1 Introduction to oral microbiology

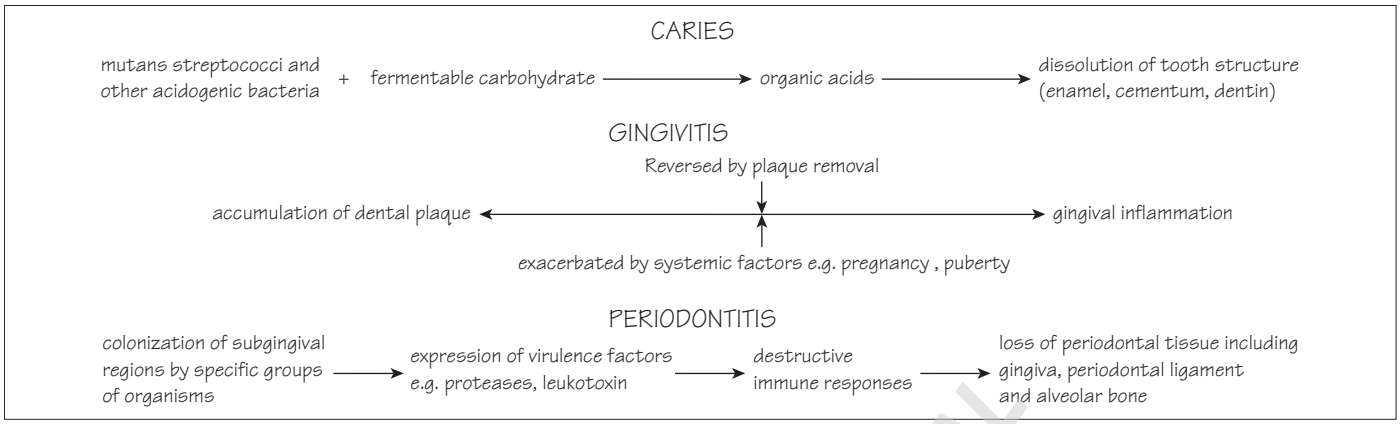

Figure 1.1 Etiology of the major bacterial diseases in the oral cavity

Table 1.1 Important oral diseases, their manifestations and the major microorganisms involved.

Disease	Description	Microorganisms implicated
Caries	Decay (loss) of tooth enamel (dental caries) or dentin (dentinal caries), or root dentin (root aries)	*Streptococcus, Lactobacillus, Actinomyces* (root caries)
Gingivitis	Redness and swelling (inflammation) of the gingival tissues (gums)	*Actinomyces, Fusobacterium, Bacteroides, Prevotella*
Periodontitis	Inflammation and either rapid (aggressive, either generalized or localized) or slower (chronic) destruction of the tissues supporting the tooth	*Aggregatibacter* (localized), *Porphyromonas, Treponema, Tannerella, Fusobacterium, Prevotella*
Implantitis	Infection and destruction of tissues surrounding a dental titanium implant	*Staphylococcus, Pseudomonas, Porphyromonas, Prevotella*
Pulpitis	Infection of the pulp, inflammation around the apex of the root, leading to abscess formation (periapical granuloma)	*Fusobacterium, Dialister, Peptostreptococcus, Porphyromonas*
Halitosis	Oral malodor	*Fusobacterium, Porphyromonas, Prevotella, Treponema, Eubacterium*
Pharyngitis	Redness and inflammation of the pharynx	Group A *Streptococcus, Neisseria, Haemophilus*, Coxsackie A virus
Tonsillitis	Infection and inflammation of the tonsils	Group A *Streptococcus, Haemophilus*
Leukoplakia	White patches on the buccal mucosal epithelium or tongue	*Candida*, human papilloma virus (HPV)
Stomatitis	Reddening and inflammation of the oral mucosa	*Candida albicans, Candida tropicalis, other Candida species*
Actinomycosis	Hard swelling (cyst) within the gums	*Actinomyces israelii*
Cold sores	Surface (superficial) red, dry lesions close to the lips	Herpes simplex virus (HSV)

