

Synthetic Humans – Should They Be Used for Risky Experiments?

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STORY AT-A-GLANCE

- › Researchers have succeeded in creating synthetic embryos for the first time, without stopping to first answer the question of if they should be created at all
- › The embryos exist without the need for egg, sperm or sexual reproduction of any kind
- › They were engineered from stem cells and, while they do not have a beating heart, gut or beginnings of a brain, they have primordial cells that are the precursors to egg and sperm
- › Researchers are only legally allowed to grow human embryos up to 14 days, but synthetic human embryos aren't subject to the 14-day rule
- › While the implications for research are exciting, there are significant ethical implications, since the synthetic embryos could, theoretically, grow into adults

Researchers have succeeded in creating synthetic embryos for the first time, without stopping to first answer the question of if they should be created at all. The embryos exist without the need for egg, sperm or sexual reproduction of any kind. They were engineered from stem cells and provide a window into the earliest days of human development.¹

The scientists behind the synthetic embryos, including Magdalena Žernicka-Goetz, of the University of Cambridge and the California Institute of Technology, hope to study this so-called "black box" development period, as researchers are only legally allowed to grow human embryos up to 14 days.²

"We can create human embryo-like models by the reprogramming of [embryonic stem] cells," Žernicka-Goetz said at the 2023 International Society for Stem Cell Research meeting in Boston.³ Further, the synthetic human embryos aren't subject to the 14-day rule.⁴

Synthetic Human Embryos Form Distinct Cell Lines

The embryos were grown to the gastrulation stage of development, when distinct cell lines develop. While the embryos do not have a beating heart, gut or beginnings of a brain, they have primordial cells that are the precursors to egg and sperm. Žernicka-Goetz told The Guardian:⁵

"Our human model is the first three-lineage human embryo model that specifies amnion and germ cells, precursor cells of egg and sperm. It's beautiful and created entirely from embryonic stem cells."

The preprint study, which hasn't been peer-reviewed yet, was published in bioRxiv,⁶ alongside a similar study by stem-cell biologist Jacob Hanna and colleagues at the Weizmann Institute of Science in Rehovot, Israel.⁷ Both studies have received some criticism that the synthetic embryos aren't as advanced as they initially appear. Nature reported:⁸

"Alfonso Martinez Arias, a developmental biologist at Pompeu Fabra University in Barcelona, Spain, says there is 'nothing' in the results described by Zernicka-Goetz and her colleagues that can be considered analogous to real 14-day embryos."

'What we can see is masses of cells separated into compartments, but no embryo-like organization,' he says. He thinks that the over-expression of some genes needed to produce the extra-embryonic cell types 'confuses what cells do,' and argues that the results do not show anything that goes beyond earlier work."

However, others have praised the work. Hanna's team, which also produced a synthetic embryo-like structure from human stem cells, also stopped their experiment at the 14-day cutoff for human embryos, but Žernicka-Goetz and others have argued that allowing the synthetic embryos to develop longer would be useful to science.⁹

Speaking with Science, developmental biologist Jesse Veenvliet of the Max Planck Institute of Molecular Cell Biology and Genetics said of the synthetic embryo developed by Hanna's team, "The similarity to the natural embryo is remarkable, almost uncanny."¹⁰

Prior to the synthetic human embryo, researchers created synthetic mouse embryos.¹¹ This was less than a year ago, showing how rapidly the field is moving. While the implications for research are exciting, there are significant ethical implications, since the synthetic embryos could, at least theoretically, grow into a human. Robin Lovell-Badge, told The Guardian:¹²

"The idea is that if you really model normal human embryonic development using stem cells, you can gain an awful lot of information about how we begin development, what can go wrong, without having to use early embryos for research."

Legal and Ethical Implications Are Significant

While it's currently against the law to attempt to implant a synthetic embryo into a human womb, the science is rapidly outpacing related regulations. "If the whole intention is that these models are very much like normal embryos, then in a way they should be treated the same," Lovell-Badge told The Guardian. "Currently in legislation they're not. People are worried about this."¹³

In animal studies, synthetic embryos implanted into mice wombs did not survive. Similarly, when synthetic monkey embryos were implanted into monkey wombs, pregnancies were induced, although the embryos spontaneously stopped developing after a few days.¹⁴

However, if the synthetic embryos could one day grow into adults, we'd be entering into uncharted legal and ethical territory. Ethicist J. Benjamin Hurlbut of Arizona State University told Science that synthetic embryos represent "a matter of significant moral discussion and of significant moral concern."¹⁵

Are We Headed for Mechanical Wombs?

Scientists are already working on how to grow life outside of a human womb and, in 2021, Hanna and colleagues grew a mouse embryo in a mechanical womb for about half of a typical gestational term – a time period equal to a human embryo at 5 weeks.¹⁶

Growing mouse embryos "ex utero," the researchers said, is a valuable tool to investigate embryonic development in detail,¹⁷ but it comes with serious ethical questions, including might humans be next?¹⁸

The answer is yes, as Hanna told MIT Technology Review, "This sets the stage for other species. I hope that it will allow scientists to grow human embryos until week five."¹⁹ Are we headed for an "era of motherless births,"²⁰ in which babies are grown in laboratories via artificial wombs? It does seem to be where the research is rapidly headed.

