interactions between bacterial adhesins and pellicle receptors.

- It is derived mainly from saliva and gingival sulcular fluids.
- The pellicle protects enamel from acids (**Lubricating layer**).
- Initially, it is free of bacteria.
- It contains glycoproteins, phosphoproteins, enzymes, and immunoglobulins.

SALIVARY PROTEINS → LUBRICATING LAYER → SALIVARY PELLICLE → FORMS ON ALL SURFACES

- Provides binding sites for bacteria adherence



BUT THIS TYPE OF SURFACES ARE SHEDDING WHILE TEETH ARE NOT.

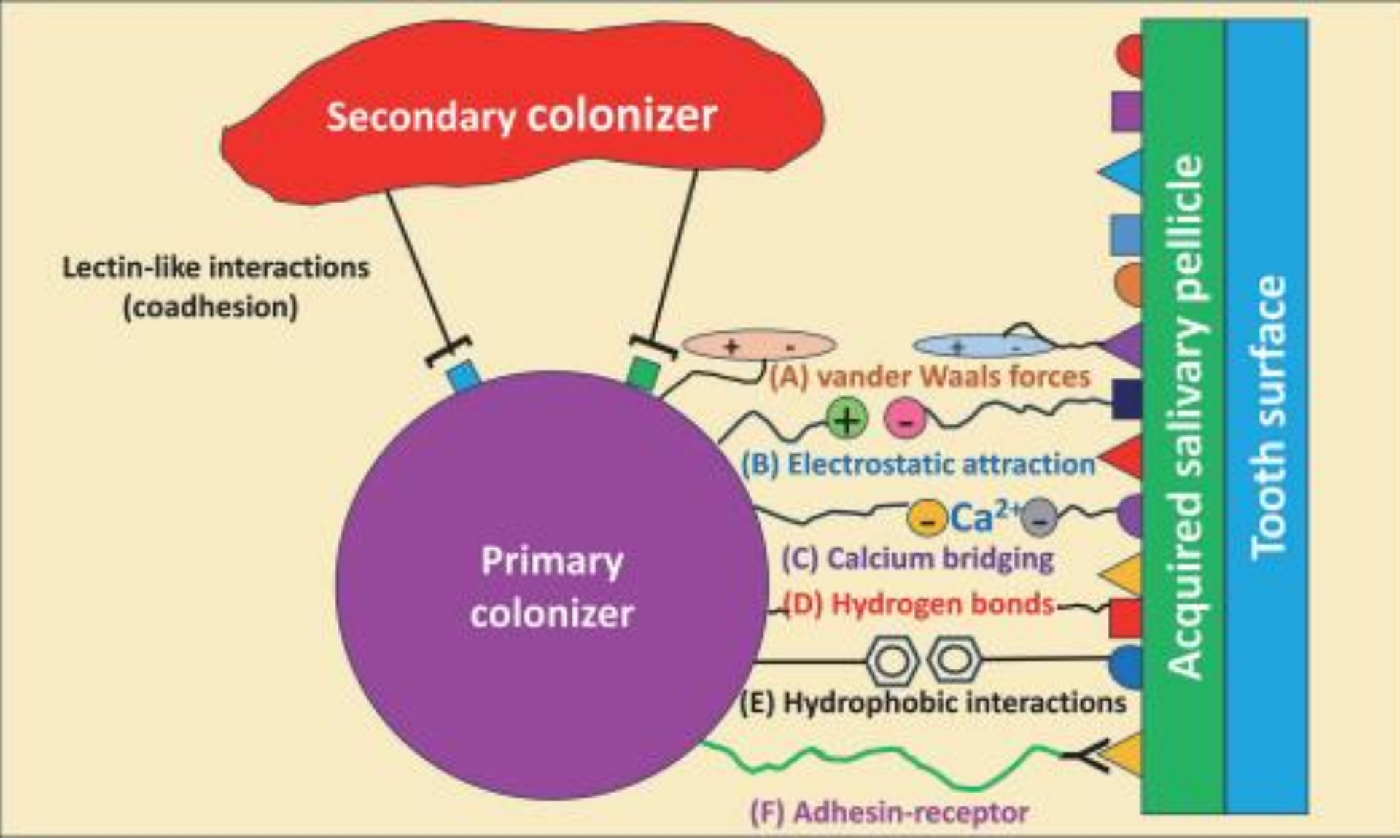
MUCOSAL SURFACE

2. Initial bacterial adhesion (early colonization):

- Tooth surface covered by pellicle
- Early bacteria attach via:
  - ✓ Fimbriae
  - ✓ Adhesins

