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The Future of Science
Young researchers call for change to make scientific careers sustainable

Kristin Krukenberg and Jessica Polka
Interviewers: Stephanie Dutchen, David Cameron

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DAVID CAMERON: Hello and welcome to the reboot of the Harvard Medical Labcast, March 2015: science that's changing your world. This podcast is brought to you by Harvard Medical School's Office of Communications in Boston. I'm David Cameron.

STEPHANIE DUTCHEN: And I'm Stephanie Dutchen.

CAMERON: And in this episode, Stephanie tells us about some neuroscience research that offers a new twist on serotonin.

DUTCHEN: And today's conversation features Kristin Krukenberg and Jessica Polka, postdoctoral researchers at Harvard Medical School. David discusses with them the future of the scientific enterprise and whether it's sustainable for young scientists.

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CAMERON: Jessica, Kristin, thanks so much for joining us. It's great to have you here. And I guess my first question, and this could go to either of you: Why did you want to become a scientist?

KRISTIN KRUKENBERG: For me, I guess it started in high school. I had the opportunity to do a research internship. So I got to go to a lab at the University of Illinois in Chicago, and do actual research. It was a fantastic experience, getting to try to understand something unknown and discover something that no one else knew. And I

think I was hooked from that moment on. And knew that I wanted to do research, and stay in the lab, and keep trying to figure out new things.

CAMERON: OK. What about you, Jessica?

JESSICA POLKA: I have this one memory of being maybe a seventh-grader, and sitting cross-legged on my carpet in my parents' room, and opening the cell biology textbook and reading about organelles for the first time. And my mind was just completely blown, that life is composed of these mechanical devices that somehow work together to produce this kind of magical experience of a living object. And from that point on, I think I was kind of set in my goal.

CAMERON: And how old were you?

POLKA: Probably like 12. Well, how old are seventh-graders?

CAMERON: Seventh-graders are, I think they're 12. Yeah.

POLKA: Something like that. Right. So obviously--

CAMERON: That's the national average. Just, I'm interested in the comparison of the vision, the dream that pulls people to do crazy things like get a Ph.D., and commit themselves to that. And then, you know, what is the reality like?

KRUKENBERG: That's a good question. I guess some of it in grad school was dealing with the first time you realize that experiments often don't work as you planned. And that you spend a lot of time just trying to get a measurement to work, to see if you can even answer the question that you want to ask. So you spend a lot of time not even working towards the question but just developing the tools to be able to answer the question or troubleshooting the assay that you want to use.

And so realizing that you have this idea of these "aha" moments, where you're like, "Oh, I figured it out. I know something new." And you realize that those don't come as often as you'd like, maybe.

CAMERON: OK. It's more trial and error than "aha"s.

KRUKENBERG: Yes.

POLKA: And in addition to that, sometimes the direction that you take is driven a lot by what you can actually know, not by what you want to know. This trouble of developing techniques and methods really restricts, and in some delightful ways, brings you to areas you might not have visited otherwise. But it is definitely a different and more convoluted journey than you might read about in a textbook, for example.

But this also, without a clear goal, I think you need to be driven by the excitement and joy of discovery, even more so than if you were working towards a concrete product.

CAMERON: Now I know that recently the two of you have spent a lot of time thinking about and talking about and writing about and sort of convening public conversations on some of the more practical aspects involved in pursuing a life of scientific research. Can you talk about that a little bit? What are some of the issues that you've been acutely aware of lately?

KRUKENBERG: One of the main issues is that there's sort of this general fear among postdocs of what comes next. So we start to realize how many postdocs there are, and how few academic positions there are. And how many of us want to have those academic positions. And then you begin to wonder, "Will I be able to attain that?" Or are there just not enough positions for the number of qualified people that there are as postdocs?

And sort of talking to other postdocs, you realize almost everyone has these same fears. That we're spending a lot of time talking with each other, not necessarily about the

science that we're doing, but about the sort of fear of getting published, the fear of not being able to get a grant, the fear of not being able to get a job. These issues are really, I think, starting to dominate the conversations, particularly among postdocs. But I think this is also happening at other levels as well.

CAMERON: Is it harder to get published now than it was maybe 30 years ago? I mean obviously, you weren't doing what you're doing now 30 years ago. But when you talk to older scientists, is that an issue?

POLKA: I think -- we had a meeting at an SCB session where Bruce Alberts had some comment about the ease of publishing his first science paper. But I'm not sure I necessarily believe anecdotes like that. I think today there's a tremendous bevy of options for getting your work out there. But I think there's an expectation of putting the work into a set number of journals that is perceived as being required for getting these positions.

