"Microbial Diseases of the Oral Cavity"

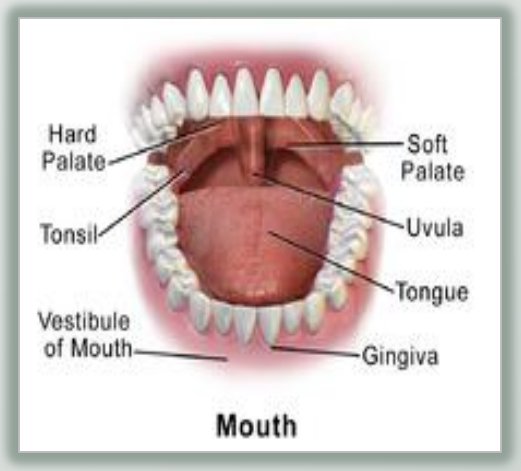
Team "The Tooth Fairies"

Christina Branco
Svetlana Ofitserova

Oral Cavity

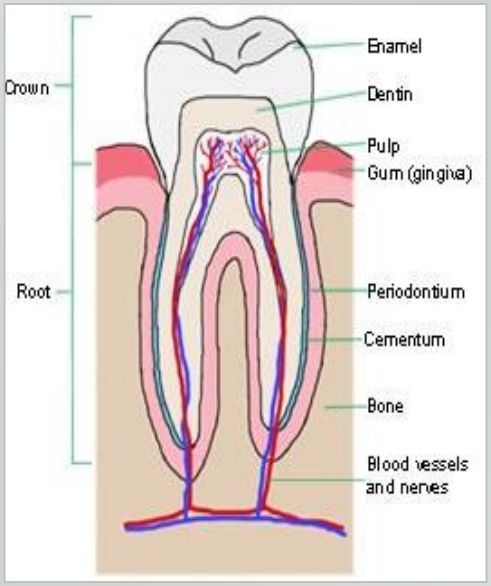
In human anatomy, the **mouth** also called **Oral cavity**, or **Buccal cavity**.

Lips: Open the mouth to the outside
Tongue: A large muscle firmly anchored to the floor of the mouth by the frenulum linguae, which positions and mixes food and also carries sensory receptors for taste
Teeth: Tear and grind ingested food into small pieces that are suitable for digestion
Palate: Which separates the mouth from the nasal cavity, allowing separate passages for air and for food
Mucous membrane: The moist tissue that lines the mouth and contains numerous small glans that, along with the three pairs of salivary glands, bathe the mouth in fluid, keeping it moist and clear of food and other debris
Gingivae (gums): Soft tissue that immediately surrounds the teeth and bone.
It protects the bone and the roots of the teeth and provides an easily lubricated surface.



Structure & function of teeth:

Enamel: The hard outer layer of the crown. Enamel is the hardest substance in the body.
Dentin: Not as hard as enamel, forms the bulk of the tooth and can be sensitive if the protection of the enamel is lost.
Pulp: Soft tissue containing the blood and nerve supply to the tooth.
The pulp extends from the crown to the tip of the root.
Cementum: The layer of bone-like tissue covering the root. It is not as hard as enamel.



Structures around the tooth:

Periodontal ligament: Made up of thousands of fibers which fasten the cementum to the bony socket. These fibers anchor the tooth to the jaw bone and act as shock absorbers for the tooth which is subjected to heavy forces during chewing..
Bone: Provides a socket to surround and support the roots of the teeth.
Nerves and blood supply: Each tooth and periodontal ligament has a nerve supply and the teeth are sensitive to a wide variety of stimuli.
The blood supply is necessary to maintain the vitality of the tooth.

Microbiota in the Oral Cavity

- The environment present in the human mouth allows the growth of characteristic microorganisms found there.

- **Factors Affecting Growth of Microorganisms in the oral cavity**
- 1. Temperature
- 2. REDOX Potential / Anaerobiosis
- 3. pH between 6.75 and 7.25
- 4. Nutrients (diet), continuously bathed with saliva
- 5. Host Defenses (Innate & Acquired immunity)
- 6. Host genetics (changes in immune response etc)
- 7. Antimicrobial agents & inhibitors

