Proteins wear clothes – and understanding their fashion choices could help us treat cancer

October 16 2018, by Pedro Beltran-Alvarez And John Greenman

Credit: Ron Lach from Pexels

We humans are top of the evolutionary tree, the most complex organisms that have ever lived on Earth in five billion years. Right? One way we might actually prove our biological complexity is to look at the number of different proteins that our bodies can produce for building all our different types of cells and the other things they need.

This number is approximately 20,418 in humans. We are clearly more complex than chickens (18,346), flies (13,931) and bacteria, some of which can produce only a few hundred different proteins. But here is the humbling news: some crustaceans can make up to 30,000 proteins and a red cabbage has nearly 60,000 different proteins.

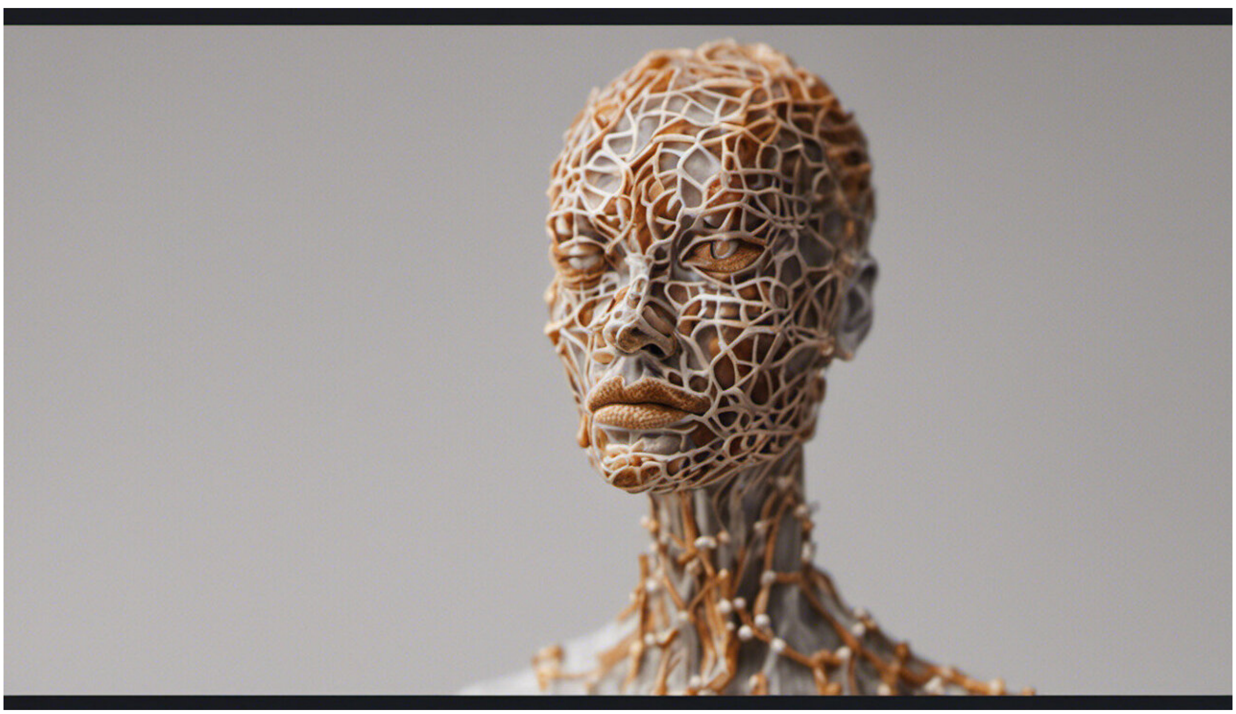
Scientists have managed to come up with an explanation for this apparent conundrum and save our dignity as a species. One of the features that make us more complex than a cabbage is what's called post-translational modifications of proteins, the way proteins can change after they are copied from our DNA. If we take these into account, then the total number of different proteins in human cells is an estimated one million.

What's perhaps more important than showing off to cabbages, however, is the fact that these protein changes, which we here call protein "clothing", could help us tackle diseases such as cancer. We have developed tiny devices that can analyse the protein clothing in a human tissue sample in a way that could help spot tumours earlier or understand what's driving them and how best to treat them.

Just like humans, the proteins in our bodies are born without any clothing. But before getting to work and socialising with other proteins, most of them undergo the equivalent of getting dressed. These items of protein clothing can change the "naked" protein's structure, function and how it interacts with other proteins. So protein clothing contributes hugely to the complexity of our bodies.

The analogy works in different ways. Just as there is only one place where you can (comfortably) wear a left-hand glove and your reading glasses will not work if you put them on your feet, proteins can only wear their modifications at specific sites on their structure for them to work.

Protein modifications can also be reversed. Just as we can take off a jacket if we're too hot, proteins can have some items of clothing, such as phosphate groups, removed in a fraction of a second. But other modifications are very stable. For example, if methyl or lipidic groups are added to proteins they are like "tattoos" that are very difficult to remove.



Credit: AI-generated image (disclaimer)

Again like us, proteins can wear many different items of clothing at the same time. In some cases, these different modifications can interact with each other and also affect what other changes can be made to the protein .

But what does all this have to do with disease? Just as we change our clothing when we're ill and in hospital, our protein modifications can be very different if we're suffering from conditions such as cardiovascular disease and cancer. In these cases, the modifications have gone wrong and the proteins may be wearing the wrong piece of clothing in the wrong place. This can happen with some of the modifications we've already mentioned, such as phosphate and methyl groups.

This means that if we can work out exactly how protein clothing in a tissue sample has gone wrong, then we can understand better what's going on inside the body. One method we've developed to do this is using what we call a cancer-on-chip system. We can place samples taken from a tumour in a microchip-like device about the size of a large coin. Instead of electronic circuits, the chip contains a network of tiny "microfluidic" tubes that can perform a series of chemical experiments on the sample.

Spotting cancer earlier

This enables us to recreate the conditions inside the body with a small tissue sample, and without experimenting on animals, to quickly test a variety of standard and new drugs and radiation therapy. Because we can control the conditions of the experiments very precisely, we should be able to investigate which treatment would be best for that specific patient, an approach known as personalised or precision medicine. But cancer-on-chip experiments can also let us investigate the tumour for changes in proteins, including post-translational modifications.

This is important because it means we could find new ways to spot cancer by identifying modifications that occur at an early stage. This would allow us to diagnose the disease sooner, giving us a better chance of successfully treating it. Identifying specific modifications could also help us understand the biology of the tumour and the mechanisms causing or driving the cancer.

We're currently using these cancer-on-chip models to investigate novel disease mechanisms and treatments, and within the next few years we hope to use them in clinical trials with real patients. At which point, we hope that protein clothing will be able to tell us not just about the biological complexity of our species but also the complex conditions that exist inside every one of us.

Provided by The Conversation

Citation: Proteins wear clothes – and understanding their fashion choices could help us treat cancer (2018, October 16) retrieved 10 April 2024 from https://phys.org/news/2018-10-proteins-fashion-choices-cancer.html