

DENTAL PLAQUE: BACTERIAL SHENANIGANS ABOVE AND BELOW THE GUMLINE

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DENTAL PLAQUE

A community of microbes, primarily bacteria, living as a biofilm attached to the surface of teeth.

Every morning and every night you clean your teeth. Your dentist tells you to do it, your family does it, and even your pets might do it using a special food or toy. Cleaning is done to remove dental plaque that accumulates over time on teeth, above and below the gumline. What is dental plaque and why is it important to remove? In this article, we provide an overview of dental plaque: what it is and why it forms, how dental plaque can hurt your teeth and gums, and what you can do to protect your teeth and gums. We hope this article inspires you to keep up with your own oral health and perhaps encourages you to consider a career in dentistry or the oral health sciences.

WHAT IS DENTAL PLAQUE AND WHY DOES IT FORM?

If you take a toothpick and gently scrape your teeth, you will often see some gunk. This gunk is **dental plaque**. Dental plaque is not leftover food—it is a living mat of microbes that grows on your teeth.

BIOFILM

A community of microorganisms held together by a mesh of sticky biological molecules.

If left alone, dental plaque can be unsightly and eventually damage teeth. Dental plaque is a mixture of microbes and a complex mix of sticky substances that microorganisms produce (often referred to as extracellular polymeric substances) that give plaque its gunky feeling. These substances are made of carbohydrates, proteins, lipids, and DNA. This mix acts like a glue, holding the microbial cells (mostly bacteria) together in a community called a **biofilm** [1]. Biofilms can form a variety of interesting shapes and can exist in a variety of habitats, not just on the surface of your teeth. Biofilms exist on the hulls of ships, surfaces of pebbles in streams, and on the leftover pizza you forgot to put in the fridge for a few days. In fact, many of Earth's bacteria live in biofilms.

Why do the bacteria in your mouth form biofilms? Dental plaque is essentially a large, sprawling bacterial city [2] spread over your teeth and in between your teeth and gums. In these cities, specific types of bacteria do specific jobs. Some bacteria make food for themselves and their neighbors, some protect against toxic chemicals, and some are villains! The outcome of the bacterial interactions within biofilms can lead to a healthy (disease-free) dental plaque community or an unhealthy (diseased) dental plaque community that can result in tooth decay, gum inflammation, and tooth loss [3].

ARE ALL BACTERIA IN DENTAL PLAQUE “VILLAINS”?

Bacteria have been living with people as long as there have been people. It is too much work for our bodies to try to keep them all out! Over time, we have developed a relationship with certain bacteria that helps both the bacteria and us: we provide good bacteria a home and they keep out the bad bacteria and other microbes that could harm us. Bacteria can make things that we benefit from and remove stuff we do not want. For example, the bacterium *Streptococcus gordonii* produces antimicrobial substances that can harm the problematic bacterium *Streptococcus mutans* [4]. The bacterium *Veillonella atypica* consumes the lactic acid produced by other dental plaque bacteria before it can harm our teeth. But other dental plaque bacteria are bad for our health. Two types of bacteria—*Streptococcus mutans* and *Porphyromonas gingivalis*—are the top supervillains. Both types of bacteria can cause tooth loss, but they do it in very different ways. One works above the **gumline** on your exposed tooth surfaces, while the other works secretly, in the dark under the gumline.

GUMLINE

The area where the top of the gums meets the teeth.

SUPRAGINGIVAL PLAQUE

Plaque that exists on the exposed surface of the teeth.

ABOVE AND BELOW THE GUMLINE—WHAT IS THE DIFFERENCE?

Dentists and scientists refer to the dental plaque above the gumline as **supragingival plaque** (“supra” means above) and refer to the

SUBGINGIVAL PLAQUE

Plaque that exists in the pocket between the gum tissue and the surface of the teeth.

