SCIENTIFIC TECHNOLOGY IN ARTIFICIAL WOMB

Abstract

Pregnancy occurs when a sperm fertilizes an egg released from the ovary during ovulation. The fertilized egg then implants in the uterus. Pregnancy can be affected by various factors, including pathologies such as abnormal vaginal discharge, congenital deformities of the uterus and vagina, vaginal agenesis, and carcinoma cervix during pregnancy. As the lungs of a fetus are still in the process of formation, artificial womb technology imitates the natural conditions of a human womb. This reduces the need for the developing child to breathe. This technology also provides health benefits to pregnant women by offering a safe alternative to high-risk pregnancies and reducing the chances of premature birth. The term for gestation that occurs outside the body is ectogestation. An artificial uterus, often referred to as an "exo-womb," would need to remove waste and provide a growing fetus with nutrition and oxygen. In addition to this, an artificial uterus system could include an interface that takes over the functions of the placenta, an amniotic tank that acts as the amniotic sac, and an umbilical cord. EctoLife has opened the world's first artificial womb facility, where customers can choose from a range of baby features. Transparent "growth pods" in the lab allow EctoLife to produce up to 30,000 offspring every year. The concept behind EctoLife is to offer parents the ability to create customized children using artificial wombs.

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When a sperm nurtures an eggs that has been released from the ovary during ovulation, pregnancy results, the fertilized egg then enters the uterus and is implanted thereafter. Pregnancy results from a successful implantation. Prenatal care and an early pregnancy diagnosis increase a woman's chances of becoming pregnant healthily and having a healthy baby. Many factors can affect pregnancy**;** the cervix serves as a physical barrier to keep out external microorganism and other objects that may enter through the vaginal opening throughout pregnancy. Pathologies that damages any of these organs or system might impair fertility, hence it is crucial for applied and translational research to be able to precisely stimulate them or restore their functionally [**1].**

I. GYNECOLOGICAL DISORDERS IN PREGNANCY

1. **Abnormal Vaginal Discharge:** About 75% of women experience vaginal discharge due to vulvovaginal candidiasis at some point in their reproductive lives, with 40–50% experiencing two or more episodes. New sexual partners and frequent relationship changes have been linked to bacterial vaginosis. Although it can develop in vaginal women, bacterial vaginosis is less common in women in monogamous sexual relationships.Sign and symptoms of Bacterial Vaginosis candidiasis Trichomoniasis are , A thin, thick, white, too abundant, odorless, fishy itch. [**2**].

Types of Vaginal Discharge

Type of vaginal discharge	**symptoms**	**signs**	**Risk factors**
Bacterial vaginosis	uniform discharge that could get worse after having sex, fishy odor,	Inflammation absent	A poor socioeconomic status. smoking, having multiple or new partners for sex, having unprotected encounters, and having sex with other women in the vaginal area
Vulvovaginal candidiasis	discharge that is white, thick, cheesy, or clumped, odor absent, itching and burning sensation in vulvar is present	Pain during sexual intercourse, edema	AIDS, corticosteroid use, pregnancy, uncontrolled diabetes, and other immunosuppressive.
Trichomoniasis	Vaginal pain or soreness is present, yellow and green discharge, filthy	Fishy odor, inflammation	poor socioeconomic class, having several partners, having other STDs,

	odor		unprotected sex, using drugs, and smoking
Irritant, allergic vaginitis	Burning sensation and soreness	Vulvar erythemia	Soaps, tampons, sex toys, pessaries, topical creams, douching, pharmaceuticals, contraceptive methods such condoms or diaphragms.
Allergic vaginitis	Vaginal discharge is purulent and burning	Inflammation and vaginal atrophy	tampons, latex condoms or diaphragms, sperm, douching, topical products, drugs, and garments

2. **Congenital malformation of the uterus and Vagina:** Abnormalities of the uterus include congenital deformity. It consists of the uterus didelphys (double uterus), the unicornuate (one-sided uterus), the biocashuate (heart-shaped uterus), the septate (uterus with a partition in the centre) **[3]**, and the absence of a uterus.

