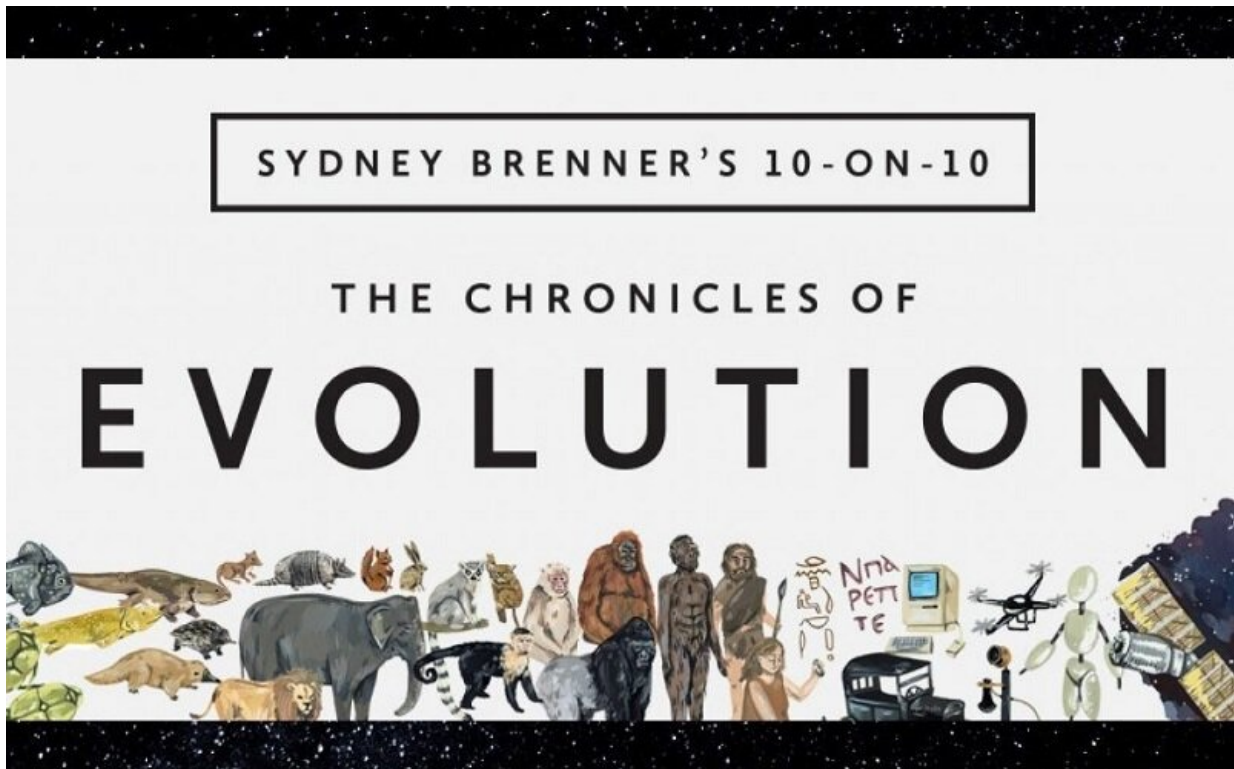


Where will evolution take us in the Fourth Industrial Revolution?

August 19 2019, by Benjamin Seet And Juliana Chan



Sydney Brenner's 10-on-10: The Chronicles of Evolution is a book commissioned by A*STAR and published by Wildtype Media Group, tracing the evolution of life across ten logarithmic scales of time.

The study of evolution allows us to reconstruct the past and to understand how life evolved from simple to complex organisms.

Evolutionary reasoning can help us make sense of the biggest questions in science, from the origin of the universe to the inner workings of the human brain.

But can evolution also give us a hint of what is to come? Will technologies like gene editing make natural selection redundant? Might evolution tell us about the limits of planetary resources and what can be done to avoid environmental collapse, or how human society might evolve?

The late Nobel laureate Sydney Brenner addressed these questions in a year-long lecture series in 2017 that took us on a 14-billion-year scientific odyssey through cosmology, chemistry, biology, paleontology, archaeology, anthropology and sociology.

We captured these ideas in a book, [*Sydney Brenner's 10-on-10: The Chronicles of Evolution*](#), which offers a glimpse of the future by considering where evolution can take us. Here are the perspectives of three experts from our book, with some of our own.

1. In the Fourth Industrial Revolution, new gene editing tools are likely to overtake biological evolution

People have always wondered whether evolution is constantly driving onwards and upwards. Is there always going to be improvement? The answer is no—evolution is a progression of form and function, but it is not purposeful.

