Uncovering a 3D universe

By Ayse Baybars

Robert Lue, Professor of the Practice of Molecular and Cellular Biology and Director of Life Sciences Education at Harvard University, is one of Harvard's most beloved personalities, especially famous for teaching Life Sciences 1a: the introductory course in molecular and cellular biology. He also teaches MCB 54: Cell Biology and MCB 234: Cellular Metabolism and Human Disease. Professor Lue is known for launching the BioVisions project, a visually scintillating 3D glimpse into the inner workings of the cell. Inspired by his contributions to science pedagogy, the Harvard Science Review sat with him to talk about changes in science teaching over the past decade.

Credit: Robert Lue

Ayse Baybars (AB): How did you first enter the field of cell biology?

Rob Lue (RL): I was always interested in biology—I grew up on an island. When I started off, my interest was in marine biology, but then I discovered cells in my freshman year of college and ever since I've been completely taken with the study of cells. I think part of it is that I'm very interested in how whole organisms work, and for me a fundamental part of understanding how whole organisms work involves understanding how tissues work, and ultimately we understand tissues through understanding the activities and behaviors of individual cells. And the interesting thing is that even though you might think that as a fundamental unit, the cell is so simple, it has its own universe of activities. I really got pulled into that; even though they're not visible to the naked eye, by and large, nevertheless, there's so much complexity there, and so much we don't understand, it was very appealing to me—that's really how I got involved. But really, it was through starting research as a freshman: experiencing what it was like to work with cells, to do analysis on them that really pulled me into them from the beginning.

AB: With regard to the past decade, how do you think cell and molecular biology has progressed, especially in terms of teaching?

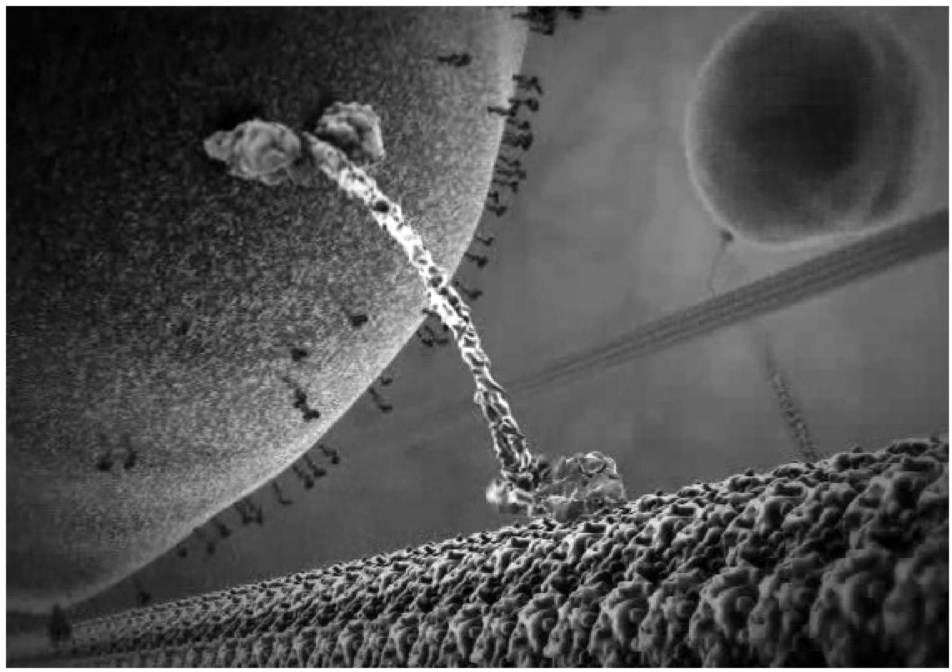
RL: Well, I think overall, the teaching of science and teaching about cells have changed a lot over the last decade in part because the field continues to change dramatically. I think we have moved way beyond a simplistic view of understanding cells—solely by understanding how individual parts work, and then how they fit together—to a much more systems-wide view of how a multiplicity of molecules work in concert. Added to that is the growing perspective that there's a lot of chaos and randomness involved, the understanding of which requires insights drawn from physics. I think, increasingly, we realize that understanding the cell as a system requires other fields even more so than it did in the past. With that happening on the science research end, the courses by definition have to become more broadly interdisciplinary in terms of the kinds of ideas from chemistry and from the physical sciences that you bring into the classroom—there has to be a lot more of that so that living systems can make sense more broadly. I think in terms of content, things have changed quite a bit. In terms of how we teach, as well, things have changed quite a bit. Ten years ago, fantastic lecturers, the so-called "sage-on-stage" model, was what ruled. But I think, increasingly, we realize that we have to be interactive, that simply having a group of students listen to a lecturer who is remarkably clear and eloquent is not enough. You need to ask questions, you need to have interactivity, and you need to break up the kind of interaction that's happening in the classroom more. This is really a major change that's sweeping through teaching. Particularly, I would say, in the last five years, there's been a lot of attention paid to activity-based learning. In the classroom and even in teaching labs, that's been a huge change.