Figure 1

Bacteria living above and below the gumline can damage the teeth and gums. **(A)** Above the gumline: (1) Sucrose enables *S. mutans* to produce lots of lactic acid and sticky substances (called extracellular polymeric substances). (2) Lactic acid damages the teeth and causes cavities and (3) harms other surrounding bacteria. **(B)** Below the gumline: (4) In the gingival crevice, *P. gingivalis* uses cell-surface structures to stick to gums and bacteria and (5) produces enzymes and other products to obtain nutrients like heme. Inflammation can damage the gums and bone around the tooth (figure credit: Richard Palmer).

CARIES

Also called cavities or tooth decay; the formation of holes in teeth caused by bacteria that produce acid from sucrose. Caries can ultimately lead to tooth loss.

plaque below the gumline as **subgingival plaque** ("sub" means below; Figure 1). While these places are close to each other, the chemical and microbial composition of the dental biofilms are very different. These differences alter the ways that the bacteria interact with each other and with your teeth and gums [5].

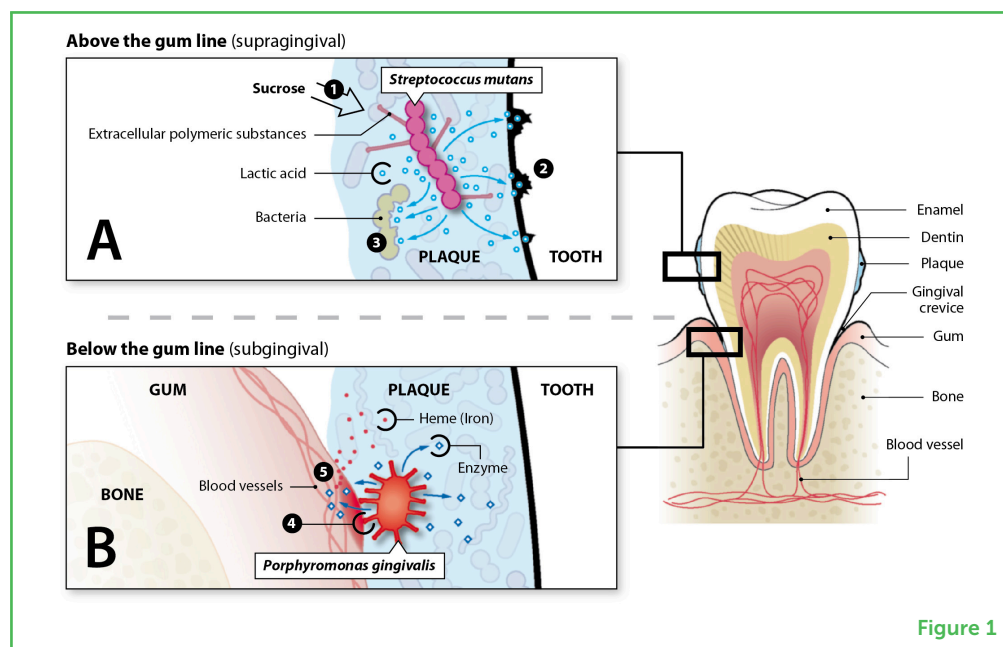


Figure 1

Supragingival plaque develops on the exposed surfaces of teeth above the gumline (Figure 1A) and is the type of biofilm where *S. mutans*, one of our most notorious dental plaque supervillains, can live. However, before *S. mutans* can cause problems it needs sucrose, which is a sugar used as a sweetener and a food preservative. Sucrose is present in many types of candies, sodas, and processed foods. Sucrose is important for *S. mutans* because it allows the bacterium to make lactic acid and the sticky substances that hold the bacterium in the biofilm. Lactic acid produced from sucrose can dissolve tooth enamel and stop growth of other bacteria, making it easier for *S. mutans* to grow. If left untreated, *S. mutans* will multiply and lactic acid will make holes in your teeth called **caries** (or **cavities**), which need to be filled by a dentist. A tooth with a cavity may also become infected, which is very painful and needs to be treated with antibiotics. If left untreated after infection, the tooth may become so damaged it will have to be removed.

