Hormones: The Inside Story

Episode 6 – Are everyday chemicals harming my health?

In America in the 1940s there was a big mosquito problem.

But people found a solution - spraying a new chemical pesticide called DDT, which controlled the outbreaks.

Problem solved right? However, over the years, environmental researchers started to notice something strange going on.

SFX birdsong stops

The birds were getting quieter.

Ecologist Rachel Carson took a closer look. She discovered that birds were consuming DDT through the food chain. Sometimes they were dying, but more often the effects were small - almost invisible. For example, their eggshells were getting thinner, causing some of them to crack before the chicks were ready to come out.

The conclusion from this research was stark: DDT was an endocrine disruptor - a chemical capable of interfering with hormones, even at low doses

Carson wrote a book about her discoveries, Silent Spring, and spent many years lobbying against the use of DDT, which has now been banned in America.

Bird populations started, slowly, to recover. But fast forward 60 years - and endocrine disruptors haven't gone away.

It's almost easier to think where aren't they being produced.

Pesticides. Fungicides.

Pharmaceuticals within the environment.

Food storage containers. Plastics.

Personal care products. Moisturisers. Cosmetics. Fragrances.

Bisphenol A found in plastics. We have combustion products.

I could go on quite a bit but I imagine your listeners would get bored.

This is Hormones: The Inside Story, the podcast where we take a look at the tiny things pulling the strings inside your body - I'm Georgia Mills.

In this episode - we're not going to look at hormones themselves, but at the things that interfere with them - are everyday chemicals harming our health? And is there anything we

can do about it? So to start with, what are these things? What are these endocrine disruptors, or EDCS?

Melissa - Endocrine disruptors are chemicals found in things like plastics and pesticides that interfere with the way that our hormones work in our body.

Melissa Kelly is a PhD student in Queen's university Belfast

Melissa - I am studying the public's risk perceptions as well as risk communication.

She's part of a project called Protected which explores endocrine disruption - from the risks to the policies to - her wheelhouse - the public's awareness of the problem.

Melissa - Endocrine disruptors are strongly linked to negative health outcomes, such as metabolic disorders like obesity and diabetes, as well as cancer and also fertility and reproduction. There's been a lot of studies done on levels of concentration and risk assessment, but as of now, there's no real studies or any baseline information about what the general public knows about endocrine disruptors.

Given that there's this potentially dangerous stuff out there all around us, Melissa wanted to know whether people are aware of endocrine disruptors - and the health risks they pose.

Melissa - And so for my research project, I did focus groups and also a large online survey for my focus groups.

And some early results are coming in.

Melissa - I can let you know that awareness is very, very low. Unless you personally are affected by maybe a hormone related disorder or you work in a field like agriculture or food sciences, you probably have no idea what endocrine disruptors are.

Which actually didn't surprise Melissa that much, she was in the exact same boat!

Melissa - Before I even interviewed for this position, obviously, I was desperately Googling, like what our endocrine disruptors because honestly, I didn't know what they were before I went into this project.

So we have growing evidence that there are endocrine disrupting chemicals in the environment - but what are they, how do they affect our bodies - and other organisms - and what should we do about it?

First - let's find out how they work.

Michelle - We know the endocrine system is made up of a collection of tissues and glands, for example the thyroid gland, the pancreas, the testes in males and the ovaries in females.

This is Michelle Bellingham - a lecturer at the school of Veterinary medicine in the University of Glasgow.

Michelle - The endocrine system itself will control normal physiology of a number of systems, for example, reproduction, stress, growth, metabolism, appetite, regulation.

So it's an important system. And these endocrine disruptors are endocrine disrupting chemicals that have the potential to interfere with its normal hormonal system within the body if they can get into the body.

So endocrine disruptors are any chemical which disrupts the endocrine system, like a phone signal disrupting a recorder

Michelle - So they can get into the body through a number of routes. So ingestion, we can consume endocrine disrupting chemicals. They can be absorbed through the skin or they can be inhaled. So there are a number of different routes in which they can get into our body.

And once they're inside the body, they have the potential to actually bind to our normal hormone receptors that are in our body. And through doing this they can have the potential to block or mimic what our normal endogenous hormones can do. They do this, because a lot of these endocrine disrupting chemicals have a similar structure to our own endogenous hormones. So some of them might look like oestrogen. They might look a similar structure to testosterone or androgens or other hormone structures. And so they are able to fool the body by binding to the receptors that are there for our natural hormones and cause their mischievous effects.

