STEM Supremes: In Conversation with Elizabeth Blackburn

Original Air Date: 18 March, 2021
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TRANSCRIPT

Brooke Grindlinger

Welcome everyone. I'm Dr. Brooke Grindlinger, Chief Scientific Officer at the New York Academy of Sciences. Thank you for joining me for the first episode in our webinar series, "STEM Supremes: In Conversation with Women in Science". We have gathered an incredibly inspiring lineup of mold breakers and ceiling crashers from across the broad spectrum of research disciplines, science, and technology. Each of these women will share with us their unique career story, the twists and turns, anxieties and opportunities, and lessons learned as they charted their course as a scientist. We'll delve into their groundbreaking discoveries and visions for the future of their fields. They'll also share their advice for how best to support and empower women among the next generation of change makers, pushing the boundaries of STEM. Now whether you're joining us tonight via Facebook Live or Zoom, I'd like to encourage all of our viewers to submit questions for our guest throughout tonight's broadcast. You can enter your questions in the Q&A box in Zoom or tag your question on the New York Academy of Sciences' social channels with the hashtag #STEMsupremes. There'll be a dedicated Q&A period between 8:00 PM and 8:30 PM, eastern time of tonight's broadcast. Without further ado, it's my pleasure to welcome tonight's guest Nobel Prize-winning molecular biologist and biochemist, and I have to add, fellow Australian, Dr. Elizabeth Blackburn. Welcome Dr. Blackburn.

Elizabeth Blackburn

Hello, glad to be here.

Brooke Grindlinger

I'm so thrilled to have you here tonight and to have this opportunity to chat with you and give you a platform to talk to the New York Academy of Sciences' community. So let's start right at the beginning. I'm always intrigued to learn about the early childhood influences - the places, the people, or other influences - that first sparked a scientist's interest in science. From your earliest days as a child in Tasmania in Australia, were there any early family influences that steered you towards the sciences?

Elizabeth Blackburn

I think there were a few. As a young child, I was allowed to wander around and pick up little ants, and pat jellyfish on the beach, and things like that. And I guess my mom who was a physician knew the dangers, but somehow was very relieved when I didn't kill myself doing this. So I'd always liked the natural, especially the natural living world around me. And growing up, I had a lot of influences. I went to an all girls school, which for me, was probably very helpful because - being a little timid as I was then - I think it would have been harder for me if there had been both boys and girls. And I'm not unique in saying that. And I also was very encouraged by my Mom, especially, to try things, not especially about science, but she would encourage me to go into a piano playing competition, or go into a drawing, an art competition, or something like that. And I think those kinds of encouragements and just this feeling that I could do interesting things was an implicit, very positive influence. And there were books around the house. I had a godmother, who was a dental nurse. And she always used to send me a book every year as a birthday present. And I would get this book, and my heart would sink

because it would look like it was much too advanced. It would be like a novel something for children. And then I think, "Well, okay, I better read this." And I'd start, and I'd realize, "Wow, I actually can understand this book." So those kinds of influences, just telling you, "You can do things in all sorts of ways," I think it was, looking back on it, really helpful for me.

Brooke Grindlinger

It's wonderful that you had such support from a female role model in your Mother from the earliest days.

Elizabeth Blackburn

Right. She was a family physician, like my Dad. Yeah.

Brooke Grindlinger

Incredible. So what were some of your early fascinations with science?

Elizabeth Blackburn

Well, I mentioned one, which was that I really liked animals and we had lots of pets at home. I could numerate them. At one point I numerated we had a dog, we had cats, we had guinea pigs, budgerigars, canaries, hens, rabbits. We had lots of animals around. But I also liked the wild world around me in Tasmania. And I had got really interested when I was taught science. And we would go on field trips, and I just was so amazed that there were so many different forms of life. I remember mosses, and I remember thinking, "Wow, mosses. They're so amazing. They spend most of their life in the haploid state," as though they were an egg, or a sperm, right? They just have haploid chromosomes. And then they just go briefly through a diploid state, which is how we spend most of our lives. Stuff like that.

Elizabeth Blackburn

And I would read. And I really loved the biography of Marie Curie written by her daughter, Ève Curie. And that biography was about Marie Curie as a scientist, of course, and how she really found huge fulfillment in science and loved it. And that she thought it was really worthwhile, but she also had people she loved in her life. And her daughter writes about how she was a real person. That came through. And that was something I used to read and reread that book over and over. So I think that was a real influence on me thinking. Being a scientist was something that you could see this figure very, very adoringly written about by her daughter, but still very real feeling to me.

Brooke Grindlinger

So the irony is not lost on me that you, a Nobel Prize-winner were inspired by another female Nobel Prize-winner from the earliest days of your childhood.

Elizabeth Blackburn

Yes.

Brooke Grindlinger

So let's talk about as a teen, and you started to get more interested in science and studying science. Did you confide in any of your family, family members, friends, and teachers about your growing interest in pursuing a career in science?

Elizabeth Blackburn

I didn't talk about it so much as a career until very much at the end of my high school, in the very last year of my high school. And by then, my family, we'd moved to Melbourne, Australia. And I was in a big high school at the end. And I had a math teacher who was, I think, a very talented math teacher, and could elicit from you the best kind of math. He was very encouraging. And he asked me what I was interested in. And I said. "Biochemistry." Because I had read a book about biochemistry. I think it was... Or sorry, molecular biology. I think it was by Gamow. And I was starting to get fascinated by the molecules that make up life. And especially I was fascinated by proteins because there was a lot known about those then. But he really encouraged me also, and said, "If you want me to introduce you to people at the University of Melbourne," and I was much too shy, and I thought that would be way too pretentious, so I didn't do it. But having teachers who saw that I would be interested in this was, again, very, very important to me.

Brooke Grindlinger

That's incredibly positive that you had such encouragement as a young woman in your interest in science.

Elizabeth Blackburn

Yeah. I mean, I'm remembering the positive things. There were negative things too. I remember, as that comment that you put up on that little initial set of clips there, that was really interesting because this is just on a social visit. And I'm making polite conversation with somebody who happened to, himself by the way, to be a high school teacher. And I said, I wanted to go into science, and this person said, "Oh, what's a nice girl like you doing going into science?" Which shocked me, but I was too polite to do what I should've done now, which is rung his neck. But...

Brooke Grindlinger

I was going to say, what would you say to that gentleman, if he was in front of you today?

Elizabeth Blackburn

Yeah. I was quite a timid child and teenager too. And I didn't really know how to cope with things like that. So I would keep it quiet, but it would make me feel much more determined inside. And now I'm happy to say, as you say, people are much more clear and frank about what are the sorts of things that really can be very damaging, even if they're not consciously meant to be, but people are much more aware now, I'm glad to say.

Brooke Grindlinger

Indeed. So you mentioned that you went on to study at Melbourne University in Australia, and you got your undergraduate honors and master's degrees in biochemistry. How did you come to land in England for your PhD in molecular biology?

Elizabeth Blackburn

Well, at that time in Australia, which was in the early 1970s, very early 1970s, people really thought that you should go overseas and study for your PhD, that that would really broaden your experience. The expectation was that you would come back to Australia, which I never did, to work. Although, I obviously visit my family when I can, but I was very much encouraged to either go to New York, or to... Because somebody who I did research with as an undergraduate, he had been at Rockefeller and loved

it as a research environment. But the other research advisor I had in biochemistry had been to Cambridge in England, and he encouraged me to really try and go there. So Fred Sanger came to Australia, and Fred Sanger was already famous as a Nobel Laureate. But I was this hick, I didn't really know Nobel... I didn't care much about Nobel Prizes, but he came by because my advisor, with whom I did master's, was working with him years ago after the Second World War and had said, "I want to introduce you to this student who's interested in going to Cambridge."