And it's not just, um -- the pressure, I think, is most acute on postdocs in this publishing sense, but certainly it affects grad students and faculty as well. I think at every level of the system, people are concerned about funding and really securing a future for their group.

CAMERON: Yeah. The both of you recently published an editorial in *Science* magazine called "Making Science a Desirable Career." Why did you write that?

KRUKENBERG: Some of it came out of -- from a lot of these discussions we've been having about the current system and people's sort of current fears. But out of this came this sense that we have a system now that's what we're calling sort of hypercompetitive. And that the two of us feel that this competition has gotten so extreme--

CAMERON: I'm sorry. Hypercompetitive among who?

KRUKENBERG: Among scientists. So I think that because funding rates are so low, and you have so many people applying for grants, there's this -- I think the funding rate at the NIH is something like 10 percent, at least at NIGMS; I don't know about the other institutes.

CAMERON: Meaning that?

KRUKENBERG: Meaning that ten percent of grants get funded. So people are spending a lot of time having to write lots of grants in order to get one funded. I think there's also the sense of competition in terms of, as Jessica was saying, this idea that, to be successful, you have to publish in a small number of journals. And the small number of journals have limited space for articles. So then there's this competition--

CAMERON: And by a small number, we mean three.

POLKA: Yeah. We're naming names, yeah.

KRUKENBERG: Yeah. So that limits -- so then there's this competition for people trying to get those few slots in these prestigious journals. And then the number of faculty positions are small, so the competition among postdocs to try to attain those positions… But--

CAMERON: But couldn't that be a good thing? Because competitiveness makes you more ambitious, it makes you sharper, hungrier. Why isn't that a good thing?

POLKA: I think, to a certain extent, competitiveness is important. It drives people to do probably better science faster than they would otherwise. And I think a certain level competition is definitely positive.

The concern is when competition becomes so acute that it drives people to do things that are perhaps not in the best interest of science. Where there's a rush to publish, so certain

experiments or controls -- you don't want to overlook things in the rush to get things out in time.

People spend a lot of time talking and worrying about their careers, rather than actually doing science. People spend a tremendous amount of time writing grants, when few of them will be funded. It becomes an exercise in grantsmanship, not necessarily in ideation, perhaps. So I think there's a level at which competition really hurts scientific productivity.

It's a difficult conversation to have and a difficult quantity to measure, but I think as a young scientist, we definitely feel some of these ill effects.

KRUKENBERG: Yeah.

CAMERON: Just to get a sense of context: Kristin, you said that it's roughly about ten percent of grants, at least according to one measure, that you've seen. Compared to what? What was it 30 years ago?

KRUKENBERG: So I think 30 years ago, it was something like 30 percent. I'd have to look up the actual numbers. But there has definitely been a drop.

CAMERON: That's sort of the scale that we're looking at.

KRUKENBERG: Yes.

CAMERON: OK. Are there ways that you think the culture of science -- the culture of academic science -- might be unwittingly complicit in some of this?

POLKA: So much of the entire scientific practice is defined by the structure of the system. We value training young scientists. We value giving grad students and postdocs an opportunity to work on exciting problems. This system is essentially the same as we

had 50 years ago. And I think, built into the system is an expectation of almost exponential growth of the scientific enterprise.

Every faculty member -- there are obviously faculty members who have dozens of trainees working under them. But I think on average there's probably about at least four or five trainees per faculty. So we have a system where the production rate of scientists is perhaps exceeding the academic employment possibilities. And I think by nature, if people are not entering the system, seeing this as a stepping stone to future careers that are perhaps different or more diverse, I think the competitiveness will be inherent in the system.

CAMERON: The incentive to get more trainees, but then there's not jobs for all those trainees.

KRUKENBERG: Right.

POLKA: That's right. Essentially all of the labor in a lab is performed by people who are training in one way or another, grad students or postdocs.

KRUKENBERG: Right. And need PIs need people in the lab to do the work, so that they can publish results and get papers in order to secure more funding. So in some ways, it's kind of this evil cycle of, to get more funding, you need more people doing work, but -- which means you need more funding. So I think it feeds on itself. And it's going to make it hard to get out of this system, I think.

CAMERON: Yeah. Almost like it's snowballing?

KRUKENBERG: Yes.

POLKA: Yes. But to get back to your point about the culture. I think that in some ways, we value new, exciting results, which is so wonderful in many ways. But it also

overlooks a lot of the really positive things that scientists do, whether that's communicating to the public, training new scientists in a very productive way, or contributing to the community in other ways.

So I think there's a lot of features of the way that scientists are rewarded that could be, perhaps, optimized to provide better incentives to do good for the entire community.

