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Study of Child Custody in Artificial Womb Using Artificial Intelligence and Genetic Engineering of the Parents' Fertilized Egg

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Annotation: Artificial womb technology is an exciting and revolutionary development that could revolutionize how humans reproduce. An artificial womb could provide a solution for those unable to conceive or find a suitable surrogate mother, reducing high-risk pregnancies and premature births. Furthermore, countries with low populations could quickly leverage this technology to find solutions through laboratory-grown babies instead of natural births. Artificial intelligence is increasingly important in medicine and healthcare today, so it's no surprise that AI will play a key role in future developments related to artificial womb technology. Using AI algorithms, such as machine learning, deep learning, and natural language processing, medical professionals can gain insights into data collected from patients.

Some medical devices are being studied as new reproductive technologies that could ensure embryo implantation or support a premature baby outside the mother's womb (whether human or animal). On this basis, it is more reliable. Based on the basic concept that every week of appropriate care outside the womb allows for significant improvements in the outcome and survival of premature babies, the "medical unit" will need to be studied and implemented in detail. For use on premature human babies, up to those born at 22 weeks of gestation, who require special assistance to

ensure the development of critically immature essential organs and, consequently, normal cardiac and respiratory function, a cause of morbidity and mortality in these vulnerable patients. Scientists will develop a prototype specifically for clinical use. Unlike current incubators, the prototypes will envelop premature babies in fluid and provide them with oxygen and nutrition via an artificial placenta connected to the newborn's umbilical cord. Genetic engineering also plays a major role in the birth process using an artificial womb, as it solves the problems of genetic deformities and mutations that may occur to the fetus in the natural womb and which cannot be modified inside the mother's body before birth. Therefore, the artificial womb has made it possible to modify the genes of the fetus before birth, as it removes the dangerous gene that causes the mutation and repairs it so that children are born in complete health and free of diseases.

Research objectives

Research into an artificial womb aims to achieve a variety of goals, including:

- Helping women with uterine problems: An artificial uterus can be a solution for women who have lost their uterus due to cancer or other medical conditions, or who have congenital uterine abnormalities that prevent them from becoming pregnant.
- Saving premature babies: An artificial womb can be used to provide a safe environment for premature babies, increasing their chances of survival and avoiding health complications.
- Expanding the reproductive spectrum: An artificial womb may allow same-sex couples or individuals who cannot conceive naturally to have children who carry their genes.
- Reducing risks associated with pregnancy: An artificial uterus can reduce risks associated with pregnancy, such as preeclampsia and premature birth.
- Providing an ideal environment for fetal development: An artificial womb can provide a more controlled environment for fetal development, which may lead to improved health for babies born this way.

However, there are also many ethical and legal considerations that must be taken into account before the artificial womb is widely used.

In addition to the above, there are several other objectives:

- ✓ Protecting fetuses from diseases, medications and drugs that may be present in the mother's body.
- ✓ Predicting extremely preterm birth, and genetic susceptibility to increased risk of death or illness in preterm infants.

- ✓ Treatment of fetal growth retardation resulting from placental insufficiency.
- ✓ Saving fetuses whose birth is threatened after a medical or surgical procedure on the fetus.

Research methodology

Study of the effect of artificial womb on fetal growth and health :

1. Fetal growth monitoring:

- ➢ Monitoring the growth of organs and tissues:
- ➢ The growth of all vital organs and tissues of the fetus, such as the heart, lungs, kidneys, and brain, must be closely monitored.
- ➢ Advanced medical imaging techniques, such as ultrasound and MRI, can be used to accurately monitor organ growth.
- ➢ Evaluation of vital organ functions:
- ➢ The vital functions of the fetus, such as heart and respiratory functions, should be assessed continuously.
- ➢ Sophisticated monitoring devices can be used to measure heart rate, respiration rate, blood oxygen level, and other vital signs.
- ➢ Monitoring fetal neurodevelopment:
- ➢ The fetal neurological development should be monitored, and the development of the brain and nervous system should be assessed.
- ➢ Techniques such as electroencephalography (EEG) may be used to monitor the electrical activity of the brain.

2. Fetal health assessment:

- ➢ Detection of congenital malformations:
- ➢ Accurate examinations must be performed to detect any congenital abnormalities that may occur in the fetus.
- ➢ Medical imaging techniques and genetic testing can be used to detect birth defects.
- ➢ Disease risk assessment:
- ➢ The risk of fetal diseases, such as infections and inflammations, should be assessed.

Introduction

The uterus has great importance and a great position as it is the primary site for childbirth Hung, CM, & Javid, pJ (2020) However, the child may be born before the completion of its normal growth inside the uterus. According to the World Health Organization, premature birth is the most common cause of death among infants around the world, as about 15 million children die before the 37th week of pregnancy. Premature birth is also the second leading cause of pneumonia, which causes the death of many. Children under five years of age generally have a survival rate of approximately 22 to 23 weeks of pregnancy. At this age, the baby weighs less than 600 grams, so the chance of survival is 30 to 50 percent. However, this survival comes at a high price in terms of quality of life, with a 90 percent risk of disease due to chronic lung disease and other complications of organ immaturity. Survivors face lifelong disability. Therefore, these children need a bridge between the mother's womb and the outside world by placing the baby inside an artificial womb until it is fully developed. This technology has emerged as the only means that contributes to saving the lives of infants who are considered vulnerable to death due to premature birth and women who suffer from health problems that prevent them from becoming pregnant, as well as reducing complications that occur during traditional pregnancy

that are dangerous to the fetus, such as chronic diseases and congenital malformations. Note that the artificial womb is a bioplastic bag that contains amniotic fluid that surrounds the fetus in the mother's womb and provides the oxygen and nutrients that the fetus needs and maintains body temperature. In general, the artificial womb provides the same conditions. The artificial womb will provide the incubated fetus with nutrients and oxygen and will be able to eliminate waste. It also requires an artificial placenta (Partridge et al., 2017) to mediate the necessary exchanges between the fetal circulation and the system that would replace the mother's blood flow. Overall, the artificial womb will in the future be a valuable tool for pregnant women seeking additional safety measures during childbirth, while enabling them to control their bodies throughout pregnancy. It provides peace of mind knowing that your child will grow safely in an infection-free environment while you maintain complete independence throughout this important period in your life. (Romanies, 2019)

Definition of the uterus:

It is a hollow, muscular organ located in the pelvic area and is one of the female reproductive organs. A woman's uterus plays an important role in menstruation, pregnancy, and childbirth. The uterus is shaped like a pear, also known as a pear, and is usually the size of an apple. However, during pregnancy, it expands and becomes the size of a watermelon. It can expand according to the size and growth of the fetus until it reaches its peak expansion at the end of pregnancy. It then gradually returns to its normal state after the fetus is born. Below are some details related to the dimensions of the uterus:

Uterus width: 5 cm.

Uterus length: 8 cm

Uterus thickness: 4 cm

Uterine volume: 80-200 ml.

Where is the uterus located?

The uterus is located in the female pelvic region, specifically behind the bladder and in front of the rectum. A group of ligaments supports the uterus in its proper position, including: J.Whitloac, 2024, the uterovarian ligament, the round ligaments, the broad ligament, the main ligament, and the uterosacral ligaments.

