

Artificial Wombs: From Embryo Farms to Fetus Farms

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Some scientists have already moved beyond experimenting on embryos in petri dishes. Using a variety of methods, they are developing animal and humans into later and later stages of development before killing them.

Yosinori Kuwabara and his colleagues, working in a small research laboratory at Juntendou University in Tokyo, **are developing the first operational artificial womb – a clear plastic tank the size of a bread basket, filled with amniotic fluid stabilised at body temperature.** For the past several years, Kuwabara and his team **have kept goat fetuses alive and growing for up to 10 days by connecting their umbilical cords to two machines that serve as a placenta, pumping in blood, oxygen, and nutrients and disposing of waste products.** While the plastic womb is still only a prototype, Kuwabara predicts that **a fully functioning artificial womb capable of gestating a human foetus may be a reality in less than six years.**

– “The End of Pregnancy: Within a Generation There Will Probably Be Mass Use of Artificial Wombs to Grow Babies” by Jeremy Rifkin, *Guardian* of London, January 17, 2000 (<http://www.guardian.co.uk/print/0,3858,4337092-103677,00.html>)

Scientists have created prototypes made out of cells extracted from women’s bodies. **Embryos successfully attached themselves to the walls of these laboratory wombs and began to grow.** . . . “We hope to create complete artificial wombs using these techniques in a few years,” said Dr Hung-Ching Liu of Cornell University’s Centre for Reproductive Medicine and Infertility. . . . Liu and her colleagues grew layers of these cells on scaffolds of biodegradable material which had been modelled into shapes mirroring the interior of the uterus. . . . “Finally, we took embryos left over from IVF programmes and put these into our laboratory engineered tissue. The embryos attached themselves to the walls of our prototype wombs and began to settle there.” The experiments were halted after six days. However, Liu now plans to continue with this research and allow embryos to grow in the artificial wombs for 14 days . . . “We will then see if the embryos put down roots and veins into our artificial wombs’ walls, and **see if their cells differentiate into primitive organs** and develop a primitive placenta.” . . . “The next stage will involve experiments with mice or dogs. If that works, **we shall ask to take our work beyond the 14-day limit now imposed on such research.**”

– “Men redundant? Now we don't need women either: Scientists have developed an artificial womb that allows embryos to grow outside the body,” by Robin McKie, *The Observer*, February 10, 2002 (<http://www.observer.co.uk/international/story/0,6903,648024,00.html>)

Working at the embryonic stages of life, Dr. Hung-Ching Liu . . . has engineered endometrial tissue in the laboratory by taking cells from a woman's endometrium and prompting them to grow on a biodegradable scaffolding shaped like a human uterus. **When Liu introduced an embryo to the artificial uterine lining, it successfully implanted.** "The embryo grows very happily and very healthy," she noted during the American Society for Reproductive Medicine conference in 2001. "The characteristic of this embryo development is very similar to that in vivo." In these early experiments, **she allowed the embryo to grow for six days.** But Liu told reporters that, **in future experiments, she has every intention of allowing embryos to develop further and longer.** . . . during an interview at the American Society for Reproductive Medicine Conference in 2001, Dr. Liu didn't exactly demur when asked about the implications of her research. **"Is it ... science fiction to say maybe in the far future you could have a real breathing embryo and have a child in the laboratory?"** the interviewer asked. **"That's my final goal,"** said Dr. Liu. "I call it an artificial uterus. I want to see whether I can develop an actual external device with this endometrium cell and then probably with a computer system simulate the feed in medium, feed out medium... and also have a chip controlling the hormone level." [emphasis added]

– "Why Not Artificial Wombs?" by Christine Rosen, *The New Atlantis*, Fall 2003
(<http://www.thenewatlantis.com/archive/3/rosen.htm>)

"The more stages of development you can study, the better understanding you have," said Stuart Newman, a scientist at New York Medical College. But ethically, many reasons may exist for halting the growth of a cloned human embryo. **Some "people say gestate for a week, or two weeks ... but the technological imperative and the business imperative just roll over any arbitrary boundary that people would like to set,"** Newman said. Under the new law in New Jersey, for example, cloned human embryos can legally be placed in women for subsequent growth, but cannot result in birth. The draft California ballot initiative says that cloned human embryos would only be allowed "initially" to develop up to 12 days. Improved technology, meanwhile, is allowing longer gestation of human embryos outside the womb. . . . **"This model would provide new avenues for testing new drugs . . ." and could also grow tissue** for possible transplants, according to Hung-Ching Liu, the team's lead scientist.

