Ottoline Leyser

Born 7.3.1965.
Life story compiled by Alex Reid.
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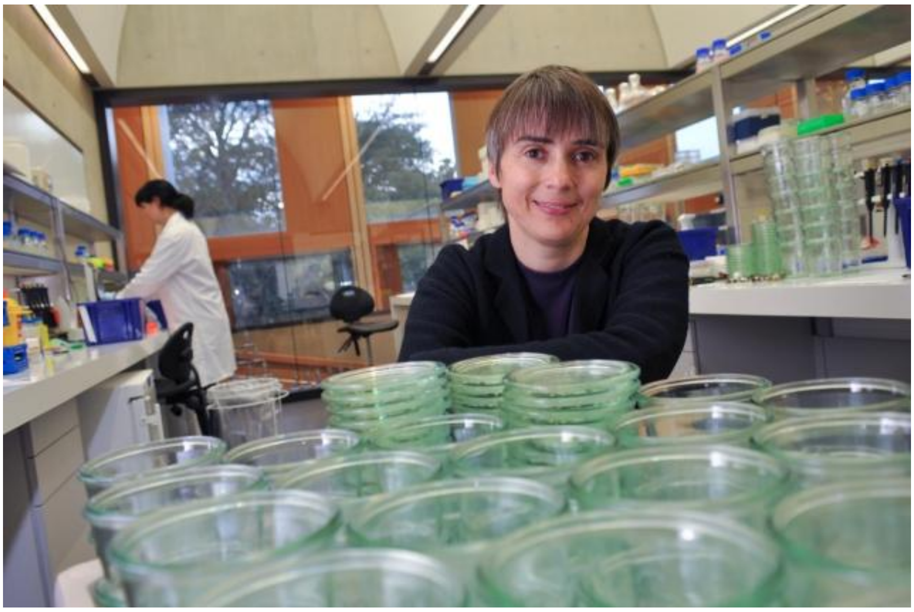

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This life story is based, with acknowledgement and thanks, on the Wikipedia articles for Ottoline Leyser and her parents, and on the transcript of a 2017 interview with Ottoline Leyser in the BBC Radio 4 Life Scientific series.

1. Parents

Henrietta Miriam Ottoline Leyser was born on 7th March 1965. Her parents, Henrietta and Karl, both had academic careers.

Her mother Henrietta Leyser (right) is an English historian. She is an expert on the history of medieval England, in particular the role of women. She is an Emeritus fellow at St Peter's College, Oxford and a Fellow of the Royal Historical Society. She was W. John Bennett Distinguished Visiting Scholar at the Institute and the Centre for Medieval Studies at the Pontifical Institute of Medieval Studies, 2011-12. She was a Distinguished Visitor at the Centre of Medieval Studies, University of Toronto (January-April 2012). In 2011, she received a Festschrift entitled Motherhood, Religion, and Society in Medieval Europe, 400-1400: Essays Presented to Henrietta Leyser, edited by Conrad Leyser and Lesley Smith (Farnham: Ashgate).

Her father Karl Joseph Leyser (24 October 1920 – 27 May 1992, right) was a German-born British historian who was Fellow and Tutor in History, Magdalen College, Oxford, from 1948 to 1984, and Chichele Professor of Medieval History at Oxford University, from 1984 to 1988. Because he was Jewish, he escaped the Nazis before World War II. He was commissioned into the Black Watch in June 1944 and saw active service with the 7th Battalion in North-West Europe.

2. Education & Career

Dame (Henrietta Miriam) Ottoline Leyser DBE FRS (born 7 March 1965) is a British plant biologist and Professor of Plant Development at the University of Cambridge and director of the Sainsbury Laboratory, Cambridge.

She was educated at the University of Cambridge as an undergraduate student of Newnham College, Cambridge where she received her Bachelor of Arts degree in 1986 followed by a PhD in Genetics in 1990 from the same University for research supervised by Ian Furner (right). Post-doctoral research in Indiana University preceded a lectureship at the University of York, where Leyser worked from 1994 - 2010. In 2010, Leyser was appointed Director of the Sainsbury Laboratory and Professor of Plant Development at the University of Cambridge.

Leyser's research interests are in the genetics of plant development and the interaction of plant hormones with the environment.[15] Leyser is chair of the University of Cambridge Centre for Science and Policy Management Committee.

Sainsbury Laboratory, University of Cambridge.

