HOUSE OF COMMONS

Science and Technology Committee

Oral evidence: 'My Science Inquiry', HC 1716

Tuesday 29 January 2019

Ordered by the House of Commons to be published on 29 January 2019.

Watch the meeting

Members present: Norman Lamb (Chair); Vicky Ford; Bill Grant; Mr Sam Gyimah; Darren Jones; Stephen Metcalfe; Carol Monaghan; Damien Moore; Graham Stringer; Martin Whitfield.

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Witnesses

I: Dr Jyotsna Vohra, Head of the Cancer Policy Research Centre, Cancer Research UK.

II: Dr Robert Massey, Deputy Executive Director, Royal Astronomical Society.

III: Dr Chris Brown, Policy and Public Affairs Manager, Society for Applied Microbiology.

IIII: Dr Nicola Patron, Synthetic Biology Group Leader, Earlham Institute.

IIIII: James Tooze, Policy Officer, Campaign for Science and Engineering.

IIIIII: Dr Emma Williams, Vice-Chancellor's Fellow in Digital Innovation and Wellbeing, School of Psychological Science, University of Bristol.

IIIIIII: Catherine Joynson, Assistant Director, Nuffield Council on Bioethics.

IIIIIIII: Professor Toby Bruce, Professor of Insect Chemical Ecology, Keele University.

IIIIIIIII: Professor Rachel Oliver, Professor of Material Science, University of Cambridge.

IIIIIIIIII: Dr Gesche Huebner, Senior Research Associate, UCL Energy Institute.

Examination of witness

Witness: Dr Jyotsna Vohra.

Q1 **Chair:** Welcome, all of you. It is really good to see you all. We very much appreciate your coming and your engagement in this interesting process.

As you know, the way in which this will work is that you will all be given exactly the same amount of time. There is a rather large clock here that you can follow. When the five minutes are up, you need to stop, so that we are fair to everybody. We will then have five minutes of questioning per submission.

After it is all completed, we will have a private discussion. We will not be able to make an immediate decision, but we will let you know as quickly as possible. Realistically, we are probably looking for about three to choose from this 10, but there will be some actions that we can take on all of them. Therefore, something will happen as a result of your submissions today. We really appreciate your engagement.

We come to the first of the presentations. Would you like to introduce yourself?

Dr Vohra: I am Dr Jyotsna Vohra. I am the head of the cancer policy research centre at Cancer Research UK. Thank you for inviting me to speak today.

On behalf of Cancer Research UK, I ask the Science and Technology Committee to call an inquiry into the use of wearable technology such as Fitbit and applications such as MyFitnessPal and 30 Day Fitness Challenge, to see how we can harness the knowledge from them and use them to inform policies that will help us to reduce the incidence of preventable cancers. We believe that, as the Committee that has oversight over the interface of technology and research, you are best placed to call for this evidence inquiry and subsequently to advise the House, using the evidence provided.

Wearable technology such as Fitbit and applications such as MyFitnessPal are growing in popularity. There are currently 25 million registered Fitbit users, and the app 30 Day Fitness Challenge has been downloaded 5 million times since 2016. This popularity continues to increase.

The potential for these technologies to support behaviour change, and how they could be used to support us to reduce the behaviours that could lead to preventable conditions, is widely discussed. However, there is a distinct lack of evidence that shows the actual impact of these technologies on behaviour change, especially in the UK. Furthermore, there is a distinct lack of evidence on how the data that we could harness from them could help us to understand how, what and why they are used.

We at Cancer Research UK see a potential in these technologies and have tried to fund some seed-funded studies in the area. However, we require

a vast evidence base before we can make a strong recommendation as to how they can be used to stop and to prevent behaviours that increase a person's cancer risk.

We all know that 40% of all cancer incidence in the UK is preventable through behaviours. Tobacco is still the leading cause, but, as you will all have seen over the last couple of weeks on your journeys into Westminster, obesity is second—and is fast catching up. Obesity can lead to 13 types of cancer, including two of the hardest to treat: oesophageal and bowel cancer. Obesity causes almost 23,000 cases of cancer every year.

In this country, we have an increasing obesity epidemic. Twenty-six per cent. of adults in the UK are obese, and one in five children leaving primary school is obese. Those children often go on to become overweight and obese adults, with a majority of preventable health conditions, including diabetes, cardiovascular disease and cancer.

Policies such as the sugar drinks industry levy and the junk food marketing restrictions are vital if we are to see a reduction in the alarming obesity numbers, but we have always known that there will never be one silver bullet to calm this rising epidemic. We must use all the resources available to us to support a healthier nation. We need to take collective responsibility.

Wearable technologies provide us with an avenue for this. Not only can they support individual behaviour change and enhance population-level measures such as those described, but the data that they provide could have huge potential in helping us to understand how those policies help the public, and how we could help those policies to help the public even more. The data could show us who is using them, where they are being used, which communities are using them and how we could better target those communities with our policies, to ensure that we reduce obesity and tackle the obesogenic environment in which we are living.

We know that the technologies discussed here can facilitate behaviour change, but is there more that we can learn from harnessing the data? Can we understand more about the user demographics? What gets the best results in the populations with the highest obesity rates? How can we communicate with them better? How can we get our information to them better? These are all things that an evidence inquiry into these technologies could help us better to understand, to ensure that we have the maximum impact with our policies to reduce the environments that help to cause preventable cancers.

We believe that an evidence inquiry has the potential to address the actual impact of these technologies and to look at sustainability in long-term behaviour change. It could look at inequalities in health and how we can use these devices to reduce those inequalities and to ensure that everyone leads a healthier lifestyle. It could look at the regulatory options around data harnessing, to ensure that the public are still safe while we

are taking this data to ensure that we can inform the best policies for their care. This Committee, with its remit across technology, research and health, is best placed to deliver that inquiry. That is why we ask you here today to deliver it.

Such an inquiry is also incredibly timely. Our Secretary of State for Health recently released a paper called "Prevention is better than cure." In this, he specifically mentions the use of prevention and addresses the challenges of using data and harnessing artificial intelligence and technologies to inform us of how we can have better health for our nation and prevent healthcare conditions.

Chair: I think that time is up. Although I cannot see the clock, I am told on the measure here that it is up. Thank you very much. We appreciate your time.

Q2 **Carol Monaghan:** I read an article in yesterday's *Times* about the Fitbit. It talked about the problem with the worried well, who are using Fitbit data to overwhelm GPs' surgeries. From what you were saying, it is obvious that there is a lot of data that we can harness. How do you see the division between harnessing useful data and overwhelming a system?

Dr Vohra: It is a fine balance. As more and more information about health becomes available, it creates that problem. However, I think we can use the technology to understand how people are using it, in order better to inform GPs of what is coming in. We can see whether we can link them to health records, so that GPs are prompted with the correct questions. There are various mechanisms that we can try to link together to support primary care.

Q3 **Carol Monaghan:** Would you see the inquiry as playing a part in that?

Dr Vohra: Yes.

Q4 **Darren Jones:** This Select Committee takes evidence. It can conduct literature reviews and then make recommendations. You said in your pitch that there is a distinct lack of evidence. What outcomes do you think we might get to, other than suggesting that the research councils should fund research into this area?

Dr Vohra: There is some evidence that is starting to emerge in other countries. We could use that to look at how it could be applied to the UK populations. Therefore, there could be suggestions from there as well. However, the majority could be to advise them to collect more evidence.

Q5 **Chair:** Our recommendations tend to be directed towards Government, although not exclusively. You mentioned the possibility of some role for regulation. Do you have something in mind? I am thinking about what potential outcomes there could be from an inquiry. Do you have anything in mind as regards the application of regulation?

Dr Vohra: I do not have anything in particular in mind as regards the application of regulation from this, but I would hope—

Q6 **Chair:** Is there anything else that the Government might be recommended to do?

Dr Vohra: They could look at how people use these technologies, to see whether the Government could look to support things such as adverts or information that are being pushed.

Q7 **Chair:** There could be public health campaigns and so forth.

Dr Vohra: Yes.

Q8 **Vicky Ford:** The first question is, why us, and not the Health and Social Care Committee?

The second question is, when you look at this data—this 25 million—is there a risk that you are biased, because only certain groups of people are using these technologies? We would be looking at wealthier groups, for example, not those on lower incomes.

Dr Vohra: The first question was, why you? It is because you are the Committee for Science and Technology and have an influence on health. I think that the technology aspect is key. That is why it should be you.

With regard to the 25 million, there is a potential for bias. We need to understand that. That is why the evidence inquiry would be so helpful—to help us to understand who is using them and whether there is a potential bias.

Q9 **Bill Grant:** I like the concept that wearable technology is accessible to some, but not to all. An inquiry may not reflect the hard-to-reach areas where cigarettes are consumed to a greater extent and obesity may be greater. I feel that, although there is merit in it when these wearable technologies are more widely used, in the wider community, it might be too early in the process. I sense that there might be a narrow group that would feed into the data.

