ELIZABETH BLACKBURN INTERVIEW
MAKERS: WOMEN WHO MAKE AMERICA
KUNHARDT FILM FOUNDATION

Elizabeth Blackburn
Biologist & Nobel Laureate
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Interviewed by Emma Cott
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ON SCREEN TEXT:
Makers: Women Who Make America
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EMMA COTT:
Okay, Dr. Blackburn, thank you so much for being here with us. So I wanted to start by talking about your childhood. Can you just tell me about your upbringing a little bit, about your family structure?

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ELIZABETH BLACKBURN:
Well, I was brought up in Tasmania, Australia. Tasmania is the island just off to the South of Australia, part of Australia, and so I grew up in a fairly small town as one of seven children. I was the second of seven children. And my parents were both family physicians. So my mom only practiced part time, as you can imagine with a big family. And so I grew up in this fairly small town in Australia, and always was very interested in animals and quite liked my schoolwork-

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-and got interested in science as I went through grade school and into middle school, and particularly got interested in biology. And partly I think that was because I really did like animals a lot and was very curious about how did biology- how did life work. I really liked animals when I was a kid, and when I was very, very small, my mom tells me I would pick up little dangerous creatures from the beach like poisonous jellyfish or dangerous ants that sting you when I was just a little kid.

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And then when I grew up, we had a house and a garden, and we had all these animals and I just loved the fact that we had cats and often a dog, and budgerigars, canaries, guinea pigs, rabbits, bantams, chickens.

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EMMA COTT:
Was it unusual for a girl, living where you lived, in the time where you grew up, to have those interests?

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ELIZABETH BLACKBURN:
I think it was unusual to be interested in animals, which was brought home to me when I tried to show my guinea pig's newly born babies to one of my little classmates and she was just horrified. When I opened my hands, my cupped hands up and said, "Look! Look at these beautiful little guinea pigs." Because they are born fully formed and fully with fur, and I thought they were just the cutest thing around, and she was just horrified. "Ugh." So I realized that my interest was not necessarily shared by other girls in my class.

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EMMA COTT:
When did you know that science was your passion?

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ELIZABETH BLACKBURN:
I mean I liked science partly because I thought it was sort of a cool thing to do. I thought chemistry classes were very interesting, and I didn't necessarily want to be a chemist but I could understand that that was the kind of precision and thinking that you could bring to any kind of science. And I just

assumed that that would be the case in biology as well. And definitely there was a fascination with living things. How did they work? I remember reading some very influential books when I was a teenager and these were books about,-

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"What was life? What were the molecules of life? How did it work? How was the genetic code working?" Which was not really, very well understood when I was growing up. And that was just very captivating to me. But there was something intellectually interesting about it, and also it was about living things which fascinated me.

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EMMA COTT:
Was it mostly books or was it that life experience, or both?

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ELIZABETH BLACKBURN:
I think what got me interested in science was a combination of things. We had lots of animals at home, and I really liked nature and was kind of very much- as a teenager, as you look at nature and you're very impressed by it. And then I read several books which in part were about science, but also books about people. Very influenced by the biography of Marie Curie which was written by her daughter, and I read that in middle school or high school or some stage like that.

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I was very, very struck by her life story, and particularly sort of her dedication to science, and this idea that there was this wonderful thing called science that you could identify with and you see all this as something going beyond yourself. I found that very, very interesting, and it was captured very well in this biography, which very much as a child I was reading.

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EMMA COTT:
Tell me about your decision to leave Australia and come to the US.

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ELIZABETH BLACKBURN:
Well, my route from Australia to finally ending up in the US consisted of, first of all, doing my PhD in Cambridge in England. And that was something that, at the time which was in the early 1970s, that was something considered as really quite an important part of your education. In Australia, if you were going to go into higher degrees or go into academical research—which I had decided by then that that was what I was going to do—it was figured to be very reasonable to go overseas somewhere.

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And so, there were possibilities to come to the US or to the UK. Those were the choices that I was looking at and I decided to go to the UK, partly because it was a more familiar setting, and then partly because in a very frivolous sort

of thing, I remember one of my undergraduate research advisors telling me that- that he said he finished his postdoctoral time in New York.

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He was a Rockefeller and he was getting all these books out and they were completely covered with black soot and so on from the pollution in New York and I thought, "Oh, I can't go to New York." So the other place I was considering was Cambridge, the MRC lab, the Laboratory of Molecular Biology in Cambridge, which was a great center then for molecular biology and protein chemistry, which was at the time what I had learned something about. And so, Cambridge also struck me as a very attractive place, in terms of I was told there was very exciting science going on there.