In 2020 Ottoline Leyser was appointed as the second Chief Executive of UK Research and Innovation. UK Research and Innovation (UKRI) is a quasi-autonomous non-governmental organisation of the United Kingdom (UK) that directs research and innovation funding, funded through the science budget of the Department for Business, Energy and Industrial Strategy (BEIS).

Established in 2018 by the Higher Education and Research Act 2017, UKRI brings together seven existing research councils, Innovate UK and the Research and Knowledge Exchange functions of the Higher Education Funding Council for England (HEFCE) into one unified body. Working in partnership with universities, research organisations, businesses, charities and government its mission is to foster research and development within the United Kingdom and create a positive "impact" – "push the frontiers of human knowledge and understanding", "deliver economic impact" and "create social and cultural impact. UKRI was created following a report by Sir Paul Nurse, the President of the Royal Society, who recommended the merger in order to increase integrative cross-disciplinary research. The first Chief Executive Officer of UKRI is the immunologist Professor Sir Mark Walport. UKRI maintains the Gateway to Research (Gtr) portal "to enable users to search and analyse information about publicly funded research".

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3. Awards and Honours

Ottoline Leyser was elected a Fellow of the Royal Society (FRS) in 2007. Her nomination reads:

Ottoline Leyser has made unique and central contributions to understanding of development. The focus of her work has been plant hormones, notably auxin, and her identification of the auxin receptor solved a classic problem in biology. She isolated several of the key mutants and has elucidated downstream pathways of hormone action, using this knowledge to characterise the control of shoot architecture. Leyser played a world-leading role in promoting Arabidopsis as a key model organism in modern biology and has provided leadership to the Arabidopsis research community through the resource network GARNet.

She was appointed Commander of the Order of the British Empire (CBE) in the 2009 New Year Honours. She was a member of the Nuffield Council on Bioethics from 2009 to 2015 and a member of the Council's Working Party on Biofuels (2009-2011). She was elected a foreign associate of the US National Academy of Sciences in 2012. She has been a Member of the German Academy of Sciences Leopoldina since 2014. In 2016 she was awarded an honorary doctorate by the Norwegian University of Science and Technology (NTNU). Also in 2016, she was awarded the Genetic Society Medal, an award which recognises outstanding contributions to genetics research.

She was appointed Dame Commander of the Order of the British Empire (DBE) in the 2017 New Year Honours for services to plant science, science in society, and equality and diversity in science.

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4. Thinking Like a Plant

The following is a transcript of Ottoline Leyser being interviewed by Jim Al-Khalili for the Life Scientific series. The interview was broadcast on 16th May 2017. Al-Khalili's words are in italics.

The untrained eye, a plant's existence may seem rather uneventful. It spends its days rooted to the spot, seemingly at the mercy of its environment. Think again, says plant biologist Ottoline Leyser. Plants are intelligent creatures that possess a unique ability to adapt in ways we animals can only dream of, altering their entire body plan of roots and shoots in response to their surroundings.

Now Director of the Sainsbury Laboratory, and Professor of Plant Development at Cambridge University, Ottoline has spent her career unearthing the mysterious mechanisms that underpin this process to reveal a finely tuned network of hormonal signals which regulate how a plant develops. And this growing understanding of what plants actually get up to is so remarkable that Ottoline is determined to change the way we think about them.

Ottoline, take me first into the secret life of plants. How should I be thinking about them?

We think that plants don't do anything partly because we, as animals, are obsessed with movement. Some scary creature rushing up to you that you have to avoid as quickly as possible. Plants, as you said in the introduction, are rooted to the spot. The reason they are rooted to the spot is that their life is all about collecting up these rather dilute resources from the environment – minerals from the soil, water, carbon dioxide, and sunlight. So plant life is really all about large surface areas to collect up those resources, and that means you are rooted to the spot.

If you are rooted to the spot, then you can't run away from the scary animal coming to get you and you have to defend yourself in other ways. And one of the results of that is that plants can't afford to have a central processing system. They have to be made in a much more distributed, democratic way. I am really interested in how those kinds of decisions are made. How does a plant take in all kinds of information about where the best light is, where the best water and nutrients are, who is shading them, who is attacking them, to make sensible decisions about how they are growing.

You do seem to have a real empathy for plants, as though you can see the world from their perspective. Has that helped you in your research work?

I get into quite a lot of trouble for this kind of anthropomorphising of plants, because a lot of people think it is unscientific! But I think the opposite. I think to try to try to think like a plant, to try to understand what their motives are in some sense is very helpful. And I think it's much more dangerous to try and do that if you are an animal biologist because you project your motives onto animals which may not have them at all. Free range eggs for example. I am sure that battery chickens are not happy. But I am not at all sure that the chicken, which comes from hot tropical laces, wants to run around in the outside in Yorkshire. But we assume that's what it wants to do, because it somehow seems like a better thing to us.