Below the gumline in subgingival plaque, a different community of bacteria exists, sheltering another bacterial supervillain—*P. gingivalis*. The growth of *P. gingivalis* depends on nutrients like heme (an iron compound contained in blood) as well as other proteins and amino acids found below the gumline. To get these resources, *P. gingivalis* uses a cocktail of chemicals and cell-surface structures to damage or modify the behavior of human cells in the space below the gumline between the teeth and gums (Figure 1B). *P. gingivalis* can cause

GINGIVITIS

Redness and swelling of the gums caused by inflammation resulting from overgrowth of certain types of oral microbes.

PERIODONTITIS

A disease in which continued inflammation can eventually damage gums and bone around teeth, potentially leading to tooth loss.

inflammation, swelling, and redness in your gums (called **gingivitis**), along with other negative effects. If left unchecked, the activities of *P. gingivalis* and similar bacteria can lead to bleeding, receding gums, and destruction of the bone supporting the teeth, which is called **periodontitis** [6]. Periodontitis makes it difficult or painful to chew and talk. Without the support of bone, the tooth becomes loose and eventually falls out.

HOW DO WE PROTECT OUR TEETH AND GUMS?

The way you treat your mouth is important for preventing bacterial supervillains from causing damage. Eating foods containing lots of sucrose (like some candy and sodas), smoking, and poor oral hygiene all help villainous dental plaque bacteria damage your teeth and gums. There are three strategies we can use to keep our teeth and gums healthy: good health habits, good oral hygiene, and regular dental check-ups. Good health habits, like eating healthy foods, avoiding foods high in sucrose, and not using tobacco, are preventative strategies. Various types of bacteria require specific nutrients to grow. For example, eating foods high in sucrose makes it easier for *S. mutans*—the supervillain that causes cavities—to grow. Good oral hygiene, like brushing and flossing your teeth, disrupts and removes dental plaque. Many toothpastes contain chemicals such as stannous fluoride that inhibit the growth of dental plaque bacteria. However, living in a dental plaque biofilm can protect bacteria from these chemicals. To overcome the protection provided by the biofilm lifestyle, we pair these chemicals with mechanical activities (such as brushing our teeth and flossing between teeth), that remove a lot of the dental plaque. Brushing and flossing allow chemicals to penetrate deeper and to more effectively kill bacteria. Regular dental check-ups do two things. First, dentists have tools to remove plaque in hard-to-reach areas and they give your teeth and gums a more thorough cleaning than you can do at home. Second, dentists can detect cavities early, before they become serious problems. They can also put sealants on teeth to protect them. If a cavity is too big to heal itself, dentists can fill the hole, preventing continued tooth damage or risk of infection. Together, these strategies help prevent dental plaque from damaging your teeth and gums.

CONCLUSION

Above or below the gumline, microorganisms in the mouth inhabit living cities called biofilms. These biofilm cities in the mouth are known as dental plaque. Mouth microorganisms have unique abilities that influence the properties of the biofilm. Dental plaque can contain helpful bacteria as well as supervillains like *S. mutans* and *P. gingivalis*. The interactions of dental plaque bacteria with each other, with your teeth, and with your gums must be carefully controlled to maintain

good oral health. We hope that, after reading this article, you have a better understanding of why we need to have healthy habits and good oral hygiene to keep our teeth healthy.

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YOUNG REVIEWERS

ANJISHNU, AGE: 14

Hello, my name is Anjishnu and I am in Ninth grade. I have a passion for writing, reading, math, and science. I also like reading about cars and other vehicles. I enjoy playing tennis. I want to study biology when I grow older so that I can pursue a career in science.

FINNEA, AGE: 10

My name is Finnea (Finn-AY-uh) and I love to read. My favorite book series is Warriors and I like to write a lot. I spend my free time taking dance lessons and playing with my cats.

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JASON T. F. WING

Jason T. F. Wing is an undergraduate student at the University of Michigan. As a young child, Jason found a passion for learning and the sciences and, over time, he developed an interest in medicine and the human body. Wanting to know more about the body, how it works, and how outside entities might affect it, Jason decided to study biochemistry and do microbiology research. Aside from academics and research, Jason enjoys activities such as watercolor, rowing, music, and dancing.

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