Your MOUTH is a WINDOW into what's going on in the rest of your BODY

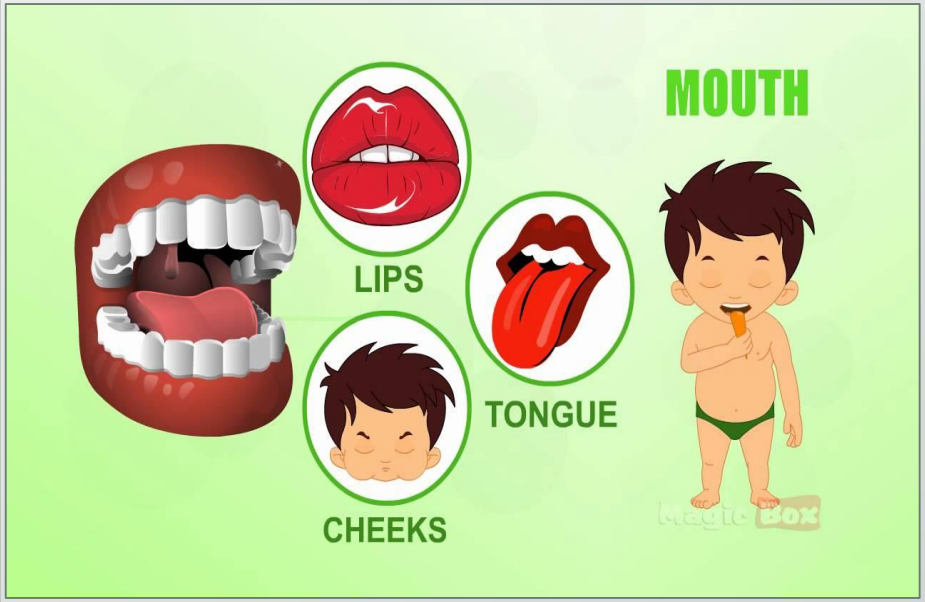
- **Your mouth as infection source:**

Saliva protects against harmful invaders: bacteria and viruses

- Saliva is one of your body's main defenses against disease-causing organisms, such as bacteria and viruses.
- It contains antibodies that attack viral pathogens, such as the common cold and HIV.
- And it contains proteins called histatins, which inhibit the growth of a naturally occurring fungus called *Candida albicans*.
- When these proteins are weakened by HIV infection or other illness, candida can grow out of control, resulting in a fungal infection called oral thrush.

- **Bacteria** from your mouth normally don't enter your bloodstream, but:

- if your immune system is weakened, for example because of a disease or cancer treatment, oral bacteria in your bloodstream (bacteremia) may cause you to develop an infection in another part of your body. Infective endocarditis, in which oral bacteria enter your bloodstream and stick to the lining of diseased heart valves, is an example of this phenomenon.



Dental Plaque – Bacterial Origin

Is a biofilm or mass of bacteria that grows on surfaces within the mouth.

It is a sticky colorless deposit at first, but when it forms tartar, it is often brown or pale yellow.

It is commonly found between the teeth, on the front of teeth, behind teeth, on chewing surfaces, along the gumline, or below the gumline cervical margins.

Bacterial plaque is one of the major causes for dental decay and gum disease.

Dental Plaque (cont.)

Components of plaque:

Different types of bacteria are normally present in the mouth as well as leukocytes, neutrophils, macrophages, and lymphocytes, are part of the normal oral cavity and contribute to the individual's health.

- 80–90% of the weight of plaque is water.
- 70% of the dry weight is bacteria,
- 30% consists of polysaccharides and glycoproteins.

- **Bacteria:**
- *Mostly - Streptococcus mutans* and other anaerobes

- These microorganisms all occur naturally present in the oral cavity and are normally harmless.
- However, failure to remove plaque by regular tooth-brushing allows them to proliferate unchecked and thereby build up in a thick layer, which cause any of various dental diseases for the host.

Steps of Plaque Formation	Description
Association	Dental pellicle forms on the tooth (normally on tooth), and provides bacteria surface to attach
Adhesion	Within hours, bacteria loosely binds to the pellicle.
Proliferation	Bacteria spreads throughout the mouth and begins to multiply.
Microcolonies	Microcolonies are formed. Streptococci secrete protective layer (slime layer).
Biofilm formation	Microcolonies form complex groups with metabolic advantages.
Growth or maturation	The biofilm develops a primitive circulatory system

Gingivitis – Bacterial Origin

- **Gingivitis** is a non-destructive type of periodontal disease, but untreated gingivitis can progress to **periodontitis.** This is more serious and can eventually lead to loss of teeth.

- When **plaque** accumulates on the teeth, bacteria colonize the **gingival space**. As this space becomes increasingly blocked, the environment becomes anaerobic. This allows a wide variety of microbes to colonize: ***Porphyromonas***, ***Streptococcus***, ***Actinomyces***. Also, the bacterial products, such as **lipopolysaccharide** (LPS), **proteases**, **lipotei choic acids**, and others, cause inflammation and gum damage

- Gingivitis often resolves with good oral hygiene, such as longer and more frequent brushing, and flossing. In addition, an antiseptic mouthwash and antibiotics, for severe cases, may help.

