

Water Fluoridation

In the early 1900s, dental surgeons probed the cause of “mottled enamel,” or fluorosis, a brown-stained tooth condition that arises through impairment in tooth enamel development. They concluded that the occurrence of fluorosis inversely correlated with the prevalence of natural fluoride in water supplies.

It is now widely believed that fluoride is not normally required for human health. Despite this, humans have significant and alarming exposure to fluoride; it is abundant in multiple forms, found in food and used in multiple industrial applications including plastics, ceramics, and pesticides.

A 1937 study on fluorosis published by Dean and colleagues concluded that water supplemented with an optimum dose of 1.0 part per million (ppm) of fluoride could prevent fluorosis as well as cavities (i.e. dental caries). Subsequent studies also reported positive health effects from water fluoridation. Although further evaluation of these data has raised a number of concerns regarding its accuracy, municipalities in the US and other countries have adopted a public policy of artificially supplementing public drinking water with fluoride.

Multiple public health agencies, including the World Health Organization (WHO), US Center for Disease Control, and the American Dental Association have all endorsed the treatment of public drinking water with fluoride. They claim it has significantly reduced tooth decay for all receiving it and is especially important in poor areas. The WHO has even declared fluoride as an essential nutrient although no fluorine-deficient disease has ever been identified. Although originally declared to reduce dental caries by as much as 60%, the WHO and others now claim that fluoridation of public drinking water reduces tooth decay by approximately 15%. Notably, fluoride treatment is believed to reduce the

prevalence of dental cavities, which are commonly caused by acid-secreting bacteria that erode the enamel layer. The major positive effect of fluoride on teeth concerns its ability to generate fluorapatite, a mineral in both bone and tooth enamel. Along with calcium and magnesium, fluorapatite is believed to render teeth less susceptible to acid-based erosion.

Publicly fluoridated water supplies have been controversial since their introduction in the 1950s, and fluoridation has even been described as a Communist plot to control American health. Yet, others have claimed that it violates medical consent laws. One scientific criticism concerns the method of how fluoridation is delivered through drinking water. As the impact of fluoride on tooth enamel is most effective when applied in a topical fashion, delivering fluoride through public water supplies should be discouraged. This is further underscored by the fact that the formation of fluorapatite is dependent on calcium and magnesium. Importantly, artificial fluoride water treatment is usually monitored for consistent fluoride levels near 1.0 ppm, but it is difficult to control consumption on an individual basis. As such, when combined with non-aqueous sources, artificially fluoridated water consumption fails to normalize for the dose delivery. Interestingly, since the 1980s, in the US, a rise in dental fluorosis positively correlates with fluoridated water programs. Skeletal fluorosis and fluoride toxicity would be expected to increase, as excess fluoride competes with iodide for incorporation into thyroid hormones. One study with subjects from New Delhi who received high fluoride levels in water showed that nearly one half of participants had hypothyroidism. Excess fluoride has also been linked to cognitive impairment and cancer. Despite public backlash derived from these flaws and the documented negative consequences of exposure to high fluoride levels, many policy makers continue to advocate for fluoride water treatment programs.

- 1) **Those against fluoridation of public water on ethical grounds would most likely be opposed to:**
- A. putting fluoride in a brand of toothpaste.
 - B. public water purification programs.
 - C. using fluorohydrocarbons as refrigerants.
 - D. required vaccination for school enrollment.
- 2) **According to the author, fluoride would most accurately be classified as a:**
- A. pollutant.
 - B. medicine.
 - C. nutrient.
 - D. supplement.
- 3) **Assume that fluoride has been implemented as a therapeutic. For which of the following medical applications would fluoride be most suitable?**
- A. skeletal fluorosis
 - B. hyperthyroidism
 - C. cognitive impairment
 - D. cancer
- 4) **The author would most likely support:**
- A. improved daily allowable fluid consumption for fluoride.
 - B. standardization of fluoride levels in water.
 - C. increased regulation of industrial fluoride discharge.
 - D. individualized consent for fluoride water consumption.
- 5) **To determine the role of fluoride in tooth decay, a study examined subjects prior to and following termination of a fluoride water treatment program. Which of the following would be most critical for making an appropriate comparison in this study?**
- A. Bottled water consumption patterns.
 - B. Number of fluoride-deficient subjects.
 - C. Fluoride levels in treated water after termination.
 - D. Determination of optimal fluoride dosing.
- 6) **Those currently in favor of treating public drinking water with fluoride would argue that it most significantly:**
- A. promotes individual freedom.
 - B. promotes overall health.
 - C. prevents fluorosis.
 - D. reduces health care inequality.
- 7) **The author argues that current health care policy regarding the use of fluoride in public water supplies is flawed because it:**
- A. fails to consider fluorosis.
 - B. relies on ingestion.
 - C. promotes dental caries.
 - D. uses evidence-based policy.