Elizabeth Blackburn

And so I had a conversation with Fred Sanger and he agreed, okay, he would take me on as a student in his lab. So then I applied to the Cambridge graduate PhD program, and got in, and joined Fred's lab. So it was really through my research teachers and advisors who introduced me to this. And honestly, I was clueless. Again, so important to have advisers who show you around what are the next steps, because I really, I didn't have much idea of what were the best steps for somebody who wanted to do science. And the lesson I look at there is you really should ask people. I was lucky enough to have people who volunteered to me what are the good steps. But I think some people may not necessarily be in a situation where they have that. And so asking, asking, "What should I do?" That is really, really important and something I was much too passive about in retrospect.

Brooke Grindlinger

So how were you received when you arrived at Cambridge? That was at a time when very few women even pursued doctorates or held faculty positions in science?

Elizabeth Blackburn

Yes. Well, I went to this research environment in Cambridge, which at the time, I felt was heaven. So this was the, it was called the MRC Laboratory of Molecular Biology in Cambridge. And it still exists, although it's much bigger. And Fred Sanger was my advisor. And he'd accepted me into the lab. So I think that automatically, "Well, if Fred has accepted her, she can't be all... She must have something going for her." And so I just joined the lab, and I didn't ever feel that I was an outsider because at the MRC, everybody was outsiders, almost, of the younger people. People came to do PhDs and postdoctoral research. The scientists and the senior scientists there, many of them were British, but there was such a community of younger people there, trainees and so forth.

Elizabeth Blackburn

And so I just felt very comfortable. And I was doing science because I was there to do science. And honestly there wasn't a whole lot to do in Cambridge in those days if you weren't part of the main university scene, which I wasn't really. I was doing a PhD. So I was just kind of a lab rat, and really, because it was so interesting all of the science that was going on, and there would be so many conversations about it, it just absorbed all of my life. So how I was received was not something that ever came up as a real issue in the setting where I most cared about, which was science, because there I was a student in Fred's lab, able to talk science with almost anybody in the remarkably informal atmosphere of this whole research institute. It really was amazing compared with, even when I went to Yale later, where things turned out oddly to be much more formal, in terms of the informality of students and their research advisors.

Brooke Grindlinger

So you were surrounded by, I guess, the gods of early molecular biology technology while you were at Cambridge. But I understand a certain postdoctoral fellow in the same lab also caught your eye while you were there.

Elizabeth Blackburn

Yes. Well, he asked me out first. So I caught his eye, I guess. My husband. My still husband. But John Sedat was his name. And John had come from Caltech in California to do his postdoctoral work, as had so many of the younger scientists had come from outside England. And so John I had started going out and became an item. And I think you've put up my picture, and that picture of us, with John with the very large beard, where we're much younger, that was actually where we got married. And we got married in New Haven, Connecticut. And we're actually in the town hall of New Haven in some corridor, where that picture was taken. And then I see the other picture. It looks like probably when I got the Nobel Prize. Yes, that's right. It's in our kitchen. And John made me a cup of coffee very early in the morning that day.

Brooke Grindlinger

An important day in your lives. Absolutely. So you mentioned after leaving Cambridge, you both went to Yale, and you were seeking a postdoc, where John also had secured a position at Yale. Now I want to talk a little bit about the post-doc period, because it's such a critical juncture for early-career scientists. There's very stiff competition for positions. It's often the first time a young scientist can really have the freedom to chart their own research course and what they want to study. How did you navigate the anxieties that come with that transition to post-doctoral fellow? And do you have any advice that you can share with other young scientists that might be at that career phase today?

Elizabeth Blackburn

Yes. Well, the first thing was I knew I had to get research done, right? That was a given. And, and luckily I was in the lab of Joe Gall is his name. And he was the person who actually had discovered the *Tetrahymena* whose beautiful picture you showed, which is just a little organism in pond scum, had very, very short chromosomes. And I knew a little bit about how to sequence DNA. And so I could bring to this interesting question something that Joe Gall's lab was really good at, which was purifying these very short chromosomes, unusually short chromosomes, in large amounts. And so I was pretty much allowed to proceed and just do that research. And so the research went, and fortunately, it went well. And I was able to find what the sequences were at the ends of these tiny chromosomes. And then, when it came for job hunting, I just thought I had no idea how I stack up against other people who are going to be competing for jobs, and Joe Gall was very encouraging and said, "Look, don't apply to every single job around the country. Really think about the ones that you want to go to." And encouraged me.

Elizabeth Blackburn

Yeah. I would have a chance at ones that I wanted to go to, places I wanted to go to. So again, part of that navigation was having a supportive postdoctoral advisor mentor. Other people helped me. A visiting faculty member in his lab helped me with my job seminar. And I've never forgotten that, because I gave a practice talk to my research group, and I put in every single piece of data that I could because I was so insecure. And it went down like a lead balloon. I felt very, very distressed by my failure to give a good talk, even to this practice talk. And this visiting faculty member, she took me in hand, she said, look, "I'm going to have you practice. We're going to go to an empty hall. I'm going to

get you giving a good research talk." And she did. And I got a job at the University of California, Berkeley. But again, I can't emphasize enough how important it is at this stage in your career to have people around you who are prepared to help you when you, yourself, are feeling very insecure about how you're going to compete.

Brooke Grindlinger

And I think you touched on a really key point about scientists needing to have good communication skills. And it's not just about writing your research for a publication in scientific journals, but being able to tell a story about your research in a way that's accessible, understandable to experts, as well as non-experts, and really tells a story without getting lost into the weeds of tables, and graphs, and data. And I think a lot of young scientists still struggle with that. And there could be more formal training for communication skills for young scientists.

Elizabeth Blackburn

There could. And on the one hand, all of that data, that is the meat of what we do as scientists. It's so important to have that really there. And so I think the part of communication of science is to have all of that and then to be able to hone it and hone it. You can't start with nothing, and then expose the hollow underneath. You have to have something. At UCSF, for years, the graduate program, PhD program, has done this wonderful thing. It's called a Journal Club.

Elizabeth Blackburn

And I think they started this much before it was fashionable and people would give journal clubs to essentially the entire basic science in our community. And they had to give it in a way that was simple. And the whole training and the coaching of this was to give talks that were crystal clear accompanied by really clear, excellent graphics. And we, 'we' being the collective faculty, were wise enough to realize the importance of exactly what you're saying.

Elizabeth Blackburn

And now I think this is much more self-evident, but it does take work. And it seems to me the procedure always has to start with, you have to sort of get your arms around the whole of the subject matter and then you can simplify because then you know the nuances in communication. And when you use certain words, phrases, symbols, ideas, you can know what the underlying truth of the science underneath them is because metaphors can actually be very good at conveying truth, but you have to yourself feel real confidence and really you've got to work hard at understanding that.

Brooke Grindlinger

So you mentioned the organism that you studied, and I think we've got a picture of it, *Tetrahymena*, which you lovingly refer to as 'pond scum'. And your work with Joe, the two of you published the first scientific paper on the molecular structure of the ends of chromosomes or the telomere. I think we have a picture, a very simple graphic that shows the simple repeated DNA sequence in the telomere. When you published that paper, did you have any inkling at that time of the special significance of telomeres?

