Report of September 2012 Meeting
Royal Society
Southern Highlands Branch

Speaker: Associate Professor Marc in het Panhuis

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ARC Centre of Excellence for Electromaterials Science (ACES), Australian Institute for Innovative Materials

Topic: The Wonderful World of Hydrogels

Hydrogels are currently being used in the exciting research areas of regenerative medicine and tissue engineering. When used as scaffolds, hydrogels may allow the introduction of human cells in order to repair tissues such as bone, cartilage, skin, pancreas, cardiovascular systems and muscle. Therapeutic drug delivery systems are also targets of this research.

Dr in het Panhuis began his lecture with examples of natural hydrogels. He cited Physalia Utriculus, known commonly as Bluebottles/Portugese Man-of-War, each one of which is in fact a colony of specialized animals living together, each performing different functions. Sharks too are examples of natural hydrogels, in particular their organs near the nose which are tubes filled with gels and are known as the Ampullae of Lorenzini. These extremely sensitive organs allow sharks to sense the weak electric fields produced by nearby animals.

Today nearly 2-3 million people in Australia are alive because of various forms of artificial organ therapy, and one in every five people older than 65 is very likely to benefit from organ replacement technology during the remainder of their lives. Current technologies for organ substitution, such as whole-organ transplants and kidney dialysis machines, have saved many lives, but they are imperfect solutions that come with heavy burdens in the lives of people with failing organs. In contrast, engineered biological tissues are customizable and immune-compatible and can therefore potentially make a significant difference in the lives of people with failing organs.

It is clear when considering hydrogels in tissue engineering and regenerative medicine, that much research will be directed at the specific requirements of different organs. Conventional hydrogels are soft, weak and brittle with usage limited to drug delivery, contact lenses and scaffolds. The stress failure of these hydrogels is clearly a problem

with load bearing tissues such as cartilage. In this application, the hydrogel used has to be much stronger, able to withstand daily compression.

One solution to this problem has been offered by Gong and Osada in 2003. In this research, interpenetrating polymer network hydrogels, referred to as double network hydrogels, were produced and tested. These materials have excellent stress fracture characteristics, but are effective on one occasion only, because covalent bonds are broken during the compression. The in het Panhuis team is now developing new and improved hydrogels with remarkable recovery behaviour after stress testing. In their latest research soon to be published, the team has produced equilibrated hydrogels which are now recovering to the 90% level within one minute of the compressive strain test.

The audience of 30 asked numerous questions of the speaker after the lecture. They had seen how advances in hydrogel research were bringing forward the day when biological tissue engineering could become a reality.

Anne Wood