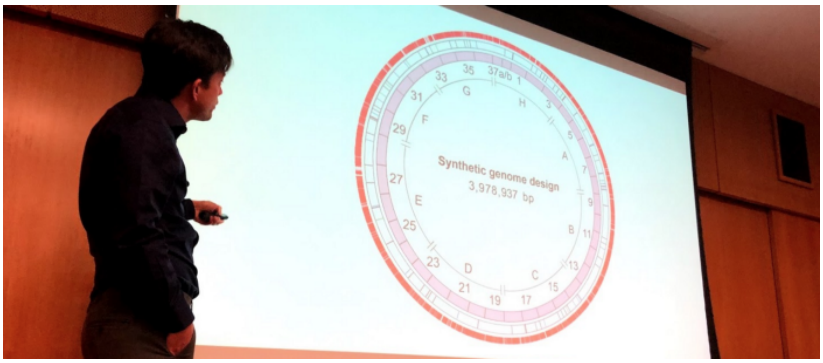
10 reasons to build the human genome from scratch

Andrew Hessel Nov 26, 2019 · 4 min read

The Human Genome Project launched in 1990 with the goal to read genomes. Now scientists are working to write them.



Dr. Jason W. Chin discusses the design for synthetic E. coli, November 2019. Photo: Genome Project-write

The Genome Project-write (GPW) is an academic, international effort to advance whole-genome engineering.

We recently held our annual meeting at NYU Langone Medical Center in New York City. It brought together 150 scientists and engineers from around the world to share recent updates from the field of synthetic genomics and to discuss the ethical, legal, and social implications of such work.

In addition to organizing several community and pilot projects, we have a "grand challenge" project to synthesize and assemble all 23 chromosomes of the human genome and demonstrate that they function in cultured cells. This goal is expected to take at least a decade.

But why would anyone want to build a synthetic human genome at all? Here are some of my top reasons.

1. **It raises societal awareness that whole-genome synthesis is already happening.** Did you know that the first complete synthetic genome was written back in 2002, and that it was the poliovirus genome? That the first synthetic cell was made in 2010? Or that the 4 megabase E. coli genome was synthesized last May and that synthesis of the 10 megabase yeast genome was just completed? In general, people don't pay much attention to the genetic engineering of any organism *except* for humans.

Building the human genome from scratch won't generate designer babies but it will spark greater interest in what's happening at the forefront of genomics.

2. **It will accelerate the development of key technologies.** The GPW Technology Working Group recently published some of the major technological challenges in writing genomes. Basically, a whole new synthetic biology "stack" needs to be created to support genome-scale engineering. GPW is focusing effort and raising money to solve these challenges. This will make it easier to write any genome — plant, animal, or microbe — and supercharge life science research and application development across the board.
3. **It will lower the cost of writing genomes a least 1000 fold (and probably more).** It's expected that GPW will incentivize the technological breakthroughs necessary to close the economic and time gap between reading and writing genomes.
4. **It will potentially lead to fixes for any disease.** Reading DNA supports diagnostics. Writing DNA supports cures. If you can build a genome from scratch, you should be able to correct any genetic errors, no matter how complex, that cause disease. It will also support the development of new biotherapeutics and gene-based therapies.
5. **To facilitate advanced manufacturing.** Cells are microscopic factories that can produce thousands of different biochemicals and materials (and more factories) from elemental building blocks and some sugar or sunlight. Being able to write the complete genome of a cell will make it easier to program and optimize these factories for high-efficiency biomanufacturing.
6. **It will lead to "ultra-safe" cells.** Biomanufacturing facilities require cells that are resistant to viruses, cancer, and senescence. They should also have a suite of built-in safety features to ensure automatic shutdown if they escape containment. Whole-genome synthesis supports the creation of such "ultra-safe" cell lines.
7. **To boost the bioeconomy.** According to Bioeconomy Capital, U.S. biotechnology revenues are at least $388 Billion, or about 2% of GDP. The Human Genome Project is estimated to have generated an impressive return on investment of about 66 to 1. Improvements to writing DNA, another core genomic technology, should also produce large returns. Industry hub Synbiobeta estimates $12.4 billion was invested in synthetic biology over the last decade — over $4 billion in 2018 alone.
8. **It will help feed and sustain humanity on Earth and beyond.** By 2050, the world population will be approaching 10 billion, and off-world bases on the moon and Mars are likely to exist. Biomanufacturing will have a growing role in just about every sector that is necessary to support humanity, including food production, air and water systems, building materials, liquid fuels, and medicines. Plus, being able to read and write genomes effectively allows organisms to be electronically "teleported" from one place to another, including off-planet.

9. **To learn more about all living systems.** Being able to code life from scratch will teach us important lessons about how cellular systems work, from the bottom-up. There's a lot to learn!
10. **Because practice makes hard things easier.** Writing any genome the first time means solving big problems. But there are few things more useful to society than mastery over the language that makes and powers every living thing, including us. The more genomes we write, the easier it will be to design and build the next one. We can only wonder what our children and grandchildren will create.

Andrew Hessel is a co-founder of the Genome Project-write. He's also the President of Humane Genomics, an early-stage biotechnology company specializing in synthetic virus engineering. The next GP-write meeting will be held at the Shenzhen Institute of Advanced Technology on October 18–21, 2020.