

Science, Innovation and Technology Committee

Oral evidence: Under the microscope, HC 622

Tuesday 1 July 2025

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[Watch the meeting](#)

Members present: Chi Onwurah (Chair); Emily Darlington; George Freeman; Kit Malthouse; Dr Lauren Sullivan; Adam Thompson; Martin Wrigley.

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Witnesses

[I](#): Dr Periklis Pantazis, Director, Imperial-Leica Microsystems Imaging Hub, Department of Bioengineering, Imperial College London.

[II](#): Professor Donal Wall, Head of Bacteriology, University of Glasgow.

[III](#): Professor Cait MacPhee CBE, Professor of Biological Physics, University of Edinburgh, and Co-Director, UK's National Biofilms Innovation Centre.

[IV](#): Professor Tony Kenyon, Professor of Nanoelectronic & Nanophotonic Materials, University College London.

[V](#): Professor Callum Littlejohns, Deputy Director, CORNERSTONE Photonics Innovation Centre.

[VI](#): Professor Ilaria Bellantuono, Professor in Musculoskeletal Ageing and Co-Director, The Healthy Lifespan Institute, University of Sheffield.

Examination of witness

Witness: Dr Pantazis.

Q1 **Chair:** Welcome to today's Science, Innovation and Technology Committee main session, which is going to be a kind of speed dating for scientists. We will hear from six scientists, giving us their pitches as part of their submission to the Committee's under the microscope inquiry, which asked for people's ideas on what the Committee should look into.

We will be working on ideas from schools and from the wider public as well—we have seen many different submissions—but today we are going to hear from the scientists. Each scientist will be given five minutes to give their pitch, and we will have five minutes of questions from the Committee. We will then move on to the next pitch.

With that, let us get going. I would like to hear our first pitch from Dr Periklis Pantazis. The first thing you may want to do is correct my pronunciation.

Dr Pantazis: Thank you, Chair and members of the Committee, for the opportunity to present. Today, I am going to talk about force. For force in general, think, for example, about the pulse in the wrist or the buzzing of a mobile phone. We can sense it with our fingers. Cells can sense force and even adapt to it accordingly. The interplay between biology and force is the field of mechanobiology.

Why does force matter? If you talk to an astronaut, he will say, "Listen, if I'm up in space, I'm going to lose bone matter." Bone matter loss occurs because the cells do not experience load. In cancer, for example, the tumour environment is being modified and the stiffness is being changed, which cancer cells can use as a pathway to move and to spread throughout the tissue. Heart failure, hypertension and even dementia are the fingerprints of mechanical cues, let's say. What is very important is that drug development is very much focused on chemistry—chemical signalling—as well as on genes. Force has been very much neglected.

Essentially, mechanobiology can fill that spot. When we talk about mechanobiology, one thing which is very important to consider is what kinds of players are there. Piezos are kinds of channels. They were identified by Ardem Patapoutian in 2010. In 2021 the Nobel prize was given, so in 10 years, which was rather a small period of time. They are channels which are expressed on the membrane: Piezo1 and Piezo2. Think about them as a spring-loaded gate, essentially. If you squeeze and push on them, they might pop open, thousands of ions go through, and then you have chemical signalling and genes happen. I should mention that "Piezo" is originally Greek and means push or press.

Why do we have Piezo? I will make it clearer. With Piezo2, if you have the urge to pee, it is because the bladder has been filled and Piezo2 senses it, so you have to go to the loo. Piezo1 is important for vascularisation and for bone growth, for example.



Where do I come into play? My suspicion is that we are the first lab in the world that developed a sensor to visualise Piezo activity. Once the channel opens, it lights up. When we did this, we made an invisible force become visible. You can have a movie; you can see the activity of the channel. You can map out, let's say, activities in the heart and the tumour environment. That allows you to make drug screens—AI-driven drug screens, for example—and you can assess them later as to the effect.

Why does it matter for the UK? There are probably three things. The first is the therapeutic market. There are billions and billions in chemical drugs and also in genes, but so far there is nothing in mechanobiology. Another thing is for diagnostics. If you can sense things much earlier—say, at the start of changes of stiffness—this could be a diagnostic tool to evaluate, for example, the onset of fibrosis or cancer. You can save lives and ease the burden on the NHS. The final thing is new spin-outs. We just had the presentation earlier, but if you understand mechanobiology in all its entirety you can have new types of devices based on mechanics—new sensors, for example, that respond to forces.

I believe that the UK could probably move into three fields, or three pillars. One is obviously a national hub, where you put mechanobiology back with sensing, so they are combined. Another thing would be to grow the right talent, and have people trained who understand not only genes but also mechanics and how they speak to each other.

Thank you for giving me the opportunity to present mechanobiology and sensing.

Chair: Thank you so much. That was fantastic on mechanobiology. Emily has some questions.

Q2 Emily Darlington: It is fascinating and clearly, as you said, it is quite a new field. What I am trying to understand, in layman's terms, is the effect of force and gravity on how diseases may progress in our body. Is that in short order?

Dr Pantazis: In general, you are right that that is one aspect. Where does force play a role? One thing, of course, could be health. It could be because, let's say, it is an indication and also a potential for cancer. It is an indication for ageing and osteoporosis, so Piezo channels are really important. Another one is for space. How can you realistically have the astronaut not losing bone matter, which cannot be replaced afterwards? You need to have a true understanding of that.

Piezo is not just restricted to health. You can think beyond human health, about crops and so on. The Piezo channel is very universal. You can see it in the roots of plants. I am not an expert on plants, but essentially if you have stiff soil, it can go through. Thinking about drought conditions, having a better holistic understanding could benefit different areas or fields.



Q3 **Emily Darlington:** This field is about 10 years old. Where would you say the UK is in terms of the research in this field, comparatively to other centres?

Dr Pantazis: Obviously, we are the first to generate a sensor which can see genetic code at once. Other people have used traditional means, but they are not what we call in science "non-invasive". You can see them outside, rather than going invasive and just test them.

In this field we are unique, but there are definitely a few labs in Leeds and also in Imperial College. I should not upset other people and their programmes at King's College, where there is research that looks at mechanobiology in its single entity but not in the interplay. How does it play with genes and mechanics? You need to visualise that, essentially. You need to understand the interplay, the feedback and the entire interaction cosmos to figure out drugs and their importance.

Q4 **Emily Darlington:** When you say "we", you haven't said where you are from.

Dr Pantazis: It is very complicated in some ways. I am Greek, but I have been at Caltech in the US for six or seven years. We can discuss California, as I am still very much involved there. I was in Switzerland at ETH. I moved from ETH to Imperial. My wife loves the UK. She studied in Bristol and wanted me to come here, so I have now been here for six years.

Emily Darlington: Fantastic.

Q5 **Kit Malthouse:** To amplify what Emily said, my reading was that you are saying we have become very good at looking at and examining chemical signals that our bodies send, but there are other signals that our bodies send that do not necessarily manifest in pain, and if we look for them and can detect them, that tells us something about what is going on in our bodies.

Dr Pantazis: Yes, although let me phrase it in a different way. As you say, we are very good on chemical signalling. Obviously, drugs that do chemical signalling cannot address diseases, which tells you that chemical signalling alone is not sufficient to understand the complexity. That is the reason why the mechanics is another aspect, which has just been established in the last 10 years. We are aware of this very much and now we have the tools to understand it.