The term ectogenesis, which describes gestation that occurs outside a human body, from conception to birth, was coined in 1924 by scientist J.B.S. Haldane.²¹ But it's only now, nearly a century later, that technology is nearing the point of making this a reality. Haldane predicted ectogenesis would make up more than 70% of human births by 2074.²²

First, however, will likely be partial ectogenesis, a field being rapidly pursued as a means to extend viability of extremely premature babies. Not only has artificial amniotic fluid been developed, but the layer of cells in the uterus that nourishes the pregnancy, known as the endometrium, is also being developed as a cell culture.

This paves the way for partial ectogenesis and then full-fledged ectogenesis in the not-so-distant future. According to the Genetic Literacy Project:²³

"The convergence of these technologies will make it possible to transfer a developing human into a system that includes the placenta and umbilical cord and supplies all consumables (oxygen and food), and removes all waste, directly through the blood. Thus, survival and continuing development would not depend on the lungs and other organs being ready yet to do their job.

Applying such a system to fetus delivered in the middle of pregnancy would constitute real partial ectogenesis. Furthermore, since bypassing the developing, not fully functional organs, stands to improve survival substantially, and might even decrease the costs of extreme premature birth, the movement of the technology from research to clinic is inevitable.

Once that happens, there will be no obstacle against pushing the limit further, toward full ectogenesis. But there will be no obstacle to pushing the limit akin to how lung viability has placed an obstacle to conventional pre-term care. At some point, an in vitro fertilized egg could be planted directly into the artificial womb, with no need for a natural uterus even for the early stages."

Scientists Develop Robot 'Skin' Made From Human Cells

As robots continue to rollout into society, scientists are looking for ways to make them more human. This, they say, will promote their acceptance and further interactions with actual humans. Writing in the journal *Matter*, researchers explained:²⁴

"Humanoids are robots created with human forms or characteristics; these robots also have the potential to seamlessly interact with human beings. By replicating the appearances and functions (e.g., self-healing) of human beings, humanoids have the potential to establish more harmonic and natural human-robot interactions."

To facilitate this, the team, from the University of Tokyo, Japan, created living skin for robots, made with human cells. They submerged a three-joint robotic finger into a solution of collagen and human dermal fibroblasts, which conformed to the finger,

forming a primer for the next layer of cells, human epidermal keratinocytes. Together, the layers formed a skin-like surface that can even self-heal if wounded.

While the researchers were pleased with the outcome, stating, "We are surprised by how well the skin tissue conforms to the robot's surface," they explained, "This work is just the first step toward creating robots covered with living skin."²⁵ Next, they intend to add sensory neurons, hair follicles, nails and sweat glands to make the robots appear just like humans.

"I think living skin is the ultimate solution to give robots the look and touch of living creatures since it is exactly the same material that covers animal bodies," study author Shoji Takeuchi said in a news release.²⁶

Will People Be Turned Into Cyborgs?

As robots continue to look increasingly real, scientists are also working on making people more robotic. A May 2021 project report by the U.K. Ministry of Defense, created in partnership with the German Bundeswehr Office for Defense Planning, is titled "Human Augmentation – The Dawn of a New Paradigm, a Strategic Implications Project."²⁷

As noted in the report, "Human augmentation has the potential to ... change the meaning of what it means to be a human." Merging humans with machines is precisely what Klaus Schwab, founder and executive chairman of the World Economic Forum (WEF), has stated is the goal of The Fourth Industrial Revolution.²⁸

Schwab dreams of a world in which humans are connected to the cloud, able to access the internet through their own brains. This, of course, also means that your brain would be accessible to people who might like to tinker with your thoughts, emotions, beliefs and behavior. The report further explains:²⁹

"Human augmentation will become increasingly relevant, partly because it can directly enhance human capability and behavior and partly because it is the binding agent between people and machines."

Future wars will be won, not by those with the most advanced technology, but by those who can most effectively integrate the unique capabilities of both people and machines. The importance of human-machine teaming is widely acknowledged but it has been viewed from a techno-centric perspective.

Human augmentation is the missing part of this puzzle. Thinking of the person as a platform and understanding our people at an individual level is fundamental to successful human augmentation."

In May 2023, Elon Musk's brain-chip company, Neuralink, received approval from the U.S. Food and Drug Administration for a human clinical trial – the first of its kind. The company plans to implant a brain chip into a tetraplegic or paraplegic patient in 2023.³⁰

It's likely that one day transhumanism will involve the use of technologies that are physically embedded in the human body or brain to offer superhuman cognition or forms of mind control. Gene-edited babies have also been developed. In 2018, He Jiankui, a Chinese scientist, modified the DNA of human embryos during in vitro fertilization by disabling a gene called CCR5, which could potentially make the babies resistant to infection with HIV.³¹

The babies, twin girls known as Lulu and Nana, were born in 2018,³² and a third baby with an edited CCR5 gene was born in 2019.³³ He's team received major backlash from the highly controversial move, as while the technology to genetically edit human babies has existed for some time, ethical considerations had stopped researchers from tinkering with the human germline.

He went to jail for three years as a result of the "illegal medical practice,"³⁴ but the momentum to create lab-grown designer babies continues. A February 1, 2022, article in Futurism, for instance, announced that Chinese scientists developed an artificial intelligence nanny robot to care for fetuses grown inside an artificial womb.³⁵

As transhumanism gets underway in earnest, there's little doubt that growing synthetic human embryos is only the beginning – and ethical considerations about growing babies in laboratories will be largely ignored in favor of advancing technology.

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