Dr Vohra: That is why we have focused not just on wearable technologies in our ask. We have also looked at the applications that people often download on to their smartphones and so on, which help them to look at things such as how many steps they have done. The duality of both would help with that, hopefully. I recognise that some communities still do not use these technologies.

Chair: You have very little time left. I will take questions from Sam and Damien.

Q10 **Mr Gyimah:** Vicky asked my first question: should this not be done in conjunction with, or probably by, the Health and Social Care Committee?

One thing that is not clear to me is whether you want this Committee to look at the different technologies and their impact, or whether we should look specifically at one technology and how it makes a difference to health outcomes. If it is the different technologies, it strikes me that it sits here. If it is health outcomes and one technology, it may sit

somewhere else.

Chair: Keep your answer tight, if you would not mind.

Dr Vohra: We would see it as looking first at wearable devices and apps that look at physical activity in the obesity area. If we could look at the evidence from that, we could see whether we could apply it to other behaviours. That is the way in which we would look at it.

Q11 **Damien Moore:** You mentioned steps. People use Fitbits to measure steps and things like that. Would you be looking at the maintenance of those devices as well? Quite often, people can do several thousand steps having not worn the device for some time. They do not want to lull themselves into a false sense of security.

Chair: Or the battery runs out.

Dr Vohra: I have not considered that, to be honest with you.

Q12 **Chair:** Out of interest, may I ask everyone in the room who is wearing a wearable device—a Fitbit or whatever it may be—at the moment to raise their hand? That is very interesting. It is a very small number. I am absolutely amazed. Thank you very much. May we have the next presentation, please?

Dr Massey: I have one on my phone, but I have not used it for months.

Examination of witness

Witness: Dr Robert Massey.

Q13 **Chair:** Good morning.

Dr Massey: Good morning. I am deputy executive director of the Royal Astronomical Society. Thank you for inviting me here today.

I would like to make the case to the Committee for an inquiry into plan S. This is the unprecedented imposition of a new model for scientific publishing, which has led to serious concerns from research scientists, scientific publishers and university libraries, all of whom should be witnesses, along with those pushing the plan forward, if an inquiry goes ahead.

The UK has a 20% global share of the scientific publishing industry. It directly supports around 3,000 jobs—a larger number is dependent on it—and has an export value of £1.4 billion. In our view, plan S may put that at risk.

To give you the background, plan S is the push by the so-called cOAlition S, a group of 13 research funding organisations and three foundations across Europe, effectively to force the scientists whom they fund to publish using the gold open access model, where authors pay to publish,

from 1 January next year. UKRI is a member of that coalition, so this is set to happen regardless of Brexit.

Why do we want an inquiry? This is an example of a one-size-fits-all approach to policy making. It assumes that researchers are unwilling to move to this open access model and that publishers are inflexible in their approach. This radical decision was announced in August last year, without consultation with the scientific community or scientific publishers.

Representing the Royal Astronomical Society, I will not pretend to speak for all of our peers in other disciplines, but I can tell you about the behaviour of those whom we represent: astronomers and geophysicists.

Astronomers were among the first groups to embrace the internet. From as early as 1991, they began to post their papers on the fully open-access repository arXiv, which allows anybody—the public and scientists—to read those papers. These days, virtually all those researchers do that. There is almost nobody, certainly in the industrialised world, who does not follow that model. Open access is already a working thing for this group.

EarthArXiv covers geophysics in the same way, although it has been slower to get going. Based on simple research that I did over the weekend, I think that there are something like 200 covering other subject disciplines.

In short, the scientists want to move to an open-access model. There is no resistance on their part to doing this. They embrace sharing their work. Our journals, which are published by a not-for-profit, Oxford University Press, actively encourage them to do that. There is no barrier on our part, either.

The issue is what this does to the process of paying for their work to be published. At the moment, journal subscriptions pay for the necessary management of that process, including peer review, which allows the ecosystem to function and allows people to present their work and have it read, so that it can be acknowledged, criticised and so on. The authors of plan S do not seem to understand that. They do not understand that there is a mixed model of so-called hybrid journals, where some people subscribe and some people can pay, if they really want to—although I do not think that it is necessary—that is favoured by research scientists. Fifty-two per cent. of UK research outputs are already available through an open-access model. We are leading the world on this already, without the need for this additional plan—or, at least, the recommendations of the plan—to impose a fundamental change on the system.

If it goes ahead, it will certainly be disruptive. Publishers need an income stream to run their journals, so plan S will force OUP and many other publishers to move to a gold model, where a researcher may be faced with a bill of £1,000—perhaps several thousand pounds—to publish their work.

What will we say to a researcher working without a grant, for example—and there are many—who makes a significant discovery? They will then have to go to their university and ask for a large sum of money just to publish that work. They simply may not be able to do it.

Who is the gatekeeper for it? Is it someone holding the grant? Is it the university library? That is the case in some institutions. Is it somebody in the university management? How are they qualified to make that decision?

It is clear that this will be a very fraught process, which will compromise the process of bringing science into the public domain. If it is inaccessible, or there is an incentive for some journals to push stuff out, because it is a money-making system, you run the risk of lowering public trust in science by compromising peer review.

It would be disingenuous of me not to say that there is an interest in this on our part, because scientific publishing supports learned societies like our own. I am not going to pretend otherwise. What I will say is that the revenues that we have pay for various activities, such as public engagement, scientific meetings, seed funding for research and travel grants for early-career researchers. In our case, we run a significant library on it as well. We are a charity, with a clear understanding of public benefit.

I think that this is a massively disruptive change to the model and that it needs more political scrutiny than there has been up to this point. I am aware of the correspondence that the Chair has had with the Science Minister on this. At the very least, such a significant and transformative move needs greater oversight. I ask the Committee to look into this in more detail.

Q14 **Chair:** Thank you very much. Do you imagine that it would take one evidence session or longer than that?

Dr Massey: I think you need at least one evidence session, with witnesses representing those who are pushing the plan forward and those who have expressed concerns. I would not necessarily say, for example, that we, as a small learned society, should be one of the witnesses, but I certainly think that the larger societies should. They are very familiar with this, too. I think that you need representatives of research scientists, because that is a voice that has been missing in this as well.

Q15 **Chair:** Do you accept that there is something of a conflict of interest, in that you have financial income—

Dr Massey: For us? Yes, absolutely. We are also there as a voice of researchers. If necessary, we could convene researchers independent of ourselves and ask them to give evidence to you.

Q16 **Stephen Metcalfe:** At the beginning of your presentation, which I thought was excellent, you said you did not speak for the other societies.

However, there must be a conversation going on. We are all aware of the important work that the various societies do to support their members. As you rightly point out, a lot of the funding comes from publishing. How wide an issue do you think that this is? Is it common among all societies, or does it vary depending on size?

Dr Massey: I think that it affects virtually all societies that represent research scientists, if they have a publishing arm. It is impossible to see that it would be otherwise. Some of them already have gold journals that tick along. Actually, we could move to that on this short timescale, if we had to. It might even benefit us financially. The problem is the impact that it has on the research scientists. We have the understanding that it is not just about maximising our revenue stream.

Q17 **Stephen Metcalfe:** There is a conversation going on.

Dr Massey: Absolutely. There are conversations going on. It is a common issue. For example, the ALPSP—the Association of Learned and Professional Society Publishers—is making representations, as well as the Publishers Association.

Q18 **Vicky Ford:** As I understand the logic of plan S, it is that, if research has been publicly funded, it should be free to view. If it is going to be free to view, somebody needs to pay the publishing costs. Therefore, you have to pay to publish it. If your biggest concern is, "Where is the money going to come from to pay to publish?" can we sort this? In the Minister's letter, he says that Walport will come up with a funding mechanism. Do we need to do a full review, or do we just need to have an intense discussion with the Minister in order to say, "You cannot move to plan S until it is clear to researchers where the cash is coming from to fund this"?

Dr Massey: There are two aspects to that. First, if you are in receipt of a UKRI grant, you can envisage a system where part of that grant covers this. There will be some tensions, because there will be a question of how much of your grant you want to spend on publishing papers. If you work in a field that demands that a lot of papers are put out, it will be more expensive. I worry about those who are not in receipt of that funding, because they will not be able to access it.

Q19 **Vicky Ford:** Are we in sync with other countries? A number of times, I have stood up in the House of Commons and said, "We lead the world on the number of peer reviews and published journals. We are the best." I do not want to find suddenly that we are doing something that no one else is doing.

Dr Massey: I think we are very far ahead on open access. The critical point missing from plan S is an understanding of the free subject repositories that already exist. In the UK, there was quite a push to encourage universities to create them, because they would benefit the institution. Actually, if you work in a particular field, what you want to do is to look at an online repository where you see your work—

Vicky Ford: So we are doing this—

Q20 **Chair:** Hang on, Vicky. We are getting very tight for time. Others want to come in.

