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An Interview with a Distinguished Pharmaceutical Scientist

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Robert Langer is the Kenneth J. Germeshausen Professor of Chemical and Biomedical Engineering at MIT. He received a Bachelor's Degree from Cornell University in 1970 and a Sc.D. from MIT in 1974, both in chemical engineering. Dr. Langer has received honorary doctorates from the ETH (Switzerland) in 1996 and the Technion (Israel) in 1997. Dr. Langer has written 590 articles, 400 abstracts, 350 patents, and has edited 12 books.

Dr. Langer has received over 70 major awards, including the Gairdner Foundation International Award (50 recipients of that award subsequently received the Nobel Prize) and the Lemelson-MIT prize, the world's largest prize for invention and innovation. In 1993 he received the Distinguished Pharmaceutical Scientist Award from the American Association of Pharmaceutical Scientists and he has received the Ebert Prize in 1995, 1996, and 1999. In 1989, Dr. Langer was elected to the Institute of Medicine and the National Academy of Sciences, and in 1992 he was elected to both the National Academy of Engineering and to the National Academy of Sciences. He is the only active member of all 3 United States National Academies.

WHAT DO YOU THINK HOLDS THE KEY TO YOUR SUCCESS AS A PHARMACEUTICAL SCIENTIST?

Response: I don't know how successful I've been. To the extent I've achieved things, I believe I was fortunate to have had an excellent education, wonderful mentors and collaborators, a stimulating place to work, superb students and postdocs, and I like to dream, I work hard, and I'm not easily discouraged.

WHAT DO YOU CONSIDER TO BE YOUR KEY RESEARCH ACCOMPLISHMENTS?

Response: This is a hard question to answer. Let me cite three of these. The first involves our discovery that it was possible to use relatively hydrophobic biocompatible polymers to slowly release large molecules. Before this, many scientists thought you could only slowly deliver molecules of low molecular weight. When we first made our discovery, it met with a lot of skepticism among polymer scientists because they thought it was impossible to do something like this. However, today through the efforts of many scientists and a number of companies, various proteins and peptides are being delivered for long periods of time such as a month or more from a single injection. Because of the very short lifetimes of these molecules, this is very important for using such molecules on a chronic basis.

The second involves the design of new polymers such as polyanhydrides. For many years, the conventional approach in the biomaterials area was for scientists to take off-the-shelf polymers and use them in medicine. For example, the polymers used in women's girdles were used in the artificial heart because they have good flexural properties. This type of approach has often led to a number of problems. For example, when blood hits the surface of the artificial heart, a clot may form and the patient may suffer a stroke. We were interested in creating biomaterials that would have the right properties from an engineering, chemistry, and biological standpoint, and then synthesize them from first principles. Based on this thinking, from a drug delivery standpoint, we proposed that a very desirable family of polymers would be polyanhydrides. Over the years, we worked out ways to synthesize these polymers. This involved overcoming a number of scientific challenges. These polymers have now been used in a new treatment for brain cancer, leading to the first new way of treating brain cancer approved by the FDA in overy twenty years.

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The third is research with Dr. Jay Vacanti where we discovered that synthetic polymers combined with mammalian cells can create new tissues. This is enabling tissues such as cartilage, bone, skin, urologic replacement tissue and others to be formed. Hopefully, this approach can be used to help patients suffering from tissue loss or organ failure.

WHAT WAS THE TURNING POINT IN YOUR DISTINGUISHED CAREER?

Response: Probably my postdoctoral research at Boston's Children Hospital.

WHO ARE THE INDIVIDUALS THAT INFLUENCED YOUR CAREER?

Response: First, my father. He was a very kind person who cared a lot about other people and also got me interested in science and math. Dr. Colin Gardner, who was a postdoc while I was a graduate student, taught me how to do careful research in the lab. Another person is Dr Judah Folkman from Boston's Children's Hospital and Harvard Medical School. I did my postdoctoral work with Dr. Folkman. One of the good things about Dr. Folkman was the fact that no matter how difficult something seemed and how impossible other people seemed to think it was, he thought anything was possible. My wife, Laura, has also been tremendously encouraging. She is a scientist herself and has been very supportive. I have also had the enormous support of several terrific collaborators who are also very close friends. These include Alex Klibanov, who I've worked with on protein delivery systems, Henry Brem, who I've worked with on the brain tumor project, and Jay Vacanti who I've worked with on tissue engineering. I've also been influenced by a number of other individuals who I also consider very close friends, particularly, Nicholas Peppas. The pharmaceutical scientists who have influenced me the most, and are also good friends, are Sung Wan Kim, Joe Robinson, and Jorge Heller.