It is supported from above by the diaphragm, while from below it is supported by the pelvic diaphragm, the urogenital diaphragm, and the perineal body. GA&Aatcha, 2023

Does the uterus change during different stages of life?

The uterus can vary in size and shape depending on a female's reproductive stage and response to female sex hormones. The following describes some of the changes in the uterus during different periods of a female's life: AM.A., Fagan, S., E.Sosa J.N., &Petreson,D.C.,2017. The uterus in prepubescent girls: The uterus is small, and the cervix is longer than the body of the uterus, with a cervical-to-body ratio of 2:1.

Uterus structure

A woman's uterus consists of four main parts:

1- **Fundus:** It is the wide, curved area at the top of the uterus that connects to the fallopian tubes.

2- **Corpus**

It is the main and largest part of the uterus, which begins just below the level of the fallopian tubes and continues downwards, becoming increasingly narrower as it descends.

3- **Isthmus:** which is the lower, narrow part of the uterus.

4- **Cervix:** The lowest part of the uterus, which is shaped like a tube and connects the uterus to the vagina.

The uterine wall consists of three distinct layers of tissue, as follows:

1- Serosa or perimetrium: This is the outer layer of uterine tissue composed of epithelial cells and is connected to the peritoneal cavity.

2- The myometrium: which represents the middle layer of the uterine wall and consists of smooth muscle tissue, is responsible for uterine contractions during childbirth.

3- Endometrium: It is the inner lining of the uterus and contains two layers: a thin underlying layer called the basal layerStratum BasaliThe thickest layer is called the functional layer. Stratum Functionalis It is a mucous layer that contains a large number of blood vessels, which increases in thickness during the menstrual cycle in response to hormones.

What is the function of the uterus?

The uterus is the hollow organ in the female reproductive system that carries the fetus during pregnancy. The uterus performs multiple functions and plays a key role in fertility and reproduction. This organ is able to change its shape by contracting and relaxing its muscles to support the fetus. During pregnancy, the uterus grows, and the muscles become tighter and thinner, like a balloon. Without this ability to expand, a woman's body would be unable to support the rapid growth of the fetus. Many women believe that this is the only function of the uterus, but in fact, there are a number of other functions of the uterus that many women are unaware of, including:

1- Care of the fertilized egg and the embryo

The uterus nurtures the fertilized egg, which later develops into a fetus. The fertilized egg is implanted in the lining of the uterus and gets its nourishment from the blood vessels that develop for this purpose. This egg turns into a fetus that develops over time.

2- Bowel and bladder support

The uterus provides structural integrity and support for the bladder, bowel, pelvic bones and organs, and also separates the bladder from the bowel.

3- menstruation

Menstruation occurs as a result of the shedding of the functional layer of the uterus, which occurs approximately every 28 days. During a typical menstrual cycle, the uterine lining undergoes a process called angiogenesis, which occurs as a result of elevated levels of estrogen and progesterone, making the uterine lining thicker, more vascular, and richer in blood. J. Whitloac, 2024. GA & Aatcha, 2023

4- Implantation and pregnancy

If pregnancy occurs, the fertilized egg will burrow into the lining of the uterus, where the placenta called the decidua basalis will develop. During pregnancy, the uterus will undergo many physiological changes. It will grow in size and its muscular walls will become thinner and more elastic, like an inflated balloon, which will help accommodate the growing fetus. GA&Aatcha, 2023

The isthmus of the uterus will also become softer and more compressible. As the fetus grows, the height of the fundus will increase. The distance from the top of the uterus (fundus) to the pubic bone can be used to estimate the gestational age. The golden rule is that every 1 cm of fundal height corresponds to one week of pregnancy (J.Whitloac, 2024).

5- Labor and delivery

As you approach the seventh month of pregnancy, estrogen levels rise and progesterone levels

begin to decline, making the uterine muscle more sensitive to stimuli that promote contractions. As a result, the uterine muscle begins to contract intermittently in preparation for birth. These contractions are called Braxton Hicks contractions, and they are similar to menstrual cramps. As labor approaches, oxytocin and prostaglandins stimulate uterine contractions and increase contraction strength. The fetus also causes the uterine muscle and cervix to dilate, further stimulating uterine contractions. As labor progresses, the uterine contractions become stronger and more frequent, which leads to the cervix dilating and weakening. This continues until uterine contractions are strong enough to push the baby out of the uterus and into the vagina. The woman's uterine muscle continues to contract after birth, causing the placenta to separate from the uterine wall and be expelled. It will continue to contract in the coming weeks as the uterus returns to its normal size (A.M., Fagan, S., E., Sosa, J.N., & Peterson, D.C., 2017).

6- memory enhancement

The uterus helps preserve memory and prevent dementia. This is one of the functions of the uterus that has been discovered in recent years. A study linking the uterus to the brain has shown that the autonomic nervous system in the body has connections to the uterus. Therefore, hysterectomy can affect memory and increase the risk of dementia with age.

The concept of the premature baby

It is the child who was born alive before the thirty-seventh week from the first day of

7 Lams & Romero, 199 The previous menstrual cycle, regardless of his weight, in the thirty-seventh week is the limit

The gap between a premature baby and a normal, full-term baby, and premature birth means losing the baby

Sufficient time for development inside the womb, so that it comes out to life with its organs immature and not

Complete, it requires intensive medical procedures to restore the vital functions of the heart and

Breathing to start working again and these medical procedures in all their forms are called

Revival and restoration of life by all available means to preserve the human soul from

A baby who has not yet entered the ninth month and is at the lowest gestational age at which he can be born

The fetus is considered viable at 22 weeks, according to the latest medical statistics

Causes of premature birth

1- Risk factors resulting from a previous pregnancy, such as multiple births or miscarriages.

2- Lack of prenatal care

3- Neglecting treatment of infections during pregnancy (Goldenberg & Culhane 2007)

4- Previous cervical surgery

5- Chronic diseases such as blood pressure, diabetes and kidney disease.

6- Premature placental abruption

History of the origin of the idea of the artificial womb

Artificial womb technology is not new; scientists have been working on it for many years (Hung & Javid, 2020). The first patent for an artificial womb design was issued in 1955 by Emanuel. The idea was first discussed in 1923 in England by Greenberg Technology, 2023, who designed a tank in which the fetus could be placed. It contained the amniotic fluid that surrounded it in the mother's womb, along with a device connected to the umbilical cord, blood pumps, and artificial