CAMERON: But our system, you're saying, it just really tends to reward--

KRUKENBERG: Publication.

CAMERON: The one --

POLKA: Yeah.

KRUKENBERG: In some ways it seems that we're training people to fit one particular mold of what a scientist should be, as opposed to, like Jessica was saying, encouraging people -- some people may be really good at mentoring and training. Other people may be really good at project development. And some people may be really good at grant writing.

Maybe -- as opposed to us saying, OK, one person who's a PI has to be good at mentoring, leading research, so running projects, getting grants, writing papers. Maybe there's room in the system to share some of that responsibility so that people who, say, don't want to be writing grants don't have to have a PI position. But there's some other position where they can still be doing research in the lab, but they don't have that sort of management role that a PI has.

CAMERON: So in the editorial that you published in *Science*, you -- as we're doing right now, you lay out some of the issues that you see. And then you do list some

recommendations. What are some of the things you would like to see happen in the culture of science today?

POLKA: I think one of the most promising suggestions -- this is certainly not our original idea, but this is an idea that we believe would be very helpful to the system -- would be to decouple the labor and training aspects of graduate student and postdoc experiences.

If the primary work that gets done in a lab is done only by trainees, I think you have a little bit of a conflict of interest in terms of wanting the trainee to perform and perhaps do the work that is outlined in a grant, but maybe not the intellectual freedom to pursue and develop their own ideas as much. Uh--

CAMERON: Is that what you mean when you say training grants and fellowships should replace grant support for most trainees?

KRUKENBERG: Yes.

POLKA: Yes, exactly.

CAMERON: Because that, I was a little confused on that part.

KRUKENBERG: So right now there are a number of fellowships -- so speaking of postdocs for example -- there are specific fellowships for postdocs from private funds and IHS postdoc fellowships. But a large portion of postdocs are paid off of their PI's research grants. So an R01 for example.

And so then I think it becomes less clear of what part of their role is as doing research to produce results for their professor's grant, and so that their professor can get renewed on that grant, versus how much of their role is to develop their own research projects that they can then use when applying for faculty positions, for example.

And so one idea is, if you have postdocs just funded off of their own fellowships, then they have more independence in the type of research they can do. And then the postdoc really does become a time where they can explore scientifically. They can try new ideas, and sort of test out new areas, and see where they want to go, and gain skills in some of those areas without necessarily just having to produce results based on their PI's ideas.

CAMERON: How would a PI feel about that? I mean, I could see why the postdoc would love that.

KRUKENBERG: Yeah. And I think this is why institutions--

CAMERON: Your view, as you're saying, you're on the job market right now. So you might become a PI pretty soon. So would--

KRUKENBERG: Exactly.

CAMERON: Would you flip over to that role--

KRUKENBERG: That's true. Because then like as a PI, you need people to do the work. So finding the balance, I think, is difficult. And it's not to be said that the postdoc would necessarily just do something completely different from their PI. Hopefully they could find an area that they can both agree on, they're both interested on, and they can sort of help each other. I don't think it has to be one or the other.

But this does bring up a point of all of these changes are going to be -- well, instituting any type of change is going to be tricky. And a lot of these issues are very interrelated. So issues of changing the training system is all dependent on funding and how the funding structure works. And…

CAMERON: Right. One of your recommendations kind of struck me, and I can't see this as being anything less than controversial. When you say we should move the career bottleneck from faculty to the postdoc or even down to graduate school admissions. So ultimately fewer trainees?

POLKA: That's essentially the proposition. And again, this gets back to this idea of perhaps having more scientists continuing to do science beyond training, in a staff scientist or perhaps research associate position of some kind.

I think that the need to alleviate hypercompetition is quite strong. And I think postdocs, at the end of their postdoc period, tend to feel this most acutely. But it definitely ramps up through the entire training process. And by no means are faculty immune to it as well.

CAMERON: Mm-hm, mm-hm.

POLKA: But as requirements for jobs become more and more intense and demanding, people are spending seven even more years in a postdoc.

And coupled with a long Ph.D. period and maybe a couple of years before starting grad school, you're essentially asking people to vote well over a decade, sometimes into their mid or late 30s in training positions, with very little assurance that they're going to be able to use the skills that they're training for in the way they had imagined. And so our primary concern is that this system is looking less and less attractive to young scientists.

And while there's a certain level where competition is good, we're now at this point where, perhaps, science is looking less attractive to talented young people. And we certainly don't want young scientists or budding young scientists to be counseled by their guidance counselor not to go into science because it's an unstable career choice, essentially.