Conditions Associated with Periodontal Disease

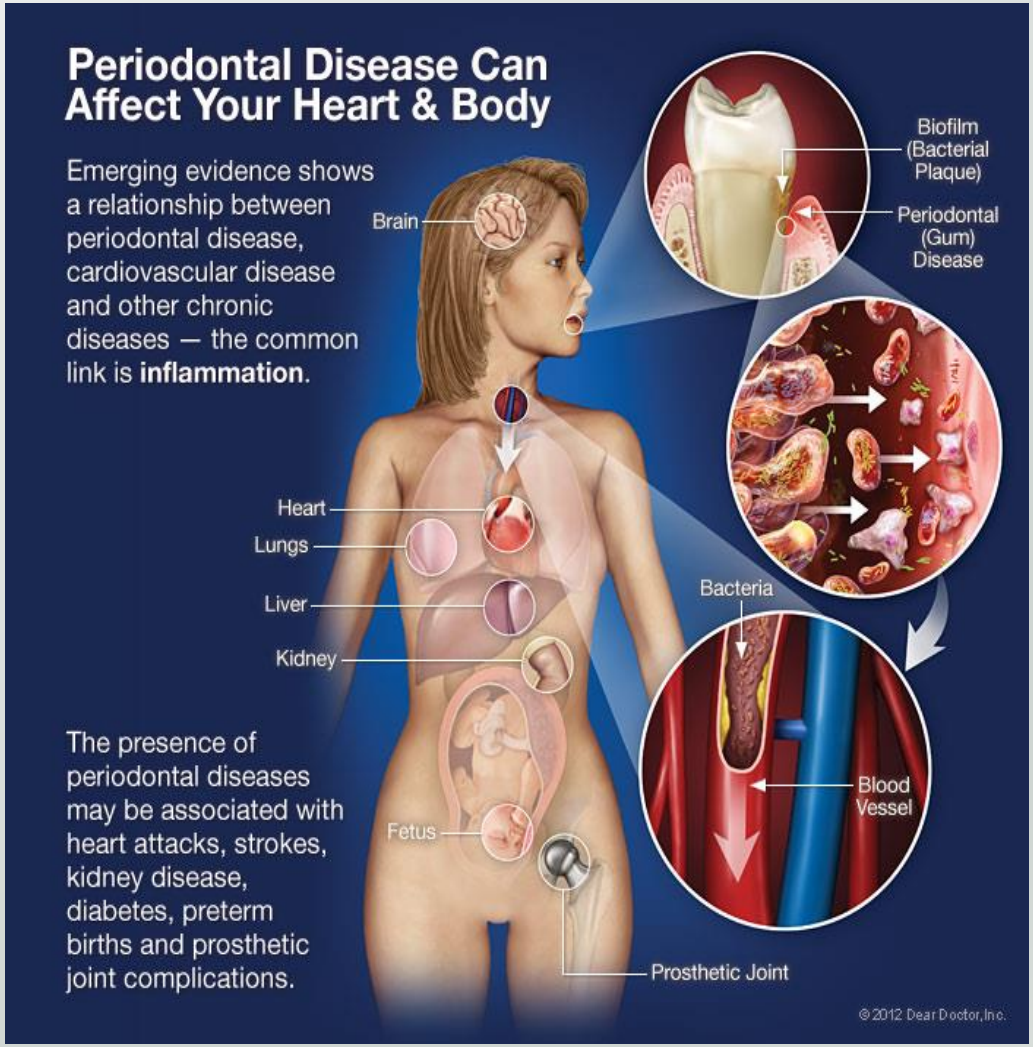
- Periodontitis has been linked to:

- increased inflammation in the body, such as indicated by raised levels of C-reactive protein and interleukin-6 (Interleukin 6 is secreted by T cells and macrophages to stimulate immune response)

- it is linked through this to increased risk of stroke, myocardial infarction, and atherosclerosis

- it also linked in those over 60 years of age to impairments in delayed memory and calculation abilities

- individuals with impaired fasting glucose and diabetes mellitus have higher degrees of periodontal inflammation, and often have difficulties with balancing their blood glucose level owing to the constant systemic inflammatory state, caused by the periodontal inflammation.



Trench Mouth – Bacterial Origin

- When certain bacteria, such as *Prevotella intermedia*, *Fusobacterium* species, and *Treponema vicentii*, are involved and periodontal disease progresses, **acute necrotizing ulcerative gingivitis** or **trench mouth**, also called Vincent's disease, can develop.
- This is severe periodontitis characterized by erosion of the gums, ulcers, substantial pain with chewing, and halitosis that can be diagnosed by visual examination and X-rays.
- In countries with good medical and dental care, it is most common in individuals with weakened immune systems, such as patients with AIDS.
- In addition to cleaning and pain medication, patients may be prescribed antibiotics such as **amoxicillin**, **amoxicillin, clavulanate**, **clindamycin**, or **doxycycline**.

Oral Thrush – Fungal Origin

- The yeast ***Candida*** is part of the normal human microbiota, but overgrowths, especially of *Candida albicans*, can lead to infections in several parts of the body.
- When *Candida* infection develops in the oral cavity, it is called **oral thrush**.
- Oral thrush is most common in infants because they do not yet have well developed immune systems and have not acquired the robust normal microbiota that keeps *Candida* in check in adults. Oral thrush is also common in immunodeficient patients and is a common infection in patients with AIDS.
- Oral thrush is characterized by the appearance of white patches and pseudomembranes in the mouth and can be associated with bleeding.
- Can be treated with **nystatin** or **clotrimazole** oral suspensions, **fluconazole** or **itraconazole**

Mumps – Viral Origin

- The viral disease **mumps** is an infection of the parotid glands, the largest of the three pairs of **salivary glands.**

- Mumps virus is transmitted through respiratory droplets or through contact with contaminated saliva, making it quite contagious so that it can lead easily to epidemics. It causes fever, muscle pain, headache, pain with chewing, loss of appetite, fatigue, and weakness. There is swelling of the salivary glands and associated pain. The virus can enter the bloodstream (**viremia**), allowing it to spread to the organs and the central nervous system. The infection ranges from subclinical cases to cases with serious complications, such as **encephalitis**, **meningitis**, and deafness. Inflammation of the pancreas, testes, ovaries, and breasts may also occur and cause permanent damage to those organs; despite these complications, a mumps infection rarely cause sterility.

