Les Echos
The Innovator

#4 – January 2018 – World Economic Forum Edition
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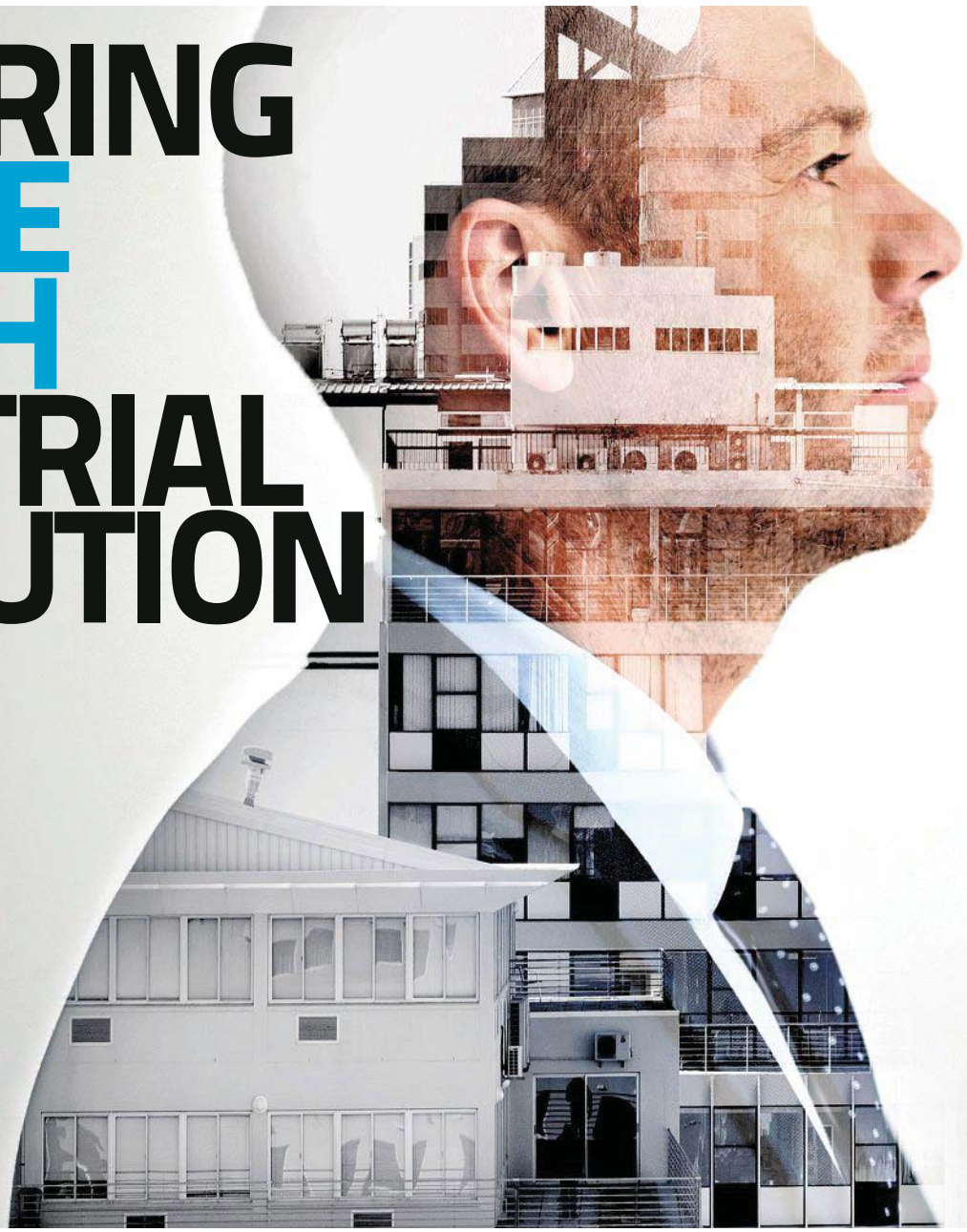
MEET YOUR DIGITAL TWIN
EVERYONE AND EVERYTHING WILL SOON HAVE A DIGITAL IDENTITY

PLAYING DEFENSE
NEW CYBER CENTRE SEEKS TO THWART DIGITAL INFILTRATORS

TINKERING WITH NATURE
Q & A WITH CRISPR-CAS9 CO-INVENTOR EMMANUEL CHARPENTIER

PREPARING FOR THE FOURTH INDUSTRIAL REVOLUTION



SUPPLEMENT GRATUIT AU #22619 DU QUOTIDIEN
"LES ECHOS" DU 23 JANVIER 2018
NE PEUT ETRE VENDU SEPAREMENT

Bayer Foundations

WE NEED YOU

“If you want to be a startup billionaire, you have to solve a billion peoples‘ problems”

Thimo V. Schmitt-Lord MBE, Head of Bayer Cares Foundations

We believe in the game changing power of innovation – we support pioneers who apply tech innovations to humanity’s biggest challenges around health and food.