Q6 **Kit Malthouse:** There is a therapy called craniosacral therapy. Their theory is that if you manipulate the membranes in the brain by gentle manipulation of the head and scalp, it can have beneficial effects. Do you think there is something in that?

Dr Pantazis: Mental wellbeing is also an important point.

Q7 **Kit Malthouse:** They would say it is physical, not mental.



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Dr Pantazis: Yes, physical. The point is that because you are talking about, let's say, a mechanical force, it is gravitational. It is pushing, pulling and everything. To give you a simple understanding of this, an example is ultrasound for activating neuro cells or microglia, which are the immune cells. There is an indication that the ultrasound generates mechanical forces and has a positive impact on the wellbeing of the cells and eventually also on the person.

Q8 **Kit Malthouse:** I am just asking because there is obviously dispute about things like, for example, acupuncture. That is basically a physical therapy, whether it works or not or whether it is psychosomatic in terms of it working. Is the exploration of this area something that may or may not disprove that acupuncture is worth having?

Dr Pantazis: Potentially you might judge what acupuncture is proper because it actually activates the mechanics that you would like. This would probably be a much more balanced approach and much more informed.

Q9 **George Freeman:** Is it patentable and protectable? Is it a UK breakthrough that we could commercialise for the UK?

Dr Pantazis: You have to deliver sensor, but obviously the sensor is very difficult to patent because you have to make a drugs screen. We have of course the expertise to make the screen now. There are pharma companies that have just started to show some interest, but not much. There are material transfer agreements in sight, and obviously we are very keen to advance this.

Q10 **Chair:** Is it personal? Are these forces, the Piezo channels, personal to individuals? I read that they can be used for personalised medicines.

Dr Pantazis: I will give you one example. My wife was diagnosed last year with breast cancer. She had immunotherapy and, thankfully, she is now cancer-free. Immunotherapy usually works for a proportion of people. If it works, you have side effects that are lifelong. They are minor, but still there. We have indications, in collaboration with Harvard, that mechanics actually influences the immune response. Imagine that you have drugs that influence Piezo. You can tune down the immunotherapy to work for patients when it doesn't work, and for those for whom it works so that it doesn't overwork. You can tune it to have the best outcome, so in some sense it is personal.

Chair: That is great. Thank you so much, Dr Pantazis.

Examination of witness

Witness: Professor Wall.

Q11 **Chair:** Professor Donal Wall, you have five minutes to give us your pitch.

Professor Wall: Thank you for the opportunity to come here today. Our planet is teeming with micro-organisms. When these microbes come



together in communities in a host environment, we refer to them as a microbiome. Microbiomes are found everywhere in the planet, in the oceans, in soils, on plants, in animals and in humans. Together, they play roles in vital processes in the health of those ecosystems. What we hope in future is that we will be able to harness the power of the microbiomes to address challenges that we face today, such as climate change, chronic human illness, antimicrobial resistance and food security.

The soil microbiome, starting from the ground up, is very important for soil health and plant health. It can influence plant growth and can alter the nutritional content. It plays a vital role in processes that are essential to life on the planet, such as nitrogen fixation. Using this knowledge, a UK-Brazil collaboration came together to work on the soya bean harvest in Brazil. By using microbes from the soil that could fix nitrogen in place of man-made fertilisers, they saved £7 billion and reduced their greenhouse gas emissions by 430 million tonnes annually compared to man-made fertilisers.

Similarly, the animal microbiome is essential to animal health. It can influence the quality and quantity of meat from food-producing animals. It can influence their resistance to pathogens. It can also influence the amount of methane they produce. Again, in the context of future challenges, it influences climate change and food security. It can reduce our antibiotic use as well.

We are now starting to understand the influence of the human microbiome on human health. All aspects of human health are affected by the microbiome. In early life it trains your immune system. In later life it influences disease such as type 2 diabetes and obesity. In the case of, for example, clostridium difficile infection—a really difficult to treat infection resistant to antibiotic treatment—by taking a stool sample from a healthy person in a process called faecal microbiota transplantation, we can put that into a patient's intestine. As a result, we have successfully treated 90% of cases of clostridium difficile infection since it was introduced in 2022. We now understand that the vaginal microbiota is important for reproductive health. In future what we would like to see, particularly around pregnancy and pre-term birth, are personalised strategies for pregnancy where we could actually have microbiome-based interventions to help reproductive outcomes, both in the UK and worldwide.

Those are all positive things. We have 400 microbiome research initiatives based across the UK, across 150 different organisations. They are run by world-leading scientists in their field. We have a number of areas of strength, such as the Quadram Institute, Imperial and the University of Oxford. We have a new microbiome innovation centre at the University of Liverpool, which works closely with industry in the north-west. It works on microbiome-based interventions such as AstraZeneca and Unilever. We have a new UK microbiome bank that saves samples for the future across the whole spectrum of microbiome research. In Glasgow, we have our own Glasgow University microbiome initiative,



which is a multidisciplinary thing, where we bring clinicians, academics and industry together to try to solve problems using microbiome-based solutions.

That is all very impressive, but we have had a number of issues flagged up in reports from UKRI, from the Microbiology Society and a report that was commissioned by Baroness Bennett of Manor Castle in the House of Lords. They flagged up a lack of access to critical infrastructure for research and production. We need higher-quality datasets and more education and training. There is a lack of clear regulations and guidelines as regards microbiome innovations. This is important to drive innovation forward and to protect the consumer. There is a gap in funding for small and medium enterprises. Seed funding would help them, as Neil said earlier, to get over the line and get their microbiome expertise out there into business creation.

Lastly, there is a gap in public knowledge. The public are keen to know about the microbiome. We feel that giving them this information, where they could actually nurture their microbiome, could only be good for human health in the long term and would dovetail quite nicely with some of the Government programmes around better health. If the Committee were to take this forward, we could certainly work together to try to move it forward so that microbiome research in the UK reaches its full potential.

- Q12 **Chair:** Thank you very much, Professor Wall. It is fascinating to hear about the role of the microbiome in soil, animals and humans. First, on the role in humans—it is exciting to think of all the micro-organisms that are living on and in all of us—you said that we understood the role of the microbiome in human bodies. Do we fully understand it? When I go into the chemist and see rows of probiotic supplements, are they useful in supporting the human microbiome? Do we fully understand how it works now?

Professor Wall: No, we don't. There are massive gaps in knowledge.

- Q13 **Chair:** That is what I thought.

Professor Wall: Clearly, there are big gaps in knowledge. The UK is one of the drivers behind research in the microbiome. It has the third most academic outputs in the world. It is innovation that falls short. Research is really positive.

I can't comment on specific probiotics. Again, if someone has an awareness of their microbiome, that in itself is a first step to indicate that that person is thinking about their health and wellbeing. That in itself is a positive.

- Q14 **Chair:** There are two questions on that. It may be a first step to know it, but then when you are faced with all these supplements costing potentially a huge amount of money, is there understanding of the health benefits? I think they claim health benefits such as a healthy gut.



