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SHORT COMMUNICATIONS

THE MOVEMENT OF WATER AND OTHER MOLECULES THROUGH HUMAN ENAMEL

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THE evaporation of water, at a mean rate of 4·0 $mm^3/cm^2/24$ hr, from the enamel of whole teeth *in vitro* was recently reported (BERGMAN and SILJESTRAND, 1963). Almost identical experiments in this laboratory have yielded comparable results. Premolar teeth were attached to water manometers by means of rubber tubing, the evaporation of water from within the manometer being reduced to a minimum by means of a mercury meniscus. The movement of the meniscus provided an index of the rate of evaporation from the surface of a tooth. Considerable variation occurred from tooth to tooth, the fastest rate of evaporation being more than twice the slowest. Reduction of the thickness of the enamel by abrasion did not significantly affect the rate although the latter was greatly increased if large areas of dentine were exposed. In similar experiments, methyl, ethyl and propyl alcohols appeared to pass through enamel but the variation from tooth to tooth was great enough to obscure any differences which might have existed in the rates of movements of the different alcohols.

Other manometers (ATKINSON, 1947) were used to observe the flow of water through enamel under the influence of osmotic pressure. Twenty erupted teeth, extracted for orthodontic reasons, and five unerupted teeth were tested, using molar sucrose within the manometers to exert an osmotic pressure, and immersing the teeth in flasks of distilled water at 20°C. With some of the teeth little or no movement occurred in the manometers; in others movement varied up to a maximum which exceeded that achieved by evaporation. Flow of water could also be established by using alcohols instead of sucrose. If the water in which the teeth had been immersed was tested after a day or so, the presence of the osmotic fluid used could be detected, indicating that the enamel membrane is by no means perfectly semi-permeable. The leakage of osmotic fluid in the direction opposite to the flow of water was obviously so great in some cases that the meniscus showed no, or even slight negative, movement. Unerupted teeth appeared to have the same variation as teeth that had erupted. Such experiments suggest that although there may be a diffuse flow of water through enamel as a result of evaporation or osmosis, there is considerable variation in membrane properties in different teeth.

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Despite the relatively free movement of water and other liquids through enamel, the passage of certain ions seems to be impeded. Tooth crowns from which the dentine had been removed were embedded in a wax disc to avoid leakage of ions over the surface. With N/10 KCl inside the crown and N/100 KCl outside, membrane potentials of up to 20 mV were recorded as a result of the retarded movement of anions through the enamel. Six crowns were tested in this way, the results being consistent with the suggestion of KLEIN and AMBERSON (1929) that, under such conditions, enamel behaves as if it possessed a negative charge. Yet again, the disturbing feature of the results is the variability from tooth to tooth. The variability shown in all these experiments seems to point to the existence of unpredictable factors. Although certain membrane characters are undoubtedly shown by enamel, it is difficult to escape the conclusion that in many of the experiments, defects such as cracks, or structures such as lamellae, are obscuring the true membrane character of the rest of the enamel. This conclusion is in accord with recently reported observations of BERGMAN (1963). This author has observed, microscopically, the flow of liquid on to the surface of a tooth and he found that some of the fluid drops so formed were localized to cracks, tufts and lamellae, although most of them were spread diffusely over the enamel surface.

In view of the potential sources of error in using whole enamel crowns, attempts are being made to design micro-techniques for studying the movement of molecules through small pieces or sections of enamel which can be examined microscopically for the presence or absence of flaws.

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