PHARMACEUTICAL SCIENTISTS ARE FACED WITH THE DILEMNA OF HAVING TO PUBLISH IN BIOMEDICAL OR BASIC SCIENCE JOURNALS AND HAVING TO PRESENT IN THEIR SPECIALTY MEETINGS IN ADDITION TO THE PHARMACEUTICAL SCIENCES VENUES. DOES IT MEAN THAT CUTTING EDGE SCIENCE WILL NOT LIKELY BE FEATURED IN THE PHARMACEUTICAL SCIENCES FORUM?

Response: I don't think so. But I think it's important to make the pharmaceutical sciences forum a place where people really want to present cutting edge science. For example, the American Chemical Society does this in some cases and may be a good role model.

YOU ARE A CHEMICAL ENGINEER BY TRAINING. WHAT MOTIVATED YOU TO PURSUE DRUG DELIVERY RESEARCH?

Response: It really goes back to part of the answers in earlier questions. When I was doing postdoctoral work, I was trying to isolate a substance that inhibited angiogenesis (blood vessel growth). It appeared to be a macromolecule and the bioassay I wanted to use involved vascular growth in a rabbits eye. The bioassay took thirty days. I needed a slow release polymer that was small, could release macromolecules for thirty days, and not cause inflammation in the rabbit's eyes. But there weren't any such systems and people told us (Judah Folkman and myself) that it wasn't possible. Even after we achieved it, many polymer scientists as mentioned above, didn't believe it. Thus, I felt it was essential to prove our results were correct and to understand them better. In addition, I could see from working in the hospital, many other ways where drug delivery might help patients. So I tried the best I could to address these issues.

WHAT ARE YOUR RESEARCH INTERESTS? WHAT IS THEIR COMMON DENOMINATOR?

Response: Drug Delivery Systems, Tissue Engineering, Angiogenesis Research, Medical Use of Enzymes. I guess the common denominator in many cases is bioengineering or biomaterials.

WHAT IS YOUR VIEW ON THE CURRENT STATUS OF RESEARCH IN DRUG DELIVERY?

Response: Drug delivery systems have had an impact on nearly every branch of medicine including cardiology, ophthamology, endocrinology, oncology, pulmonology, immunology and pain management. Annual sales in the United States of advanced drug-delivery systems exceed $10 billion and are rising rapidly. And yet, there is still a lot of exciting research to do.

WHAT ARE THE FUTURE CHALLENGES IN DRUG DELIVERY RESEARCH?

Response: There are many. Some of these include-conducting studies in immunology and human genomics to provide greater insight into the type of targeting molecules that can be used to acheive site-specific drug delivery; taking advantage of progress in microelectronics and nanotechnology; delivery to sites that are not easily accessible such as the sinuses or nerves; the development of mathematical models that can predict delivery performance to facilitate the design of various delivery systems.

WHAT ARE THE FUTURE CHALLENGES TO THE PHARMACEUTICAL SCIENCES?

Response: Drug Delivery is one big challenge. Others include new ways to predict pharmacokinetics, new imaging technologies, better understanding immunology, the development of combinatorial approaches for drug development and high throughout screening for better formulation and drug development approaches, gene therapy, tissue engineering, and nanotechnology.

WHAT IS THE KEY TO DEVELOPING SUCCESSFUL COLLABORATIVE RELATIONSHIPS?

Response: Very close personal relationships and both sides offering unique and needed skill sets.

YOU ARE EXCEEDINGLY WELL FUNDED. WHAT ARE THE INGREDIENTS TO YOUR SUCCESS?

Response: Writing a lot of grants, but also patenting our inventions and using those patents to help bring in funds.

