Welcome to the *ASPB News* "Luminaries" column. Student and postdoc members are welcome to submit their ideas for a 500- to 750-word interview they might like to conduct with a prominent scientist. Just contact Membership Committee Chair David Horvath at david.horvath@ars.usda.gov, who will help you develop some questions to frame your story. If we publish your interview, you will receive a $50 Amazon gift card.

For our inaugural column, we are delighted to publish Christos Noutsos's interview with Professor Rob Martienssen. Rob is a professor at Cold Spring Harbor Laboratory, and Christos is a postdoc at Cold Spring Harbor Laboratory.

FULL INTERVIEW

Rob Martienssen

BY CHRISTOS NOUTSOS

CN: Thanks for sitting for this interview. Let's start at the beginning. How did you become interested in biology? Which scientific fields attracted you the most?

RM: Like many molecular biologists, I was more interested in physics and chemistry as an undergraduate. However, I quickly realized that mathematics was a major component, and my mathematics wasn't that hot. As a result, I pursued genetics, which still has an abstract, mathematical side to it that I fell in love with.

CN: Was there a specific adviser or scientist who inspired you to pursue a career in science?

RM: That's a very difficult question. Obviously, my PhD adviser, David Baulcombe, is a very important person for me. But as an undergraduate, I read genetics at Cambridge, and Mike Ashburner was a really important inspiration for me at the time and very much since then. His appreciation for the subject is really unique, and he's quite a character as well! He probably led me on this path more than anyone else.

Later on, obviously, Barbara McClintock's work was a huge inspiration to all of us. I learned about transposons first in genetics undergraduate classes and was really inspired by the whole area. It was a privilege to meet her when I first came to Cold Spring Harbor 10 years later. It was remarkable to be able to spend about three years with her before she died, and I got to know her pretty well. She taught me a lot, not just about science but also about scientists. She was a tremendous inspiration.

CN: You have many awards, including HHMI. Which one has had the most impact on your career?

RM: That's hard to say. Awards are usually given after the event rather than during. The one that means the most to me is being a fellow of the Royal Society. I am British and was obviously educated in Britain. The Royal Society is a wonderful, old institution. It's been around since the mid 17th century. Fellows included Charles Darwin and Isaac Newton. It's really a huge privilege, and I deeply appreciate being elected.


Rob Martienssen

CN: If you had a chance to redo your graduate student or early postgraduate years, would you do anything differently?

RM: This is so interesting. I did my PhD with David Baulcombe, who at the time was just starting his position at the Plant Breeding Institute at Cambridge. I was his first graduate student. He was working on a number of things, and I ended up working for my PhD on a transposable element we discovered in wheat. Transposons has been a theme of my research ever since.

At the same time, he was just beginning to work on viruses. At the time, I didn't see viruses as particularly interesting. However, he and I have both speculated about what might have happened if I actually had chosen viruses instead of transposons,. The very first experiment he did of significance on viral silencing was done when I was there, but by someone else in the lab. It was a really important experiment on virus satellites having a significant effect on silencing that implicated RNA. Of course, it took almost 15 years for small RNAs to be discovered, but in the end we've both ended up working on small RNAs. In his case, mostly in viruses; in my case, mostly in transposons. But it all turns out to be the same thing. It's an interesting thought as to what

continued on next page

ROB MARTIENSSEN (*continued*)

would have happened. But I'm still very happy that I ended up working on transposons, and I wouldn't change that.

CN: What scientific discoveries over the last couple of years have influenced your research directions and why/how?

RM: Obviously, RNAi has really changed everybody's view of gene regulation and epigenetics. Epigenetics is the broad area we work in and includes everything from transposon regulation to developmental biology and, of course, gene regulation. RNAi turns out to be a unifying mechanism, which really allows us to think about all aspects of biology. The discovery of small RNAs themselves was a profound insight. But the connection between small RNAs and epigenetic marking of chromosomes, which we'd had a major part in about 10 years ago, really had an impact on the way we think about epigenetics. The ability to reprogram chromosomes with RNAi is really key to all of this, and that's been a major part of our work over the last few years.

CN: What are the most important things you look for in potential team members? What is the advice you give them on their first day in the lab?

RM: That's interesting. Well, at this point, I tend to rely quite a lot on the existing members of the group in terms of what we look for in new postdocs or new students. I think often I rely on other people's opinion as much as I do on my own.

I would say, from an advice standpoint, being a postdoc is probably the best time of one's scientific career. It allows you a lot more freedom to do research and nothing else, no teaching - none of that.

If you are in a good lab with good prospects, you can take the time to do novel and exciting research that really interests you. My best advice would be to do something that you are really interested in and not be too worried about the future or whether this will lead to a career. The early part of your postdoc is a time when you can explore science and find out what it is you love about it. Certainly for me that was true.

