We take it for granted that broken bones can always be mended, but this is not always the case.

Many fractures or bone diseases present significant surgical challenges and may require the use of bone grafts. Bone from the affected patient (autograft) is often used, but there are limited sites from which the bone for grafting can be taken. The use of bone from a donor (allogenic graft) is complicated by ethical issues as well as immunological interactions and the potential for disease transmission.

Examples of challenging fractures are those in which there is significant bone loss (or situations in which diseased bone has had to be removed, as in bone cancers), or where there are too many small fragments for successful realignment by traditional steel plates, screws or wires. Other situations, such as injury to bones with complex shapes (such as facial bones) or where there is significant reconstructive surgery required, make the prospect of an unlimited supply of a biocompatible artificial bone, which can be fashioned into any shape, very attractive indeed.

They also need to be non-toxic and have a degradation rate which will allow for cells from the host to steadily recolonise the area and permit the formation of blood vessels necessary for the delivery of nutrients to the forming bone tissues.

Methods and results

As is often the case in complex problems, the solution often lies in the coming together of different disciplines in a joint effort to use their collective intellectual and technical resources to achieve a common goal. In this example, the development and testing of a novel ‘nanobone’ material was facilitated by collaboration between the School of Veterinary & Life Sciences, the College of Veterinary Medicine, and the School of Engineering & Information Technology’s Applied Nanotechnology Group.

Combining our skills in physics, nanotechnology, veterinary surgery and veterinary pathology, we synthesised nanometre-scale hydroxyapatite (HAP) in the form of a ceramic, sponge-like structure with varying density and porosity. We already knew that synthetic HAP was a good material to study for possible use in bone-related medicine, but we needed to find out if the pellets we’d engineered were bio-compatible. We therefore tested this synthetic bone for biocompatibility in sheep. We found that not only was the material well-tolerated, without significant inflammation, but it was also colonised by new tissues, including the stimulation of blood vessels (Figure 1), new collagen, new bone matrix (Figure 2), and bone cell development within the artificial bone itself.
This was made possible because of the porous properties of HAP, allowing cells to infiltrate the material. Our results are very positive for the future use of HAP as a bone replacement – our pellets acted as a scaffold for the growth of bone material, and are bio-compatible.

**Conclusions and recommendations**

The results have shown that a hydroxyapatite-based synthetic nanobone is capable of being used as an effective tissue scaffold. The finding that it was tolerated, and encouraged development of several cell types (including deposition of new bone matrix), suggests that our nanobone has the potential to be used as a bone graft.

This pilot study provides encouraging results for further work, in which we plan to improve and match the physical and mechanical properties of the nanobone with those of natural bone. This should then pave the way for studies to establish the potential for HAP to be used as a synthetic, biocompatible bone.

**More information**

Contact Phil Nicholls
E: P.Nicholls@murdoch.edu.au
Gerard (Eddy) Poinern
E: G.Poinern@murdoch.edu.au

**Reference**


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**FIGURE 1** Microscopic examination of the implanted nanobone shows development of vessel-like structures (black arrows) lined by flattened cells resembling those expected in normal blood vessels — vascular endothelium (open arrows)

**FIGURE 2** Special staining of newly-deposited material in the artificial bone shows a positive reaction with Sirius Red (left) and polarised light (right) techniques, confirming new bone formation within the implant.