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So I was given good advice about places to go and was pretty influenced by that advice I was getting from my undergraduate advisors. After I had finished my PhD, and then there was a question of, "Where would I go?" And coming to the US was a very natural thing to do because that's where I really felt that you had possibilities to do science, and especially this was in the mid 1970s. I really felt that as a woman, I would be able to thrive there. I didn't think that women could thrive especially well in the UK, the British environment, or particularly well in the Australian environment.

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I loved being a student in the UK but I didn't see that that was going to be a place that you could easily thrive in science. And my sense from the US visitors, people who were at the MRC lab and visiting Britain or doing

research in Britain from the US, was that was where there was sort of a dynamism and the- where a lot of exciting science was happening, and where people- women could thrive. So I was very influenced in that, and for me going to the US was a very natural next step.

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And then the question was where, and so I originally applied to come to San Francisco and it was all arranged. But in the meantime, love intervened, right? And so my now husband, who wasn't my husband then, but we had a relationship, and so I decided to go to the same place he was going to go to, which was Yale University. And so I looked at possibilities there.

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And again, getting good advice from people, identified Joe Gall, who is a very good scientist, superb scientist and also was known to be sort of a good mentor of people as well. And so a combination of things was what motivated me to apply to work in his lab as a postdoc.

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EMMA COTT:
When you got here, did you ever counter sexism, or did you feel like you were hitting up against the glass ceiling?

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ELIZABETH BLACKBURN:

I noticed that men and women were in very different situations. When I became much more in a- what would be regarded as a more senior position, and so here I was at the university in a big medical school, and I remember I was appointed chair. We had rolling 5-year chairmanships and so I was appointed chair of my basic sciences department. I remember negotiating what that would mean, and not doing a whole lot of negotiation which I think was- Since at the time, that probably was a somewhat gender specific thing but it was fine enough, I thought.

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And then I had this moment when I went to my first medical school chair's meeting, and I went into this room and I was the only woman chair there. And there was this funny feeling, I had this absolute flashback. I'm back in the 1970s. It was really, really strange, because suddenly here I was in a situation that I had forgotten was so common back then,-

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-which was to be either the only one or very few or one of very few women in a room of scientists or people who were talking about science with or going to a conference with, they were very predominantly men when I was starting. So it was a sudden flashback, where that things had not really changed all that much.

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EMMA COTT:

What was the next feeling after you felt that? I mean, back in the 70s, was it, "Oh, I'm just going to ignore it," or, "This isn't happening…"

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ELIZABETH BLACKBURN:

Yes, yes that's right. Back in the 70s, I really felt that that was something that wasn't- It was going to change was my feeling, that there would be more and more women in science, and particularly I felt, well, this is something that I was doing science and that was my main preoccupation, and I was somewhat willfully not really paying a whole lot of attention to these issues, realizing they were there but choosing for whatever reasons of self defense or otherwise that that wasn't going to be my preoccupation.

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But then as a departmental chair, then I realized that no, these dynamics were- these were very real, and now these were affecting things in a very different venue in some ways, from the science itself, which was always somewhat of a refuge, if you will, in some senses, from this. But now I was being a chair and so I would have to start really functioning in this manner.

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And so that was challenging, I found, and I think it remains challenging for women in these kinds of settings. But I learned interesting things. I learned what good leadership looks like, and so it was very worthwhile to be doing this, but also learned that there's a lot of stuff that has to be done when you

are taking on administrative responsibilities, and my sense was this was important but my science was also very important to me at the time.

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It coincided with where the science was going at a very full tilt, and so I found myself, while I was doing chair duties, I was thinking, "Well, okay, when can I get back to the science?" While I was doing science, I never thought, Oh, when can I get back to the chair duties?" So it was pretty much telling me where my true interests lay, even though I realized how important it is to have good leadership and how important it is for women to be involved in that at that point.

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I could also read myself and see what I really thought was- what I was passionate about, and I liked the chairing and administration in some ways because it was interesting and challenging and worthwhile. But it wasn't where my passion lay.

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EMMA COTT:
But what was part of it motivated by feeling a call to duty as a woman in a high profile position?

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ELIZABETH BLACKBURN:

Yes, yes. A definite part of accepting being a chair in a department in the medical school was that there were very few women in such chairing positions, and by then I had realized that it was very important for women to be seen, and the word 'role model' is used and I think that's very valid. To see people doing something makes it less unlikely that then more people will do it.