So you are saying that anthropomorphising plants is somehow safer, because they are so different from us.

Absolutely.

You also talk about plants being intelligent. They don't have brains after all, so in what sense are they intelligent?

A lot of this depends on your definition of intelligence. Obviously a lot of the decision processes going on in animals are at least quasi-automatic. How you define something beyond that is a bit difficult. But certainly the kinds of decisions plants are making will depend on previous decisions they have made, on the environmental conditions in which they are making them, and so on. So they are very attuned to the situation in which the plant finds itself.

It's obvious that you are absolutely passionate about plants. How did you first become interested in them?

I suppose I have always been interested in how things work. I particularly like to understand how things that are operating at multiple levels work. So in biology that means the molecular level of events in cells, events at the level of the cell, and of tissue. Events at the level of organs, and then whole organisms. And how those different levels of organisation relate to each other.

You actually studied genetics. Why genetics?

I really was gripped by genetics right from school. When we first covered it. A single change in your DNA, a long string of letters, you just change one of those letters out of the millions and millions and you can wind up with a big impact on what the organism looks like. How you connect up those things – that single tiny change – into this big knock-on effect, that has always been an appealing question. And the power of genetics in picking apart complex systems has been quite unparalleled in biology. And the classical work that Mendel was doing is still core to the work we do today.

Of course Mendel was interested in plants, but you were mainly studying developmental genetics in animals. What was going on in that field at the time?

There was a just wonderful course in my final year at university. It was primarily focused on classic genetic systems. Fruit flies and those kinds of things. And it was just at the time that some of the most exciting work was going on in flies, identifying how the segmented patter that flies have is organised. So for example there was this work demonstrating the way that the fly body works. You chop it up into segments, then layered on top of that are decisions about what those bits should do. Everyone in my field is aware of the iconic picture of a fruit fly which in theory should have two wings, but because of a mutation, one change in the DNA, has two sets of wings. This happens because the segment adjacent to the segment that makes wings has just one change in its DNA which causes it to make wings.

We hear a lot about geneticists being obsessed with fruit flies. Why was a fruit fly such an important model?

Having a good model for genetics is crucial, and it involves having an organism that reproduces quickly, so that you can get through the generations. And one of the things that became clear when I was an undergraduate was that there wasn't a good equivalent for plants. Arguably the best genetic reference system for plants is maize, buy you have to have a big field, and the most you can get to is two generations a year. So it is not therefore ideal.

As you mentioned, plant genetics really started in earnest with Mendel's work in the mid 1800s when he showed how particular physical characteristics of the common garden pea plant was transmitted through generations. Did Mendel inspire you?

Absolutely. Those classical Mendelian experiments are so elegant. You can deduce huge quantities of things just by tracing the inheritance of these particular traits, and I still find that very exciting.

During your final year at university, a new model plant, equivalent to the fruit fly in terms of its usefulness to researchers, arrived on the scene?

Yes, so this was very exciting. Just at the point where I was hearing about all this wonderful genetics in flies, and thinking that it was annoying that we couldn't do that sort of thing in plants, along came a very insignificant looking weed that's called Arabidopsis Thaliana (right). It revolutionised plant biology, because it has these properties that we were talking about. It goes from seed to seed in about six weeks, which is a big improvement on maize. And it's very unfussy and easy to grow. You will probably have seen it in the cracks in your driveway. It's one of those plants that has that little flat rosette of leaves. It sends up stems with some insignificant looking flowers, and little pods.

As we are going to find out, you have this little plant to thank for much of your career. But when you first started studying it for your PhD in the late 1980s, there was everything to discover. What questions were going through your mind back then?

One of the things that I find really interesting about plants is this flexibility they have in the way that they grow. We are born with two arms and two legs, and that's about it. Plants do their developmental programmes continuously throughout their life cycle and can change their minds. So really that's really the burning question I have been trying to understand. What are the choices they are making? And how are they making them as they go through their life cycle?

So, plants continue to change and morph throughout life in a way that animals don't?

Absolutely. So animal development on the whole tends to happen at these distinct windows in time. So in the case development occurs in the embryo in the womb.

Whereas plants are different. A plant can change throughout its life?

Yes. So two genetically identical plants can wind up looking like an enormous bush with many many branches and a huge root system, or a single branch and a weedy little root system. A huge range from just one set of genes.