Dr Massey: The point is that you can put things in those repositories for nothing, at the same time as publishing. That is what we do. More and more publishers are okay with that model.

Q21 **Martin Whitfield:** You have partly answered my question. In your submission, you talked about a risk to the quality of peer review. Will you explain that a little?

Dr Massey: First, there is an incentive to publish. You would have a system where you were asking for article-processing charges for someone to put in a paper. Arguably, that charge would be paid whether or not the paper was published. In practice, however, it is very easy to see that it incentivises journals to accept them. There may be less reputable ones that come into existence—which is already happening, to an extent—that simply accrue fees from people. Fees are rather lower, and everything gets published. In doing that, you undermine peer review.

Q22 **Mr Gyimah:** Are we too far down the track for an inquiry to make a difference? To the extent that you want an inquiry, is it really about defending the revenue stream, or do you think that a public policy interest is at stake?

Dr Massey: I do not think that we are too far down the track, given that the decision was announced before we had had an opportunity to run an inquiry. I am not necessarily suggesting that the decision should be reversed entirely, but there are core details that are very disruptive and that need to be looked at in more detail.

I have said explicitly that we have a revenue stream from this, so we are conflicted, of course. My view is that there is an issue for the wider research community as a whole. Irrespective of what it does to our membership and our revenue stream, there will be researchers who could be very disadvantaged by this. It is not just about low-income countries—it is about people without grants. What will they do?

Chair: Thank you very much, Robert. We really appreciate your time.

Examination of witness

Witness: Dr Chris Brown.

Q23 **Chair:** May we have the next submission, please? Welcome.

Dr Brown: I am policy manager at the Society for Applied Microbiology. Thank you for the opportunity to come and speak today.

We are living in a microbial world. Not only are we surrounded by trillions of micro-organisms, but experts estimate that over half of our body is not actually human—the majority is microbes. Discoveries such as these are changing the way in which we view ecosystems. In a relatively short period of time, the field of microbiome research has exploded, driven by powerful and cheap genomic technologies.

What is the microbiome? It is a community of micro-organisms such as bacteria and viruses that have adapted to live in a particular environment. They are everywhere. They are in and on our body, and throughout nature, from the bottom of the ocean to the surface of a plant leaf.

Microbiomes have a profound effect on the health of their local environment, which is why microbiome research holds significant potential to tackle aspects of human disease, pollution and food security.

For example, a person's microbiome may tell us about their risk of certain conditions and diseases. Altering the microbiome could help to optimise health and to tackle disease. You may have heard of the use of faecal transplants to help to treat severe bowel infections.

The agritech sector is developing products that modify the microbiome of plants and soils to boost plant health and to reduce the need for pesticides and fertilisers.

Lastly, researchers are investigating microbiomes in the search for new products. For instance, the marine microbiome is being looked at for potential new drugs, as well as microbes that can eat through plastic.

The UK has a very strong microbiome research base. It has centres of leading excellence such as the Quadram Institute in south Norfolk. Despite this strength, many scientists are worried that other nations are overtaking the UK, especially when it comes to the innovation and development of new products for market. Last year saw meetings organised by the Royal Society and Innovate UK, among others. Reports from all those meetings highlight the need for better policy and enabling regulation to push forward in this area. Something needs to move the needle.

We believe that an inquiry by this Select Committee could be the catalyst that brings the concerns and needs into sharp focus for the Government. Microbiome research spans many different sectors, so it really needs a cross-governmental approach, including the involvement of the Government Office for Science. We think that this Committee has the wide vision necessary to look at the various policy levers within the industrial strategy, health and agritech policies and the bioeconomy strategy, which came out late last year.

Why should this be looked at now? Other nations are already ahead of the UK in having a co-ordinated plan. In 2016, the US Government put

$120 million into the launch of a new national microbiome initiative. They also created a working group to create a cross-governmental strategic plan for microbiome research. That was published last April. Globally, there has been an exponential increase in microbiome-related patents, clinical trials and start-up companies. Many of those are overseas—in the USA, but also throughout Europe—so rapid action is needed to capitalise on the excellent research that we have in the UK.

I want to touch on one or two issues the Committee could look at if it were to conduct this inquiry. As I hope that I have demonstrated, microbiome research has many wide-ranging applications in different sectors. However, some research fronts are more advanced than others, and some fundamental science questions remain. The Committee could investigate the potential for a UK road map, or something like that, to identify the key opportunities for our business and the need for co-ordinated funding methods to accelerate innovation and to stimulate early adoption of technologies.

The Committee could look specifically at regulation of microbiome research and innovation. In many cases, microbiome products have been developed for use in healthcare and agriculture. They are facing regulations that are meant for the chemical and pharmaceutical industries and, therefore, are not really fit for purpose. The Committee could look at ways of setting out clear, appropriate methods to regulate clinical trials and microbiome products that come to the market.

It could focus on consumer regulation. Members of the public can now buy kits to get their microbiome—their gut—tested. They are similar to commercially available DNA testing kits. However, the links between microbiomes and health—certain diseases—are not yet fully clear, so urgent action is needed to make sure that the public are not misled into following the health advice from such tests, rather than that of their healthcare professional.

Finally, where could you source information and expertise? I have already mentioned the numerous reports from multi-stakeholder meetings involving academia and industry. In addition, last year the Parliamentary Office of Science and Technology produced a briefing on human health and the microbiome. It is preparing one on soil microbiomes for early this year. There is a good wealth of information and expertise there.

In summary, we think that the microbiome presents a timely opportunity for the UK Government to demonstrate their commitment to a vibrant, prosperous national bioeconomy. This Committee could be the catalyst that brings all of this need to the Government's table. I would be delighted to answer any questions that you have.

Q24 **Chair:** Thank you very much. You have described how this covers a whole multitude of different areas. Do you think that one inquiry could do justice to the strategy and approach that are required for all of those, or do you think that it needs to focus on one particular area?

Dr Brown: You could take it in a few ways. I suppose that the crux of our argument is that it could be a catalyst, to get the Government to pull together and formulate a strategy. You could highlight some of the needs and the fact that, in agritech, there are already one or two products—microbial-coated seeds—on the market. Things are already happening overseas, where things are on the market, but not here. It is really about looking at what the broad possibilities are and saying to the Government, or the Government Office for Science, "Do you need to do a foresight report on this, for instance? Do you need to look at what happens across Government?" You could also look at what the USA has done with its working group on this topic.

Q25 **Bill Grant:** Thank you for that excellent presentation about microbiomes. You suggest that we as a nation have been overtaken by other countries. What would be the advantage of an inquiry by this Committee? How would that assist us in regaining our place?

Dr Brown: It is not a case of our having been completely overtaken and left in the dust. We have an excellent basis of knowledge and expertise throughout the UK. The research is really strong. It is about turning that into some sort of economic benefit. In the Government's bioeconomy strategy, they talk about ways of taking that excellent research and applying it. It could be about that gap and making sure that we are at the forefront of this. Throughout France, microbiome companies have received a lot of funding to have that start-up.

Q26 **Bill Grant:** Are you suggesting that we are not capitalising on the good research that is already done here? Is that what you are hinting at?

Dr Brown: Yes. Industry and academia come together regularly. At those meetings, they say that these are issues.

Q27 **Carol Monaghan:** Do you envisage this inquiry being about raising awareness of the UK research base, or do you see it being more about directing Government policy with respect to development? Can it do both?

Dr Brown: I suppose it could cover both. There is policymaker awareness and POSTnotes on human health and microbiome covering that to some extent.

There is also public awareness. The public still have conceptions about whether microbes are good or bad. If you tell people that you will create new crops with live microbiome and live bacteria that have been adapted on them, they might think that is a terrifying message when really it is just adapting what is naturally there anyway.

I suppose that the crux of our argument is making sure that the Government are aware of this area and the potential behind it, because a lot of industry and academia want to drive this forward in other places where there are products.

Q28 **Darren Jones:** I want to be clear about where we are in the research innovation journey. I think you are saying that we are pretty good at fundamental research in the UK, but we are now in the space where we are trying to commercialise that research in key industrial sectors. I think that is right, is it not?

Dr Brown: It is really both at the same time, because it is such a vast area. A skin sample will have thousands and thousands of different things on it, and to be able to analyse those you need to overcome some fundamental science hurdles to get down to the deepest level of immersion.

At the same time, some aspects of microbiome research are being developed, so it is about splitting apart what still needs to have that fundamental science funding to find out what the new possibilities are at the same time as capitalising on things like the agritech sector that are developing things.

Q29 **Darren Jones:** Therefore, that could be our assessment—where are we in the space between research and application?

Dr Brown: Absolutely.

Q30 **Chair:** You have described the need for some road map to guide our way through this.

Dr Brown: That would be a suggestion. It could ultimately lead towards a sector deal. There is not really a microbiome sector. Because it is such a broad area it might need that kind of holistic viewpoint.

