Teaching and textbooks

An interview with Jocelyn Krebs, Professor of Biology at the University of Alaska Anchorage, and lead author of *Genes*

EMBO reports: How did you become involved in editing and updating Ben Lewin's book?

Jocelyn Krebs: I had long been a reviewer for a number of different textbooks and I know a previous editor of *Genes*, with whom I had been working for many years. Apparently I have a reputation for giving detailed and thoughtful reviews, so when Ben Lewin planned to step back, that editor invited me to be the lead author on *Essential Genes*, then on *Genes*.

EMBO reports: Do you consider it now to be a lifetime's work?

Krebs: I feel heavily invested in it because we can change it: not only keeping the science up-to-date but also improving how we explain things. For example, when we took over *Genes*, there wasn't really anything about RNAi [RNA interference] and we have added that and considerably expanded that section. Frankly, I don't know how Ben kept up with it, because we are three authors now and keeping on top of all the updates in a 2- to 3-year revision cycle is a lot to do when you have another full-time job.

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EMBO reports: Which sections are your special responsibility?

Krebs: Obviously the chromatin and epigenetics chapters are mine, since those are my areas of specialty. So are DNA repair and recombination and RNA stability. There are

about ten chapters that each author works with. One thing that we have changed is to seek experts in certain fields to review and add to the content.

EMBO reports: Do you criticize each others' chapters?

Krebs: Yes, the primary author takes each chapter first, sends it to the secondary author and then it ends with me. If I'm the primary author, it goes through the other two and then back to me.

EMBO reports: How do you handle the harmonization? Do you think there should be just one party line? If not, how do you avoid contradictions that confuse students rather than enlighten them?

Krebs: We definitely try to come to a consensus. There have been cases where the authors have gone back and forth multiple times on a single sentence, especially if it is an area that none of us have the expertise in. We then ask outside consultants about what they think is the current best view.

EMBO reports: Do you think that the basic scheme of the book is ever going to change? Or would it be almost impossible because of the all-engaging spirit of Ben Lewin?

Krebs: No, I don't think that is a problem. For years it was Ben's book and we still keep him in the title to pay homage to all the work he did, but we are starting to change it drastically from what it has been.

EMBO reports: Could you tell us how you would wish your sections of the book to be used by university teachers?

Krebs: I can tell you how I use it myself, which is admittedly more as a resource. I want to give students the big picture and then send them to the book to get the details. The book has to reinforce what you are covering in class, where you have to leave out a lot of details—as long as you keep it interesting with examples like, "Here is the most spliced gene that we know about." The content sticks better if students have more conceptual context.

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EMBO reports: How much do students need to know about the historical perspective and the classic experiments in molecular biology?

Krebs: Historical anecdotes make great teaching tools—there are a number of classic experiments like Meselson and Stahl that are easy to understand, beautifully illustrate the scientific method, and have great stories associated with them. I usually give only a few of these examples, because there is so much else to cover. But I think it is important for students to have a sense of history and progress in science, because it helps to emphasize that our understanding is always changing.

EMBO reports: How can texts or teaching materials keep abreast of the explosion in factual knowledge, especially in rapidly developing areas such as molecular biology?

Krebs: It's a huge challenge. Most textbooks are on a 3-year revision cycle and some have internet resources to allow them to include new information between editions. But I don't know how effectively that is utilized by either the publishers or the instructors. It's certainly a burden on authors to revise a book more frequently than this.

EMBO reports: Do you think that the explosion of mini-reviews actually makes updating the book less necessary, because there is an additional pool of material that students can dip into?

Krebs: In practice I do that, but of course I do it mostly in the fields I'm familiar with. If there are chapters in the textbook that aren't really my specialty, I'm not up-to-date on the reviews in the same way.

EMBO reports: Until some irritating bright student comes along and finds them. Could textbooks just become an internet resource? If so, do we still need printed textbooks at all?

Krebs: It's certainly possible. These days, students have access to internet textbooks, and a number of textbooks have an online version. Some students still prefer to have access to a physical book, but more and more students are comfortable doing all their reading electronically.

EMBO reports: How do you think an online-only textbook would differ from the traditional model?

Krebs: It wouldn't have to differ much. It can be hyperlinked to mini-reviews; you can get access to updated content very effectively. But as long as schools have adequate connectivity and all the students are prepared with computers I don't think that it makes a difference.

