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# Fluoride and Your Teeth: How Fluoride in Dental Products Protects Your Teeth from Cavities

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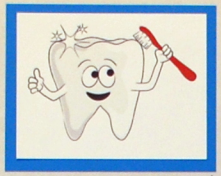

## How Fluoride in Dental Products Protects Your Teeth from Cavities


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Chemistry 101-006


### All about Fluorine

Fluorine is a chemical element naturally found in fluorspar, which for centuries has been used as a cleansing agent. The colorless, transparent crystals in fluorspar are tinged blue when illuminated. Only found in this natural compound, Fluorspar deposits are harvested in Illinois, Kentucky, England, southern Germany, southern France, Russia and Greenland. At room temperature, fluorine is a faintly yellow gas with an irritating odor. Just one stable isotope of fluorine exists in the elemental form, fluorine-19. When separated and alone, Fluorine will react with itself to form a diatomic molecule. Fluorine is the most electronegative element and it seeks to bond with many different metals, metalloids and nonmetals. [4]

### Fluorine in Dentistry

Fluoride is a well known additive which is used for dental care. Fluoride's role includes the prevention of caries and improving oral and health. [1] There are many different types of fluoride compounds used in toothpastes and mouthwashes in order to replace lost calcium and phosphate ions due to demineralization. [3]

- $NaF$
- $CaF_2$
- $H_2SiF_6$
- $Na_2SiF_6$
- $SnF_2$

### How do Teeth Decay

Oral caries and tooth decay begin when the outer surface of the tooth is attacked by acid produced by bacteria commonly known as plaque. This overall process is called mineralization.[2]

The equation for the mineralization process of teeth is as follows: [3]

$$Ca_{10}(PO_4)_6(OH)_2 \rightleftharpoons 10Ca^{2+} + 6(PO_4)^{3-} + 2OH^-$$

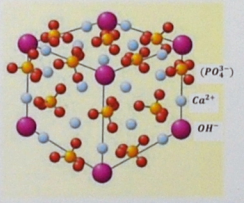
The enamel is made of a three-dimensional molecular network of calcium ions ($Ca^{2+}$), phosphate ions ($PO_4^{3-}$) and hydroxide ions ($OH^-$). This structure is called *hydroxyapatite*. Further strengthening the bonds between these ions are *various* fibrous proteins, dispersed between the empty spaces between them. Mineralization occurs due to *hydroxyapatite* continually dissolving and reforming within the mouth. This occurs when bacteria quickly converts sugars consumed through food and drink into an acidic byproduct. The acid from the bacteria eats calcium and phosphate minerals in the enamel through a process called *demineralization*.[5] At the same time, ions in saliva are working to neutralize the acid by recombining to deposit enamel back on the teeth. The process of saliva replenishing calcium and phosphate ions in the enamel is called *remineralization*. If the bacterium is left undisturbed for extended periods of time and remineralization does not occur at an equal rate as demineralization, a net loss of calcium/phosphate ions will occur, leading to the formation of pits or cavities in tooth enamel.[5] Eventually, bacteria will break through the enamel and further destroy the tooth structure. [2]

### Replacement Reaction of Fluorine in Mineralization:

$$Ca_{10}(PO_4)_6(OH)_2 + 2F^- \rightarrow Ca_{10}(PO_4)_6F_2 + 2OH^-$$

Fluoride replaces hydroxide in *hydroxyaptite* to produce enamel that is less soluble in the presence of acid, thus showing the effectiveness of fluoride for dental health.[1]

### Enamel Structure [5]





| Age (years) | Mean Number of DMFT | | Decrease in DMFT, (%) |
|---|---|---|---|
| | 1984 | 1995 | |
| 6 | 1.71 | 0.22 | 1.49 (87%) |
| 12 | 6.72 | 1.08 | 5.64 (84%) |
| 15 | 9.60 | 3.02 | 6.58 (68%) |

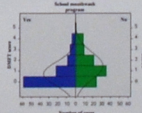
The chart above from the World Health Organization shows the mean number of decayed, missing or filed permanent teeth (DMFT) in Jamaican children before the introduction of fluoridated salt in 1984, and after the successful implementation and continuation of fluoridated salt in 1995. A national survey in 1995 showed extremely similar results across all age groups. [6]

### Case Study: Toothpaste in Indonesia

The World Health Organization conducted a study on school-aged children in Indonesia, and the effects of Fluoride toothpaste had on the percentage of students with Decayed, Missing, or Filed teeth (DMFT). After three years, students whom brushed daily had an average 23% fewer DMFT, with younger students having as high as 40% fewer DMFT.[6] Other studies conducted by the World Health Organization have shown that fluoridation of products such as milk, salt and municipal water worldwide have led to a decrease in DMFT and dental caries amongst different ages, genders and ethnicities of the global population. [6]

### Mouthwash Makes a Difference

A study conducted by the Department of Pediatric Dentistry at the Tabriz University of Medical Sciences found that in the course of three years, elementary students whom simply used 0.2% Sodium Fluoride mouthwash weekly had the overall number of DMFT decrease by as much as 51.5% compared to the control group. [1]



### What's the Difference

Mouthwashes are advertised in many different ways. In order to prevent caries, mouthwash must contain fluoride in them. An added benefit is that many mouthwashes use antibacterial agents such as alcohol to fight bad breath and gingivitis.[7]

### Health Benefits of Fluoride in Dental Products and Municipal Water

The British Fluoridation Society recognizes that while the relationship between fluoride and tooth decay is complex and not fully understood, fluoride in toothpastes, mouthwashes and even municipal water are known to intervene in the progression of tooth decay through at least four ways. [2]

1. Fluoride alters the structure of the developing enamel, making it more resistant to attack acid
2. Low levels of fluoride in the plaque and saliva both encourage remineralization and ensure that enamel is replaced with improved quality
3. Fluoride works to reduce the ability of plaque acid to produce acid by preventing enzymes from functioning properly
4. Fluoride ingested during childhood while the teeth are developing minimize the depth of grooves on the surface of teeth, preventing bacteria from embedding deep in the enamel

### Save your Teeth!

Fluoride is an essential and necessary component to ensuring the health of and well-being of teeth. Using fluoridated products such as water, milk, salt, toothpaste and mouthwash is essential to preventing dental caries by protecting the strength of your enamel. In a given routine, even using mouthwash daily on top of brushing your teeth can severely lower your chances of getting tooth decay and cavities. The effects of Fluoride on your teeth have been widely recognized to improve dental hygiene, harden enamel and kill harmful bacteria.

### References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[2] http://www.bfsweb.org/facts/dental_benefits/howfworks.htm , British Fluoridation Society, "*How Fluoride Works to Control Tooth Decay*", copyright 2001.

[3] http://www.bfsweb.org/onemillion/04%20One%20in%20a%20Million%20-%20The%20Dental%20Benefits%20of%20Water%20Fluoridation.pdf , British Fluoridation Society, "*One in a Million, the facts about water fluoridation*", copyright 2001.

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[5] Stoker, H. S. *General, Organic and Biological Chemistry, Fifth Edition*. Cengage: Belmont, CA, 2010. p 100.

[6] Jones, S.; Burt, B. A.; Petersen, P. E.; Lennon, M. A. Bulletin of the World Health Organization. **2005**, *no. 83*. Pg. 670-676. http://www.who.int/bulletin/volumes/83/9/670.pdf

[7] http://www.teethcenter.com/can-mouthwash-prevent-cavities/ , Teeth Center, "*Can Mouthwash Prevent Cavities?*", copyright 2012.