Chair: Thank you very much indeed; we appreciate your time.

Examination of witness

Witness: Dr Nicola Patron.

Dr Patron: Good morning, and thank you. I am a research leader in plant molecular biology and biotechnology at the Earlham Institute.

Like much of the research that is currently done by UK scientists, the work in my lab has the potential to be applied in agriculture and industrial biotechnology. Projects currently in my lab may lead to crops that are better able to grow with fewer applications of agrichemicals and have improved nutritional value.

To achieve these goals, we are also funded to engineer new and improved tools—plant biotechnology—in particular, tools for genome editing. We have worked with other scientists to demonstrate that these tools work in crop plants. We have been able to demonstrate that we can predictably engineer useful traits into a plant by making a very small change, perhaps one or two letters of DNA in the five or more million in the genome of that plant.

I appreciate that the speed of science and technology is fast. To those outside my field, the work we do can sound fantastical, even unnatural. However, science mainly uses tools adopted from the natural world. We are able to make small mutations in DNA because nature already has mechanisms to do this.

If we look around at populations of wild plants, animals and even humans sitting in this room today, we can see differences between individuals. These are due to the small differences in our DNA. Thousands of years ago humans began domesticating plants and animals. To do this, they selected individuals with the traits that they wanted and bred them together. Over thousands of generations this has resulted in, first, the incredibly productive food system we have today that enables us to feed an extra 6 billion people on the planet since the Neolithic. However, that process of domestication means our crops lack genetic diversity and are very uniform.

Consequently, the goal of crop improvement is to bring new traits, like resistance to emerging diseases, increasing nutritional value and other consumer and agricultural traits into those very high-yielding genetic backgrounds. Some of this is done by breeding, as it has always been done, but this also brings in very large numbers of undesirable genes that reduce yields, making this a slow and expensive process.

In the mid-20th century humans began using x-rays and chemicals to induce mutations. That process has brought thousands of new varieties to market, but it also takes many years of development for each variety because, as well as the useful mutations, there will be a background of many non-useful and unwanted mutations.

In the 1980s science developed technologies to bring in just the specific gene of interest. This has become known most commonly as GM. GM crops are now grown on 185 million hectares of land worldwide by 18 million farmers with some impact.

However, genome editing is different. As we and others have demonstrated, genome-editing technologies allow us to make just a few changes to the DNA at a very specific sequence. Foreign DNA does not need to be inserted, and the end product may be indistinguishable from one made using older, unregulated technologies, like chemical mutagenesis.

Countries around the world, including the US, Canada, Brazil, Australia and many others, have agreed that the products of targeted mutagenesis enabled by genome-editing tools do not require the regulatory process of GM, and they are now using these technologies to develop products.

Last autumn, several countries issued a statement via the World Trade Organisation advocating a functional, risk-based regulatory approach that encourages innovation. They warned that, without international alignment, different regulatory oversights would impose barriers to global

trade, and it would be difficult or impossible to develop tests that distinguished between plants with mutations using an older technology and those using genome-editing technologies.

However, last summer the European Court of Justice ruled that all organisms obtained by genome-editing techniques should be governed by the same regulations as GMOs, even though the Advocate General had previously given the opinion that the organisms obtained by mutagenesis were in principle exempt.

This ruling means that currently much of the work of UK scientists, including the work I am doing now, is suddenly far less likely ever to have impact in UK agriculture. While scientists and companies in the US, Canada, Brazil, Australia and Argentina are adopting these new technologies, increasing the sustainability and profitability of their agriculture and producing higher yields at lower cost per hectare, progress in Europe will stagnate.

Therefore, we ask that this Committee investigate the case for regulatory divergence from Europe, whatever type of Brexit we have. We think the UK needs to ensure the advancement and prosperity of our scientific and agricultural sectors in the global market. We believe that this parliamentary Committee is best suited to this inquiry because it provides a format for responsible and evidence-led informed consideration of the scientific evidence, alongside the wider opinions that might be held by other consumer groups, without being led by the sensationalist headlines that we feel have tainted previous debates.

Chair: That is very impressive. You are dead on time. Thank you very much indeed.

Q31 **Stephen Metcalfe:** Thank you very much. That was a very interesting presentation. Your work sounds fascinating.

Do you accept that some of the objection and perhaps the reason the ECJ is putting genome editing in the same category as GMOs is based not on the science but on the politics—it is a philosophical dislike of the research? However we might do the inquiry and come up with responses, it will be hard to get over that hurdle. Do you agree, and how do we get people to see the philosophical argument as two separate arguments?

Dr Patron: It depends on who you are asking to see this philosophical argument. We are looking at the case for the UK, not necessarily changing the ideals of the European Court of Justice. It is not my experience that a very large number of people are philosophically opposed to it; I think it is a small section of people. No one is suggesting that all of our agriculture would do this; people would still have consumer choice about what they eat. This is about allowing some sectors of industry to move forward so we are globally competitive. I do not think one excludes the other.

Q32 **Chair:** Is it also right that the Commission's chief scientific advisers have

called for revisions to the GMO directive to facilitate different approaches?

Dr Patron: I am sorry.

Q33 **Chair:** Your submission says that recently the European Commission's chief scientific advisers have called for the GMO directive to be revised to reflect current knowledge and scientific evidence.

Dr Patron: The advocate did, but then the ruling was different. What is confusing about this is that everybody expected something different because it is not what the evidence says, but the Court of Justice has decided that this is the way it will be regulated.

Q34 **Chair:** The point I am making is: is there a recognition by the Commission, as opposed to the European Court of Justice, that perhaps change is needed to the directive?

Dr Patron: Yes, there is a recognition of that.

Q35 **Martin Whitfield:** Thank you for your very interesting submission. On one side you have the legal problem with the European Union; on the other side you have the opportunity, if it is an opportunity, with regard to Brexit. While not necessarily disagreeing with you, is not what sits behind this an attempt to "de-Frankenstein" the public view of GMOs? There needs to be better education and understanding of the potential of the technology and the fact that all you are doing is what nature has done for millions of years anyway, just with more control and certainty.

Dr Patron: There is a need for that. Clearly, the Committee can help with the submission of evidence. There is also evidence we can submit. We do not believe that a very large number of people hold that view. We believe a very vocal minority put forward that view. I do not believe it is a majority view, but we would absolutely engage in providing that information.

Q36 **Vicky Ford:** Why now?

Dr Patron: It is timely because of the decision of the European Court of Justice; it is also timely because the World Trade Organisation is looking to Europe and mostly the UK to do this. It will be our trading partner.

Q37 **Bill Grant:** Thank you for the presentation. Looking at climate change, changes to crop yields, the growing global population and so on, is there an urgency in relation to the work that you and your team are doing?

Dr Patron: There is an urgency. At the moment, we predict that we need to increase global yields by about 50% by 2050 to feed populations. Traditional breeding techniques usually manage to increase yields by about 2% a year. We have seen technologies using these techniques that are able to provide yield increases of 20% or 30%, which would move us away from a catastrophic future scenario to a safer one.

Bill Grant: Therefore, there is an urgency.

Q38 **Chair:** Norfolk is very significant in this regard.

Dr Patron: Norfolk is very significant.

Chair: I am not biased in any way. Thank you very much indeed.

Examination of witness

Witness: James Tooze.

James Tooze: Good morning. I am here on behalf of the Campaign for Science and Engineering. I will refer to us as CASE for the purposes of this inquiry. We are the UK's leading independent advocate for science and engineering.

The Government's Chief Scientific Adviser's guidelines on the use of science and engineering advice in policy making set out how scientific advice should be both sought and applied in Government. CASE is recommending that this Committee review the uptake of and adherence to these guidelines by different Government Departments.

The task facing policy makers has arguably never been greater as the UK is set to navigate leaving the European Union. It is likely that, regardless of any future agreement between the two parties, there will be significant flux in domestic policy across all Departments in the short, medium and long term. This increases the importance of ensuring that the processes and structures for accessing and using evidence to inform decisions are fit for purpose, performing well and as joined up as possible across Government. The uptake of external scientific advice and the in-house capacity for Departments to solve problems in a scientific way are crucial in integrating science and engineering across the whole of Government.

The guidelines state that the Departments should have sufficient in-house scientific and engineering capability to act as intelligent customers of research. Unfortunately, there have been a number of cases over the past few years where Departments have been without a chief scientific adviser for months and years, and to this day some still remain without one. Although the guidelines and the current Government Chief Scientific Adviser recognise that not all Departments are uniform in their make-up, without supportive structures to absorb scientific advice, this expertise will be missed out on in shaping and permeating through to the policy-making process. In order to support the Government's aims to make the UK a more research-intensive nation, the use of scientific advice will be important not just for Departments like BEIS but for all.

I believe the Science and Technology Committee is well placed to conduct this inquiry as it is an issue that cuts right across all Government Departments. In an almost unique way, this Committee holds that remit.