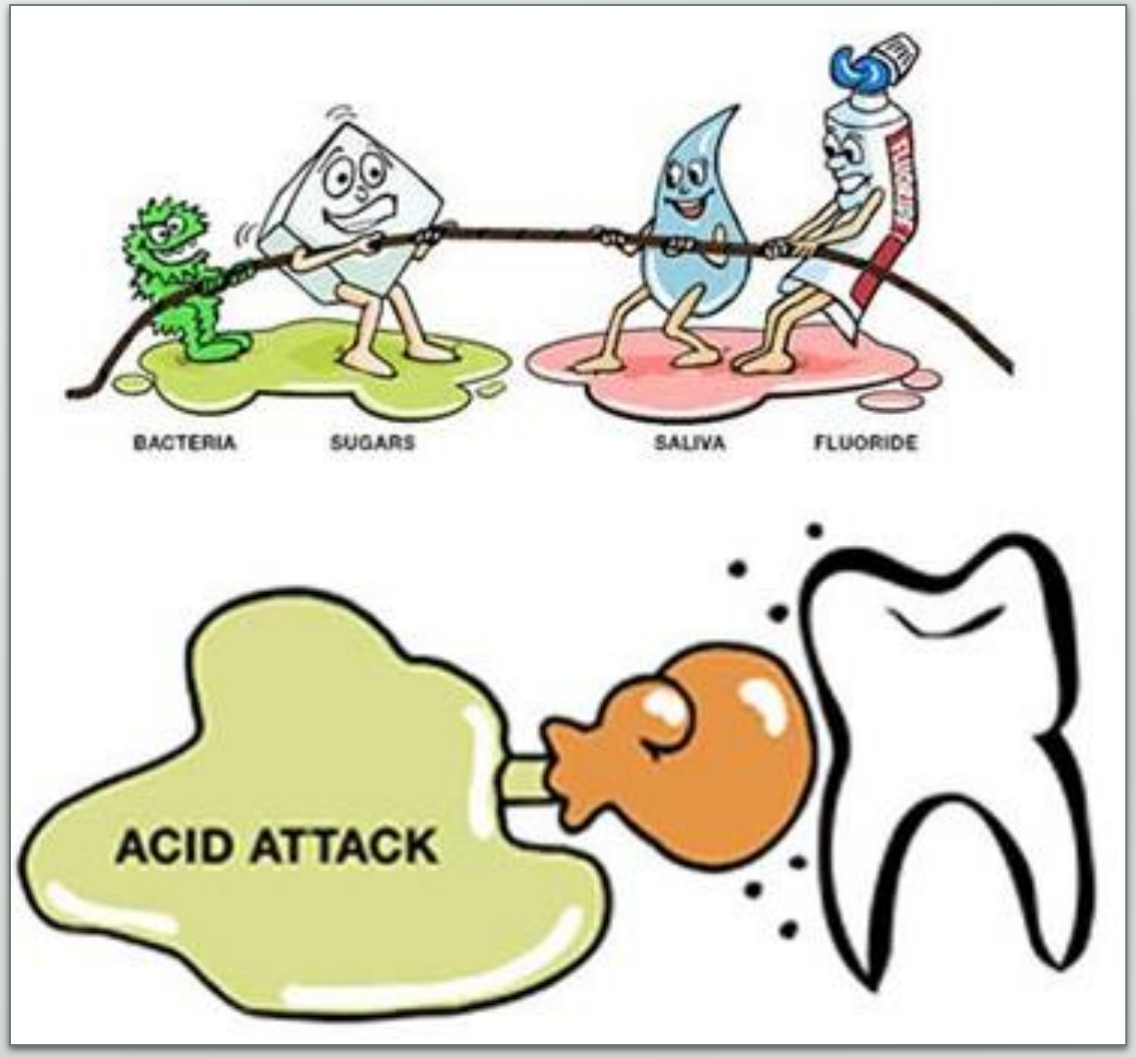
Key Concept and Summary

- **Dental caries**, **tartar**, and **gingivitis** are caused by overgrowth of oral bacteria, usually ***Streptococcus*** and ***Actinomyces*** **species,** as a result of insufficient dental hygiene.
- **Gingivitis** can worsen, allowing ***Porphyromonas***, ***Streptococcus***, and ***Actinomyces*** species to spread and cause **periodontitis**. When *Prevotella intermedia*, *Fusobacterium* species, and *Treponema vicentii* are involved, it can lead to **acute necrotizing ulcerative gingivitis**.
- The herpes simplex virus type 1 can cause lesions of the mouth and throat called **herpetic gingivostomatitis.**
- Other infections of the mouth include **oral thrush**, a fungal infection caused by overgrowth of *Candida* yeast, and **mumps**, a viral infection of the salivary glands caused by the mumps virus, a paramyxovirus.

