Tebello Nyokong

'As chemists, we are designers'

What is the common thread running through denim jeans, cancer and pesticides? None springs to mind, yet when chemist Tebello Nyokong describes her fascinating research, a link begins to emerge: light. A specialist in nanochemistry, Nyokong is using laser in ways that could revolutionize not only the diagnosis and treatment of cancer but also water purification.

Born in Lesotho, Tebello Nyokong is Professor of Medicinal Chemistry and Nanotechnology at Rhodes University in South Africa and Director of the Nanotechnology Innovation Centre for Sensors (Mintek). In 2009, she was one of the five Laureates of the 2009 L'Oreal–UNESCO Awards for Women in Science.

You are involved in research into an alternative to chemotherapy for cancer patients. Can you explain your work in simple terms?

As chemists, we are designers. My research deals with the development of drugs from compounds called phtalocyanines. We call them dyes because their molecules are similar to those of dyes you use to colour jeans blue. These dyes are used to treat cancer via a process called photo-dynamic therapy, or PDT. The approach is multi-disciplinary, with chemists, biologists and biotechnologists all working together.

As a chemist, I am at the centre of this work because I am the one who makes the molecules. I have a big team of about 30 people, plus others all over the world who are doing the preclinical testing in their own laboratories.

Molecules that dye blue jeans can also treat cancer?

Look at a plant: its leaves are green because of chlorophyll. Blood is red because of haemoglobin. Those molecules are actually almost the same, except that the one in leaves has magnesium at the centre and the one in blood has iron at the centre. A small change like that can make the difference between non-medicine and medicine. The molecule in blue jeans is the same as the one I am using to develop a treatment for cancer, with a slight change in its composition, a different metal at the centre, to make it do what you want.

PDT is a new treatment?

No, what is new are the drugs we are developing. PDT is already available for use on some cancers in the USA, Europe and Russia. The drug is introduced into the body and activated using light. The problem is that the side effects are very strong. The drugs currently available tend to hone in on healthy tissue as well as on cancerous tissue once they have been introduced into the body. The problem with chemotherapy is that the patient has to stay indoors out of the sun to prevent the healthy tissue from being killed along with the cancerous tissue.

Can this treatment be used for all forms of cancer?

It cannot replace surgery. The light used to activate the drug is transported by tubes; we are using a combination of laser and fibre optics. If the cancer has spread throughout the body, this cannot work. It is a localized treatment. You have to direct the laser to exactly where the cancer is.

Are your molecules safer than current PDT drugs?

That is the whole aim. We are making molecules that are cancer-specific, so they will not attack healthy tissue. Also, with my own drugs, you need very small quantities in order to absorb light. I have gone much further than my peers because I am now combining my drugs with drug delivery, which has never been done before.

This is the nanotechnology aspect. The molecules have nanomaterials called quantum dots attached to them that can penetrate any part of the body very easily. They are good at drug delivery and, secondly, they give off light, enabling us to see more easily where the cancer is located.

How did you come to choose this domain for your research?

It was accidental – that is the beauty of chemistry. Once you have developed an interest, you are always thinking: 'what more can I do with molecules?'

The bottom line for me is that I started working with laser because I just really love light. I love laser. It is bright, direct and offers a wide spectrum of colours. I started finding different applications for it. That was wonderful. My interest was in laser, not cancer.

Is nanochemistry dangerous?

I am afraid so because something that can penetrate any part of the body *is* dangerous. Secondly, at the centre of the molecules we have made so far, known as nanoparticles, are heavy metals. If they leak out, they can attach themselves to your haemoglobin or to other parts of the body and become a danger to you.

With the help of biologists, we are testing these nanoparticles to gauge their level of toxicity and trying to develop molecules that are the least toxic possible. In parallel, we are conducting research on applications and their toxicity.

How long do you think it will take before your drugs are in general use?

There are many variables when it comes to using these drugs on people. One thing which is problematic for oncologists is that lasers are expensive and difficult to maintain. I can do nothing on my own. I am a chemist; we can develop things but collaboration is important to see if they work.

The Centre for Scientific and Industrial Research is doing preclinical testing for me in South Africa. Beyond that, a group in Switzerland has developed a very interesting way to test the methodology using egg embryos. To test the dye's activity, you inject the dye into the veins around the embryo.

What environmental applications does your research have?

These molecules are really magic. They can do so many different things. The process can be used to purify water that has been polluted by pesticides, in particular. In Lesotho and South Africa, people still have to fetch water from open sources; run-off from the fields ends up in household water. We have to deal with that.

Throughout history, light has been used to purify water. You expect bacteria to be killed by light. But if you put the nanoparticles we have developed in the water, they accelerate the process and the end products are less toxic. If you purify water solely with biological means using the sun, the bacteria can form molecules that are more harmful to the body than the original ones you set out to kill. By using our drug, combined with light, we have managed to make nanoparticles that are no longer toxic at all to human beings. This is much closer to success. We have just patented this process.

Your goal is to develop a product?

That is my mission. Product development will come more quickly in the area of depollution. Drug development will take much longer. Dealing with people implies so many rules to ensure the drug is safe.

I plan to persevere, however, in order for young people to see that, in South Africa, they can take science and develop a product. They cannot imagine this; they believe anything new *must* come from somewhere else.

Did you imagine when you were younger that chemistry would be your life's work?

Not in a million years. We had no role models but I was always ambitious – I always thought I could be a doctor or a dentist.

Teachers are very important. I met a lecturer in my first year at the University of Lesotho who was in the US Peace Corps. He made chemistry so much fun. He made me feel that chemistry was the place to be. After that, I was hooked.

The University of Lesotho gave me the opportunity to train as an academic. I then won a scholarship to train in Canada, where I completed my masters and doctorate. I am doing the same for others now. I have lecturers training with me from all over Africa – from all over the world, in fact – who will later return to their universities.

As the first woman in your department at Rhodes University, you have said you feel challenged by doing the 'impossible.'

This is the reality. It was very difficult for me to progress with little support. Many women give up because of this. You have got to be a little mad to do what I have done. But I vowed that I would help other women as much as I could. Their confidence levels are not as high as men's. I don't know why but men feel confident even when what they are saying does not make much sense!

Interview by Cathy Nolan

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Professor Nyokong with a student next to a laser in her laboratory at Rhodes University