Elizabeth Blackburn

Not all the ramifications for sure. I had some, so there were two aspects to it. One was it that really this was so early in the years of DNA and DNA sequencing. I mean, there were very few methods for

sequencing DNA available then. And so it was only by piecing together methodologies that I'd picked up and also learned in Fred Sanger's lab that I was able to pick up this sequence of this chromosomal end. And so just having any DNA sequence was already exciting because nobody knew what was out there, but there was a whole other side to telomeres, which I didn't yet know how this would fit in, but people had been looking under the microscope, like Barbara McClintock had been looking under the microscope for decades, at what functionally makes the ends of the chromosomes protected, as opposed to if you break a chromosome, the break becomes very sticky and tries to glue itself back together again. And so you can imagine if every chromosome tried to glue itself back to every other end of the chromosomes, you'd have a terrible mess, which does happen by the way sometimes in cancers, when the telomeres don't protect properly. But McClintock had functionally thought about telomeres and she had found genetic mutations in maize in which she told me about when I was a post-doc and visited her lab. And she told me that there'd been a mutant that couldn't stabilize the ends of telomeres properly.

Elizabeth Blackburn

And so I knew there was something interesting there, but I had no idea of what form it would take. I just knew it was fascinating and just there were more and more ramifications that grew into my life's work. So I didn't really stay on a narrow focus of telomeres, but more and more over the years was able to approach from different angles and particularly in recent couple of decades, collaborate with people to bring my expertise to see how telomeres intersect with other aspects of cells, and then organisms, and now humans.

Brooke Grindlinger

And we'll get there in your story tonight. You joined the faculty next at the University of California, Berkeley in 1978. This is the first time as a junior faculty member you had to do things like negotiate for your research space and your salary and take on teaching responsibilities for the first time. Any lessons learned or things you might do differently as a junior faculty member if you had to do it over again today?

Elizabeth Blackburn

Well, I think I would have thought through more of what I would need. But I was fortunate to go to a research heavy institution, UC Berkeley, where the expectation was that, yes, if you needed things for your research program to grow, then they would arrange for you to have them. So I was lucky enough, by then I realized you should ask people's advice. And so I did ask a lot of people's advice about how I should talk with the Chair of the Department about getting what I needed. And so I got what I needed, but it was sort of with the very short-term view. And that was fine because it let me do the research that I wanted to do, which was continue looking at all of the ins and outs of the telomeres initially in organisms like *Tetrahymena*.

Elizabeth Blackburn

When I think about it more, perhaps I shouldn't have been so trusting. But it worked out fine, it did work out. And again, I was in a department where research was a major part of what, as well as teaching, the department was about and so they understood that you would need resources. But I would say, really think it through much more because you won't always be lucky or have a supportive department Chair all the time. And so I think what I learned was you should always plan it very carefully and deliberately and sort of look ahead as much as you can.

Elizabeth Blackburn

But then at some point, you just have to say, look, I need to be in an environment if you can do it where your support is something that the other members of the department care about. And that's an important decision to make too, in terms of what kind of research environment or environment of science of any kind you go into, is it the kind of environment that will be a place where you can thrive?

Brooke Grindlinger

So it's now 1980 and after a chance meeting with Jack Szostak, you and Jack began a collaboration putting telomeric DNA into another organism, into yeast. What did your joint collaboration reveal about telomeres and why was that collaboration so important?

Elizabeth Blackburn

Well, what I've been doing so far with everything I'd been doing so far had been really focusing on this group of organisms called protozoans, *Tetrahymena* is one of them. But protozoans are thought to be kind of pretty distant from much of the rest of the eukaryotic world. And so lots of research activity in the seventies, and into the eighties obviously more, was going on with yeast as a model system with a lot of big research community doing that. And they were thought to be so distant from each other, and they are. I think the evolutionary difference when they diverge from each other, people have put back something like, I don't know, 800 million years ago or something. So these have been on different tracks.

Elizabeth Blackburn

So what the conversation was, I wonder was there any sort of conservation of the function of telomeres in this, what seemed like an outgroup of organisms, the protozoans. Perhaps they work that way in other organisms as well. And in my heart, I had been in the molecular biology lab where the whole kind of ethos was, it was like Watson and Crick and the genetic codes, that things were universal. So I kind of thought that maybe it was true, but maybe not, maybe things were really different.

Elizabeth Blackburn

And so Jack and I had this conversation, we thought, well, we'll just see, would a telomere stabilize the ends of a little artificial chromosome that Jack works with, which normally has to be a circle. And otherwise, if it's not a circle, it just gets eaten up by the cell, so basically if it's linear. So we put telomeres, *Tetrahymena* telomeres, on the ends of that, and Jack put them into yeast. And then in my lab, Janis Shampay, my student, analyzed the DNA sequence of what came out of those yeast cells. And lo and behold, it turned out we found that the *Tetrahymena* sequence had yeast repeats added onto the end and, furthermore, stabilized the ends.

Elizabeth Blackburn

So it was a big cross-phylum conservation of general function that was so exciting. And it also brought the telomere research then into a bigger research community because it wasn't just now that seemingly more specialized branch, the protozoans. Although I loved working with protozoans because there weren't that many people doing the kind of thing I was doing, so I didn't feel people were snapping at my heels all the time trying to grab my experiments all the time. So there was a freedom in working with the protozoans that was terrific for getting things started.

Elizabeth Blackburn

And that's a really interesting thing to think of as you try and think of research directions you want to take. It's very exciting to take what's then a new technology, which then was just being able to do primitive DNA sequencing, and apply it in a system where other people aren't necessarily trying the same thing. That for me was very freeing and very empowering. But then it became much more mainstream, which was great, but that's different. And so having got my confidence and my feet wet and all those things on something where I could kind of say, "Yes, this is really where I can make a contribution," was very helpful to be able to do early on in my career.

Brooke Grindlinger

So I've read a little bit about, I came across the quote from you talking about your work with Jack and you described your crucial early conversations with him as, "a cockamamie idea pursued just for the fun of it."

Elizabeth Blackburn

Absolutely.

Brooke Grindlinger

I'm curious sort of what percentage do you think breakthrough scientific work comes from a hunch or just taking a gamble?

Elizabeth Blackburn

Yes. This was a gamble. The "cockamamie" part was, as I mentioned, these organisms were so far apart evolutionarily that to think that an element of chromosomes might have consultative conservation, so deeply conserved, and telomeres are really deeply conserved throughout all of the life, except in bacteria. That was cockamamie, for the fun of it. It was sort of no risk. I hadn't put a whole... I was studying telomeres and the molecular basis of telomeres, and I was NIH-funded for it. Jack was studying recombination and he was funded for it, and we had funding to do that research. And we could just do that experiment and if it didn't work, we would have just said, "Well why would this have worked? They're so far apart evolutionarily," but we just thought this would be really interesting to do and it would just open up new doors, but we didn't know which.

Elizabeth Blackburn

So I think that's the lovely part of really basic science is that there is a fun of it part. And as a scientist, working with *Tetrahymena*, we used to bat ideas around in the lab among the students and technicians, and so on, because *Tetrahymena* does very strange things: chops its chromosomes up, puts new telomeres on them at a certain developmental stage. So we used to think about what might be going on and why, and one of my students used to call it 'theory of the month'.

