In vitro fertilization \(IVF\): how it works and stages of a cycle

What IVF is and why it is used

IVF stands for in vitro fertilization, meaning fertilization occurs outside the body, in a laboratory environment. Eggs are retrieved from the ovaries and combined with sperm to create embryos. One embryo, or sometimes more depending on medical guidance and regulations, is then transferred into the uterus with the aim of implantation and pregnancy.

IVF may be used when eggs and sperm are unlikely to meet effectively inside the body, such as when fallopian tubes are blocked or absent. It can also be part of care for severe male-factor infertility, reduced ovarian reserve, endometriosis, recurrent unsuccessful fertility treatment, unexplained infertility, use of donor gametes, fertility preservation before medical treatment, or preimplantation genetic testing in selected situations.

It is helpful to think of IVF not as a single procedure, but as a coordinated cycle of clinical visits, medications, ultrasound monitoring, blood tests, a minor surgical egg retrieval, laboratory work, and embryo transfer. Many clinics also offer counselling or psychological support, which can be valuable because uncertainty is a major part of fertility treatment.

Before the cycle: evaluation and treatment planning

Before starting IVF, clinics usually assess both reproductive partners when applicable. Evaluation may include ovarian reserve testing, pelvic ultrasound, infectious disease screening, uterine cavity assessment, semen analysis, medication review, and discussion of medical conditions that could affect pregnancy or anesthesia. The team may also review prior pregnancies, menstrual history, previous fertility treatments, surgeries, and genetic or family history.

Ovarian reserve tests, such as anti-Mˆ…llerian hormone levels and antral follicle count, do not predict pregnancy with certainty, but they help estimate how the ovaries might respond to stimulation. Semen analysis guides whether standard insemination in the lab or ICSI may be more appropriate. If the uterine cavity has not been evaluated recently, a sonohysterogram, hysteroscopy, or similar test may be recommended to look for fibroids, polyps, adhesions, or congenital differences that could affect implantation.

The planning visit is also when patients often discuss embryo transfer strategy, including whether to aim for a fresh transfer or freeze embryos for transfer later. Some cycles are designed as "freeze-all" cycles, especially if hormone levels are high, the risk of ovarian hyperstimulation is increased, genetic testing is planned, or the uterine lining is not optimally timed for transfer.

Stage 1: ovarian stimulation and monitoring

In a typical menstrual cycle, one follicle usually becomes dominant and releases one mature egg. IVF stimulation aims to recruit multiple follicles so that several eggs may be collected in one cycle. This is usually done with injectable gonadotropins, which contain follicle-stimulating hormone and sometimes luteinizing hormone activity. Other medications are used to prevent premature ovulation before retrieval.

Monitoring is central to this stage. Patients usually have repeated transvaginal ultrasounds to measure follicle growth and blood tests to assess hormone levels, especially estradiol. Medication doses may be adjusted based on response. This period commonly lasts around 8 to 14 days, although timing

varies.

When follicles appear sufficiently developed, a "trigger" injection is given to complete egg maturation. The trigger may contain human chorionic gonadotropin, a GnRH agonist, or a combination, depending on the protocol and risk profile. Egg retrieval is usually scheduled approximately 34 to 36 hours after the trigger, before ovulation would be expected to occur naturally.

Stage 2: egg retrieval

Egg retrieval, also called oocyte retrieval or egg collection, is usually performed under sedation or anesthesia. Using ultrasound guidance, a clinician passes a thin needle through the vaginal wall into the ovarian follicles and aspirates follicular fluid. The embryology team then examines the fluid to identify eggs.

The procedure is often brief, but recovery varies. Cramping, bloating, light spotting, and fatigue can occur afterward. Most people are advised not to drive themselves home after sedation and to follow the clinic’s instructions about activity, hydration, pain relief, and when to call for help.

The number of eggs retrieved is not the same as the number of mature eggs, fertilized eggs, usable embryos, or pregnancies. IVF naturally involves attrition at each stage: some follicles may not contain an egg, some eggs may be immature, some may not fertilize, and some embryos may stop developing before transfer or freezing. This can be emotionally difficult even when the cycle is medically proceeding as expected.

Stage 3: sperm collection and fertilization in the laboratory

On or near the day of egg retrieval, sperm is obtained from a partner or donor. In some cases, sperm may be collected surgically from the reproductive tract, particularly when sperm are not present in the ejaculate. The sample is processed in the laboratory to select motile sperm and prepare it for fertilization.

There are two common approaches to fertilization. In conventional insemination, eggs and prepared sperm are placed together in a culture dish and sperm

fertilize eggs without direct injection. In intracytoplasmic sperm injection, or ICSI, an embryologist injects a single sperm directly into a mature egg. ICSI is often considered for significant male-factor infertility, prior fertilization failure, use of frozen or surgically retrieved sperm, or some genetic testing protocols, but its use should be individualized.