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And in fact there was another chair, a woman chair in the school of medicine when I began my chairmanship, and I'll never forget, because I rode in the elevator up to some chairman related meeting, and my colleague said, "Well, I think I should tell you I'm stepping down from the chairmanship in a couple of months." So we were two chairs in the entire school of medicine for the short period of a couple of months and that was it, and then went back to one again which was me.

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And then when I rotated off being a chair, and there was by then another woman chair in surgery, interestingly enough, which is not a stereotypical department for women to be a chair of. But here it was, in this very large medical school, one, and at most two, women chairs. So the disparity was extremely clear to me, especially given that we had equal numbers of higher degree students, PhD students, medical students, postdoctoral fellows who were women compared to men,-

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and yet look at what was happening at the full professor and chair positions where women were very, very much fewer. So it was very clear to me that there were major issues in terms of what was happening to women's careers.

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EMMA COTT:
Why do you think that happens if there are so many women are getting PhDs?

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ELIZABETH BLACKBURN:
There's a very clear discrepancy between the fact that there are equal numbers of women, at least in the biological sciences, in the PhD level and also at the postdoctoral fellowship level which is this very important career stage before one can launch into later stages of independent research positions or faculty positions, and then the discrepancy is with those equal numbers compared with the very few women who are in sort of the more senior advanced positions that still quite low even in the biological sciences, and I think lower in other kinds of sciences and also in positions that are regarded as leadership positions, such as departmental chairs and so forth.

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And so the question is where does the drop off happen? And so what I see currently is that it's happening at the stage after the first doctoral period, and that's where- there's all sorts of ways these numbers are being collected. For example, I see it when I serve on selection committees for new starting

independent positions, assistant professor positions, in our institution. This is typical, and not unique to us, and so what you see is the number of applicants now is not 50-50 any more. So there's a huge sting that's happened here.

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And so we have to say, "Well, why do women find it so repellent to apply?" I mean, what repels them from applying, right? And so we have to start thinking there must be something really about either the way the jobs are, how people perceive the jobs are, and yeah, how women feel about throwing their hat into the ring and applying for a position in fairly demanding research universities such as the one that I'm in.

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And so here I see men and women performing equally well, and then there's this big change. So we know that there are dynamics there such as people who are very concerned about their career structures and where can you have a life, and I think this is something I hear over and over again and it's a justifiable real concern which, "I want to have a family and how am I supposed to do this when you're supposed to be working incredibly hard?"

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So what I think we've failed, 'we' meaning a very collective 'we,' as we've failed to say, "Well, how can we be creative about having women continue?" And so institutions have done things, tenure clock holds, child care leaves, things like that. They do them, but the culture is very much still- Women feel

disadvantaged if they have to ask for such things, as though somehow, this is putting them on a weaker footing.

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And I've seen that reluctance because- and it's true that it is made difficult for women, not so much overtly stated but tacitly, that it's harder for women who are now not 100%… producing, if you will, in whatever some external mnemonic, or an external sort of way of counting is. And I think that's a big mistake.

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And I've seen examples where people I have known, and they haven't always been in the US, have wanted to have families, have been part time for a while, or sometimes that while can go on for quite a while, and then very successfully come back into full time positions. And I know cases where this has happened very successfully, in Europe, in Australia- People I've known from my contemporaries in Australia, that was how some of them had their career structure, which was to go part time and then the system was such that they were able to come back in and I think because they were very good scientists and kept their research going through various sorts of devices of part time.

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I think we really have to rethink how we imagine careers for women in science because the current way is a very much one size fits all kind of career structure in which if people deviate from a completely full time model with a certain sort of trajectory, then they are regarded as not functioning properly

as scientists or competitively as scientists. And so we lose very good scientists because we don't have just a more imaginative way of thinking about how careers can work.

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EMMA COTT:
Can you give me a sense of how much a normal young scientist sort of on the cusp of discovering something, or really into their research, how much do they work? Or how much have you worked at a certain point of your life?

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ELIZABETH BLACKBURN:
Well, people often wonder, "Well, what kind of work does it take to be a scientist?" And it basically is in waves. So there's very intense times, and then there are times when experiments are going on and just the nature of the experiments, it's not necessarily 100% of the time, although you're probably having your time taken up with administrative and other university and ever more bureaucratic impositions that seem to happen these days. So the time can get filled up but it's not always with science.