Elizabeth Blackburn

But that taught me something: it's actually very important because you have to have ideas, but then if they're not right, you have to be prepared to let them go, right? And not sort of stick to them, even if they're leading you down all the wrong rabbit holes. So science is this very interesting mixture of having ideas and then subjecting them very rigorously to very tough tests and questioning to see if they're really true or not.

Brooke Grindlinger

So moving along in your career, we're now in the early eighties, you're an Associate Professor and you have tenure, and you connect with a Berkeley PhD student, Carol Greider who joined your lab. And in December of 1985, you and Carol published your joint discovery of a new enzymatic activity, that of telomerase. And if we think back to the 1950s, the discovery of the enzyme DNA polymerase secured the Nobel Prize. Did you or Carol dare to think at that time that your discovery of telomerase might warrant the same recognition?

Elizabeth Blackburn

I think we both recognized, when we realized we were onto the right track, that this was something big. I don't think I ever would have said "Nobel Prize" alive, talk about jinxing it, but there was something about this that was very new, and because of this conservation of telomeres that we knew more and more was emerging among more and more different organisms, not just the protozoans and yeast, but others had been finding similar things in other organisms. And so more and more, this was looking like an important part of how chromosomes are stabilized. And there'd been this big question from, as you said, the DNA polymerase world, which the DNA polymerase replicates DNA, but it can't replicate the very ends. And so there's always been this question of, well, what happens to a linear DNA, which of course chromosomes are, if DNA replication can't fill out the very ends? So I think we both kind of knew there was something pretty exciting there. And I have to say, the journal editors didn't laugh at us. I mean, they published the work.

Brooke Grindlinger

So fast forward to 2009, and you, and Carol Greider, and Jack Szostak shared the Nobel Prize in Physiology or Medicine. And that's considered by many to be really the pinnacle of scientific achievement. And as we saw in the little video clip at the opening of tonight's conversation of the more than 220 Laureates in Physiology or Medicine, you and Carol are just two of 12 women that have been recognized with that honor. I'm curious how you feel about science prizes.

Elizabeth Blackburn

Well, in general, the way I saw the Nobel Prize particularly was because it's well-known, it is a way of a public celebration of science. It's like Oscars, right? They celebrate the genius of terrific actors and directors and musicians, right? They celebrate something very creative that humans do. And so when you have something like a Nobel Prize, which actually does get more publicity, it does celebrate science. And so from that point of view, I think that that kind of thing is positive. Everybody in science knows that for every Nobel Prize, there are many other deserving people, right? And so we all know that science doesn't happen by a few people and there are different kinds of contributions and different ways they get recognized by different prizes.

Elizabeth Blackburn

But I think they can be distorting, and a lot of people think that the Nobel Prize as the important part of my career. And for me, it was like a wonderful celebration and stuff, but the important part was all those years of what I've been doing, loving doing science, yeah, and hazing and tearing my hair out some of the time too, this is hard work, but that's been my life. And so the Nobel Prize was just a part of it. It wasn't like, "Oh, this is it," you know?

Brooke Grindlinger

You can stop now.

Elizabeth Blackburn

But I was older, I was older when I got it so I didn't feel I had to be continuing to prove myself in the same way that I'd felt I had to. I'm sort of internally driven, I guess, to try and achieve and so forth. So prizes in general, I think they're okay up to a point if you put them for what they really are, right? And it is lovely to recognize somebody in a way. And by the way, nobody's ever disliked getting a prize. If they're really honest about it, sometimes people said the Nobel Prize brings all sorts of weights upon you, and it does, lots of responsibilities and so forth because of its more publicly known nature. But most prizes are not that way. And being recognized by people, innumerable times being on selection committees and told the recipient about they've been selected for a prize in immunology and microbiology or molecular biology, and they don't say, "Oh, that's terrible." No, they don't say that, they're happy that their peers have appreciated their work. So it's nice for the person.

Elizabeth Blackburn

However, what you're saying more seriously is for the field for science, is this a good thing to have a kind of 'winner takes all' trophy-driven thing? And given the real nature of science, it has to be kept very much in its place in terms of not distorting what more and more in science we know must be much more collaborative than you could get away with before because the demands of technologies - in at least the biological sciences - mean that you need to bring different brains and expertise in to tackle really complex problems like those in science and medicine. And so, there, how would you distribute these prizes? So now the Nobel Prize has given for whole organizations - the Climate Prize included a whole organization. So you can reward people in different ways. And perhaps that will be an evolution we'll see more and more in recognizing people's accomplishments and contributions.

Brooke Grindlinger

Thank you. So let's take a turn now. I'd like to delve a little bit into one of the more challenging areas that women in science face and that's balancing family and career. Like many other women scientists of your generation, you postponed having a child until you were 38. And I guess the ecosystem for a scientist, long hours, little pay, very extreme pressure to publish, to get your credentials through a high output of publications and grants that tends to coincide with a woman's peak childbearing years. And the difficulties of balancing family life and work play a really large role today of women opting out of continuing in scientific careers. So did you struggle in trying to find a balance between family and career? And what advice do you have for scientists, for administrators, for principal investigators that are helping younger scientists come through their labs to deal with this balance? How do we support these young women in their pursuit of scientific careers?

Elizabeth Blackburn

Well, I think there are so many aspects to this. So the first is yes, I can really speak to what a struggle it is. And having a child later in my career actually made it somewhat easier because I had an established research group, I was tenured, we could afford to have help with our child, and my husband and I both working scientists so we kind of needed three parents in the family, but that's not going to be the way it is for many people. And so I'll talk about administrative and so forth first of all, because I think institutionally, we are still very far behind what we ought to be doing, which is that Meryl Streep said something I love this, because she had four or five children, I forget and she was talking about this, she said, "Every successful actress's life, there are ebbs and flows."

Elizabeth Blackburn

And what she was talking about was in the context of family, there are times when you need 'family time', there's times when 'career'. So we have a 'man without a family'-structured science career mode most of the time, which is monotonically just doing one thing full-time, and this is really, really a disservice, I think for everybody. And there are other ways of doing it, which are not rocket science: going part-time in certain times when you need to, keeping up continuity so people could reenter. And I've been really pleased to see women who've done that over the years. And I can't think of that many examples in the US sadly, but I could think of some in Australia and some in Holland, one of my past students. Part-time for a number of years, and then could roll back full-time when the children got old enough, and we wouldn't lose scientists, especially women scientists.

Elizabeth Blackburn

But men also want family time, and so on. So I think we've structured careers really badly. And administrators can do something. I've heard of one institution director who's just said, "When we advertise a job, I'm happy to advertise it for two people and they can divide it up as they wish," there are ways. So I think we can become very much creative as institutions in how science careers get structured. Because as you said, the loss of women because they're daunted by this is just extraordinarily bad, and it's so unnecessary if one's structured and had flexibility and understanding, there are times when it just isn't practical to do everything at once. People do and struggle, then they say, "Well, you can do it," but I don't think that's a smart way to go about it.

Elizabeth Blackburn

What advice would I take? So first of all, it's much, much better now, there are things like tenure 'clock stop' and things, but there's just much better understanding if you have a need for a child's needs or your family's needs, now it's just acceptable to say, "I have those needs." When I was younger, as younger in my career, I think I was much too intimidated about feeling I wouldn't be taken seriously and I'd be marginalized if I said, "I don't want to have a Chair's meeting at seven o'clock in the morning because that's the time I spend with my son," and that was something I couldn't even bring myself to say in the early 1990s. I didn't know how to cope with that. And now, I think it's really acceptable to say you need to make sure people can have balanced lives because there is a realization for the long haul, it pays. It pays institutions, it pays individually, it pays not to have people drop out. So I think being very clear, advice for people would be, yeah, be clear about what your needs are and saying,

Elizabeth Blackburn

"This is not that I'm not serious about my job," of course, but there are going to be real times, and there'll be times when children do grow up. I've noticed they grow up. And then you've got all these decades again. So we kind of forget during those busy years of having children that they actually will finish and they do grow up. And so then one can, full-strength, come back into one's career if one had been part-time. The problem is if someone drops out and then it's very hard to just keep one's hand in something like fast-moving areas in science.

