Advances in Tissue Culture and Replacement Organs

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Replacement Organs

Worldwide, an estimated 2 million people need an organ transplant (1), yet less than 120,000 organ transplants occurred in 2014 (2). Possible solutions to this chronic shortage of donor organs include mechanical or lab-grown organs, or organs from other species.

It has proven extremely difficult to create biocompatible mechanical organs, due to the complexity required. The only mechanical organ that has enjoyed any degree of success is the artificial heart. Other non-living structures have been used as passive scaffolds, such as skin and windpipe replacements.

Xenografts - transplanting organs from one species to another - could provide a ready source of organs; however there are practical as well as moral issues. Severe immune responses have foiled past xenografts - with the notable exception of pig heart valves, which require both sterilisation and immunosuppressive drugs. However NIH researchers recently reported that they were able to keep pig hearts alive in baboons for over two years, using new antibodies which prevent graft rejection without disabling the immune system (3). Together with other technologies such as gene editing, this may pave the way for xenotransplants.

Another option is to grow the organs. This approach may sound very futuristic, in recent years, stem cells have been used to create noses, ears, windpipes, heart tissue, blood vessels and even a simple liver (4).

Thanks to technological advances, it has also become possible to 3D print living cells onto scaffolding material. Printed tissues such as noses and ears have been shown to develop blood vessels when implanted into rats, suggesting that they are biocompatible (5). However some researchers doubt that it will ever be possible to print complex structures like kidneys (6).

Research into artificial and lab-grown organs is occurring at a faster pace than ever before, and it is possible that human donations may eventually become a thing of the past. However for the moment human donors will continue to be the main source of replacement organs, as they have for the last 60 years.

Tissue Culture

Culturing cells is an essential preliminary step to developing replacement organs. With current technology, nearly all the cells in the human body are able to be cultured in the laboratory.

Early attempts at creating artificial skin, used for severe burn patients, served only as a framework for new skin cells to grown on. However earlier this year, researchers were able to reprogram mouse stem cells, derived from gum tissue, to form skin cells (7). Not only did the implanted tissue contain sebaceous glands and hair follicles, but it also made connections with the surrounding muscle and nervous tissue, bringing the prospect of growing fully functioning skin one step closer.

Cell culture is also an essential part of two emerging methods of vaccine production (8). Both involve the mass production of either the virus or its surface proteins, by means of the cultured cells. These methods, which are beginning to be used for making vaccines for influenza and other viruses, have the potential to reduce the time to create a vaccine from 6 months to 6 weeks (8).

References