# Game-changing Genetic Potential

## Genomics guru gives glimpse at what's possible with gene editing.

*by **Kindra Gordon,** field editor*

When explaining to audiences the potential genomics and gene editing hold for the future, one story that Juan Enriquez likes to share focuses on teeth.

When babies are born, they have no teeth, Enriquez points out. "Their mothers are grateful for that." Within a year or two's time, a baby grows a mouthful of teeth. As the child grows, they lose their teeth and a second set of teeth replaces them.

Here is where the story takes a twist. Enriquez notes the problem is that if you lose one of those permanent teeth, it doesn't regrow a third time. But could it?

From the perspective of a geneticist Enriquez shares, "Your cells have the code to grow teeth." Thus, he says, he believes growing a tooth a third time is possible. More amazingly, he reports that Harvard Dental School is currently growing teeth from cells in petri dishes.

"Your body knows how to grow a bladder, to grow heart valves," Enriquez continues. "Regenerative medicine is the future." For those unfamiliar with the concept, a basic definition of regenerative medicine is research using tissue engineering and molecular biology for the process of replacing, engineering or regenerating human cells, tissues and organs to restore or establish normal function.

PHOTO BY LEANN SCHLEICHER, ANGUS MEDIA

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### Say what?

While it is hard to fathom teeth growing on their own in a petri dish or a bladder or organ replicating itself, Enriquez is one of the world's foremost authorities on the subject. He has a Harvard master of business administration degree (MBA), was profiled as "Mr. Gene" by *Fortune* magazine, and is considered the world's leading authority on the economic and political impacts of life sciences. He's also the author of several books and papers on the life sciences and is a venture capitalist.

Most notably, Enriquez is credited with co-founding the company Synthetic Genomics, where he collaborated with two other world-renowned scientists — one who sequenced the human genome, the other a Nobel Peace Prize winner and authority on splitting cells — to create the first synthetic life form, as well as the first standard, programmable cells.

### How did we get here, and where are we going?

How did the world get to the point of having the ability to "program cells" and create synthetic life forms? Will this science be beneficial?

Futurist Juan Enriquez suggests the process of learning gene code can be traced back to the earliest cavemen. He points out that their form of code — or communication — was drawing pictures to share and document stories and information on cave walls.

Enriquez notes, "No other animal on Earth codes."

The next step in the coding evolution came when human beings progressed to using hieroglyphic symbols and then the ABCs.

"The 26-letter alphabet told you everything from last centuries, creating enormous amounts of data," says Enriquez. Then, code changed again to a two-letter digital alphabet of 1s and 0s.

"All of a sudden, every word, photo and piece of music is transmitted in this digital code language. ... Digital code can be applied to a whole series of functions," says Enriquez.

Today, the world is moving from digital code to life code, he reports, adding, "Life code is really important."

What is it? Every life form on this planet, every clover, piece of hay, sheep and politician is made of the same stuff, reports Enriquez. He explains that all life code is created with varying combinations of the four nucleotide bases of a DNA strand, which are known as A, T, C and G (adenine, thymine, cytosine and guanine).

Enriquez states, "All life is coded in the same letters. ... That makes everything a programmable life form. Change a couple letters and an orange becomes a tangerine, or a grapefruit or a lemon." While the same is true with humans, for perspective, one must also recognize that there are 3.2 billion letters of genetic code in each of a human's 10 trillion cells.

Still, having a mapped genome of humans and other organisms provides a road map, which allows for the potential to read code, copy code and edit code, according to Enriquez. He also points out that this programmable ability means humans are "increasingly in charge of evolution."

While the applications for genomic-editing technology remain to be determined, Enriquez is hopeful about some that are under way. He says the technology will be "like editing a sentence in a book." He cites Humira medication specifically engineered to treat arthritis, and references cloned cows in Argentina, where a gene in one calf was changed so the calf produces medicine in its milk that can be used to treat cancer.

Will these new medicines come to fruition? It's a new frontier ahead, and only time will tell where this science ends up.

The effort was successful in yielding a medium with which scientists can ultimately do different things. Enriquez describes it various ways, including, "programming cells in the same way you program a computer," as "software that makes its own hardware" and "green soup."

Today, this technology is being applied to energy, chemicals, vaccines, agriculture, information storage and other fields. As specific examples of uses for these programmable cells, Exxon Mobile can take the medium — the green soup — and make fuel, chemicals, paints, inks and plants that grow faster. ADM could make food proteins, oils and animal feeds. Enriquez explains that making these products with green soup is more efficient and cheaper.

The medium can also be used to make medicines. Enriquez gives the example that the flu vaccine for the world could be made from green soup in one week vs. one year. Plus, green soup could be used to make humanized organs.

## Ethical dilemma

If you're starting to feel uncomfortable or uncertain about this futuristic science, Enriquez acknowledges there are some ethical considerations.

He notes that before he and his partners pursued development of synthetic life and programmable cells, they "spent a lot of time on the science and genetics and also the ethics." He reports that they received approval from both the White House and the Vatican before progressing with the research.

Says Enriquez, "You don't make changes of this magnitude without thinking about ethics and morals."

He also notes that the impending genomics technology "gives choices," but he adds, "Some you want, some you may not."

Of the future, Enriquez quotes Yogi Berra saying, "Where there's a fork in the road, take it."

With a little more seriousness, he adds, "I don't want you to be scared of this stuff. … I don't know the right road to take, but I do know things are going to change. Things have changed, will change and will continue. Americans are not afraid of change, and it's an opportunity not everyone in the world has."

Enriquez gave the keynote address during the International Genomics Symposium sponsored by Neogen Geneseek Operations hosted in conjunction with the 2016 Angus Convention in Indianapolis. He is co-author of the book titled *Evolving Ourselves: How Unnatural Selection and Nonrandom Mutation are Changing Life on Earth,* which is available via Amazon. He is also featured in several TED talks online. His most recent talk from November 2015 is titled: *We can reprogram life. How to do it wisely.* It can be viewed at *https://www.ted.com/talks/juan_enriquez_we_can_reprogram_life_how_to_do_it_wisely.*

**Editor's Note:** *Field Editor Kindra Gordon is a freelance writer and cattlewoman from Whitewood, S.D.*