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Will artificial wombs mean the end of pregnancy?

By Scott LaFee

UNION-TRIBUNE STAFF WRITER

February 25, 2004

Just over eight decades ago, the British scientist J.B.S. Haldane imagined a time in which human pregnancy disappeared. It would be 1951, he prophesied in his essay "Daedalus, or Science and the Future," the birth year of the first ectogenic child.

Ectogenesis – a word Haldane coined – means to be created outside the womb. In Haldane's trenchant vision of the future, having children would become a common and complete out-of-body experience.

He was wrong, of course, but maybe only in timing. After years of fits and starts, researchers in the United States, Japan and elsewhere claim to have successfully tested crude prototypes of artificial wombs with animals. Some say an experimental human version could be ready within the decade.

The idea of children not born but incubated has long been the stuff of science fiction and horror stories. In his 1932 novel, "Brave New World," Aldous Huxley (a friend of Haldane's) conceived



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of a future in which "normal" people were genetically designed, cloned and gestated in artificial wombs while "savages" living outside civilization gave natural birth like animals.

Both Haldane and Huxley viewed ectogenesis as a eugenics-inspired technology intended to promote survival among select members of the species while suppressing all those deemed inferior.

Modern advocates and investigators of ectogenetics take an altogether different tack. They say their pursuit of an artificial womb is not meant to perpetuate or promote racial or social division, but to save unborn children and offer a new avenue to motherhood.

"At first glance the artificial womb seems like the 'Blade Runner' technology of medicine gone amok," said Gregory Pence, a bioethicist at the University of Alabama at Birmingham and author of "Brave New Bioethics."

"But further reflection shows that the artificial womb could be ethically justified in some cases. For example, as a measure of last resort for some premature, dying babies, it could offer unique benefits. Also, for some babies being gestated by drug-dependent mothers, it could offer a better gestational environment."

That's one argument.

Anatomy lessons

Attempts to mimic or improve upon the design, development and delivery of human life are hardly new. Early students of human anatomy in the 16th and 17th centuries probed and parsed numerous animal species – and the occasional body of deceased pregnant women – to better understand how reproduction and gestation worked.

Serious (but scattered) efforts to build an artificial womb began in the 1950s. These were, by and large, unsuccessful until 1997, when researchers at Juntendo University in Tokyo announced they had removed a 14-week-old goat fetus from its mother's uterus and kept it

creating new problems and issues even as it solves old ones. Nowhere is this more true than in the scientific pursuit to better understand and alter the human mind and body.

Blanks for the memories



Researchers are investigating the use of drugs to dim harmful memories and maybe prevent post-traumatic stress disorder. But some worry that marketing memory loss on demand diminishes the importance of remembering.

Trading faces



Surgery to transplant the face of a dead person onto burn victims or those with other facial deformities may be imminent. Critics question whether society is really ready to face the ramifications.

Spare womb



Ever so slowly, medical technology is developing the means to carry an unborn child to term outside the mother's womb. Doing so may save lives, but does it alter the meaning of those lives? Is such a child born or incubated?

A reproductive history

1677: Human sperm discovered by student of Antonij van Leeuwenhoek, inventor of the microscope.

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alive for three additional weeks in an artificial womb. That device consisted of a bread box-sized acrylic container filled with warmed, amniotic-like fluid. An external machine hooked up via tubes to the fetus' umbilical cord provided oxygen and nutrients while filtering out waste.

Dr. Yoshinori Kuwabara, who led the research, said he hoped his artificial womb could eventually help prevent premature infant deaths and miscarriages. He predicted a human version might be available by 2007.

More recently, Dr. Thomas Schaffer at Temple University has reportedly tested with success a synthetic amniotic fluid on premature lamb fetuses. The breathable fluid is made of perfluorocarbons, which are capable of carrying more oxygen than air. Schaffer says he is ready to try the technique on needy premature infants, but lacks sufficient funding.

The ability to care for premature babies has greatly increased in recent years. Doctors can now keep human fetuses alive and developing outside the mother's womb at 24 weeks of gestation – 2-½ months short of the full nine-month term. It is possible to save children weighing just 2 pounds.

"That's not so much of a challenge anymore. The science is fairly routine, and most premature babies are normal and healthy," said Dr. Sherman Silber, director of the Infertility Center of St. Louis at St. Luke's Hospital in Missouri.

Bigger obstacles lie at the other end of gestation, in the first few days and weeks of developing human life. Here, artificial womb research can be best described as budding, although there have been some notable achievements.

Medical scientists have fairly well mastered the process of artificial insemination and in vitro fertilization technology – the fusing of egg and sperm in a petri dish. The technology is now more than a quarter-century old and astonishingly sophisticated.

1780: Italian priest and scientist Lazzaro Spallanzani develops first artificial insemination techniques using dogs.

1785: Scottish surgeon John Hunter attempts first human artificial insemination, resulting in birth of a child same year.

1827: Human female egg discovered by Prussian embryologist Karl Ernst von Baer.

1843: Physician Martin Berry discovers that conception begins when sperm enters ovum.

1890: Walter Heape of England recovers pre-implantation embryo by flushing a rabbit oviduct, then transferring embryo to foster-mother where normal development continues.

