

## The Oral Microbiome - How Microbes Connect the Mouth and Gut

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As dentists, we wrestle with microbes every day. Yet, despite the known role of bacteria and disease, advancing understanding of the human microbiome may assist the dental community to understand the oral-systemic connection and how nutritional advice can be our key preventative tool for disease all over the body.

### A big perspective of a tiny world

In 2008, The Human Microbiome Project launched with the goal to identify and characterise the spectrum of microorganisms found in association with both the healthy and diseased state.

The results are simply staggering. Despite the human organism consisting of billions of cells, its microscopic inhabitants outnumber them by 10 to 1 and comprise 1 - 3% of the body mass. Through genomic sequencing techniques, scientists show the genetic material of microbial species outnumber a human host's genes by 100 to 1 [1,2]. Our previous notion that bacteria were only present in disease is a gross simplification of the microbial world that we insignificant humans live in.

### The gut, a galaxy not so far away

The colon hosts the largest population of microbes in the body with a cell density of  $10^{11}$  -  $10^{12}$  per millilitre of gut content [3]. This is one of the highest numbers recorded for any microbial population on Earth and close to the number of stars in the Milky Way.

In fact, the gut and its microbial populations are working in synergy by moving, digesting and absorbing nutrients to pass into the bloodstream. Additionally it's fighting off pathogens all whilst sending signals to the rest of the body what is coming next.

### How microbes speak to the immune system

As it turns out, microbes don't just assist in bodily processes – they are essential to its proper functioning. In the gut, microorganisms inhabit, coexist and work with human cells in a mind-boggling complex environment of biological diversity.

Living within and amongst the surface of the gut lining, our gut microorganisms serve many further purposes including capturing heavy metals, the secretion of hormones, vitamins and fatty acids that all play a role in managing the integrity of a healthy gut barrier [4,5].

On the other side of this barrier, 80% of the body's immune system cells reside on the underlying side of the gut lining, making it the largest antibody-producing organ in the human body. If unwanted organisms do cross the intestinal barrier, this large concentration of immune cells are designed to eat and dispose of them [6-9].

The microbe and immune interface represents a system with a function to allow our body to understand, interact and respond to the environment appropriately. It represents the connection between our stomach and the world around us.

### Gut permeability and disease

Studies are now revealing that a compromise of the gut lining may link to a broad spectrum of chronic diseases. As an example, intestinal permeability may be a key mechanism in triggering an over reactive immune system. It's suggested to contribute as a precursor to autoimmune disease, an immunological haywire state of the body's own cells occurs due to the exposure to certain antigens, for example gluten in coeliac disease [10].

However a wave of new research is highlighting links between imbalance of gut bacteria population and digestive conditions such as irritable bowel disease [11,12] and allergies. <http://www.ncbi.nlm.nih.gov/pubmed/23909601>

The gut's management of neurotransmitters and connection between the digestive system and brain, may even associate gut bacterial dysbiosis to psychological disorders such as depression [13], anxiety and autism [14] as well as degenerative processes such as Alzheimer's and Parkinson's dementia [15].

However whilst our understanding is improving, the majority of research at this stage is currently based on animal models. Human gut bacteria are as mind-boggling as they are variable and conclusive studies remain difficult.

### The oral microbiome, the gut's bodyguard

The mouth could be considered as having the significant role of shielding gut microbes from the rest of the world.

With between 500 - 700 common species [16,17], the oral environment is a separate but not completely unique population to the gut. Between the two, 45% of species overlap between mouth and colonic microbes [18].

Both the mouth and gut remain largely sterile until birth. During the first two weeks of life the mouth proceeds to 'seed' the gut population. Within this initial fortnight, oral and stomach microbial populations are identical, before establishing themselves as unique, functioning entities [19,20]. However, with the mouth like a doorman in a nightclub, they remain in constant communication throughout life.

### The mouth-gut axis

It's estimated that swallowed saliva carries around a trillion bacteria into the body everyday [21]. The dental profession has long been aware of 'bacteraemia' associated with endocarditis [22] as well as the relationship to other systemic diseases liketype-2 diabetes and arthritis [23].

Research is also revealing how microbes implicated in gum disease can alter the gut bacteria. This has been linked to diseases such as liver cirrhosis [24], cancer [25] and even obesity [26]. Our new appreciation of the gut as a microbial ecosystem could provide the missing link in demonstrating how the mouth dictates disease processes all over the body.

### How diet changed our mouth

Genetic sequencing technology has allowed new understanding of the mouth's microbial population and dental disease.

Research showing that human dietary shifts has had significant impact on our oral microbial environments. Scientists who measured the fossilised dental plaque of ancestors have revealed that our modern oral inhabitants decreased in diversity compared to hunter-gatherer forbearers. This has coincided with the proliferation of disease causing bacteria due to the large-scale introduction of processed flour and sugar, that is, the industrial revolution [27].

Along with these dietary changes was the rise of modern rates of tooth decay where the pH of the oral environment shifts as a result of simple carbohydrate metabolising bacteria, such as *Streptococcus mutans*.

### Dental health as a sign of all disease

Whilst we have much to learn, it may not be long before a simple bacterial saliva test enables us anticipate the health of our gut. The known shifts in oral bacteria associated with dental disease could be a key marker for processes in the gut and a compelling opportunity to understand exactly how the mouth and our diet impacts the entire body.

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