Fighting tooth decay: new atoms for old

Tooth decay is one of the commonest chronic diseases of mankind. Fossil skulls several hundred thousands years old show the unmistakable signs of dental caries, to give tooth decay its formal name, and modern man is no healthier: a 1968 survey in England and Wales found that only three people in a thousand were free of the disease, and in 1978 the average Australian 14-year-old had six decayed teeth.

Australians suffer one of the world's highest rates of caries, presumably because we can afford plentiful sugary delicacies. With increasing use of fluoride, the nation's dental health should gradually improve, but we need to understand tooth decay fully before we can hope to conquer it, and scientists still have much to discover.

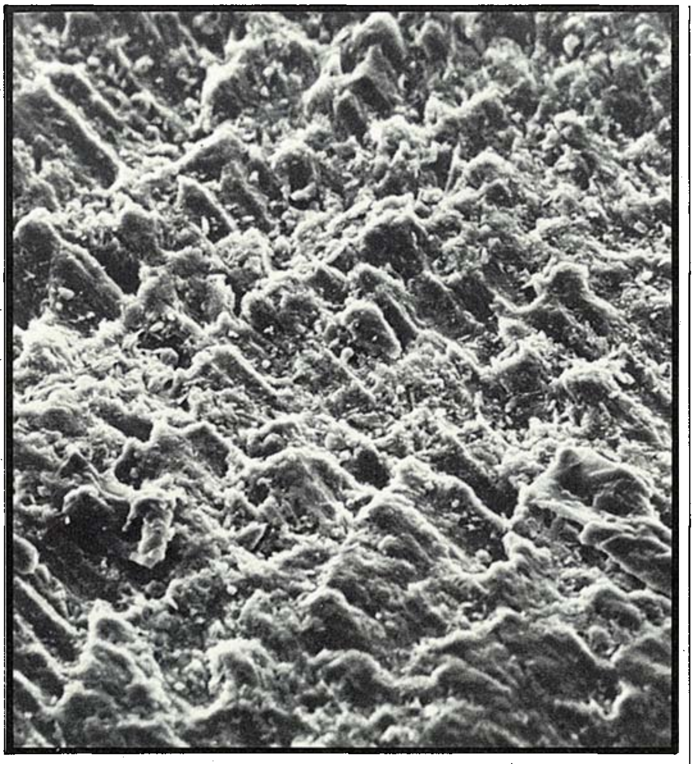
We know that bacteria make acids as they feed on carbohydrates in the mouth, and that these acids can erode the outer enamel and inner dentine of teeth, but where does the attack begin and why are some teeth more susceptible than others?

Dr John Featherstone, formerly of the New Zealand Medical Research Council Dental Research Unit and now at the Eastman Dental Centre, Rochester, U.S.A., and Dr Des McLean of the CSIRO Division of Chemical Physics think they may have some of the answers. They have been using an electron microscope to examine carious lesions, the sites of early decay, in both natural and synthetic enamel.

Dental enamel is the hardest substance in the body. Its strength comes from its high content of the mineral hydroxyapatite, which is one form of calcium phosphate, and the orderly arrangement of this mineral into crystals lined up perpendicularly to the tooth's surface.

As bricks are neatly patterned in a wall, so most of the crystal atoms form a neat lattice, but some of the atoms are different. Here and there a calcium ion has been replaced by another metal such as sodium, or a carbonate group has substituted for phosphate.

About 4% of natural enamel consists of such inclusions as carbonate, sodium, zinc, strontium, lead, fluorine, and chlorine. The exact composition of enamel varies from person to person, from tooth to tooth, and even within each tooth.



An early stage of enamel decay: both the 'bumps', which are bundles of crystals, and the spaces between have been attacked by acid. The picture was taken using a scanning electron miscroscope (magnification approx. ×1000).

Some of the 'intruder' ions occupying calcium sites are smaller than calcium ions. If one brick is too small, a wall will be weak, and the researchers believe that such crystal lattice defects are chinks in the enamel's chemical armour, where the lactic and acetic acids made by bacteria are most likely to launch their attack on the enamel.

If Dr Featherstone and Dr McLean are right, then it may be possible to strengthen teeth by plugging calcium-deficient sites with ions of suitable metals, perhaps in a mouth-rinse. The researchers are testing various formulations.

They have already experimentally introduced lead ions into the lattice, but lead is toxic and therefore unsuitable as a medication. The scientists think that strontium, zinc, or tin (stannous) ions may prove useful in reducing decay. Indeed, stannous fluoride has been in clinical use for some years.

The researchers have also shown that, after an acid attack, enamel crystals can regrow and may even be more resistant than before. Fluoride helps here: it promotes better crystal growth during both formation and repair of teeth. What's more, fluoride makes the hydroxyapatite less soluble in acid and slows the metabolism of the bacteria, thus cutting down the rate of acid formation.

It is for these reasons that many dental scientists recommend that both children and adults should treat their teeth with fluoride, in tablets, toothpaste, or the water supply.

Dr Featherstone believes the most effective single preventive measure is also the simplest: cutting down on sweet snacks between meals.

Suppose you allow the bacteria-rich layer called plaque to accumulate on the surfaces of your teeth for 48 hours. There will now be enough bacteria in the plaque to lower the pH around your teeth from 7 to 5 within 2 to 5 minutes of your eating a lump of sugar. The acidity, in other words, will have increased 100-fold, and, as Dr Featherstone comments 'that dissolves enamel quite rapidly'.

Brushing teeth before meals reduces the bacterial population, and so lessens the harm done by subsequent sugary delights.

Defect zones in dental enamel and their relation to dental caries. J.D.B. Featherstone and J.D. McLean. *Chemistry in Australia,* 1979, **46,** 284–6.

Chemistry and physiology of dental caries. J.D.B. Featherstone. *Chemistry in New Zealand,* 1980, **44,** 21–4.

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