kidneys. In 1987, Kuwabara (Partridag et al., 2017) conducted an experiment in Tokyo to preserve a goat fetus in an artificial womb for an extended period. This was the first scientific experiment in this field, and with this advanced technology, a 17-week-old goat fetus was preserved for three weeks. American William Cooper then obtained a patent in 1993 for a system at the end of the 21st century. In 2017, scientists from the Embryo Research Center in Invented in a different way, the most significant development in the field of artificial wombs occurred in Philadelphia, USA, with a new technology based on a bio-bag containing synthetic amniotic fluid. The test was conducted over four weeks on lambs whose biological age was equivalent to that of a human fetus at 24 weeks of gestation. The fetuses were able to develop brains, lungs, movement, the ability to swallow, and open their eyes. Researchers sought to improve the system and adapt it to human fetuses. In 2018, a proposal was presented for a speculative design for artificial wombs for premature infants, in which the infants receive oxygen through the umbilical cord. This new technology increases the survival rate of premature infants. The devices and bio-bag aim to facilitate the EVE platform. In 2019, two research teams claimed proof of principle for artificial womb technology to treat live birth in a natural environment and biological condition similar to pregnancy in the mother's womb, enabling ectopic pregnancy. Premature babies can continue to grow. When artificial wombs are used to continue pregnancies outside the womb, this is called exocrine embryogenesis. Exocrine embryogenesis (EVE) can significantly reduce mortality and morbidity among premature babies. Also in 2019, Osuda published a second experiment with a similar design. The EVE device encloses the fetus in a warm amniotic fluid bath in a sterile plastic bag. The fetal heartbeat and oxygenator maintain blood circulation. In 2022, scientists from the Suzhou Institute of Biomedical Engineering Technology actually operated the artificial womb on mice. The institute's artificial womb consists of several vessels containing a mixture. The idea for the artificial womb was inspired by an existing treatment called extracorporeal membrane oxygenation (ECMO), a type of life support that can help a person whose lungs and heart are not functioning properly. In ECMO, blood is pumped outside the patient's body into a machine that removes carbon dioxide and adds oxygen. The oxygenated blood is then sent back to the body's tissues. This method allows blood to bypass the heart and lungs, allowing these organs to heal. However, this method is not suitable for premature babies, so an artificial womb device was designed to incubate the fetuses and keep them safe.

What is the artificial womb technique?

Artificial womb technique / It is a technology that creates the natural conditions of a woman's uterus in plastic incubators to enable the fetus to grow until birth. Hung & Javid 2020. This alternative can be defined as providing the incubated fetus with oxygen and the necessary nutrients for growth to save thousands of children born prematurely. The artificial womb filled with fluid allows premature babies to complete their lung and other organ development in a healthy way. (Partridge et al., 2017)

artificial womb It is a virtual piece of technology made from safe, non-toxic plastic materials that can withstand pressure and temperatures. This piece enables pregnancy outside the body, or an incubator for an embryo outside the womb. This is done by

Figure (1) A picture of the initial design of the artificial uterus.

growing the embryo outside the device that is normally supposed to carry the

pregnancy. This technology is intended to provide the embryo with oxygen, nutrients,

and waste removal via an artificial womb. Romanis, 2019. Oxygen, nutrients, and waste removal. The artificial womb is one of the most prominent modern innovations that promises to radically change the way medical care is provided in the field of reproduction. Simply put, it is a device designed to simulate the biological conditions and environment provided by a natural womb for the fetus, with complete control over essential factors such as temperature, oxygen levels, humidity, and nutrients. Pioneering research aims to make this womb capable of nurturing the fetus from the early fertilization stage until it reaches a stage where the fetus can grow and develop safely and enter in good health. The device is designed with incubators that rely on a fluid that closely resembles amniotic fluid, which is the fluid that surrounds a fetus inside a natural womb. These incubators include gas exchange and temperature levels. Modern models simulate the mother's movements that the fetus normally feels, providing the sound of the heartbeat and blood flow, allowing the fetus to feel factors close to those of a real mother's womb. The device also provides oxygen to the fetus and removes carbon dioxide. This device performs the function of the lungs and blood vessels, using medically safe pumps and tubes to provide a continuous and adequate blood flow. The artificial umbilical cord helps these premature babies eliminate their waste into this second chamber, where it then passes through a fine layer of engineered enzymes that recycle this waste into useful nutrients such as glucose, amino acids, and fatty acids—similar to what happens inside our bodies when we digest food! This recycling process ensures that all the nutrients the fetus needs to grow healthy are provided within this closed system, without harming the mother's health or human health. Artificial wombs are one of the most promising and futuristic technologies in modern medicine, with the potential to save countless lives across generations.

artificial uterine lining

The artificial endometrium consists primarily of endometrial epithelial cells cultured on artificial three-dimensional support matrices (e.g., Matrigel). The support matrix enables critical processes to occur in the same three-dimensional orientation as in the uterus. Similar endometrial cultures and their responses to steroid hormones have been reported previously by several research groups (Schatz et al., 1984, 1994). The epithelial cells exhibit spontaneous orientation and can therefore be used to study maternal-fetal interactions (Figs. 1 and 2). Ectopic pregnancies (Fig. 3) also provide evidence of embryo implantation and development in unusual contexts. Goat and human placental tissue preserved in vitro (Zapol et al., 1969) has been used to study hormone metabolism (Guller et al., 1984), as a source of components for fetal life support, and to filter maternal components, including immune factors (Unno et al., 1993). The human placenta may continue to supply nutrients and remove waste products. This technology could be used for human infants to improve survival, although intensive care infants still exhibit high mortality rates compared to their full-term counterparts (Patel, 2016). In the near future, one or more in vitro utilization systems may be available to support extremely premature infants. The in vitro system provided artificial intravenous nutrition and included a pump-free oxygenation circuit connected to the fetus, providing dynamic parameters for hemodynamics, blood gases, and oxygenation. Using this platform, Artificially, eight of the 13 cases were viable for 20–28 days. The authors elegantly delineated the stages of embryonic development from early intestinal formation (day 5.5) to late intestinal formation (day 7.5) and onwards through posterior embryogenesis (day 11) (Aguilera-Castrejon et al., 2021). More recently, autologous somatic and stem cells have been used for organ and tissue proliferation, particularly in support of authentic tissue engineering, to maintain propulsive perfusion and oxygenation of the artificial lung with filtered blood (Deane et al., 2013; Alaawadhi et al., 2014; Cervelló et al., 2015). It offers an alternative to gestational surrogacy, the software and procedures involved being highly complex and laborious. Live donor surgery requires more than 10 hours and requires a high level of immunosuppressive therapy to prevent uterine rejection. Immunosuppression is associated with

significant adverse events, including renal toxicity, increased risk of serious infections, and diabetes (Knight, 2002; Kisu et al., 2013; Ejzenberg et al., 2016; Hellström et al., 2017).

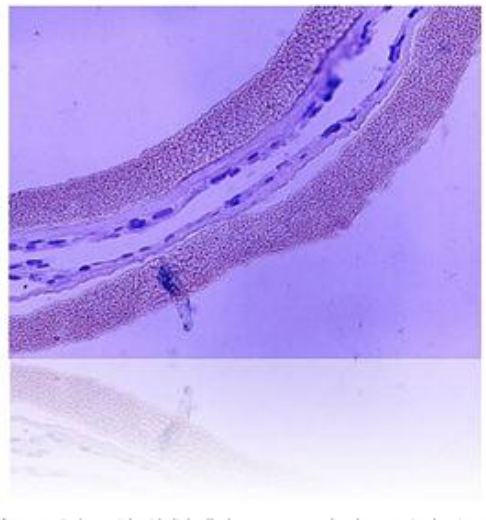


Figure 1. Attached and appropriately oriented uterine epithelial cells after incubation with a Matrigel platform. Uterine epithelial cells can be cultured on this matrix when connected to the maternal blood supply by extracorporeal perfusion.