In 2018 we are scouting for Startups, Innovators, and Impact Innovations particularly focused on agriculture and food production for our seed funding programs and new book "The Beauty of Impact - Food". We are searching for innovations that solve the food crisis and other global grand health-related challenges that we can promote and fund to bring to the rising billions in need around the world.

Seeking funding yourself for a crazy “innovation-4-good” idea?

Get in touch with us at bayer.foundations@bayer.com. More Info: www.bayer-foundations.com

The next opportunity to meet the Foundations CEO Thimo V. Schmitt-Lord and Open Innovation Hub Director and Speaker Marc Buckley is at the 48 Forward Conference in Munich on February 22, and on March 9 at SXSW in Austin, Texas.

How CRISPR Cas9 Could Help Curb Disease And Feed The World

An Interview With Emmanuelle Charpentier,

The technology's co-inventor

The discovery of CRISPR/Cas9 is revolutionizing life sciences research and is opening whole new opportunities in biomedical gene therapies, with a huge potential impact on the future of human health and on food production. Emmanuelle Charpentier, a French national and a director at the Max Planck Institute for Infection Biology in Berlin, Germany, is the inventor and co-owner of the fundamental intellectual property comprising the CRISPR-Cas9 technology and is co-founder of CRISPR Therapeutics and ERS Genomics, two companies that she created, together with Rodger Novak and Shaun Foy, to develop the CRISPR-Cas9 genome engineering technology for biotechnological and biomedical applications.Charpentier has been awarded over 60 different honors and her scientific contributions have been featured in TIME magazine (2016 short list for Person of the Year), Vanity Fair (2016 list of The New Establishment; 2014 and 2015 list of the 50 most influential French people), Foreign Policy (2014 list of 100 Leading Global thinkers), and many others. She recently agreed to an interview with The Innovator.

Can you explain in layman's terms how CRISPR/Cas9 improves on previous gene-editing tools?

—EC: One of the greatest hopes of modern gene technology is the fight against serious genetic diseases. In order to push research in this field forward more efficiently, the CRISPR-Cas9 technology is a very promising tool. CRISPR-Cas9 works much like a text editing software: It can edit or correct typos in your document. i.e. your DNA. It functions as target-seeking molecular scissors, kind of like a Swiss army knife, that can be used to introduce a variety of changes into the genome of any cell or organism. Compared to previous gene-editing technologies, CRISPR-Cas9 is extremely versatile, easy to use and inexpensive to develop, tailor and apply. Furthermore, multiple mutations can be introduced at the same time by

using multiple guide RNAs, helping to design complex disease models that would otherwise require lengthy procedures and complicated strategies.

CRISPR/Cas9 shows promise for treating everything from cancer to Type 2 diabetes and malaria, and trials have already begun on humans. Is there a real chance it could completely eradicate certain diseases?

—EC: The potential of the CRISPR-Cas9 technology is very promising for the development of therapeutic measures against serious genetic diseases, for example cancer, HIV infection or sickle cell anaemia, among others. For the latter, CRISPR Therapeutics, the company I co-founded with Rodger Novak, has recently filed an application for clinical trials here in Europe – so yes, there is hope that certain diseases may be treated effectively in the future.

Nevertheless, we need to be aware of the fact that the biological mechanisms of diseases all work differently. Furthermore, it takes a lot of time and understanding to elucidate those mechanisms before one can actually think about applying genetic therapies to treat diseases on human beings.

At least one study showed there could be unintended mutations when you dice and splice the human genome. To what extent is this fear and ethical issues around gene editing, such as the creation of "designer babies," holding CRISPR-Cas9 back?

—EC: It is true that unintended mutations were found with certain CRISPR-Cas9 applications. But they are quite rare and easy to identify. Obviously, the goal is to avoid unwanted off-target effects, especially since the consequences can be very serious in the medical field. Therefore, the scientific community is working hard to develop CRISPR-Cas molecular tools further to improve their accuracy.

In your opinion is there a need for legal and regulatory authorities to step in and come up with guidelines for balancing the interests of human life with research, and avoid any possible large-scale negative implications for future generations? How should such rules be devised globally and who should have a say?

—EC: CRISPR is a very powerful tool, and as such the technology has also attracted private interest, both in the field of agriculture and also in what we call human enhancement. I strongly believe that there is a need for more discussions and international regulations about the potential risks of CRISPR-Cas9 as a gene-editing technology. After all, we also bear a certain responsibility as scientists: We need to make sure that appropriate safety and efficacy measures for any potential therapy that involves patients are taken and that any use of the technology that is ethically questionable is prohibited. In this regard, we can currently witness a very lively discussion about using CRISPR-Cas9 in human germlines (the process by which the genome of an individual is edited in such a way that the change is heritable). In my opinion, this is problematic and we need clear regulations on an international level. But I also believe

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