Western Science

WESTERN SCIENCE SPEAKS PODCAST
SEASON 3, EPISODE 9

EPISODE TITLE
The Physics of Cancer

PODCAST SUMMARY
We all know someone who has or is suffering from cancer. This week on Western Science speaks, Dr. Eugene Wong, a medical physicist at Western University, tells us about the wide variety of imaging technologies he uses to better understand the contexts in which cancerous tumors grow.

INTERVIEW

You're listening to the Western science speaks podcast. Presented by Henry Standage.

Henry Standage 0:15
We tend to look at physics in a one-dimensional manner. Yes, physics encompasses the universal laws behind what goes up must come down, the laws of attraction between magnets, and impact equaling mass times velocity. But physics also have a secret side that isn't heard about as much. I'm speaking about the physical processes that exist in all living things. Today on the western science speaks podcast, we're joined by Dr. Eugene Wong from the Department of Physics and Astronomy to talk about these physics specifically, and how we can use methods to counter diseases, such as cancer, that demonstrate their own physical abilities to harm our body. Here's the interview.

Henry Standage 1:03
You're a physicist by trade, what can someone in your position do to help solve the cancer problem?

Eugene Wong 1:10
As a physicist, we contribute to the technology of treating cancer, for example, in radiotherapy or the technology, improving imaging so that we can detect where the cancer is and help address the problem of the cancer.

Henry Standage 1:27
What kind of physics are you looking at when you're doing this?

Eugene Wong 1:30
The physics that for example, for imaging, could be magnetic resonance imaging, a CT scan with x rays could be optical. And there's a variety of physics that is applied to that imaging. To treat patients, we tend to use radiotherapy. But there are also other technologies that are currently developing to treat cancer and each of them has their own physics associated with it. So, for example, radiotherapy, we use gamma rays, high energy x-rays. So, we need to know how the x-rays interact in the body. We can also treat cancer by radio ablation, we send in radio waves to heat up the tumour. And so, we need to figure out how that works. So those are the examples that we use to treat cancer. And one of the latest that I'm working on is using electric fields to treat cancer, so that is applying electric field to intake to the cancer cells to automate or disrupt this ability to divide.

Henry Standage 2:53
Another interest of yours is the tumour dose response relationships. So that's kind of the targeted therapy that you were talking about - what methods do you use to find the optimal application?

Eugene Wong 3:04

Well, the method is we do clinical trials, but we also do it in animals first. So, the most recent exciting things that we can do is take tumour samples from patients and put it in animals and investigate that biological system, figure out what the response would be, and hope that responsible will imitate what the patient's outcomes are. So that's kind of the research that biologists are doing. As a physicist, I like to create more well controlled environments. So, I am using something called a microfluidic device. I like to put cancer cells into these devices in a well controlled physical environment and study how we can change it when we add drugs. If we change the physical environment, how would that impact on the response of the cell and take advantage of this basic research to find out if, say, applying an external electric field, when we do radiation at the same time or chemotherapy with that, more than doubles the effects if compared to when you use each modality alone. So, these are the things I like to do and, in my research, to use the well control physical environment to study how the cells behave when we give that treatment.

Henry Standage 4:35
So, I think most people or a general audience viewer might see physics as something that's not man made. It's something that kind of comes with, you know, being in the world. But you look at physics that occur naturally in the process of living things. So rather than externally out in the world, something happening internally within us. Can you just give us a few examples of this phenomenon?

Eugene Wong 5:00
There are two interesting way of looking at it. The physical environment actually will give clues to cells and will change its behaviour. So, depends on what environment it is, if you, for example, place some cells into a petri dish that is hot, it will become fibrotic - they will spread out. But if you put it in gel, it will actually grow in 3D and they will be more round. So, the cells respond to the physical cues of where they are, and they will behave differently. The thing that is interesting is that if you alter the physical environment, you can actually change what genes are turned on and off. And that is sort of built into cells that when we are in our past embryo, as the cells divide, they get clues from the environment and divide into cells that form muscle cells, that forms lung, your brain. And they somehow get clues to figure out how to divide and specialise. The other opposite thing is, instead of using the physical clues to influence how the cell behave, the cell also uses physics to do things for themselves. So, if one cell has to divide, they have to physically divide into one to two. And when they want to go from one place to another, they have to be able to move when our brain is telling muscles to do certain things. The electrical signal, it uses electrical signal from our brain all the way down to our muscles to tell it to contract or relax. So, everything in the biological system is used for sex.

Henry Standage 7:14
The external physics around us interact with us internally. We've grown up in this environment. Okay, let's look specifically at cancer cells and how they manage to divide.

Eugene Wong 7:26
First the DNA, the genetic material has to double. And the cell has to grow big enough for it to divide into two. The magic happens when it is ready to divide into two. To divide correctly it has to have the correct genetic materials. So 23 pairs of chromosomes have to go one way and the other 23 has to go the other way.

Henry Standage 7:54
Are their forces working there to pull them in certain directions?

Eugene Wong 7:58
Very surprisingly, there are forces that pull them apart. And these are called microtubules. They start from a soames, you have two central songs and it will start growing these microtubules to the DNA, and then they will pull them apart in equal amount, and then the cell will actually physically divide, and be able to get two identical daughter cells afterwards.

Henry Standage 8:37
Would you describe that as a magnetic force?

Eugene Wong 8:41
Electric force.

Henry Standage 8:42
That leads me to my next question, which is, does chemotherapy demonstrate its own kind of physics like is it a means to alter the physics of our body?

Eugene Wong 8:52
In fact, it is. The chemotherapy would interfere with the deficient kind of light, what radiation does by disrupting the DNA. It can also disrupt the process of self deficient.

Henry Standage 9:09
Because you don't want to allow the spreading you want to you know, keep it tucked away in one part of the body and treat that.

Eugene Wong 9:15
Yeah. But for chemotherapy, the drug, you inject the drug and the drug has to find it. Right now, a lot of drug is not, doesn't have eyes, so to speak. So conventional chemotherapy will go to wherever the dividing cells are, and we'll stop the division there. So that's conventional, more recently, you have targeted therapy. So, you look at the tumour and look at what special things, genetic things that is different from normal cells, and you try to target those. So at least those are more targeted, but it's still you know, it's still a cell. Most cells have some you will find some cells in your body Having the same receptor, same kind of signals. So, you sometimes will have side effects that you cannot avoid. When you use chemotherapy with radiotherapy it is kind of like surgery - more targeted. So, you can target the radiotherapy to one region of your body where the tumour is and spare the rest of them.

Henry Standage 10:28
Cell sense their biological, chemical and physical environment and respond to it in a variety of ways, including turning certain genes on and others off. In addition, in order to achieve their biological functions, they secrete chemicals or employ physics. Cancer cells are no different in that respect, except that they will not stop mutating, spreading, growing and invading where they do not belong. Understanding how the physical environment can influence cancer cells behaviour, or seeking the physical vulnerabilities of cancer cells, offers a unique approach that complements others. The goal of physics-based technologies is to improve what experts called the therapeutic ratio, maximising tumour control while minimising side effects. being diagnosed with cancer turns a patient's world upside down. Work like Dr. Wong's helps improve patient outcomes and reduces cancer recurrence. I'm Henry Standage, signing out. Thanks for listening.