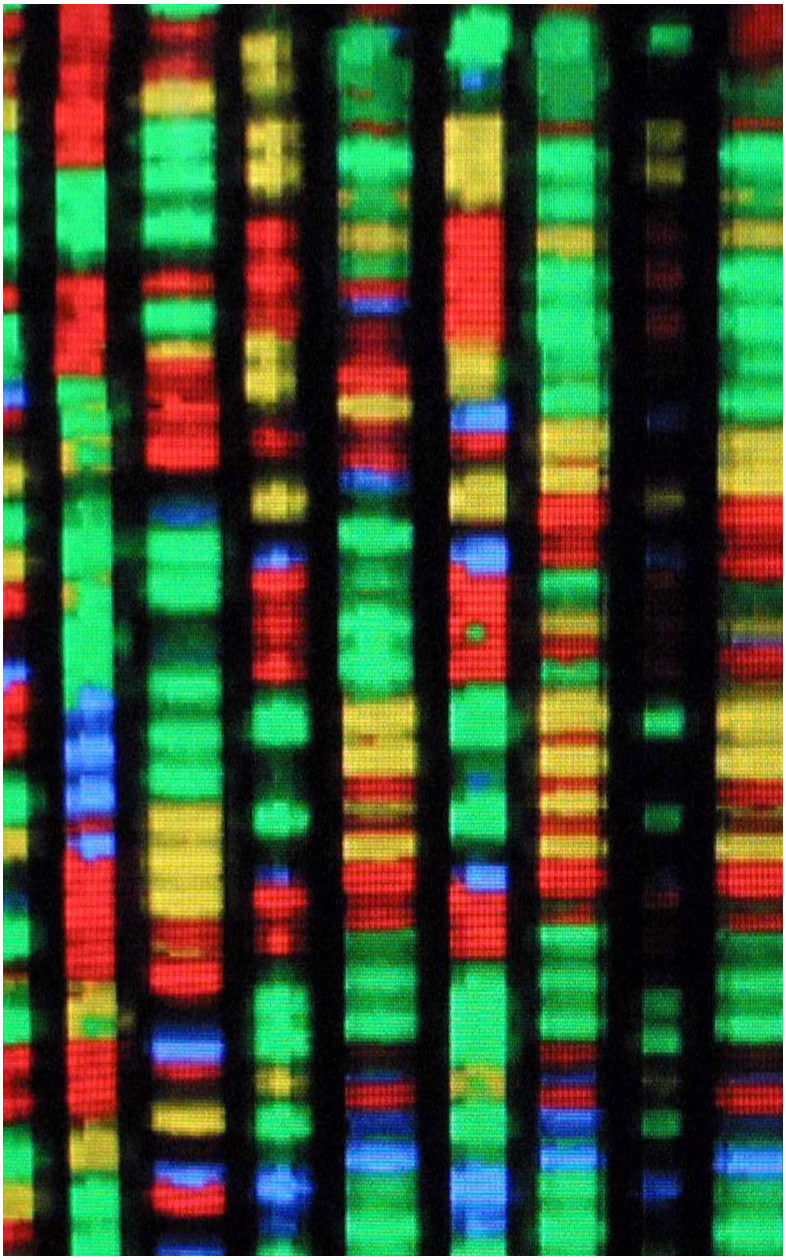
Should we synthesise a human genome?

As specialists gather in private to discuss a grand plan for constructing a human genome, Drew Endy and Laurie Zoloth argue that such an enormous moral gesture should not be discussed behind closed doors.



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At Harvard today, an invitation-only group of about 150 scientists, lawyers, and entrepreneurs, met to discuss if and how to construct from scratch an entire human genome – the heritable genetic material that in nature is transferred from parents to children.

The meeting was originally organised to focus on "deliverables and industry involvement" with the primary goal of the project being "to synthesise a complete human genome in a cell line within a period of 10 years".

Such a synthetic genome could then be tested in a laboratory by replacing the existing genome within a human cell. All this would still be far removed from making a synthetic human.

However, the possibility of making a human cell, whose genome is realised from only digital information and raw materials, should trigger broader considerations.

For context, total synthesis of a human genome is becoming plausible at an accelerating rate. Thanks to new production techniques developed since 2003 the cost of assembling the genetic material encoding genes, the "building blocks" of life, has decreased from $4.00 to just three cents per individual letter, or "base pair" of deoxyribonucleic acid (DNA).

As a result, the estimated initial cost of printing the DNA fragments encoding a three billion base pair human genome has dropped from $12 billion to $90 million.

If cost reductions continue in the way they have been, then this price would approach $100,000 within 20 years. However, such dramatic additional cost reductions might never be realised without an overwhelming demand.

Advocates of synthesising a human genome, therefore argue that some open, collaborative "grand challenge" is needed to drive development of such technologies.

While we strongly agree that sustained improvements in DNA construction tools are essential for advancing basic biological science and improving public health we are sceptical that synthesising a human genome is an appropriate demand driver.

We recall how controversies associated with many of the earliest genome synthesis projects delivered unintended consequences.

For example, a project that made polio virus from scratch in 2002 generated such fear that public funding for improving DNA synthesis tools was cancelled, unwittingly harming research across diverse and unrelated fields while policy makers struggled to imagine how such tools could ever be controlled.

We argue that the synthesis of less controversial and more immediately useful genomes along with greatly improved sub-genomic synthesis capacities (for example, the real-time printing of plasmids the casettes that transfer genes between cells) should be pursued instead.

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These are alternatives that would deliver broad and diverse public benefits.

Other topics on today's agenda included changing the human genome itself. For example, could scientists synthesise a modified human genome that is resistant to all natural viruses?

They likely could, for purely beneficial purposes, but what if others then sought to synthesise modified viruses that overcame such resistance? Might doing so start a genome-engineering arms race?

And, what of even greater changes that can be imagined?

In a world where human reproduction has already become a competitive marketplace, with eggs, sperm and embryos carrying a price, it is easy to make up far stranger uses of human genome synthesis capacities.

Would it be OK, for example, to sequence and then synthesise Einstein's genome? If so how many Einstein genomes should be made and installed in cells, and who would get to make them?

Taking a step back, just because something becomes possible, how should we approach determining if it is ethical to pursue?

Given that human genome synthesis is a technology that can completely redefine the core of what now joins all of humanity together as a species, we argue that discussions of making such capacities real, like today's Harvard conference, should not take place without open and advance consideration of whether it is morally right to proceed.

When the first people at the table mostly have significant and direct material interests in proceeding, everyone, not just those in the room, risk out-of-control competition between public and private interests, ethical conflicts of interest, and temptations to manipulate human subject consent.

Pluralistic, public, and deliberative discussions are instead the best appropriate way to frame paths forward.

We note that the narrative of creation of the human is the central narrative for many religious communities.

To create a human genome from scratch would be an enormous moral gesture whose consequences should not be framed initially on the advice of lawyers and regulators alone.

The perspectives of others including self-identified theologians, philosophers, and ethicists from a variety of traditions should be sought out from the very beginning.

Critical voices representing civil society, who have long been sceptical of synthetic biology's claims, should also be included.

The creation of new human life is one of the last human-associated processes that has not yet been industrialised or fully commodified. It remains an act of faith, joy, and hope.

Discussions to synthesise, for the first time, a human genome should not occur in closed rooms.

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