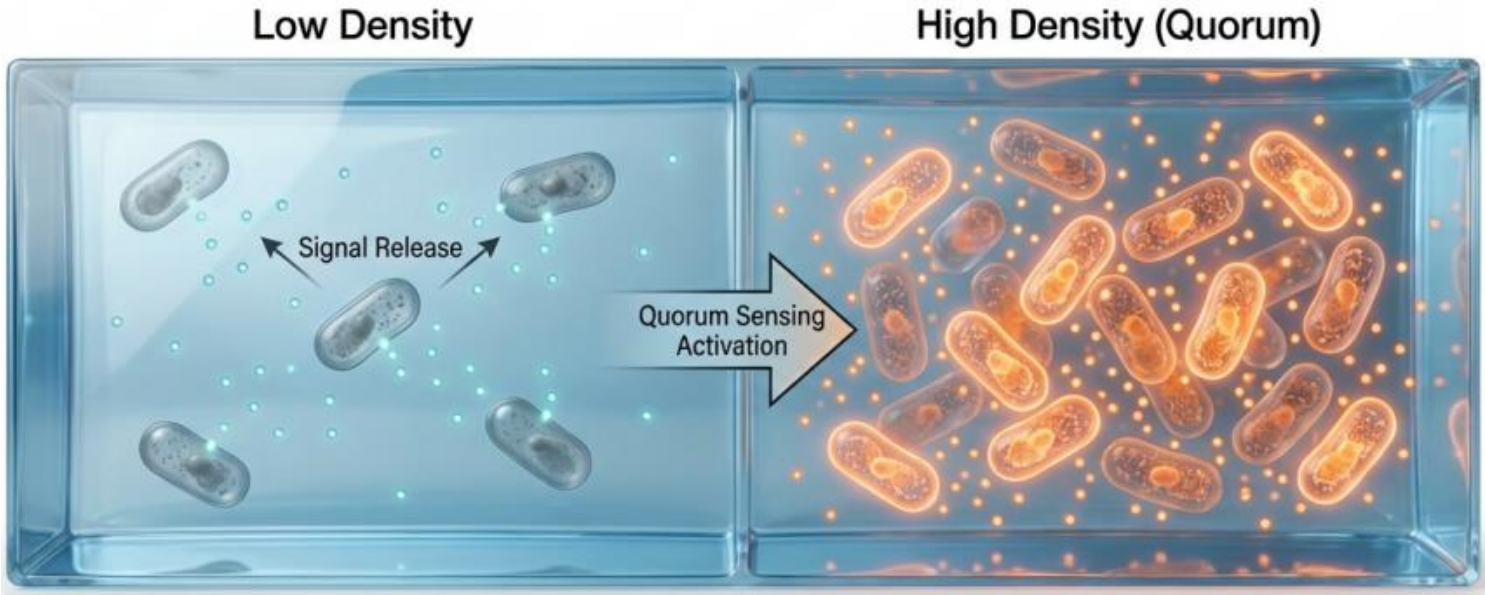
- Initial colonizers:
  - ➢ ***Streptococcus spp.***
  - ➢ ***Actinomyces spp.***

- Primary colonizers create receptors for secondary colonizers.


Secondary colonizer
Lectin-like interactions
(coadhesion)
Primary
colonizer
(A) vander Waals forces
(B) Electrostatic attraction
Ca2+
(C) Calcium bridging
(D) Hydrogen bonds
(E) Hydrophobic interactions
(F) Adhesin-receptor
Acquired salivary pellicle
Tooth surface

3. Growth and Matrix Production

- Bacteria enter logarithmic growth phase
- EPS matrix production increases, (glucans and fructans), which act as both an "**anchor**" for more bacteria and an **energy** source
- Biofilm becomes structured.
- Quorum Sensing regulates



Quorum Sensing: The ability of bacteria to detect their population density through chemical signals.

