

## Nanotechnology in Cancer Therapeutics

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Joe Balintfy: We're re-launching a series on nanotechnology and cancer in this episode. Back in episode 117 in September, we got an overview of nanotechnology and learned how micro-machines 50-thousand times smaller than a human hair are being studied to improve screening, diagnosis and treatment of cancer. In the next episode, we talked about testing these tiny particles, nanoparticles, for safety. Now we're going to get some more details on nanotechnology and cancer treatments. I'm talking to Dr. Robert Langer at the Massachusetts Institute of Technology. First can you explain the work you do?

Dr. Robert Langer: Yes, well, I've been fortunate to co-direct along with Ralph Weissleder at the Massachusetts General Hospital NCI Nanotechnology Center. We started it five years ago, and it was just renewed again. And the specific work that we do in our lab has been aimed at drug targeting and delivery of these small interfering RNAs, and with Michael Sema [spelled phonetically], new kinds of diagnostics that might someday be implanted under the skin that could detect specific signals in the body that might tell you how a particular cancer treatment was doing. So those are the major areas that we are working on.

Balintfy: Can you briefly explain interfering RNAs and its potential?

Langer: Yes, well, there is a discovery that was made, in fact it won the 19—well, it was made in 1998, and I believe it won the Nobel Prize in 2006. And this was a discovery made by Andrew Fire and Craig Mello that you could have pieces of RNA that could—which is called small interfering RNAs—that could basically shut off specific genes. So it's very, very highly specific. In other words, if there was a gene for a cancer being invasive, you might be able to shut that off. If there was a gene for a cancer that could recruit blood vessels, you might be able to shut that off. And so these would provide highly specific therapies unlike most drugs that really affect many targets. So that would be the potential benefit of it.

Balintfy: Dr. Langer, in general, how would you say nanotechnology can be used for cancer treatments?

Langer: Well, I think that nanotechnology, I think, can be helpful in a variety of ways. I think it can be useful in new types of drug therapies, in particular for targeted drug delivery, where you could take nanoparticles and put an anticancer drug in them, and by decorating the nanoparticle with the right substances, have it go to the cells that you want, the cancer cells, for example, rather than other cells in the body. It can also, I think, be useful in creating new medicines. Like one of the big problems with some of the potentially newer drugs, like ways of silencing RNA, for example, which could be a terrific new kind of therapy. One of the issues with that is getting it, again, into the right cells. And so nanotechnology, again, could be useful in carrying these kinds of new drugs to the cells. And it can also be useful in new imaging agents, for example, new MRI agents and a new diagnostics. So, I think it can be very, very useful in a range of ways.

Balintfy: Would you say nanotechnology is better than current treatments?

Langer: Well, I think it relates to what I said. In other words, I think if, you know, right now, current cancer treatments are fairly nonspecific, in other words, they travel throughout the entire body. So, one of the things that nanotechnology might offer, again, if you could target the nanoparticles correctly, is the ability to target them to the specific cancer cells. And then also, as I mentioned, I think it could be useful for delivering medications that now are not yet here yet. But new kinds of genetic medicines, like ways of silencing RNA, I think that those could offer huge potential advantages because they would offer brand new therapies and safer therapies and more effective therapies, potentially.

Balintfy: When do you think nanotechnology or nanoparticles will be available to treat cancer patients in the clinic?

Langer: Well, nanoparticles have been used clinically, but the targeted nanoparticles have not yet been, though the first clinical trials I expect we'll see within the next few months. But clinical trials are a long ways away from making them widely clinically available. But I think we'll start to see the first human proof of principle, you know, over the next year or two because the test will be going on. And there are other nanoparticles that have been developed, for example, by other scientists at Caltech like Mark Davis and others and other companies that could—that are in the clinic now. And so people are starting to see—starting to see results. The idea of delivering sRNA has also started, that's the small interfering RNAs, that's also started, though it's not yet been—that much has not yet been done with nanoparticles, but again I expect to see clinical trials start on that in the next year as well.

Balintfy: You talked earlier about what was it, coloring nanoparticles to get them to do different things. Can you explain what you meant by that?

Langer: Well, I think what I said is decorating them, and what I meant was by decorating that—so what I meant by that was that if you had a nanoparticle and you want it to travel, say, the tumor, what you might do is decorate the outside of it with something that attracts it to the tumor, like it might be, for example, what's called an antibody or an aptamer which is a piece of RNA that might be directed to a specific cell in the tumor. For example, we have done work on—with Omed Farak Ahzad [spelled phonetically] who's a clinician, and Phil Kantoff [spelled phonetically], and one of the things we've looked at is prostate cancer. So there we have directed nanoparticles to prostate-specific, you know, we have used prostate-specific membrane antigen as a target. And so that's what I meant by decorating, rather—as opposed to maybe coloring.

Balintfy: Do you think it's worth emphasizing how tiny these nanoparticles are? What's a good way to grasp the scale of nanotechnology?

Langer: I think so. I think the way that I usually try to think about nanotechnology is take the thickness of a human hair, and now think about something that might be 1/1,000 or 1/10,000 that size. So something in that range would be in the nano-thickness range, so it is very, very tiny. But that's important if you want to have it go into cells and things like that. So -- but I think you

can think of it, like I say, in terms of the thickness of a human hair and then an awful, awful lot thinner than that.

Balintfy: And these nano-machines are actually doing something.

Langer: Yes, they are, I mean, of course they are doing different things depending on how they are designed, and I think that is what is great about the National Cancer Institute's funding of this area, that different academic groups and companies are making different designs that might lead to new treatment, new therapies, and in some cases, like I mentioned, new imaging agents, and in some cases new diagnostics.

Balintfy: Dr. Langer, what do you think is most important to emphasize when talking about nanotechnology and cancer?

Langer: Well, I think you think of things into two areas: one, future research, and two, clinical treatments. So the clinical treatments are—they are going to start. I mean, they are starting already, and more of them will start. So I think that we will probably see in the next five years a lot of clinical trials and possibly even some clinical products based on things that the NCI has funded. I think in terms of new future work, I mean, people are working on all kinds of, like you said, nano-machines that could do different things in the body, from better drug targeting to better imaging to better diagnostics.

(THEME MUSIC)

Balintfy: Thanks to Dr. Robert Langer at MIT. For more information on nanotechnology and cancer, visit the website, [nano.cancer.gov](http://nano.cancer.gov). This nanotechnology series will continue next episode when we'll talk more about nanotechnology and imaging.

“So the hope is that, because nanotechnology solves specific problems, that nanotechnology and nanoparticles coupled with the right imaging instruments, all those will benefit from nanotechnologies in the future.”

For now that's it for this episode of NIH Research Radio. Please join us again on Friday, December 17 when our next edition will be available. And remember, as mentioned in the break, NIH Research Radio is taking a break: Episode 125 scheduled for Friday, December 31 won't be available until Friday, January 14. As usual, if you have any questions or comments about this program, our holiday schedule, or have story suggestions for a future episode, please let me know. Best to reach me by email—my address is [jb998w@nih.gov](mailto:jb998w@nih.gov). I'm your host, Joe Balintfy. Thanks for listening.