

Want to fix that liver or cartilage? Just turn on the printer.

☒ Another new term to learn and understand: **bioprinting**. Well, two actually: the other is biofabrication. Together, they are the latest wrinkle in the 3-D printing story.

Bioprinting is the creation of tissue or body parts for humans by using 3-D printing technology. The latest breakthrough is that four universities are together offering the world's first masters degree in biofabrication. Two of those institutions are in Australia –the University of Wollongong (just south of Sydney) and the Queensland University of Technology in Brisbane – while the other two are in Germany (University of Würzburg) and the University Medical Centre Utrecht (the Netherlands).

Bioprinting is not that far away, according to *The Australian* newspaper. It quotes the man leading the country's effort as saying Australian hospitals could be employing 3-D bioprinters within five years for some medical procedures (but certainly not the more complex ones such as regenerating a liver).

The technology has been in the making for at least a decade. According to the journal *Genetic Engineering and Biotechnology News*, the first patent for a bioprinter was taken out in 2003. Much of the cutting edge work is being done at the Wake Forest Institute of Regenerative Medicine in Winston-Salem, North Carolina. There printers have been developed giving doctors the option of using two or more cell types, and the end product is 100% fully cellular tissue. However, there are challenges, among them ensuring that the printing process does not alter the cells; and the cells must remain viable until they are implanted in the body of the intended recipient.

The rush is on now to print miniature hearts, lungs, blood vessels and livers in order to create the necessary tissues. Clearly, the healthcare industry is extremely keen to see the development of printing technology for everything from prosthetic limbs to key human organs. And not just to replace always: the technology could be used to repair and improve bones, cartilages and skin.

As to the genesis of the Australian-led master's qualification in this field, the University of Wollongong has been working on the issue for some time. In 2012 it was reported that the Centre of Excellence for Electromaterials Science at the university was working to develop a bio-ink that improves the viability of living cells and allowed better control of cell positioning through the printing process. (This is one of a number of centres of excellence, financed by the federal government through the Australian Research Council.)

According to the team, they had developed a new bio-ink that was printable and cell-friendly. The team had applied itself to this after discovering that none of the inks previously available had been optimised in terms of both printability and cell-suspending ability.

Meanwhile, the Queensland University of Technology has a well-advanced biofabrication printing system. They use bio-ink infused with the patient's stem cells; it will be applied to help the body grow a new breast after mastectomy, and now women with mastectomies have been targeted for the first clinical trials. Another application already in use was making a 3-D printed structure to fill the hole on patients with a piece of skull missing. The QUT's Professor Dietmar W. Hutmacher, of the university's Institute of Health and Biomedical Innovation, said the work was the first step to ensure that Australia has a high-value, high-tech manufacturing future. He sees the Australian-German-Dutch project as producing graduates for an industry that will always be in demand as populations age. He said that each of

the four universities involved had established track records in key areas of biofabrication, including polymer chemistry, cell biology and clinical implants. The universities will each admit 10 students each year.

But those with more complicated issues will not be fixed any time soon. Hutmacher says it may take up to 50 years to perfect the 3-D technology to regenerate a kidney or liver.