Professor Wall: Yes, they may refer to gut health and things like that. There is no substitute for eating a healthy and balanced diet. Eating well is better than any kind of probiotic. Trying to get bacteria and microbes to colonise your gut is incredibly difficult. It is a really challenging environment. To try to get probiotics to pass through the stomach, and then to go on and colonise your gut, is incredibly challenging. Again, I cannot comment on specific ones. For me, it is a challenging thing to say that these things are colonising your gut for your better health.

- Q15 **Chair:** Finally, you talked about needing access to cutting-edge infrastructure. What is that infrastructure? Is it shared among different sectors or areas of research? Is there an appropriate Catapult to provide access to infrastructure for start-ups?

Professor Wall: There are a number, like the knowledge transfer network on the microbiome which has been running for a number of years. There are a number of networks coming together, and that has been the driver for a number of the reports. They say that we need microbiome centres of excellence, where we can concentrate access to equipment. Because it is a constantly evolving field, the equipment is constantly evolving as well, and to keep up you need new equipment.

In terms of production, there is lack of access to the specific fermentation vessels that are needed to produce high-quality materials that can then be used in trials. This is not something that is just specific to the UK, but it is something that could be addressed in the UK and would be of benefit for small and medium enterprises, as well as researchers who want to translate their findings into the clinic.

- Q16 **Dr Sullivan:** I want to ask about the challenges of connecting the immune system and the gut microbiome. Of course, we see that maybe two or three children in every classroom have a severe allergy. Could you expand on whether there is a correlation or whether anything is going on there?

Professor Wall: I can give an example of a specific type of research in Glasgow. It is called the BINGO Group and is run by Professor Konstantinos Gerasimidis. They work on Crohn's disease and are using nutritional interventions to dampen down inflammation and maintain people in remission. That works both in paediatric and adult cases. Again, there are specific interventions.

There is research looking at eczema and other inflammatory conditions. It is trying to nail down mechanisms, but there are clearly connections that can be exploited. The specific mechanisms are often more challenging to actually understand.

- Q17 **George Freeman:** That is very impressive. Where are the UK centres of excellence? I think there is one in Norwich, just down the road from me, at the Quadram Institute. Years ago, I think UCL helped to set up a digestive health institute. Secondly, what are the companies that should



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be reaching into this? Are we talking Unilever, Danone and food companies? Who are the people who would pull this through into healthy nutrition?

Professor Wall: There are centres of excellence across the UK, springing up everywhere, which is a good thing. In our own case, I set up the Glasgow University Microbiome Initiative and we got 40 research groups into that quite quickly, because a lot of people are interested. A lot of clinicians who wanted to know more reached out to us as well.

As regards industry, I mentioned AstraZeneca and Unilever working on microbiome-based therapies. There are also Alantra and Croda. There is the medicines Catapult in Manchester as well. There are industries focusing on this, but as regards microbiome-specific therapies hundreds of companies have been established since, I think, 2013, yet only a handful of them are in the UK. We are far beyond; as Neil said in his evidence, places like California are leading the way and we are lagging behind.

Q18 **Chair:** But you seemed to indicate that we were in the top three for research.

Professor Wall: That is for research outputs, but it is not translating into—

Chair: Yes, I understand that. Again, we are in the top three for research but not for commercialising it.

Q19 **Kit Malthouse:** You talked about this primarily being based on a kind of healthy cocktail of micro-organisms that are mixed in the gut or the soil, or whatever. Is there any crossover between that and the science of the manipulation of micro-organisms? Obviously, synthetic biology is doing this work in lots of areas. Do you see any exploration there at all, at the moment? What benefits and dangers does it present?

Professor Wall: Probably the most successful ways of manipulating the microbiome are through things like prebiotics; you give things to the microbiome that will select for specific micro-organisms. It may be a type of nutrition that they particularly want, which will get them to grow quicker. As I said, faecal microbiota transplantation has been used really successfully in cancer treatments. It improves the outcomes of immunotherapies and reduces side effects.

Q20 **Kit Malthouse:** The science of the basic manipulation of the DNA of these micro-organisms: are you seeing any crossover of that?

Professor Wall: Efforts are being made at the moment, but I think to edit micro-organisms in the gut is probably at least a decade away. It is challenging, but work is going on in that area at the moment. I am not sure if it is in the UK. There is work in that regard in California. We had a recent visitor to Glasgow from California describing that kind of work, but it is challenging, and a number of years away.

Chair: Thank you very much. We have to move on, but thank you for your pitch.

Examination of witness

Witness: Professor MacPhee.

Q21 **Chair:** We now move to Professor Cait MacPhee. Good morning. Let's hear your pitch.

Professor MacPhee: Good morning. My name is Cait MacPhee. I am from the University of Edinburgh and I am one of the directors of the National Biofilms Innovation Centre. Biofilms are related to the microbiome, which you have just heard about. We like to say that biofilms are the engine of microbiomes. They are communities of microbes that stick together. They often stick to surfaces as well, and when they do that they produce a glue—a sticky matrix—that protects them from the external environment and makes them very difficult to get rid of, once they have formed. That offers great challenges and potentially great opportunities as well. NBIC estimates that the global economic impact of biofilms is roughly £3.5 trillion per annum. I will go into that in a little bit.

There is an impact across multiple industrial sectors. You can imagine, in food and drink, that if you get a biofilm forming on a production pipe in a manufacturing plant, it can cause downstream contamination of food products, which then have to be recalled. You can get biofouling of the hulls of ships, in the marine sector. Just a very thin layer of biofilms on the surface of a ship's hull can cause drag. Increased drag causes increased fuel use, and something like \$5 billion a year is spent on increased fuel and increased greenhouse gas emissions as a result. Any industry that uses water pipelines—for example, the pharma industry has water piped through—can suffer from microbial growth and biofilm growth and, again, once it is formed it is very difficult to get rid of.

It is not all doom and gloom, because biofilm communities are the basis for waste water treatment, for example, and are very successful at water remediation, purifying water and getting rid of what we like to call the organic content from humans.

We are an innovation and knowledge centre—an IKC. We translate fundamental research through to multiple and varied industry sectors. We are four universities—the University of Edinburgh, the University of Liverpool, the University of Nottingham and the University of Southampton. We bring together those four regions of the UK, and all the expertise there. We have 59 associated research institutes as well, which are partners in the IKC. That covers all the four nations of the UK, so we can bring all that expertise together to address some of the industrial challenges that companies face.



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The ability to bring everyone together means that we can use that infrastructure and share it, along with all that knowledge. Questions that come into one centre might be addressed by another one. That has allowed us to be globally competitive. There are two other biofilm centres in the world. We have existed for seven and a half years, coming up for eight, and we compete with them; and we are larger in terms of our infrastructure and knowledge base.

The field is young. It still needs fundamental research. The problem of biofilms impacts multiple different sectors, and the IKC model means that we are in a position to recognise where an intervention in one sector may have unexpected benefits in another. Something that works in food and drink may have an impact in oil and gas, for example, where microbial growth causes corrosion on metalwork. We are able to recognise those potential cross-sector implications, and make connections.

