

# Oral Microbiology

## Lecture 18

Dr. Samer Y. Alqaraleh

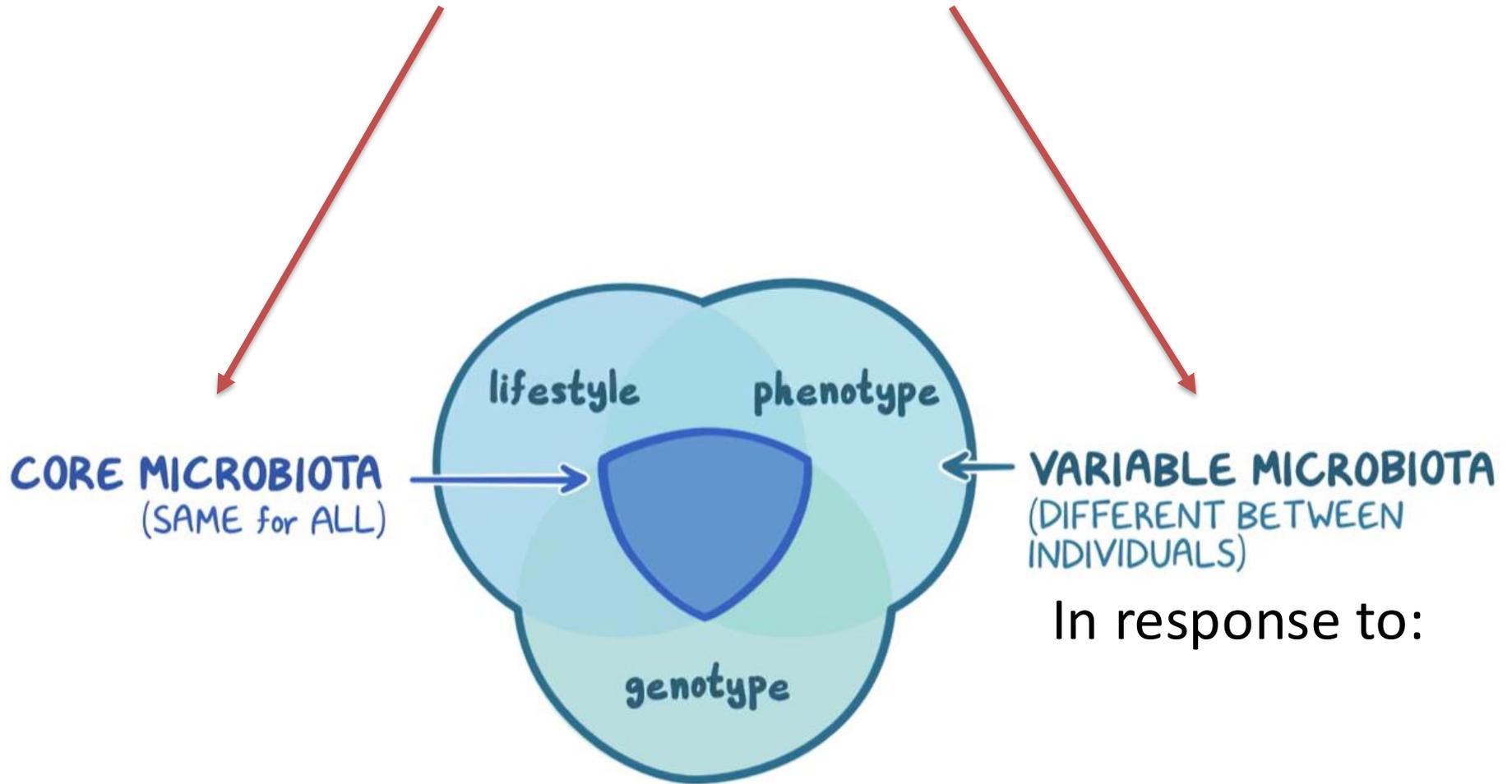
PhD. Nanobiotechnology (Microbiology)

