SCIENCE & TECHNOLOGY

Is Science Finished?

THE SOURCE: "Science's Dead End" by James Le Fanu, in ***Prospect***, Aug. 2010.

Has the era of major scientific breakthroughs run its course? Lord Kelvin famously claimed at the end of the 19th century that future scientific achievements would be found "in the sixth place of decimals." Just a few years later, Albert Einstein proposed the theory of relativity and forever changed our understanding of physics. Science writer John Horgan caused a minor stir in the 1990s by arguing that science has reached its limits now that we have a basic understanding of the physical world, from the nanoscale to the universal.

That's true for matter, agrees James Le Fanu, a columnist for Britain's *Telegraph*, but our understanding of *life* still leaves something wanting. If more breakthroughs are made, they will be in clarifying two of the greatest mysteries: how it is that the double helix of DNA gives rise to vast biodiversity, and how the electronic impulses in our brains create an individual—personality, free will, memories. "At a time when cosmologists can reliably infer what happened in the first few minutes of the birth of the universe, and geologists can measure the movements of continents to the nearest centimeter, it seems extraordinary that geneticists can't tell us why humans are so different from flies, and neuroscientists are unable to clarify how we recall a telephone number," Le Fanu muses.

Life is much harder to study than matter. For one thing, it's "immeasurably more complex." Think of a fly and a pebble of the same size. A common fly is "billions upon billions upon billions" of times more complicated. Life's most basic units—cells—are at work in every living thing, converting nutrients into tissue, repairing, and reproducing, and each cell is a tiny fraction of the size of the smallest machines ever built. Another wrinkle: Many of the mysteries of life produce no tangible evidence. What do you "look" at if you want to study thought, memory, or belief? The assumption that science could one day probe such inscrutabilities "remains an assumption," Le Fanu writes, as, "strictly speaking, they fall outside the domain of the methods of science to investigate and explain."

Times are flush for Big Science. Biomedical research alone is a $100 billion industry, dwarfing the gross domestic products of a dozen countries. The quantity of research is astonishing, with many journals publishing around 100,000 pages of articles each year. Yet the results have been "disappointing." The Venter Institute's announcement last spring that it had managed to create "artificial life" may have grabbed headlines, but Le Fanu remains unmoved. "Fabricating a basic toolkit of genes and inserting them into a bacterium—at a cost of $40 million and 10 years' work—was technologically ingenious, but the result does less than what the simplest forms of life have been doing for free and in a matter of seconds for the past three billion years."

For all its money, Big Science is not supporting those who are "discontent with prevailing theory," and could make history-altering discoveries. The end of science won't come when there's nothing left to discover, but "when the geeks have taken over and the free thinkers [have been] vanquished."

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The Frozen Past

THE SOURCE: "A Humanist on Thin Ice" by Tom Griffiths, in ***GriffithREVIEW***, Spring 2010.

In the three billion years of life on this planet, ours is not the first era of mass extinction and global climate change. But we are the first creatures to live through such upheaval and know what is happening. Much of our understanding comes from studying simple, frozen hydrogen dioxide. The story of ice—how it came to exist in such concentrations at the planet's poles and what makes up the gases

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trapped within it—"is the key to understanding climate change," writes Tom Griffiths, a historian at the Australian National University in Canberra (and no relation to the *GriffithREVIEW*'s namesake).

The first inklings of the role ice has played in shaping the world emerged in the late 1830s, when Swiss-born scientist Louis Agassiz postulated that large sheets of ice once covered much of the globe. Decades passed before this idea gained wide acceptance. In 1859, Irish researcher John Tyndall went poking into the causes of the Ice Age, examining the gases in the atmosphere to see if they all behaved the same way. He found that not all atmospheric gases are transparent to radiant heat—in particular, carbon dioxide ($C0_2$) is opaque—which means that fluctuations in the amount of $C0_2$ in the atmosphere could affect how the earth heats and cools. One and a half centuries ago, the role of greenhouse gases in setting the earth's temperature was flagged. What we know about climate and global warming today began with efforts to understand the climate of eras past and the glaciers that once covered large swaths of Europe.

Griffiths is quick to point out that nothing in the first century of climate research supports the sinister, left-wing conspiracy many global warming skeptics imagine. When scientists did raise the possibility of global warming, "they saw it mostly as positive. . . . Indeed, if the world were warmer, it might make winters more comfortable and agriculture more productive, or even help stave off the next Ice Age. For the first two-thirds of the 20th century the global warming trend was called the 'embetterment' of climate, or the 'recent amelioration.' "

It wasn't until very recently that scientists began to recognize the peril posed by global temperature fluctuation. There were two key discoveries. First, in the early 1980s, scientists studying the Greenland ice sheet found that climate change had occurred much more quickly than they had assumed was likely, sometimes as much as five or six degrees Celsius within a few decades. Second, the levels of $C0_2$ in the atmosphere today are higher than at any time in at least 400,000 years, as indicated by archived ice cores from Antarctica.

Until now, major scientific discoveries have invariably established that humans are less than central actors in the physical world. Copernicus upended the notion that the sun revolves around Earth; geologists and biologists have demonstrated the incredibly recent appearance of Homo sapiens on the planet. By contrast, the century-long study of ice reveals "the cumulative, insidious, all-pervading power of people on Earth," Griffiths observes.

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Cloning the Neanderthals

THE SOURCE: "Should We Clone Neanderthals?" by Zach Zorich, in ***Archaeology***, March–April 2010.

NEARLY 50,000 YEARS AGO IN northern Spain, 11 Neanderthals were murdered. The circumstances remain mysterious, but the evidence—1,700 broken bones—is today providing scientists with many clues about what color hair Neanderthals had (red), what their skin looked like (pale), and whether they spoke (probably). It's possible that in due time, DNA extracted from those bones or those of another Neanderthal will be implanted in a cell, that cell will be coaxed into multiplying, and, with the right techniques and no shortage of luck, the result will be a living, breathing Neanderthal. Such an achievement will "force the field of paleoanthropology into some unfamiliar ethical territory," writes Zach Zorich, a senior editor at *Archaeology*.

Neanderthals are modern humans' closest extinct relative, having branched off from our line of the family tree some 450,000 years ago. Locked in their DNA could be priceless information for scientists studying diseases that are "largely human-specific, such as HIV, polio, and smallpox." If Neanderthals turn out to be genetically immune to such ailments, it's possible that studying their DNA could lead to gene therapy treatments. But for scientists interested in cloning a Neanderthal, technical hurdles stand in the way. A