Additionally, the fallopian tube, cervix, and repper vagina may be affected by these malformations. It might lead to infertility and pregnancy issues. Minor degrees of congenital deformity have little impact on obstetric performance and typically go undetected. Severe degrees usually result in infertility. The vaginal typically develops as two tubes that meet in the center and fuse to produce a mono vagina. These are occasionally fusion problems that lead to a fully developed vaginal septum, the wall of which that runs up the vagina vertically and effectively divides it into two. A full vaginal rupture can be treated surgically. The whole fibrous layer and septal wall are removed during an entire vaginal septum resection. The upper reproductive tract is duplicated in women with a full vaginal septum, resulting in the presence of two uteri and two cervices.

Vaginal Agenesis: An inborn condition in the female reproductive tract, agenesis of the vagina, or the lack of a vagina. The causes are unknown

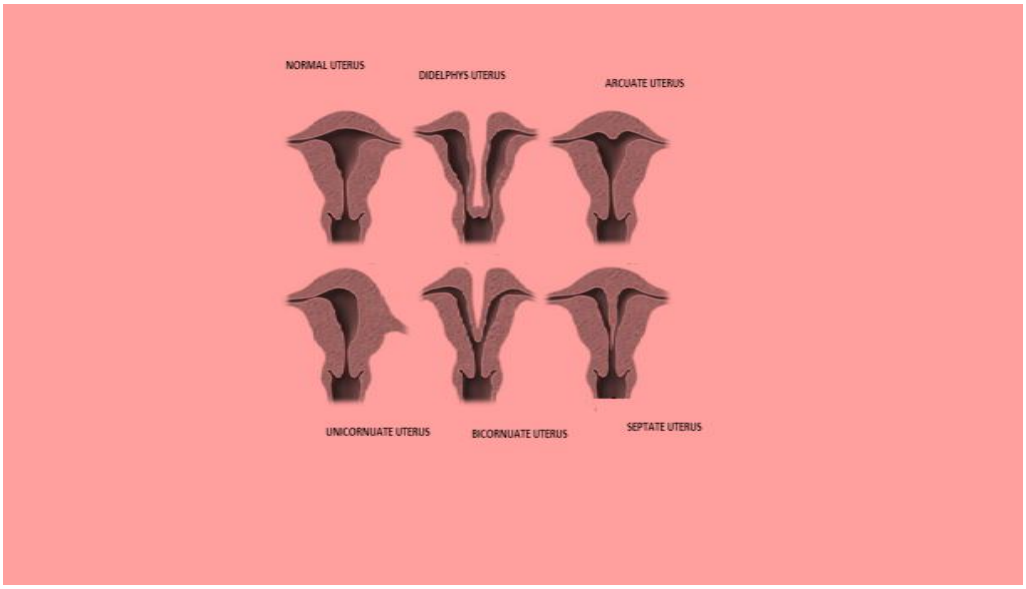

Figure: Congenital malformation of the Vagina

It can occur in women who experience complete vaginal agenesis to develop a condition known as Mayer-Von Rokitansky-Kuster-Hauser's syndrome that is defined by the vagina not growing throughout embryologic development.

3. **Carcinoma cervix with pregnancy:** Older women getting pregnant at a higher rate is more likely to develop malignant tumors. Cervical malignancies and ovarian malignant tumors are the two most prevalent malignant tumors during pregnancy. The symptoms are easily confused with other diseases in pregnancy. Cervical cancer that had been identified during the current pregnancy was discovered 6–12 months later. One of the most prevalent malignancies in pregnancy, cervical cancer is identified in around half of cases during the pregnancy and the other half within a year following birth. During pregnancy, lymphatic circulation and blood flow in reproductive organs strengthens immunity, which diminishes in the early stages of cervical dilation after delivery and contributes to another factor that "accelerates tumor metastasis." therefore speeding cervical cancer development. Few symptomatic patients mostly display stench-filled vaginal discharge, purulent bloody discharges, and regular vaginal hemorrhage.