Our internal system of hormonal messages and receivers is extremely clever, but it can be tricked.

Michelle - Because the body can't really tell the difference between the shape of a normal hormone and the shape of a synthetic chemical that enters the body.

And as we heard earlier - these chemicals can be in our food, water, pesticides, skin care products. But what's the big deal?

Michelle - So we've seen over the past few decades now an increase in a number of diseases, for example, diabetes, obesity, metabolic diseases and a number of reproductive problems and defects in humans. Now, there's obviously lifestyle factors, genetic factors that are associated with these diseases, and that's unequivocal. But there's also an indication that in some of these diseases, such as diabetes, obesity, reduction in fertility, can have the underlying role of a chemical within their environment.

So there are these chemicals that can affect our hormones systems, and there are troubling rises in diseases with a hormonal component. But how do we link the two? Some of our major clues that these chemicals can be really dangerous come from tragic accidents.

Michelle - One of the big incidents occurred that led us to show association between chemicals and endocrine disruptive effects was the Seveso explosion in Italy in 1975.

There was a factory in the Lombardo region of Italy, making chemicals called dioxins. Something went very wrong.

Michelle - There was an explosion. An explosion where these chemicals ended up being released into the environment over an 18 kilometre radius.

The effects were seen almost instantly.

Michelle - so immediate, local impacts were evident: lots of deaths of wild animals.

Farmers reported things like cats falling over and their tails falling off. Hundreds of cattle were killed. But the impacts were long lasting.

Michelle - But over a number of years, scientists have been able to study the people who were affected and their offspring and from this there's been an association between the exposure to these dioxins and a number of endocrine and reproductive defects, but also carcinogenic effects as well. So this led us to a greater understanding of the impacts of these dioxins and the potential that they have to enter the body and have negative consequences, not only on those that were exposed at the time, but also a generational effect on their offspring.

There were cancers, low fertility rates. It was an international scandal, and it led to greater regulations of these chemicals, dioxins. But an accidental large-scale event like this doesn't

tell us about the impacts of more normal exposure levels to endocrine disruptors, or how best to regulate them.

Michelle - It's not a normal exposure. We're not normally exposed to these high levels of these chemicals. So although having that incident to people to study the impacts of this one chemical, these dioxins and. It's not a realistic exposure to be able to base all risk assessments on that chemical on because this is exceptionally high exposure and we're not exposed to those levels of dioxins.

We're exposed to a number of different chemicals on a daily basis, and these are probably most likely at very low levels.

Think of it like this. Like if you eat 1000 bananas at once it might kill you, but we would never ban bananas. Dose is really important in understanding how to control substances that are harmful to health. Something could be toxic only at extremely high levels, while something else might have harmful effects in miniscule amounts. Or it could be safe on its own, but dangerous if it interacts with other chemicals. Tricky right?

So this is where experiments can come in - testing combinations or small concentrations on study subjects - usually animals. For example, Michelle looks at sheep, she grazes them on grass fertilised by sewage sludge, which might contain some of these chemicals.

Michelle - bio solids that come from wastewater treatment plants are a common fertiliser that are used in agriculture. And they are a fantastic fertiliser. They and they contain all the nutrients that we need for fertiliser. And it's a way of waste water being recycled to land. However, alongside this, these bio solids, because they come from wastewater, contain a complex mixture of all the chemicals that we as humans are exposed to so because they come from our own wastewater they contain all the pollutants and all the chemicals that humans will use on a daily basis.

They grazed sheep on land that had been fertilised in this way, and then looked at the health of the sheep, and of their lambs.

Michelle - So we looked at their hormone levels. We looked at their size. We looked at the size of their testes, which would be an indicator of fertility. We looked at other measures of fitness in these animals and on the outside, these males appeared healthy and with no significant impact on their hormonal systems, looking at just the hormone levels.

Great news, the lambs seemed normal. But then Michelle and her team looked closer at the male lambs' testicles under a microscope, expecting to see a normal structure.

Michelle - You'd see beautiful round structures with lots and lots of nuclei, so lots of dots, which should indicate the cells which are proliferating and developing into normal sperm cells.

But instead they saw something quite different.

Michelle - We saw tubules which had significantly less or significantly fewer of these cells that would go on to produce normal sperm. And that and also of significance was there was fewer of a specific cell type, which nourishes the cells to become mature sperm. So there's lots of tubules which looked empty, in fact. So it wouldn't even take an expert microscopy expert to tell the difference between our exposed and control animals.