Key Concept and Summary (cont'd)

- **Tooth decay (caries/cavities)** results from the production of acid by bacterial fermentation of the food debris accumulated on the tooth surface.

- Bacteria occupy the ecological niche provided by both the tooth surface and gingival epithelium. However, a highly efficient innate host defense system constantly monitors the bacterial colonization and prevents bacterial invasion of local tissues.



Oral Infections

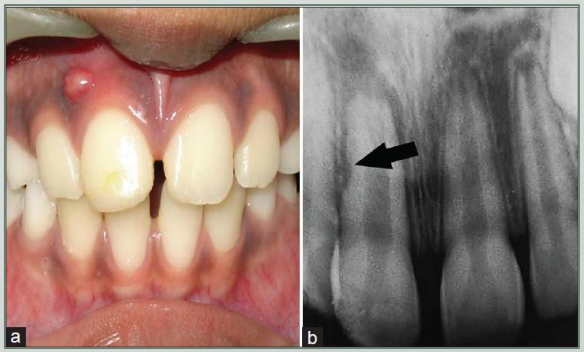
Table 1 summarizes the main characteristics of common oral infections

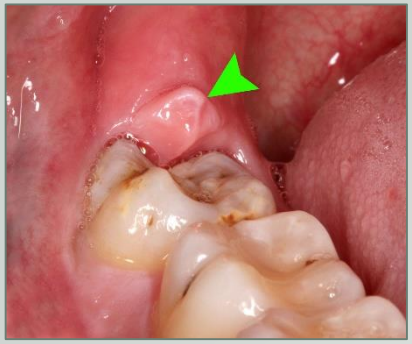
Table 1. Oral Infections

Disease	Pathogen	Signs and Symptoms	Transmission	Diagnostic Tests	Antimicrobial Drugs
Dental caries	*Streptococcus mutans*	Discoloration, softening, cavities in teeth	Non-transmissible; caused by bacteria of the normal oral microbiota	Visual examinations, X-rays	Oral antiseptics (e.g., Listerine)
Gingivitis and periodontitis	*Porphyromonas*, *Streptococcus*, *Actinomyces*	Inflammation and erosion of gums, bleeding, halitosis; erosion of cementum leading to tooth loss in advanced infections	Non-transmissible; caused by bacteria of the normal oral microbiota	Visual examination, X-rays, measuring pockets in gums	Tetracycline, doxycycline, macrolides or beta-lactams. Mixture of antibiotics may be given.
Herpetic gingivostomatitis	Herpes simplex virus type 1 (HSV-1)	Lesions in mucous membranes of mouth	Contact with saliva or lesions of an infected person	Culture or biopsy	Acyclovir, famcyclovir, valacyclovir
Mumps	Mumps virus (a paramyxovirus)	Swelling of parotid glands, fever, headache, muscle pain, weakness, fatigue, loss of appetite, pain while chewing; in serious cases, encephalitis, meningitis, and inflammation of testes, ovaries, and breasts	Contact with saliva or respiratory droplets of an infected person	Virus culture or serologic tests for antibodies, enzyme immunoassay, RT-PCR	None for treatment; MMR vaccine for prevention.
Oral thrush	*Candida albicans*, other *Candida* spp.	White patches and pseudomembranes in mouth, may cause bleeding	Nontransmissible; caused by overgrowth of Candida spp. in the normal oral microbiota; primarily affects infants and the immunocompromised	Microscopic analysis of oral samples	Clotrimazole, nystatin, fluconazole, or itraconazole; amphotericin B in severe cases
Trench mouth (acute necrotizing ulcerative gingivitis)	*Prevotella intermedia*, *Fusobacterium*species, *Treponema vincentii*, others	Erosion of gums, ulcers, substantial pain with chewing, halitosis	Nontransmissible; caused by members of the normal oral microbiota	Visual examinations, X-rays	Amoxicillin, amoxicillin clavulanate, clindamycin, or doxycycline