CASE initially made the recommendation for the Committee to review the uptake of and adherence to these guidelines in 2017, but since then we have had an election, a restructuring and reshuffling of Government

Departments and a new Government Chief Scientific Adviser, who has now been in post for 10 months. Now feels like the opportune time for this Committee to build on its previous work and the work of its predecessors around chief scientific advisers and their networks.

What can be achieved in undertaking this inquiry? In holding Departments to account, this Committee can act as an effective champion to support a more efficient, rigorous and transparent policy-making process to help the Government be better equipped for the challenges of the present and future. At a time of constrained public resource, efficient policy making is also crucial for the Government to deliver policy in the best interests of the public.

Scientific and technological expertise underpins the creation of and adherence to regulations that affect all areas of day-to-day life. As the UK is set to leave the European Union, significant scientific advice will be required to ensure that the UK can create and adhere to its own regulatory standards so that it continues to be an outward-looking nation in trading with international partners. Whether in food, agriculture and the environment through to building regulations after Grenfell and working time directives currently legislated by the European Union, all Departments will be able to benefit from scientific and engineering expertise.

As recently as Friday, the Science Minister outlined the Government's aim to place R&D at the heart of the UK economy. In addition to providing R&D funding, Departments can act as intelligent customers of research to help stimulate science and engineering in the UK. More extensive networks of scientific and engineering expertise can enable Departments not only to see how research and innovation will be able to support their respective departmental aims but deliver forward-looking and future-proof policy for the benefit of the public. In turn, a more intimate understanding of science and engineering will be to the benefit of the growth of R&D in the UK. That is why I believe this Committee should review the GCSA's guidelines for each Government Department.

Q39 **Chair:** Thank you very much indeed. I am trying to understand what might emerge from an inquiry. Would it effectively be saying to Government that it needs to follow evidence more effectively than it does?

James Tooze: Yes, I think so. I wish I had more time to talk a little about the guidelines, but within that it is not only supporting the structures in which scientific evidence can find its way into the policy-making process but being a strong advocate for open and transparent policy both in publishing any evidence that goes along with policy decisions or, if there is a policy decision that is made contrary to the scientific advice, ensuring it is well explained by Government Departments why they have come to that decision.

Q40 **Martin Whitfield:** That is very interesting, James. Do you envisage a

position where a Government might choose to go against the scientific evidence for subjective reasons? Would that be acceptable to you, or is what sits behind this that all policy should be based on evidence?

James Tooze: Scientific evidence is obviously very important, but so are other aspects. I am certainly not advocating that scientific evidence should be the only thing that is ever taken into account in policy making. It is a much more complex process than that. In particular, with the GCSA guidelines, it is about having the opportunity for the scientific evidence to be heard or for problems to be solved in a scientific way, if you like. The vision of this inquiry is to help better equip Government Departments at least to be able to have access to that scientific expertise that hopefully will be able to shape policy, but obviously it forms part of a more complex process.

Q41 **Martin Whitfield:** And probably and rightly takes account of that scientific evidence in coming to a conclusion, and then publishes the evidence for transparency.

James Tooze: Yes.

Q42 **Carol Monaghan:** The Science and Technology Committee is almost always calling on the Government to use evidence when they are developing policy. How do you see this changing things?

James Tooze: Given the change afoot with this Government and the amount of policy we will have to take on in this country, which was previously delivered by the European Union, it feels like a good opportunity for us to say, "This is how the United Kingdom could be more forward-looking." In particular, the current Government Chief Scientific Adviser, Sir Patrick Vallance, is a big advocate of this. He is massively keen to get Government Departments on side not only to champion the use of scientific evidence but to go out to Government Departments that might not see science as within their remit and say, "What are your problems? How can we help science to solve these?" That is a platform on which this Committee may wish to build as well in championing the use of scientific evidence.

Q43 **Darren Jones:** In a post-Brexit world, how do we deal with science input into policy? Is it merely a question of organisational capacity, or are you saying that something that we do in Europe is particularly good and that we need to think about it for the future?

James Tooze: I do not think so. I would like to place on record that I do not think the UK is bad at this; there is just a real variation between Departments. Some Departments have good structures and accountability for the scientific evidence they use, and some perhaps struggle to see where science is relevant. Having a better understanding of where priorities lie for Departments in thinking about how science can underpin and help them reach their aims is something that hopefully this inquiry will be able to achieve.

Chair: James, thank you very much indeed. That is very helpful.

Examination of witness

Witness: Dr Emma Williams.

Dr Williams: I am a research fellow at the University of Bristol. Thank you very much for inviting me to speak to you today.

The UK aims to be a world-leading digital economy that works for everyone. Part of this strategy includes being the best place to start and grow a digital business, and being the safest place to live and work online. To ensure that digital innovation can be fully exploited, it is vital that emerging so-called smart technology products are secure. These devices can range from connected home appliances, smart thermostats and lightbulbs to smart locks and home security systems that can be controlled remotely via wi-fi, Bluetooth or other forms of connectivity. The increasing ability of these devices to talk to one another is a key concept within the internet of things.

The proportion of UK households with smart devices specific to home environments has been predicted to rise from 8.4% in 2017 to 26.8% in 2022. This has the potential for substantial societal benefits in areas such as healthcare, maintaining the independence of older adults and energy use. However, it also brings substantial potential risks. Previous research has shown that many devices can be easily exploited by others, leading to threats to information security, privacy and personal safety. A 2016 study by the organisation GFK claimed that personal privacy and security in the home were both cited as key barriers to smart home adoption by UK consumers.

Damaging data breaches related to particular smart products have already been identified. For example, you may have seen in the media that flaws in particular Bluetooth and wi-fi-enabled smart toys have been found that enable strangers to hack the devices and talk to children. In June 2018 Amazon and eBay were among retailers to remove a particular brand of smart toy from sale due to security risks. However, the fact that these devices made it to market at all risks damaging consumer trust in these emerging smart technology products.

There are currently a number of mechanisms to support the safety of products that people purchase, such as the Consumer Rights Act 2015 and the General Product Safety Regulations 2015, which include technical and legal requirements related to product design, packaging, insurance and things like that. People and organisations can be held liable if they supply or manufacture products that lead to harm to consumers or businesses due to product failure or unanticipated side-effects. There is, however, currently no legislation focused specifically on the security of consumer products.

Recently introduced regulation, including the general data protection regulations last year and the networking information systems directive, provide a degree of enforceable regulation regarding information security. GDPR requires holders of personal data to provide assurances regarding security and how data are kept, and the NIS directive maintains and ensures that the networking information systems that support essential services such as healthcare are safe, secure and reliable. However, these regulations do not extend specifically to consumer product environments.

The 2018 UK Government's secure by design review recently considered the potential to introduce wider regulations specific to this area. It identified that a number of products do lack basic cyber-security, which can lead to threats not only to individual consumers but the wider economy if such devices are used collectively to launch large-scale cyber-attacks. It suggested that the burden of responsibility for security should be removed from consumers and proposed a draft code of practice for manufacturers, so it provided clear guidelines regarding what should be required. However, this remains voluntary at present. Although some aspects of it can be enforced by other means, it is not explicitly focused on this area.

It is very timely, therefore, to conduct an evidence-based consideration incorporating the views of technical and legal specialists, computer scientists, economic and social scientists, businesses developing products in this space and consumer groups regarding whether the UK should introduce regulation focused on the security of consumer smart products; and, if so, how best this regulation should be designed in order effectively to meet the needs of both consumers and product innovators so we do not stifle innovation and, therefore, fully support the digital economy going forward.

Q44 **Mr Gyimah:** Not to pre-empt anything, how are other parts of the world dealing with this problem, and what public policy responses do they envisage coming out of this?

Dr Williams: It is very much developing at the moment. Germany has been a little bit more advanced in looking at regulation. As to the US and other countries, I am not sure what stage they are at. It is a very quickly changing dynamic. A lot of countries are wary of putting a burden on organisations and stifling innovation. Because the technology is relatively new and changing and because of the threats currently emerging, it is very difficult to get a handle on what needs to be done.

I suggest that it would be very good for the UK to lead the field in this respect. It might be that voluntary approaches are effective and a market-based approach will regulate itself, but if it does not and we are ready with potential options for how we could regulate that space it would be very beneficial.

Q45 **Chair:** The Government have indicated that regulation may be necessary. They have taken the voluntary approach and it has failed.

Dr Williams: There was definite awareness that this voluntary approach might not work. We need to see how that pans out. The guidelines came out only in October 2018, so they need a chance to bed in. Some of the bigger companies have said they will sign up to them. We have to wait and see what it means in reality. We also have a lot of product suppliers and things that are not necessarily linked to these big organisations and companies. Ensuring that we have the means to regulate some of the smaller companies on a global scale, which might be hard to keep track of, is important.

Q46 **Chair:** I guess a regulatory approach is quite challenging in a rapidly changing field. Would you agree with that?

