SRI LAKSHMI NARAYANA INSTITUTE OF MEDICAL SCIENCES

Osudu, Agaram Village, Villianur commune, Kuduppakkam Post, Pudhucherry-605 502

Date: 09/01/2022

From

Dr. Somashekar I Tolanur
Professor and Head,
Department of Anatomy,
Sri Lakshmi Narayana Institute of Medical Sciences,
(BIHER University),
Puducherry-2.

To

The Dean,
Sri Lakshmi Narayana Institute of Medical Sciences,
(BIHER University),
Puducherry-2.

Sub: Permission to conduct value-added course: **A Short Course on Assisted Reproductive Technology (Art) for Medical Undergraduates** – reg.

Dear Madam,

With reference to the subject mentioned above, the department proposes to conduct a value-added course titled: "A Short Course on Assisted Reproductive Technology (Art) for Medical Undergraduates" of 2021-2022 batch. We solicit your kind permission for the same.

Kind Regards,

FOR THE USE OF DEAN'S OFFICE

Names of Committee members for evaluating the course:

The Dean: **Dr. Jayalakshmi. G**
The HOD: **Dr. Somashekar I Tolanur**
The Expert: **Dr. B. Rajesh**

The committee has discussed about the course and is approved.

Dean	Subject Expert	HOD
(Sign & Seal)	(Sign & Seal)	(Sign & Seal)

Dr. G. JAYALAKSHMI, BSC., MBBS., DTCD., M.D.,
DEAN
Sri Lakshmi Narayana Institute of Medical Sciences
Osudu, Agaram, Kudapakkam Post,
Villianur Commune, Puducherry - 605502.

PROF & HOD OF ANATOMY
SRI LAKSHMI NARAYANA INSTITUTE OF MEDICAL SCIENCES
Osudu Agaram Village, Pondicherry-605 502

OFFICE OF THE DEAN

Sri Lakshmi Narayana Institute of Medical Sciences

OSUDU, AGARAM VILLAGE, VILLIANUR COMMUNE, KUDAPAKKAM POST,
PUDUCHERRY - 605 502.
[Recognised by Medical Council of India, Ministry of Health letter No. U/12012/249/2005-ME (P -II) dt. 11/07/2011]
[Affiliated to Bharath University, Chennai - TN]

Circular

22.01.2022

Sub: Organizing Value-added Course on "A Short Course on Assisted Reproductive Technology (Art) for Medical Undergraduates" – Reg.

With reference to the above mentioned subject, it is to bring to your notice that Sri Lakshmi Narayana Institute of Medical Sciences, Puducherry affiliated to Bharath Institute of Higher Education and Research University is organizing a value added course on "A Short Course on Assisted Reproductive Technology (Art) for Medical Undergraduates" during February 2022 for 1st year M.B.B.S students (2021 – 2022 Batch). The course content for the same is enclosed below."

Dean
(Dr.G Jayalakshmi)

Dr. G. JAYALAKSHMI, BSC., MBBS., DTCD., M.D.,
DEAN
Sri Lakshmi Narayana Institute of Medical Sciences
Osudu, Agaram, Kudapakkam Post,
Villianur Commune, Puducherry- 605502.

Encl: Copy of Course content

COURSE CONTENT

Particulars	Description
Course Title	A short course on ASSISTED REPRODUCTIVE TECHNOLOGY (ART) for medical undergraduates
Course Code	ART01
Objective	At the end of the course the students will be able to 1. Discuss the sequential nature of fertilization in which ordered changes in the gametes "drive" the process of fertilization toward completion. 2. Explain the role of specialized sperm and egg surface structures in fertilization. 3. Describe how egg and sperm receptors were identified. 4. Explain the current state of knowledge about sperm-egg membrane fusion and how sperm components are incorporated into the egg. 5. Describe Assisted reproductive technology (ART), include the handling of eggs and/or embryos, methods like • in vitro fertilization (IVF), • gamete intrafallopian transfer (GIFT), • pronuclear stage tubal transfer (PROST), • tubal embryo transfer (TET), and • zygote intrafallopian transfer (ZIFT).
Further learning opportunities	Pre implantation genetic diagnosis
Key Competencies	On successful completion of the course the students will have skill in various assisted reproductive technologies
Target Student	1st MBBS Students
Duration	30hrs February 2022
Theory Session	10hrs
Practical Session	20hrs
Assessment Procedure	Multiple choice questions