Despite these animals - and their testicles - appearing healthy on the outside, zooming right in with an expert eye revealed that something had indeed gone wrong.

Michelle - It would probably be a cliché to say it was a eureka moment, but it certainly was exciting in terms of and there was this outwardly normal appearance of these a testicular structure on the outside. So I guess a lesson, in fact, is to not automatically assume just by the external phenotype that everything's going on OK at the internal and at the cellular level.

Enabling endocrinology's potential to advance science and health

This gave them enough evidence that something was affecting the lamb's normal development in the womb, which could be having an impact on their reproductive health later down the line. And given that sperm count is a worry in the west, there are concerns that endocrine disrupting chemicals could be causing fertility problems in men, which are currently going under the radar.

Obviously, we're not sheep and the vast majority of us don't tend to graze on grass, our exposure and our reactions could be quite different - so we don't yet know for sure that the chemicals in these fertilisers are acting as endocrine disruptors in people - or even which chemicals are causing the changes. And, as it turns out, that's harder to pin down than you might imagine.

Paul - Sewage sludge is a complex mixture of many chemicals, many of them at low doses. And this reflects where we are in real life.

This is Paul Fowler from the University of Aberdeen, who has worked on these studies with Michelle. The complicated nature of chemical mixtures means that even when you have a successful study and find a significant impact, that doesn't leave clear answers for what to do about it.

Paul - One of the complexities and I've experienced this personally when speaking to two politicians, for instance,

And speaking to some MEP and they're saying, "wow, really, that's great. So what can we push to legislate? What's the compound that's causing all this problem?" Well, not to say to them, well, I ,I haven't a clue.

Paul first got involved in researching these compounds 20 years ago.

Paul - I have to confess that to start with, I was very cynical.

But he's since been convinced that they do pose a risk to health, and is now a group lead on a project FREYA looking into health risks for a particular group of people.

Paul - For me, one of the biggest concerns is in pregnancy. And that's because of the time when there is a very complex conversation going on between hormones, because you have three entities in a pregnancy. You have the mother, the placenta and the foetus. And they're all busily signalling to each other. And the way they do that is important for whether the pregnancy is normal, whether the baby's born healthy. And so on.

With the potential of lifelong impacts, it's critical to find out what is and what isn't safe for pregnant women. But Paul says this is a really complex and expensive problem to solve. Even just doing the research.

Paul - It's pretty difficult, to be honest. You can do a lot of animal studies or studies in culture dishes where you can give various doses of compounds that are thought to be endocrine disruptors and see what effects they have. To look at humans, we have to rely increasingly on epidemiological data, so population level data. So if you're doing an epidemiology study and you need to get really good data, that's really convincing it to do. Ten thousand women, for instance, I'll leave your audience to do the sums. That's an awful lot of money.

But the stakes in pregnancy are high. Take thalidomide, for example.

Paul - So thalidomide was developed by a German company and was not properly tested before being used to treat women for morning sickness. And it turned out to be a teratogen, and so it actually interfered with development and children were born with missing fingers or very short arms or short legs. Quite a lot of very obvious developmental abnormalities. And it went on for quite a while. And

people like me are old enough to remember classmates who had been marked by their mothers' use of thalidomide.

If thalidomide had been properly tested, that would not have happened.

So we have an issue where something could be really dangerous, or it could be fine. And of course, there are problems in doing research when there are billions of pounds on the line.

Paul - There's sometimes quite heated debate about endocrine disruption and accusations that are thrown backwards and forwards. For some scientists at the opposite ends of the extremes I think this is reaching the point of being more or less open warfare, unfortunately. And the pro EDCS, if I may use that phrase, although it's not really appropriate, the pro EDCs might go as far as to accuse some of the scientists who say, "hang on a minute, I don't think there is really a problem" of having vested interests.

A*nd that's because quite a few toxicologists might have had industrial funding or might work for companies.*

If you think about it, all this testing that needs to be done, it's inevitable that it's going to have to be commercialised.

And vice versa, there can be accusations the other way that scientists overegg the danger, to make it more likely that their work will be funded.

Paul - People might say, if we work for a university in particular, that scientists might have a conspiracy to say, make endocrine disruption worse than it is. And that always makes me chuckle because the thought of a global scientific conspiracy is so utterly ridiculous that it shows these people don't really know scientists. Because in my experience, if you put five scientists in a room, you pretty soon have 10 arguments, equally defended, sometimes opposing arguments by the same scientist as a principle.