Faculty of Dentistry

2025-2026

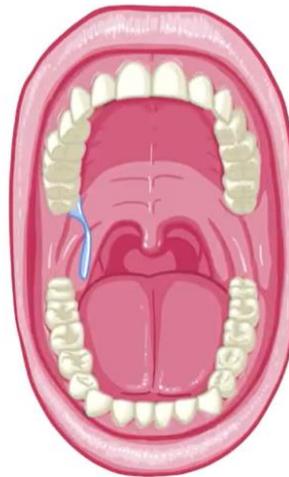


# Classification of oral microbiota



# General characteristics of oral microbiota

## HUMAN ORAL MICROBIOTA

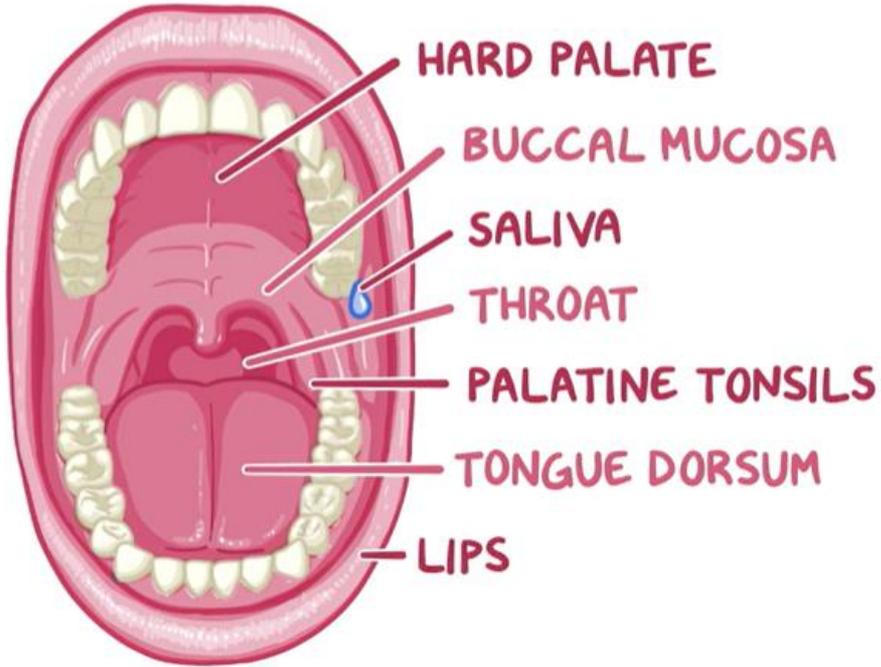
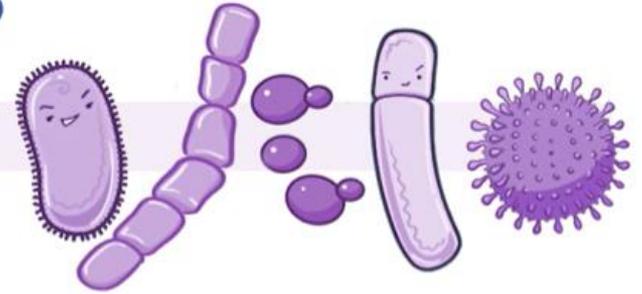
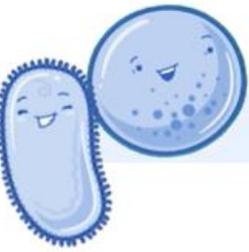


- The human oral microbiota is represented by the community of
  - \* **Commensal (+/0)**
  - \* **Symbiotic (harmony)**, loss of it lead to
  - \* **Pathogenic**, which are normally found in the oral cavity.

# > 700 SPECIES

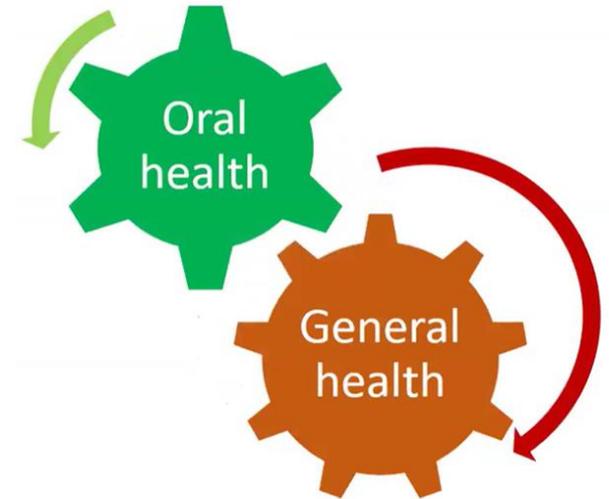
COMMENSAL

OPPORTUNISTIC



# General characteristics of oral microbiota

- ✓ How play a role in **maintaining oral health**.
- ✓ Also, understanding how these microbes, can **cause diseases** like dental caries and periodontal disease.
- ✓ How the oral microbiome is linked to overall **systemic health** and influences chronic diseases such as cardiovascular disease and cancer.



