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Genetic Engineering and its Ethical Consequences: "Technology should reflect fundamental values of society"

*In an exclusive interview for stars, **Susan M. GASSER**, Professor of Molecular Biology at the University of Basel and Director of the Friedrich Miescher Institute for Biomedical Research in Basel, Switzerland, speaks about the latest developments in genetic engineering, the problems caused by the unwise use of technology and the increasingly difficult challenge faced by our society to define what is normal and what is abnormal. The interview was conducted by Sophie Liu, stars alumna, on the sidelines of the 11th stars Switzerland symposium in September 2018 in Stein am Rhein.*

Sophie Liu: Which scientific fields have shaped or continue to influence the development of genetic engineering?
Susan M. Gasser: First, computer science has completely changed biomedical research and its related applications, like genetic engineering. A second major influence has been genomic sequencing, and a third is epigenetics, a field of research that examines how the environment or experience can impact gene expression. Understanding epigenetics is very important, because it may help explain the incomplete penetrance of disease phenotypes, or account for diseases linked to behaviour. In the long run, it may also help us explain the fine tuning that distinguishes what is normal from what is abnormal. Disease-causing alterations in gene expression that arise from lifestyle or experience will not be corrected through genetic engineering, which entails changing the genome, but by epigenetic modulation; that is, using epigenetics tools to change gene expression.
With the advent of genome sequencing and high throughput technologies, we are beginning to evaluate disease states quantitatively, in terms of standardized levels of proteins or metabolites. We tend to believe that there will be a quantifiable difference between healthy and disease states, yet such measurements may make it difficult for our society to define what is normal and what is abnormal. In the end we will almost certainly find that some people we call normal have abnormal values and others we call abnormal have completely normal values for a given marker. This makes the distinction between health and disease harder to discern. We will rely much more on patient input to decide on how much pain they are in and whether they need treatment or not. Eventually, when it becomes financially untenable to treat every abnormality, we will have to decide collectively on which diseases we will treat, and which ones not. To take this to the limit: when it is possible for most people to live 120 years, will we encourage all to do so?

What do you see as the most important recent developments in genetic engineering and what trends should we pay attention to in the next five to ten years?
The most important development is the targeted mutation of genes through CRISPR (Clustered Regularly Interspaced Short Palindromic Repeats) which enables us to create or correct specific mutations, and not simply make gene disruptions. We are also now able to use CRISPR to turn genes on and off, helping us understand the genome and differentiation on the cellular level. A related innovation is something called a CRISPR toolkit for genome editing. These three CRISPR based developments make a powerful argument that targeted genetic engineering in somatic cells is a reality even today. I think that in this regard we should pay particular attention to the development of in vitro models

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of disease, to understand how human organs work and how the mutation of specific genes can affect the cooperative interactions between cells that underpin tissue function.

Beyond CRISPR technologies, I predict that in the next five to ten years we will see the emergence of studies that attempt to explain human behaviour, by asking questions like "Is homosexuality genetic?" or "Is abnormal human behaviour genetically determined ?" In order to answer these questions, understanding the cellular basis of behaviour is crucial.

Globalization has had a tremendous impact on business and politics over the last decades. What challenges and opportunities has globalization brought for science?
Science is by its very nature international. Even in the 17th and 18th century, scientists communicated long-distance. No matter whether one is in Africa, Europe or Asia, the questions posed about nature are the same, and we have always shared results worldwide. In this sense, the globalization of science happened centuries ago, and computers and the internet simply make international communication more immediate. When I wrote papers in the early 1980s, I had to type the article, make carbon copies and mail it with the original figures to a distant office. Today, people immediately publish their findings on the internet. I think this development is both good and bad. For example, as soon as one places a discovery online, there can be an immediate response from scientists all over the world. But, at the same time, we also lose the perspective of investing careful thinking, optimal interpretation and accurate phrasing into our communication, something that comes naturally through the process of writing, rewriting and revision of an article. As exposure becomes faster and faster, we feel pressure to "publish or perish", rather than to perfect our communication. Nevertheless, being able to share information immediately all over the world is fantastic.

You said in your keynote speech that it is the unwise use of science, rather than science itself, that causes problems. When looking at powerful and disruptive technologies today and how they could develop in the future, are you worried that we as human beings risk getting lost in this technological evolution?
Humanity cannot really get lost in technology, as long as we reflect on what technology is good for. Let's look at the history of our society: in the 1940s and 1950s, people were motivated primarily to defend principles of human rights and democracy. Then, in the 1960s and 1970s, society became focused on the individual – nobody cared about defending democracy in Vietnam, they simply did not want their own son to die in a war; they cared only for individual interests. We still focus too much on the individual and not enough on the principles that define our society or culture. We must return to the point at which we reflect regularly, "What is good for humanity?", "What serves our society?", "What will enable our race to last another thousand years?", instead of "What will give me a better life for the next ten years?" If people would think beyond themselves, this would be a very important step. Humanity might regain respect for the practice of discussion, dialectic and conversation, which could help limit the unwise use of technology, to the profit of individuals. We need to shift our focus towards the principles that are important for all.

How do you define innovation?
Innovation is a problematic word. I like to differentiate creativity from innovation. Creativity means having an idea that nobody had before; innovation means finding a new solution to an existing problem. Both are important, but when facing a challenge, creativity will allow you to define the problem in a completely different way. Often what is limiting is creativity, not innovation.

The vision of stars is to develop better leaders of the next generation. In your opinion, what are the essential qualities of leaders of the next generation?
First, compassion, or the ability to listen and see another person's point of view. Second, the ability to integrate information. Third, is honesty, which is synonym of humility; being humble about leadership.

The views expressed here are solely those of the speaker and they do not necessarily represent or reflect the views of the stars Foundation.

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