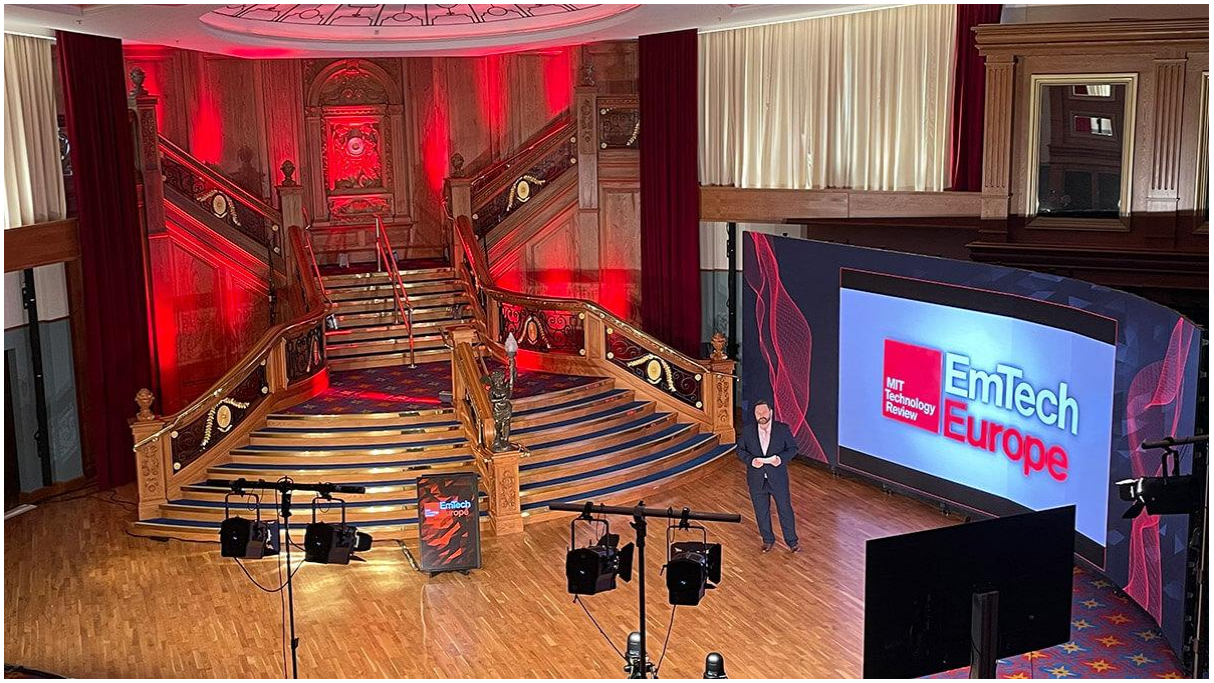
# #EmTechEurope 2021. The Personalized Medicine Revolution - The Personal Genome Project and Digital Twins

*EmTech Europe 'Forging a Brighter Future' took place between the 1st and the 2nd of July 2021. The event was organized by the MIT Technology Review and it focused on presenting innovative ideas and the technologies and forces that influence rapid change worldwide, in areas such as AI, Greentech, Health and Ethics. The event took place virtually, with the main broadcast location in Belfast.*




The second day of the event focused on the healthy and intelligent future, and one of the top sessions was the one dedicated to the **Personalized Medicine Revolution**. Four international opinion leaders, pioneers in personalized medicine and innovators, presented their ideas in this field:

- Angela Brand, Professor, Department of International Health, University of Maastricht, The Netherlands (moderator)
- Hans Lehrach, director of the Max Planck Institute for Molecular Genomics, Germany
- George Church, Winthrop Professor of Genetics at Harvard Medical School, USA
- Dr. Philippe Menu, Chief Medical Officer, Sophia Genetics, Switzerland

Personalized medicine (now understood as precision medicine) has been a "very disruptive" concept in recent years, promoted by the scientific community and several innovative initiatives internationally. In Europe, it is defined as “a medical model that uses the characterization of phenotypes and genotypes of individuals (eg molecular profiling, medical imaging, lifestyle data) to adapt the right therapeutic strategy for the right person at the right time and / or to establish the predisposition to diseases and / or the provision of timely and targeted prevention”. During the session, two very important initiatives were discussed: the Personal Genome Project and Human Digital Twins.