Gingival, Periodontal, and Pericoronal Abscesses – Bacterial Origin

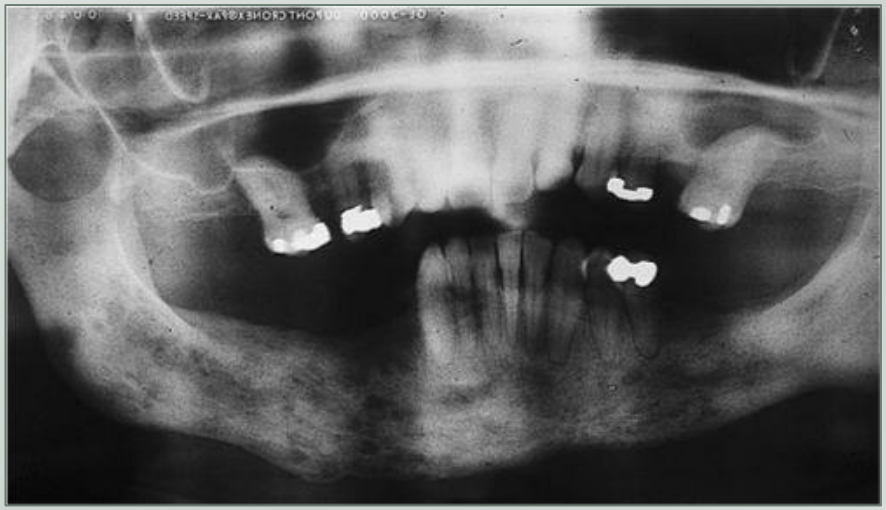
- What it is: an acute, localized infection of the gingiva or periodontium, marked by pain, swelling, and pus
- How they form: gingival – an irritant lodged in the gingiva; periodontal – bacteria invaded the periodontal tissues; pericoronal – bacteria invaded gingiva adjacent to 3rd molar
- Symptoms: swelling, redness, warmth, pain (not necessarily present with PDA), mass near gingival margin or higher up on side of tooth, edematous operculum (PCA)
- Bacteria: ***Porphyromonas gingivalis, Prevotella intermedia, Fusobacterium nucleatum, Campylobacter retus, Capnocytophaga*** species
- Treatment: incision and drainage, periodontal debridement, PA – root canal, extraction, or surgery





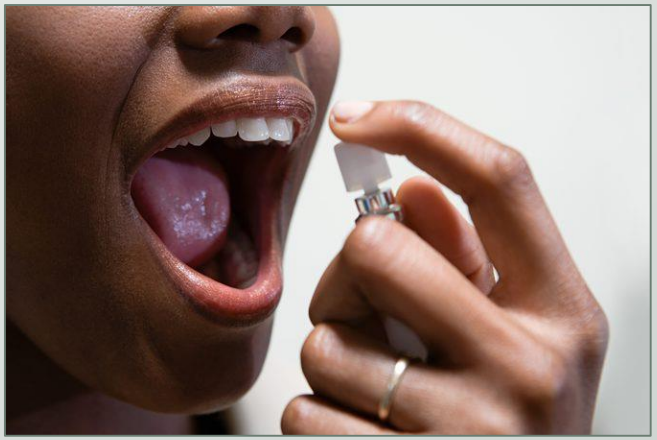
Osteomyelitis of the Jaw – Bacterial Origin

- What it is: an infection of the bone with inflammation of bone marrow
- Symptoms: pain, swelling, trismus (difficulty opening mouth), dysphagia (trouble swallowing), paresthesia (numbness), fever, loss of appetite, tooth pain on percussion, tooth loosening, pus, odor
- Bacteria: **alpha hemolytic streptococci and anaerobic bacteria from the oral cavity - *Peptostreptococcus, Fusobacterium* and *Prevotella,* also *Stapphylococcus epidermidis* following trauma**
- Cause: spreads from infection of teeth or tissues, introduced through injection, trauma, oral surgery (via blood supply)
- Treatment: antibiotics
- Prevention: regular oral care



Halitosis – Bacterial Origin

- What it is: bad breath caused by bacteria in the mouth
- How it happens: bacterial metabolism of proteins releases volatile sulfur compounds (VSCs); can also occur due to dentures, periodontitis, post-nasal drip, lung/bronchial infections, other systemic conditions
- Bacteria: ***Treponema denticola***, ***Porphyromonas gingivalis***, and ***Bacteroides forsythusare*** on the teeth, anaerobic asaccharolytica species, such as ***Prevotella*** (***Prevotella oralis***), are found on the tongue, also ***Actinobacillus***, and ***Fusobacterium*** species
- Treatment: good oral hygiene incl. flossing, tongue brushing/scraping, oral hydration, mouthwash, change in diet



Herpes Labialis, aka “Cold Sore” or “Fever Blister” – Viral Origin

- What it is: a viral disease that affects the skin around the lips
- Symptoms: painful ulcers or blisters around the outside of the mouth, crusting, tingling or burning
- Virus: **herpes virus – type 1**
- Transmission: direct/indirect contact, saliva
- Treatment: OTC medications, antiviral medications

Hand, Foot, and Mouth Disease – Viral Origin

- What it is: a viral infection that affects the mouth, and skin of hands and feet; usually affects children 0-5yrs old, sometimes in older children and adults
- Symptoms: variable, fever, reduced appetite, sore throat, small red dots/sores/blisters at the back of the mouth and throat, rash of flat, red spots with blisters on palms and soles of feet
- Virus: **Coxsackievirus A16, Enterovirus 71**
- Transmission: contact, air, pool water
- Treatment: OTC medications to control symptoms
- Prevention: hand hygiene, disinfect surfaces, limit personal contact with infected person