I AM CERTAIN THAT, FROM TIME TO TIME, DISTINGUISHED INSTITUTIONS FROM ALL OVER THE WORLD HAVE ATTEMPTED TO RECRUIT YOU. YET, YOU CHOSE TO STAY AT MIT. WHY?

Response: It's been a wonderful place to do science and engineering, and its close association with the Harvard hospitals make it a great place to do biomedical engineering research. Plus, they've treated me well.

YOU ARE THE ONLY SCIENTIST WHO HOLDS ACTIVE MEMBERSHIP IN THE INSTITUTE OF MEDICINE, NATIONAL ACADEMY OF SCIENCES, AND NATIONAL ACADEMY OF ENGINEERING. WOULD YOU SHED SOME LIGHT ON WHY SO FEW PHARMACEUTICAL SCIENTISTS ARE REPRESENTED IN THOSE THREE AUGUST BODIES?

Response: There are a number of pharmaceutical scientists in the Institute of Medicine, including Les Benet, Jere Goyan, Milo Gibaldi, Gerhard Levy, and George Zografi. Since there aren't many engineers among pharmaceutical scientists, I would generally not expect pharmaceutical scientists in the National Academy of Engineering. As for the National Academy of Sciences (N.A.S.), I don't know, but perhaps because pharmaceutical scientists generally do applied research while the academy generally elects basic researchers.

YOU SERVED AS PRESIDENT OF THE CONTROLLED RELEASE SOCIETY IN 1991-92. WHAT IS YOUR VIEW ABOUT SCIENTISTS TAKING UP ADMINISTRATIVE AND PUBLIC SERVICE RESPONSIBILITIES?

Response: I think it's very important. Scientists can help shape important policies and foster important scientific endeavors by so doing.

MANY OF YOUR FORMER GRADUATE STUDENTS AND POSTDOCTORAL FELLOWS ARE EXCEPTIONALLY SUCCESSFUL. WHAT DO YOU THINK CONTRIBUTES TO THEIR SUCCESS?

Response: That makes me very proud. First, I think I choose them carefully so I'm not sure how much I really contribute to what they do later since they may do well no matter what. But I do work hard with my students to teach them to think big in terms of ideas. I try to help them get good jobs, and I continue to spend time with them after they leave, reviewing grants and doing other things I think will help them.

HOW HAS YOUR PHILOSOPHY OF EDUCATING GRADUATE STUDENTS BEEN CHANGED OVER THE YEARS?

Response: It really hasn't. I see graduate students as making the transition from people who find answers (the class room) to people who ask questions (real life) and my role is to help give them the support, courage and vision to do the latter.

HOW HAS YOUR PHILOSOPHY OF MENTORING JUNIOR FACULTY CHANGED OVER THE YEARS?

Response: It hasn't either. I think junior faculty should work on 2-3 important areas, and they shouldn't be afraid to take risks. They should try to raise sufficient grants and they should try to attract and select excellent students and post-does.

WHAT WOULD BE YOUR ADVICE TO OUR JUNIOR PHARMACEUTICAL SCIENTISTS EMBARKING ON THEIR CAREERS, PARTICULARLY IN THE DRUG DELIVERY AREA?

Response: The same answer as above, but I would add that they should choose cutting edge drug delivery problems.

WHAT WOULD BE YOUR ADVICE TO THE JUNIOR PHARMACEUTICAL SCIENTISTS PURSUING RESEARCH IN THE MATERIAL SCIENCE ASPECTS OF DRUG DELIVERY? DO YOU THINK THAT THERE ARE AREAS OF RESEARCH THAT SHOULD BE PURSUED BUT WHICH ARE NEGLECTED BY THE PHARMACEUTICAL COMMUNITY?

Response: I think material science is a fertile area. There are many new types of materials like starburst dendrimers, shape-memory materials, and many others- and many materials technologies like tissue engineering, new manufacturing approaches, combinatorial approaches, imaging and others- that can create new pharmaceutical opportunities.

WHAT IS THE PLACE FOR ENTREPRENEURSHIP IN ACADEMIA?

Reponse: I think it's a terrific thing. It gives academics the opportunity to create real-life products out of their concepts. Products can be life saving or life extending and the companies that produce them can also create many jobs.