مؤسسة قطر
Qatar Foundation

Unlocking human potential.

"What stuns me is the leadership here and where you are really trying to take Qatar. It's moving at an astonishing pace and it's magnificent. We are sitting here with some of the biggest universities surrounding us who are really building on the talent of those young Qataris coming through who will be the future scientists, the future physicians who will look after me and you."

LORD ARA DARZI

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Special report

The **Foundation.**

EDITORIAL COMMUNICATION DIRECTORATE Rima Ismail rismail@qf.org.qa +974 4454 0960 Dima El-Mched dalmched@qf.org.qa +974 4454 0958 PUBLISHER Brian Scudder brian@switch.ae +971 50 655 7490 EDITOR Philip Fenton philip@switch.ae +971 50 553 9430
DESIGN CREATIVE DIRECTOR Carl Bergman carl@switch.ae +971 50 342 6926
ARABIC DESIGNER Mohammad Marei mohammad@switch.ae +971 50 895 9836

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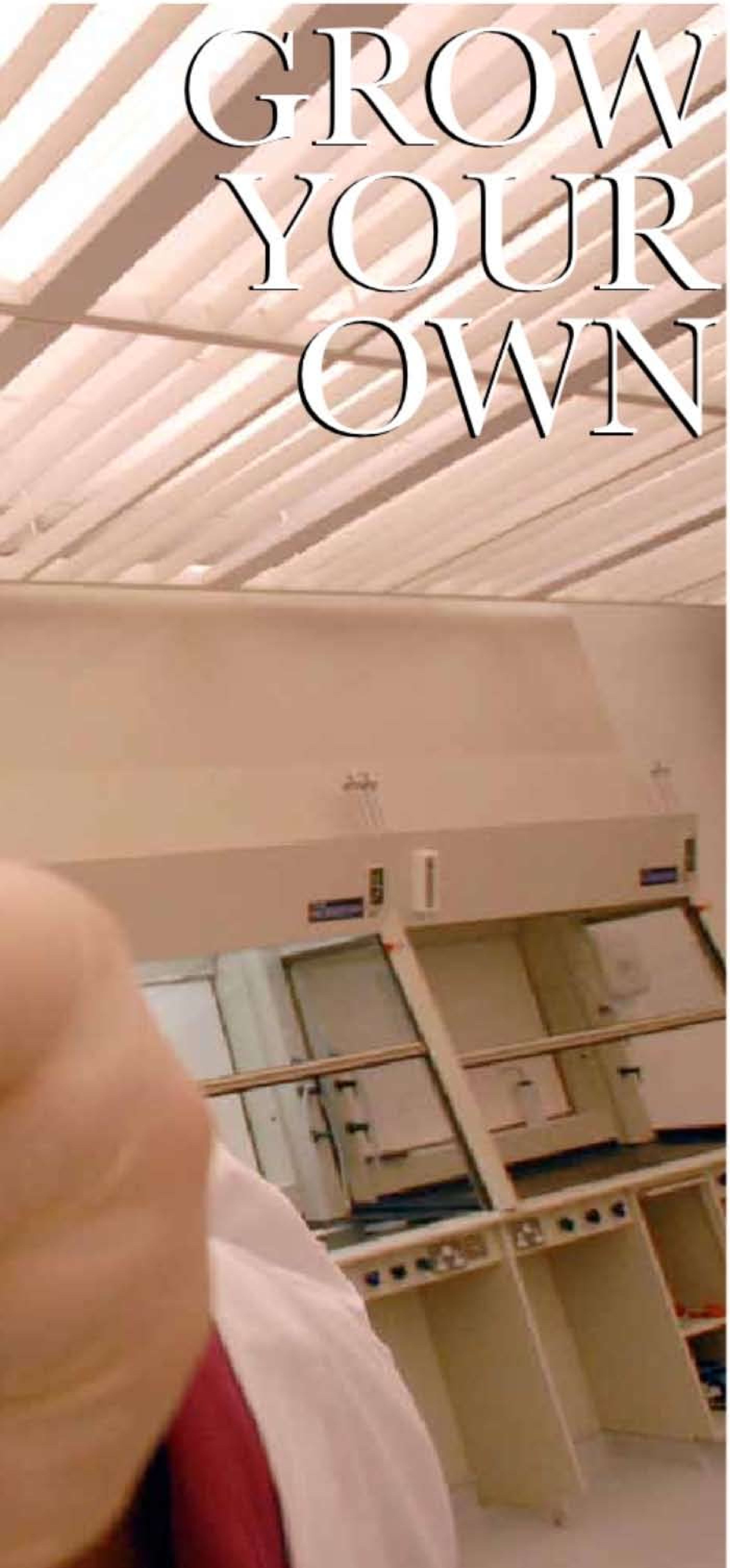