Oral Hairy Leukoplakia – Viral Origin

- What it is: a viral disease that affects the tongue; often occurs in patients with Epstein-Barr virus and HIV
- Symptoms: white linear patches on the sides of the tongue that appear fuzzy or hairy
- Virus: **herpes virus – type 4 (Epstein-Barr)**
- Transmission: direct contact, saliva
- Treatment: antiviral medications

Human Papilloma Virus – Viral Origin

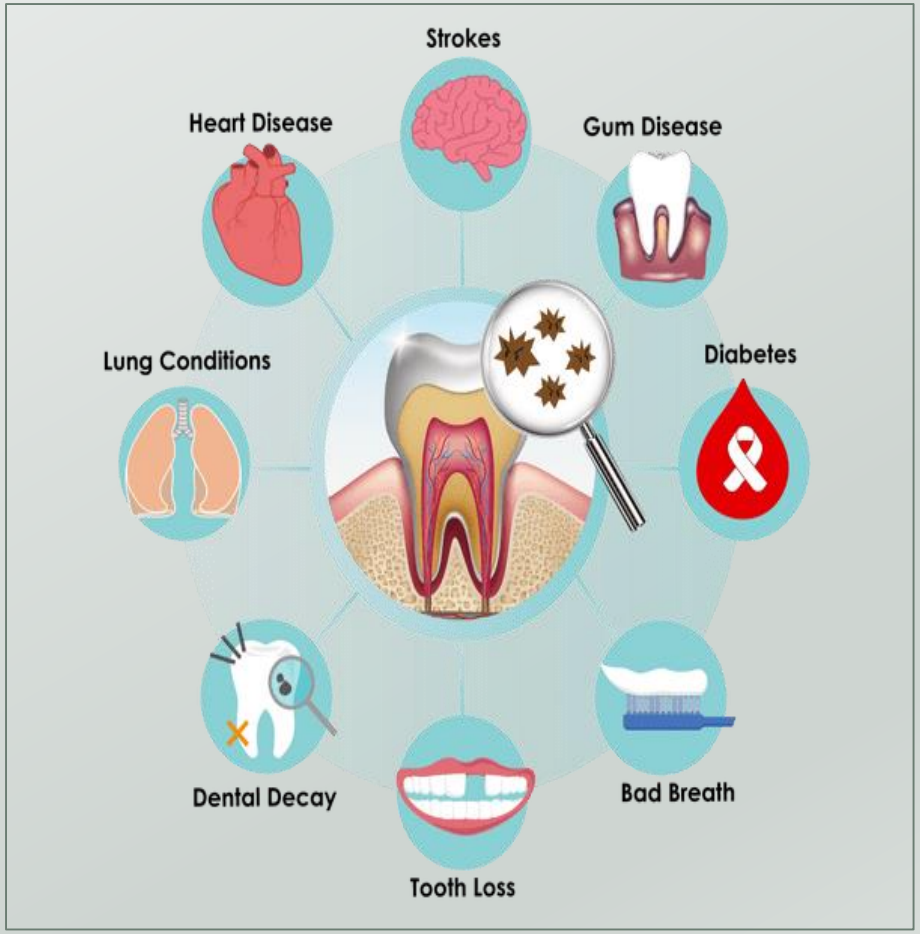
- What it is: a sexually-transmitted virus that can lead to oropharyngeal cancer
- Symptoms: viral infection – usually none, may develop oral warts
- Virus: **human papilloma virus (HPV)**
- Transmission: oral sex, via a small cut or tear in mouth
- Treatment: warts – surgery, cryotherapy
- Prevention: vaccine, practice safe sex

Dysbiosis and its Consequences

- What it is: an imbalance in oral bacteria, decreased beneficial bacteria and increased pathogens
- Bacteria: increased gram-negative anaerobes and decreased gram-positive aerobes, increased ***Porphyromonas gingivalis***, ***Aggregatibacter actinomycetemcomitans, Helicobacter pylori, Prevotella intermedia, P. nigrescens, P. micros, Fusobacterium nucleatum, P. gingivalis, Tannerella forsythia,*** and ***Treponema denticola***

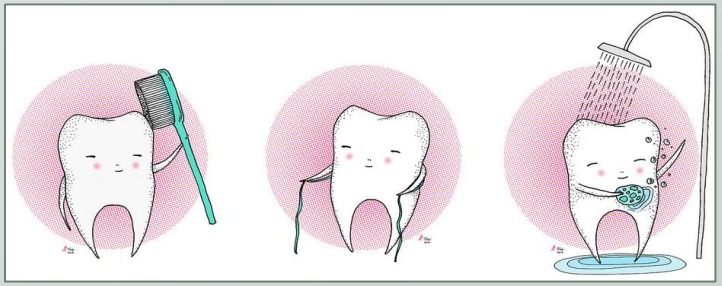
Dysbiosis, Continued

- Consequences: increased caries, gingivitis, periodontitis, change in gut microbiota, linked to cardiovascular disease, rheumatoid arthritis, adverse pregnancy outcomes, stroke, inflammatory bowel disease and colorectal cancer, pancreatic cancer, respiratory tract infection, meningitis or brain abscesses, lung, liver or splenic abscesses, appendicitis, pneumonia and diabetes
- Prevention: maintain good oral health – oral hygiene habits, see a dental professional regularly