We thought that the Committee might be willing to look at something that has already been mentioned briefly: the notion of a biobank. That is the idea of collecting, maintaining and storing samples for use by the community. With samples of model biofilms—samples from environmental biofilms—researchers could all be working on essentially the same sort of material, which would be standardised. Also, companies wanting to start to make product claims could test against a standardised biofilm. We have been working with some of the metrology centres and the KTNs, to discuss how we set up a biobank, but it requires sustained support and it needs to be agnostic. It needs to be an independent voice. We think that, by bringing together all the strengths of those different institutions, we can have a biobank that would allow our companies to push through their products, with their product claims, faster and better; and that would allow us to maintain our leading position.

Q22 **Chair:** Thank you very much, Professor MacPhee. That was fascinating. Am I right in thinking that plaque on teeth is a biofilm?

Professor MacPhee: It is.

Chair: That obviously has a huge health impact. Lauren, would you kick off the questioning?

Q23 **Dr Sullivan:** Sure. Incredibly interesting: once a biofilm is there, in a catheter, for instance, what can you do to get rid of it? Is there a route?

Professor MacPhee: Physical abrasion is often the way. You basically scrub it off.

Q24 **Dr Sullivan:** Elbow grease.

Professor MacPhee: Yes, elbow grease. There are some treatments in existence or in the works that go for the glue that holds the biofilm together, but they are still coming up and through. Otherwise, it is just replacement. That is what happens with hip joints, when people have had hip surgery. Sometimes, if you get biofilm growth on one of those, the



only thing you can do is take the hip joint out and replace it; and it is an enormous cost to the NHS to have to do that.

- Q25 **Dr Sullivan:** You spoke of potential benefits. The biofilm that grows, and the glue you described: are there any universal applications for that growth of biofilm?

Professor MacPhee: Certainly in waste water. It is widespread in waste water and there is room for innovation in that. There are potentials in engineering biology applications. You can artificially bring together two communities of microbes that might not otherwise necessarily co-exist, where one performs one function and the other uptakes it and performs another. There are potentials in engineering biology.

We have already heard today about the soil microbiome. In terms of plant growth promotion, biofilm communities can be chosen or selected that promote the growth of crops and so increase productivity.

- Q26 **Chair:** Thank you very much. Is it possible that we can develop targeted biofilms for specific applications, such as antimicrobial resistance? Can we use these biofilms as building blocks?

Professor MacPhee: Yes, but that is one of the grand challenges in the field. At the moment there is still a need for fundamental research. We do not really understand, in these communities that are polymicrobial—where lots of different species have managed to come together, which, when we look at them individually or one-on-one, will compete, fight and kill each other—how they somehow manage to collaborate and co-exist in a polymicrobial biofilm. We do not necessarily have all the information to understand how that works. The holy grail is to be able to engineer a bespoke biofilm.

- Q27 **Chair:** You mentioned glue. Is the glue always the same?

Professor MacPhee: No, it's not. It is very much dependent on the species that you have in there.

Chair: Kit, do you have a question?

- Q28 **Kit Malthouse:** A couple of questions. First, what is the crossover with this area of research and materials science? Presumably there are materials that are repellent, resistant and all the rest of it. In shipping or boating, obviously lots of yachts have copper coats on them, designed effectively to repel anything—because nothing really wants to settle where there is a high copper content.

Secondly, I want to understand whether there is research on the impact of our ability to control or deal with these fundamental parts of the microbiome. We might think that it is positive for us to be able to control, remove or all the rest of it, but there might be knock-on effects. One theory is that the advent of modern antiseptic means that we are all much more prone to disease, because we do not build up resistance, as we are not exposed to these things. What if, for example, you came up



with a way of removing the biofilms that must coat every surface of the tube in London, because it is disgusting and everybody tries very hard not to touch anything with their hands if possible? If you cleansed the tube of all those biofilms, would Londoners then come down with all sorts of horrible diseases that they have built up resistance to from over-exposure?

Professor MacPhee: I will address the second one first. If you cleaned the tube of all biofilms, it would be undone within about the first five minutes. Microbes are everywhere. You are not getting rid of them. You don't want to get rid of them. They are an integral part of us and our environment. We want to be able to manage them where we do not want them to be, or eradicate them if we have to. The mantra we use is, "Prevent, detect, manage and engineer"; prevent them where we want to, or manage them where we have to.

The first question was about materials science, and, yes, it is vitally important. Modifying surfaces so that microbes do not want to adhere or, alternatively, selecting for different microbes, so that we can have some control over what is deposited on a surface are very important things. The biofilms themselves have interesting materials properties, and are materials in their own right.

Q29 **Chair:** Emily and I are passing sanitiser between us, after Kit's description. I want to ask a quick question. Back to teeth, because there are high levels of tooth decay in children in the north-east, I am searching for a cure for tooth decay. If we can understand the plaque biofilm, can that help us with tooth decay?

Professor MacPhee: We were saying right at the outset that one of the easiest and most effective ways to get rid of biofilms is abrasion.

Q30 **Chair:** Brushing.

Professor MacPhee: Yes. Brushing teeth is fundamental and incredibly important. You have a native oral biofilm as well, so you want to maintain a healthy biofilm community and microbiome, but you want to get rid of things that, downstream, are going to cause plaque. Brushing is important, but you cannot get rid of everything.

Q31 **Chair:** And not everybody brushes, and years of instruction have not hugely changed that. I guess I am looking for protection for the teeth for those who, unfortunately, do not brush as they should. Could biofilm technology help there?

Professor MacPhee: Biofilms tend to be the problem with plaque formation on teeth, so you want to get rid of those particular biofilms while maintaining a healthy oral environment. It is all about balance.

Chair: Thanks.

Q32 **Emily Darlington:** A final question: it sort of relates to both your presentations. There is a lot of marketing being done about how we



maintain our biofilms. I had somebody looking at my scalp yesterday and telling me how I was lacking a microbiome on my scalp to keep it healthy. Are we actually being sold a little bit of quasi-science, and how do we make sure that if we are going to pay for additional supplements for our gut biome or scalp biome we get something that is quality—scientifically proven—as opposed to additional marketing from a beauty industry that sells us quite a bit?

Professor MacPhee: Did you invite someone to look at your scalp?

Q33 **Emily Darlington:** The beauty industry is of course a really important science-based industry in the UK and does contribute, and it had a lobby of Parliament yesterday. One of things they did was to look at our scalps. It was not just about the microbiome, but it was one of the things they were detecting. Is that something we should worry about and invest in, or is there a bit of stretching of the science?

Professor MacPhee: There is an open question about the regulatory environment around this, and whether you can make claims about what the microbiome responds to, and how, and whether that will make you healthier, and what healthier even means. That is where we come back to the idea of something like a biobank, so that we have testable samples. Then when someone says, “Removes 99.9% of your biofilm community,” we have a standard you can test against, to say, “Yes, it does.” We need those sorts of benchmarks to assess against, and we currently lack them.

Chair: Thank you very much. That was fascinating. Thank you for your submission.

Examination of witness

Witness: Professor Kenyon.

Q34 **Chair:** We are going to hear from Professor Tony Kenyon. What do you think the Committee should put under the microscope, Professor Kenyon?

Professor Kenyon: Thank you for the introduction. My name is Tony Kenyon. I am from UCL and the pitch that I am putting forward is for neuromorphic computing, so I should probably start by saying a little about what neuromorphic computing is, and maybe one or two words about what it isn’t.