## ❖ Gateway of the body

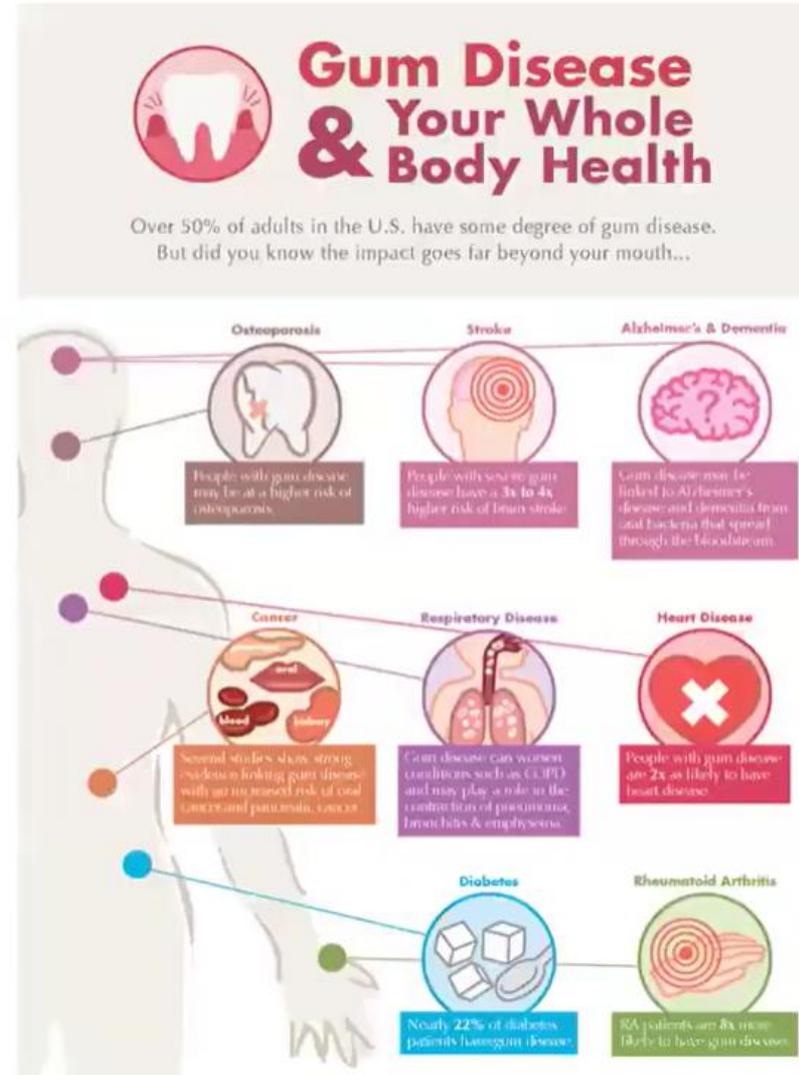
- The mouth presents a series of different microhabitats, each of may be colonized by different micro-organisms.
- Each habitat contains its **characteristic population** with many different microbial species.
- **Bacteria** are the most predominant type of microorganisms present in human oral cavity.
- More than **30 genera** of bacteria have been detected in human mouth.

- These belong to both **aerobic** and **anaerobic** groups of bacteria.
- Bacteria present in the oral cavity are both **gram positive and gram negative**.
- On average 750 million microorganisms are present in each ml of saliva.
- Natural microflora in the oral cavity become **established** during childhood and then change throughout the life.

- **Systemic disease** reflected in the mouth through signs like:
  - ✓ Gum disease (diabetes, heart disease),
  - ✓ Tongue changes (anemia, vitamin deficiencies),
- The mouth acts as a "mirror" to overall health, allowing early detection of **endocrine, immunologic, hematologic, nutritional**, and infectious disorders.
- **Saliva** as a **key diagnostic fluid** in addition to tissues to detect the systemic health.

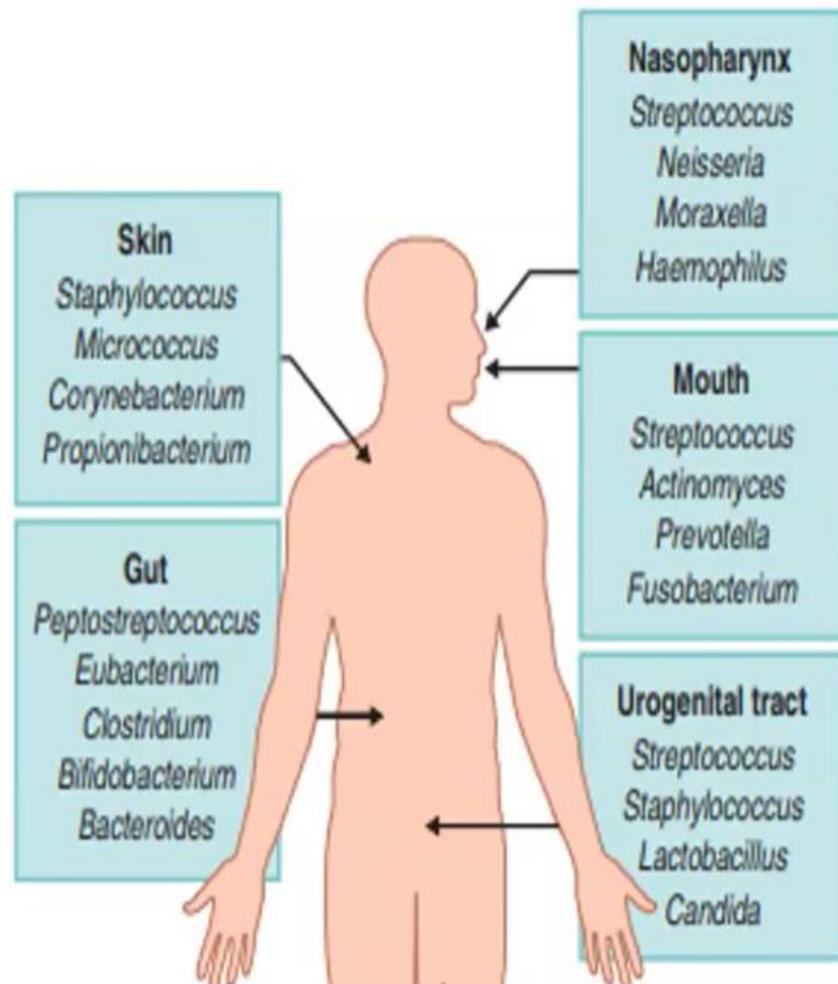
# Severe periodontal disease might be a risk factor :