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So one can be very long hours working, but it's not all related to science and it comes and goes. So there are times when you can be working very long and intense days because that's the way the sort of trajectory of the experiments are going. And then there will be times when your timetable is under your

command. Now, often of course, you are very limited by experimental material and you are having to go along with that. But it's hard to put into actual hours per week, because not all of the hours per week are actually engaged in science.

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A lot of them are engaged in say institutional requirements or bureaucratic requirements. So the interesting thing about doing research is that a lot of it has an inherent degree of autonomy to the person doing it, and you can actually, for many kinds of science, choose your trajectory of time and one can be quite productive in part time settings without diminishing the commitment sort of to the intellectual, scientific thrust of what one is doing.

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EMMA COTT:
So now just tell me about your work.

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ELIZABETH BLACKBURN:
Well, my research is on telomeres which are the ends of chromosomes. And so if we think about chromosomes which carry all our genetic material, and the native DNA and associated proteins- If we think about chromosomes like a metaphor, like a shoelace, then the telomeres are the little protective tips at the ends of the shoelaces, that you can think of as stopping the ends of the

shoelace fraying away. And literally, the ends of the chromosomes are very important because if they are weakened in any molecular way,-

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-then they stop protecting the genetic material and cells will react to that by ceasing to be able to replenish themselves for example. And so what happens with telomeres is they have a natural tendency for their DNA to dwindle away and get shorter and shorter with time, and so, that has a tendency to make cells eventually stop dividing. Now what we discovered back in the 1980s was an enzyme which we called telomerase and that makes the telomeres longer.

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It actually adds back to that telomeric DNA, and so now there is a sort of constant sort of push-pull of the telomeres getting longer and shorter, and basically the whole dynamics of that race going on in all the different kinds of our cells, is turning out to have very interesting implications for how long our tissues can self-replenish throughout our life spans for example. So when the cells can't replenish themselves, that means tissues can't replenish themselves.

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And so we see it played out, for example, when the immune system starts to fail and bone marrow production and immune system cells fades away, and if you don't have enough telomerase through just inborn errors of your genetic material then rare mutations that happen in unfortunate individuals. If they just have half the amount of telomerase enzyme that they should have then

over the life, life times their telomeres dwindle down too fast. And they, they basically die of various diseases prominently of progressive bone marrow failure. So they can't fight off infections. But also actually they are also cancer prone and they are prone to fibrosis in their liver and the lung and various things, all indicative of cells not being able to keep replenishing throughout life as they should be doing.

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ELIZABETH BLACKBURN:

What's important about research and what the things that one finds and I really think of it in two ways. I mean one is that— just finding out how life works. to me that's incredibly important. It's a little bit like finding out well what does the universe look like does it really matter what is happening in these galaxies? I mean honestly how practically is this affecting our lives? And yet we are really interested in that as just as people. we really want to understand how things work. And, and really the main motivation for my research over many, many years was all about that. I really wanted to understand how nature worked and it was, the process of finding out which is like solving puzzles and trying to second guess nature and then think of rigorous ways of testing it.

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That was the great fun of doing science and then, in more recent years, as the science has moved more and more into being able to study things in human bodies and human cells, it became clear that this running down or wearing

down of the telomeres is something that we can see that's being played out in ways that look as if it's affecting the chronic diseases of aging.

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So as medical science has solved many problems of human health, infectious diseases, broken legs. You know, medical science is terrific at lots of things. But that's laid bare now some of these other more chronic diseases, which tend to be the ones that killed much of the population in middle to late age such as diabetes, cancer and cardiovascular disease. And those big killers are very influenced by the ability of telomeres to be maintained in the body. So the research has become interesting to people because now we can sort of see more and more clearly, lots to learn still, how this is relating to quite profound issues of how we continue to live our many decades of life.

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EMMA COTT:

Can you tell me about the moment and when you realized that telomerase did what you thought it did?

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ELIZABETH BLACKBURN:

The way we found telomerase was… there's probably a few eureka moments right. There was only a couple of eureka moments when I was throwing every DNA into the pot and seeing whether I could see any evidence of something that was adding telomeric DNA to either telomeres that existed or even telomeres that were going to be formed from where there were no telomeres

before. So I was doing these very sort of speculative experiments early in my career.

