Adviser Q&A

Tissue Engineering: Making Blind Rats See

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When I first met the brilliant yet commercially pragmatic Shuguang Zhang, his work centered primarily on tissue engineering and energy. But days before this interview was going to print, he co-authored groundbreaking work on restoring vision in rats that were made blind from brain damage. The work, which uses self-assembling peptides to coax neurons to grow, might one day be critical for patients suffering from stroke or spinal cord injuries.

Zhang is now associate director of MIT's Center for Biomedical Engineering. He received his Ph.D. in biochemistry and molecular biology from the University of California, Santa Barbara. Postdoctoral work at MIT led to a position as a research scientist, and ultimately his current position. His early work at MIT led to the discovery of a self-assembling peptide system; such systems are the basis of Zhang's research into plant-powered solar cells. His tissue re-engineering research is becoming commercialized at privately held 3DM, which is up against a number of others making strides in this field, such as Acorda Therapeutics, Baxter International, Sanofi-Aventis and Johnson & Johnson.

Forbes: Why are you so interested in developing an alternative source of energy?

Zhang: Because energy is so important for civilization. Oil supplies are running out, and we have not found an alternative except nuclear energy. Wind and hydropower are small potatoes. The other alternative is solar energy, which is nearly untapped. That has to be changed.

Solar energy is inexhaustible, and we must learn how to harvest it. I wrote a piece that said that if water is the matrix of life, and without water, life as we know it would not exist. Energy is the matrix of our civilization. Without energy, civilization as we know it would collapse. People cannot go backwards--once you have a car, you won't walk a hundred miles a day. Once you have a mobile phone, you can't live without it, and all of this requires energy.

The U.S. has not paid enough attention to this. There's a Chinese proverb that you cannot go hunting when you're hungry--you have to do it before you're hungry. We cannot wait for the oil to run out.

How are you working on harvesting solar energy?

Plants and bacteria have been doing it for billions of years, and we're learning from them. They have the most efficient machines for harvesting light from individual photons. Plants use the energy for growth, but we want to take the photons and convert them into electrons to produce electricity--for your phone, your car, your home. We're taking the photosynthetic systems from plants to collect the photons, and then combining that with metal wires as a carrier to generate electricity. It's very simple.

You first published research on this in 2004. How have the devices advanced since then?

In 2004 it was a new, breakthrough concept to combine the photosynthetic machinery, inorganic wire and a semiconductor material to harvest photons and convert them to electrons. We were only able to collect some of the electricity, and only did one monolayer of material, so there was a small surface area.

We realized afterward that if we could increase the surface area we could gather much more energy. One square mile of Manhattan has much more surface area than one square mile of a field in Wyoming, because you have the sides of all the buildings. So our first step was engineering to increase the surface area, and that paper will be published in a few months.

Also, in the 2004 work, we could only produce nanoamps of electricity, which is essentially useless. Now we have produced 100 microamps, so we only need to increase the current output by 10 to 100 times and we're in business--that's the range for watches, calculators, pacemakers and more.

What's the biggest challenge you face?

Long-term research support, from both government and industry. We wrote a grant proposal for the Department of Energy, which we thought would be very interested in our research. We only asked for $500,000 over three years, but we were turned down. We were told there was no additional money available for 2005, so no additional research funding could be provided. That seems very shortsighted. Also, most U.S. companies have little interest, but Japanese and European companies are very interested.

How long do you think it will take to commercialize the technology?

It's a function of time and money. If nobody supports it and we do it on our own, it will take a long time--up to 20 or 50 years, or we may never finish. But if somebody has a vision and puts effort into it--like the Apollo program--it will go much faster if we have essential resources and manpower.

Stepping away from energy, is there anything new going on at 3DM?

3DM is focused on biological applications of self-assembling peptides, things like tissue repair, tissue engineering and medical technologies. We have a paper coming out in a few months on a new peptide nanofiber scaffold to repair nerves. We cut an animal's optical nerve--the eye is intact but the animal can no longer see, like cutting phone cord but the phone itself is fine. When we put in this nanofiber scaffold, cells migrate along the scaffold to repair the nerve, and the animal's vision returns in a few days.

Is there a person whose research you particularly admire?

J. Craig Venter. He's a maverick. He accelerated sequencing the human genome, later moved on to sequence other genomes, and now he's doing the soil genome. He's finding hundreds and thousands of different bacteria in the soil, looking at the whole ecology system. It's much more complex than the human genome.

He's also done sequencing of ocean systems around the globe. He's putting in a huge amount of effort to understand the science of the planet Earth and biodiversity. Doing that kind of work will help us understand everything from evolution to how cells interact with each other. His work is good not only for basic science but also humanity.

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