Why is this ability of a plant to change over its lifetime so important?

It's the only way plants have really of dealing with the different environments in which they find themselves.

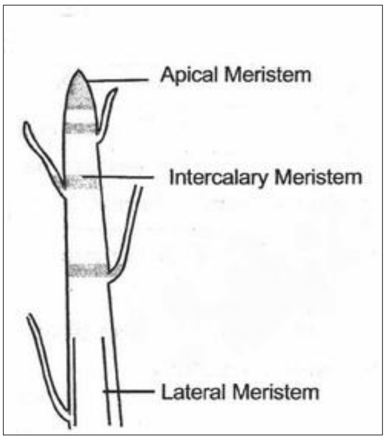
How do they adapt to cope with harsh environments?

One is they have to be able to recognise what those environments are. They need to process the information. And then they need to make some kind of decision. So that if they are in an environment with an awful lot of nitrogen, then making a lot of branches makes a lot of sense because you can capture more sunlight and make a bigger plants, and make more seeds, and win in the race. But if on the other hand fertiliser is very limited, then you want to suppress branching and invest in your roots and explore the soil around you. So it's almost an economics question that we are trying to address. How do plants decide where to invest in growth, given the environment they are in.

And this ability of plants to invest in growth in different areas, this plasticity that plants have, this has been the focus of your research. So how did you begin to answer this question?

Plant growth is very much driven by these tiny groups of cells at the very tips of roots and the very tips of shoots that are called meristems. So many of the decisions about how to grow are about how many meristems to have active, and which meristems to repress and stop growing.

Do they communicate with each other, as I guess they would have to?



Absolutely. That is exactly the question that we are centrally interested in. So how do meristems tell each other what they are doing, and what should grow and what should not grow? (time 10.30)

Now around this time, in 1994, you moved to York University, and spent nearly two decades there, researching this complex network, becoming Professor of Plant Developmental Genetics in 2002. So what did you discover during those years about how plants make the decision to grow. What are the key mechanisms that are involved?

I have been very focused on whole group of different molecules that are called plant hormones. They seem to be really important in allowing the different parts of the plant to talk to one another. Our initial focus was really on understanding how plant cells recognise whether or not the hormone is there. We spent quite some time piecing together the events that happen when these hormone molecules arrive at a cell. The central one in the context of shoot branching is called Auxin, and this is a molecule that many people are familiar with, because it is also the active ingredient in rooting powder. Which immediately tells you something interesting, because Auxin is not only about the shoots talking to each other, but it is also about the shoots talking to the roots.

So bearing in mind these hormones, how does an individual plant decide to grow?

In the context of the shoot, which is the main thing I am working on, the little seed germinates. The tip of the seed is one of these meristems. The meristems make leaves, and are making a lot of this hormone called Auxin, and the Auxin is being exported down the stem. But also every single one of those leaves has another meristem at its base, and that meristem can make a whole other shoot. But that meristem is actually prevented from growing by the Auxin made by the main meristem that is being exported down the main stem.

So effectively the main leading shoot is inhibiting all those other meristems from going anywhere. And this is why pruning works in your garden. When you chop off that leading shoot, you've chopped off that source of Auxin, and that will allow the other buds, that have been waiting there, to grow out and make side shoots. And they do that by getting going their own Auxin export out into the main stem. So effectively what is happening is that all the meristems are competing for access to the main stem.

How does a plant know which buds it needs to grow?

If the plant has more nutrients available to it, coming in through the roots, and the roots make another load of different hormones which are exported up to the shoots, and they are able to modulate the level of competition between the different buds so that more buds can grow. So they make it easier for all those buds to export their

Auxin despite the fact that there is Auxin coming from the primary shoot. So the plant can get bushier if there is lots of fertiliser.

And that means there's this whole collection of different hormones all competing with each other to control the way the plant grows?

Exactly, we used earlier this economic analogy. The plant is deciding where to invest its resources and those investment decisions are being relayed through the hormones, which are kind of acting as banker in some way!

This secret life of plants you are revealing, presumably wouldn't have been possible to understand with the technology, particularly in genetics. How has that shaped what you've been able to do?

It's been so exciting working through this time. Classical genetics is still there, still really important, but the next step, when you've got a single DNA level change that's turned the plant into some enormous branching monster for example, you need to work out what change you have made, and you don't know. So that link between the DNA and what the plant looks like, that was a complete black box and it was very difficult to bridge that gap. Now there are more and more tools to help that. And so I spent three and half years of my life doing something in the early 1990s that you can now do in a month with new DNA sequencing technologies.