Brooke Grindlinger

I know from talking to some of my colleagues who are active scientists that they still do struggle and feel like they have to hide their family obligations and hide that from their work colleagues. What

advice could you give for scientists who still feel that they need to hide that or perhaps they come forward, and as you say, say, "I need help. These are the resources I need," or, "I need a more flexible working environment." What can they do if their institution isn't as supportive as some other institutions might be, or if there isn't things like part-time work share of roles, as you suggested?

Elizabeth Blackburn

Yes. And part-time may be only necessary for a limited time. I think over and over again, I've learned in my career, lessons I've learned, which has been more and more: find people to talk to and get advice from and they will start supporting you. And that's really important in terms of just talking to colleagues. You think that there's a lot of people who really want to help you succeed. If you're a young scientist, everyone recognizes that you've invested a lot into it. There's been a lot invested in you. People actually do want you to succeed and they don't always know what it is you need. And so talking to people... And I don't just mean... I don't know... just your friends, but talking to faculty members, older ones, younger ones, people going through the same thing as you, just finding ways to have conversations, people, and saying, "Look, I'd really love some advice. Can you help me?"

Elizabeth Blackburn

People are very, very much wanting to give advice. I'm not getting very specific. My general point is: get out there and really ask people. I was very afraid to. I thought, "They'll think I'm weak and I'm not serious." And now where I think society, at least, as a lot of people growing up into interest in STEM will find, people want you to succeed and they know it is perfectly good to ask these questions and to ask for advice. It doesn't show that you're hopeless. It shows that you're being smart and thinking through how are you going to make this work.

Brooke Grindlinger

So being a little bit outspoken, being proactive, advocating for yourself when you need assistance and resources, and tapping into mentors, I guess. You really touched on the topic of mentors and mentoring.

Elizabeth Blackburn

Mentors can be every kind of mentor, from the formal science career kind to mentors on how do I manage my busy life? Before there were home deliveries of groceries, one of my colleagues said, "If you're having quality time with your children, that isn't dragging them around the supermarket. Get the shopping done some other way and spend the time with them in a way that means something. Think of all the things you do and prioritize." And I have to say I did, without feeling heroic about it. I just basically stopped going to restaurants and movies and things, and just spent time with family and time with work, which I loved. And could go to lousy kids' movies sometimes. But before I had a child and after I had a child, lots of decades doing those things.

Elizabeth Blackburn

So I didn't mind homing in and saying, "These are the things that are important to me at the time." You don't have to be balanced in everything every single day of your life. You can focus on certain things for certain periods of time and then other things will come and be more important. But I think really, I can't say enough, ask people for advice. It doesn't have to be senior people or people who know about science. Sometimes it's people in business and just say, "How do I deal with awkward colleagues? How have you dealt with them?" Because human nature is just going to be the same in all sorts of

workplaces. So you can get workplace advice way beyond the sciences, or academia, or research-based institutions.

Brooke Grindlinger

So speaking of advice, what were some of the, I guess, qualities or practices or advice that were imparted to you by your mentors that you found most valuable? And then what do you impart to younger scientists as a mentor yourself - the most important things that you want people to really register and take to heart?

Elizabeth Blackburn

When I look back, I think that my advisors - who were my PhD advisor, my post-doctoral advisor, my colleagues, my more senior colleagues when I was a young faculty member - they all conveyed, not always explicitly, that they kind of had some faith in me, that they sort of trusted me to do what I do. And that was really important because I think I didn't quite trust myself. I was very unconfident in a lot of ways. I probably set ridiculous standards for myself. I don't know. But having that was very, very helpful for me.

Elizabeth Blackburn

And so over the decades, I've particularly noticed that my trainees, not only the PhD students, but the postdoctoral fellows, have often doubted their capacities when they are women. And they have been the ones who've said, "Have I got what it takes? I'm not really sure if I can handle this career." The men trainees had not said that to me. And so I really feel that you need to be helping people get confidence because so... I mean, it really is quite striking. It has been the women trainees over these decades who have clearly not had the confidence that their obvious abilities and capabilities have shown they could have confidence in. So we can look into all sorts of causes and societal, and so on, about that because those are very real, but that's what I was lucky enough to have sensed from my advisors of various kinds. And that's really what I try to impart, as well as do feel that you should ask for advice and get advice and get help. Make sure you do that.

Brooke Grindlinger

Good advice. So let's dip back into the science again. And I guess now in your career course, we're in the early 1990s and telomeres are being implicated in human cancer and aging. And so it wasn't surprising that this notion soon appeared that replenishing your supply of telomeres might somehow be able to cure or counter the aging process. So this idea of there being some magical elixir to extend life pretty much captured the public's attention. And how did you react to your research suddenly being thrust into the popular press this way about telomeres might help me live forever if I do this?

Elizabeth Blackburn

Yes. I was dismayed, because what had been learned about aging was that there's a lot of pathways in aging, and it wasn't clear at all in that trajectory of the life course where telomeres worked in terms of the aging part because what was known was that for cells, cells needed to have protective telomeres because if they didn't have them, if the telomeres got worn down, then the cells go into the state of alarm. They send out alarm signals. They start misbehaving, getting senescent. And so cells get very unhappy, but it didn't have a context of human aging until really, I'd say '90s and 2000s. But we also know from genetics of model organisms that there are whole other pathways of processes to do with lots of controls themselves that end up affecting the age at which, for example, model organisms like mice will become older and older-seeming and eventually die.

Elizabeth Blackburn

So it was a real big puzzle for quite a long time. And then this sort of immortalization idea was like, "Well, wait a minute, that's a bit much," is what I thought and sort of, "Hold this back here. You're setting expectations weirdly high here." But what has emerged over the years is that we humans, we live for many, many decades, 80, 90 years and whatever life expectancy is. So we have to look at what happens in the very long life courses. And what has been fascinating through a lot of studies of others looking at human aging and the processes going on, we took our part in it by measuring telomeres in people as they age. And you could see that they were getting shorter and shorter. And then more and more, the genetics started saying, "Yes, there's actually some role that telomeres have. When they have these effects on cells, when they get too short, that does have effects on the kinds of diseases that are the chronic diseases that account for most of the deaths in the elderly."

Elizabeth Blackburn

And so there's a role there. It's a part of the puzzle. But that took a while. So your question was how did I respond? And my feeling was initially, this was being so overblown. And then I'm going to fast-forward really forward and say, and that picture of maintaining telomeres has gotten nuanced because cancer cells love to maintain their telomeres. And they love to have lots of telomerase. It's the most frequent upregulation in cancers in humans. 80, 90% of humans' cancers have very active telomerase, so they just love their telomerase. And so it turns out that having a little push in the balance of the too much telomerase can tip cells into that multi-step pathway whereby they come cancerous.