CAMERON: Yeah.

KRUKENBERG: So in talking about moving the bottleneck, there's the question of where do we move it to? Do we try to limit the number of postdocs? Do we try to limit the number of graduate students? And I think many people, myself included, would argue that there's a lot of value to having a Ph.D. So many people who get a Ph.D. move on to other positions, including consulting, science writing, policy, teaching. And all of these areas, I think, benefit from people who've had rigorous science training from a Ph.D. program.

And so we may not need to limit the number of Ph.D.s, but maybe we should think about limiting the postdoc. So a postdoc may not be required for many of these career choices.

POLKA: But at the same time, if I could play devil's advocate a little bit, I think we should be thinking about whether there is actually demand in all of these areas for -- there certainly is demand in industry and all these places that you mentioned, but I think that we should take that demand into account as we determine how many grad students should be trained.

KRUKENBERG: And that's where the hard part lies, is trying to figure out what is the actual demand. So how do you match number of Ph.D.s, for example, with possible positions? I think we have no idea what the demand for a scientific Ph.D. really is.

CAMERON: If nothing changes, and we just keep going in the way we're going, other than lots of postdocs, you know, not getting jobs, what -- looking more broadly at society, what are consequences that we could see, that people who are not postdocs and grad students would need to be aware of?

KRUKENBERG: Part of the cool thing with doing science is, you often don't know. The result you find now, you may have no idea how important that may be for another 10 years. And if we're really limiting the research that gets funded, you may be missing out on a lot of those discoveries that, in the end, could be key to finding new cures for things

or discovering really important aspects about life that would be, you know, great for humanity.

POLKA: I agree. And I also worry about excluding people from science who might not have the socioeconomic stability in order to make a career risk. So I think diversity in science continues to be a huge challenge and something that we need to work towards. But I worry that the environment disproportionately affects women and people who might not have a sort of safety net.

CAMERON: So tell me a little bit about the organization that you've participated in forming, called Future of Research?

POLKA: Well, it's currently an informal network of postdocs across Boston. So we have representatives from about eight institutions across the area.

KRUKENBERG: We also have a few graduate students who've been involved.

POLKA: Thank you. Yes.

KRUKENBERG: It's expanded beyond just postdocs. We realized that these conversations have been ongoing, but they've been happening at a much higher level in the scientific hierarchy. And we felt that the voice of trainees and junior scientists was really missing from the conversation. And that they -- they, we -- have a lot to bring to the conversation.

So this was partially a way to both inform junior scientists of the system in the current issues and problems that people are discussing, but also a way then to have the voices of junior scientists heard as part of the discussion.

And I think on the longer term, the young scientists, the junior scientists now, they'll be the next round of faculty and professors. And if we really want to change the culture of

science, in terms of the way we think about career prospects or the way we think about rewarding people for their work, I think part of it is making today's young scientists aware of the issues and problems with the current system. So as they move on in their careers, they can make different choices. And that they can then change the culture from within.

CAMERON: Well, good luck.

KRUKENBERG: Thank you.

POLKA: Well, thank you!

KRUKENBERG: We will save the world!

CAMERON: Yes. Well, we will all stay tuned. Kristen, Jessica, thanks so much for joining us.

POLKA: Thank you, David.

KRUKENBERG: Thank you for having us.

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CAMERON: And now for this month's abstract.

DUTCHEN: Breathing, body temperature, mood, appetite. Name a physiological function and it seems the neurotransmitter serotonin has a hand in regulating it. How do serotonin-producing neurons do so many jobs? Neuroscientists wonder if they come in different subtypes with different responsibilities.

Thanks to new genetics tools, Harvard Medical School Professor of Genetics Susan Dymecki and collaborators have now shown this to be true, at least in mice. They identified several molecular subtypes of serotonergic neurons, and found that just one subtype is responsible for increasing breathing when too much carbon dioxide builds up in the body. They were then able to characterize the subtype's unique properties.

Until now, neurons have been classified by the neurotransmitters they produce and where they are located in the brain. Dymecki's results suggest that's not enough.

The study also offers new ways to think about how to diagnose, assess risk, and develop targeted drugs for a range of serotonin-related disorders.

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CAMERON: Thanks for joining us. This podcast is a production of Harvard Medical School's Office of Communications and External Relations. And we'd love to hear what you think at HMS.Harvard.edu/podcasts. You can also follow us on Twitter, where our handle is @HarvardMed or like us on Facebook.

Now we'd like to leave you with a thought by Marie Curie. "Nothing in life is to be feared. It is only to be understood. Now is the time to understand more so that we may fear less."

END OF INTERVIEW