Dr Williams: I imagine so, because the technology changes so fast. It is hard enough to keep up with the risks and threats, but that is why I think it is important to understand the current risks and what we can do now to try to adapt.

Q47 **Vicky Ford:** To ask the same question, why now?

Dr Williams: When we saw this review we thought it useful. The UK Government have already done a very good review. It did focus on the voluntary aspect. We are probably now in a period when we will be watching whether that works. For us, we could be ahead of the game in already having considered the regulations we could use, because it is likely that we will need to use them.

Q48 **Bill Grant:** Thank you for that input. In looking at products, how can you apply policy or regulation to those manufactured abroad? Take as an example China, which mass produces them at low cost. How do you see regulations tackling that issue, if indeed it is one?

Dr Williams: It will be an issue. The current review and voluntary code are targeted at a global audience, in multiple languages. We are now seeing potential differences in the regulatory approach to how we trade with a number of different countries. It is probably quite a good time to consider, if we do end up having particular trading relationships and deals with other countries that are not established yet, what regulations we want in terms of the security of some of these products. We will have to take a more global view, and the Committee should probably consider how that is done.

Chair: Thank you very much indeed.

Examination of witness

Witness: Catherine Joynson.

Catherine Joynson: The Committee is well aware of the potential benefits and ethical challenges raised by genomic medicine in the NHS. Today, I want to draw your attention to a parallel world of genomics that we believe is not being subjected to the same checks and balances,

namely the direct-to-consumer genetic testing industry.

Genetic testing companies are now offering a wide range of tests, including ancestry checks; health checks; carrier screening, if you are thinking of having a baby; prenatal screening, if you are pregnant; new-born screening when you have just had your baby; and whole genome sequencing, where you can acquire your full DNA sequence and store it with a company as a resource for life. You may have seen at the weekend in the media that the NHS is thinking of offering whole genome sequencing, for a fee, to healthy individuals in future.

Buying these tests can be a way for people to take responsibility for their health in a positive way and business appears to be booming, but in this country we do seek to protect consumers from being misled or harmed by products that they buy, and with genetic testing the stakes can be high.

For us, the commercial genomic industry raises questions that we think the Committee would be well placed to investigate, and I am going to briefly explore five of these now.

First, does the science back up the claims being made? The sequencing bit is now relatively straightforward; it is the interpretation of the data that is difficult, and we have a long way to go here. Even if we know about the effect of a gene variant in ill people, or those with a family history, we also have very little knowledge of what these variants mean in apparently healthy people. For example, testing for a predisposition to Alzheimer's disease has a low predictive value, which is why it is not offered in the NHS as a screening. Should companies be making predictions based on shaky evidence?

Secondly, are people being adequately prepared for the kinds of results they might get? The results of genetic tests can be shocking, distressing, uncertain and confusing. What kind of information and support are people getting before and after testing? Sometimes, the results might have implications for family members as well. In the NHS this would be discussed before testing and relatives could be contacted with the person's consent. Are people receiving test results through the private sector being supported in this way?

Thirdly, how is this impacting on the NHS? Genetic specialists working in the NHS tell me that they have seen an increase in the number of people being referred to them who have a result from a paid-for genetic test, particularly over the past year. Genetic centres have been advised not to see people if the test is not offered on the NHS, but clinicians tell us that it can be hard to turn people away. If many of these tests are next to useless, why should the NHS be expected to pick up the pieces? If the test does show something useful, why should people who can afford it get bumped up the NHS queue? Why is it not available to everyone?

Fourthly, what happens to people's genetic data? Are consumers reading the fine print? Testing companies often ask people to give them broad permission to use their genetic data for purposes such as research and product development. What does this mean? Do users of ancestry services who choose to share their data realise they might be contacted by distant relatives, or that the police might be searching a database containing their genetic data, as in the case of the golden state killer in the US?

Finally—I think this is the crux of the matter for the Committee—are genetic testing companies being adequately regulated? Regulation of the tests themselves is light. Test manufacturers can self-certify to get a CE mark. Stricter EU regulations are coming in, but how will this affect tests on sale to people in the UK after 29 March? If the test is offered through a clinic, which is the case with most privately available prenatal tests, it is exempt from the inspections of the Care Quality Commission. Although we have advertising codes of practice, I would question whether some of the claims being made by companies' websites fall within them. This area is complicated due to the fact that many test manufacturers are based in other countries. How can we protect people in the UK when they are buying tests from companies based abroad?

When we at the Nuffield Council looked at this area back in 2010 and in some other inquiries we have done, we have generally recommended better information should be available to customers and that regulators should pay more attention to the health claims being made, but the market has expanded massively since then and we see no interest in the concerns I have mentioned from Ministers, regulators or the companies themselves.

We think it would be timely for the Committee to consider these and other questions raised by this rapidly expanding market.

Chair: That is really interesting. Thank you very much indeed.

Q49 **Martin Whitfield:** You mentioned in essence a data resource that is effectively being held by private companies. How concerned is the Nuffield Council? Is what sits behind this presentation today a concern that people are giving out huge amounts of genetic evidence without any real understanding of how it will be used, who will use it and the consequences of that use from an individual point of view, in that other companies will seek to exploit the data for their own manufacturing and marketing purposes and things like that? In my stupid layman's language, are those the fears that sit behind this presentation?

Catherine Joynson: It is definitely one of the concerns. That is one of those hidden harms. People might not even realise it is happening to their data, but it is still a harm; it is a breach of privacy in that way. We have published some work to do with the sharing of biological data in the past. In essence, we think people's data should be used in a way that they reasonably expect it to be used. I think that many people when

ticking a box to say they are happy for their data to be used for research do not intend it to be sold to a third-party pharmaceutical company.

Q50 **Chair:** I guess there is a significant ethical element in this given the psychological consequences of being told something, particularly when we perhaps do not have a full understanding of what we are being told.

Catherine Joynson: Absolutely. Maybe I can give you a short story about an individual that might bring it to life a bit. I have recently been in contact with a woman who when she was pregnant went to a clinic to have a private non-invasive prenatal test for Down syndrome. She was offered a menu of a number of other conditions that could also be tested for. She opted to have those tests, which came back positive for Turner syndrome, which she had not heard of before. She was in turmoil given the fact her foetus had a genetic condition. When she looked into it a little bit further she saw that the test result was extremely likely to be a false positive, and that Turner syndrome was not, in her opinion, a particularly serious condition.

Her options were to find out for sure by having an invasive test—an amniocentesis, which carries a risk of miscarriage—or to wait and see. She chose to wait and see. The baby has now been born. She has decided not to have any further testing and there is no sign of Turner syndrome.

Q51 **Chair:** That is a significant extra strain and anxiety during quite an important period for her.

Catherine Joynson: Yes. I would question why she was offered a test that had the very high likelihood of a false positive.

Q52 **Carol Monaghan:** I take it there is a significant financial incentive for these companies.

Catherine Joynson: To offer more and more tests, yes. There is now a big market; they are competing.

Q53 **Carol Monaghan:** I have a mutt—a brown dog; I do not know what it is. You can have a test on your dog to find out what it is at a cost of £100 or whatever. I imagine it is more than that for humans. Do you feel that at the moment it is sufficiently on the Government's radar?

Catherine Joynson: No, which is why I have brought it to this Committee. We have had very little success in this area in getting anyone to take any notice. To have the Committee's clout in being able to bring companies and regulators to account and question whether they are conducting their business ethically and whether the regulators have got to grips with this would be fantastic. We do not have the same clout that you have, which is why we are putting this forward.

Q54 **Chair:** Are there developments internationally one would want to look at in the creation of a regulatory framework and how the ethics are considered elsewhere?

Catherine Joynson: You would certainly have to take into account the international framework, because these are global companies based all over the world, so taking just a UK approach would not work.

Q55 **Damien Moore:** Your view is that there is potentially an industry growing around fear, and people are potentially exploited.

Catherine Joynson: I am not sure I would be that cynical. I am not saying they are completely useless. There is obviously a demand for these tests and people want to buy them, but I think they should be offered in the right way. They should not be misled about what they are going to get; there should be support for interpreting the results afterwards in the way you would have in a test on the NHS.

Chair: Thank you very much indeed.

Examination of witness

Witness: Professor Toby Bruce.

Professor Bruce: Thank you for inviting me to give evidence on food security, the environment and crop protection. It is a great pleasure to be here. My name is Toby Bruce. My role is professor of insect chemical ecology at Keele University.

I would like to draw your attention to the alarming loss of tools in the toolkit available to farmers for protecting their crops against pests, weeds and diseases. These cause billions of dollars of losses to global harvests. Pests jeopardise food security and the viability of agricultural enterprises. The availability of tools to combat pests is declining as they evolve resistance. This is analogous to antimicrobial resistance to medicines in the medical sphere, but is further complicated by pressure groups and protesters complaining about pesticides.