4. **Leiomyomas with pregnancy:** The majority of patients with uterine fibroids do not experience any difficulties during pregnancy related to the fibroid. Leiomyomas (uterine fibroids) start in smooth muscle tumors of the uterus. The most frequent issue is pain, and patients with many fibroids may be at slightly higher obstetrical issues like early pregnancy loss and preterm labor are possible, fetal malpresentation, and placental abruption.

5. **Ovarian Tumor in pregnancy:** During examination, frequently find adrenal masses. Accidentally found, with most of them being found in the first trimester. The majority of these adrenal masses is asymptomatic and spontaneously regresses, with about 3-6% of them being malignant and typically being found at an early stage.

More than 50% of malignant tumors exhibit symptoms such as pain, hemorrhage, dystocia, and ovarian rupture.

As it occurs in roughly 0.51 to 1.1 of all pregnancies, cancer is a reasonably common prenatal finding. Compared to young adults, who have a 10-year Survival rate of up to 85%, ovarian cancer is frequently associated with a poor prognosis with a 35% 10-year Survival rate.

6. **Retroverted Gravid uterus:** The significance of a retroverted uterus—a uterus that curves backward at the cervix rather than forward—is a contributing factor to infertility and abortion. Although this belief is generally supported by the findings of a small number of cases, it is no longer believed to be linked to a higher rate of abortion. Signs are One can feel the enlarged bladder vaginally. The cervix is elevated and pointed high anteriorly. Douglas pouch mushy mass is thought to be the uterus's body.

   Symptoms are urinary symptoms include frequency, difficulty, and acute urine retention as a result of the urethra's elongation and compression. Abortion, pelvic organ pressure, and bladder distension are a few causes of pain.

7. **Genital prolapsed in pregnancy:** The uterus (womb), which resembles an upside-down pear and is housed inside the pelvis, is a component of the female reproductive system. A muscle hammock between the coccyx and the pubic bone or the pelvic bone supports the uterus, bladder, and colon. These muscles are known as the pelvic floor, or the levatorani muscle. The uterus and pelvic organ were also held in place by ligament and connective tissue. If the muscular or connective tissues have been compromised or damaged. It is possible for the uterus to enter the vagina. It is referred to as prolapsed. The descent of at least one of the uterus (cervix), the anterior vaginal wall, or the apex of the vagina (vaginal vault or cuff scar following hysterectomy) are all example of pelvic organ prolapsed. Common factors that contribute to uterine prolapsed include vaginal childbirth, obesity, hard coughing while using the restroom, and hormonal changes following menopause that can harm the pelvic organ support structure. Symptoms include increased vaginal discharge and bleeding after vaginal childbirth. Difficulty with sexual intercourse, Urinary leakage, Bladder infections **[4]**

II. IN VITRO FERTILIZATION

In vitro fertilization is referred to as IVF. When using IVF, sperm and eggs are fertilized by a combination of medicines and surgical techniques, and the fertilized egg is then assisted in implanting in the uterus. Since the first test baby was born more than 25 years ago, in vitro fertilization (IVF) Science has advanced significantly **[5].**

IVF is a length process that takes months to finish despite the fact that it sometimes works on the first try, many people need more than one round of IVF to get pregnant.

IVF procedure the initial phase in IVF involves using fertility medications for several months of fertility medicine use are required during the first stage of IVF in order to encourage the development of several mature eggs that are prepared for fertilization. The process of inducing ovulation is known as that to monitor your hormone level and egg production; you may have routine ultrasound or blood test.

To help you feel more at ease and comfortable throughout the procedure, you will be given medication. Using an ultrasound to see inside your body, the doctor inserts a tiny, hollow tube into your ovary and the follicles that holds your eggs. The suction tool attached to the needle carefully removes the eggs from each follicle.

Insemination is the process of fusing sperm from a partner or donor with eggs in a lab. While the eggs and sperms are kept together in a specialized container, fertilization occurs. to encourage conception, sperm with decreased motility or sperm that swims less well might be injected directly into the eggs. People who work in laboratory keep an eye on how the cell in fertilized eggs divides to produce embryos.