Elizabeth Blackburn

So it's all about a balance. That's what we've learned over the long course of human life. It's a trade-off as we go through the later decades. But by and large, telomere maintenance overall is still... natural telomere maintenance the best, not slugging down telomerase, which you could never do anyway. This idea that you could do one thing and you could... like a magic pill. If you had too much telomerase, I think your chances of getting cancer would get awfully dangerous, too. It's been quite a journey of the science moving over the last few decades into getting that real, nuanced understanding in the whole human organism. It's been understood very well at the cell level for quite a lot. A lot of terrific research has gone on all around the world in understanding telomeres and how their changes affect cells and how cells can regulate what goes on in their telomeres and their maintenance.

Brooke Grindlinger

So you shifted your research into clinical research and you started to look at the impact of severe psychological stress and how stress can age the body at the cellular level. I think it's safe to say everyone in the world right now probably has a higher-than-normal level of stress as we cope during a pandemic. How does stress get into our cells and how do we see stress have a broader effect on our bodies?

Elizabeth Blackburn

Well, I didn't shift... I was a molecular cell person and we kept doing that, but a marvelous collaboration initiated by a then-postdoc, Elissa Epel, who's now a Professor in the Department of Psychiatry at UCSF. She was studying chronic stress, and she said, "Stress makes people look old and haggard, and what's happening to their telomeres?" And I said, "Nobody knows." So it began, this whole series of collaborations with Elissa. We still collaborate to this day and with also many other groups, just asking about what's the physiology of what happens with chronic stress that others have been studying. So the physiology is that a lot of changes happen. Stress hormones go up and so on. So

one simple example I'll give you is if you have dysregulated cortisol, which is a stress hormone, which has a real role, and it has a cycle of the day, but if you get chronically stressed, it gets dysregulated and it's chronically high up in level.

Elizabeth Blackburn

So it's circulating around, and bathing yourselves, and it's being taken up by cells. Now, immune system cells really need a good amount of properly-regulated telomerase because they have to keep replenishing and replenishing, and they need to keep replenishing their telomeres. So they have regulated, but properly regulated telomerase. And cortisol dampens down that activity. So there's a very simple way. Stress, cortisol levels go up, cells that need to have enough telomerase get bathed in a hormone, a stress hormone. That now dampens down their ability to maintain telomeres. And when they can't do that, the cells in certain ways get exhausted and can't then proliferate appropriately for proper immune responses. And that can lead to inflammatory situations, which then, in turn, many researchers now find that then can provoke or promote cardiovascular disease, diabetes, even aspects of dementia. So all of these things, there's this role in the background the telomeres are quietly playing.

Elizabeth Blackburn

So we found it very important to keep thinking about how you can measure these in cohorts of people to look statistically at what happens in humans. We're actually now doing a study collaborating with UCSF people. We're involved to look at telomeres in: what is the effect of severe stress on how people will respond long-term to the vaccines. We don't know this, right? This is an open question. So it's NIH-funded. Just started the study. I mean, we just play a small role in this very collaborative study, which has multiple centers. But there's a lot that people understand; stress has these real physiological effects, and they can in turn affect serious things like cardiovascular disease. But nobody knows about vaccine response. We know that shorter telomeres in your immune cells are a harbinger of not being able to fight off the common cold infection so well. Very clear studies on that. So we want to learn these things because more and more people are realizing we have to integrate all of these questions into the general health and wellbeing of a person.

Brooke Grindlinger

We're going to have to have you back when the results of that study are ready for publication so you can tell us what the impacts are.

Elizabeth Blackburn

Well, they'll be followed out for seven months or so. So hopefully we'll find out something about longer-term responses.

Brooke Grindlinger

Can I ask, can parents pass their shortened telomeres onto their children?

Elizabeth Blackburn

There's two ways that... One, we know they can. If people have a rare genetic mutation... and there are actually several of these known... that directly affects either telomerase or telomere-protective protein, those parents will have extremely short telomeres and they can pass them on to the child. And in the clinical cases where this has been looked at, even though the child may get good genes - because there's only one copy of the bad gene from one parent coming in - that unfortunate parent passes it

onto the child. Sorry. If the good gene gets passed on, the child has normal genes but the telomeres have started off, right from the get-go, let's say from the egg, it's very short. And that child has a milder version of the telomere diseases. They're called 'telomeropathies', or 'telomere syndrome diseases', that happen when somebody actually carries the mutation.

Elizabeth Blackburn

So that's rarer, but it says it can be done. It can happen. And so more to the general question is, we now know that chronic long-term stress will be associated, statistically, with people having shorter telomeres. And so now since you pass your chromosomes to your offspring, of course, every chromosome is equipped with the telomeres it was there with when it went into the, let's say the egg or the sperm, and then became zygote and grew into a person. You're starting off potentially with shorter telomeres. And it's not clear that the corrective mechanism, which is readjusting them back up, is always going to work perfectly well. We know it doesn't work perfectly well for those rarer cases where the telomeres are especially short. So there are studies now going on looking at multiple generations to try to say, "Is this something that we acquire through, for example, exposure to things such as stress?" But there's also a lot of other exposures to adverse environmental situations that also... such as pollution of certain kinds, that definitely are associated with shorter telomeres.

Elizabeth Blackburn

So I think this is something that, to me, raises a huge caution. It's like climate change. It's like, what are you handing on to the next generation? Being aware of these things is empowering, right? Not to blame. It's to say if we know things are the way they are, and we don't yet know how much this will happen for the population, then it's something to be aware of, something to think about and act on. So we're in the middle of those studies and many other groups that are in the middle of those studies.

Brooke Grindlinger

That's fascinating. So you mentioned your collaborator, Dr. Elissa Epel. The two of you published a New York Times bestselling book in 2017. It's called "The Telomere Effect: A Revolutionary Approach to Living Younger, Healthier, Longer." So you've told us about some of the things that can shorten your telomeres. Are there healthy behaviors that we could all adopt, something we could do proactively, to make our telomeres more resilient?

Elizabeth Blackburn

Yes. And they're basically... I like to say, "Everything your mother told you: get a good night's rest, have a good attitude, eat well, get some exercise every day." All of those things. So there's nothing new there. What the telomere science does is it both rationalizes, but also measures these things. And so there are certain other interventions that have been more and more done as proper controlled studies. Initially, there was lots of observations, but there were some observational studies that said, "Let's actually test this. What happens if you don't do certain thing or you do it? And let's look at telomeres." And you find that for certain kinds of things such as certain kinds of meditative practices, doing this for months, people's telomeres will actually, on average, lengthen rather than just stay the same or shorten. And so over and over again, we've found, as I said, what can be simply described as: what your mother told you.

Elizabeth Blackburn

You know, all the things are good for your health, right? And somehow knowing it can be quantified in telomere measures, which then are a very useful, integrative measure of a lot of influences, but they

can get collapsed into this measuring telomeres and looking at the statistics across large enough numbers of people to get strong statistical significance. You can see, yeah, there's something real going on. Yeah. And it can be very helpful. 15, 30 minutes worth of exercise done daily is really quite helpful for telomeres. And if people are under stress... This was, I thought, fascinating. In a study where people were under stress or not, and this is how they feel about the stress. Stress is coming all the time. The big thing is how people can handle that. And there's tools to try and deal with stress, which again, these studies emphasize they're important.