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But I had tenure after six years at Berkeley, which is where I was doing the research. I had tenure. And I had NIH funding to explore the general questions of telomere function and structure. And so, this was very good funding because it basically said go, go find out, figure this out. You know, the best kind of research funding that you can think of because it didn't specify every last little detail.

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It said go out and do something interesting and so I felt I had this ability to start doing experiments, and so I remember very early one was starting to see some evidence that over time there was building up more and more of this new DNA sequence that was being synthesized in the test tube. By something inside some extracts. And so I had started these experiments very much throwing everything but the kitchen sink into the reactions to try and get cell extracts to produce telomeres.

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And then, then clearly a hint is not good enough and so then I was joined by a PhD student, Carol Grider, with whom together with Jack Shutaker she had the Nobel prize and so and I told Carol about this project and she said this is the most interesting project in the lab and this is the one I'd like to work on. And so then she then really started working very hard in getting the reaction to work and, and at some point we made a couple of crucial decisions, which

was to use different kind of way of visualizing the DNA that was added on to the ends of the artificial telomeres that we were putting into our enzyme reactions in the test tubes.

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And this visualization made it very clear that the DNA sequence that we were looking for to be added to the ends of chromosomes was being added on. And so Grider had got the result on Christmas Day and showing that there was a pattern that I had expected to see for a telomeric DNA sequence that we knew what the sequence was because I had determined the sequence some years ago. I knew what the sequence was and there was a pattern we expected to see.

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And we saw that on the autoradiogram of the radioactive products that were being synthesized. And so we knew that there was something there. And so I think we both had this strong sense this was very likely to be it. And then we spent many months trying to think of every experiment that you could to try to deal with what possible artifacts might be causing this.

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And you were just deluding yourself right. So one day Carol would think of an experiment and then some horrible possibility and then we would try and design some way of addressing that possibility. And gradually one by one we eliminated all the kinds of possibilities that rationally you could think of that could be accounting for this result that wasn't this new enzymatic activity.

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EMMA COTT:

How did that feel at that moment when you said, “we’ve got it.”?

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ELIZABETH BLACKBURN:

Well I think the realization that we really had the enzyme came in several stages. There were certainly stages when we’d get a particular result. We’d see a pattern and we’d say ah ha this looks like this is the right thing, and then it was more like chipping away at all the different sorts of possibilities until more and more we got to the point we said well ok we can write a paper now and submit a paper on this research. And, and by then I felt pretty confident that we really had something and in fact the reviewers only came back with one, one small experiment pretty much to do and we did that quite easily and I was able to do some chemical procedure which, which worked to just sort of cross an I and dot a T in a way.

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You know, life doesn’t happen in just one moment. It happens in incremental ah ha moments so there was a series of incremental Ah ha moments and they just slowly became more and more solid.

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EMMA COTT:

In 2009 you won the most prestigious award given in science. What was it?

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ELIZABETH BLACKBURN:

Well, in 2009 I and Carol Grider and Jack Shustak shared the Nobel prize in physiology or medicine. And people always like to hear how did you find out about this? And so I found out at 1:55 AM on Monday morning. October, early October when I received a phone call very early in the morning. And I have to say I was not expecting that this was going to be this, this wonderful phone call.

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Usually when you get phone calls at that hour of the morning you expect there is bad news. Actually we had just been visiting my 95 year old mother in-law in down in Los Angeles, having a family reunion so I must say my first thought was oh dear we've overdone it and maybe something has happened and we have exhausted her or something. So I was very happy when I got the phone and a very Swedish voice told me– told me the good news. And then he said, "I advise you to have a cup of coffee because the media are going to be there within minutes." And he was right. And then nothing stopped for about many, many months after that.

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EMMA COTT:

What was your reaction to receiving it? Had you expected it?

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ELIZABETH BLACKBURN:

I had heard rumors every now and then over a few years and so I hadn't specially expected it because I'm not that old and there's lots of good science going on. So I had sort of heard this and I thought well that, that's wouldn't

that be exciting kind of thing but it wasn't like I was particularly expecting this phone call, and as I said I was actually expecting a very when the phone rang what leapt into my mind was a very different kind of phone call.

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EMMA COTT:

What does it mean to you that only ten women have won this prize?

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ELIZABETH BLACKBURN:

Yes, very few women, compared with men, have won Nobel prizes and so it was particularly… I thought, gratifying, the year in fact that I was one of the Nobel laureates, so was my former PhD student, Carol Grider. We got the prize together with Jack Shustak and another woman in science, Ada Yonath won the prize. She had that in chemistry and a woman shared it in economics.