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Annotations.

1) **D** 2) **A** 3) **B** 4) **C** 5) **C** 6) **D** 7) **B**

	Foundation 1: Comprehension	Foundation 2: Integration of multiple concepts	Foundation 3: Reasoning beyond text
Concepts	2		
Inference	7		
Integration		4,6	
Application			3,5
Assessment			1

Big Picture. This passage examines the history and health impacts of the practice of public water fluoridation. The discussion starts with a historical look at the reasons why fluoride started to be added to public water supplies. The author is obviously knowledgeable about the subject, presenting numerous facts about fluoride. There is an emphasis on the negative health risks of fluoride, and the passage presents the general opinion that adding fluoride to public water should be discontinued, as the risks outweigh the benefits. Additionally, the author discusses the difference in efficacy between oral ingestion and topical application of fluoride and the futility of the current delivery system. This opinion would lead one to believe that the author works in the health industry and is an advocate for public safety.

- 1) **D. required vaccination for school enrollment.** The passage describes how critics argue that it should be a person's choice if they use fluoride as a supplement. **Choice D is the credited answer** because a required vaccination would preclude such a choice. **Choice A is incorrect** because a person could choose not to use that type of toothpaste. Water purification programs and the use of fluorohydrocarbons as a refrigerant aren't programs that affect public health as was described for an additive like fluoride, **eliminating choices B and C.**
- 2) **A. pollutant.** To answer this question you must recognize that the author possesses a negative opinion of the use of fluoride. **Choice A is the credited answer** because the author discusses fluoride toxicity and how fluoride is not required for normal physiology. **Choice B is incorrect** because the author does not describe any role for fluoride as a medicine. Fluoride is not a nutrient, according to the passage, thereby **eliminating choice C.** In fact, the author states: "It is now widely believed that fluorine is not normally required for human health." **Choice D can be removed** because it is stated that excess fluoride causes fluorosis and is physiologically unnecessary, so there is no reason to believe that fluoride is a "supplement."
- 3) **B. hyperthyroidism.** The passage cites a study from New Delhi where excess fluoride levels caused hypothyroidism. **Choice B is the credited answer** because fluoride treatment for hyperthyroidism would be a logical solution. **Choice A is incorrect** because the passage states that fluoride treatments are responsible for skeletal fluorosis. The passage also describes how fluoride treatments have been linked to both cancer and cognitive impairment **removing choices C and D** as possible answers.

- 4) **C. increased regulation of industrial fluoride discharge.** Choice C is the credited answer because the author's tone throughout the passage is that fluoride in the water is unhealthy so additional regulation in the form of controlling industrial fluoride release would help reduce fluoride exposure to the public. **Choices A and B can be eliminated** because the author believes that fluoride treatment of public water is largely harmful making it unlikely that she/he would approve any daily allowable consumption values for fluoride. The author is against any amount of fluoridation and consent from the public would unlikely change this belief, **removing choice D.**
- 5) **C. Fluoride levels in drinking water after treatment.** This question is challenging because it requires you to apply what you learned in the passage to a new situation. Thus, you must reason beyond the text. For the study described in the question stem, it is important to determine that the fluoride levels actually dropped during the second part of the experiment, making **choice C the credited answer.** This gives the researchers the ability to measure before and after levels and compare them with outcomes. **Choice A is incorrect** because a subject's bottled water consumption is not critical for the final analysis of the experiment (only tap water is fluoridated). The author states there has never been a description of a fluoride-deficient person, making **choice B irrelevant.** Optimal fluoride dosage is not required despite the fact that the researchers should know the levels of fluoride being put into the water. This **eliminates choice D.** The passage discusses how it is difficult to determine an optimal dose because the amount of fluoride consumed varies on an individual basis.
- 6) **D. reduces health care inequality.** The passage states that advocates of water fluoridation claim it has significantly reduced tooth decay, especially in poor areas, making **choice D the credited answer.** **Choice A is incorrect** because the passage describes how fluoridation of public water often comes without any choice, not freedom of choice. **Choice B is eliminated** because the author cites multiple deleterious links between fluoridation and diseases: fluorosis, cognitive impairment, thyroid disorder, and cancer. **Choice C is incorrect** because it's stated that excess fluoride promotes fluorosis.
- 7) **B. relies on ingestion.** Choice B is the credited answer because the author discussed how fluoridation has been shown to be most effective when topically applied to teeth. Therefore, a mode of treatment relying on ingestion would be flawed in the author's opinion. **Choice A can be removed** because the public fluoride treatment program was started to combat fluorosis. **Choice C is incorrect** because the WHO estimates that water fluoridation reduces dental caries by approximately 15%. The passage cites a study claiming the benefits of fluoride as the reason for the initiation on the public fluoride treatment program, **eliminating choice D.**