There is growing public concern about the side-effects of pesticides—for example, on bees—leading to the banning of certain products, but crops are still highly vulnerable to pest attacks. Despite widespread pesticide use, pests destroy about 30% of global harvests.

We have the choice between food security and environmental protection. This is an unworkable choice because we need both. There are consequences to banning pesticides before alternatives have been made available. It is not realistic to assume we can simply go back to nature and ban pesticides overnight. Even organic farmers use natural products and pesticides to protect their crops. Even wild plants produce toxic molecules for their defence. If pesticides could be abandoned so easily, farmers would have done it long ago because it does not make business sense to spend money on treatments that are not necessary.

The NFU-commissioned Andersons report found that proposed restrictions on pesticide use in the UK could lead to a 36% drop in overall UK farming profits. We already import 50% of our food supply and, if we take our eye

off the ball with crop protection, we will become even more import dependent.

While it may be possible to import cheap food from abroad for the foreseeable future, there are questionable ethics about shifting the environmental footprint of our food production abroad. There are environmental consequences.

Although often considered a quaint rural occupation, farming uses more land and water than any other human activity. If yields go down, there will be an environmental cost as farming spreads sideways to produce the same amount of food but uses more resources.

The pace at which old tools are being lost is faster than the pace at which new ones are being provided. There is market failure. New solutions are not forthcoming. It is not just a matter of funding research, although this is a critical factor. There is also a need for a regulatory system that is fit for purpose, because it is currently stifling innovation. Regulation is needed, but it should not be so precautionary that it blocks innovation.

It is of paramount importance to increase research investment in crop protection. Back in 2009 the Royal Society published the landmark report "Reaping the Benefits." Its primary recommendation was to make global food security a priority with the investment of £50 million to £100 million per year of new Government money in addition to existing research spending.

The BBSRC is the main and strongest supporter of frontier bioscience research and has been maintaining its research investment, although not increasing it as much as the Royal Society would have liked. However, the same cannot be said of DEFRA. The DEFRA research budget has fallen from £250 million in 2005 to £100 million in 2014, a drop of 60% in nine years, instead of the increase recommended. This has had a severe negative effect, especially for crossing the valley of death between basic and near-market science.

Q56 **Chair:** Thank you. What do you think could be achieved by an inquiry?

Professor Bruce: It will make a big difference to food security and the environment.

Q57 **Chair:** In what way?

Professor Bruce: The choice at the moment between food security or the environment is a very unhelpful one. We need to find a way forward where we can safeguard our crops without the environmental impacts.

Q58 **Chair:** In effect through the use of smarter regulation.

Professor Bruce: Partly through smarter regulation to bring more interventions on to the market, because there is a critical shortage. Even regulators are saying there is a critical shortage of new treatments, but it is not just regulation; there is under-investment in this area. It is not

being taken seriously enough. There is a lot of complacency because it is thought that agricultural problems were solved back in the green revolution and nothing more needs to be done, but in the 21st century we have a very different situation. It is like the perfect storm Sir John Beddington talked about where you have to produce more food to meet growing demand in the face of climate change in a resource-finite world. We face a major challenge this century. How can we feed the world without wrecking the environment in the process?

Q59 **Carol Monaghan:** This may be a question that will take far longer than we have available to answer. Are we wrong to be concerned about the decline in pollinators? You seem to be saying that we need to be updating our pest control, whereas the environmental push is concerned about the impact on bees, for example.

Professor Bruce: I am not saying we are wrong to be concerned about pollinators. That is a very important thing too. We need to find a way of making sure that our crop protection measures are compatible with safeguarding pollinators. It requires more investment.

You cannot have neonicotinoids any more; they are banned, but because there is nothing else available it has led to a massive increase in the use of pyrethroids. These are also broad-spectrum pesticides. Even environmental pressure groups and pesticide companies are in agreement.

Q60 **Carol Monaghan:** This is probably part of a bigger problem. If we develop more effective pest control, we are affecting the pollinators that are going to increase crop yield.

Professor Bruce: It is all about targeting. When you say, "more effective pest control," it does not necessarily mean that it has to be very broad spectrum and that we will kill more pollinators. We need to find a nice way of dealing with it so that we can kill the insects that are causing a problem while safeguarding and conserving the beneficial insects. That is what we need.

Q61 **Carol Monaghan:** We do not have that now.

Professor Bruce: We do not really have that now. There are market drivers. It is so expensive to get a new product on the market. If you have a very target-specific pesticide, it is not so financially rewarding for pesticide companies to develop it because they want to have something that kills a lot of big pests and market it for a lot of different insects, but then it will not have that target specificity that we require.

Q62 **Bill Grant:** Thank you for your excellent presentation. I am sure you agree that food security and the environment are intertwined and inextricably linked, but that from time to time they conflict with each other. What element of urgency is attached to dealing with that, and who in Government should be listening? Should it be this group, or is there anybody else in Government who should be hearing your concerns?

Professor Bruce: It is primarily this group because it is about research and innovation, and that is what we need. It is absolutely urgent. This should have been dealt with 10 years ago when the Royal Society put forward the report "Reaping the Benefits." There is a time lag between initial concept and field delivery. That is not unusual; it is the same in the pharmaceutical sector.

We already have huge problems. I know that a farmer local to me has switched to growing maize on his farm. He cannot grow wheat any more because of problems with herbicide-resistant blackgrass. In 10 years' time, if the evolution of resistance keeps increasing and the regulation and banning of products gets more and more severe, there will be even fewer tools in the toolkit and the situation will be even more difficult, so it is absolutely urgent.

Chair: Thank you very much.

Examination of witness

Witness: Professor Rachel Oliver.

Professor Oliver: I am here representing not just myself but about 200 colleagues from across the country, all from different STEMM disciplines in science, technology, engineering, maths and medicine.

All of us passionately want to improve the diversity of the STEMM workforce. Currently, that workforce utterly fails to reflect the diversity of the UK population.

That lack of diversity means there are thousands of people who are missing out on opportunities for fantastic careers in science. I am here to tell you that this is not just a problem for those people; it is a real problem for science and, by extension, the UK economy. Increasing diversity in STEMM will open up new avenues of research because it will bring in new talent, new ways of thinking and new creativity into our disciplines. There is increasing evidence in the literature that both gender diversity and racial diversity in research groups leads to better quality science with greater impact.

The lack of diversity in STEMM has many complex causes, but some of them can be addressed by changes to Government policy or regulation. One thing which the Government control is the purse strings. Taxpayers' money is used to fund scientific research and training in science, and the Government delegate the task of distributing that money to a number of bodies, most prominently UKRI but also others. It is incredibly important that that money is distributed fairly without the influence of conscious or unconscious bias coming into funding decisions. We need to avoid funding mechanisms that prop up the status quo, which favours particular groups, and that damage prospects for diversity.

I would love to stand in front of this Committee today and say, "We have identified where the problems are in the funding system, and this is what you ought to do to resolve it," but I cannot. The available data simply do not have the necessary detail. UKRI publishes data. They show that, if you look at the success rates between different groups in applying for grants, they are often fairly similar.

Unfortunately, those data conceal problems. I give an example from the Engineering and Physical Sciences Research Council, which is the funding council I mostly work with. About 20% of the EPSRC's researcher base is female, but, if we take 2016 to 2017, fewer than 7% of all research grants went to teams led by women, and the average size of the grants going to those women was 40% lower than the grants going to men, but those data had to be obtained by a female scientist making a freedom of information request.

There are some data available on the question of gender, but when we get into other questions—race, sexual orientation, gender expression, disability and social class—on those questions the data are poor, or in many cases non-existent.

The first thing that needs to be done to make our funding environment improve diversity is to ensure that the data available are analysed in proper granular depth so we can see which funding streams are disproportionately routeing money towards particular groups. Do some subject areas fund particular groups disproportionately? Are there different ways of delivering funding that help diversity? For example, we have managed calls and responsive-mode calls. Is one of those better than the other?

Once we have the data, the next step is to identify why certain funding streams tend to improve or damage diversity. Is it because certain groups do apply but fail to win funding? If so, where is the bias in the system? Is it because the rates of application from particular groups are very low? If so, we cannot just say that those groups need to do better. We need to look at the barriers to their application for that funding. Once we have identified the problems, the funding bodies need to take action to solve them. They need to break down barriers and eliminate biases, and we need to do that in a framework of international best practice. We want the UK to be a leader in diversity in science.

This Committee is right now addressing balance in UK research funding. The Committee will make recommendations that will influence future funding streams and opportunities. If you ignore issues of equality, diversity, inclusion and accessibility, you risk exacerbating the current problems. If you take on the inquiry that we propose, you can be part of the solution. You can remove any regulatory hurdles that prevent these diversity problems from being addressed; you can influence the funding bodies, and by doing that you will influence the whole broader STEMM ecosystem, including industry.

Hence, we call upon the Committee to open an inquiry into the extent to which funding, policies, procedures and cultures are damaging diversity in STEMM, and we ask you to recommend policy changes that will level the playing field and safeguard the future of UK science.

