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Lab-grown Embryos and Human–monkey Hybrids: Medical Marvels or Ethical Missteps?

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In Aldous Huxley's 1932 novel "Brave New World," people aren't born from a mother's womb. Instead, embryos are grown in artificial wombs until they are brought into the world, a process called ectogenesis. In the novel, technicians in charge of the hatcheries manipulate the nutrients they give the fetuses to make the newborns fit the desires of society. Two recent scientific developments suggest that Huxley's imagined world of functionally manufactured people is no longer far-fetched.

On March 17, 2021, an Israeli team announced that it had grown mouse embryos for 11 days – about half of the gestation period – in artificial wombs that were essentially bottles. Until this experiment, no one had grown a mammal embryo outside a womb this far into pregnancy. Then, on April 15, 2021, a U.S. and Chinese team announced that it had successfully grown, for the first time, embryos that included both human and monkey cells in plates to a stage where organs began to form.

As both a philosopher and a biologist I cannot help but ask how far researchers should take this work. While creating chimeras – the name for creatures that are a mix of organisms – might seem like the more ethically fraught of these two advances, ethicists think the medical benefits far outweigh the ethical risks. However, ectogenesis could have far-reaching impacts on individuals and society, and the prospect of babies grown in a lab has not been put under nearly the same scrutiny as chimeras.

Mouse embryos were grown in an artificial womb for 11 days, and organs had begun to develop.

Growing in an artificial womb

When in vitro fertilization first emerged in the late 1970s, the press called IVF embryos "test-tube babies," though they are nothing of the sort. These embryos are implanted into the uterus within a day or two after doctors fertilize an egg in a petri dish.

Before the Israeli experiment, researchers had not been able to grow mouse embryos outside the womb for more than four days – providing the embryos with enough oxygen had been too hard. The team spent seven years creating a system of slowly spinning glass bottles and controlled atmospheric pressure that simulates the placenta and provides oxygen.

This development is a major step toward ectogenesis, and scientists expect that it will be possible to extend mouse development further, possibly to full term outside the womb. This will likely require new techniques, but at this point it is a problem of scale – being able to accommodate a larger fetus. This appears to be a simpler challenge to overcome than figuring out something totally new like supporting organ formation.

The Israeli team plans to deploy its techniques on human embryos. Since mice and humans have similar developmental processes, it is likely that the team will succeed in growing human embryos in artificial wombs.

To do so, though, members of the team need permission from their ethics board.

CRISPR – a technology that can cut and paste genes – already allows scientists to manipulate an embryo's genes after fertilization. Once fetuses can be grown outside the womb, as in Huxley's world, researchers will also be able to modify their growing environments to further influence what physical and behavioral qualities these parentless babies exhibit. Science still has a way to go before fetus development and births outside of a uterus become a reality, but researchers are getting closer. The question now is how far humanity should go down this path.

Human-monkey hybrids

Human–monkey hybrids might seem to be a much scarier prospect than babies born from artificial wombs. But in fact, the recent research is more a step toward an important medical development than an ethical minefield.

If scientists can grow human cells in monkeys or other animals, it should be possible to grow human organs too. This would solve the problem of organ shortages around the world for people needing transplants.

But keeping human cells alive in the embryos of other animals for any length of time has proved to be extremely difficult. In the human-monkey chimera experiment, a team of researchers implanted 25 human stem cells into embryos of crab-eating macaques – a type of monkey. The researchers then grew these embryos for 20 days in petri dishes.

After 15 days, the human stem cells had disappeared from most of the embryos. But at the end of the 20-day experiment, three embryos still contained human cells that had grown as part of the region of the embryo where they were embedded. For scientists, the challenge now is to figure out how to maintain human cells in chimeric embryos for longer.

Regulating these technologies

Some ethicists have begun to worry that researchers are rushing into a future of chimeras without adequate preparation. Their main concern is the ethical status of chimeras that contain human and nonhuman cells – especially if the human cells integrate into sensitive regions such as a monkey's brain. What rights would such creatures have?

However, there seems to be an emerging consensus that the potential medical benefits justify a step-by-step extension of this research. Many ethicists are urging public discussion of appropriate regulation to determine how close to viability these embryos should be grown. One proposed solution is to limit growth of these embryos to the first trimester of

pregnancy. Given that researchers don't plan to grow these embryos beyond the stage when they can harvest rudimentary organs, I don't believe chimeras are ethically problematic compared with the true test–tube babies of Huxley's world.

Few ethicists have broached the problems posed by the ability to use ectogenesis to engineer human beings to fit societal desires. Researchers have yet to conduct experiments on human ectogenesis, and for now, scientists lack the techniques to bring the embryos to full term. However, without regulation, I believe researchers are likely to try these techniques on human embryos – just as the now-infamous He Jiankui used CRISPR to edit human babies without properly assessing safety and desirability. Technologically, it is a matter of time before mammal embryos can be brought to term outside the body.

While people may be uncomfortable with ectogenesis today, this discomfort could pass into familiarity as happened with IVF. But scientists and regulators would do well to reflect on the wisdom of permitting a process that could allow someone to engineer human beings without parents. As critics have warned in the context of CRISPR-based genetic enhancement, pressure to change future generations to meet societal desires will be unavoidable and dangerous, regardless of whether that pressure comes from an authoritative state or cultural expectations. In Huxley's imagination, hatcheries run by the state grew a large numbers of identical individuals as needed. That would be a very different world from today.

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Featured image: Researchers have grown mammal embryos later into development than ever before in an artificial womb. Vitalii Kyryk/WikimediaCommons, CC BY-SA

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