I think this is very important, but tends to get a little obscured. These days, the economic situation is very bad and jobs are difficult to come by. But if you worry too much about that, it can really detract from your science. In my opinion, really good science will always be recognized, and good scientists will always end up with a career. It's more important to do really good work than to worry about the future. Maybe that's a bit too extreme. (laughing)

CN: When you graduated, research on characterizing a single gene was being reported in prestigious journals. Now you need a way to generate more data. What do you think of the amount and quality of work PhD students produce now?

RM: Technology has really moved on, obviously. It's been an incredible ride the past 20 years, just thinking about sequencing, for example. I sequenced one gene, maybe two, for my PhD; now it's about how many genomes you sequenced. I think it's important to not get too wedded to the technology. What really matters is understanding, and sometimes you can understand a huge amount of biology through just a handful of genes or a single pathway. These days, it tends to be put in a much broader context, so understanding everything around that pathway or that phenomenon is now much more important. That's really the big change, I think.

But getting insight into mechanisms still requires the same sort of deductive reasoning and logic that it always has, McClintock being a great example. Just look at what she was able to do with such limited tools (though don't forget she was a fantastic experimentalist—her microscopy, for example). But the genetic logic she used is still absolutely viable today, and that sort of logic can still provide extraordinary insights into biology.

So it's not just the huge amount of data that's important. You can't ignore it, and it's no secret that informatics and the ability to handle and summarize large datasets in meaningful ways has become a key skill that I think all biologists entering the field now have to learn some aspects of. I think it's impossible to do biology without understanding at least the principles of informatics

CN: How do you see the future of research qualitatively, in terms of the way publications should move?

RM: It's a very interesting question. Research is not all about getting publications. But publications are an extremely important part of disseminating the results of the research. The Internet has revolutionized how research is disseminated, but publications are still important for several reasons. The most important reason, in my mind, is quality. It's very easy to generate large data sets and place them in a database in a way that is either easy—or perhaps not so easy—to access. But the quality of that data and the interpretation is still something that the mechanism of scientific publishing does best, I think.

Peer review is also extremely important. We all complain about it—but it's important. Having colleagues preview your conclusions before they are published is a good thing. Two minds are better than one, and maybe three or four minds are better than two. There are some innovative ideas out there about how to make the review process even better by allowing a larger community of people to comment both pre-publication and post-publication in various formats. Social media and such are definitely venues where community comments can be a powerful thing.

Even with the Internet and social media, publication is still important. The formal publication, where you know the quality is assured, will be important in some way in the future, I think.

CN: Do you think we should move more toward Open Source like Open Access?

RM: Definitely. I'm a huge fan. I'm still on the editorial board of PLoS Biology. PLoS, the Public Library of Science, was a great idea. They were able to apply some innovative thoughts to that—not just making everything open access but the way they review and edit papers. Most journals are now open access to some extent, and I think that's made a big difference.

We've also seen the demise of the printed word. I don't have subscriptions to any printed journals any more. You can use your mobile phone during a conference to check the references cited by a speaker. It's an incredible change. You can look at your own data from thousands of miles away and say, "Oh, did we see that?" It's difficult—and almost dangerous—to predict where that's going to go in the future. But it can only get more powerful, not less. We shouldn't in any way underestimate the importance of Google in science. It's been a true revolution.

CN: How do you compare research in genetics during the time when you were PhD student to now, taking into consideration all the sequencing technologies?

RM: Well, certainly technology has changed dramatically in epigenetics. We can now routinely look genome-wide at all sorts of epigenetic marks, not only DNA methylation. When I was a graduate student, DNA methylation was pretty much the only widely accepted epigenetic mark. Now, of course, we have hundreds of histone modifications, not to mention all the noncoding RNAs and small RNAs. I think what's interesting is that the principles behind epigenetics haven't changed that much. We still know the importance of heritable changes that are not caused by DNA mutation. They're reversible, environmentally induced, and can be inherited through generations. All of that is still true. Some of the observations made by McClintock, Ed Coe, and R. A. Brink working in maize in the 1940s and 1950s are still principles we live by now. We just understand a lot more about the mechanism, and the technology has helped a lot with that.

CN: In the last decade, genomics monopolized attention compared to phenomics. Do you think it's now time for phenomics to catch up and maybe do some studies out in nature?

RM: Absolutely I do. I think certainly natural variation is something that has become much more accessible with this new technology. Surveying large populations of plants, even at the genomic level, is now a real possibility, and that has huge implications. I would say the epigenomic level as well, and obviously, there's a lot of interest in this field.

Phenotyping in general has always been important. Phonemics, or the genome-wide cataloging and measuring of phenotypes, is in its infancy though. I think there are some well-defined phenotypic groups for which it's been applied in a particularly powerful way. For example, Arabidopsis root development has been looked at in an extraordinarily intricate way from a phenomic point of view. I think other types of phenotypes are still very difficult and each one is different. We're not dealing with DNA sequence anymore, which is the sort of lingua franca of genetics. Phenotypes is a *very* different type of ball game. But understanding phenotypes, in a genetic context, is still the answer. I'm biased because I'm a geneticist, but knowing the difference between a mutant and a wild type or a variant and another variant is still a good way to define a phenotype.

