TheScientist
EXPLORING LIFE, INSPIRING INNOVATION

What A Long, Strange Decade It's Been

For the past 10 years, life science has moved us closer to a complete understanding of what makes us human—our similarities, our differences, and our shared history.

Dec 20, 2019
BOB GRANT

ABOVE: © ISTOCK.COM, ARTOLESHKO

Another decade is soon to be in the history books, and the 2010s was an eventful one on many fronts. Massive cultural and political shifts occurred on a global scale, and science—particularly biology—accelerated at an unprecedented pace. From the conception and early development of precision genome editing as a tool that humans can now wield to the rewriting of our paleoanthropological history, life science researchers made great strides helping our species better understand our own biology and our place in the biosphere. Some the discoveries and the experiments were accompanied by ethical questions and ofttimes stark rejections of research directions. But here, we present some of the innovations, both conceptual and technological, that stood out throughout the past decade.

At the dawn of the 2010s, genomicists were still grappling with how to make human genome sequencing a more widespread and affordable reality. Prior to the start of the decade, in 2007, Harvard University researcher George Church founded Massachusetts-based biotech firm Knome. The company marketed the world's first direct-to-consumer genome sequencing service, priced at $350,000. Over the ensuing years, the cost of sequencing plummeted as new tools came online and reagent prices dropped.

By 2010, Illumina advertised a genome sequencing service that cost $50,000 per person. And since then, the field has achieved the long-held goal of a $1,000 human genome sequence. In 2016, Veritas Genetics marketed the first $1,000 whole genome sequencing service to both consumers and physicians, and this year, the firm lowered that price to less than $600, though the service is listed as "currently not available" on the Veritas website.

Other firms offering direct-to-consumer genetics analyses, such as 23andMe and AncestryDNA, charge a much lower fee but only sequence particular loci of interest to questions involving the customer's ancestry and other specific traits. Not only did these advances fuel a robust consumer market, genome sequencing—whether whole

As they have been throughout the decade, bioethicists in the 2020s will need to remain ever vigilant, considering continuing developments such as the creation of human/animal chimeras, the genomic modification of human embryos, and the potential

genome or more targeted—also gave physicians and researchers an increasingly sophisticated method for diagnosing and studying certain diseases. Many ethical caveats, privacy concerns, and societal misgivings exist when placing the power to probe the human genome in the hands of consumers, and more are likely to arise in the near future.

of more-accessible genome sequencing.

See "Top 10 Innovations"

This continued maturation of sequencing technology spurred discovery outside the realm of the clinic or the marketplace. Using these rapidly evolving tools, researchers in the past decade were more able than ever to peer inside ancient biological samples—fossil bones and teeth, for example—to piece together the genetic portraits of bygone human species.

In 2010, an international group of scientists published the first draft of the Neanderthal genome. And three years later, another large group of coauthors published a high-coverage, complete Neanderthal genome, sequenced from DNA they pulled from a centuries-old bone fragment found in a Siberian cave. Ancient DNA, combined with good, old-fashioned paleoanthropology, would reveal many more surprises that helped rewrite human history throughout the decade. New species were added to our family tree (Denisovans in 2010, *Homo naledi* in 2014, and *H. luzonensis* in 2019). And a new hybrid between ancient human species (a Neanderthal/Denisovan hybrid) was described in 2018. Researchers also redrew the map of human migration and interbreeding across the planet by sequencing ancient DNA and comparing it to that of extant populations.

See "What's Old is New Again" and "Neanderthal DNA in Modern Human Genomes Is Not Silent"

Beyond the remarkable advances concerning the sequencing of DNA, the 2010s saw the rapid establishment and development of a revolutionary genome editing strategy: CRISPR. The intricate molecular system has been used by bacteria and archaea for eons as a form of adaptive immunity against viral invaders. And cheese and yogurt makers have been using CRISPR since about 2005 to help make bacteriophage-resistant starter cultures.

It wasn't until 2012 that researchers published a paper positioning the CRISPR/Cas9 system as a tool for targeted, precision genome editing. From that point forward, CRISPR-mania ensued, with researchers applying the approach to everything from pigmentation changes in lizards to developing new human therapeutics. Of late, legal battles concerning the patenting of CRISPR as a genome editing tool continue to play out, as the technology is nearing clinical relevance, with human trials testing its feasibility in treating blood disorders and cancer.

See "A Brief Guide to the Current CRISPR Landscape"

The 2010s were also momentous for personalized medicine and gene therapy. In 2017, the FDA approved the gene therapy Luxturna, which treats a single-gene disease that causes childhood blindness, making it the first such therapeutic to receive FDA approval. This year, a gene therapy called Zolgensma, which treats a rare childhood muscular disorder, gained FDA approval, making it the second gene therapy to hit the market.

Also in 2017, personalized medicine took a step towards becoming a broader clinical reality, with Kymriah, a therapy that entails reprogramming acute lymphoblastic leukemia patients' own immune cells to attack a specific antigen on the surface of cancer cells, being approved by the FDA. Just two months later, in October 2017, the FDA approved another so-called chimeric antigen receptor (CAR) T cell therapy—Yescarta, which treats patients with certain types of B cell lymphomas. As of 2019, there were more than 360 ongoing clinical trials of CAR T cell therapies around the world.

See "On Target" our July/August 2019 special issue on personalized medicine.

Another trend that seemed to experience an acceleration in the 2010s was artificial intelligence as applied to questions of basic biology and human health. AI made international headlines throughout the decade as our transportation systems are set to be transformed by the advent and maturation of self-driving vehicle technology. But researchers in the lab and field, drug developers in the pharmaceutical industry, and physicians in the clinic are also incorporating AI tools and methods in their work.

See "AI Tackles Biology" our May 2019 special issue on the topic.

Perhaps everyone on the brink of a new decade projects a sense of hope and anticipation into the mists of future time. But still, I can't help feeling that the 2020s have big things in store for several areas of life science. The excitement that has built around personalized medicine, CRISPR as a therapeutic tool, and AI presage wide applications for these still-young technologies. As they have been throughout the decade, bioethicists in the 2020s will need to remain ever vigilant, considering continuing developments such as the creation of human/animal chimeras, the genomic modification of human embryos, and the potential of more-accessible genome sequencing. As ever, our society and the scientific community will be faced with the conundrum of pursuing different research questions or development projects based on what we should do, and not simply on what we can do.

Bob Grant is editor in chief of The Scientist. *Email him at bgrant@the-scientist.com.*

Keywords:

ancient DNA, CRISPR, DNA analysis, editorial, end of year, genetics & genomics, genome sequencing, human history, innovation, paleoanthropology, roundup, sequencing, technology