"Every person is unique, every disease is unique, and the taxonomy of disease has changed. We have transitioned from the study of the human genome to the study of the personal genome, and epigenomics has become the bridge between the biological and social sciences. More and more analytical tools help to implement personalized medicine: nanotechnology sensors, cloud computing, 3D printing, organ-on-a-chip, NGS, CRISPR, individual virtual models (Digital Twins), AI, etc. ", declared **Prof. Angela Brand** in the opening of the event.

## George Church, on the Personal Genome Project (PGP), which he founded in 2005

The debate began with a brief description of the Personal Genome Project, which, according to its founder, was a manifesto, a demonstration of the various capabilities of the scientific world: for example, the ability to share data, to provide information to the individual following genomic sequencing, without sharing the entire genome. This was considered radical in 2005. But also the ability to test new technologies on certain cell lines, to test the individual response to certain therapies.

The Personal Genome Project is about demonstrating that all these technologies and data can be customized and shared.

"*It is difficult to get people to give you your data without the promise that you will give them information about their health. The use of whole-genome-sequencing (WGS) and not isolated sequencing has become financially accessible. You can get almost complete genome sequencing for about $ 300. It's a whole new world.* "

The epigenomic approach that PGP proposes is also very important - understanding how social, chemical, and biological environments impact the individual: "*The genome is assigned to you only once in your life, but the immunological, microbiological, transcriptomic factors - these omic factors - should be tested as early as possible in the process of understanding the individual body.*"

## Hans Lehrach, about the DigiTwins Project - the creation of the human virtual twin

"*We are all different, we have different genomes, different diseases, we come from different backgrounds, we have different microbiomes. Although diseases have the same name, they are different at the molecular level. Not surprisingly, we react differently to therapies. And the consequences of non-personalized therapeutic administration are devastating (...), because most therapies have developed from the presumption that we all suffer from the same disease ".*

The concept of Digital Twins in medicine started with the need for advanced personalization of therapies and a deep understanding of molecular mechanisms. Therefore, Digital Twins can be considered the highest degree of medical

personalization. The main utility of DT would be as a predictive model to determine the effect of therapies on the individual. Although there are numerous research projects, none of them reached this maximum potential.

In industry, DTs are widely used. There are DTs both for objects and for the production cycles themselves or even buildings. The idea of DT first appeared at NASA, which wanted to have a virtual model of its aircraft, which would ensure the connection between the physical model and the changes that the ground team could bring from a distance. But things are simpler in terms of space crafts because they were created by man, from scratch, the mechanisms being easier to replicate.

- A CALL TO ARMS: WE CAN ERADICATE SARS-CoV-2 NOW

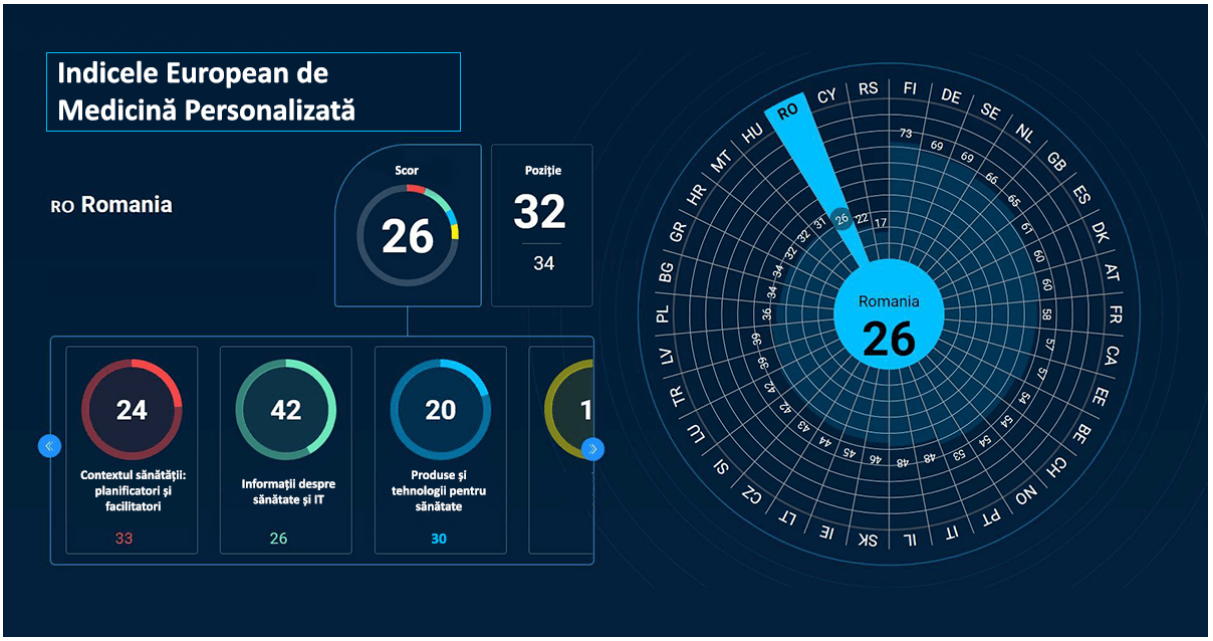
In May 2020, Prof. Lehrach and Prof. Church issued a call for the use of mass genomic sequencing techniques to win the fight against Sars-CoV-2: "We already have the tools at hand to end this intolerable situation now, based on on repetitive screening of the entire population, possibly due to the enormous progress in new generation sequencing techniques (NGS), in combination with smart contact-tracing. We need to establish infrastructure at the national level (and ultimately at the global level), with the ability to test entire populations several times, at certain intervals ”.