A researcher at Weill Cornell Medical College in Qatar believes he may have found a unique way to construct artificial organs: using a technology that has existed for thousands of years.

During the space race of the second half of the last century, scientists were faced with a serious problem: how to write in orbit. The traditional ball point pen relies on gravity to pull the ink down to the nib. In zero gravity it was useless.

The Americans, so the story goes, committed teams of researchers and spent millions of dollars on developing a pen that can work upside down. The Russians simply used a pencil.

The story is actually an urban myth, but it illustrates an important point that is often overlooked as we increasingly turn to high technology to solve our problems: sometimes the solution is simpler than we realize.

That point is not lost on Dr Albert Liberski, a Postdoctoral Fellow at Weill Cornell Medical College in Qatar.

"I try to find the gaps," he told *The Foundation*. "I try to take old tools from other areas and transfer them to new things."

A good example of his work is a recently published paper on controlling the growth of cells. While it's easy enough to encourage cells to grow in a laboratory, getting them to grow in a specific pattern – something that will be increasingly important in the rapidly-growing field of creating artificial body parts – is more challenging.

Dr Liberski discovered it requires nothing more complicated than a laser printer of the type found in any office.

He stumbled across the solution when trying to use plasma to burn cells into specific shapes. "I was going to use the toner as a mask for a plasma treatment," he said. "You etch the surface but you put something over it, like toner, for protection so that you etch only in specific places. We were trying to do this and we found that the toner itself is not friendly for cells. So why use the plasma when you can use this directly?"

Any pattern, from a straight line to complex shapes, can be designed on a computer. The image is then converted into a negative and printed on a piece of transparent plastic of the kind used on old-fashioned overhead projectors.

"The question now is how to transfer the toner from the transparent sheets of plastic you can put in the printer to the glass where you grow the cells. The solution is very easy. You put the plastic on the glass, add a little bit of heat, and you transfer the toner to the glass. It's extremely useful because the resolution is very good and it's much cheaper than any other method that's available."

But it's in the field of creating artificial organs that Dr Liberski believes he may have really discovered something.

Most medical experts agree that creating replacement body parts, ideally using a patient's own cells, is going to be a major part of medicine in the future. The problem is that it's extremely difficult. Using existing methods, even creating a relatively simple structure such as a blood vessel is labor intensive and can only be

done on a small scale. Larger blood vessels must be made from a number of individual sections that are joined together.

Creating more complex organs remains years, possibly even decades, in the future. Currently the best option for a patient needing a new organ is to receive a transplant from another person or animal, but this carries a high risk of failure and typically condemns the patient to a lifetime of taking immunosuppressant drugs to prevent rejection.