Elizabeth Blackburn

People who are not under stress gain a benefit from exercises, we clearly know, and you can measure what effect, benefit that has on the telomeres. But people who are under severe chronic stress, the benefit they get for the telomeres is actually proportionally greater, is actually greater. So it's like when you're really stressed... this is how I would take it home... if you feel really stressed, that's the time to go exercise. Everything says, "Eat that ice cream." No. Actually, if you exercise... So knowing that the telomeres do this, that's the response. It's very helpful to know. We wrote the book because there was all this helpful information that was coming from all sorts of different journals and was piling up and piling up. And so Elissa and I agreed to write this book because we could put it all in one place in a way that, especially with Elissa's professional work as a psychologist who's interested in studying stress, we could put that into a form that we hoped would be helpful for people.

Brooke Grindlinger

And I have to say the book is written for very broad audiences. It's very accessible. I really enjoyed reading it and would certainly recommend it to those who are looking for some of those pieces of advice. Mom's advice. Damn it. You're telling me that all these years, my Mom was telling me to do things, and she was right after all? I want to switch back a little bit into your career and talk about leadership as a woman in science. You joined the University of California, San Francisco in the early '90s, and you took over as Chair of your department. So you had a lot more ability to exercise power and influence as a high-level administrator. And I guess I want to ask about ... science is still often represented as a bastion of sexism. Did you become more attuned to gender barriers that impacted women during that period as a high-level administrator? And can you share some of the steps that you endeavored to take to implement positive change around some of those gender barriers?

Elizabeth Blackburn

Yes. Well, I think you're absolutely right. I think the interesting thing is that we see at levels of 50-50 PhD students, at least in the life sciences, postdoctoral fellows, and then more and more, we see an attrition of women.

Elizabeth Blackburn

And I really think that this is because there are a lot of societal forces, and we're all aware of many of these kinds of things. And they do operate at levels of power, and so forth. And for me, the hardest part was that there is much more... Still, there's a feeling of, people call it 'old boys' club', or something. I didn't feel as included as I would have felt if I'd been one of my male colleagues in so many of the informal discussions. All the formality parts were done fine, but I just didn't feel that I had that same, I don't know, power, access, and so forth to the real decision-making. I was there among them, but didn't feel part of it either. And that to me was just exemplifying what I think is true across so many different professions. When it comes to power and so forth, there's a long ways to go.

Elizabeth Blackburn

So there's various things I've tried to do. I'll give you one big broad example, which is now, for people interested in STEM, which was that I was really thinking about how we go about science, the whole picture of science. And there's so much about science that has grown up in recent couple of centuries, which was very much against the participation of women, because it was things like the lone hero scientist, and the full-time thing, and not collaborating. And all those things where there were more and more opportunities for women to be left out. And so in the last couple, last few years, I've got very interested in can we think about some real guidelines for scientists, and how can we deal with the new generation of scientists... How can they deal, rather, with what they want to make of science? What science world did they want to make?

Elizabeth Blackburn

So with something called the Lindau Nobel Laureates Meetings, which is every year, and hundreds of young scientists come and meet with Nobel Laureates in a place called Lindau in Europe every year. And we just spend a year talking about science, and came up with this idea that we really should have some guidelines about what science should be about. And one of the important aspects of these, it's got several points, is we should make a commitment, as all scientists, to support talent, regardless of where you come from, and what your gender is, and what your religion is, and what your background is. And so that kind of thing should be built into the ethos of science.

Elizabeth Blackburn

Just we build in, you should be rigorous, you should be truthful. You should be... Build in those practices in science so that it becomes the norm. And we even think of it almost like a Hippocratic Oath for science. You will do these things, and layout these kinds of practices in science, because some of them are implicit, and some of them have really been not very well adhered to. There has been a lot of exclusion of women and many other groups in science. And that is terribly to the detriment of science, I have to say. And it's also it's not the right way to do any kind of profession or activity. So that's one thing, just one example.

Brooke Grindlinger

I think we have a couple of slides actually about the Lindau Declaration. I wonder if we can put them up on the screen so that people can see where they could learn more. And I guess, could you just say something about, if anyone who's watching wants to get involved in this movement, in the Lindau Declaration and supporting the goals, how can they get involved in this initiative that you are spearheading?

Elizabeth Blackburn

There's a website which invites you to participate. I think it's probably the thing you're going to put up, but if you just... Yes, yes. The key words are Lindau Declaration. There we are. But Lindau guidelines will bring it up. And then it has various follow on things that you can... Yes.

Brooke Grindlinger

Some of the goals.

Elizabeth Blackburn

And there are some of the goals, and I talked about one of them already, which was, I think it was support all talent, right? And yeah. So, oh no. We changed the order. Number seven. Support, yes. And so it's just talking about things that we know have been very important in science. Open access to science, communicating science, listening to others who are not convinced that science is going to be helpful for them or meaning for them. Listening, learning to communicate, and listen, and engaging in education. Just all sorts of things that, in general, we can say, "Yeah, these are good things to do." But to have this formalized, and say this really is part of being a scientist. It is not part of just... It's not just writing papers, and making your discoveries, and pushing knowledge forward.

Elizabeth Blackburn

A scientist is a more rounded person, figure these days. And you need to say, "This is what is going to be valued and rewarded." And we need more and more to collaborate in science. A lot of it happens naturally, but a lot of it is not rewarded. Institutions don't always reward collaborative researchers. This is changing, but it was a real problem in science when there was true collaboration, they say, "Well, who's the person who did it?" It's like, "No, no. This is more than one mind getting together. That's what produced the science." You can't just say it was one versus the other. So practices of science, I think, are ripe for change. And those include being much more inclusive in how we do science, in all senses.

Brooke Grindlinger

Well, thank you for taking a leadership role in stewarding the Lindau Declaration initiative. I'm mindful of our time tonight. We have about 12, 13 minutes remaining. So I'd love to take some questions from our viewers. If anyone does have a question, put them into the Q&A box in Zoom, or you can tag it on our social media channels with the hashtag #STEMsupremes. So I'm going to take a question from Barbara. This hearkens back to your point about the notion of maybe job sharing, and maybe moving part-time. Barbara's question is: "What's your advice for early-career scientists, pre-tenure track, with family duties who might manage to get part-time positions, but then face the consequence of slowing down their publication output, which in turn can put them at a disadvantage when it comes time to apply for tenure track positions?" In the end, I guess today, the researcher who publishes the new data first gets the credit. So what could be done to level the playing field in this situation?

Elizabeth Blackburn

Yes. Well, I'm going to argue, that's to your very last point. That is the one about precedents, because I always used to say to my very anxious students, "You know what? The paper that's going to be remembered and valued in the field will be the really good paper." That isn't to say don't get things out in a timely way, but if somebody publishes a few months ahead of you, it feels very disappointing. And it really is not that... The good work is recognized, right? And so that's just an aside. So yeah, so the more practical things. So if you have a part-time position. Now, for example, I understand, and I don't know the details that the National Institutes of Health has become much more aware of what is happening in somebody's career. And I would talk to somebody in the funding agency for the research funding agency, whichever one you're in. You may not be in National Institutes of Health, but in NSF, or something like that. And whatever's funding research and say, "What is your process for this situation?"

Elizabeth Blackburn

You see, this is a changing world, and more and more people are realizing this is important. Tenure, of course, there are now delayed tenure clocks for people who are having family needs. And that is often built into institutions. And that took leadership at the top. And I think Shirley Tilghman at Princeton, President of Princeton, was very influential in that kind of thing. Certainly one of the people who activated that. And so, but for somebody in their career like this, I think ask the funding agencies, ask your department colleagues and Chair, "What do I do?" Because solutions can be found to these things. And this comes back to my: "Ask, ask, ask." Don't just think you have to try and work out the situation yourself because often you won't necessarily be privy to all the information that you need to have.