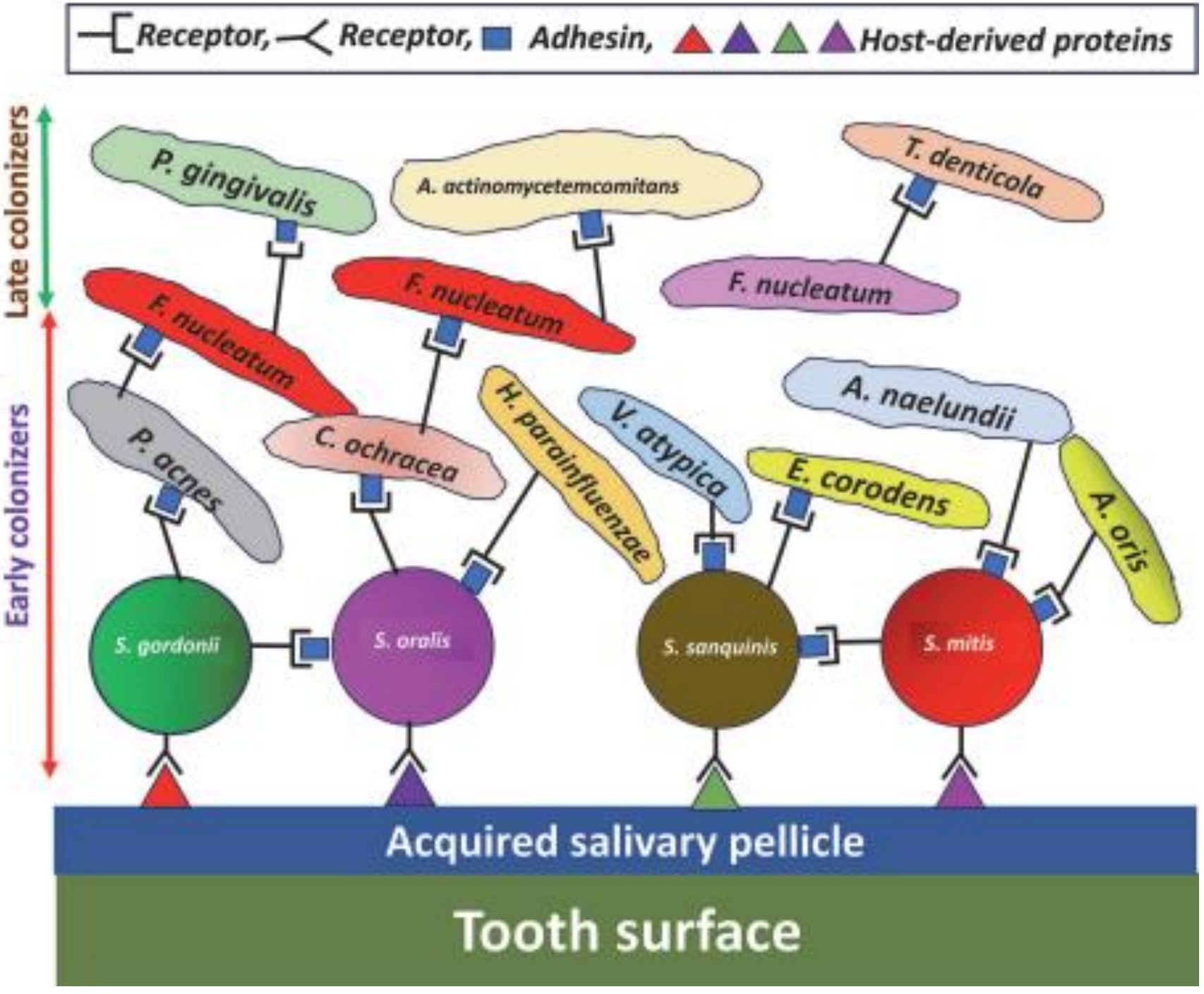
Collective Behavior: When the population reaches a critical mass (a quorum), they simultaneously change their gene expression.

The Result: Up-regulation of virulence factors, increased resistance, and coordination of metabolic activities. The mob is smarter than the individual.

