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IEEE VIC Summit
Speakers Highlight Feature: Will humans live disease free in the future?

Scientists are using the power of a genetic editing tool, "CRISPR," to transform the world of medicine. CRISPR could hold the cure to any number of genetic diseases. Here, they share how they are making a difference, their future predictions, and advice to anyone interested in this biomedical research.

Dr. Bruce Conklin, UCSF, is an Investigator at the Gladstone Institutes and a Professor at UCSF in Medicine, Ophthalmology, and Pharmacology. Dr. Conklin is also the Deputy Director of the Innovative Genomics Institute, focusing on Biomedical applications of CRISPR technology. His research focuses on using genome engineering to identify therapeutic approaches to human disease.

Dr. John Tisdale, NIH, is now the Chief of the Cellular and Molecular Therapeutics Section. His group focuses on developing curative strategies for sickle cell disease through transplantation of allogeneic or genetically modified autologous bone marrow stem cells.

How did you get started in your field?
Bruce: We were modeling human diseases in human iPSCs, and we needed isogenic controls. When TALENs became available, we used them to make dozens of isogenic iPS lines that have been very useful at finding mechanisms for these diseases. When CRISPR came along in 2012, we switched since CRISPR is so much easier. Soon we realized that CRISPR could be used as a therapeutic, which opens a whole new set of challenges.

John: I got started in the field after my exposure to patients with sickle cell disease and the severe pain it causes. At that time, we had only pain medicines to treat the patients, and those were reluctantly given in most centers. The lack of any specific treatment of the disease along with the fact that this is the first disease to be understood at the molecular level pushed me to begin to think about the development of molecular tools to combat the disease.

What are some of the major challenges/obstacles you've had to face to reach this level of innovation so far?
Bruce: Controlled, tissue-specific delivery of CRISPR tools remains a major challenge. Since the CRISPR system is bacterially derived, it is likely that we will need limit exposure to just a few days when immunosuppression can keep an immune reaction in check. Currently Cas9 protein delivery could be a good option, but it lacks tissue specificity. Other challenges to therapeutic editing include patient safety and regulatory issues.

John: Like any challenge in science, progress is slow, and the slow progress can be very discouraging. Furthermore, patients with sickle cell disease face so many challenges that it makes their participation in clinical research difficult. Building a sustainable program with these challenges has proven difficult, but not insurmountable.

Thinking five years from now – what sorts of innovations do you think we'll see in your field?
Bruce: Five years from now, therapeutic editing will be in trials for at least a dozen diseases. In addition, CRISPR will have a large role in drug discovery, where the largest public health impact will be. All of biomedical research has been accelerated by CRISPR.

One hundred years from now is hard to tell. In 100 years there are also likely to be technologies that are much more powerful than CRISPR, and all medical/genetic sciences will have advanced dramatically. Somatic editing will be a routine medical/surgical procedure. Germ line editing (passed to the next generation) is also likely to be approved for specific disorders that have severe medical consequences.

John: In the next five years, I think we will be considering correction of the genetic mutation in the bone marrow stem cells of patients with sickle cell disease using gene-editing strategies. Furthermore, we will see the implementation of less toxic ways of performing transplants with these genetically corrected hematopoietic stem cells such that these therapies can become more widely available.

What sorts of benefits does this technology bring to society at large?
Bruce: For individual patient, therapeutic editing will have the largest impact, but this is still a small number of people. The largest benefits to society as a whole will be in accelerating the development of new drugs, new foods, and the production of biotech products. Also gene-drives to immunize disease vectors (mosquitos) could dramatically alter the spread of insect borne diseases such as Malaria, Denge fever, and Lyme disease. This will probably have the largest positive effect on Africa, where insect-borne diseases are holding back development.

John: These technologies will certainly be of benefit to patients with sickle cell disease, allowing them to become engaged in society in a way that their disease prevents. Furthermore, the developments achieved in this disease setting will be relevant to a number of diseases affection the bone marrow and beyond.

What advice would you give someone just starting out in this field?
Bruce: Enjoy science. This is a golden age in biology and a great time to be entering the field. I also always tell college students to take the opportunity to learn to communicate, since science is highly dynamic, and that requires constant communication. Make sure to take courses that require lots of writing and oral presentations. Courses like journalism, debating, history, anthropology, and social sciences are all relevant to a successful career in science.

John: My advice would be to pick a field of study wisely, dig deep, work hard, and stay focused.

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