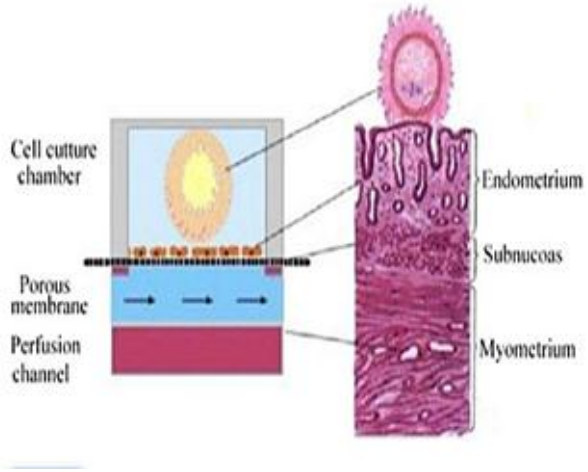


Figure 2. Embryo-maternal interaction during implantation, both in vitro and in vivo.

Figure 3. Ectopic pregnancy (tubal ectopic) at 9 weeks of development.

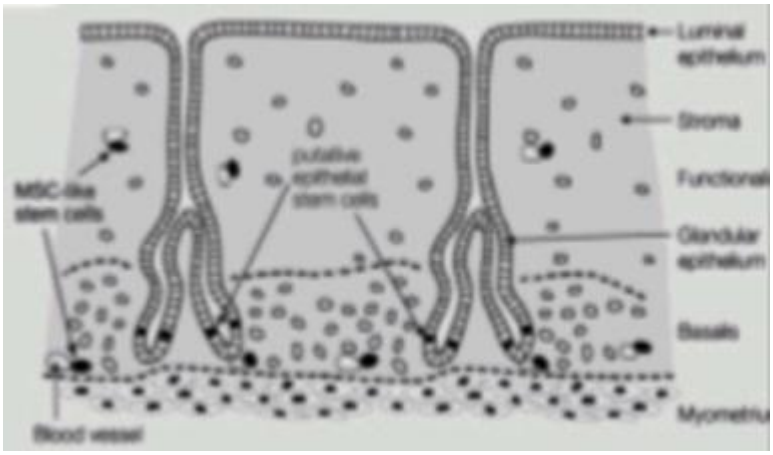


Figure (3) Location of endometrial stem cells

Components of the artificial uterus device

The artificial womb consists of several main components, which are:

*** Sterile, sealed plastic bag:** This sac represents the environment in which the fetus grows, and it contains a fluid similar to the amniotic fluid that surrounds the fetus in a normal uterus (Hung & Javid, 2020).

Job:

* Provides a sterile and protected environment for the fetus, simulating the mother's womb.

* It contains a fluid similar to amniotic fluid, which provides protection and nutrition to the fetus.

Materials:

- ✓ Made of safe and non-toxic medical plastic materials.
- ✓ Materials must be able to withstand appropriate pressure and temperature.

Artificial respirator: It provides oxygen to the fetus and removes carbon dioxide. This system performs the function of the lungs in the fetus. Partridge et al, 2017

Job:

- ✓ Provides oxygen to the fetus and removes carbon dioxide.
- ✓ Simulates the function of the lungs in a developing fetus.

Technology:

- ✓ It can use various technologies, such as oxygenated membranes, to provide efficient gas exchange.
- ✓ **Artificial circulatory system**: It pumps blood to the fetus and removes waste. This system functions as the heart and blood vessels in the developing fetus. : It provides the nutrients necessary for the fetus's growth. This system functions as the placenta in a normal uterus. Romanis, 2019

Job:

- ✓ Pumps blood to the fetus and removes waste.
- ✓ Simulates cardiovascular function in the developing fetus.

Technology:

- ✓ Uses medical-grade pumps and tubing to provide continuous and adequate blood flow.

Artificial feeding device:

Job:

- ✓ Provides nutrients necessary for fetal growth.
- ✓ Mimics the function of the placenta in a normal uterus.

Technology:

- ✓ Uses balanced nutritional solutions suitable for the fetus's needs.
- ✓ Different techniques can be used to deliver nutrients, such as intravenous tubes.

Monitoring device: This device monitors the fetus's health and development, providing information about the fetal heart rate, fetal movement, and oxygen and carbon dioxide levels. In addition to these main components, the artificial womb may contain:

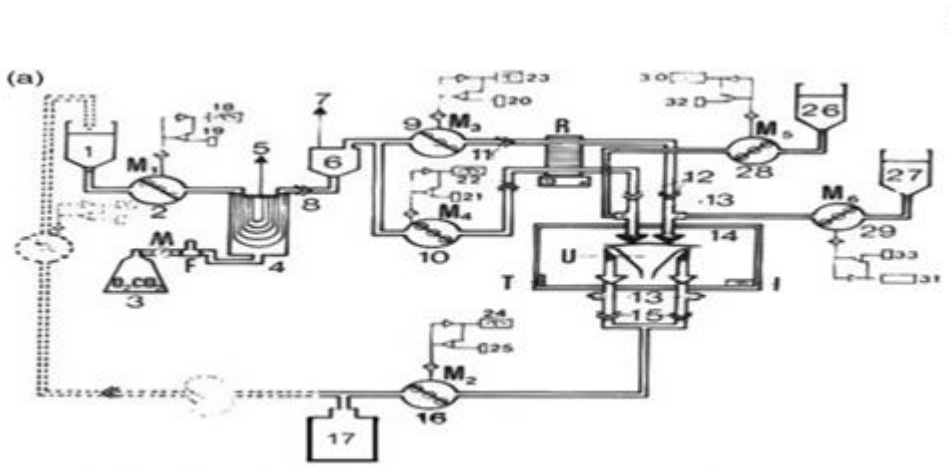
Job:

- ✓ Monitors the health and growth of the fetus.
- ✓ Provides information about heart rate, fetal movement, and oxygen and carbon dioxide levels.

Technology:

- ✓ Uses advanced sensors and imaging techniques, such as ultrasound, to monitor the fetus.
- ✓ Displays information continuously to medical staff.
- ➢ **Heating device:** Maintains a constant temperature inside the plastic bag.
- ➢ **Humidifier:** It keeps the air inside the plastic bag moist.
- ➢ **Lighting device:** Provides the light needed for fetal growth.

The components of an artificial womb vary depending on its type and purpose. For example, artificial wombs used in research may contain additional components such as imaging devices and biopsy devices.



