Preventive Dentistry

2021-2022 **5th stage**

Cariogenic potential of bacteria

Virulence of microorganism

The low level of nutrients in the oral cavity gives rise to complex pattern of competition for the available nutrients among the different microbial populations of the oral microflora. Most oral bacteria are only able to grow if the pH is within a narrow range, but some oral bacteria are aciduric and will grow at significantly low pH values. These organisms are favored when the environment on the teeth becomes acidic. Sugar is the main energy source for the micro-flora, some of micro-flora on the teeth may utilize carboxylic acids, amino acids rather than sugars to drive cellular activity. However, many organisms are able to utilize a wide variety of sugars by the induction of specific enzymes that are synthesized only in the presence of the specific sugars.

Oral bacteria protect themselves by:

- ✓ Regulating the rate of glycolysis
- ✓ The efficient conversion of pyruvate to metabolic end-products
- ✓ Synthesis of intracellular polysaccharites
- ✓ Inhibition of sugar transport by phosphotransferase system

Microorganisms have a variety of systems for the conversion of cellular end products which vary according to:

- Type of organism
- Amount and type of sugar available
- Presence of oxygen and carbon dioxide

Bacteria must possess certain caries-promoting characteristics to play a role in

caries include:

- ✓ The ability rapidly to transport fermentable sugars to acid.
- ✓ The ability to maintain sugar metabolism under extreme environmental conditions, such as at a low pH. Few oral bacteria are able to tolerate acidic conditions for prolonged periods. *Mutans streptococci* and *lactobacilli* not only remain viable at a low pH, but preferentially grow and metabolize, they are both acidogenic and aciduric.
- ✓ The production of extracellular (EPS) and intracellular polysaccharides (IPS). EPS include glucans and fructans, both of which contribute to the biofilm matrix. Fructans are labile and can be metabolized by biofilm bacteria under carbohydrate-restricted conditions. IPS is glycogen-like storage compounds that can be used for energy production and converted to acid when free sugars are not available in the oral cavity. Thus, the metabolism of IPS can prolong periods over which biofilms can generate acids (formic and acetic acids). Many factors may influence the types and amount of acids formed by such a complex microflora as dental plaque.

Major dental caries-associated bacteria

Oral streptococci

The current classification of the human oral streptococci puts them into four species groups, the *mitis, mutant, salivarious,* and *sanguinosus* groups. *Streptococcus sanguis* was found to play an important role in the initiation of plaque formation while *S. mitis* was reported to a role in gingivitis and periodontitis as well as it was isolated from carious dentine and infected root canal. *Mutant Streptococci* (MS) are gram-positive facultative coccus commonly found in the oral cavity. Species of streptococci may vary in their cariogenic determinant, *streptococcus mutans* were found to be the predominant bacteria in caries process.

S. mutans commonly arranged in chains, subspecies are: S. Rattus, S. Sobrinus, S. Cricetus, S. Ferus.

Certain physiological characteristics of the *Streptococcus mutans* :

- The ability to adhere to tooth surfaces by either of two mechanisms:

(1) attachment to the acquired pellicle through extracellular proteins (adhesins) located on the fimbriae (fuzzy coat) of these organisms; and (2) sucrose-dependent mechanisms, in which bacteria require the presence of sucrose to produce sticky extracellular polysaccharides (glucans), that allows attachment and accumulation of additional waves of bacterial colonization.

- Rapid production of lactic acid from a number of sugar substrates,

- The production of intracellular polysaccharide (energy) stores.

As a general rule, the cariogenic bacteria metabolize sugars to produce the energy required for their growth and reproduction. The by-products of this metabolism are acids, which are released into the plaque fluid. The damage caused by oral streptococci is mainly caused by lactic acid, although other acids, such as butyric and propionic, are present within the plaque. A positive correlation is found between the counts of these bacteria in saliva and plaque.

Lactobacilli

Lactobacilli (LB) comprise a diverse collection of gram-positive bacilli. They are aero tolerant or anaerobic bacteria. It was thought previously that LB play a major role in the carious process. Later, it was found that LB are more a consequence than a cause of caries initiation During the initial phases of the developing carious lesions,

large numbers of MS are involved, only to decrease later in number as the LB population increases. *Lactobacillus* is acid tolerant (aciduric) and can carry out glycolysis at pH values as low as 3. However, lactobacilli are poor colonizer of smooth tooth surface. Lactobacilli are generally believed to exacerbate the initial enamel lesion to deep dentine lesion. A positive correlation is found between the counts of these bacteria in saliva, plaque and caries activity. Also, these bacteria have ability to produce both extracellular and intracellular polysaccharides.

Actinomyces

Actinomyces are a genus of gram-positive anaerobic pleomorphic rod-shaped bacteria. They have been frequently isolated from both root caries lesions and sound root surface, suggesting their association with root caries. Results of several studies documented that MS and LB were found in root caries lesions. However, the knowledge about the involvement of individual *Actinomyces* species in caries initiation and progression is not well-understood.

Veillonella

They are gram-negative anaerobic cocci appears as plaque oxygen levels fall, are unable to metabolize dietary carbohydrates but they are able to use lactate that is produced by other microorganisms and convert it to a less cariogenic and weaker acid. This may consider a beneficial effect of these bacteria in relation to dental caries.

Plaque hypothesis

The oral cavity is inhabited by hundreds of bacterial species, forming complex ecology system. The “specific pathogen hypothesis” has led to the identification of

a single or very small numbers of species were actively involved in disease. In contrast, the "nonspecific plaque hypothesis" supports the concept that caries is the consequence of the overall acid production activity of the total plaque microflora rather than a few specific bacteria but also species that produce alkali or consume lactate need to be considered. An alternative hypothesis has been proposed the ecological plaque hypothesis suggested that the organisms with the disease may also present at sound sites but at a low level.

The converse situation is also not uncommon, where mutans streptococci are found in high numbers in plaque but in the apparent absence of any demineralization of the underlying enamel. This may be due to:

- The structure of the biofilm and the localization of mutans streptococci in plaque
- The presence of lactate-consuming species (e.g. Veillonella)
- The production of alkali to raise the local pH (by ammonia production from urea or arginine by S. salivarius and S. sanguinis, respectively).

Species interactions and caries

The viability of oral microflora is dependent not only on the host genetic and environmental factors but also on interactions between microbial residents. The residents interact extensively forming biofilms structures, carrying out physiological functions and inducing microbial pathogenesis.

Microbial interactions include:

- ✓ Competition between bacteria for nutrients
- ✓ Synergistic interactions for growth and survival
- ✓ Antagonistic interactions by secondary metabolites production
- ✓ Neutralization of a virulence factor that produced by another resident
- ✓ Interference in the growth-dependent signaling mechanisms of each other. A dynamic balance of both synergistic and antagonistic interactions with

the residents plays an essential role in determining whether these pathogenic factors cause damage or not. Hence, dental caries is the net result of the interaction of multiple acidogenic/aciduric bacteria with others within dental plaque.

Bacterial colonization can be controlled by:

- Antimicrobial approaches (fluoride, chlorhexidine and others).
- Mechanical approaches (teeth brushing and others).
- Dietary assessment (use of non-cariogenic sweeteners as xylitol, avoid frequent consumption of carbohydrates between meals).
- Probiotics are live microorganisms which, when applied in adequate amounts, will benefit the health of the host.
- Salivary antimicrobial substances.