Course Proposal

Course Title:

A Short Course on Assisted Reproductive Technology (Art) for Medical Undergraduates

Course Objective:

1. To introduce Assisted reproductive technology to I MBBS students
2. To learn various IVF techniques with better understanding and orientation

Course Outcome:

Undergraduate Medical students will gain knowledge regarding Assisted Reproductive Technology (Art)

Course Audience: 1st year MBBS

Course Coordinator: Dr.Somashekar I Tolanur

Course Faculties with Qualification and Designation:

1. Dr. B Rajesh, M.Sc., Ph.D, Professor/Anatomy
2. Ms. Santhi V M.Sc, Assistant Professor/Anatomy

Course Curriculum/subtopics with schedule (30 hours)

Sl. No	Date	Topic	Time	Hours	Faculty Name
1.	01.02.2022	Sequential nature of fertilization in which ordered changes in the gametes "drive"	2-4p.m	2	Ms. V. Santhi
2.	03.02.2022	The process of fertilization toward completion.	4-5p.m	1	Dr. B Rajesh
3.	04.02.2022	Role of specialized sperm and egg surface structures in fertilization.	4-6p.m	2	Ms. V. Santhi
4.	06.02.2022	how egg and sperm receptors were identified.	4-6p.m	2	Ms. V. Santhi
5.	07.02.2022	current state of knowledge about sperm-egg membrane fusion and how sperm components are incorporated into the egg.	4-5p.m	1	Dr. B Rajesh
6.	08.02.2022	Assisted reproductive technology (ART), include the handling of eggs and/or embryos, methods like	4-6p.m	2	Ms. V. Santhi
7.	09.02.2022	In vitro fertilization (IVF) 1	2-4p.m	2	Ms. V. Santhi
8.	10.02.2022	In vitro fertilization (IVF) 2		2	
9.	11.02.2022	Gamete intrafallopian transfer (GIFT) 1	4-6p.m	2	Dr. B Rajesh
10.	13.02.2022	Gamete intrafallopian transfer (GIFT) 2		2	
11.	14.02.2022	Pronuclear stage tubal transfer (PROST)1	4-6p.m	2	Ms. V. Santhi
12.	15.02.2022	Pronuclear stage tubal transfer (PROST)2		2	
13.	16.02.2022	Tubal embryo transfer (TET)1	4-6p.m	2	Dr. B Rajesh
14.	17.02.2022	Tubal embryo transfer (TET)2		2	
15.	18.02.2022	Zygote intrafallopian transfer (ZIFT) 1	4-6p.m	2	Ms. V. Santhi
16.	20.02.2022	Zygote intrafallopian transfer (ZIFT)2		2	
			Total Hours	30	

REFERENCE BOOKS/ARTICLES:

1. Textbook of Assisted Reproductive Techniques. Editors: David K. Gardner, Colin M. Howles, Zeev Shoham, Ariel Weissman
2. Fertility and Assisted Reproductive Technology (ART): Theory, Research, Policy and Practice for Health Care Practitioners
3. The Art and Science of Assisted Reproductive Techniques by Gautam N. Allahbadia & Rita Basuray Das

VALUE ADDED COURSE

1. Name of the programme & Code

"A Short Course on Assisted Reproductive Technology (Art) for Medical Undergraduates"
(Code – ART 01)

2. Duration & Period

30 hrs & February 2022

3. Information Brochure and Course Content of Value Added Courses

Enclosed as Annexure- I

4. List of students enrolled

Enclosed as Annexure- II

5. Assessment procedures:

MCQ Questions - *Enclosed as Annexure- III*

6. Certificate model

Enclosed as Annexure- IV

7. No. of times offered during the same year:

1 time – February 2022

8. Year of discontinuation: 2022

9. Summary report of each program year-wise

Value Added Course - September 2022					
Sl. No	**Course Code**	**Course Name**	**Resource Persons**	**Target Students**	**Strength & Year**
1	Code – ART01	"A Short Course on Assisted Reproductive Technology (Art) for Medical Undergraduates"	Dr. B Rajesh Ms. Santhi	Ist M.B.B.S (2021– 2022 batch)	20 / February 2021