- Premature or low birth weight babies
- Heart disease
- Pulmonary disease
- Rheumatoid arthritis
- Some forms of cancer
- Diabetes mellitus



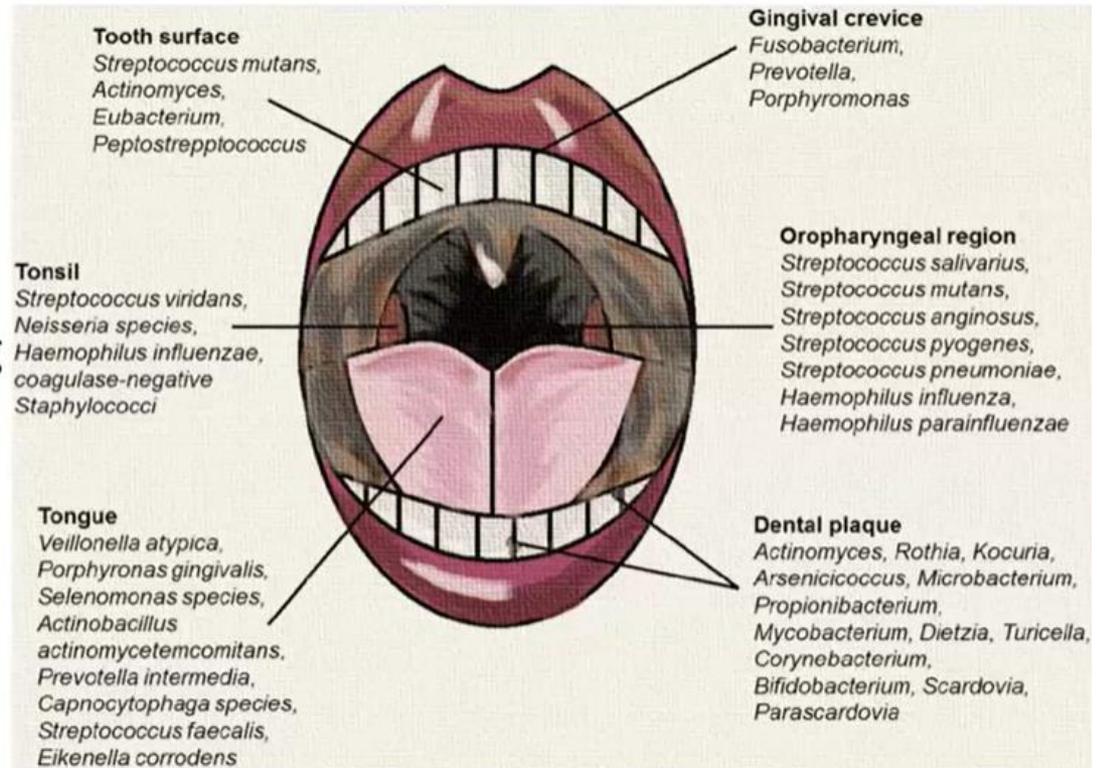
- Microbiota relatively stable over time.
- The differences in **physical** and **biological** properties, each surface is suitable for colonization by only a proportion of these microbes, resulted in the **acquisition, selection and natural development of a diverse but characteristic microbiota at distinct sites**

for ex: Staphylococci and micrococci predominate on the skin surface BUT not in the mouth of healthy people.



# ORAL HABITATS

- Less than 30 out of over 700+ types of oral microorganisms GIT.
- The predominant species of bacteria can differ markedly at distinct surfaces in the mouth despite these organisms having equal opportunities to colonize each site, **why?**
- Because of subtle variations in key parameters that influence microbial growth and competitiveness



# Oral Microbiota In Health And Disease

This is usually associated with:

- **Exogenous Factors** examples include: antibiotic treatment or the frequent intake of fermentable carbohydrates in the diet.
- **Endogenous** such as such as alterations in the integrity of host defenses following drug therapy, can weaken the body's natural defenses, such as the immune system or protective barriers like skin and mucous membranes
- **Oral hygiene**
- **Colonization of sites not normally accessible to oral microorganisms:** Systemic effect of the disseminated bacteria to distant organs (endocarditis)



## *Streptococcus viridians*

- Shift in Homeostasis to Dysbiosis can lead to develop diseases.