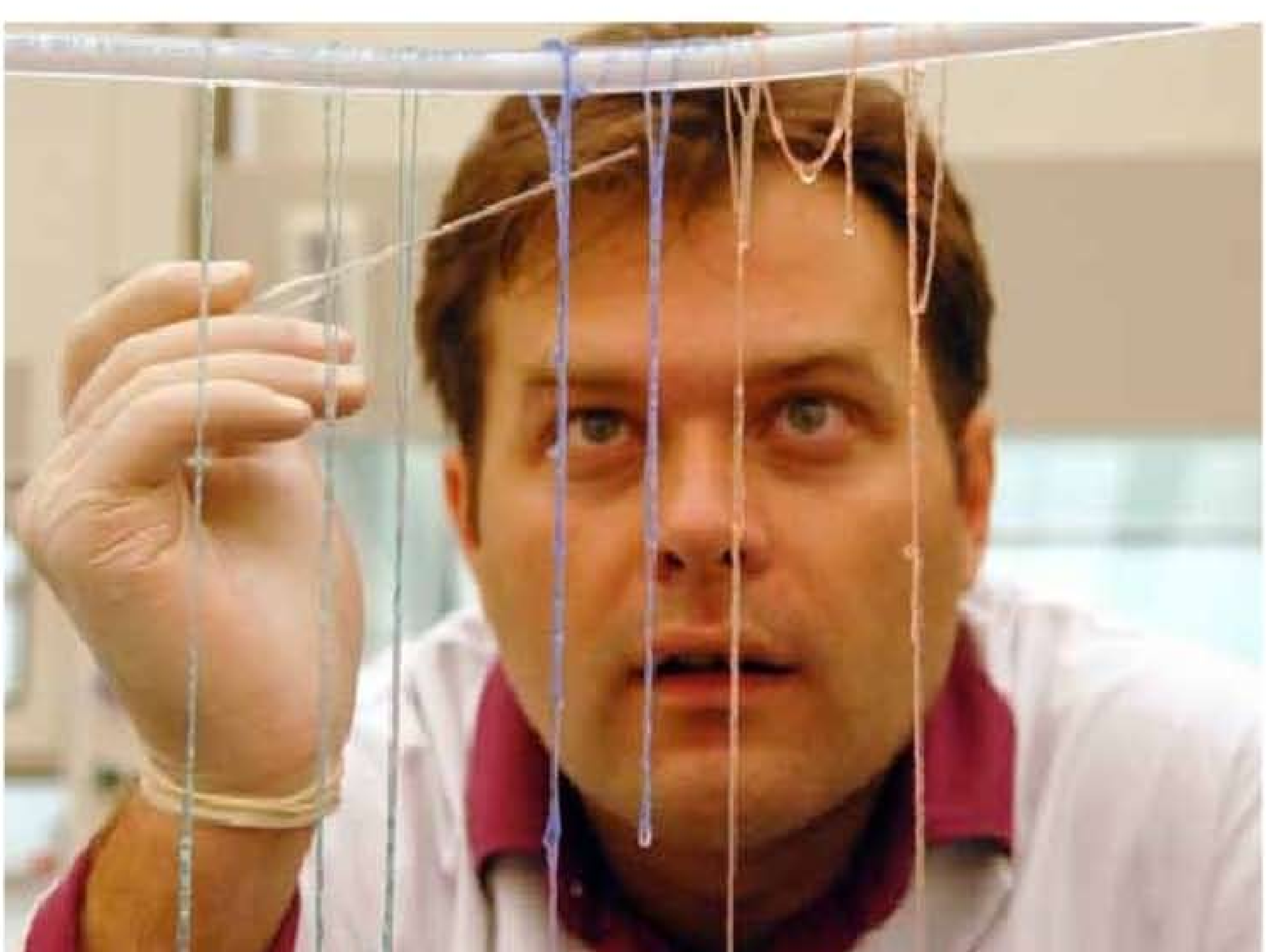
"There are three main challenges in creating new organs: connecting different types of tissue, so you have two bones or a bone and muscle and you need to join them; developing complex internal structures; and vascularisation, so if you develop some nice tissue at the moment it's a waste of time because you need to get blood vessels inside to sustain life," he said.