4. Co-aggregation and Diversification

- As the initial colonizers grow, they deplete the oxygen in the micro-environment, paving the way for (anaerobic gram-negative) bacteria to join the mass.

- **Important species:**
  - *Fusobacterium nucleatum*
  - *Capnocytophaga species*
  - *Treponema spp.*
  - *Prevotella intermedia*
  - *Porphyromonas gingivalis*


Receptor,
Receptor,
Adhesin,
Host-derived proteins
Late colonizers
Early colonizers
P. gingivalis
A. actinomycetemcomitans
T. denticola
F. nucleatum
F. nucleatum
F. nucleatum
P. acnes
C. ochracea
H. parainfluenzae
V. atypica
A. naelundii
E. corodens
A. oris
S. gordonii
S. oralis
S. sanquinis
S. mitis
Acquired salivary pellicle
Tooth surface

5. Maturation & Dispersion

- Synergistic & antagonistic interactions
- Nutrient & oxygen exchange
- Strengthening of EPS matrix
- Homeostasis achieved
- Bacteria disperse to colonize new surfaces

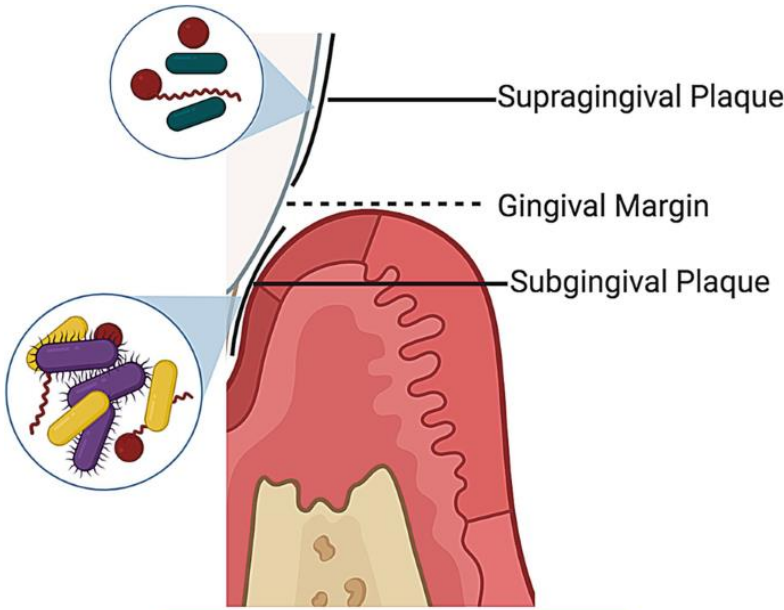
Types of Oral Biofilm

1. Supragingival Biofilm

- Located above gingiva
- Mainly **Gram-positive, facultative anaerobes.**
- Dominated by ***Streptococcus spp*.**
- Associated with dental caries

2. Subgingival Biofilm

- Located in gingival crevice
- Mainly **Gram-negative, obligate anaerobes.**
- Includes ***Porphyromonas gingivalis***
- Associated with periodontitis