It is a fundamentally different way of doing computing, which requires different types of computing chips, systems and algorithms, and it is inspired by the human brain, which is the most power-efficient system we know for computing, on the planet. The human brain typically expends about 20 W, and an equivalent digital computer will be somewhere in the region of 10 MW, so there is about a millionfold difference in power consumption. It also deals extremely well with the uncertain, noisy and imprecise data—the sort of data that surrounds us in the everyday world—that is very difficult for digital computers to deal with.



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The technology is one whose time has come. It has been around in one incarnation or another since probably the 1990s, but there have been recent developments in new technologies, systems and algorithms that are opening up huge new possibilities, and there is massive growth in interest not just in academia but more and more in industry around the world.

What neuromorphic computing isn't is that it is not building an artificial brain. We are not in the business of trying to build something. We are trying to take inspiration from the human brain, rather than mimic it.

What problems does it solve? The big one is the problem of the unsustainability of our existing computing systems. If we think of AI particularly, and large language models—the things that we run in the cloud such as ChatGPT and so on—their computing requirements double roughly every two to three months at the moment. There has been a huge inflexion in that demand. Our technology cannot keep up with that, and particularly our energy generation industry cannot keep up with it. We are now in the situation where Microsoft, for example, is talking about reopening the Three Mile Island nuclear plant in the US, just to power its cloud servers. You have to question the sustainability of a technology that requires that. Neuromorphic computing addresses that directly, by trying to close the gap in power consumption between the brain and computing systems.

Another problem that it solves is that of security. Thinking about computing edge devices—a mobile phone or a smartwatch or sensors in the environment—if you could embed more intelligence in those systems, at very low power, they would not need continually to send data backwards and forwards across the cloud. They would be inherently much more secure.

Where is the UK in this, and what is its potential? The UK is actually leading, and I am very pleased to say that. We are in a leading position in this space and until recently we hosted the world's largest neuromorphic system—the SpiNNaker system. It is a 1 million core system, based in Manchester, and is now being upgraded to a 10 million core system, which is unfortunately going to Dresden. Perhaps there is a missed opportunity there, but we lead in many areas of neuromorphic computing, across the stack—all the way from materials to algorithms and systems, and so on. One of the problems is that it is a bit fragmented in the UK so we need to bring the community together a bit more and have more of a national initiative.

Neuromorphic computing addresses some of the Government's priorities directly, particularly around making the UK a leader in AI. I think most people now agree that neuromorphic will be a central pillar of AI going forward. It will be some combination of existing digital, neuromorphic and quantum in the longer term. It also gives the opportunity to provide the infrastructure to underpin more power-efficient AI.



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It will increase the UK's security and resilience. I have talked a little about security, but you can also think about having a high degree of autonomy in sensors in the environment, for example. It can help to modernise healthcare, for exactly the same reasons: we might think of edge devices or smart devices—very low power devices—for personal health monitoring, neural implants or artificial retinas and so on.

Very importantly, there is a fantastic opportunity to kick-start new industry in the UK. A number of companies are already starting to emerge in the UK, such as Fractile, Literal Labs, Stanhope AI, Intrinsic, which is a spin-out from my group at UCL, VisionChip, and others. Any one of those could be the next Arm or even the next NVIDIA.

To wrap up, why should you have a session on neuromorphic computing? It is not just another emerging technology. It really gives the opportunity to significantly help the UK deliver ambitions on leading in AI, reaching net zero and bolstering security.

Chair: Thank you very much.

Q35 **George Freeman:** Fantastic, thank you. Congratulations; I think you have been appointed to direct the UKRI-sponsored UK Innovation and Knowledge Centre.

Professor Kenyon: Yes. It should start next month.

Q36 **George Freeman:** Brilliant. In the vein of your last point and earlier comments, what is the challenge in a fast-moving sector for us to build on this UK-leading research, and commercialise it? What message would you like us to share with Ministers who are keen to do that in this sector?

Professor Kenyon: The thing is to look at other areas where it has been done successfully—at quantum, for example, and some of the initiatives around AI. It is about building an ecosystem. That ecosystem is not just about funding for research, while that is important. It is also about providing an infrastructure, such as national facilities—computing facilities—and prototyping facilities. This comes up a lot when we talk about semiconductors. There is a gap between what can be done in a university and what is needed if you are taking a spin-out company from a university—I speak from personal experience—and try to persuade one of the big semiconductor foundries to take on your technology. There is a gap and I think an opportunity to provide some infrastructure there, maybe in partnership with industry, to provide prototyping facilities and design facilities early on.

Q37 **George Freeman:** Would that be an equivalent of the National Quantum Computing Centre, say—

Professor Kenyon: Exactly that. That would be one aspect of it, yes—an ecosystem.

Q38 **George Freeman:** Would the natural home for it be—you are going to



say UCL, obviously—UCL, or Manchester? Is it a networked thing where we could have various hubs in the UK?

Professor Kenyon: It absolutely is. In our IKC, for example, we have partners in London—UCL, Imperial, King's, the NPL—and in Manchester, Strathclyde and Sheffield. It is all around the UK.

George Freeman: Great, thank you.

Q39 **Adam Thompson:** Good morning, Tony. You have already touched on quantum a couple of times. I think we all know that quantum computing is coming at some point, hopefully, in the future. Could you elaborate on some of the opportunities that quantum will offer when you combine it with running neuromorphic algorithms?

Professor Kenyon: Yes. We have already been involved in some work that tries to marry the neuromorphic and the quantum, more to support quantum technologies than anything else. For example, in quantum technologies, you often need some sort of error correction. Errors creep up in quantum systems. Some of the neuromorphic systems that we are working on are very fast and efficient at being able to correct those errors, and enable greater functionality from quantum devices.

Adam Thompson: Thank you, Tony.

Q40 **Martin Wrigley:** My study of neural nets stopped in about 1984. What is fundamentally different about neuromorphic compared to what one might—

Professor Kenyon: It is a good question—

Q41 **Chair:** Just on that, what is the node in this? Is it electric? Is it a valve?

Professor Kenyon: Okay, first of all I will address what is different, and then maybe the node. It is a very good question. One of the biggest differences is that if you look at existing computing it suffers from something we call a memory bottleneck. You have the thing that stores the data, and the thing that does the processing of the data, and they are constantly communicating with each other. They are separate. You find that probably 80% to 85% of the time, any computer, whether it is a mobile phone or a laptop, is shuffling data backwards and forwards. It is not actually doing any useful processing. The brain does things fundamentally differently. In the brain, the thing that stores is the thing that processes—neurons, synapses, dendrites: those structures are all the fabric of storage and processing. If you can bring the two together, it gives you an orders-of-magnitude saving in energy, because it costs much more energy to move data than it does to process it.

Q42 **Martin Wrigley:** Forgive me. That, as far as I understand, was the fundamental basis of neural net computing anyway.

Professor Kenyon: No. Neural net computing is a simulation. You use additional computers to simulate a neural network and then you build



something that looks in the simulation like the physical neural network, but it still has to create a simulation that moves data backwards and forwards.

Q43 **Martin Wrigley:** Rather than simulating, you are building the real thing.