AB: Where do you think the teaching change is headed? Do you think we'll ever leave the lecture hall?

RL: I don't think we'll leave the lecture hall. I think the format of the lecture hall will transform. I think, increasingly, you're not going to see lecture halls with stadium seating, the way we have them now. Rather, I think lecture halls will move towards students being able to cluster: imagine a very big lecture hall, and then reduce the angle of that slope and break it up into a series of large tables where maybe six students sit around the table, and instead of listening to the lecturer up front, the lecturer circulates in the room as the discussion of a problem or topic comes up. I think we're definitely moving towards that. I don't think the lecture will ever be replaced, but I think there's going to be more of a blend of delivery styles, which I think is always important, and a shift towards an almost equal balance, if not maybe a greater emphasis on discussion.

AB: Where do you see the imaging industry, BioVisions and similar projects, headed in the coming years?

RL: Well, I think, increasingly, visualization is going to be a huge part of both research and teaching. Interestingly enough, it's always been a big part of research, especially in cell biology, but I think in all the science fields, the ability to create visual models remains crucial to progress in research. In the same way that a visual representation of a model is crucial to communicating that model to fellow scientists, we're now way overdue bringing that same kind of approach to teaching. Earlier, there was the sense that only small subsets of students are visual learners. In fact, research shows that we're nearly all visual learners in some manner, and now we need to take advantage of that more fully so that the kind of modeling that we do, that we use in the classroom, will go way beyond diagrams in textbooks, diagrams in PowerPoint slides. You need to put things into motion, you need to put them in context, and you need to show different responses to different variables. All of this requires motion and requires some sort of visualization that's closer to animation than still diagrams. I think it's very much the future.



Credit: http://bchs.uh.edu/~frankino/life/

AB: Do you think 3D technologies like the ones being used today to reconstruct ancient cities could be applied to biology?

RL: Oh yes, certainly. For example, I'm in discussions with a number of science museums where we're thinking of doing a cell biology rendering that will be shown on the IMAX domes. The idea is to create that immersive experience because, ultimately, and I underline my use of the word "understand", we understand our environment from looking at it and looking at it in a way that emphasizes the physical positioning of our bodies in an environment. So, in the same way that you can understand a spectacular ruin in the Yucatan better by being there or by at least being able to interact with it in a 3D space, absolutely the same is true of understanding a cell, of understanding a tissue, of understanding an organ, and even understanding the arrangement of subatomic particles in an atom. And this is a spatial understanding—the understanding of the galaxies, of the organization of the universe, of the organization of a single cell, I mean all of that. I think we need to think about everything in three dimensions, because that's how we understand the world.

Indeed, understanding the world is the underlying goal of science. In the past decade, research and visualization methods have brought us far in our aspirations to better comprehend and model our universe. Over the years, Prof. Lue's work has greatly enhanced the way young scientists understand both science and the interplay of science with 21st-century resources. H