British team grows human heart valve from stem cells

Tissue for transplants could be available within three years if trials are successful

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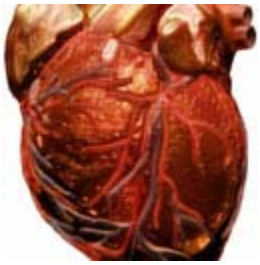

A British research team led by the world's leading heart surgeon has grown part of a human heart from stem cells for the first time. If animal trials scheduled for later this year prove successful, replacement tissue could be used in transplants for the hundreds of thousands of people suffering from heart disease within three years.

Sir Magdi Yacoub, a professor of cardiac surgery at Imperial College London, has worked on ways to tackle the shortage of donated hearts for transplant for more than a decade. His team at the heart science centre at Harefield hospital has grown tissue that works in the same way as the valves in human hearts, a significant step towards the goal of growing whole replacement hearts from stem cells.

According to the World Health Organization, 15 million people died of cardiovascular disease in 2005; by 2010, it is estimated that 600,000 people around the world will need replacement heart valves. "You can see the common pathway of death and suffering is heart failure," said Prof Yacoub. "Reversing heart failure could have a major impact."

Growing replacement tissue from stem cells is one of the principal goals of biology. If a damaged part of the body can be replaced by tissue that is genetically matched to the patient, there is no chance of rejection. So far, scientists have grown tendons, cartilages and bladders, but none of these has the complexity of organs, which are three-dimensional structures of dozens of different types of cells.

To crack the problem, Prof Yacoub assembled a team of physicists, biologists, engineers, pharmacologists, cellular scientists and clinicians. Their task - to characterize how every bit of the heart works - has so far taken 10 years. The progress of his team and that of colleagues around the world will be published in August in a special edition of the journal Philosophical Transactions of the Royal Society.

Prof Yacoub said his team's latest work had brought the goal of growing a whole, beating human heart closer. "It is an ambitious project but not impossible. If you want me to guess I'd say 10 years. But experience has shown that the progress that is happening nowadays makes it possible to achieve milestones in a shorter time. I wouldn't be surprised if it was some day sooner than we think."

Currently, many people suffering from heart valve disease have artificial replacement valves. Though they save lives, the artificial valves are far from perfect. They perform none of the more sophisticated functions of living tissue, children need their valves replaced as they grow, and patients need a lifetime of drugs to prevent complications after surgery.

"The way a living valve functions, it anticipates haemodynamic events and responds and changes its shape and size. It's completely different from an artificial valve which will just open and shut. The heart muscle itself will appreciate something which will make it free to contract properly," said Prof Yacoub.

Adrian Chester, one of the lead scientists at the Harefield centre, has focused on characterising the valves in the heart. "You have mediators in blood or released locally in the valve that can make parts of the valve contract and relax. That work has then extended into looking at the incidence of nerves in the valve - these can cause the types of contractions and relaxations in a very specific way."

By using chemical and physical nudges, the scientists first coaxed stem cells extracted from bone marrow to grow into heart valve cells. By placing these cells into scaffolds made of collagen, Dr Chester and his colleague Patricia Taylor then grew small 3cm-wide discs of heart valve tissue. Later this year, that tissue will be implanted into animals - probably sheep or pigs - and monitored to see how well it works as part of a circulatory system.

If that trial works well, Prof Yacoub is optimistic that the replacement heart tissue, which can be grown into the shape of a human heart valve using specially-designed collagen scaffolds, could be used in patients within three to five years.

Growing a suitably-sized piece of tissue from a patient's own stem cells would take around a month but he said that most people would not need such individualized treatment. A store of ready-grown tissue made from a wide variety of stem cells could provide good matches for the majority of the population.

Prof Yacoub's inspiration has come not only from other scientists but also from an unexpected source - the celebrated British artist, Antony Gormley, who has donated a sculpture to the heart science centre. "We need a lot of experts from different fields but we also need a lot of imagination and a lot of understanding of how form interacts with function," said Prof Yacoub. "Art gives a lot of inspiration and beauty. And beauty is part of science."

Mr Gormley, who has also contributed to the upcoming special issue of the Philosophical Transactions of the Royal Society with an article on the relationship between form and function in sculpture, said he admired the universalism with which Prof Yacoub approached his work. "He manages to do the Robin Hood job in a very important way for the benefit of all humanity. I found in him a fellow traveller in terms of trying to do

things at the fringes of the possible with the highest levels of input in terms of technology and intelligence. Everybody breathes air, everybody pumps blood."

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