Professor Kenyon: We are building the real thing—faster electronics. The node is that there are electronic devices, but there are also opportunities to integrate them with light—photonic devices—as well, so then you have multiple ways of being able to address the devices, and multiple ways of processing data. You get some of the advantages of the very high processing speeds of optics, but also the ability to model some of the electrical structures or electronic structures in the brain.

Q44 **Chair:** The node is based on existing technology and is not biological in any sense.

Professor Kenyon: It can be a combination of the two. There are people who are working on neuromorphic technologies that include neurons that are grown on to silicon prints.

Chair: Oh, my gosh.

Professor Kenyon: It is rather niche, but there are those areas, based largely on new materials. A lot of the new technologies that have come out are new underpinning technologies that require you to work with the semiconductor foundries to develop new processes. That can be quite a painful process and I think that is where the support is needed.

Chair: Well, I think you have inspired, terrified and excited the Committee all at once.

Q45 **Kit Malthouse:** But why is it going to Dresden? How come we let it slip through our fingers?

Professor Kenyon: I think the funding was available in Dresden and not in Manchester. Also, Dresden is a key centre for neuromorphic—there are some very strong groups there—and is growing into something of a silicon valley in Germany. They have the foundries set up; there is a new foundry there. It is funding.

Q46 **Chair:** On that, you said that we were leading. Did you mean that we were in the top three, the top five, the top one?

Professor Kenyon: The top three, I would say.

Chair: The top three. Well, that is absolutely fascinating. Thank you very much for your pitch.

Examination of witness

Witness: Professor Littlejohns.

Q47 **Chair:** We now move to our next pitch, from Professor Callum Littlejohns.



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What would you like the Committee to put under the microscope?

Professor Littlejohns: Good morning, everybody. Thank you very much for the opportunity to come and speak here today. I am Professor Callum Littlejohns. I am from the University of Southampton, and I want to showcase why silicon photonics can become an economic engine for progress, and why it is a strategic enabler for UK missions in AI, quantum, defence, net zero and more.

Silicon photonics is a technology of light on tiny little silicon chips about the size of your fingernail. It fuses the mass manufacturability of silicon electronics, which powers the digital world, with the advantageous properties of light to drive revolutionary advances. This is not just theoretical. It is happening right now.

The industrial strategy identifies high-growth sectors and frontier technologies. Silicon photonics is a critical enabler for many of them. For example, in AI, UK-based Saliency Labs are building silicon photonic switches for AI data centres. They harness the higher data rates and lower energy consumption that is possible with photonics. In defence, UK-based Zero Point Motion leverages the size, weight and power advantages of silicon photonics to build ultra-sensitive inertial sensors for GPS-less navigation. In healthcare, just three weeks ago UK-based Siloton used silicon photonic chips to trial groundbreaking sight loss prevention technology that could be deployed in every eye clinic in the country to transform patient access and outcomes. In quantum, PsiQuantum, founded by UK academics but headquartered in the US, is racing to build the world's best quantum computer and is leveraging the mass manufacturability and noise resilience that silicon photonics can offer.

Meanwhile, in research the UK leads the way. Universities like Southampton, Glasgow, Cambridge, Bristol, Cardiff and more are all world leaders in the field. At the University of Southampton we are one of the founding groups of the entire field. We hold the world record for the fastest data rate from a silicon transmitter. This is a faster and greener version of a device that Intel has been deploying in data centres for the past decade.

At our CORNERSTONE photonics innovation centre, which is an IKC—you have heard about them in other fields—we provide 108 industrial and academic partners with silicon photonics prototyping services. The companies to which we have supplied chips in the past year have raised more than £60 million collectively, but these companies are scaling up outside the UK.

As highlighted in the industrial strategy, scaling up is a formidable challenge, particularly when it comes to hardware innovation, which is why we are delighted to see a commitment in the strategy to invest in R&D and scale-up infrastructure for frontier technologies. The infrastructure required in our community's case, in the form of pilot line



facility, is precisely the platform and strategic certainty that our partners have been telling us they need to be able to invest and grow to become global superstars in the field.

The economic case for photonics is clear. Photonics as a whole contributes £18.5 billion to the UK economy every year, supporting nearly 85,000 jobs. In the bigger sector of photonics, silicon photonics is one of the fastest-growing fields, projecting 25% growth year on year with immense potential in many applications where global leaders have yet to emerge. Therefore, it is a huge opportunity for the UK to lead in these areas.

In conclusion, silicon photonics is a transformational enabler for many high-growth sectors and frontier technologies. The UK has the potential to move from research leadership to become one of the top three places in the world that creates and invests in a fast-growing silicon photonics-enabled business.

Thank you for listening, and I welcome any questions.

Chair: Thank you, Professor Littlejohns.

- Q48 **Martin Wrigley:** I go back to the mid-'80s. The world has changed significantly, and I suspect fundamental physics probably has, too. I was always taught that electrons whizzed around at virtually the speed of light, or not far off. Other than replacing electrons in certain structures with photons, what is the real benefit of using photons instead of electrons? It's not speed.

Professor Littlejohns: It is speed once you get to very high data rates. A data centre is very hot. Electrical wires heat up and slow down data communications. Using light, we can go at the speed of light, although in silicon it is very slightly slower because of the material it is in, but the real beauty is that we can multiplex signals. We can encode data on one wavelength of light and simultaneously on other wavelengths of light we can encode multiple data streams. In that way, on a single data chip we can have extremely high data rates, but the key point is lower energy; we can do it much more energy-efficiently.

- Q49 **Martin Wrigley:** It is about connectivity. It is about moving data around, rather than necessarily processing data; it is about changing from light into something that traditional electron-based processing chips can handle. Is that right?

Professor Littlejohns: That's right, and that is what is commercially proven at this moment in time, but there are many other applications in different sectors as well.

Coming back to energy savings, NVIDIA claims it can save 3.5 times the power by transitioning to optical interconnects. We spoke about AI first thing this morning. The amount of energy that system needs to train that algorithm is astronomical. We will need more power plants if we do not



improve the energy efficiency of data centres, and that is where silicon photonics comes into its own. The beauty of it is that we can leverage existing know-how in the electronics field, and we know we can manufacture these things in huge volumes.

Q50 Martin Wrigley: You take the fibre connection from just being something that is converted in a box on the outside of a house, or at the end of the road—fibre to processor.

Professor Littlejohns: That is where the field is right now, but we are moving towards what is called co-package optics. We are putting electronics and photonics into the same package, so the optical connection is moving closer and closer to the compute. Tony highlighted the point that a lot of time is spent communicating between processes. That is the role photonics can play. We can do that with higher data rates and lower energy consumption, and we can deploy it at scale.

Martin Wrigley: Fantastic.

Q51 Chair: As an electrical engineer, I find that fascinating. I have two questions. You are saying that the processing is currently still being done electrically, but there are options for optical processing of data.

Professor Littlejohns: There is research in that field. I think that Tony in his IKC is exploring photonics-based neuromorphic computing.

Q52 Chair: That would be all light-based computing.

Professor Littlejohns: It is possible, and then you save, in that you don't have to convert between the electrical and photonic domain.

Q53 Kit Malthouse: From the human perception point of view it is instantaneous because it is the speed of light and you are minimising the passing of data.