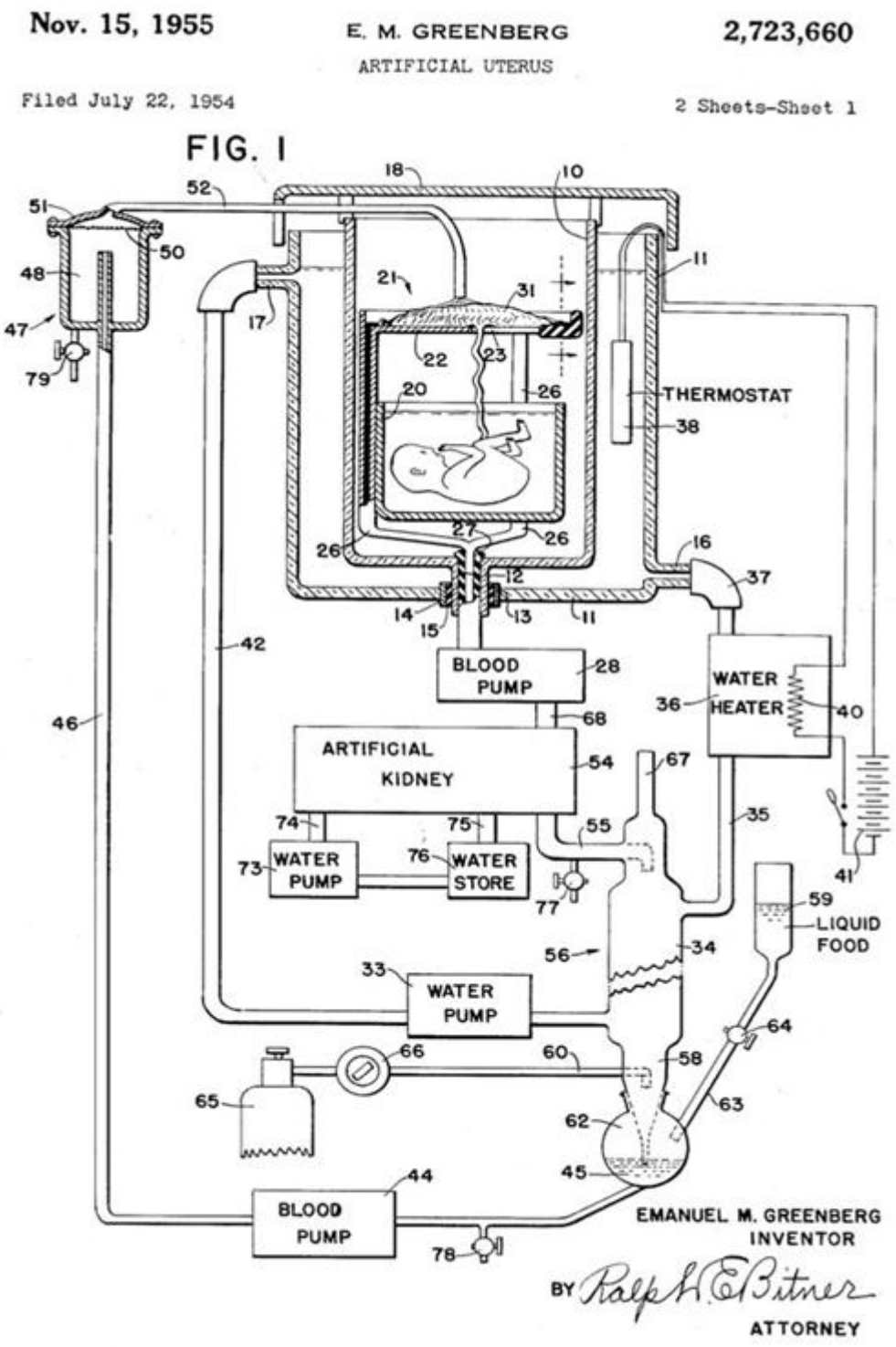


Figure (4) Illustration of an artificial uterus device as described in a US patent issued on November 15, 1955

Key figures in the diagram:

Main parts:

- ✓ 10: The top cover of the device, which is an essential part of the external structure.
- ✓ 11: Represents the wall of the device, which keeps the internal environment tightly sealed.
- ✓ 20: This is the fetal chamber, where the fetus is placed inside the device.

- ✓ 23: Refers to the fetus itself within the fetal chamber.
- ✓ 54: Represents an artificial kidney, which filters fluids inside the device.
- ✓ 59: Refers to the reservoir of nutritional fluid, which provides the necessary nourishment for the fetus.

Fluid systems:

- ✓ 13and14: They represent the inlets and outlets of fluids, where fluids are exchanged within the device.
- ✓ 28and44: Refer to the blood pumps, which keep blood flowing within the system.
- ✓ 33and73: They represent water pumps, which keep the water flowing inside the device.
- ✓ 36: Refers to the water heater, which maintains the proper water temperature.
- ✓ 75: Represents the water tank, which stores the water used in the device.

Control devices:

- ✓ 38: Refers to the thermostat, which controls the temperature inside the device.
- ✓ 66: Represents a pressure gauge, which monitors the fluid pressure inside the device.

Other parts:

- ✓ 15: Represents a valve, which controls the flow of fluids.
- ✓ 21: Refers to a fluid sprayer that distributes fluids into the fetal chamber.
- ✓ 45: Represents a vessel for collecting fluids.

Mechanism of action of the artificial uterus device

The implementation of this technique (Hung & Javid 2020) depends on placing the fertilized egg through the external insemination method in an incubator made of transparent acrylic material containing artificial amniotic fluid similar in composition to natural amniotic fluid for the fetus to grow in this incubator (Partridge et al 2017). During this, scientists provide it with a device that replaces the natural placenta and pumps oxygen into the blood to transfer oxygenated blood carrying nutrients through a tube connected to one of the arteries connected to the umbilical cord. The physical conditions of the fetus, such as temperature, are adjusted, and the fetus is monitored through the transparent wall of the incubator.

Artificial incubators, or wombs, are designed to mimic the natural biological environment surrounding a fetus in the mother's womb. They are made of materials that prevent germs from adhering to their surfaces, providing an infection-free growth environment. Each growth incubator contains sensors to monitor the baby's vital signs, such as heartbeat and body temperature, and an artificial intelligence-based system that monitors physical characteristics and sends reports regarding any fetal abnormalities that may occur in the baby.

Each set of Romanis EC incubators, 2019, is connected to two bioreactors. The first reactor contains nutrients and oxygen supplied to the baby via an artificial umbilical cord and a fluid that replaces the amniotic fluid that surrounds a fetus in its mother's womb. The fluid contains hormones, growth factors, and antibiotics. The second reactor is designed to dispose of any waste produced by the baby and contains enzymes that help convert this waste into nutrients that aid growth, ensuring a continuous supply of babies in the facility.

Parents can track their child's growth and development through a screen at the bottom of each artificial womb that displays real-time data about the child's development. This data is sent directly to the phone via an app that provides high-quality live streaming of each stage. Because children have the ability to learn language and new words while in the womb, Actolaive incubators contain built-in speakers that play a variety of different words and music. Parents can

choose their desired playlist via the phone app. The incubator also contains a 365-degree camera that enables parents to hear what the child hears and feel what they feel using virtual reality glasses. The facility also offers exclusive features, allowing parents to genetically modify the fertilized egg before implanting it in the artificial womb using a gene editing tool that includes modifications to more than 300 genes.