Elizabeth Blackburn

And secondly, there might well be some constructive solutions that somebody will come up with because, as you say, it will look competitive, but I've got to say something. I have to tell you a story about Janet Rowley, who was very famous because she discovered something called the Philadelphia chromosome, which is a very common translocation of two chromosomes together. And that causes some very severe cancers, blood cancers. And what Janet did was she made that discovery when she was working part-time. She had, I think, four kids at that point or something, and she was part-time working. She'd gone somewhere because her husband, a researcher, had got the job. She was working part-time and she did this work working part-time. And she said working in that situation of having to do certain things in limited ways, focused her in on looking at these chromosomes, and she made the big insight. Oh, this is the insight she's famous for. This chromosome has this special rearrangement and that's what's underlying these cancers. And so you can make profound discoveries part-time as well.

Brooke Grindlinger

So perhaps we need to do more to spotlight those cases, in where women have made incredible contributions, but maybe taken a slightly less traditional path throughout their career. And prove that it really is possible to make significant contributions while not following that 'monotonic', I think you called it, career track that tends to be the norm in science. I have another question from a viewer. This is from Alaa Hamada, who's a high school senior from Egypt: "I would like to know, would you advise that people study two specializations simultaneously. For example, biomedicine and nanosciences. Or should people focus on just one specialty at a time?"

Elizabeth Blackburn

Well, I think it depends a lot on... Some people just would be able to fill their lives with just one, right? Or they just wouldn't have the capacity necessarily for two. And so at any one time, you might do better just to focus on one. But perhaps for practical reasons of college, time, and so forth you have to get them both in. And then you would have to say, "Well, I might not do either at a completely high level as I might've if I'd only been doing one, but I'll get the two together." So I wouldn't say intrinsically there's anything wrong with doing that. But I will say that science is very collaborative, as I was saying, especially now. And one of the things that I've really noticed is important is that when you collaborate, you bring some real deep expertise to the table, and then your other collaborators bring their deep expertise.

Elizabeth Blackburn

So when I collaborate with people who work on the psychology of stress and so on, what do I know about that? But what do they know about telomeres, and telomerase, and the ribonucleoprotein? And so we both brought our expertise, and then we talked to each other a lot. And you have to do that. So I think, but if you're passionate about both of those, then if you love doing both of those, and just can't decide, yeah, go for it. And you might have to then focus more or less on one or the other to get yourself to some depth of expertise, but it might've been very useful for you to have had that other perspective. You can have a major and a minor in college, and perhaps one could be the major and one could be the minor.

Brooke Grindlinger

Great advice. Great advice. I have another question this time from Susan. You mentioned, Dr. Blackburn, you and your husband are both successful scientists. It's not uncommon for there to be successful husband-wife scientists, throughout many different fields of science. Susan asks: "Were there times earlier in your marriage where perhaps he had to make sacrifices for your career, or you had to make sacrifices for his? And how did you navigate those two challenges together?"

Elizabeth Blackburn

Well, in the first case, I was the one... I was actually going to move from Cambridge to San Francisco. I had arranged a postdoctoral fellowship and lab there. And then my husband and I decided we'd get married. And he had already arranged to go to Yale. And so I just thought, "There are lots of good scientists at Yale." And so was able to... I made the switch. So we didn't even discuss it, which I'm shocked about in retrospect, but that's the way I was. And so now. But now, so we've never made sacrifices, per se. We're both fortunate, we looked for jobs in the same place, and we both found positions in the Bay Area. And my husband's science is different enough from mine that we never competed. That was an interesting thing. We had our own turfs, so we could understand each other's language. And we understood what it means when an experiment goes on late. And we understood weird hours and stuff like that. But luckily we just had our own areas. About every 10 years, I think it was, on average, we've tended to publish a paper together because our expertises have a brought something useful to a question. But I think everybody's going to have their individual dynamics. And I did hear some wise advice, which was, "Choose your husband wisely." I won't go into that, but you can see what I mean.

Brooke Grindlinger

I think it's safe to say that you feel like you successfully followed that advice?

Elizabeth Blackburn

Yeah. And we were lucky, because I think both of us felt we each had our interests and passions that could be met by, first of all, both going to Yale and pursuing our research interests there. And then, but as a team, we did both look for something in the same general area geographically. And so there might be real negotiations about who would do something and that would be a conversation for the couple to discuss.

Brooke Grindlinger

Sure. So I'm going to take one last question and then we will wrap up our conversation tonight. I have a question from one of our viewers on Facebook Live. They've asked about the Lindau Declaration 2020:

"How can non-scientists find ways to support these goals that are fundamental to global society's current needs?"

Elizabeth Blackburn

I'm so glad you asked that question because part of the motivation for this was there was this atmosphere of distrust of science coming from people who were not scientists. And the understanding of what is science like as a profession, we wondered if that isn't part of the problem, or is part of the problem, that people don't trust science as a profession, and what they do, and its motivations. So if people could see that there's a Hippocratic Oath-like thing. The Hippocratic Oath says, "Do no harm." Now this is much more, and the Hippocratic Oath is much more. But this is a profession that is wanting to do no harm, right? And if you saw that these... If this could become the norms of the profession, this might be one step for people feeling. "Yeah, yeah. I'm getting more what science is about, and it ain't so bad."

Elizabeth Blackburn

I know there's a lot of reasons why people don't trust science, but if I were somebody who wasn't a scientist, and I looked at this set of things, I'd say, "Yeah, I think that people who really buy into this set of guidelines, and they really commit to it, and they think this is the right way to do things, yeah. I think I would trust the kinds of things these people do." So what's the answer to your question, what can you do? Spread the word that, especially for younger scientists, but we think this is true generally, just having an idea of what this profession is about is, you can find it in these guidelines. And a lot of it is implicit and a lot happens, but a lot of it hadn't been laid out. There've been certain things, declarations. United Nations has had certain declarations that have laid out what science should be, and there've been other ones as well, but this had laid them all out for somebody doing science. But then you can look at it and say, "Yeah, this is what somebody's doing, science, this is what they're their professional life is about."

Brooke Grindlinger

Well, thank you so much for bringing this declaration to the community of scientists and non-scientists. And in closing, we do need to wrap up our conversation. I just want to extend my most sincere thanks to you, Dr. Blackburn, for sharing your journey and your wisdom with us tonight. And I want to thank all of our listeners and those who participated in the Q&A. And a full recording of this event is going to be available on Facebook Live and also on the New York Academy of Sciences' website in the coming days. And before we close, I just want to say a quick, thank you to our team behind the scenes who work very tirelessly to bring programs like this to you. For today's webinar, my colleagues behind the scenes are Crystal Ocampo, Danny Habashi, Derwin Knox, Susan Schultz, Dr. Sara Donnelly, and Dr. Barbara Knappmeyer.

Brooke Grindlinger

And finally, I hope you join us for the next episode in the STEM Supremes series. Next week on Thursday, March 25th, I'm going to be joined by astrophysicist, Dr. France Córdova, the former director of the United States National Science Foundation, and the youngest person, and first woman to serve as Chief Scientist at NASA. So I look forward to welcoming you all back to the Academy, albeit virtually, very soon. Thank you all so much for joining tonight. Stay safe and healthy. And I shall bid you all a good night, and leave you with this sneak peek of next week's guest, Dr. France Córdova.