Professor Littlejohns: Absolutely.

Q54 Chair: That is a very good point, and it is really exciting. My other question is about manufacturing. If I heard you aright, I think you said we could manufacture silicon photonics here. We know that traditional silicon chips require huge fabs. We do not have the density of use to make it cost-effective to manufacture here, so why is silicon photonics different?

Professor Littlejohns: Excellent question. A photonic wave guide is fundamentally bigger than state-of-the-art electronics. The typical dimension is hundreds of nanometres rather than single-digit nanometres, so the beauty is that we can use older technology, or more cost-effective technology. We do not need to invest billions and billions in infrastructure to build these things because they are bigger. We have the demand in the UK. I mentioned that we are building chips; we are doing so in our CORNERSTONE photonics innovation centre at the Universities of Southampton and Glasgow. We have academic clean rooms that are



brilliant for demonstrating the proof of principle. We supply companies and academics with chips. They take those to their investors and say, "My technology works. Can I have some more money?" They do so and then they take the technology abroad, because we can't scale it in the UK. The facilities that we need to demonstrate scalable manufacturing conflict with how we need to operate in a research environment, so there is a gap between mass manufacturing and research that we could fill in the UK.

Chair: That is a gap in which we are very interested, aren't we, George?

- Q55 **George Freeman:** We are. Governments generally invest quite heavily in public sector research infrastructure. We know it is an area that Minister Vallance is looking at. Is there a particular piece of public infrastructure that would anchor UK leadership, wherever one put it, or is it not so much that but about industry being here? Is there a barrier that we could help Government to unlock?

Professor Littlejohns: I think so. A piece of infrastructure is what we call a pilot line, a facility where we can take innovative ideas and prove they work at scale, but the places that mass-manufacture are not interested in doing it. They have to shut down their money-printing machine to do it, but that is where we place the UK's strengths in innovation.

- Q56 **George Freeman:** You call it a pilot line.

Professor Littlejohns: Yes. The role Government can play is to provide the strategic certainty businesses need that this sector is important to the UK Government.

- Q57 **George Freeman:** Is it something like Daresbury where industry can book a session?

Professor Littlejohns: Absolutely. It would be a shared facility and would be operated centrally by a team of experts, bringing together all the highly skilled people who know how to make these things. Then individual companies and academics would be able to buy our time and come in, and we would build things for them. The great thing about that is that they do not have to field a facility on their own. In the early stages companies are not ready for that, so they can share the infrastructure with other companies and grow as a collective.

- Q58 **Kit Malthouse:** You said there was a company working on a sensor for GPS-less navigation. Could you explain how that works? Is it a chip that is so powerful and so power light that it is able to say, "Kit's turned left, so I know where he is"?

Professor Littlejohns: Absolutely. They merge NEMS functionality, which involves tiny moving structures, with optical chips; they bond them together. The optics are very sensitive, so even the tiniest movement in a structure can be detected with light, in a resin structure very accurately. I



am not an expert and don't speak on their behalf, but they have demonstrated huge improvements in the accuracy of navigation once you lose a GPS signal, which is obviously interesting.

- Q59 **Kit Malthouse:** Effectively, they have spatial awareness on the processing. They don't need a satellite signal to triangulate where you are. They can just tell from the movement you have made.

Professor Littlejohns: Exactly. They need a trigger to know where they are in the first instance, but if the GPS signal is lost they can accurately track where they progress over time.

- Q60 **Chair:** As it often is in this case.

Professor Littlejohns: Yes.

- Q61 **Chair:** You have obviously excited a lot of interest. Who would fund the pilot line that you are looking for?

Professor Littlejohns: Great question. It is something that Innovate UK could probably fund. We need long-term certainty and the skills required to operate a facility like this. We have all talked about skills. Without long-term certainty, and having to rely on iterative grants, it becomes a huge risk that we train people and they leave.

- Q62 **Chair:** Yes. Is that long-term certainty a commitment by UKRI or Innovate UK to a particular part of the infrastructure?

Professor Littlejohns: Yes, absolutely. We can back it up with businesses that are interested to use it. It is not going to be 100% Government funded. We can definitely build a business case—in fact, we are already doing so—together with businesses that show that it is something that the UK should be interested in.

Chair: Great. Thank you very much. You have excited a lot of interest.

Examination of witness

Witness: Professor Bellantuono.

- Q63 **Chair:** Our final pitch is from Professor Ilaria Bellantuono. Please, Professor, could you tell us what you would like us to put under the microscope?

Professor Bellantuono: I would like to start with the story of my grandmother. She was 93 when she passed away. Until the age of 92 and a half, she had not used a hospital and she never saw a doctor. She lived alone independently and she volunteered for three charities. She was far away, for me, from the image of older people as a burden. She was still contributing to society till the very end. That is what healthy ageing should be for me: a short period of disease before passing away.

Unfortunately, that is not the case at the moment. In the UK, the average time that a person spends with disease is 12 years, and they are really



complex conditions, of which frailty is an important one. Frailty is the diminished capacity of multiple organs to function. As a result, when older people experience a minor adverse event like flu, which you or I might overcome in a couple of days, an older person will take a longer time to do that. They will be functionally incapacitated, may require hospitalisation, and may not recover back to the baseline, requiring social care. These are the people we hear about in wintertime trapped in hospital waiting for social care support. There are 1.7 million people with frailty in the UK, and it is due to double in the next 20 years. They cost twice as much in GP appointments, four times more in hospital admissions, and 10 times more in social care than people of the same age without frailty. It is not about ageing; it is about ill health. It is more frequent in women and in the most deprived, so there is also an equity issue.

What is the solution that we propose? Geroprotectors are drugs that target ageing cells. When we age, we accumulate these cells in our body in multiple organs. It happens at different rates in different people, and depends on the experiences we have in life, such as whether we are exposed to polluted environments and whether we have a good diet, exercise and so on—all the things that we know are good for us. When we reach a certain number of these cells, the cells are no longer functional and they secrete a lot of toxic factors that impact the function of the different organs. That impacts the spare capacity that is required to respond to an adverse event. Geroprotectors either stop the building up of those cells in the body or selectively kill the aged cells. By doing that, if there are still some healthy tissues around, they can repair and regenerate, and they can give the spare capacity that is required for the older person to face an adverse event in a better condition and in a more resilient way.

We know it works really well in mice, but unfortunately we cannot test it in people. The reason for that is primarily regulation. Frailty is not a condition recognised by the regulator, which means that there is no pathway to registration, the process by which a drug is examined for safety, efficacy and quality. That means that it cannot be marketed. Of course, if you can develop a drug but you cannot market it, nobody is going to want to fund the work for it. That includes MRC, which asks, when we write the grants, "What is your route to market?" Unfortunately, we don't have one. We have interacted with MHRA and with MRC, but we are basically in a vicious cycle whereby MHRA says, "We need more data to engage," and MRC says, "You need MHRA to tell you the route to market," and we are stuck there.

My proposal is that MHRA, NICE, MRC and NIHR form a working group together with academics and industry in the sector to map out the route to registration and then to de-risk it—to develop ringfenced funding to de-risk and at least produce some clinical proof of concept. If we do that, we can attract investors in the market. The market is big. At the



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moment, it is valued at £60 billion, and it is going to grow. There is an opportunity. Thank you.