- **Dental caries**

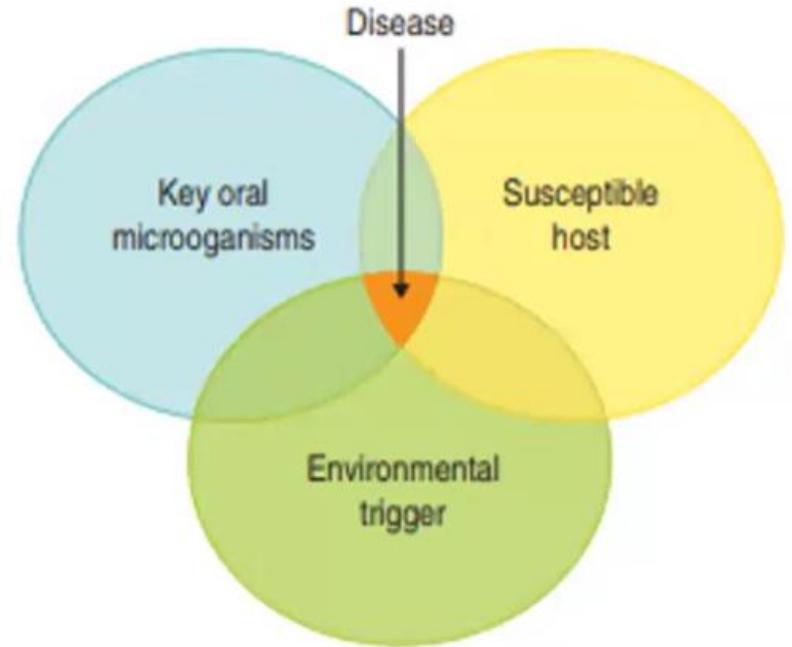


STAGES OF TOOTH CARIES



*Streptococcus mutans*

- **Periodontal diseases**



**The interrelationships that lead to oral disease.**

# ORAL HABITATS

The major oral habitats are:

## NON TOOTH HABITATS

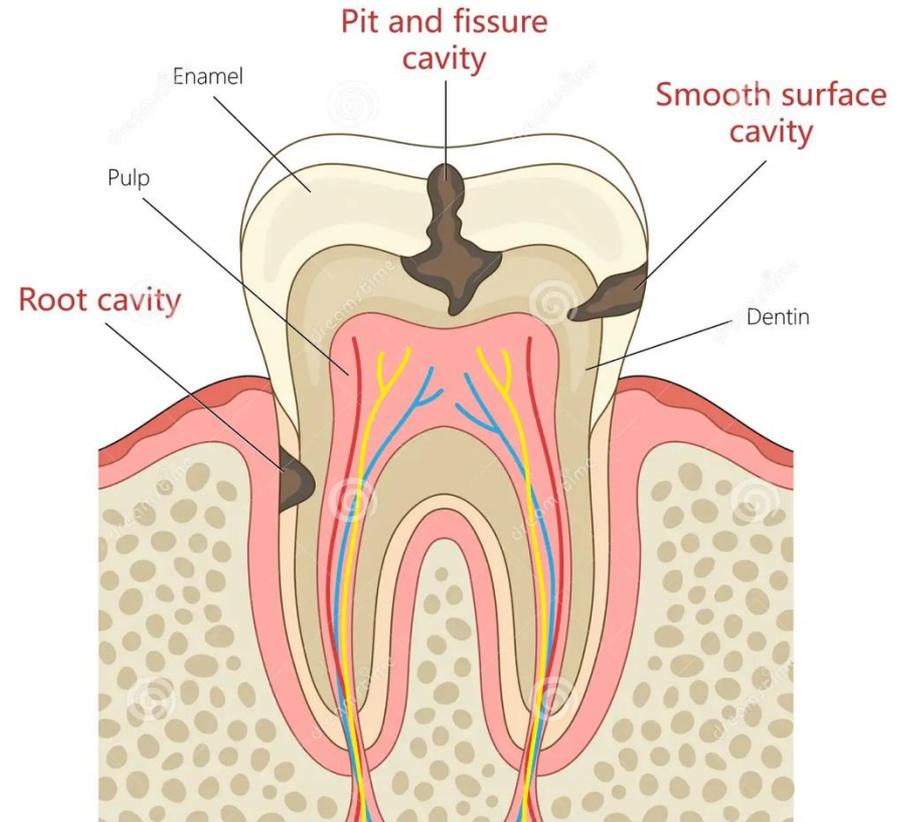
- Oral mucosa (lips Cheeks, palate)
- Dorsum of tongue
- Saliva and tonsillar areas
- Appliances



# Types of Dental Cavities

## TOOTH HABITATS

- Sub gingival areas
- Root surfaces
- Pits and fissures
- Smooth surfaces



## ❖ Oral mucosal habitats Characteristics:

- **Microbial load on these surfaces remains relatively low due to:**
  - ✓ **Cell turnover:** The oral mucosa has a high turnover rate, with epithelial cells being replaced roughly every 14 to 21 days due to constant exposure to functional demands.
- Specialized surfaces that enhance the microbiota diversity the papillary structure on the dorsum of tongue. That protect the microbes from the chewing and saliva flow.
- Tongue provides an environment that favors growth of obligate anaerobic bacteria (Gram –ve) implicated in periodontal diseases.

