# Growing spares

**We may soon be able to generate our own body parts for transplant, says** S ANANTHANARAYANAN

PEOPLE in need of organ transplants face two challenges: the first is to find a donor and the next is that the body should accept the organ that has come from a different person. Generating organs from our own body cells would eliminate both these challenges at one go. Professor Doris Taylor, director of the Center for Cardiovascular Repair at the University of Minnesota, has spearheaded work that uses an animal's stem cells to build organs, in just weeks — organs that the animal would not reject because it is made of the animal's own body cells.

When cells that do not belong in the body are introduced, the body calls out agencies that throw the intruder out – a built-in defence mechanism to protect the body against infection and invading pathogens. What these policing agencies in the body use to recognise outsiders are specific proteins found on the surface of cells. If the patterns do not belong in the body, *flash*, antibody production starts – production of specific antibodies that have the patterns actually found on the predator cells so that they can swiftly identify and destroy them. It is this system of surveillance that keeps the body safe from billions of foreign organisms that invade the body every minute!

But the same system would also throw out a massive foreign body like a whole organ that has come from another person's body. In organ transplant, the doctors carefully select the donor – apart from the same blood group, the more genetically similar the donor, the less eventful the transplant. And then, powerful drugs that weaken the body's immune response are used to hold back the body's defences against the "friendly" outsider. Apart from the side effects of these drugs, weakening body defences, with their help, allow other pathogens a field day and the patient needs to be carefully quarantined. And still, in most cases, the immune system does revive and not many transplants succeed for a long time.

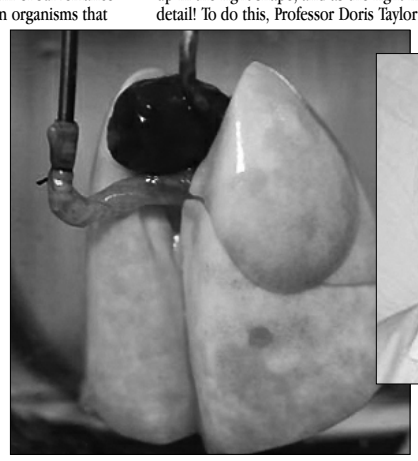
### Using native cells

While the effort in organ transplant is to get "as near as possible" to the recipient's cell genetics, the best solution would be if the organ was not donated by an outsider but built from the recipient's own cells. Biologists do have experience in growing living cells in the correct media. But cells grown in this way just grow as a lump and can scarcely form an organ. A first start to building body parts was to grow cells on a suitable mould so that the cells assumed the desired shape. Special materials, called *biorubber*, were developed and once the cells began to grow they were allowed to develop on the body of a living thing, like a mouse, so that they received nutrients and oxygen. Artificial ear cartilage and blood vessels, skin, even bladders, have been grown in this way for some years now.

*Doris Taylor.*

But this method cannot work for a more complex organ, which has internal parts and a network of blood vessels that branch, ending as capillaries that connect with each individual cell.

What is needed for building cells in such a complex way is a scaffold or the framework, on which the cells need to grow, to end up in the right shape, and as the right kind of cell, down to the last detail! To do this, Professor Doris Taylor and her associates have used an ingenious method



*Harald Ott and a rat's lung (left) at his laboratory.*

### Exposing the skeleton

The method of extracting this scaffold from a real heart to build a new one was discovered by Doris Taylor's colleague, Harald Ott, now in Massachusetts General Hospital. Getting at the scaffold underlying an organ means stripping the organ of its cells, and nothing else, so that the scaffold remains intact. Ott thought one way could be to use the organ's blood vessels to deliver a chemical to each cell so that the cell got washed away but left everything else unchanged.

He experimented with a host of candidate reagents and finally zeroed in on one, ironically a common soap used in cosmetics. This chemical, as it dripped through the blood vessels of the dead heart of a rat, slowly stripped away every cell, leaving only a translucent jelly that was the exact protein framework on which every cell of the heart had been placed. Injecting a dye into the blood vessel showed graphically that the network was complete and undamaged.

Ott then went on to build a new heart by allowing stem cells to build on the scaffold, or the mould, now available for the complex organ.

The cells could grow in the exact shape of the organ, developing, in the case of the heart, the chambers, the valves and the blood supply system of vessels. Along with not only creating the cells body, there was the challenge of providing blood supply, with oxygen for the cells and the blood pressure for the heart, and the electrical signals to get the heart muscles contracting. In short, creating an artificial body to try out the new grown heart. But in a space of eight days of handling the complexity, the team was thrilled to see the heart they had built from scratch burst into life and start beating!

After this first success, Ott has used the same method to build a living lung, which was transplanted into a rat. Soon after, the method has been used in Barcelona, Spain, to build a new windpipe for a patient who had lost her own through tuberculosis. Surgeon Paulo Macchiarini, of the Instituo Univeritario Dexeus, took a windpipe from a cadaver, cleaned it of cells and used living cells from his patient to

*Paulo Macchiarini.*

build a new windpipe. The new organ was put in place in just four days and the patient, Claudia Castillo, has been doing fine, without any immuno-suppressant, and was home just four days after surgery.