Prevention – Taking Care of Your Mouth

- **Prevention** is vital to maintaining oral health.
- **Brush** your teeth twice daily. Don't forget to brush your tongue, or use a tongue scraper!
- **Floss**! Remember, bacteria lives between your teeth too.
- Use antimicrobial **mouthwash**.
- **Limit** refined sugars (ex. candy), acidic foods and beverages (ex. soda, coffee), and other carbohydrates. Rinse mouth or brush shortly after eating/drinking.
- See a **dental professional** regularly!
- Remember, the longer biofilm (plaque) stays on your teeth, the more likely it is to mineralize into calculus (tartar). This accumulates more biofilm, which leads to gingivitis and cavities.
- Neglecting the teeth and gums can have serious consequences, not only for your smile, but for your whole body!



Conclusion

- **Hundreds of bacteria** live in the oral cavity.
- Some bacteria are more pathogenic than others, and can **cause many serious diseases**.
- **Oral health affects systemic health**, so take steps to ensure your mouth is in good shape.
- **Brush** twice a day, **floss**, and use **mouthwash**.
- Visit a **dental professional** regularly!

References

Cafasso, J. (2017, December 12). Recurrent herpes simplex labialis. Retrieved from https://www.healthline.com/health/fever-blister-causes

Center for Disease Control and Prevention. (2018). Causes and Transmission. In Hand, foot, and mouth disease. Retrieved from https://www.cdc.gov/hand-foot-mouth/about/signs-symptoms.html

Center for Disease Control and Prevention. (2018). Prevention & Treatment. In Hand, foot, and mouth disease. Retrieved from https://www.cdc.gov/hand-foot-mouth/about/prevention-treatment.html

Center for Disease Control and Prevention. (2018). Signs and Symptoms. In Hand, foot, and mouth disease. Retrieved from https://www.cdc.gov/hand-foot-mouth/about/signs-symptoms.html

Christian Nordqvist, Causes and treatment of gingivitis. Retrieved from https://www.medicalnewstoday.com/articles/241721.php, Last updated Fri 5 January 2018, Accessed May 1st 2018

LumenCandela (n.d.). Bacterial Diseases of the Mouth. In Boundless microbiology. Retrieved from https://courses.lumenlearning.com/boundless-microbiology/chapter/bacterial-diseases-of-the-mouth/.

Nath, S. G., & Raveendran, R. (2013). Microbial dysbiosis in periodontitis. Journal of Indian Society of Periodontology, 17(4), 543–545. http://doi.org/10.4103/0972-124X.118334

References, Continued

Olsen, I. (2017). Oral microbial dysbiosis precedes development of pancreatic cancer. Journal of Oral Microbiology, 9(1), 1374148. http://doi.org/10.1080/20002297.2017.1374148

Oral hygiene. Retrieved from https://en.wikipedia.org/wiki/Oral_hygiene, Accessed May 1st 2018

Oral microbiology. Retrieved from https://en.wikipedia.org/wiki/Oral_microbiology, Accessed May 1st 2018

Patil, S. (2016, April 06). Halitosis. Retrieved from https://emedicine.medscape.com/article/867570-overview#showall

Periodontal disease. Retrieved from https://en.wikipedia.org/wiki/Periodontal_disease, Accessed May 1st 2018

Purdie, J. (2017, December 13). Human papillomavirus (HPV) of the mouth: What you should know. Retrieved from https://www.healthline.com/health/hpv-in-the-mouth#statistics

Tooth decay. Retrieved from https://en.wikipedia.org/wiki/Tooth_decay, Accessed May 1st 2018

References, Continued

Weinberg, M. A., Westphal Theile, C. M., Froum, S. J., & Segelnick, S. L. (2015) Comprehensive periodontics for the dental hygienist (4th ed.). Upper Saddle River, NJ: Pearson.

Wikipedia contributors. (2017, August 15). Osteomyelitis of the jaws. In Wikipedia, The Free Encyclopedia. Retrieved 15:18, April 28, 2018, from https://en.wikipedia.org/w/index.php?title=Osteomyelitis_of_the_jaws&oldid=795588761

Wikipedia contributors. (2017, December 21). Herpetic gingivostomatitis. In Wikipedia, The Free Encyclopedia. Retrieved 15:14, April 28, 2018, from https://en.wikipedia.org/w/index.php?title=Herpetic_gingivostomatitis&oldid=816387355

Wikipedia contributors. (2018, March 2). Dysbiosis. In Wikipedia, The Free Encyclopedia. Retrieved 15:49, May 1, 2018, from https://en.wikipedia.org/w/index.php?title=Dysbiosis&oldid=828339493

Wilkens, E. M. (2017) Clinical practice of the dental hygienist (12th ed.). Philadelphia, NY: Wolters Kluwer.