"Some people have been trying to do this by organ printing, but they're generating very small structures and they have some problems with scalability.

"So I was thinking that printing is an existing technology, but it only produces quite simple things. I started thinking about existing technologies that can produce more complex structures.

"Look at weaving, at the structure of your clothes, and it's a very complex three dimensional structure; the fibres connect in a very specific way. So I started thinking about how we can use this technique in medicine. The trick is to put living cells inside the fibre."

Of course, cells cannot grow inside the cotton or nylon threads used to manufacture clothing: and in any case you can't implant materials like these into the human body. Dr Liberski began searching for a solution and eventually settled on alginate, which is derived from seaweed. It's a simple matter to create long, relatively strong threads and, most importantly, living cells are able to both survive and reproduce inside it.



Currently Dr Liberski's research is being conducted in his spare time, with many of the materials scavenged from leftovers, although he hopes to win funding from Qatar National Research Fund to further the project.

So far, four different types of cells have been tested, and all were found to multiply, although Dr Liberski is the first to admit that there are many issues to be overcome before the technique becomes medically useful.

One issue was the fact that, while relatively strong, the alginate threads were too weak to be woven by machine. The solution was to use biodegradable surgical thread to add strength by providing a temporary scaffolding that will eventually be absorbed into the body.

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Dr Liberski

Using the reinforced alginate, Dr Liberski has been able to create three dimensional structures using a variety of cells, allowing them to multiply over a period of eight days. It's important to note, though, that these are not yet functioning organs. It has yet to be tested if the cells are capable of expanding beyond the boundary of the individual alginate strands to create a continuous organ rather than a contiguous collection of threads.

Nevertheless, Dr Liberski is confident that the technology yields huge potential. "We believe we can build complex structures," he said.

"First, what we like to go for is blood vessels, because we can get patents, we can bring money to our institution and it's very useful: a lot of people need this around the world for things like bypasses. It's an easy task and it's achievable. That's the first step, and nobody can say that it's science fiction: it's quite close to reality."

The second step would be to create replacement organs. And the third – and this is likely something that is decades away – is to actually improve on the design of existing organs. The heart, for example, is unnecessarily complex, hence the reason it so often fails. "Our task at some really far point in the future is to redesign this, and make a living pump that's more efficient and less prone to failure than the human heart."

But for now Dr Liberski's aims are rather more humble. "Creating blood vessels is the first thing," he says. "Even going from blood vessels to organs is a Nobel Prize-winning project. So you can imagine the distance to actually talking about redesigning organs."

The great advantage of organ weaving, if it can be made to work, is that it's a simple matter to use a patient's own cells, dramatically reducing the risk of rejection. Other techniques being worked on either take cells and material from other people and animals, or rely on a patient's stem cells being available.

Dr Liberski believes the technique can bring dramatic benefits not just to patients, but to Qatar.

"This will be something new, revolutionary, and Qatar can be at the forefront of this. All of this can be patented, and that brings benefits to the owner. This cake is growing, and we have the chance to take a huge stake of this.

"This is really a good place to do this, because Weill Cornell is one of the best institutions of this kind in the world, and Qatar is providing the funding and the environment to really make things happen. And it's not only a matter of money and logistics, but the calibre of people working in Weill Cornell Medical College in Qatar, Education City and Qatar. If you're going for something really innovative, this is the best place in the world to do it.

"Whether it's through organ weaving or something else, this market exists, it will grow, and it will be worth billions of dollars in the US alone. So this market will grow with me and with Qatar, or without us."

Research at Qatar Foundation

Every month, *The Foundation* takes a closer look at some of the research projects supported by Qatar Foundation. In the process of constructing its own research institutes, Qatar Foundation is building partnerships with top international research institutes to accelerate its research programs. Qatar Foundation also coordinates and monitors the activities of its centers, such as Qatar Science & Technology Park, Sidra Medical and Research Center, and the six branch campuses in Education City.