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| **Pathology Question:** |
| How does fluoride affect the enamel structure? |
| **Report:** |
| Enamel is a highly mineralized acellular tissue in which microscopic calcium phosphate crystals comprise some 99% of the dry weight [1]. Recall that a m**ineral is** a solid inorganic compound of natural occurrence (many different definitions but this one is most appropriate). In general, the molecular structure of minerals are crystalline. There are four closely related of apatite crystals which constitute the vast majority of different “flavors” of enamel structure [1]   * + Hydroxyapatite (HAP)   + Carbonated Hydroxyapatite (CHAP)   + Fluorhydroxapatite   + Fluorapatite   In simple terms we can think of enamel as a mass primarily composed of four different salts that exist in solution (our saliva) inside the oral cavity. The pH of the solution (saliva) varies between acidic (lower pH) or alkaline (higher pH) depending on the macro and micro environmental conditions. Le Chatelier’s principle tells us that if a system is in dynamic equilibrium and is then disturbed by changing the conditions the position of the equilibrium will move to counteract the given change [2]. In a more acidic environment enamel is more soluble and therefore exists in a more disassociated or dissolved state (the product side is favored). That is, the enamel exists in a more demineralized state. Therefore, Le Chatelier’s principle allows us to understand the thermodynamic function the fluoride ion plays in both demineralization and remineralization of enamel.  Let us assume that we disturb the system by adding fluoride ion (F-) to the acidic oral environment. In this way we are adding more F- to the product side of the reaction in dynamic equilibrium and therefore the reaction will move to the left (the reactants side). This is the process of enamel remineralization the addition of fluoride ion.  Ca10(PO4)6(OH)F 10 Ca2+ 6PO43- + OH- + F-  Ca10(PO4)6(OH)F 10 Ca2+ 6PO43- + OH- + F  Additionally, if we disturb the system by removing fluoride ion (F-) from the acidic oral environment, then in effect, we are taking away some of the F- from the product side and thereby driving the reaction to the right (the products side). This is the process of enamel demineralization.  Ca10(PO4)6(OH)F 10 Ca2+ 6PO43- + OH- + F-  Ca10(PO4)6(OH)F 10 Ca2+ 6PO43- + OH- + F- |
| **References:** |
| [1] Chapter 12. “Chemical Interactions between the Tooth and Oral Fluids.” *Dental Caries: the Disease and Its Clinical Management*, by Ole Fejerskov and Edwina A. M. Kidd, 2nd ed., UK: Blackwell Munksgaard , 2009, pp. 211–231.  [2] Atkins, P. W., and Julio De Paula. *Physical Chemistry: Thermodynamics, Structure, and Change*. W.H. Freeman, 2014. |