Chair: Thank you very much, Professor Bellantuono. Adam has the first question.

Q64 **Adam Thompson:** Thank you, Chair. Yes, thank you, Ilaria. That is fascinating. It seems that the case hinges on frailty as a concept. Could you elaborate a bit more on what you define frailty as and then maybe a route to how you might create frailty as a diagnosable condition?

Professor Bellantuono: Frailty is basically the inability to respond to an adverse event due to a lack of intrinsic capacity—the ability of the body to react. There are different definitions. Different people agree to different things. That is why there is a need to agree on a definition. Most importantly, there is a need to agree on hard end points for clinical trials. That is the big thing. We have sketched out potentially an initial clinical trial for patients with cancer. There are a lot of older people who have cancer, and the intervention itself—the surgery and the chemotherapy—makes at least a proportion of them frail. That is an opportunity where you can pretreat a person with cancer before they undergo the therapy, so that they do not become frail afterwards. That would provide the tool and the proof of concept.

There are different issues in designing clinical trials for frailty. These patients are usually excluded from clinical trials, which considering they are the major users of drugs is quite something. The reason is that frailty evolves very slowly and is very complex. The UK has a leading edge in a way, because we could be very innovative in using AI and digital patients to perform augmented clinical trials where some of the patients are real and some are not to overcome some of those hurdles. We can use the fantastic infrastructure of data to predict who is going to get frailty beyond cancer. With cancer, we know when they are going to get the hit, but in other situations we don't. Having access to longitudinal data gives us the opportunity to look at who is at risk and when.

Q65 **Adam Thompson:** How could we as a Committee and as a Government support the work?

Professor Bellantuono: If we can bring MHRA and MRC around the table to engage meaningfully and ringfence the funding, it will unblock huge potential from a commercial point of view, and investment. The companies are there. At the moment, they are investing in the US. The US at the moment is leading the way, and it is leading the way because the NIH and the FDA have decided that it is the strategic area that they want to invest in.

Q66 **Adam Thompson:** A final question from me. Let's say we manage to unblock some of the barriers and we can move forward with research, what are the realistic outcomes of the research in five years, 10 years and 20 years?



Professor Bellantuono: Obviously, we will need to know how effective they are in people, the size of the effect and the cost-effectiveness. We know from modelling that if we prevent only 1% of people from transitioning to frailty, there is a saving of £4 million per year just in social care, without counting the healthcare cost, as well as the fact that people can stay productive in older age—something that sometimes is not talked about enough.

Adam Thompson: Brilliant. Thank you, Ilaria. Thank you, Chair.

Q67 **Chair:** Thank you, Adam. To clarify, are you saying that you are ready today scientifically, absent the regulatory environment, to do a trial where you would provide geroprotectors to ageing people and reduce their frailty?

Professor Bellantuono: Yes. Our cohort of patients is breast cancer patients undergoing surgery. We know that a proportion of these patients lose mobility, which is one of the measures of frailty, within six weeks of the surgery, and they never recover over a period of two years. We have good cohorts to do it.

Chair: Fantastic. Everybody is interested, so Kit, George and Martin.

Q68 **Kit Malthouse:** Sorry if I missed this, but I wasn't entirely clear about what level your science is operating at. It is clear to me just from my experience that something happens in elderly people, particularly following trauma. There is some signal switch that is flipped. Given the number of elderly people who fall and break a bone and then go into significant decline, it is pretty obvious that the trauma is flicking some kind of switch. There is a search for the science of cell ageing, the signals and the switches that could be reversed to stop all that. Is that the level where you are operating?

Professor Bellantuono: We know what the signals are. Aged cells are called senescent cells, and there have been quite extensive studies on them. Our cohort of breast cancer patients are still well before going into surgery, but they are not when they come out of surgery. We know that there are people who are well and then the hit gets them into a place. What we do not really know at the moment is how to differentiate those who do well and stay well even after the surgery and those who are well but then get the hit and are not able to recover.

Q69 **Kit Malthouse:** If frailty is a product of a deterioration of the quality of the cells that make me up, are you searching for whatever is changing, whereby the cells say, "Do you know what? We've given up now"?

Professor Bellantuono: There are two ways to do it. Some drugs look at how to prevent the cells from becoming old. The ones that are more interesting are those that selectively kill the aged cells that accumulate in our body. You are going to give these drugs only for short periods of time like a week, two days or three days, just to purge, and then you wait for them to re-form. You do not have to take them every day. In older



people, it is quite important because the less drug you give, the better it is. There are different types and different ways of doing it.

Chair: Thank you.

- Q70 **George Freeman:** This is completely fascinating. I want to ask about space as a model for ageing. I should declare an interest. I do some work with the Guy Foundation, a quantum biology charity looking at pulling together global research on the effect of space on ageing. Have you done any work looking at space as a model? We know that astronauts go through accelerated ageing, effectively, and then repair, in many ways, when they come back to Earth. Is that a helpful area for you?

Professor Bellantuono: I have not done any work personally. I know there is some work ongoing in the University of Liverpool, but I believe it is more on muscle. I cannot tell you. If you want, I can see where there is something.

- Q71 **Martin Wrigley:** It sounds intriguing. It sounds like you are very close to that marvellous regeneration pill or rejuvenation pill. Some of the older members of the Committee are looking for that already. Every tech billionaire in America has a side project of wanting to live to 150 or wanting to live forever. We see that America has various other mechanisms for looking into ageing by-products. Why have they not already tested this, or are you that far ahead in the science?

Professor Bellantuono: No, in the US, as I said, the NIH has funded quite a number of clinical trials, not only in frailty. These drugs can target multiple long-term chronic conditions as well as frailty. A clinical trial in frailty is feasible now, whereas a clinical trial in multiple long-term chronic conditions requires more work on identifying which patients would benefit. The drugs work best if given preventively. They have some effect if you give them once you have the disease, but the effect is not as good. When you talk about prevention, you need to know who is going to benefit. There are clinical trials already ongoing.

There are some people who want to live forever, and the field has suffered from that, but I stress the fact that that is not what we want to do. There is nothing wrong with ageing. What is wrong is ill health. Those two things are really different. If there is one message that you keep today, it is that.

- Q72 **Chair:** What you are saying, Professor Bellantuono, is that you would not provide these drugs to everyone over the age of 60, and if you did that it would not keep them young.

Professor Bellantuono: Not necessarily. It depends on what "young" is. I hope they will have fewer deficits and they will be more active. They do not have to be taken in isolation. You may see them working with exercise or with diet, because ultimately the principle is always the same. Exercise prevents the formation of aged cells.



Q73 **Kit Malthouse:** It is about quality rather than quantity.

Professor Bellantuono: Absolutely. It is about quality of life. It is about preventing people from going into hospital and needing social care. That is what it is really about. It is people having a full life.

Chair: Fantastic. That is absolutely fascinating. You can see how interested the Committee has been in your contribution. Thank you very much for making that contribution. I extend that to all the pitches that we have heard this morning. They have been absolutely fascinating, inspiring and, in some cases, worrying. They give testimony to the strength of British science, which this Committee very much wants to champion, as well as providing us with serious ideas for what we should look at in the future. Thank you very much for that.