"I think we're years away and not decades away. It is not unreasonable to imagine within the next four or five years we'll have some organs we can transplant", says Professor Doris Taylor.

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## Harvesting stem cells

**THE living cells that are used to build organs are stem cells or pluripotent cells that have the capacity to become a particular type of cell — for example, a liver cell or a kidney cell. Apart from following the shape that the protein collagen framework defines, stem cells also discover what kind of cells to become from the proteins in the framework.**

**Stem cells are created in bone marrow and are present, although in smaller numbers, in the bloodstream. One method of collecting stem cells is to put the donor under general anaesthesia and tap the bone marrow, generally in the pelvic region, with needles. A safer procedure, called the peripheral blood stem cell harvest, which is usually followed now, is to collect stem cells from the bloodstream. The method is to tap the blood flow, intravenously from one arm, separate stem cells in an a*phaeresi*s machine and send the blood back, intravenously, through the other arm. The word, "aphaheresis" means "taking away" in Greek and the machine is basically a centrifuge that which spins the blood round so that heavier components collect on the outside and lighter components on the inside. It is not unlike separating butter from milk by "churning".**

**Peripheral blood harvests produce better results and are also less stressful. But sometimes, if the yield of stem cells is not adequate, the traditional bone marrow harvest is the fall back.**

S.A.

Aphaeresis *machine*

# Under the skin

**A stick-on circuit can monitor heart rate as well as conventional devices but is weightless, wireless and inconspicuous, writes** steve connor

IT may soon be possible to wear your computer or mobile phone under your sleeve with the invention of an ultra-thin and flexible electronic circuit that can be stuck to the skin like a temporary tattoo. The devices, which are almost invisible, can perform just as well as more conventional electronic machines but without the need for wires or bulky power supplies, scientists said.

The development could mark a new era in consumer electronics. The technology could be used for applications ranging from medical diagnosis to covert military operations.

The "epidermal electronic system" relies on a highly flexible electrical circuit composed of snake-like conducting channels that can bend and stretch without affecting performance. The circuit is about the size of a postage stamp, thinner than a human hair and sticks to the skin by natural electrostatic forces rather than glue.

"We think this could be an important conceptual advance in wearable electronics, to achieve something that is almost unnoticeable to the wearer. The technology can connect you to the physical world and the cyberworld in a very natural way that feels comfortable," said Professor Todd Coleman of the University of Illinois at Urbana-Champaign, who led the research team.

A simple stick-on circuit can monitor a person's heart rate and muscle movements as well as conventional medical monitors, but with the benefit of being weightless and almost completely undetectable. Scientists said it may also be possible to build a circuit for detecting throat movements around the larynx in order to transmit the information wirelessly as a way of recording a person's speech, even if he/she were not making any discernible sounds.

*The patch of electronic skin consists of an array of electrical devices for monitoring the vital signs of the body.*

Tests have already shown that such a system can be used to control a voice-activated computer game, and one suggestion is that a stick-on voicebox circuit could be used in covert police operations where it might be too dangerous to speak into a radio transmitter.

"The blurring of electronics and biology is really the key point here," said Yonggang Huang, professor of engineering at Northwestern University in Evanston, Illinois. "All established forms of electronics are hard, rigid. Biology is soft, elastic.

It's two different worlds. This is a way to truly integrate them."

Engineers have built test circuits mounted on a thin, rubbery substrate that adheres to the skin. The circuits have included sensors, light-emitting diodes, transistors, radio frequency capacitors, wireless antennas, conductive coils and solar cells.

"We threw everything in our bag of tricks on to that platform, and then added a few other new ideas on top of those, to show that we could make it work," said John Rogers, professor of engineering at the University of Illinois at Urbana-Champaign, a lead author of the study, published in the journal *Science*.

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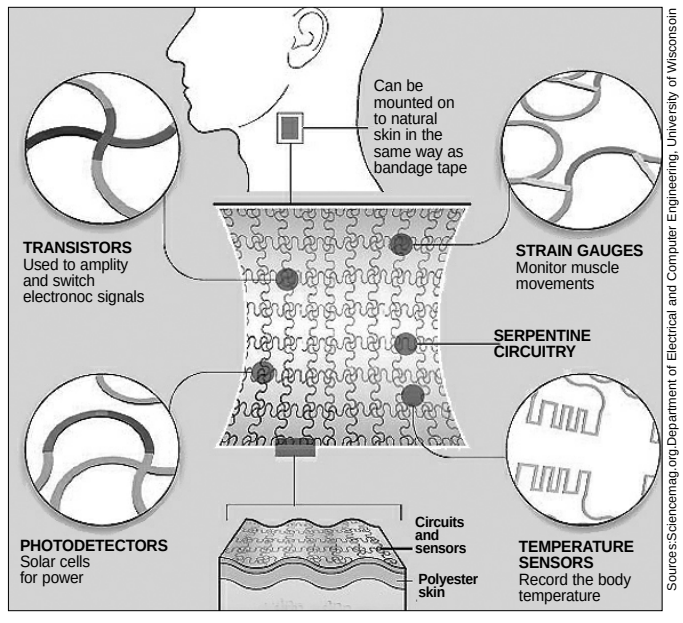


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