EMBO reports: How do you think the 3-year turnaround affects the financial viability of a textbook? It is a lot of money

for a student to fork out for an edition that will be out of date within a couple of years and which they can't even then sell on to the next class.

Krebs: It's one of the reasons e-books are becoming more popular: they are cheaper. I think publishing in general is facing a financial crisis because of the transition from physical books to e-books. But, it turns out that it doesn't cost that much less to produce an e-book, so there is a big drain in revenue if the e-books are cheaper. Authors receive reduced royalties on e-books compared to physical books and it becomes harder to keep authors engaged.

EMBO reports: Can you honestly say it's a financial benefit to authors?

Krebs: It's not a financial benefit in the sense that you could really make a living out of it. Primary authors have royalty rights and so

that's a different level of income than just the kind of 'pay-by-the-chapter reviewing and writing'. But still, when you think about the time that you could be spending on getting grants or doing other things, it's not big money.

EMBO reports: What about recognition? The work that you put into the textbook, does that get recognized by the faculty?

Krebs: Not by all of them, but at least by those who grew up with *Genes*. There are a lot of people who say: "Oh my God, you took over *Genes*, that's amazing!" Certainly my chair and some of my peers recognize the effort that goes into working on a textbook. I think because this is primarily an undergraduate teaching institution, there is the recognition that some of these activities are important. I think it must be a lot harder at a primarily research university where teaching is something you do occasionally.

EMBO reports: Do you think that, in the future, academics could get paid or get some other credit for updating and correcting textbooks, so it would become something that we all participate in and get recognition for?

Krebs: I think that would be a great system where we are both recognized and properly acknowledged.

EMBO reports: Wouldn't it require a system to screen authors to make sure that they were qualified? Of course, then you need somebody who is policing that.

Krebs: Yes, but even on Wikipedia entries are reviewed and improved by other users.

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EMBO reports: Is there then a danger that we'll have something worse than lack of authority, namely the dictatorship of the majority?

Krebs: That's an excellent point. Current textbooks have the same problem, in that they most often represent consensus opinion. Books for more senior students or graduate-level courses have more freedom to treat controversial areas and present several models.

EMBO reports: Should students be taught the latest information on a topic or solid information to the point where it makes sense and is robustly demonstrated?

Krebs: I make that distinction at different course levels. Introductory-level courses are often based on information that represents the current consensus of a topic. Beyond the introductory level, cutting-edge knowledge is the best because it gives the latest understanding of a topic, but also provides an excellent platform for teaching the scientific method and how to evaluate new ideas or interpret data.

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EMBO reports: Molecular biology is an interdisciplinary science, which has grown into something bigger than its different subject areas. Do you think interdisciplinarity is here to stay or is it a passing fad?

Krebs: I think it is very hard to go backwards from an interdisciplinary view. In a way, what we are doing is defining new disciplines that are amalgams of other disciplines. Interdisciplinarity is just a bridge to a new discipline. So it's hard to imagine going back to the basic disciplines that went into modern molecular biology.

EMBO reports: Should university education aim at teaching rational thinking and scientific method instead of facts?

Krebs: I think many courses already do that. Some factual basis is essential for any course, naturally, but teaching students how to think about science and how to evaluate

the scientific literature is much more important than learning a vast array of facts—many of which will soon be out of date anyway.

EMBO reports: How should we structure exams to reflect that concept?

Krebs: That is the hardest thing to do. One method I've done is take-home exams in which students are writing detailed research proposals. Take-home exams have their own challenges in terms of fairness and students working together. Then I have tried in-class workshops where I give an experimental scenario to a team and they have to design an experiment and show what the results would be—with full access to the textbook and internet resources.

EMBO reports: There is resistance among university teachers to consider new teaching methods such as the things you use yourself. Why do you think university teachers are so reluctant to change things?

Krebs: Ultimately, it comes down to the time burden, especially when you have both research and teaching obligations. Any time you spend on one takes away from the other and if you have a series of lectures that you have been teaching for years there is not a lot of incentive to do this in a radically different way. I think it's more: "I just feel too busy to come up with something really creative; I need to save my creative energy for this grant I'm writing."

EMBO reports: Should university teachers continue to be practicing scientists or should we move to having professional teachers and research scientists as separate professions?

