WHERE CAN I FIND OUT MORE?

The Bone and Musculoskeletal Research Programme at the Institute of Medical Sciences investigates how bone cells work in health and disease. More information is available at: www.abdn.ac.uk/ims/bone

More information about the new dental school at the University of Aberdeen is available at: www.abdn.ac.uk/medicine-dentistry

Further information about osteoporosis can be obtained from the National Osteoporosis Foundation: www.nof.org/

All images shown in this brochure and in the exhibition were taken using microscopes in the Histology-EM and the Microscopy and Imaging Facility in the IMS.

www.abdn.ac.uk/ims/histology
www.abdn.ac.uk/ims/microscopy

Text: Miep Helfrich and Michal Kawecki m.helfrich@abdn.ac.uk

Images: Kevin Mackenzie k.s.mackenzie@abdn.ac.uk

Dictionary:

Corticosteroids: drugs used to treat chronic inflammation.
Deciduous teeth: baby teeth, or milk teeth. Enzymes: chemicals that modify other chemicals, for example break down collagen.
Osteoblasts: cells that produce new bone. Osteoclasts: cells that can break down mineralised tissues such as bone and dentine.
Osteoporosis: thinning of the bone, leading to increased risk of bone fracture. microCT: micro computed tomography, an X-ray machine that takes images in 3 dimensions, used to reconstruct a structure in great detail. Resorption: the process whereby osteoclasts break down mineralised tissue (the bone or dentine).
Scanning electron microscope: a microscope that uses electrons, rather than light, to generate an image; it can magnify a structure hundreds of thousands of times.

BONING UP ON TEETH

Information leaflet to accompany the images on display in the waiting room.

Teeth and bones are made of similar material which makes them vulnerable to attack by similar substances. The images on display illustrate some of the naturally occurring changes in teeth during childhood and explain how similar processes act on our bones. We also show the tools the dentist and our own bodies use to remove and repair mineralised tissues, like the ones found in teeth and bones.

WHAT HAPPENS IF OSTEOCLASTS WORK TOO HARD?

Normally there is a balance between the activity of osteoclasts and osteoblasts. If osteoclasts work too hard, osteoblasts cannot keep up with making new bone to fill in the gaps quickly enough and we end up with less bone in our skeleton overall. This can lead to ‘osteoporosis’, a thinning of the bone that affects mainly women after the menopause, but also older men and patients on treatments that reduce bone formation, such as corticosteroids.

Adult teeth should not normally fall out. If root resorption does occur in adulthood this often indicates an underlying problem, for example a local infection, which can activate osteoclasts.

Deciduous teeth, on the contrary, are meant to fall out and the high work rate of osteoclasts in the jaw during that specific time in childhood is entirely normal.
BONING UP ON TEETH

Teeth and bones are composed of hard tissues. They contain sheets of collagen fibres, coated with calcium salts, a so-called "mineralised matrix". The mineral is what gives the tissue its strength and makes it very difficult to break down. Because of this we can still find bones and teeth in old burial sites whereas all soft tissues have completely decayed. Even so, mineralised tissues are not indestructible. For example bacteria in our mouth produce acids (by converting substances in our everyday food and drink), which can dissolve the mineral in teeth and lead to tooth decay.

Similarly, in bones, specialised cells called "osteoclasts" make and then release acid to deliberately dissolve bone mineral. These cells also produce other chemical substances called "enzymes" which can break down the collagen fibres to make holes in the bone matrix. They do so to repair small cracks in bone accumulated over time as a result of wear and tear. Once the damaged bone has been removed other cells, called "osteoblasts", move in to fill in the gap with new bone. This process is going on in our body all the time and is essential to keep bones strong.

Apart from breaking down bone, osteoclasts are also important in the process of tooth eruption. This can be easily noticed during the changeover from baby teeth to adult teeth. Our baby teeth become wobbly because osteoclasts in the jaw are beginning to eat up ("resorb") their roots. This process allows the adult tooth, which is forming in the jaw, to move through the jaw bone and finally cut through the gum to take its predecessor's place. Sometimes this process does not work perfectly and only part of the root is resorbed.

Permanent teeth are generally left alone by osteoclasts.

Unfortunately, sometimes a perfectly healthy adult tooth needs to be removed by the dentist, for example when there is not enough space in the jaw for all teeth. Such extracted teeth have perfectly smooth roots.

TOOTH IMAGES

1. A permanent tooth, pulled out by the dentist with roots completely intact.
2. A tooth with only partially removed roots. This tooth was eventually pulled out by the child.
3. A baby tooth, naturally fallen out after complete resorption of its roots by osteoclasts.

All tooth images are taken with an microCT machine and the colours indicate the hardness of the tissue. The enamel on the outside of the tooth is the hardest material. The dark hole on the inside is not mineralised. It is the root canal which contains blood vessels and nerves.

WHAT CAN REMOVE HARD TISSUE?

The dentist uses instruments to "drill" out damaged bits of teeth and replaces it with a durable artificial hard material (a "filling"). The tooth in image 2 contains a filling, which can be seen because of the different hardness of the filling material compared to the enamel. The filling, made of hard plastic, does not contain any calcium salts at all.

Dental drills (images 4 and 5) are made of hard steel and are often encrusted with diamonds to make them more suitable to cut through the mineralised enamel and the underlying tooth tissue called dentine.

Our own bodies have osteoclasts as specialised tools to remove hard tissue. These cells work continually in bone while their dental job in the jaw is largely restricted to the few years during childhood when children change their deciduous teeth to permanent teeth.

In the laboratory scientists study how osteoclasts work. They do so by giving these cells slices of bone or dentine to resorb. As osteoclasts eat the hard tissue they form pits and long trails in this material and the amount of material removed can thus be measured.