1960: FDA approves sale of Enovid, first commercial birth control pill.

1969: Robert Edwards of England successfully fertilizes human egg outside female body.

1978: Louise Brown, the original "test-tube baby," is born in Cambridge, England.

1981: First fish – a golden carp – is cloned in China.

1996: First adult mammal a female sheep named Dolly is cloned in Scotland.

2001: Advanced Cell Technology announces cloning of human embryos.

2004: South Korean scientists create stem cells from cloned human embryo.

Human embryos created through IVF technologies are currently implanted in a woman's uterus within days of conception in a test tube. In 2002, Dr. Hung-Ching Liu of Cornell University's Weill Medical College made headlines by taking a stab at creating a new option.

Liu announced that she and colleagues had removed cells from the lining of a woman's womb then induced them, using hormones, to grow atop a biodegradable matrix that resembled a human uterus. After the matrix dissolved, Liu placed a human embryo onto what was, in effect, a kind of artificial womb. The embryo attached itself and began to grow, just as it would naturally.

Liu terminated the experiment after just a few days, in accordance with laws governing current IVF and stem-cell research that limit embryonic growth in the lab to a maximum of 14 days.

At a meeting of the American Society for Reproductive Medicine, Liu said her eventual aim was to create the means to artificially carry an embryo to full-term.

"That's my goal," she said. "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."

Liu thinks success is years away, maybe decades, but said, "I believe this can be achieved."

Others aren't so sure.

Dr. Stanley Korenman, associate dean of ethics at the David Geffen School of Medicine at UCLA and an obstetrician/gynecologist, thinks there is a huge difference between sustaining the life of a premature baby and promoting development of new human life.

"By the second trimester, fetuses have essentially completed their embryological development. They have all of their organs," Korenman said. "It's in the first 12 weeks when embryogenesis takes place, and from a purely technical point of view, I find it a very distant possibility that we will ever understand enough about that development to be able to control it. I'm not sure we even want to go there."

Dr. Randy Morris, an associate professor of reproductive endocrinology and a private practitioner, sees real problems with just building a functional artificial womb.

"The uterus of a pregnant woman draws about 25 percent of the heart's output, every minute of the day. That's an enormous amount of blood flow that an artificial womb would have to duplicate. Beyond that, you'd have to know exactly how much oxygen to infuse within that blood, how much nutrients and what kinds, what sorts of hormones and when. I truly doubt we know enough about how to gestate a natural pregnancy, let alone put all of that into action in a laboratory setting."

Fundamental doubts

While a few feminist philosophers view a futuristic artificial womb as a sort of liberating device – writer Shulamith Firestone says it would allow women to avoid the health risks of pregnancy – there is no shortage of opponents to the idea.

"A large number of people, I think, will find this idea ethically unappealing," said Korenman at UCLA. "An artificial womb commodifies the outcome, the child. It interferes with the relationship between the mother and child and imprinting that is a part of pregnancy. There's an intrinsic feeling that it's the wrong thing to do."

Rosemarie Tong, a distinguished professor of health care at the University of North Carolina-Charlotte, questions the need.

"On any issue like this, I ask myself, why? Why would science or people want this? What is the desired end to this particular technology? My intuition tells me that most people would prefer to do things the natural way, to experience the intimacy and connection with ingesting new life."

Tong suspects the market for an artificial womb would be extremely small.

"I think there are other, already viable options for most situations. It could help in cases where premature babies require a lengthy incubation period of many weeks. Current technologies in this area are far from perfect. But other reasons seem morally problematic. And the sheer economic cost would be huge. It seems gratuitously ugly to invest in something like this when there are more urgent health care needs that can be addressed and solved."

Fertile imaginations

Critics of some kinds of human reproduction research worry about where and when it will end. They talk about slippery slopes ending in a place not unlike Huxley's "Brave New World" in which one character recalls:

"Human beings used to be ... well, they used to be viviparous."

That is, folks gave birth to live young, rather than eggs.

It's a fear fueled by undeniable change.

Last year, for example, researchers at labs in Japan, Europe and the United States reported significant steps toward being able to create eggs and sperm –

What do you think?

Scientific developments sometimes compel us as individuals and as a society to ask if what can or might be done, should be done. Are there ethical questions that need to be asked and answered before we can take the next step?

Below are three questions related to today's cover story, and to aspects of ethics and morality in the pursuit of knowledge. We'd like to know what you think. You can share your thoughts by sending an e-mail to science@uniontrib.com or by writing to:

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Please include your name, address and phone number. On March 3, after the series has concluded, we will highlight some of your thoughts.

Leigh Fenly, Quest editor

the former by combining the nucleus of a body cell with an egg cell that had its nucleus removed, the latter by inducing embryonic stem cells to develop into sperm.

Earlier this month, scientists in South Korea derived stem cells from a cloned human embryo, a critical step toward being able to grow replacement parts for humans.

"The age of human cloning has apparently arrived," declared Dr. Leon Kass, chairman of the President's Council on Bioethics. "Today, cloned blastocysts (an early embryonic stage) for research, tomorrow cloned blastocysts for baby-making."

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