– "Cloning as Economic Development," by Neil Munro, *The National Journal*, March 6, 2004

Four months ago, Japanese researchers . . . demonstrated a way to grow human adult bone marrow stem cells into kidney tissue: by putting the cells in embryonic rats. The embryos had gestated for nine to 10 days – in human terms, about four months. The researchers extracted them from their mothers, injected the human cells into regions of

the embryos where kidneys were forming, and cultured the embryos in vitro for two days. The researchers called this process “whole-embryo culture.” . . . The embryos died, but the researchers removed the developing kidneys and cultured them separately for another six days. They reported that “kidney rudiments continued to grow.” . . . The authors called this “an in vitro organ factory.” . . . Dr. Helen Liu . . . has grown artificial womb tissue in the lab, put mouse embryos on it, and watched them implant and develop. After a week, she moved some of them to the abdominal cavities of adult mice. At 17 days - four days shy of full term - she took them all out....The embryos in vivo, which had spent nearly half their gestation in vitro - and none of it in a womb - seemed small but otherwise normal. . . . Put the two technologies together, and you can grow organs in embryos without ever implanting them in a womb....**Artificial wombs erase the line between in vitro embryos and implanted embryos. Whole-embryo organ culture erases the line between therapeutic and reproductive cloning.**

– “The Organ Factory: The case for harvesting older human embryos.” Five-part series by William Saletan, *Slate*, July 25-29, 2005
(<http://slate.msn.com/id/2123269/entry/2123270>)

Liu’s artificial womb is a surprisingly simple construction. She created it after researching the making of artificial skin and adapting those methods. First she and her co-workers mold a base, a womb-shaped matrix of collagen and chondroitin, substances that are biodegradable. Over time, they dissolve, leaving only the endometrial tissue that is placed over the matrix. Each womb is shaped like a section of the mammalian version it mimics: The artificial human mold is bowl-shaped; the faux mouse womb is a doughnut-shaped section of a mouse’s tubular uterus. In the beginning, Liu used endometrial cells donated by some of the clinic’s female patients to grow human tissue. Then she added human embryos left over from IVF treatments, donated by other patients. These zygotes **implanted and started to grow**. But after they had gestated for 10 days, Liu ended the experiments, well short of viability. Under current federal regulations, two weeks is the limit for human fetal growth in the lab. “So we switched to an animal model,” Liu says with a shrug. In 2002 she and her colleagues started making mouse wombs and growing mouse embryos inside them. . . . Liu thinks she and her team should have a viable mouse womb in 5 to 10 years. A human model will take longer – “10 years, maybe, or a little more,” she says, assuming that restrictions on fetal testing

are lifted or eased.

– “Artificial Wombs: Will we grow babies outside their mothers’ bodies?,” by Gretchen Reynolds, *Popular Science*, August 2005.

In 2002 Hung-Ching Liu, at Cornell University, in the United States, announced that her team had successfully grown a sample of cells from the lining of a human uterus and had used tissue engineering technologies to shape them like a womb. When a fertilised human egg was introduced into the womb, it **implanted into the uterus wall as it would in a natural pregnancy**. The experiment was ceased at six days’ gestation . . . **It is also feared that scientists involved in cloning could continue their experiments without the need for surrogate mothers.**

– “From foetus to full term – without a mother’s touch,” by Ainsley Newson, *The Times* of London, August 30, 2005 (<http://www.timesonline.co.uk/article/0,,2-1755908,00.html>)