Krebs: I would be disappointed, since I love having the interface between teaching and research. I feel that being a practicing scientist brings an immediacy and passion for discovery to my teaching. Often, students in my classes have become excited about the idea of research and have gone on to do projects in my lab—that natural synergy would be harder to achieve if the functions were entirely separated. On the other hand, it is certainly true that it is a challenge to do both well—there is only so much time.

EMBO reports: In Europe, the Bologna process standardizes the format and duration of university education in three

cycles: bachelor, master and doctorate. Do you think this is a good way to train scientists? Or would you create a researcher training stream from the start?

Krebs: Many US universities have reduced the time to the PhD over the last decade or two, but I value flexibility in higher education—if a student needs an extra year for an excellent dissertation, I would certainly hope that student could have that time. I also feel that the more intense the research experience early on, the better prepared a student is for a research career.

EMBO reports: That sort of begs the question: What actually constitutes a PhD?

Krebs: That's such a hard question because we all know that in molecular biology you can spend 6 years on something that gives you nothing and so the idea that a PhD is someone who has published this many papers, is not a good measure. A good qualifying exam and thesis defence are much more important measures of whether a student has learned to think experimentally, to be critical of their own results and the results in the literature. Those are the kinds of tools that are really essential if you are going to be a scientist. It shouldn't just be based on whether you had a particularly successful experiment as a PhD student.

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EMBO reports: Do you feel that those principles are put into practice in your own faculty?

Krebs: I think it's highly mixed. There are students who have graduated from our programme that if they had been in my lab I would have insisted on a little more time and development.

EMBO reports: Do you think the standards being employed generally in the US are at this point, not just in molecular biology, are uniform?

Krebs: No, not at all.

EMBO reports: Where are the wrinkles?

Krebs: It depends on the faculty and their commitment. Are we trying to pump out PhD students because it looks good for us or are we really trying to train competent scientists? It is an investment to train good students. Their pedigree then feeds into that success, so that it becomes self-sustaining. PhD programmes are rarely money makers—so there is unfortunately an incentive to pump the students through fast because you'll get a lot of tuition out of them to pay for other students.

EMBO reports: Do you think we are training too many PhD students?

Krebs: It certainly seems like it. The applicant pools we see for every position suggest that there is a real flood on the market. We are certainly training too many PhD students along the “you must become an academic or you are not a success” path and that is part of the problem.

EMBO reports: The content and the method of teaching depend on whether we are educating scientists, educators, technicians or just citizens. To which of these does the traditional model fit best?

Krebs: I think the traditional model is probably best aimed at scientists and educators with a balance of both. Technicians are a different breed because they need to be focused on the techniques—I don't want a technician who just reads the protocol of the kit and couldn't create their own protocol if they needed to. If all of these people are in a single classroom it's a big challenge to teach all of them. Bard College has this

new Citizen Scientist Program, in which every freshman gets a crash course in the big concepts of modern science, genomics and molecular biology.

EMBO reports: So this is aimed at people who are going to study law and humanities, as well as others?

Krebs: Yes, every student entering Bard College now does this programme and I think that's a really interesting approach.

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EMBO reports: It almost sounds like a version of the traditional concept of the liberal arts: a liberal sciences degree.

Krebs: Yes, it is very much like that.

EMBO reports: Molecular biology, at least to most people, is nowadays just a tool kit. So what is more important, the theory or the practice of molecular biology? What is the right balance between the two?

Krebs: The target audience does matter, because some people, especially in other fields, are trying to use molecular tools to advance in different kinds of research. We have people in our department who have done one PCR and think they're a molecular biologist but I always say: “Just because you can hammer in a nail doesn't make you a

carpenter.” I think we need to educate people that the techniques are not the whole story and help them to understand that this is just a little piece of a very large complex field.

EMBO reports: There was a period when the technology was expanding very rapidly and it was exciting to teach the practical aspects of molecular biology. But now we've got to the point where the technical aspects are less important, no longer accessible to most of us and anyway all contracted out to some service in China. Isn't it now more important to teach students to understand how to integrate data sets and draw out hypotheses?

Krebs: Yes, I think that's true. The technology is still expanding rapidly, but the scale of the data sets we can now gather is expanding at an even greater rate. I agree that teaching students how to analyse and critically evaluate data is essential, but if we don't cover the basis of the methods as well, who will be able to produce technical innovations in the future? We either have to tailor the content for different trainees—or dramatically increase the course time we invest in these areas, so that we could address all these topics in a multi-semester sequence.

EMBO reports: Many thanks for the interview.

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