## ❖ Characteristics of the Tongue's Microflora Habitat

- The highly textured surface with numerous **papillae** and deep **crypts** provides a large surface area where microorganisms can anchor and form complex.
- Offers a suitable environment; oxygen(aerobic near the surface, anaerobic deeper in the crypts), pH, nutrients derived from saliva.
- Bacterial communities, including **phyla** such as:
  1. *Firmicutes*
  2. *Actinobacteria*,
  3. *Proteobacteria*
  4. *Bacteroidetes*
  5. *Fusobacteria*
  6. Fungi and viruses are also part of this micro-ecosystem



*Candida albicans*

## ❖ Cheeks

- Predominant bacterium is
- *Streptococcus mutans*
- *Streptococcus sanguinis*
- *Streptococcus salivarius* .
- Yeasts may be isolated from carriers.



## Lips

- *Staphylococcus albus* and micro-cocci predominate
- large no. of *Streptococci* (*S. salivarius*, *S. mitis*)

## ❖ Palate

- Soft Tissue Habitat
- Common microorganisms found on the palate in healthy individuals include:
  1. *Corynebacterium* spp.
  2. *Haemophilus* spp.
  3. *Neisseria* spp.
  4. *Bacteroides* spp. (non-pigmented)
  5. *Candida albicans* (usually in low numbers, can become an opportunistic pathogen)
  6. *Staphylococcus aureus* (may be present)

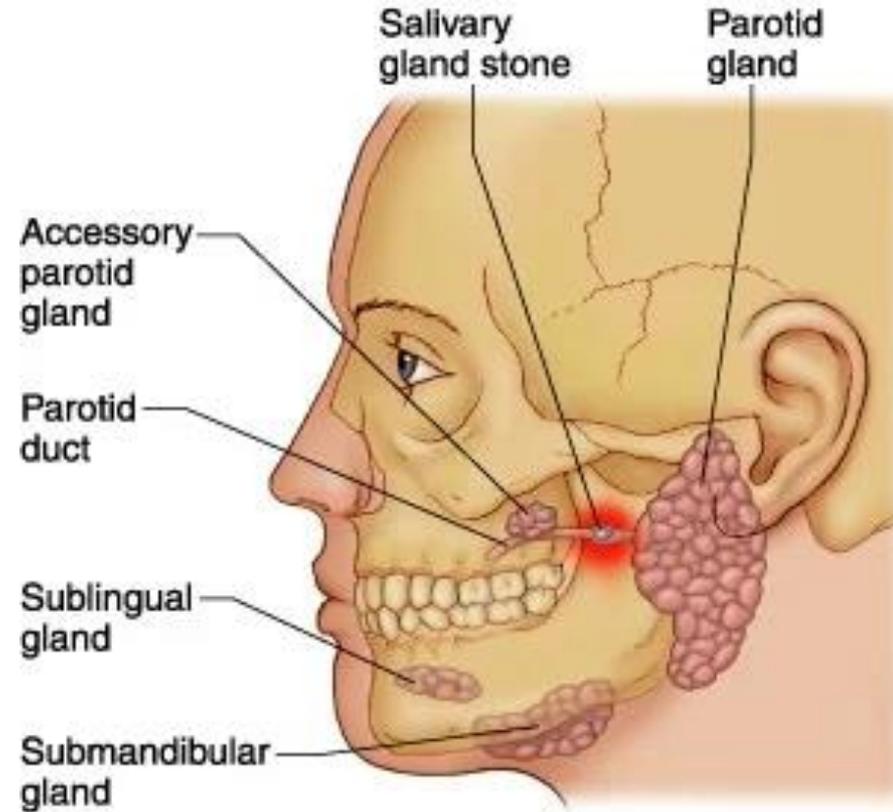


Figure 3 – A cluster of vesicles on the hard palate occurs in the distribution of the maxillary nerve. A similar pattern of facial lesions also appeared in this patient with herpes zoster.

Herpes zoster

## ❖ Saliva:

- Saliva itself is not a primary habitat for microflora; it acts as a **carrier** fluid and a **reservoir** for microorganisms within the oral cavity.
- It helps maintain a stable pH (around **6.75–7.25**), which is favorable for most bacteria.
- Protect teeth (Demineralization, Remineralization).
- All species of streptococcus especially *Streptococcus oralis* and *Streptococcus salivarius* are found in the saliva.





