EDITORIAL

Toxicology at the Speed of Light: An Interview with Dr Craig Venter

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Later this month (March, 2015) the Society of Toxicology holds its 54th Annual Meeting in San Diego, California. The keynote speaker will be Dr J. Craig Venter. Dr Venter is best known for his role in the sequencing of the human genome. Often referred to as a maverick and even a narcissist, his ability to accomplish the seemingly impossible, or at least the improbable at unimaginable speeds, is uncanny. He tackles big problems with aplomb, many of which no others dare approach. It is clear that he is a visionary scientist who continues to make major advances.

One of Venter’s current ventures is synthetic biology. He wrote extensively on the subject in his 2013 book, Life at the Speed of Light, and this is the topic of his keynote address. One might wonder where the field of toxicology fits into this schema. Simply put, the idea of engineering organisms to address toxicological problems is no longer far-fetched. Native bacteria have already shown promise in cleaning up persistent pollutants, but when one can precisely manipulate the bacterial genome to engineer an organism to perform a very specific task the results could be extraordinary. His group is working on synthetic bacteria to clean up oil spills and sequester carbon dioxide from our atmosphere. I predict that some of Venter’s inventions will help reduce many of the toxicological burdens that our planet faces today.

What is amazing is that his highly criticized renegade approach to science has consistently delivered results in a rather spectacular fashion. What can we learn from his success? As scientists we like to teach very particular and specific methods, i.e., that there is one right way to do science. Venter’s achievements suggest that such rigid thinking and methodology may be slowing things down. Venter does not suggest that we dispense with scientific rigor, quite the contrary. He is a staunch supporter of the mantra “extraordinary evidence for extraordinary claims.” He believes in careful controls and conducting thorough follow up experiments, but that doesn’t prevent him from thinking outside of the box ... and by outside, I mean at a level that transcends the cliché.

There is a chasm between truly cutting-edge science and its ultimate application to toxicological problems. The challenge for toxicology is to bridge that gap. In order for toxicology to utilize highly advanced methods we need to do a better job engaging with these fields at earlier stages. The field of toxicology likely does not need to invent entirely new technologies, but we do need to innovatively adopt and adapt emerging approaches to make them work to our ends. This is precisely what Dr Venter has done throughout his career and meeting attendees are encouraged to attend what promises to be an inspirational and inspiring talk.

In anticipation of his keynote address, I posed a few questions to Dr Venter. The questions and his answers are below:

Miller—In your 2013 book, Life at the Speed of Light, you mentioned the potential adverse consequences of technological innovation in life sciences. Toxicologists are trained to evaluate the adverse effects of chemicals, whether they are pharmaceutical agents or industrial compounds and their byproducts. Toxicologists also study the adverse effects of radiation, nanomaterials, and biologicals. Thus, the field of toxicology would appear to be relevant in these emerging areas. What advice would you give to the trainee currently conducting research in toxicology? What skills will be necessary to address the challenges we will face in 2030?

Venter—As I have said many times, I think we are living in an era that is 100% dependent on science. Personally I also think this is truly the genomics era because so many breakthroughs are happening in this area on so many different fronts—synthetic biology/genomics, environmental genomics, and especially right now human genomics. Thus, I would say that someone going into the toxicology fields should have at least
some basic training and understanding of genomics. I also firmly believe that computing is as necessary a skill for anyone entering a science career today. We hire as many informatics/bioinformatics and software engineers as we do biologists, etc.

Miller—Reading the furious pace of advancement you describe in “Life at the Speed of Light” in 2014 (published in 2013) made me wonder how far out of date it already was. If you had to write an epilogue or additional chapter what would be the highlights? Or what do you view as the greatest advancements that have occurred since you finalized that book (late 2012).

Venter—We continue to make good progress on a variety of fronts but I do need to stress that I think often times people assume or even expect a very high and rapid rate of discovery that just really doesn’t happen in science. While for some it might appear that these advances happened in a short amount of time, they have actually taken quite a long time (first synthetic cell was approximately a 15-year process). I think we will see continued advances in certain commercial sectors such as using modified algae in animal and nutritional products, continued development of new detections of emerging infectious diseases, and more rapid and precise vaccines especially in the influenza area. On the basic science side of things we hope to announce this year that we have indeed constructed a minimal synthetic cell. But I must stress that we do still have so much to learn about biology.

Miller—You have discussed at length the self-imposed limitations scientists enact upon themselves. Doctoral students are mentored by professors steeped in tradition. As creative as the halls of academia can be, they still suffer from a degree of confined thinking. There are a few institutions (Janelia Farms and J. Craig Venter Institute, JCVI) that foster wild creativity, but they are limited. How (and do we even want to) do we get the upcoming generation of scientists to liberate themselves from the dogmatic and reductionistic science and begin to embrace the digital evolution you have described?

Venter—There are some things in basic science research structure that will always be good for the field as a whole. I think the rigor of basic science research is necessary especially in a field like synthetic biology. However, I do think our funding agencies and our government need to allow for and thus create mechanisms to reward “out of the box”/riskier thinking and research. We need a DARPA for more research areas.

I think some of this is happening since more and more kids are engaged and excited about synthetic biology and going into that as a career. But as I said we need to do more at the federal funding level to incent researchers to think more creatively and not just continue to write safe grants with “me too” science in order to get funded.

Miller—As digital life evolves I suspect that the regulatory infrastructure needed to evaluate the implications will continually lag behind. What do our regulatory bodies (FDA, EPA, and even university research administrators) need to be thinking about?

Venter—My teams and I have long been thinking about the societal/ethical concerns surrounding synthetic biology. Our policy team at the Venter Institute has published a number of reports looking at a variety of areas of synthetic biology. One of the most recent specifically looked at oversight and regulatory options for engineering organisms. When we announced the construction of the first synthetic cell the Obama Administration’s Bioethics Commission reviewed our work, convened several days of hearings and issued a report. There has been a lot of review worldwide of synthetic biology but that doesn’t mean it can stop. As advances happen there will be more and more for regulatory agencies and governments to stay on top and ahead of. One of the challenges is ensuring that these bodies are educated about genomics, educated about the science, and what the issues truly are as opposed to falling victim to science fiction scenarios. I worry that an uneducated governing body could do more to harm the field and, in turn, society by stopping advances than something unintentional happening from the science.

For more information on JCVI’s activities in regulation and oversight please see http://www.jcvi.org/cms/research/projects/synthetic-biology-and-the-us-biotechnology-regulatory-system/overview/ and http://www.jcvi.org/cms/press/press-releases/full-text/article/venter-institute-led-policy-group-publishes-report-on-challenges-and-options-for-oversight-of-organism/. I would like to thank Dr Venter for his participation in the Society of Toxicology Annual Meeting and for providing his insight to the readers of Toxicological Sciences. As a scientist, Dr Venter possesses extraordinary vision and his passion for science exudes from the pages of his books. I encourage you to attend his talk, read his books, and study his papers. The field of toxicology could use a few renegades.