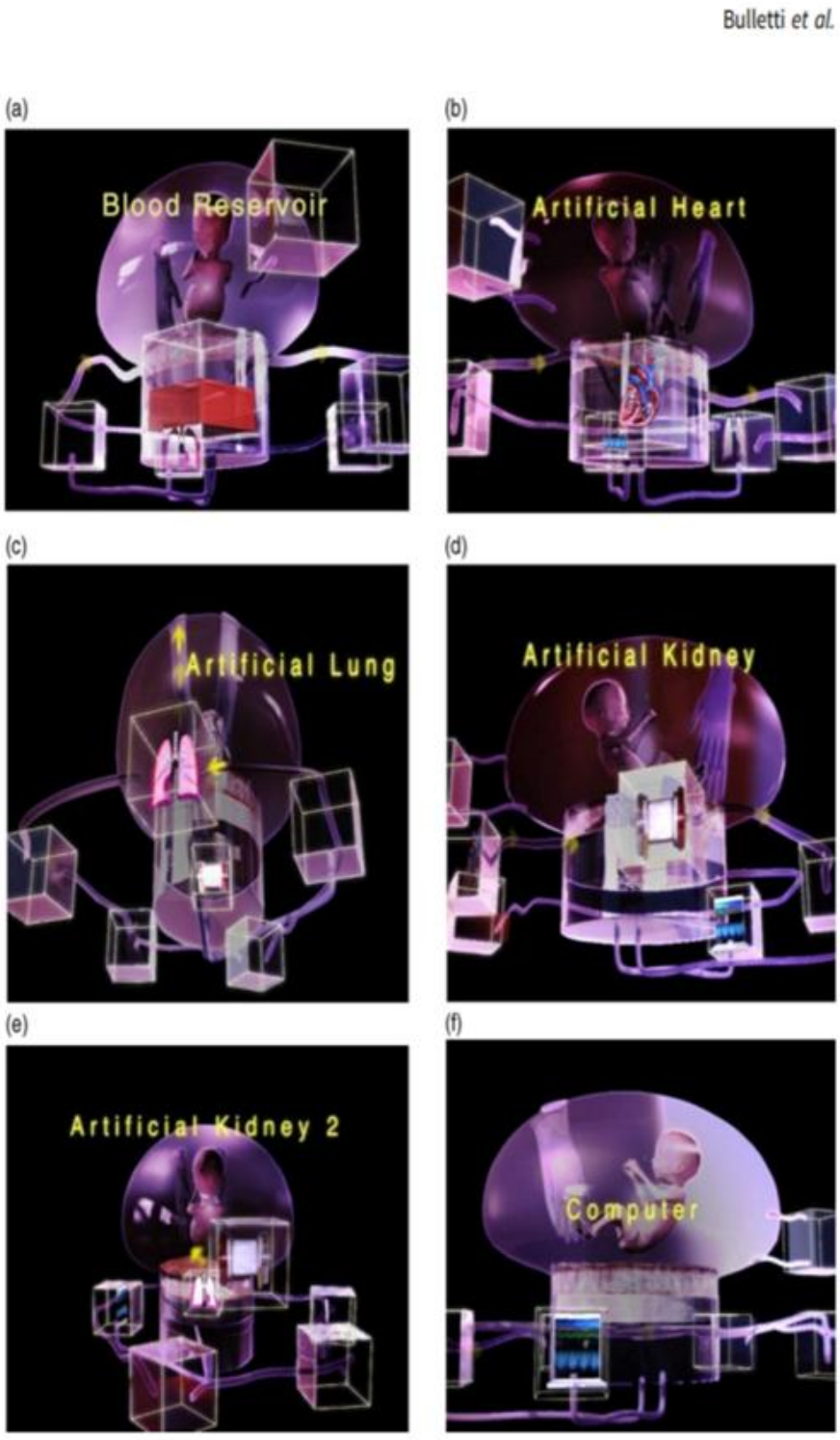


Figure (5) represents the components of the artificial uterus device
(a) Blood reservoir (b) Artificial heart (c) Artificial lung (d) Artificial kidney
(e) Artificial kidney (f) computer

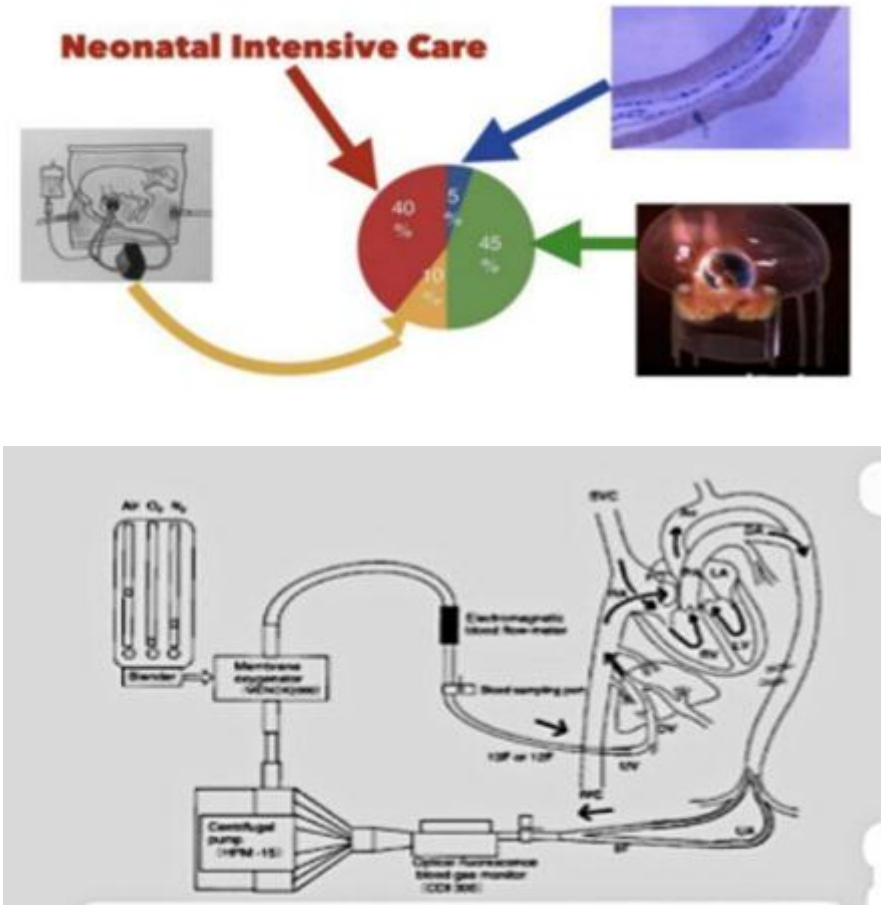


Figure (6). A schematic drawing of the venous membrane oxygenation system known as the artificial placenta, which is connected to the fetal circulation and performs the function of filtration and pumping air mechanically.

AI-powered artificial wombs for pregnant mothers.