## ❖ Dental appliances:

- Orthodontic braces and removable dentures, significantly alter the oral microflora by creating new surfaces for microorganisms to accumulate.
- Creation of more anaerobic conditions in the subgingival area, which favors the growth of pathogenic microbes.
- *Specific pathogens:*
  1. *Streptococcus mutans*, *Lactobacillus spp.* (acid-producing, development of dental caries and white spot lesions).
  2. *Porphyromonas gingivalis*, *Tannerella forsythia*, and *Aggregatibacter actinomycetemcomitans*. (anaerobic, gram-negative, periodontal (gum disease))

- Clasps and other parts of appliance that cause **stagnation** will promote the build up of dental plaque and hence lead to accumulation of various bacteria and their products.



# Structure of a Tooth

Each tooth is composed of four tissues:

- **Pulp**: Sensory organ, receives nerve signals and blood supply.
- **Dentine**: Supports enamel, protects the pulp, composed of collagen and mineral crystals.
- **Enamel**: The hardest, highly calcified tissue exposed to the environment.
- **Cementum**: Covers the root and anchors the tooth with the **periodontal ligament**.

Gingival tissue recession with age can expose **cementum**, increasing the risk of **root surface caries**.

# Ecological Complexity of the Teeth

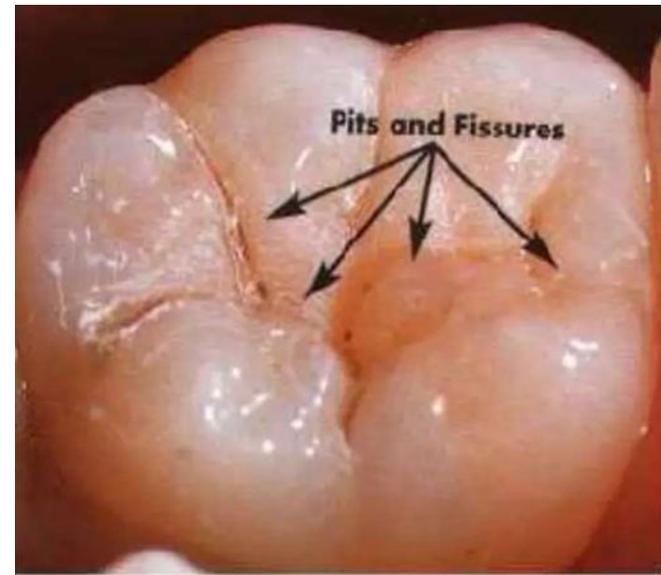
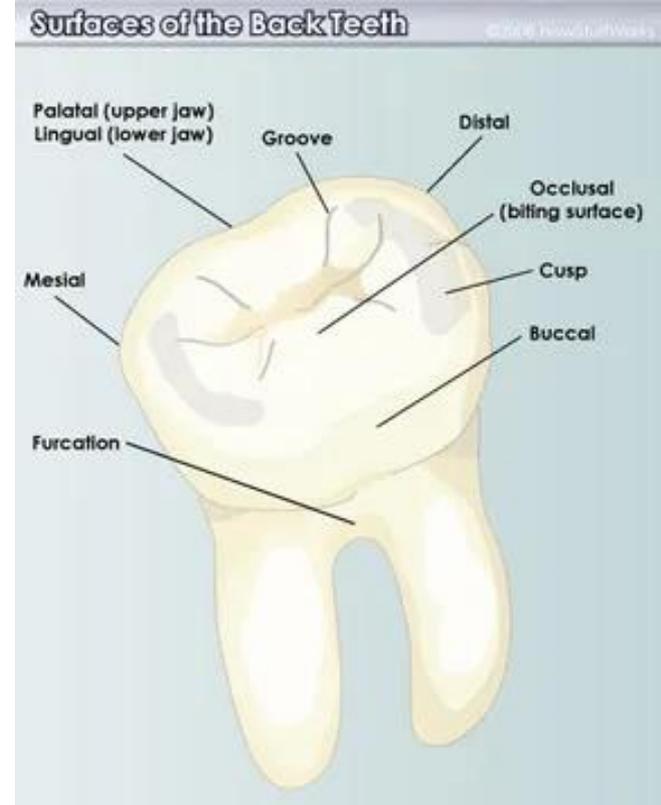
- Teeth present various distinct surfaces that serve as **unique habitats** for different microbial communities:
- **Approximal surfaces** (between teeth) and **gingival crevice**: Protected areas that often become anaerobic, supporting diverse microbiota.
- **Smooth surfaces**: More exposed, can only be colonized by a limited number of bacterial species.
- **Pits and fissures** (biting surfaces): Provide protection from saliva flow and can trap food debris.