Three to five days following the retrieval of the eggs, one or more embryos are implanted in the uterus (this is known as embryos transfer). A little tube that the doctor inserts directly through your cervix carries the embryo into your uterus.

If one of the embryos fuses with the uterine lining, a pregnancy results., Get ready to rest so you can remember to do so in the days after the embryo transfer. Patient can continue their routine activities to the next days. Female may also take progesterone in the forms of pills or a daily injection for the 8-10 weeks after the embryo transfer.

III. ARTIFICIAL WOMB

The artificial womb also referred to as artificial amnion and placenta technology which were created in response to the need to lower infant's mortality and offer an environment for the ectogestation of the fetus. **[6]** .Ectogestation is the term for gestation that occurs outside of the body **[7].**Artificial womb technology recreates the natural environment of the human womb, decreasing the need for the developing fetus to breathe because of its immature lungs. Because this technology provides a safe alternative to high-risk pregnancies and lowers the chance of bringing a pregnancy to term, pregnant women can also profit from its health benefits. Pregnancy- related disorders include anemia, hypertension, mental health conditions, and viral infections are regularly experienced by women. Some of them might be fatal for both. The mother and the child, but AWT (artificial womb technology) could stop them **[8].**

Ectogenesis literally means development outside, that is , outside of the body, as suggested by the root of the terms ecto(outside) genesis(development)[**9].**

During gestation, the womb is built to stimulate all required physiological mechanism. Extracorporeal membrane oxygenation is used to carry out gaseous exchange. The use of a pump less arteriosclerosis circuit that only uses blood from the developing fetus heart in combination with a low resistance oxygenator and dialysis to carry out waste disposal, the bio bag is made of polyethylene film, they offer fluid and space volume efficiency, size adjustability, and sterility. It can be modified to resemble the uterus size and form more closely, replacing the natural womb**[10].**globally, 15 million premature children, or those born at <37 weeks of gestation (GA), are born each year; 0.4% of these are extremely premature infants (EPI).The results of preterm infants may be improved by the AW system, according to various studies**[11].**The success of experimental models has improved recently, though, in order technological improvement and a focus on imitating utero-placental physiology, which has brought the field closer to clinical translation**[12**].By

developing a fetus outside of an organism that usually takes it to terms, an artificial womb or artificial uterus would enable extracorporeal pregnancy.

Numerous artificial uterus could be advantageous for replacement organs. It could be used by male and female partners to promote pregnancy growth. By converting from a natural uterus to an artificial uterus, the fetal viability barriers could be reached far earlier in the pregnancy process. In this sense, it can be compared to an extremely versatile neonatal incubator. Additionally, it could be used to initiate fetal development. Additionally, an artificial uterus could enable fetal surgery treatments to be performed earlier rather than waiting until the term of pregnancy. The device aims to facilitate human development after being prematurely delivered from a pregnant person's uterus **[13].**

An artificial uterus, sometimes known as an "exo-womb," would need to give a fetus with nourishment and oxygen while also getting rid of waste. The interface that performs the function that would otherwise be performed by the placenta, an amniotic tank that serves as the amniotic sac, as well as an umbilical cord, may also be included in the scope of an artificial uterus (or "artificial uterus system" to underline a broader scope).

Uterine wall in a healthy uterus, the endometrium aids in the formation of the placenta while the myometrium of the uterine wall serves as the mechanism for fetus expulsion at the conclusion of pregnancy. Equivalent components may be found in an artificial uterus. Methods to directly connect an artificial placenta and other "inner" components to an external circulation have been considered.

Interface (artificial placenta) when extracorporeal membrane oxygenation (ECMO) is used, one or more semi-permeable membranes can be used as the sole contact between the provider and the embryo or fetus.

Human endometrial cells may also be used to create a placenta. Endometrial cells from a human donor have been effectively generated in tissue samples. Human embryos were subsequently put into the tissue after it had been designed to take on the structure of a natural uterus. The lining of the artificial uterus was properly inserted with the embryos, and they began to develop. However, in order to adhere to the regulatory restrictions on in vitro fertilization (IVF), the tests were stopped after six days. The transport of nutrients via an artificial uterus in which a human placenta has been transplanted is still a problem that needs to be resolved.

