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Best + Brightest: Anthony Atala

Science, Tissue Regeneration: "Using these techniques, we've been able to engineer several tissues and several organs. We've learned how to make cartilage, and heart and other muscle. We've been able to engineer an entire bladder."

By: Unknown

Anthony Atala

[45, surgeon, Wake Forest University] The director of the Wake Forest Institute for Regenerative Medicine, Atala is at the forefront of the field of human cell-and-tissue engineering. Lured this year from Harvard, he leads a thirty-person lab that builds replacement organs and tissues that could treat patients suffering from disease and trauma. He has applied for more than 170 patents and in 2000 was the recipient of the federal government's Christopher Columbus Foundation Award, bestowed on a living American who is currently working on a discovery that will significantly benefit society.

THE WORK OUR TEAM does is regenerative medicine. Just to go back a little bit historically, it was fifty years ago this year that the first organ was ever transplanted: A kidney from one patient was placed into another patient. What is most amazing about that today is that we're still dealing with a lot of the same challenges in terms of organ shortage and transplantation. The statistics are fairly startling: From 1993 to 2003, the number of patients on organ- and tissue-transplant lists nearly tripled; during that same period, the number of actual transplants has remained totally flat--about fifteen thousand a year. Last March, the Joint Commission on Accreditation of Healthcare Organizations, which regulates tissue and lots of other health-care issues, called this a public-health crisis because of the aging population. So that's the background for what we do.

Regenerative medicine, then, is a science that is aimed at creating tissues and organs for patients, and cells for therapy, to improve organ function. It's a combination of different fields--tissue engineering, chemical sciences, bio-hybrid organs. The goal is to have cells for therapy, for diabetes and Parkinson's; to have tissues available for therapy, such as heart patches or pieces of esophagus; and to have organs available, such as bladders or kidneys.

For the past fifteen years, we have been trying to engineer organs. There are two major challenges in the field, basically. One is the inherent inability to grow cells outside of the body. Up until just a year ago, if you tried to grow liver cells outside the body, you just couldn't do it. You still can't grow pancreas cells outside the body. And the second challenge is, if we were to engineer these organs, how do we get them to vascularize? How do you get blood vessels to feed the tissues that you're putting into the body?

When we got started in this area, our team began to look at the body's natural healing response and tried to replicate that outside the body. So by looking at the growth-factor biology of cell-to-cell interactions, we were able to come up with a strategy that had to do with finding the cells in the body that actually do the regeneration. Not just to take a piece of tissue, but truly to target these cells. Of course, now we call them committed-progenitor cells, but back then we didn't know what they were. But, in fact, they're the stem cells of the organ.

Now we can harvest those cells and grow them in large quantities, so much so that we can take a centimeter-square piece of tissue, and by day sixty you'll have enough cells to cover a football field. But how do we then put these cells into the body? The largest group of cells that you can put into a body without blood vessels is three millimeters cubed. That's about the size of a pencil eraser. So you can see that if we're going to try to repair a heart that's damaged, it's going to be a lot larger than that.

Nature solves that problem by branching. From the lowest forms of life, like algae, to an individual organ

system to trees in the field and their leaves, branching is the solution. Therefore, we designed scaffolds that have a pattern that allows the cells to grow in branches. Using these techniques, we've been able to engineer several tissues and several organs. We've learned how to make cartilage, heart and other muscle, and endothelial cells, which might lead to blood vessels learning how to make bone.

And we can do this with many different kinds of tissues. We've had urethras in patients for five years. We've been able to engineer an entire bladder. We've been able to engineer other organs as well that we haven't yet published on.

One of the challenges, however, is what you do with a patient for whom you don't have tissue available. Say that you have a patient with heart disease who is so sick that you can't go in and take a piece of his heart. In that instance, you would want to take a population from elsewhere. And that's where the stem-cell field comes in. Stem cells have the ability to become other tissues, so you don't have to go to the particular organ to take the tissue. Using stem cells, we could just take a stem-cell population, grow the cells out, differentiate them into different tissues, and put them back into the patient. But there are challenges, even if we were to use a human embryonic stem cell, which is what everyone debates. There are other areas we are looking at, but our work really entails trying to get alternate sources of stem cells, so you avoid a lot of the issues of rejection as well as a lot of the ethically controversial issues of production.

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