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And a woman received it in literature that year. And so, that was an unusual year for Nobel prizes. The numbers are small in any one year, so fluctuations are to be expected but, but given the fact that very few women, considering the many hundreds of Nobel prizes that have been awarded, the fact that very few have been women, I was thrilled just from the point of view of again…

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Once, once somebody sees it's happening and then they can think well this could happen to me too. And I think this has had that effect. Many women have said to me that this has meant something to, to see, to see us winning

Nobel prizes and particularly, as I said, this year of 2009 there were 5 women who got various Nobel prizes.

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EMMA COTT:

Your research today, what is the goal and where is the research right now?

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ELIZABETH BLACKBURN:

Well in biology things are always very complex and the more you look the more complexity you find. And also the more depth you get in understanding something. So this is true for telomere research and telomerase, and so our research very much focuses still, although not entirely, but still on really trying to understand how telomerase does its job in how it works with the telomere to protect the chromosome ends.

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And while in very crude outline we've known this for a while there is a lot of it we actually don't understand, surprising gaps in our understanding which of course makes then for very exciting and interesting research still. The thing that's grown out of that kind of question, which was the original science that I was doing, has been how does this relate to issues of human health. Particularly as we look at the particular major diseases that are the emerging problems, in fact world wide.

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As we solve, we being the medical world, solves many of the very acute medical problems and I'm not saying they are all solved but what is becoming

clear is that we have to really think about the diseases of middle aged to aging populations, which are much more chronic diseases and for which medical science has actually not done a great job in preventing or intercepting early.

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So a lot of my research is now, in addition, collaborative research, where we collaborate with clinicians, doing various studies trying to understand how we can anticipate and how we can alleviate some of these processes that are going on where the telomeres are running down and that's leading to increased diseases of aging.

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ELIZABETH BLACKBURN:

The major diseases of aging that we know are affected quantitatively by having inadequate telomere maintenance. They include diabetes and to certain cancers and cardiovascular disease. Now those happen to be the three major killers of the elderly in developed populations, and so this is not a trivial question. And, not only are they major killers, the morbidity and the huge disease burden that these things cause, you know, this is a large problem for humanity and not just in developed countries either.

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This is really worldwide—These are the things that are the big issues, in addition obviously to the more severe childhood and other diseases and of course we still have some major diseases such as HIV world wide. And yet our research also touches on some of the HIV questions as well. So, so I'm

very interested now in the collaborative possibilities that we bring our expertise on telomeres and telomerase and our collaborators bring expertise in various aspects of diseases and medicine.

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EMMA COTT:
What is the end goal in that?

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ELIZABETH BLACKBURN:
I think if we really think about medicine the real end goal is prevention. Right? Right, better to prevent a disease or to intercept it very early than to let it run its course and then run around like firemen raising to a house on fire. The house is on fire, you've got to put the fire out but there will be a lot of damage and let's try and preserve the house from day one. So, so that's where I think the science can go and what we are finding is that as the telomeres shorten, in some ways, there is sort of a warning of risks of diseases to come down the line. So that has put me very much in the way of thinking about how this research we are doing can play into that.

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It's by no means the only factor. Nothing is one factor in biology. But we do see this really underlying in such a prevalent way. A lot of the… these insidious diseases the chronic, chronic diseases in so many societies. So I'd like to see that being used for that forward looking goal. Let's not just treat the diseases that exist, which of course is important to do but there's lots of

activity. But let's try and look ahead and get ahead of the game and try and think much more ambitiously about prevention.

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EMMA COTT:

If your research continues to progress, could we prevent the diseases of aging eventually? Is that the ultimate goal to harness that power?

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ELIZABETH BLACKBURN:

So, one question one might ask is can we prevent diseases of aging because we see that inadequate telomere maintenance contributes to diseases of the aging or developing as not even, not even people getting that old. I mean this is something that can start in adulthood onwards. And so I'm not sure that we can just simply prevent it. There's not some sort of magic pill or something like that, and I also don't think that our life spans are necessarily determined only by this.

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There are clearly a lot of genetic inputs into what determines our maximum life span. However, what's more important is how healthy is our life until we die, which is somewhat genetically determined the latter, when we die. The maximum lifespan has probably got a lot of genetic determinants in it, but how healthily we are living until that time is something that it looks as if the telomere related research does relate to and that is if we can think of ways that we maximize the action of telomere maintenance.