"*We now have evidence that such a strategy was feasible and we have estimated that, for example, Germany could have avoided about 90% of deaths caused by COVID-19 (not taking into account the first pandemic wave, as implementation could not be done to and the first wave) if they approached such a genomic testing strategy from the beginning (...). However, no one was interested in such a strategy. Probably because the leaders did not see the potential ", said Prof. Hans Lehrach.*

## 2017: Sophia Genetics, in the top of the smartest companies, according to the MIT Technology Review

Sophia Genetics is a Software-as-a-Service platform based on cloud computing technology - the SOPHiA DDM platform - that allows medical institutions to obtain fast and robust information from their data. It applies technology developed for diseases such as cancer and inherited genetic disorders, where the combination of genomic and phenotypic information is vital to support drug discoveries, treatment decisions and development efforts.

*"We believe that there is a great need for a technological platform that contributes to the standardization of data and facilitates their distribution. There are three success factors to consider: decentralization (leaves data generation in the service of hospitals and institutions), standardization (must be able to process data in the same way, whether they come from a sequencer or MRI), multimodularity (as in Digital Twin, the idea is to be able to combine all kinds of data). As in oncology - DNA information is fundamental. Things get complicated if you add phenotypic data: radiomics, pathological, clinical data, etc. ", said Philippe Menu*




**What stage of Personalized Medicine are we currently in? Are we moving too slowly towards the MP?**

*"I think things are moving pretty fast towards reaching the maximum potential of the MP. For example, The FDA's Orphan Drug Act has made it possible for more and more companies to target the development of more personalized molecules, even if they benefit fewer people. On the other hand, we understand better and better the interactions between drugs, but also between drugs and the human genome. And oncology is becoming more and more personalized. ”- George Church*

However, although these advances, which mankind only dreamed of only 10 years ago, are now a reality, not enough citizens have access to them. In the opinion of Prof. Church, this paradox of access to genomic sequencing is similar to that of seat belts - *“I have over 97% chances of survival. Why should I wear a belt? ”* Therefore, government intervention is needed to impose certain safety measures and standards in practice. It could be useful for health systems, health insurance

companies, to see the long-term economic and social benefits and start including genomic testing in the packages offered.

"*Unfortunately, we see how the protection of commercial interests greatly slows down the adoption of innovations that bring enormous benefits in health and care services. (...) We need to take the IT example: no matter what Microsoft thinks about the browser you use, it will not declare it dangerous to use for health and will not be able to restrict your access to it easily ”- Hans Lehrach*

## Take home messages

"*We should measure everything we can about the individual human body. We are as valuable as spacecraft engines, even if governments do not like to acknowledge this. Technology does not impose as many restrictions as one might think. We could, at more than decent costs, systematically analyze every cancer patient ”- Hans Lehrach*

"*Even if you are not willing to apply the principles of personalized or precision medicine to yourself, you would certainly apply it for the benefit of loved ones. I think this is an important message. ”- George Church*

"*I think it is clear that AI and state-of-the-art technologies will have an impact on us, individually and in society. What will medical universities look like in 10 years from now? Well, you will not have to master all these technologies, because there will be specialized centers that will do that. AI will allow doctors to be closer to humanity ”- Philippe Menu*

**The two-day conference explored the latest advances and trends at a time when the Covid-19 pandemic is adding fuel to global climate flames and economic crises. In a world full of dizzying change, the revolutionary summit set out to create an environment in which technology, business and culture can converge.**