

Merrimack College

Merrimack ScholarWorks

Honors Program Contracts

Honors Program

Spring 2021

Streptococcus mutans and the Oral Microbiome

Danielle Pintone

Follow this and additional works at: https://scholarworks.merrimack.edu/honors_component



Part of the [Biology Commons](#), and the [Oral Biology and Oral Pathology Commons](#)

Danielle Pintone

March 30, 2021

BIO3045

Honors Contract Project

Streptococcus mutans and the Oral Microbiome

In the dental world, the idea of cavities are described in many different ways depending on the age of the patient. With adults, it is explained that bacteria and sugar causes cavities and for younger children “sugar bugs eat away at your teeth”. Although there are no “ bugs”, in your teeth, both of these explanations do have some truth to them. In the oral cavity there is a bacteria called *Streptococcus mutans*, this bacteria uses sugars on the teeth to create lactic acid which will demineralize, “eat away” parts of the enamel, and sometimes the dentin, therefore creating a hole in the tooth known as a cavity. The longer this demineralization of the tooth goes on undetected for, the more damage it can do and can cause the patient severe pain. This is why going to dental cleaning appointments at least every six months is crucial to the health of your teeth as well as keeping up with your dental hygiene by brushing twice a day and flossing every day.

The bacteria *Streptococcus mutans* is part of the phylum *Firmicutes* which explains its gram positive characteristics, and is in the genus *Streptococcus* which explains its appearances of round cells formed together in chains. This bacteria is a mesophile meaning that it grows in moderate temperatures from 18- 40 degrees celsius. In the lab, this bacteria can be identified by the fact that it is catalase negative, gamma hemolytic, and resistant to optochin. The way that this bacteria creates cavities is by breaking down the sugars left behind on teeth and using it for energy, this produces an acidic environment that ultimately demineralized calcium in the tooth

structure and creates a hole in the tooth (Zelnicek 2016). The enamel of the tooth is covered in a pellicle which is a layer of salivary glycoproteins, phosphoproteins, and lipids. Early colonizers attach to the pellicle and allow for more bacteria to adhere and replicate in the pellicle. These adherents to the pellicle are a biofilm commonly known as dental plaque. This bacterial biofilm metabolizes carbohydrates such as glucose and fructose and produces lactic acid which decays the enamel and can further decay the dentin. (*Stages of Development: Caries Process and Prevention Strategies: The Agent: CE Course*) *S. mutans* is also a facultative anaerobe meaning it can survive with or without oxygen. It can survive using aerobic respiration in the presence of oxygen or go through fermentation in the absence of oxygen. The process by which the cavity forming happens is glycolysis and lactic acid fermentation where glucose is converted to pyruvate and then to lactic acid. Through culturing *S. mutans* under aerobic conditions, it has been shown that in the presence of oxygen there is an 80% reduction in the bacteria's ability to form biofilms on the teeth (Krzyściak et. al. 2014). This means that although cavities can form in the presence of oxygen, the cavity forming process is much more harmful in the absence of oxygen. This is why it is extremely important for brushing and flossing the teeth before bed because when our mouth is closed when we are sleeping, the oral cavity is an anaerobic environment where *S. mutans* can thrive, and if there is not any sugar on the teeth, the bacteria won't have anything to feed off of.

Streptococcus mutans is said to be able to be transmitted vertically, meaning that the mother passes it on to a child, or horizontally, between individuals of the same generation. When a child is young, it can usually receive *Streptococcus mutans* from either of the parents from close contact such as testing food before giving it to the child. Studies show that breast-fed babies had a lower colonization rate of *S. mutans* than those of babies that were fed by spoon or

by bottle. This confirms that vertical transmission is indeed true. Once the oral microbiome is contaminated with *S. mutans*, there is not much that can be done besides prevent the bacteria from becoming virulent (Zelnicek 2016). The best way to do this is to brush and floss all areas of the teeth in order to rid the environment of any sugars that the bacteria could feed off of. (Mokeem. Et.al 2021). Staying away from sugary foods and drinks is also a good idea, but since those types of things are irresistible, the dental hygiene routine should follow soon after these are ingested. Human error can cause the ignorance of sugar and other bacteria to remain in certain areas of the mouth, routine dental check ups are a great way to stay on top of keeping the oral microbiome clean. Dental x-rays should be taken every 12 to 18 months to check for cavities, and when the infection enters the dentin, the cavity should be cleaned and filled.

Although hygiene ignorance is a very prominent cause of cavities, sometimes teeth can be exceedingly prone to cavities due to hypoplasia. With “hypo-” meaning below normal, or missing, and “-plasia” meaning development or formation, hypoplasia is the underdevelopment of teeth. This disturbance of minerals in the dental tissue normally happens while the teeth are developing during the mother’s pregnancy or in early childhood. This can be due to malnutrition or sickness in the mother during pregnancy or in the child during the postnatal period. The hypoplastic teeth are most common on the six year molars and it is linked to sickness around the age of two when those teeth are forming, during this time the child may have spiked a fever possibly due to the eruption of the primary molars. Clinically these demineralized spots appear chalky and white and can be diagnosed without a radiograph. The defects in these areas allow for *Streptococcus mutans* to readily colonize and cause cavities quicker. (Caufield, et al. 2012)

An additional reason for susceptibility to caries is the anatomy of the mouth. Orthodontics, or the correction of misaligned teeth, is not only for the aesthetics of the smile but

can also be for the health of the teeth. When the teeth are crowded, or close together to the point that they are overlapping, it can trap plaque and bacteria which can cause cavities to form due to the multiple areas where a toothbrush can't reach. Large gaps between teeth can also be places for large food particles to get stuck and also cause cavities. When orthodontics are used and the case is complete, the patient should have light contacts between their teeth small enough that large particles can't get in and wide enough that brushing and flossing are possible. Another anatomical reason for cavities to arise due to deep grooves on the occlusal surface of the molars. With these deeper grooves, sugars can get stuck within them and are not always able to be brushed. A dental procedure called "sealants" is usually completed to make those grooves shallower in order to prevent this.

With the information of how *Streptococcus mutans* can enter our oral microbiome, preventative measures can take place. Without sugars for the bacteria to use as a carbon source, acid would not be formed and the demineralization of the teeth (cavities) would not happen. This is why it is extremely important for brush and floss teeth to rid the area of the fuel for bacteria. Since there are areas of the mouth that can be missed, regular dental check ups allow for the doctor to examine the mouth clinically for any areas of demineralization, view radiographs to look for the beginning of cavities or any dental deformities, and also to review proper hygiene techniques.

Caufield, P W et al. "Hypoplasia-associated severe early childhood caries--a proposed definition." *Journal of dental research* vol. 91,6 (2012): 544-50. doi:10.1177/0022034512444929

Krzyściak, W et al. "The virulence of *Streptococcus mutans* and the ability to form biofilms." *European journal of clinical microbiology & infectious diseases* : official publication of the European Society of Clinical Microbiology vol. 33,4 (2014): 499-515. doi:10.1007/s10096-013-1993-7

Mokeem, Lamia S., Lisa H. Willis, L. Jack Windsor, N. Blaine Cook, George Eckert, and Richard L. Gregory. "Combined Effects of Soft Drinks and Nicotine on *Streptococcus Mutans* Metabolic Activity and Biofilm Formation." *Journal of Oral Science* 63.1 (2021): 75-78. Print.

Zelnicek, Taylor. "Streptococcus Mutans- Tooth Decay." *Microbewiki*. 11 Feb. 2016. Web.