It has really changed the kinds of questions that we can ask. We can be much more ambitious. And then of course on top of that is the ease with which you can make genetically modified plants in the lab. And that's an incredibly important tool for genetic research, because you can introduce into the plant versions of the genes that the plant has tagged with some protein that you can easily see. We are very interested in the proteins that help Auxin move about the plant, and you can fuse those to a fluorescent protein that comes from a jellyfish, and put those back into the plant and then you can see where those proteins are and that gives you a direct route into understanding how the Auxin is moving through the plant in a way that we just didn't have before.

In 2011 you moved from York to the newly opened Sainsbury Laboratory in Cambridge, taking up the role of Associate Director and then Director. Why was the laboratory set up?

It's a very exciting project, and it's been established to push forward our understanding of plant developmental biology, which as you will have gathered I am quite keen on. The core concept is to understand these complex systems that I have talked about. You can't do it any more on the backs of envelopes with sketches and arrows. We need dynamic computational mathematical models. So the goal is to put together people with expertise in plant development with people with expertise in dynamical systems modelling to understand some of these huge unsolved questions about how plants grow and develop.

I find it quite brilliant that you are asked to head up a brand new research establishment doing exactly what you are passionate about! It sounds like any scientist's dream.

It is a total dream. It is serious pinch yourself. Do I really work here? And is this my job? And I do, and it is!

The Sainsbury Laboratory is dedicated to pure blue sky research, but applications of such research are of course vital as well. We are all aware of the need for sustainable and secure food supply. How might your knowledge of how plants grow help?

Plants are at the base of every single ecosystem that we know about, so understanding how they work is going to have very broad implications. We need to combine not only our knowledge of genetics and breeding but also the way that we grow the plants and understand how the crop variety that you are growing, in the field in which you are growing it, with the resources that you have can be best combined to get the best yield you can get with the least input.

We hear a lot about modern technologies like GM playing an increasingly important role in agriculture. How might GM fit into the new holistic picture?

GM can play a really important role. The role is very specific and limited where there are traits that you can introduce into a crop that depend on a single gene or a very small number of genes.

Such as?

One very good example is disease resistance. There are single genes that can make a huge difference in protecting plants against major plant pests.

Obviously a lot of people are nervous when they hear GM. So should we be worried?

No! GM has very little to define it uniquely that is different from anything that we have been doing for a very long time. We used to be thinking about the collection of genes that a plant has as a very stable fixed thing, and that bringing one in through genetic modification was somehow a big disturbance to that system.

But what we have learned about genomes over the last two decades is that they are frankly a mess, and the kind of things we have done to them through conventional breeding – the scrambling of genes – has far more effect than anything we can do by putting in one gene by GM. It would be a good thing if we moved forward into a discussion about how we deliver a safe and sustainable supply of high quality food that was distributed with some improvement in the level of social justice. There are no simple solutions and it is certainly the case that having GM or not having GM will make no difference on that landscape at all.

People often tend to think of any changes that we make to the environment as unnatural and therefore bad.

This is another key area where if you think like a plant, its very rapidly clear that that way of thinking is absurd. So let’s think like a plant. The thing that we are eating as people is mostly seed. Seeds are plant babies. Plants do not want you to eat their babies. So most plants in nature are hotly defending this seed. It is indigestible, it is small. Some of the nastiest toxins we know about come from seeds. What we have done in ten thousand years of agricultural domestication is essentially unilateral disarmament to take out from the natural plants the things that make them poor crops, not so good to eat, not so easy to cultivate. We have to move forward from this natural/unnatural dichotomy because it's a false dichotomy.

It sounds like scientific research is thriving under your watch at the Sainsbury Lab, but as deputy chair of the Nuffield Council on Bioethics you led a project to explore the culture of scientific research in the UK. What interested you about that project?

I think we all appreciate that a lot of the time we are spending either public or charitable funding and we need to spend it as efficiently as possible. So some level of competition in the system is exactly what you need. But if you have too much competition, and if the rules for winning the competition become overly constrained, that is a very dangerous situation. And I think there is quite a lot of evidence that in science both of those things are happening.

In an attempt to make it easier to assess what the best project is, or who the best scientist is, a relatively small number of things are counted. And those tend to be have you published your paper in the right sort of fancy journal? And the fact that those kind of indicators are being over-emphasised has led to quite a lot of distortions in the way science is being conducted. And I think that needs to shift. This was one of the main findings that came out of this project.