Brenner said, "The big lesson to learn here is that in science, only mathematics is the art of the perfect. Physics is the art of the optimal, and biology is the art of the satisfactory: if it works, you keep it; if it doesn't, you get rid of it."

In the Fourth Industrial Revolution, "satisfactory" may no longer be the status quo. We are now witnessing the most revolutionary stage of evolution, when we give up evolving by biology alone. With new life sciences tools such as CRISPR-Cas9 gene editing, we are now able to reshape genomes and alter biological form and function.

The quest for human perfection through gene editing has already begun. In November 2018, Chinese scientist He Jiankui claimed to have created the world's first gene-edited babies. In June 2019, Russian scientist Denis Rebikov announced similar plans to edit the DNA of human embryos to confer immunity to HIV. These developments present new ethical challenges and have triggered calls for a global moratorium on heritable gene editing.

The potential to accelerate and direct the course of biological evolution raises further questions, the most urgent of which is how to manage collateral changes to the environment. Such concerns have led the European Union's highest court, the Court of Justice, to rule in July 2018 that gene-edited crops should be subject to the same stringent regulations as conventional genetically modified organisms.

Plant breeders and scientists have called the EU ruling overly rigid, as it requires all CRISPR-Cas9 food to go through a lengthy approval process, essentially grinding agricultural gene editing research to a halt.

2. The arrival of the Anthropocene may lead to a global tipping point

When massive volcanoes erupted 252 million years ago, it triggered the Great Dying, a mass extinction event that wiped out 96 percent of all marine life and 70 percent of all vertebrates on land. Some 186 million years later, a giant asteroid hit the Earth, causing catastrophic changes in

climate that brought an end to the era of the dinosaurs.

As anthropologist J. Stephen Lansing explained, there is growing consensus that the arrival of humankind has similarly ushered in a new epoch called the Anthropocene. Unlike every epoch, era or eon before it, the Anthropocene's climate and environment are thought to be predominantly influenced by human activity.

The advent of the Anthropocene may also bring Earth to an imminent tipping point—a non-linear change that is known to ecologists as regime shifts, where the effects are not proportionate to the cause.

One possible tipping point is plastic. Under business-as-usual, the ocean is expected to contain more plastic than fish by 2050, with untold effects on the fish themselves and the humans who eat them. Plastic aside, there is new evidence that there could be a slowdown in the global meridional circulation, the ocean's great conveyor belt that is responsible for moving heat and nutrients on a planetary scale.

Rapid urbanization might represent another tipping point, dwarfing the impacts of climate change and the acidification of our oceans. In 2014, the G20 nations agreed to invest US\$70 trillion in new infrastructure by 2030, which translates into 25 million more kilometers of roads and hundreds more dams, 90 percent of which will be built in the tropics.

But there are still rare signs of hope in this age of the Anthropocene and the Fourth Industrial Revolution. Take the problem of ozone depletion, which was initially dismissed by industry players. Rigorous scientific evidence later convinced world leaders to recognize the problem and act decisively, making the Montreal Protocol to ban ozone-depleting chemicals the world's first universally ratified treaty.

3. There is a need to take a humble view in the Fourth

Industrial Revolution

For the good part of human civilization, most people believed that the future was pre-ordained by the gods, fate or other forces of the universe, and that only prayer could change one's destiny. It was only from the middle of the 18th century that people came to realize that the future could be different from the past, and that their destiny could lie in their hands.

This new way of looking at the future, of seeing it as a wide, open horizon rather than a circular loop, had much to do with science and technology, according to social scientist Helga Nowotny.

But the focus on—and even obsession with—[technological innovation](#) might cause us to overlook that social innovation is just as important. The more technological innovations we create, the more social innovations we need to accompany them.

The field of medicine, for example, is undergoing amazing technological disruption. But its full potential cannot unfold without equally innovative changes in how health systems are run and how healthcare is delivered. Advances in our ability to exploit expansive data has brought us into the realm of smart devices and artificial intelligence, but at the same time, has changed our outlook on privacy and security.

In the Fourth Industrial Revolution, Nowotny cautioned that we should be careful to avoid hubris—the over-estimation of our capacity and our over-reliance on a single solution, be it a technological or economic fix that does not take into consideration the complexity of societal systems.

The humble view acknowledges that technology, science and culture must evolve together, and that life will continue to change in unpredictable ways that we cannot entirely control. We have the

privilege of being the only species on Earth that is able to see evolution from the inside. That obliges us to reflect on what we are doing with [evolution](#), as it is our own choices that will guide our evolutionary destiny.

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