

The Science of Biomaterials

Roger Nilen

Caveman Og gazed down at the fist-sized hole in his thigh – so much for Mammoth hunting! A scientist at heart, he figured filling this gaping defect with, say, clay would be better than nothing. It was ... for a while. Plugged into the hole, the clay stopped the bleeding and offered some structural support to the damaged limb. Being the days before sterilization, however, infection quickly set in and Og's days were numbered. But the seeds of biomaterials science were sown*!

Fast forwarding eighty thousand years to 2005, the philosophy of biomaterials science remains largely unchanged: *design and engineer materials to replace or repair worn out, damaged or diseased parts of the body*. It's just that these days the results are stunningly successful, and on the back of worldwide research and development (R&D), success rates are getting higher, patient recovery times shorter.

Squeezed between materials science and medical implant technology, biomaterials science is the spare parts department of the human body workshop, and it's improving the quality of life of people around the world. Examples of biomaterials in common use today include the titanium alloys (typically Ti₆Al₄V) used for total hip replacements, calcium phosphate bone cements and injectable collagen preparations. Even those stitches that don't need to be taken out because they simply dissolve away over time are made from a polymer-based biomaterial.

So what's happening in South African biomaterials science? Quite a lot really. Our group at the Council for Scientific and Industrial Research (CSIR) carries out biomaterials research with the aim of putting technologically novel and affordable medical implants on the country's hospital shelves. One of our first successes has been the Eyeborn[®] orbital implant – a porous artificial eye made of sintered hydroxyapatite (a calcium phosphate compound).

Why hydroxyapatite? Well it turns out that hydroxyapatite is one of the few materials the human body tolerates and can bond with internally (a material property known as 'bioactivity'), so it's the perfect body-friendly volume filler. This is exactly what is required for an orbital implant application.

Eyeborn[®]'s pores are also critical. They let all the necessary cells, fluids and tissue grow into the implant, ensuring the eye muscles can be securely fastened to the ball. Thus the patient has control of the artificial eye's movement – this is the reason porous hydroxyapatite has superseded

* Well, this is how it *might* have happened!

glass as the material of choice for false eyes. Launched into the market last year, there are some 200 people walking around South Africa with the Eyeborn[®] orbital implant.

Currently our R&D sights are set on two principal targets: a bone graft material and a cartilage graft material. Initially these materials will be formed into artificial bone and ear implants, and a combination of the two will be used for internal soft tissue augmentation. The research is happening right now, with trial stages drawing near!

“No bucks, no Buck Rogers,” said Guss Grissom in *The Right Stuff* over twenty five years ago. Pioneers need funding, and this is especially true in the world of research. Fortunately the expected biomaterials market will be around \$6 billion this year – a figure that is certain to grow as the world population grows and ages – so it’s a lucrative field. Good news, but it also means that we’re up against some seriously heavyweight, big budget labs overseas.

How do we compete? Being a small scientific community, we have to combine our strengths through collaboration. As biomaterials scientists we need to collaborate with folks from a wide range of disciplines such as cell biology, mechanical engineering, biotechnology and the medical sciences. This makes for a broad and colourful ‘workscape’. Our other strategy is to follow the advice of Sir Basil Schonland, founding president of the CSIR in 1945, who said *“take what is unique from your local environment and build your research around it”*. That’s just what we’re doing – putting the R&D required into providing affordable alternatives to the often prohibitively expensive imported medical implants. These are real challenges that give rise to and feed the passion we have for our work.

Another great source of this passion is surprise. Surprise is the fuel wonder runs on, and biomaterials science is dense with the stuff, as one by one Mother Nature reveals Her secrets to us. It’s a tantalizing dance that keeps our love for science strong. After all is said and done, however, perhaps the main reason we scientists love our work is true for all those who love their work: *we have the chance to make a difference!*