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And that might mean making sure that the telomerase enzyme is as active as it can be, you know, with or without pharmacological intervention. Then perhaps we can really minimize the time that we might end up in our lives getting these diseases. So if we can push them away further and further by maintaining telomeres then that would be a wonderful aim. But I don't know if we can do it entirely by doing that, but we know that that would help.

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EMMA COTT:

Do people ask you a lot if you've found the fountain of youth?

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ELIZABETH BLACKBURN:

So people say well, you know, is this the fountain of youth? And now for cells growing in a petri dish, yes this is one way, if you can maintain your telomeres forever with telomerase, then you can maintain a cell in a petri dish. Now the thing is that real human beings, we have other things that make us have a maximum life span. But the fountain of youth also consists of being healthy while you are living and so I think rather than something to do with pushing out our maximum life span and making Methuselahs or something of us, I think rather than that our research more relates to delaying, if possible, the major diseases of aging, which are the main cause of ill health as people get older. Not going to put off forever the maximum life span. I think that that is very likely to be a whole lot of other things.

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EMMA COTT:

What are the challenges that you deal with in your personal life? And how do you balance that?

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ELIZABETH BLACKBURN:

Yes, yes well it's, it's certainly very challenging for anybody to balance family and work life, and it's particularly challenging for women and particularly because of children. And so I, I found that in my own situation, our son wasn't born until I was actually a full professor and I found out that I was both promoted to full professor at the University of California at Berkeley and pregnant, all in the same week. First the professor, then the pregnancy.

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One of my colleagues said, "How do you think you are going to spend the extra salary?" I said I think I know. So, so in my case it was rather late in the trajectory of life, and I wouldn't recommend this necessarily, but so in some ways the lab was established. On the other hand, I had a very demanding situation because I had a very active lab and lots of things that I needed to be doing, and so I had to learn to use time well and juggle and realize that basically I just didn't do certain things for a long time.

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So I didn't go to restaurants, I didn't go to movies. Except in terrible kid movies. So, basically I had to become a real problem solver and that's what I think scientists are good at, actually. So by hook or by crook I learned that there were just… there were things that you were confronted with that you

hadn't been confronted with before. And so I think I sort of fell back on this since of well what was important?

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And basically there they were. It was family work and that was important. And I also realized, somewhat belatedly, that this wouldn't' go on forever. So now our son is grown up. And so you have many, many decades of productive life as a scientist and your children, you know, they come and they go. There's many decades, too, which is when the children are grown up. Certainly are very, very, very busy times, but that was my sense that you could be very busy and it's ok.

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You know, being tired is not the end of the world, and I'm not trying to be tough there cause I'm not trying to say it's not difficult. It was quite difficult and demanding at the time and yet I, I always sensed that my feet were sort of on the ground with respect to I knew these were important family and work were important. And so even though I was not necessarily enjoying every minute of it because it was very demanding, I didn't sort of feel I had strayed in some direction that was not the right direction.

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EMMA COTT:

Do you think young women going into science now face the same challenges?

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ELIZABETH BLACKBURN:

I think it's much more challenging for women who are more junior going into science, in some ways, than it was when I did. First of all, my family and I started later and so I sort of felt I had more resources to say look this is the way I want things to be. Whereas I think it is harder for young women. On the other hand, the good news is that I think there is much more awareness that yes, this is important to have women be in, in science.

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And I see it institutionally. I mean, people's hearts I think really are in the right place. They want this to happen, but there are a lot of cultural things that don't really work in favor of this. But when women do ask for it and realize that it's ok to ask for it and talk among their peers and with mentors and so forth and get support, then I think it, it is better in some ways than when there were perhaps fewer women in, in science and you didn't really feel that you had such resources to talk to.

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I think the good news is that there's much more of a sense that it's ok to ask for help among peers and people in general are realizing that it's important not to undercut women's careers in science. Not, not to say it's easy, but I think things have improved in certain ways.

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EMMA COTT:
There's still very few women in science. Is there some other aspect that would explain that?

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ELIZABETH BLACKBURN:

So why are there so few women in, in what is considered sort of the upper, upper upper reaches of science where one looks at senior professors and women who are chairs or deans or things, something like that? And you see many fewer women than you see men. So what is it about science? And I think that there is a culture of science which, you know, is it's been very heavily much with men in that culture, and so women are rare in there and so it's much harder to relate to somebody who's not quite the same as you.