The most significant benefit of AI-powered artificial wombs is the advanced monitoring capabilities they will offer in the future. Glasser & Shah, 2021. The system can track your baby's physical characteristics and report any potential genetic abnormalities, allowing parents to monitor their child's health even before birth. Additionally, the capsules are equipped with a monitor that displays real-time data on your baby's developmental progress, so you can stay up-to-date on all developmental milestones while they grow inside the womb. Artificial wombs powered by AI offer a range of benefits to expectant mothers seeking an alternative birth experience that gives them greater control over their health, while ensuring peace of mind regarding their fetus's prenatal health. Thanks to their ability to monitor physical characteristics, coupled with advanced genetic analysis capabilities, the potential for AI in advancing artificial womb technology is enormous. AI can be used to better understand and control complex biological processes, including creating a suitable environment for fetal development outside the woman's body. AI has been successfully used in medical applications such as drug discovery, diagnosis, and surgical planning. It is obvious that AI will be effectively applied to the development of artificial womb technology. For example, AI algorithms can analyze massive amounts of data with high speed and accuracy, making them ideal for analyzing fetal health parameters during pregnancy inside an artificial womb. Furthermore, AI-powered robots provide precise control over the device's temperature regulation, as well as the nutrient delivery systems necessary for sustaining life in this environment—all without any human intervention. Advances made possible by AI will undoubtedly greatly improve our understanding of how to create safe environments outside the mother's body, where fetuses can develop properly. Parents can now provide a unique educational experience for their unborn children. These devices feature built-in

speakers that play a variety of words and music, and even allow parents to sing directly to their unborn babies. This new technology is designed to enable babies to learn language while in the womb, as well as to learn new words by listening to various types of audio content. This innovative approach gives parents an unprecedented level of control over the type of information their child receives before birth. The technology allows parents to choose a playlist for their baby to listen to, or sing into the device themselves so it can recognize your voice before birth. These developmental devices aim to give pregnant women greater peace of mind during their pregnancies and ensure their children have intelligence similar to their parents throughout their lives. Artificial womb, technology, 2023.

How does artificial intelligence control embryos in artificial wombs?

1. Continuous monitoring and problem prediction:

- Big data analysis Artificial intelligence can analyze massive amounts of data. collected about fetuses, such as photos, videos, and vital signs. This helps In identifying patterns that may indicate developmental problems, such as deformities or developmental delays.
- Predicting problems Using machine learning techniques, artificial intelligence can build models Predictive testing is able to identify embryos most at risk for future health problems. Allows for early intervention and action to improve survival chances.

2. Improve the growth process:

- Controlling environmental factors Artificial intelligence can control environmental factors. Artificial intelligence can operate more precisely inside the womb than humans. For example, it can continuously adjust temperature, humidity, and the flow of nutrients and oxygen based on the fetus's condition and changing needs. * Developing growth protocols: Artificial intelligence can analyze data from many new, more effective growth protocols. Embryos can be identified to determine the best conditions for healthy growth. This could lead to the development of new growth protocols.

3. Reducing human intervention: * Automation Artificial intelligence can automate many tasks performed by humans.

Typically, procedures such as changing amniotic fluid and monitoring vital signs are performed. This reduces the risk of human error and allows workers to focus on more complex tasks.* Decision making Artificial intelligence can help doctors make better decisions about embryo care. For example, it can provide recommendations on the best time to implant an embryo or intervene to treat a health condition.

4. Research and Development:

- Accelerating Discoveries: AI can analyze data more quickly than humans, helping accelerate discoveries in embryo development. For example, it can be used to identify genes that play a role in healthy development. * Developing new treatments Artificial intelligence can help develop treatments.

Ethical considerations:

- Transparency and accountability It is important to have transparency about how AI works in case any errors occur in the artificial womb embryos. There must also be accountability mechanisms in place.
- Bias and discrimination It must be ensured that the AI is not biased against any group of embryos, for example, because of gender or race.
- Future of Reproduction: We must be aware of the potential impact of this technology on the future of reproduction and society. Overall, artificial intelligence holds great promise for

improving the outcomes of artificial womb embryos. However, it is important to develop this technology in a responsible and ethical manner.

Identifying genetic problemsArtificial intelligence can analyze the DNA of embryos to determine whether the fetus continues to develop. This helps in making decisions about whether to continue the process.

Figure (7) shows the role of robots in controlling the embryos of the artificial womb.

Uses of genetic engineering in artificial wombs

1. Preventing single-gene genetic diseases:

- Technologies such as 9Cas-CRISPR can be used to correct genetic mutations that cause For single-gene genetic diseases, such as cystic fibrosis, Huntington's disease, and sickle cell anemia. * This is done by precisely targeting and repairing the defective gene, preventing the disease from being passed on to the fetus.
- It can significantly reduce the suffering of individuals and families suffering from these genetic diseases.

2. Improving tissue compatibility of transplanted organs:

- Genes in embryos can be modified to produce organs that are tissue-compatible with a specific recipient.

Which reduces the risk of rejection of transplanted organs.

- This technology could be used to produce customized organs for individuals who need them.

Organ transplantation. * It can solve the problem of the shortage of organs available for transplantation, and save the lives of many.

Patients.

3. Strengthening the immune system to resist diseases:

- Genes responsible for immune system function can be modified to enhance the fetus's ability.

To resist infectious diseases and cancers.

- This could include introducing new genes that boost the production of antibodies or cells. Immunity.
- It can reduce the risk of serious infectious diseases and improve survival chances.

Modifying genes associated with intelligence and cognitive abilities:

- Although it raises significant ethical controversy, in theory, it could be

Editing genes associated with intelligence and cognitive abilities to improve the intellectual performance of embryos.* This requires a thorough understanding of the complex genetics that contribute to intelligence, a field still under investigation.* It could raise profound ethical questions about equality and justice, and require broad discussions about the limits of gene editing.

5 applications in space exploration:* Genes could be modified to produce embryos that can withstand the harsh conditions of space, such as radiation and zero gravity.* This could include introducing genes that enhance radiation resistance, or modifying genes responsible for regulating bone density.* It could open the door to space colonization, allowing humans to adapt to new environments.* Genetic engineering in artificial wombs must be used with extreme caution, considering potential risks and long-term effects.* Transparency and accountability must be fundamental to all aspects of research and development

Figure (8) shows the process of cutting the gene causing the mutation (gene modification).

"The process of childbirth" in the context of the artificial womb:

Preparing for childbirth:

- **Close monitoring**: Before birth, the fetus will be closely monitored to ensure it is ready to emerge from the artificial womb. Focus will be placed on indicators such as lung growth, neurological development, and the fetus's ability to regulate body temperature. Jensen, 2018
- **Unit preparation:** Aspecial unit will be equipped to receive the newborn, providing a warm and sterile environment, respiratory support devices, and vital monitoring devices (Artificial womb technology, 2023).
- **Specialized team:** Aspecialized medical team will be present, including pediatricians, nurses, and neonatal intensive care experts.

Excretion process:

- **Drain the fluid:** The procedure will begin by gradually draining the amniotic fluid from the uterus artificially. This may be done using a pump or a suction device.
- **Placental abruption:** The artificial placenta will be carefully separated from the fetus. This may require the use of delicate surgical instruments or other specially designed techniques.
- **Removal of the fetus:** The fetus will be gently removed from the artificial womb. Robotic arms or other instruments may be used to assist this process.