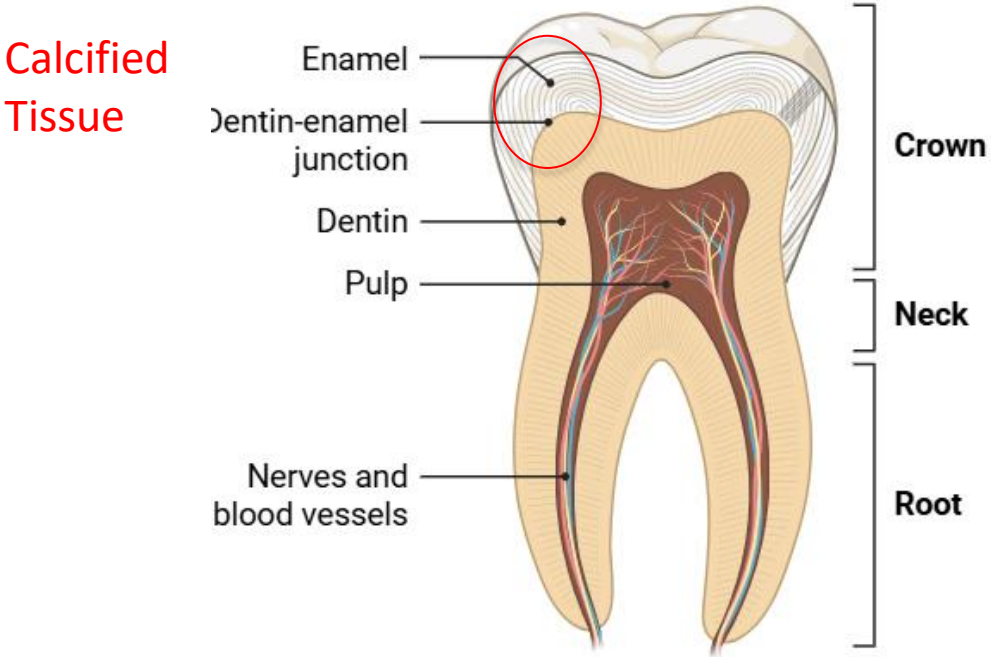
Supra and subgingival plaque

Definition of Dental Caries

- An infectious microbial disease caused by bacteria. (Shafer's Definition, 1993).
- Modern definition: Disease of calcified tissues of teeth.

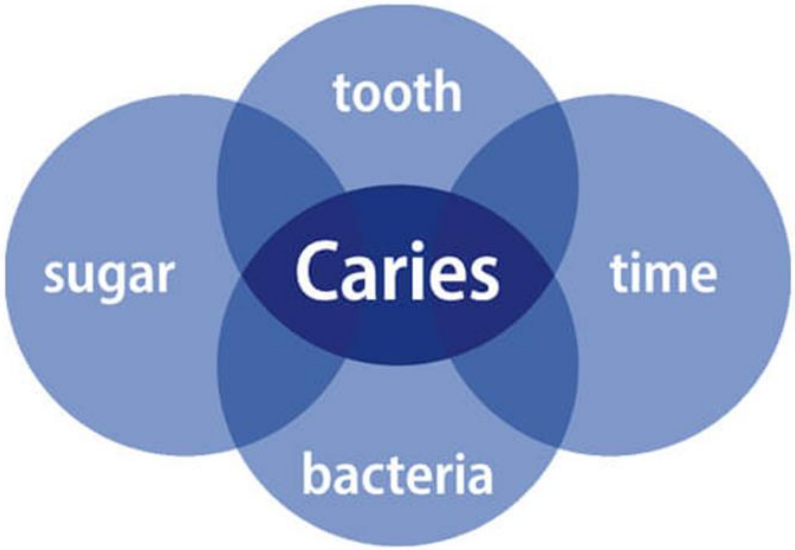
- Characterized by **demineralization** and **destruction** of tooth structure.