Amniotic tank (artificial amniotic sac) an amniotic tank's primary purpose would be to replace the amniotic sac's role in protecting the embryo or fetus physically while providing the best possible range of motion. Additionally, it must to be able to sustain an ideal temperature. Amniotic fluid can be replaced with lactated Ringer's solution.

Umbilical cord the natural umbilical cord could theoretically be used in the event that the fetus was prematurely removed from the mother's uterus. It would be kept open by medical means such as, bypass surgery, anti-coagulation, or physiological occlusion inhibition.

The first artificial womb facility in the world, ectolife, was introduced on December 9, 2022, by a filmmaker and science communicator headquartered in Berlin, Germany **[14].**

EctoLife has introduced the world’s first centre for artificial womb, allowing consumers to choose from a menu of infant traits. In translucent "growth pods" in a lab, EctoLife will be able to have 30,000 children every year. With the use of artificial wombs, EctoLife is a concept that allows parents to 'create' personalized children. People may customize their baby's intellectual level, height, hair, eye color, physical prowess, and even skin tone with an "Elite Package." Each of the 75 labs in the complex, which would run on renewable energy, would have up to 400 growth pods or artificial wombs. These pods were created to resemble the condition found in the mother’s womb. Each development pod is equipped with sensors that can keep an eye on your baby's vital indicators, such as heartbeat, temperature, blood pressure, breathing rate, and oxygen saturation.

Two central bioreactors are connected to these pods. A synthetic umbilical cord is used to deliver nutrition and oxygen to your baby from the first bioreactor. A liquid solution that simulates the amniotic fluid that surrounds infants in the mother's uterus is also present in this bioreactor. The second bioreactor is made to get rid of any waste that babies make. The waste product is subsequently transformed once more into a consistent and long-lasting supply of fresh nutrients using enzymes. In vitro fertilization is utilized to make and choose the most viable and genetically superior embryo before inserting your baby's fertilized embryo inside the development pod, providing your child the best chance to develop without encountering any biological obstacles. Furthermore, the Elite Package from EctoLife gives you the option to genetically modify the embryo before inserting it into the artificial womb. Through a variety of over 300 genes, the CRISPR-Cas 9 gene editing technique enables you to modify any trait of your baby, including eye color, hair color, skin tone, physical strength, height, and degree of intelligence.

According to Metro, a screen on the pods that displays real-time data allows parents to keep an eye on their child's progress. This data can be tracked via a mobile application as well. The infant may be evacuated from the pod with the "push of a button" during delivery, and the artificial intelligence-based device "also monitors the physical features of the baby and reports any potential genetic abnormalities."

The distribution process is easy and convenient, requiring only the click of a button. After the artificial womb releases the amniotic fluid, release you can easily take your infant from the growing pod.

EctoLife uses clean, sustainable energy sources like solar and wind, according to its developer, so you don't have to be concerned about power outages or your carbon footprint.

The safe, painless option offered by ectolife helps reduce the stress of childbirth. The delivery process is straight forward and practical, requiring simply the push of a button. After emptying the amniotic fluid from the artificial womb, you can easily remove your infant from the growing pods. .

IV. PODS

The pods are made to keep germs from adhering to their surfaces, giving the infant a healthy environment to grow in. A single facility may host up to 30,000 lab-growing kids annually, and each lab can house up to 400 growth pods. Special sensors in the pods keep an

eye on signals like heartbeat, blood pressure, breathing rate, and oxygen saturation. (Hashem Al- Ghaili's 2022)

V. ADVANTAGE OF ARTIFICIAL WOMB

1. Providing the fetus with the ideal environment for growth, including the proper ratio of nutrients and hormones.
2. refraining from subjecting the developing fetus to external dangers like infectious illnesses.
3. Making it simpler to operate on the fetus if necessary
4. Letting a fetus grow outside of its mother's body without any risks or issues related to pregnancy or childbirth.
5. Creating a more controlled environment devoid of toxins that may later lead to birth abnormalities or other health problems.

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