The oral cavity is the most complex and the most accessible microbial ecosystem of the human body. The teeth, gingivae (gums), tongue, throat and buccal mucosa (cheeks) all provide different surfaces for microbial colonization. The constant production of saliva and intermittent provision of sugars and amino acids from ingested food provides nutrients for microbial growth. The human oral cavity is home to about 700 identified species of bacteria. This number will probably turn out to be closer to 1000 in the future, when all taxa and phyla have been recorded. It is also home to at least 30 species of fungi (mainly of the genus *Candida*), several species of protozoa (which graze on the bacteria for food), and various intracellular viruses. Generalizing, in a single subject it is usual to find between 20–50 species of bacteria at healthy oral sites. At diseased sites there is a tendency for higher numbers of different species to be present, perhaps 200 or more. These facts underline two main features in the field of oral microbiology. There are a number of different micro-environments within the oral cavity and the ecology of these is complex and diverse. Second, microorganisms do not exist as single species; rather they are almost always present in communities.

Commensals and pathogens

The organisms present in the oral cavity are a mixture of commensals and pathogens. A commensal microorganism is defined as one that lives on or within a host but does not cause any apparent disease. However, this terminology may be misleading, as many commensal bacteria can, under certain conditions, be associated with human disease. Subjects whose immune systems are not working optimally, i.e. immunocompromised, are especially susceptible to infections by microbes that are commensal in healthy individuals. For these reasons, commensals are nowadays often referred to as opportunistic pathogens.

Many of the cultivated bacteria present in the mouth probably contribute to oral diseases to a greater or lesser extent, because these diseases are almost always associated with polymicrobial infections (see Figure 1.1). Monospecies infections are rare; however, localized aggressive periodontitis (LAP) is predominantly associated with *Aggregatibacter actinomycetemcomitans*, while *Actinomyces israelii* can cause oral cysts (see Table 1.1). Overt pathogens are organisms that usually cause disease when present, unless the host has protective immunity. There are very few organisms in the oral cavity and nasopharynx that can be considered overt pathogens. *Streptococcus pyogenes* (Group A Streptococcus), *Streptococcus pneumoniae* (Pneumococcus), *Neisseria meningitidis* (Meningococccus) and *Haemophilus influenzae* all reside within the nasopharynx and have the potential to cause life-threatening diseases. It is important to note, however, that even in such cases these bacteria may also be carried by subjects with no overt signs of disease. This is termed the carrier state. Vaccination of children against meningococcus (MenC) or *H. influenzae* (Hib) has been very effective in protecting against disease. In addition, the immunization programs have led to reductions in the numbers of carriers of these bacteria in the human population. One of the problems with this kind of approach is that removal of one species of bacteria from a population creates a vacant niche for arrival of other organisms. This might result in replacement by a similar species of different serotype that is not covered by the vaccine. This occurs in children immunized using the 7-serotype (heptavalent) pneumococcal conjugate vaccine. Alternatively, a different bacterium may become resident, such as *Staphylococcus aureus* on the nasal mucosa of subjects immunized against Pneumococcus.

Oral diseases

Almost every member of the human population is afflicted at some stage of their lives with an oral disease (see Table 1.1). The incidence of dental caries has declined generally in the developed world, due in part to fluoride in the water supply, in toothpaste, or taken in tablet form. However there are many groups within societies that are still seriously afflicted with caries. Polymicrobial infections of the gingivae and sub-gingival regions (periodontitis, implantitis and pulpitis) are major conditions requiring clinical intervention. These diseases impose a significant burden on the heath care system. Halitosis is often caused by bacteria on the tongue processing proteins into volatile sulfur compounds. Pharyngitis and tonsillitis are common diseases in children and are caused by bacteria or by viruses (see Table 1.1). Osteonecrosis of the jaw is associated with the use of bisphosphonates particularly in cancer patients with multiple myeloma. Fungal infections, most frequently by the yeast *Candida albicans*, are associated with reduced salivary flow, ill-fitting dentures, hormonal changes, or compromised immune function. Viral infections of the oral mucosa include HPV, EBV and HSV.