- **Careful handling:** The fetus will be handled with extreme caution, given its extreme sensitivity. All necessary precautions will be taken to avoid any injury or complications (Glasser & Shah, 2021).

After output:

- **Instant evaluation:** An immediate assessment of the newborn's health will be performed, including checking vital signs, assessing breathing, and checking reflexes.
- **Respiratory support:** The newborn may require respiratory support, especially if born prematurely. Oxygen will be provided or a ventilator will be used as needed.
- **Intensive care:** The newborn will be transferred to the neonatal intensive care unit, where he will be closely monitored and provided with the necessary care.
- **Heating:** The baby's body temperature will be maintained constant, using incubators
- **Nutrition:** The newborn will be provided with appropriate nutrition, either through breastfeeding, formula, or intravenously if necessary.
- Microscopic surgery may be needed to remove the fetus if there are adhesions.
- Maintain complete sterility of the procedure to prevent any infection.
- Very sophisticated respiratory support equipment may be needed.

I hope this detailed explanation has given you a clear insight into this aspect of giving birth in an artificial womb.

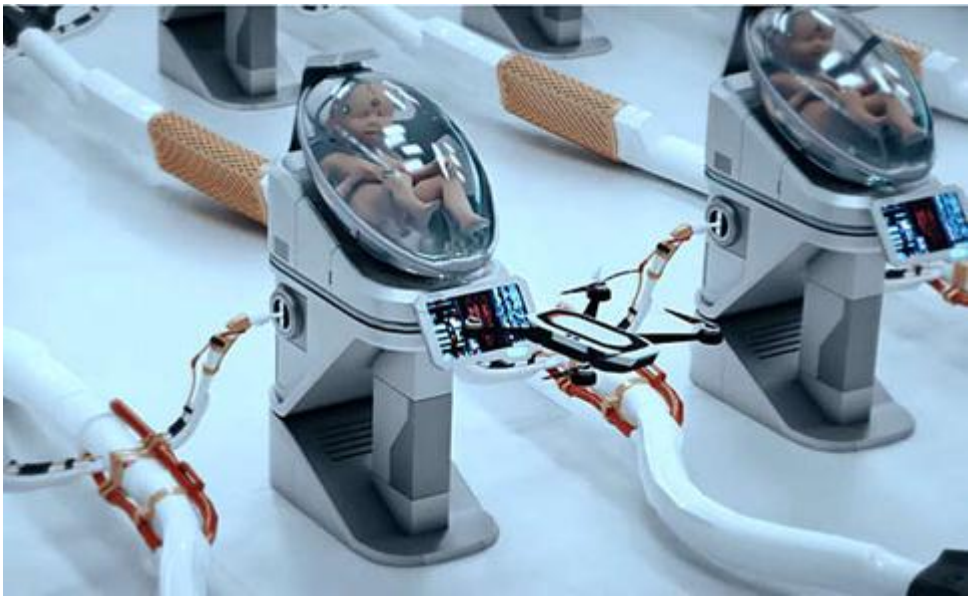


Figure (9) shows the presence of the fetus inside the uterus.artificial

Advantages of artificial womb technology:

The artificial womb has many advantages that make the idea acceptable and palatable to the human mind without going into the details of this idea. These advantages include the following:

Firstly: Saving and Preserving the Human Soul from Perdition Sparo, R, 2018

secondly: Increasing the survival rate of premature babies born in the fifth month of pregnancy

Third: Helping women who cannot get pregnant due to infertility or hysterectomy for any reason.

Fourth: Artificial womb technology may facilitate surgery on fetuses before birth, if necessary, without endangering the mother's life. Savulescu, 2019

Fifth: Monitoring the stages of embryonic development moment by moment helps us understand the origin of life and human embryonic development and provides a basis for solving birth defects and other major reproductive health problems.

Sixth: It ensures that the human fetus develops away from any external risks that it may be exposed to as a result of the mother being in an unsuitable environment.

Seventh: Avoiding the problems of traditional pregnancy for women who suffer from a terminal illness that may pose a threat to their lives

Eighth: Helping women with uterine problems: An artificial uterus can be a solution for women who have lost their uterus due to cancer or other medical conditions, or who have congenital uterine abnormalities that prevent them from becoming pregnant.

Ninth: Protecting fetuses from diseases, medications, and drugs that may be present in the mother's body.

Tenth: Reducing risks associated with pregnancy

Disadvantages of artificial womb technology:

Despite the promising potential of the artificial uterus, it has several drawbacks and challenges, which can be summarized as follows:

1. Technical and medical challenges:

- ✓ Difficulty in fully simulating the uterine environment: The natural uterus is a very complex environment, and it is difficult to accurately mimic all of its functions.
- ✓ Developing biocompatible materials: The device requires special materials that do not interact with fetal tissue or cause any harm.
- ✓ The need for accurate and continuous monitoring systems: The device requires advanced monitoring systems to continuously track the health of the fetus.

2. Ethical and legal challenges:

- ✓ Impact on the relationship between mother and child: The use of an artificial womb may affect the natural relationship between mother and child.
- ✓ Potential for unethical use: There are concerns that this technology could be used for unethical purposes, such as producing genetically modified babies.
- ✓ Complex legal issues: The use of an artificial womb requires new laws to regulate its use and define responsibilities.

3. Social challenges:

- ✓ High cost: The cost of this technology is expected to be high, which may make it unavailable to everyone.
- ✓ Impact on women's reproductive role: The use of an artificial uterus may lead to radical changes in women's reproductive role.

4. Potential risks to the fetus:

- ✓ Unknown effects on neurodevelopment: Growing the fetus in an artificial environment may affect its neurodevelopment.
- ✓ Difficulty simulating hormonal interactions: It is difficult to mimic the complex hormonal interactions that occur in a normal uterus.

Comparison between the natural uterus and the artificial uterus

Side	Natural Uterus	Artificial Uterus
Primary Function	Natural Incubator for Fetal Growth and Development	A technological device that simulates the natural uterine environment for fetal development outside of it
Environment	A complex and constantly changing biological environment that depends on the mother's condition	An artificial environment that can be precisely controlled with the possibility of modifying conditions
Components	Vital natural internal organs, namely the uterus, placenta, and amniotic fluid	A technological device consisting of tubes, sensors, control systems, and nutritional solutions
Nutrition	Via the placenta from the mother's blood and depends on the mother's condition	Via specially designed nutritional solutions whose composition is precisely controlled
Respiration	Mother and fetus via the placenta from the mother's blood and gas exchange between	Via devices that provide oxygen and remove carbon dioxide
Protection	Natural amniotic fluid, the uterine wall, and the mother's immune system	Technology: Sensors, control systems, and sterile solutions
Risks	Pregnancy complications and genetic diseases	Technical risks and ethical risks
Control	Limited: Depends on the mother's health and lifestyle	High: Ability to precisely control temperature, humidity, and nutrition
Development	A system developed over millions of years, integrated and balanced	In the early stages of development
Cost	Low, depends on healthcare costs	Very high, advanced technology and complex devices
Relationship with Lam	A deep biological and psychological relationship, a close bond between the mother and the fetus	May significantly affect the relationship between the mother and the fetus

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