AN AUDIENCE WITH...

Robert S. Langer

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Robert Langer obtained his Bachelor's Degree from Cornell University in 1970 and his Sc.D. from the Massachusetts Institute of Technology in 1974, both in Chemical Engineering. He holds more than 500 issued or pending patents worldwide, many of which have been licensed or sublicensed to pharmaceutical, chemical, biotechnology and medical device companies. In 1989, Langer was elected to the Institute of Medicine of the National Academy of Sciences, and in 1992 was elected to both the National Academy of Engineering and to the National Academy of Sciences — he is the youngest person in history ever elected to all three United States National Academies. In 2002, he received the Charles Stark Draper Prize, considered the equivalent of the Nobel Prize for engineers, from the National Academy of Engineering.

With a background in engineering, why did you decide to move into the world of drug delivery?
After my doctorate, I was not sure what I wanted to do. Most of my fellow graduates took jobs in oil or chemical companies, but I dreamed about using my background to improve health. Fortunately, I obtained a postdoctoral position with Judah Folkman, which resulted in the isolation of the first angiogenesis inhibitor, which turned out to be a macromolecule. However, at the time I started this research there was no way to study macromolecules *in vivo* to see whether an inhibitor could work. We felt we needed a non-inflammatory system to slowly release these substances and, because none existed, I decided to invent one.

What challenges did you encounter when you started working in a different discipline?
I was working on a biological problem in a surgery lab and the only relevant class I'd ever taken was 10th-grade biology. For two years I made little scientific progress, and when I finally did develop approaches for controlled release of macromolecules my ideas were greeted with a great deal of scepticism and ridicule. Even once the angiogenesis inhibitor work was published in *Science*, grant reviewers said it was impossible for engineers to do such work and turned down my applications. It also looked like I would not get my Assistant Professorship renewed at MIT because several senior faculty members did not think my work was important.

How did you overcome this scepticism to establish your lab and achieve such success?
When we first developed approaches for controlled release our findings went against conventional wisdom. So my students and I worked hard to determine the mechanism of release and eventually we succeeded. Then, within a few years other research groups began to reproduce our work to study a variety of informational macromolecules, and this began to dispel the doubts.

Is there still reluctance to fully integrate disciplines at MIT and other universities?
I think things are greatly improving. There are a variety of cross-disciplinary departments or divisions at MIT and elsewhere. For example, the number of new Bioengineering departments has more than doubled in the past decade.

Do pharma companies appreciate new delivery options or focus too much on small molecules?
I think they are certainly aware of new delivery options. I also think orally available small molecules are the ideal option if it's possible to achieve that. However, even these molecules have major formulation issues such as solubility, appropriate crystal form, stability and so on.

How could pharma companies better integrate delivery into the pipeline?
It's really up to them, and some, to a certain extent, do integrate delivery. To further improve integration, one might have increased interaction between formulation scientists and discovery scientists; also, having the pharma company interact early on with a specialized delivery or formulation company is another approach.

Is this lack of interaction a reluctance to integrate or is it a different issue?
I'm not sure that there is a single answer. It may be due to reliance on long-standing approaches, or to cultural differences between formulation scientists and drug discovery scientists.

What needs to happen to forge these interactions?
Senior management could encourage these interactions and recognize that researchers often suffer from 'not invented here' syndrome.

How long will it take for nanotechnology to make it into the clinic?
That's really hard to say. It depends on how well nanotechnology can solve unmet needs compared with other approaches. There are also challenges still to be overcome in safety and quality control, clinical trials, regulation, manufacturing and development of nanotechnology-based treatments.

Is there any proof that nanotechnology can solve unmet medical needs?
It's probably too early to say, but there is certainly the possibility that it could aid fields such as drug delivery, imaging (perhaps new contrast agents), biosensors and nucleic-acid delivery.

Which novel method of delivery would you bet on becoming a successful marketed product and when?
I believe they all will at some point; the problem is predicting when. In our laboratory, we have many bright students and postdocs who want to solve interesting problems in all of these areas. I've been impressed enough with the ingenuity and perseverance of these people to believe that many of the novel delivery methods being studied today will make an impact in the future, just as those studied 20–30 years ago are doing today.