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And so the critical mass of women is much smaller. So I think there's… that science has, has really not been especially friendly to women, for reasons that probably are similar to other kinds of professions. I mean there are some professions in which women do well, but if you still look numerically it's generally the case that they're not represented in as high numbers as when they started off earlier in these careers.

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I don't know if science is exceptional in that, but I suspect that there are just cross currents about even how science is conceived of. As if somehow it sort of there are terms that are much more seen as traditionally male sorts of terms. And… and even the culture of science sometimes has competitiveness to it which in the older versions of science, certainly much more favored things that traditionally men were more comfortable with.

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A lot of modern science, interestingly now, is much more collaborative and I think that's very interesting because now different disciplines come together and together produce ways of doing things, and so I see that there are certain shifts in which women are really able to thrive because of what traditional sorts of characteristics women have been traditionally praised for. Those ones now serve them well in that kind of science.

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So, perhaps if science is changing in some ways then, then there will be more interesting possibilities for women. But things like computer sciences I notice there were very, very few women, particularly young women even who are actively in computer sciences and again I think that must be a very cultural kind of sort of milieu that makes younger women not so comfortable going into computer sciences. And that's very important for science in general because that's so much a part of science.

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EMMA COTT:

Were you a part of the Women's Movement at all? Do you relate with that?

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ELIZABETH BLACKBURN:

So in the 1970s I, I was a student and so I very much was aware of the fact that women– the women's movement was really changing, changing views. I didn't myself go out politically and, and take active part in– in events, but I was very aware of it. and, and I think that sort of had the sense that your

actions were speaking in the sense that if you are… you are pursuing a higher degree and then a career you, you are, you are sort of living that out.

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But it was certainly something that I very much identified with and realized it was very important. And personally it was important for me because I was wanting to have career options and, and the women's movement, which was particularly noticeable in the US and that to me was, was one of the reasons why I felt very much that I would have a career in which I could thrive, in the US rather than perhaps in some other countries.

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EMMA COTT:

Do you consider yourself a feminist? And what does that term mean to you?

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ELIZABETH BLACKBURN:

Yes, I think in some ways I'm a feminist. I don't like stereotyping and so I think if you say well a feminist is to do with people living their full potential if they are female. Then, then of course that's exactly what I think is the minimum that anybody should ask. And so if that's how one defines it, certainly I would say that, that I am.

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EMMA COTT:

Polls show that many women consider ambition to be a dirty word and something not characteristic they find desirable. Why do you think that is?

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ELIZABETH BLACKBURN:

I don't know what… I think, again, it's probably because there's been a certain amount of stereotyping in the media where ambition gets equated with something which is well some undesirable not feminine sort of ideal. But I don't really know that that's new. I think this has been something pretty old in some ways. There's many women have that there's been power struggles over the years let's say and so ambition is something where there is a certain threat to the established order. That ambition and women might represent. So why, thought, this has become disfavored by young women now I don't' know all the forces behind that, in terms of why at this particular moment.

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EMMA COTT:

Do you see any downsides to the Women's Movement? In what ways have you seen that it's successful and what ways has it left either men in a difficult position or women feeling they have to do it all?

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ELIZABETH BLACKBURN:

I don't see a lot of downsides to the Women's Movement. I don't think it's disadvantaged men. I mean, having people who are more living their potential and doing better and so and that doesn't seem to me to disadvantage any other group. And, and it adds right and don't really see a downside to this idea of well you can, you can do it all. And I know, I know

I've heard all the anecdotes and so forth that people say well the expectations were so high and the pressure was so high and, and so forth.

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But I haven't yet been able to balance that in my mind with what the alternative was, which was to not have such possibilities. So I think before we get too upset about this we really should try and do a little comparativeness. Because not everything will be easy. So, put it this way, I'd so much rather have had the Women's Movement than not and if we look at the comparison I'm not sure that I see a relative down side.

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EMMA COTT:

What is the one piece of advice you would give to a young woman?

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ELIZABETH BLACKBURN:

Well I think the advice I'd give to somebody is don't try to think about balance as something that you are going to achieve all the time, you know, every day every week. Think about balance as something you will achieve over perhaps decades. You will have very intense times of work. There will be very intense times of family or perhaps other things that you feel are important to you, and think of your life much more in terms of over the long term you might be achieving balance in the sense that you experience different things.

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But I think there's nothing wrong with experiencing and doing things intensively for periods of one's life, but not to cut yourself off from the breadth of life at different stages. But it doesn't all have to happen at once.

END TC: 00:50:50:00