CN: What do you think will be the next big thing in your specific area of study, and why?

RM: Obviously, I think there are a lot of new technologies that are coming together. I think modeling is very exciting. Mathematical modeling again, like phenomics, is really just beginning. A bit like phenomics, it has to explore its boundaries. Boundary conditions, so to speak, are needed because you can't study the infinite universe of possibilities. You have to look at one thing, and how you choose and make those boundaries is really key.

In my own field, epigenetics, and especially epigenetics in the germ line, mechanism is something that we're really coming to grips with now. The extent to which these mechanisms affect both short-term and long-term evolution, breeding, and selection in plants are areas that are just now beginning to be modeled. The idea that the environment can influence heredity became heretical in the 1940s and 1950s, but actually there is mounting evidence that this is real. That is probably going to be the next big thing in the field of epigenetics.

CN: What do you think is the next big thing in plant biology, and why?

RM: Plant biology is such a huge field. I often complain that we talk about plant biology as a single topic, but people don't talk about animal or human biology in the same way. I think plants have every bit as much complexity and they're just as important to the planet—probably more so than many aspects of biomedical science, for example. So, it's difficult to say what the biggest thing in plant biology will be. There are technological changes that are going to happen. Synthetic biology is going to happen in plants, for sure. Maybe starting small, with chloroplasts or something, but synthetic biology is going to happen, and that's going to be an interesting application.

CN: What do you think are good career moves (experience, training) for young scientists, and why?

RM: Science and technology drive society and culture *far more* than society and culture drive science and technology. Never underestimate the importance of science on culture. The extent to which human society has advanced in the last 2,000 years is, more or less,

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ROB MARTIENSSEN (*continued*)

entirely dependent on what's happened in science. Science is a good thing to get into.

Whether you really are suited to the academic path is something that all students have to decide. There are many other career opportunities for scientists—from investment and consulting to law or teaching. This is the century of biology, so biologists are going to have roles throughout the economy, not just in academia.

For myself, academia is the perfect life. I can't really imagine *me* doing anything else. You can still enjoy some aspects of economic activity as well as an academic. But, academia allows you to explore the new frontier with fewer restrictions than a career in economics or law would impose. If you really want to do something new, I would say academia is a great path.

CN: What one thing in your view is most important to a successful career in plant biology research?

RM: I think imagination, creativity, and persistence are all important, and we all know what that means. If an experiment doesn't work, the worst thing you can do is just give up. It's being able to figure out why something behaves the way it does, whether it's an experiment or an organism. I think that sort of persistence and insight is the most important thing. Not everyone has it. And it's not just intelligence. There are a lot of characteristics that make a good scientist. Never underestimate persistence.

CN: What advice would you give to educators to encourage young people to explore science and plant biology?

RM: That's an excellent question, and a very important one. I think the appeal of science as a career is changing. We see this in applications to graduate schools in the United States. There are fewer American students who are interested in going on to a postgraduate degree.

I would say that in the early years, encouragement, confidence, excitement, and conveying the importance of science all matter. Young kids in school are very smart; they want to know what the most important things are. Emphasizing science and giving it the attention it deserves is half the battle.

Part of the problem that we've had in the past few years has been the emphasis on the economy. The disparity between scientists and other professions is something that should be addressed economically, and different countries have very different ways of addressing it.

Getting people excited about science from a sort of "inner sense" is the most important thing, I think. You're not going to appeal to their pocketbooks; you're going to appeal to their imagination and to the future. And don't underestimate the importance of the arts and culture. The science fiction of today may be the science of tomorrow! It certainly plays a big role in promoting science.

There are lots of ways to get people excited aside from traditional lecturing. Involving kids in experiments *early* is a good thing. I remember being fascinated by chemistry sets when I was a child, and I think that's still true of most kids. Getting them involved in DNA experiments early—why not? I think the DNA Learning Center has done an outstanding job of that. It's really impressive. The kids love it!

CN: What advice would you give to a high school student interested in plant biology today?

RM: I think plants are coming into their own. Traditionally, plant biology has played a supporting role, especially in biomedical science. Herbalists and medicinal gardens was how it all got started. But plants have led the way in basic biology. We tend to forget that Charles Darwin was also a botanist. Many of his important ideas in evolutionary biology were from plants. He was a big fan, actually, of Lamarck's ideas about the heritability of environmental influences.

Mendel first discovered Genes in plants, of course. In epigenetics, I would argue that McClintock and Brink described the first (or some of the first) epigenetic systems. And, of course, these days plants are very important for other reasons: for environmental sciences, for climate change, for biofuels. There's a tremendous interest in plants. Just look at China—the investment China is making in plant biology is staggering, and much bigger than the United States. Plant biology is going to lead the way, rather than follow, in the biology of this century. ■