And here's the other problem. When we ban products containing chemicals we have discovered to be harmful, what do we replace them with? Take BPA, for example, which is a chemical that's commonly used in plastic manufacturing, including plastic drink bottles, food containers, and the linings of metal food and drink cans. It's a similar shape to the hormone oestrogen, there are concerns that Bisphenol a, BPA can interfere with processes in the body involving it. And because there's a risk that BPA might leach out into food and drinks, it has been banned from products like baby bottles, and many manufacturers are using other chemicals instead. Michelle.

Michelle - The issue we're seeing now is that for example for BPA we're getting the manufacture of other chemicals similar to BPA, for example, BPS and BPF, which we know very little about. So BPA has been swapped out for other chemicals of similar structure, but for which we have very little evidence to know whether they are safe or not

So BPA is gone, but BP something else has been swapped back in.

Michelle - Yes, that's where the issues lie in manufacturing and regulations. So I guess it's been likened to this game of whack-a-mole. Where if we get rid of one, only for another one to pop up in its place but we just know less about it.

So even when we do know something is an endocrine disruptor, we often simply don't know if the thing taking its place is more, less or equally harmful. So is this just a risk of modern life we have to accept? Well, the good news is there are ways to limit exposure to endocrine disruptors in your daily life. Paul.

Paul - Make sure you use fresh food. Use fewer beverages in cans or plastic containers. Don't microwave anything in plastic. Look at what your personal care products use, what they contain. Look at the contents list. There's some argument for reducing the use of non-stick frying pans and things, particularly while pregnant or nursing, and to try and find good gardening approaches rather than spraying pesticides and fungicides everywhere. Use medicines appropriately, particularly as directed by the clinician, not to overuse over-the-counter analgesics and painkillers, for instance, but of course, above all, women should be following the advice of their practitioner, their medical practitioner.

It's definitely not a case of 'everything synthetic is bad' - for example, naturally occurring chemicals in red clover plants are endocrine disruptors that can cause problems for pregnant sheep, and the perfectly natural molecules in soy - a widely eaten food in many parts of the world - also mimic the hormone oestrogen.

Paul - Lead is entirely natural. But if you have a lump of it travelling at high speed, it's not very good for you. But it is an utterly natural compound. And some herbs are, of course, toxic. If you can think about mushrooms, for instance. And how many people in the UK end up with kidney failure through eating the wrong mushrooms? So be aware of the safety of products, but don't be too willing to just throw anything synthetic away and use particularly untested so-called natural products. I would say that people should not be frightened to use properly tested products.

Michelle agrees that we can try and limit our exposure and risks - it definitely can't hurt, and might help - but it's important to keep things in perspective and not freak out.

Michelle - And so it shouldn't be it shouldn't cause you stress if you can't make these changes? If you can. That's great. If you can't, then you shouldn't become overly stressed about it. And also, the things that we do know that can have a massive impact on your health and well-being and risk for diseases and are a healthy diet and exercise and watching your alcohol consumption, because these are well known.

And what about Melissa? She went from having never hearing of these things to reading about them all the time.

Melissa - it really makes you think about what you're putting into your body. And I definitely went through a stage of, you know, not drinking out of plastic water bottles and, you know, making little changes like that. But it's difficult because they are so ubiquitous. I think I read somewhere that there's over fourteen hundred registered chemicals that disrupt your endocrine functioning. And so there's no way that you could possibly, you know, avoid all of those chemicals. If you use plastic once, it's not going to kill you.

At the end of the day, it's all about deciding what risks we're happy to take, and knowing what we can - and can't - control. More research certainly needs to be done into the effects of the chemicals we put into the world around us on our hormones - and the hormones of our wildlife. Taking the lead from Rachel Carson all those years ago, we need to look more closely at our manufacturing and farming processes, to keep an eye out for the almost-invisible impacts of endocrine disruptors in the environment - even if it's just the thinning of an eggshell.

Thanks to Melissa Kelly, Paul Fowler and Michelle Bellingham for their help, with the final episode of this series of Hormones: The Inside Story! Thanks so much for sticking with us.

This series was brought to you by the Society for Endocrinology. If you are hungry for more hormone content, of course you are - they have some great resources about the hormones we've covered, and many many more at yourhormones.info, follow them on twitter

@soc_endo and find them online at endocrinology.org - and if you did enjoy the series do let them know, we might get to make another one!

I'm Georgia Mills, I had the pleasure of producing the series, and thank you to Kat Arney who was the executive producer. This has been a FIRST CREATE THE MEDIA production. Thank you very much for listening, and goodbye.