- Infectious microbial disease associated with dental plaque



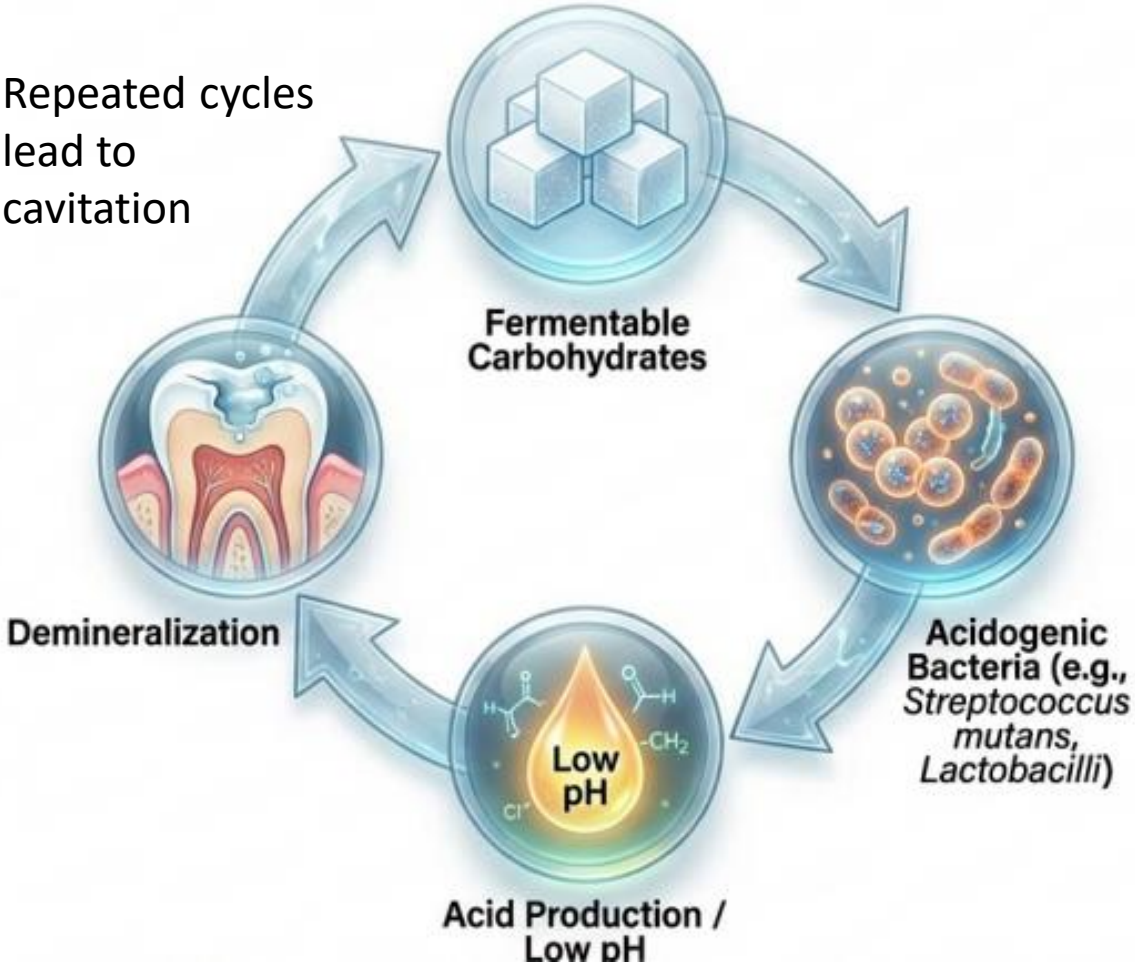
Factors Influencing Caries Development

- Microbial composition of plaque
- Diet and frequency of sugar intake
- Saliva flow and buffering capacity
- Oral hygiene practices



Pathogenic Mechanism of Caries

Repeated cycles lead to cavitation



The Culprits: *Streptococcus mutans* and *Lactobacilli.*

Key Traits:

1. **Acidogenicity:** The ability to produce acid from sugar.
2. **Aciduricity:** The ability to survive in that acidic environment.

The Shift: Frequent sugar intake keeps the pH low, killing off healthy bacteria and selecting for acid-loving pathogens.

Types and actions of oral microorganisms in dental caries

1. ***Streptococcus mutans*:**

Action:

- It is considered the primary initiator of dental caries.
- It ferments carbohydrates, particularly sucrose, to produce lactic acid.
- The lactic acid lowers the plaque pH below the critical threshold (5.5), leading to enamel demineralization.
- It also produces extracellular **glucans** through glucosyltransferase enzymes, which promote bacterial adhesion and plaque cohesion.

2. *Streptococcus sobrinus*:

Action:

- Similar to *Streptococcus mutans*, it is highly **acidogenic** and contributes to the initiation and progression of caries.

3. *Lactobacillus species*:

Action:

- Strongly **aciduric**, thriving in low pH environments created by earlier colonizers.
- Mainly involved in the progression of established carious lesions, particularly in dentin.

4. ***Actinomyces species*:**

Action:

- Associated with root surface caries and early enamel lesions in areas of gingival recession.
- Can metabolize carbohydrates to produce acids and adhere to the tooth surface, contributing to plaque development.

5. ***Veillonella species***:

Action:

- Utilize lactic acid produced by streptococci as a nutrient source, indirectly influencing the caries process by modulating acid levels in plaque.

6. Other anaerobic bacteria: ***Prevotella***, ***Porphyromonas***, ***Fusobacterium***

Action:

- More abundant in mature plaque; contribute to acid production and plaque biofilm stability.