## ❖ The tooth surface:

- Serve as a unique microbial habitat in the mouth, providing a protected, non-shedding surface.
- Ideal for bacterial colonization and dental plaque biofilm formation.

## ➤ Pits and Fissures:

- *Streptococcus* (*Streptococcus mitis*)
- *Lactobacillus*
- *Actinomyces*
- *Bifidobacterium*



➤ **Smooth surface:**

- **The proximal area** is physically protected and is largely unaffected by chewing forces, tongue movements, or salivary flow.
- The microflora in this region is diverse and complex, but is mainly dominated by *Actinomyces* and *Streptococcus* species.
- **Several factors can affect this site to dental caries or periodontal disease, including:**
  1. Rough tooth surfaces caused by defective or poor restorations.
  2. Changes in the size or shape of the gingival papilla, such as apical migration.
  3. Inadequate oral hygiene



# Impact of Disease on Tooth Ecology

- The relationship between the environment and microbiota is **dynamic**: Early colonizers consume oxygen, creating an anaerobic environment for obligate anaerobes.
- In **dental caries**, local conditions become more **acidic and anaerobic**, altering the microbial composition as the lesion penetrates the **dentine**.(nutritional sources change, conditions become acidic and more anaerobic because of the accumulation of products of bacterial metabolism)
- In **periodontal disease**, the **gingival crevice** transforms into a **periodontal pocket**, increasing **GCF** flow, which encourages the growth of bacteria adapted to these new conditions.

## ➤ Root surface:

- Does not continuously shed cells, allowing large masses of microorganisms to accumulate and form stable, thick biofilms.
- The primary nutrient source for the root surface microflora is the gingival crevicular fluid (GCF), a serum-like fluid that flows into the gingival sulcus (the space between the tooth and gum).
- low-oxygen environment, which selects for specific anaerobic bacteria
- **In Health:** microflora is dominated by (*Streptococcus salivarius*) and *Actinomyces* species, which are generally commensal (harmless).
- **In Root Caries (Disease):** *Streptococcus mutans* and *Lactobacillus* species, *Actinomyces viscosus*, *Enterococcus faecalis*.



➤ **Sub-gingival areas:**

- The space below the gum line, between the tooth and the gingival tissue is a unique, anaerobic habitat that supports the growth of a diverse microbial community.
- **Healthy** sites have a less diverse microbiota, predominantly featuring genera such as *Streptococcus* and *Actinomyces*.
- In **Disease**: In periodontitis, the environment changes (e.g., deeper pockets, more GCF, more inflammation), favoring the growth of specific pathogens.
- The "**red complex**" bacteria are strongly associated with diseased sites.
- *Porphyromonas gingivalis*
- *Tannerella forsythia*
- *Treponema denticola*.



# Acquisition of Oral Flora

- ✓ The presence of **nutrients**, **epithelial debris**, and secretions makes the mouth a favorable habitat for a great variety of bacteria.
- ✓ The mouth presents a succession of different ecological situations with **age**, and this corresponds with changes in the composition of the normal flora.
- ✓ The process begins with the colonization of habitat by **pioneer** microbial populations.
  - In oral cavity of newborns, *Streptococci* are the pioneer organisms.
  - They fill the niche of the new environment and modify the habitat and new population develops.
- ✓ When no additional niche is available for new population, a stable assemblage of bacterial population is achieved called as **climax community**.

## At birth:

- The mouth of full term fetus is usually sterile, transient flora from the **birth canal** may be acquired.
- Mouth then rapidly acquires organisms from **mother** and from the **environment**.
- It consists of several *Streptococcal* and *Staphylococcal* species with *Lactobacilli*, *Neisseria* and *Yeasts*.
- *Streptococcus salivarius* is the most common and forms the pioneer community with *Staphylococcus albus*.

# Environmental Factors Influencing Growth

## pH:

- Most bacteria have an optimum pH for growth in the range 6.75 - 7.25 with limits somewhere between 5 and 9.
- Acidophilic bacteria can grow at a low pH, and such organisms are very important in oral microbiology as the causative agents of caries: *Lactobacilli* and *Mutans*.
- *Streptococci* produce acid as end products of metabolism of dietary sugars, and are able to survive and grow in the acidic conditions created.
- The organisms found in periodontal disease are usually not aciduric as they tend to rely for growth on protein/peptide breakdown and this produces slightly alkaline end products.

## Metabolism of Oral Microorganisms

- Oral microorganisms derive nutrients from saliva and gingival crevicular fluid (GCF).
- Carbohydrate metabolism is of attention because of its role in caries production.
- End products of such fermentation in the mouth are varied e.g., *Streptococcus mutans* produces only lactic acid from sugars, some *lactobacilli* produce lactic acid and ethanol, whereas *yeasts* convert glucose to ethanol and CO<sub>2</sub>.
- The substrates used are also varied and many of the anaerobes seen in the mouth are able to utilize amino acids as substrates for fermentation; therefore, periodontal organisms are predominantly proteolytic.