Q63 **Chair:** Thank you very much indeed.

Do you want to focus particularly on funding policies and the culture around them—how that leads to under-representation in the awards made to groups on the basis of gender, race and so on—or do you also want to look at why groups are under-represented in STEMM careers in the first place? For example, I have seen interesting research on people who end up taking triple science at GCSE and the under-representation of people from lower socioeconomic groups. They get cut off in their early teens and never have the chance to go into a STEMM career. How limited do you want the scope to be?

Professor Oliver: I am suggesting an inquiry that does focus on funding streams. There are some very good reasons for that. One of the big problems with science is what we call the leaky pipeline. We are feeding quite a lot of young people from diverse backgrounds into the beginning of the STEMM ecosystem: doing degrees and moving forward. At every level we lose women, ethnic minorities and disabled people from that pipeline.

I believe that if we fix funding we will fix a lot of that problem, because whether you get funding determines whether you do good research; doing good research is what gets you the next job; it is what gets you to the good papers and promotion; it gets those people who are moving up the stream to be the mentors, sponsors and role models for young people coming through.

There has been a lot of work on trying to encourage people—young children in schools, right up to GCSE and then A-level—into science, but if we have a leaky pipe there is not a lot of point in first pouring lots more water on top before we fix the leaks. I want this Committee to look at ways of fixing those leaks that will influence the entire ecosystem.

Q64 **Carol Monaghan:** Amen. This is such a complex issue. As you have said, it starts with the very young and we see the issues all the way through. Funding may make a difference, and hopefully would make for increased diversity within the academic field. How is it going to change industry? The majority of our young scientists and engineers are not staying in academia; they are going out to industry, and funding academia is not going to fix a leaky pipe there.

Professor Oliver: The UKRI pipeline is spending some of its funding in industry now, because that involves Innovate UK. Therefore, there is industry funding in the same scheme, but it is about having the people who inspire young people in academia and who advise, mentor and show people the way. Those are the people who are directing young people into careers in industry. I feel that fixing the STEMM pipeline in academia

can help to send diverse talent—male, female, black, white, all sorts of people—into the industries with skill shortages, which is one of the reasons I feel quite strongly that this needs to be done.

Q65 **Martin Whitfield:** Listening to your submission, there are really two steps. The first one is the data, the actual information. Correct me if I am wrong. Your call-out is, first, let us get the data, for which this Committee could ask. Only once the data are present can the next steps be taken about analysis of the funding and the removal of the bias from it. Is my understanding right?

Professor Oliver: It is incredibly important to do this on a data-driven basis, because we do not want to start solving problems that are not there. Data at granular level will point to where changes need to be made. The data have to be done first, but I would be very disappointed if the Committee took on this inquiry, found a way to mandate better data collection and publication but did not try to ensure something was done with the data. It cannot be right-only data, which is essentially what it is at the moment. If the data are showing up problems—I am sure they will show up rather significant problems—it has to be mandatory to take action in consultation with the relevant communities.

Q66 **Stephen Metcalfe:** I completely agree with your analysis of the problem. Every person I have ever met says the problem is exactly the same across the whole science community. To be fair, we have been looking into this probably in the time I have been on the Committee, which is the past eight and a half years. Why is it going to be different this time because we do another inquiry and make some recommendations when, across the whole landscape, everyone is trying to address the same problems? They could already do a lot of the stuff you are talking about.

Professor Oliver: There are two things. First, I am asking you to do something very specific, which is to look at the funding infrastructure. An awful lot of inquiries have led to very broad recommendations. I would like this to be quite tight in the hope it is effective. Secondly, we are in the infancy of UKRI. This is the time to embed good practice in that organisation, and doing it now will make a difference potentially for generations to come.

Chair: Thank you very much indeed. We appreciate your time.

Examination of witness

Witness: Dr Gesche Huebner.

Dr Huebner: I am from the UCL Energy Institute.

Climate change is the biggest threat to human health. The 2018 Lancet Countdown report states that unmitigated climate change has the potential to disrupt core public health infrastructure and overwhelm health services.

The health impacts related to climate change can be broadly classified into three categories depending on what they are caused by. The first one is the health consequences resulting from the driver of climate change; that is, the burning of fossil fuel. There is more and more evidence on the impacts on health of both internal and external pollution. With an estimated 40,000 deaths in the UK annually and costs of £22 billion to the economy, this is an important phenomenon.

The second category encompasses health effects from the change of climate per se. One of those is extreme heat. Extremely high air temperatures increase the risk of cardiovascular and respiratory disease resulting in death. In addition, high air temperatures have been linked to reduced performance, reducing economic activity as well. You will see more extreme weather events, more flooding, more droughts. You will also see new diseases brought to the UK.

Those are the impacts as a result of changed climate, but I would argue that there is a third category: impacts from the changed atmosphere per se. We will see higher CO_2 concentrations. I do not think anyone is debating this. CO_2 is increasing in our atmosphere. You might have seen press headlines in December of last year: in *The Times,* "Greenhouse gases are making us more stupid"; in the *Daily Mail,* "Surging levels of greenhouse gases are making people tired and stupid, scientists claim."

These headlines refer to a paper published by me and colleagues at the UCL Energy Institute. We reviewed evidence on the impact of increased CO_2 concentrations on cognitive performance. We reached the worrying conclusion that there might be such an effect. Reduced performance would mean lower productivity, accident rates could increase substantially and there might be other direct health consequences.

If we tried to keep internal CO_2 levels at levels similar to today's, in a world of outside higher CO_2 levels, we would have to change completely the way we ventilate our buildings, using more energy to do that, producing more carbon emissions and creating a monetary crisis. In particular, poorer people and smaller businesses would have a hard time paying.

There has been previous work on the effects of climate change in the UK—for example, by the Committee on Climate Change and Public Health England—but it is now time to draw all evidence together into one place and integrate it with novel evidence and the health impacts we have recently discovered. In particular, I suggest we consider all three categories of health impacts in one inquiry.

This inquiry would need contributions from: a range of Government Departments—for example, the Department of Health and Social Care, DEFRA and BEIS; a number of public bodies, such as the Committee on Climate Change, Public Health England, the Building Regulations Advisory Committee and organisations such as the UK Health Alliance on Climate Change; and, finally, from academia.

By drawing on the expertise from these sources the inquiry could have impacts on, first, where Government funding is best positioned to fill the gaps of knowledge, for example on the link between CO_2 and performance, and, secondly, on improving standards and regulations.

We need to make sure that our regulations are fit for the future. As an example, the industrial strategy has the mission of at least halving the energy use of new builds by 2030, which is a very important goal. We know that new buildings are very likely to overheat. How is that risk factor involved in this mission, and do we need to reconsider our building regulations or the way they are enforced?

Thirdly, we have to make sure the same metrics are used. For example, Public Health England stated that there were 906 summer deaths in 2016. The Committee on Climate Change spoke in a report in 2017 about 2,000 dying annually from heat-related conditions. Both numbers are worrying and I am sure both are valid, but which is the one you want to address and reduce?

Finally, we have to make sure that health benefits are costed in Government calculations and policies around mitigating climate change. For example, BEIS has integrated health benefits into its national household model and now, when it thinks about energy efficiency interventions, it also sees what health benefits might result from those.

Chair: Thank you very much indeed. It is very interesting.

Q67 **Martin Whitfield:** You talked about CO_2 and ventilation. What other engineering aspects do you think need to be looked at with regard to climate change, given that climate change will happen?

Dr Huebner: Given that I come from a building background, I would say that we have to focus on buildings, because we spend most of our time—90%—indoors. We need to find a way to retrofit our buildings better to reduce energy use but also ensure we do not create a risk of overheating, so for me that is very much an engineering challenge.

Q68 **Chair:** Would the purpose of the inquiry be in effect to raise awareness of the issues you have described, or to expect the Government to take particular actions, perhaps through regulation or incentives?

Dr Huebner: I would say the latter. Concrete steps should be taken to make sure the Government cost the health benefits of mitigating climate change. For example, if we have more electric vehicles on the road, this can mean less air pollution, which has very direct and immediate health consequences. Similarly, if we have better-insulated buildings, we will have fewer issues with excessive winter deaths, for example, so we want to see actual changes in our policies and regulations for all those things.

Chair: Thank you very much indeed. We appreciate your time.

That completes the exercise. It will be incredibly difficult to work out

which three or so to choose from an absolutely fascinating set of presentations. We appreciate the engagement of all of you in making these presentations to us.

Something will happen as a result of all the presentations. There are other actions we can take as well as conduct inquiries. As I said at the start, we will probably identify three lead proposals for inquiries that we will undertake over the course of this year. We may well identify others that we add to a long list for consideration for future inquiries.

We will have our deliberations now. We will tell you all as soon as we are able to. We cannot say exactly when that will be, but it will hopefully be in the next week or so. Many thanks. We appreciate your time.