And what kind of impact is this having?

It has quite a pervasive and insidious impact if your next grant depends on whether or not your paper is published in a particular journal, the you are going to do your damnedest to ensure that your paper is published in that particular journal. And you don't have any incentive to publish all the surrounding data, and the experiments that told you something different. So you wind up with a very distorted picture of the scientific system.

I see this in physics quite a lot, where people will publish what is called a Letter in a journal which is the high impact rewarding publication. In the past this would have been followed up with a more considered longer paper which has all the details in. But they are not bothering with that, because they are moving on to the next Letter because they know those are the ones that get the rewards, the grants, the promotions.

There is an awful lot of talk about ground breaking research, which I find an interesting comparison. Because ground breaking is what you do when you start a building. You go into a field and you dig a hole into the ground. If you are only rewarded for ground breaking research there is going to be an awful lot of fields with a small hole in, and no buildings. And we need to change that.

So what can be done?

It is clear that everybody has to contribute to shifting this culture. To me the key issue is to take into account a much wider range of things than just where you published. We should think about the contribution people are making to building community resources for research, to training the next generation of researchers, to collaboration. I think we just need to take the responsibility back for making the subjective decisions in the best way we possibly can, in collaboration with others. And there is quite good evidence that that produces much better decisions than just counting something which is a proxy for what you are trying to measure.

Looking at the challenges to scientific research, of course Brexit is on everyone's mind. As chair of the Royal Society's Science Policy group, you gave evidence to the UK Parliament's Science and Technology Committee on the impact leaving the EU might have. What is your view?

There's a very local pragmatic question about what the impact will be on collaboration, on the freedom of movement of scientists around the world and certainly between the UK and the rest of Europe. Those are really important issues. Collaboration is central in science. Movement of people is essential in science. So we need to keep our borders open to the flow of ideas and people and scientists. So that's one really key issue.

But I think it is a really important time for scientists to ask themselves what has really happened here. Most of the scientific community were very much in favour of staying in the European Union, and most of us have been quite shocked by the result. And I think it tells us something about divisions in society that we need to address and think about. And we need to do that particularly as scientists because I think science has a huge role to play in building a much more inclusive culture.

Science is an extraordinary thing, and it has a number of fantastic properties. One is that it is the same for everybody. If I drop and apple, and someone else drops an apple, the same thing will happen. And that's a very unifying force. On top of that it is very clear that the kind of manufacturing type of economy is changing. We are moving into something that you can badge as the knowledge economy. And that means that in order to ensure that everyone is included in economic growth in the future people need to feel comfortable with that kind of world. Everybody is a scientist. It is not a scary different place, where only particular boffin type people can go. Everybody can do science. We need as a community to spread that message much more strongly.

Another burning issue for you in scientific research is the role of women. You wrote a book called Mothers in Science to inspire women who want to combine motherhood with a career in scientific research. Why was this?

There is a strong feeling that in order to succeed in science you have to work at least 24 hours a day, focus entirely on your little experiment, and if you want to have a life outside you may as well forget it. That looks incredibly unwelcoming to a lot of people, and particularly to women. So I put the book together to illustrate that it is perfectly possible to combine real life with doing science. So the way the book is structured is that it is 64 different women who have combined their family lives with their careers in different ways. The key messages are that it is possible, and there are no rules. So I was very fortunate in that my husband worked from home, and was able to have the kind of flexible career that allowed him to be the primary carer for our children. And that makes it actually quite easy for me, relatively speaking. I used to say that he was my wife! He gave to me what a lot of men get from their wives. Genuine sharing across the partnership is an entirely viable way to go. There are many different ways to do it. Science has got to be about diversity. It is about thinking about new ideas and new stuff that nobody has ever thought about before. And you will not get that if you have a homogeneous bunch of 60 year old men from a particular educational background.

Mothers in Science.

So there have got to be two things going on. One is that you need to have the courage to say I am going to do this my way. And, two, everybody in the workplace has got to have the awareness to realise that they need to build a workplace where there are multiple people who are different from them. And that is quite a difficult thing for people to do. There is something comfortable about being with a bunch of people who are exactly like you. But the exciting creativity actually comes from opening up yourself to an environment where there are lots of different people with different ideas. Managing that balance is a really important and difficult job to do, for example when you are trying to run an institute, trying to organise it so that people feel comfortable and happy. And welcome – that's the key.

Have you achieved it at the Sainsbury Lab?

You would have to ask my colleagues! I hope so. That is certainly what we are aiming for.