The next day, the embryology team typically checks whether fertilization has occurred. Normally fertilized eggs then continue in culture. Laboratory conditions are carefully controlled for temperature, pH, gas composition, and culture media to support early embryo development.

Stage 4: embryo culture, grading, freezing, and optional testing

After fertilization, embryos are observed as they divide. Some transfers occur at the cleavage stage, around day 2 or 3, while many clinics culture embryos to the blastocyst stage, around day 5 to 7. A blastocyst contains an inner cell mass, which can develop into the fetus, and trophectoderm cells, which contribute to the placenta.

Embryologists may grade embryos based on developmental stage and appearance. Grading can help prioritize embryos for transfer or freezing, but it is not a guarantee of implantation or a healthy pregnancy. Embryos of similar grades may behave differently, and embryo quality is only one part of the overall picture.

Some patients choose or are advised to consider preimplantation genetic testing. This usually involves biopsy of a few trophectoderm cells from a blastocyst, followed by freezing while results are pending. Testing can provide information about chromosomal status or specific inherited conditions in selected circumstances. It also has limitations, costs, and ethical considerations, so counselling with a fertility specialist and, when appropriate, a genetic counsellor is important.

Embryos not transferred in the current cycle may be cryopreserved for later use. Frozen embryo transfer has become common and can allow the body to recover from stimulation, permit genetic testing results, and provide more flexible timing for endometrial preparation.

Stage 5: embryo transfer

Embryo transfer is usually simpler than egg retrieval and typically does not require anesthesia. A clinician places a thin catheter through the cervix into the uterus and releases the embryo in a small amount of fluid. Ultrasound guidance may be used to help position the catheter.

The number of embryos transferred is a careful medical decision. Transferring more than one embryo may increase the chance of twins or higher-order multiples, which carry higher risks for the pregnant person and babies, including preterm birth and pregnancy complications. Many patients, especially those with good-quality embryos, are advised to consider single embryo transfer.

After transfer, progesterone or other hormonal support may be used to support the uterine lining. The "two-week wait" before pregnancy testing can be especially stressful. Clinics generally recommend a blood pregnancy test at a specific time rather than relying only on home tests, because timing and medication effects can complicate interpretation.

Fresh versus frozen embryo transfer

A fresh embryo transfer occurs in the same cycle as ovarian stimulation and egg retrieval. A frozen embryo transfer occurs in a later cycle after embryos have been cryopreserved and thawed. Both approaches are widely used, and neither is automatically best for everyone.

A frozen transfer may be recommended when ovarian response is high, progesterone rises earlier than desired, ovarian hyperstimulation risk is a concern, genetic testing is planned, or the uterine lining needs separate preparation. Some patients also proceed with frozen transfer after banking embryos over more than one retrieval cycle.

Frozen embryo transfer cycles may be natural, modified natural, or medicated. In a natural or modified natural approach, the transfer is timed around ovulation. In a medicated approach, estrogen and progesterone are used to prepare and time the endometrium. The best option depends on ovulatory function, clinic protocol, prior response, and medical factors.

Success rates, limitations, and emotional realities

IVF success rates vary substantially. Age, especially the age of the egg provider, is one of the strongest predictors. Other factors include ovarian reserve, sperm quality, embryo chromosomal status, uterine health, body health, lifestyle factors, prior pregnancy history, and the underlying fertility diagnosis. Clinic-reported success rates can be useful but should be interpreted carefully, because patient populations and reporting methods differ.

It is possible to have an excellent stimulation response and still not have a pregnancy. It is also possible to retrieve few eggs and still achieve a viable embryo. IVF provides more information and more control over certain steps of reproduction, but it cannot control every biological variable.

The emotional side deserves explicit attention. Treatment may involve repeated appointments, injections, financial strain, waiting periods, difficult decisions about embryos, and grief if a cycle is unsuccessful. Many people benefit from setting boundaries around updates, planning practical help for retrieval day, asking the clinic what to expect at each step, and using counselling or peer support when available.

Risks and safety considerations

IVF is generally well established, but it is not risk-free. Ovarian stimulation can cause bloating, discomfort, mood changes, headaches, and injection-site reactions. A more serious complication is ovarian hyperstimulation syndrome, in which enlarged ovaries and fluid shifts can cause significant symptoms. Modern protocols can reduce this risk, but anyone with rapid weight gain, severe abdominal pain, shortness of breath, dizziness, or reduced urination after stimulation should contact their clinic urgently.

Egg retrieval has small risks, including bleeding, infection, injury to nearby structures, and anesthesia-related complications. Embryo transfer can cause mild cramping or spotting. IVF pregnancies may still carry risks of miscarriage, ectopic pregnancy, and pregnancy complications, and multiple pregnancy risk increases if more than one embryo implants.

Safety planning should be individualized. People with chronic conditions such as diabetes, hypertension, autoimmune disease, thrombosis history, severe

endometriosis, or significant psychiatric history may need coordination between fertility specialists and other clinicians before and during treatment.