10. Course Feed Back

Enclosed as Annexure- V

RESOURCE PERSONS

1. **(Dr. B Rajesh)**

2. **(Ms. Santhi)**

COORDINATOR
(Dr. Somasekar I Tolanur)

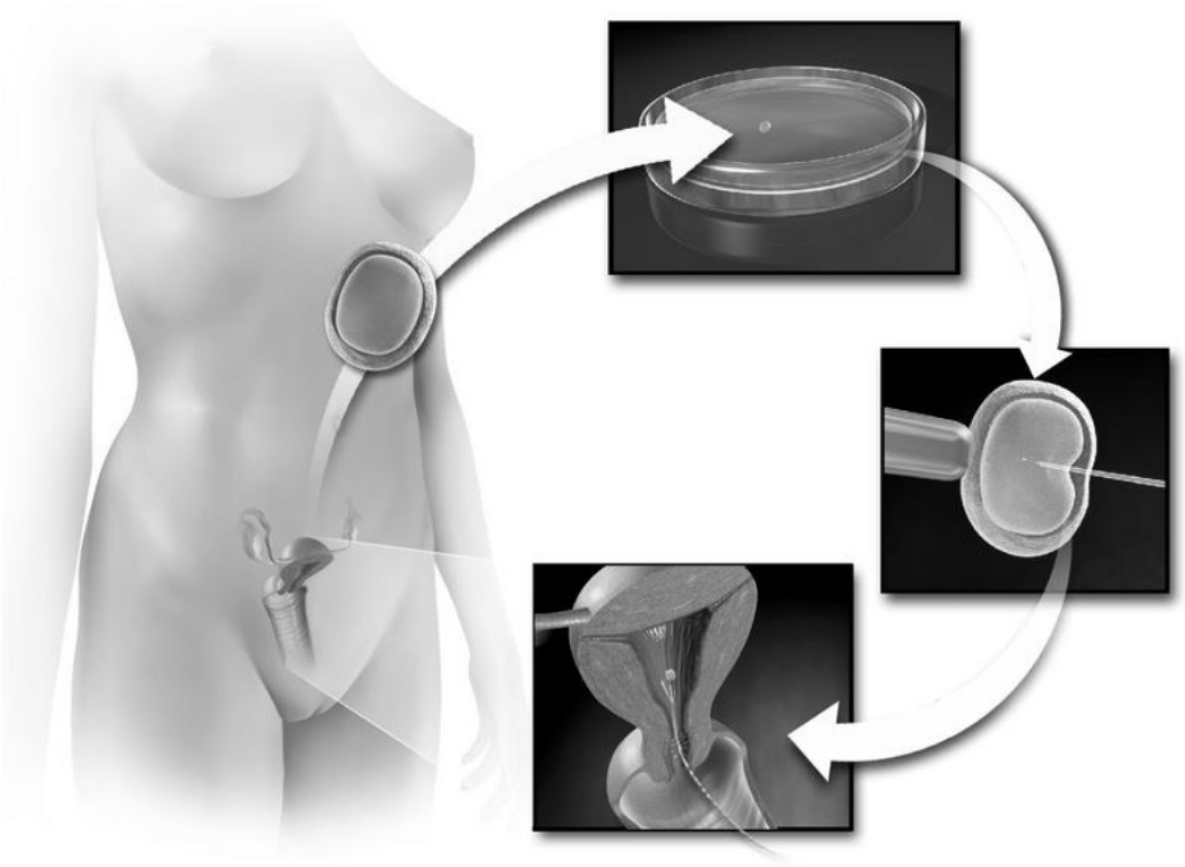
PROF & HOD OF ANATOMY
SRI LAKSHMI NARAYANA INSTITUTE OF MEDICAL SCIENCES
Usudu Agaram Village,Pondicherry-605 502

COURSE DETAILS

Particulars	Description
Course Title	A short course on ASSISTED REPRODUCTIVE TECHNOLOGY (ART) for medical undergraduates
Course Code	ART01
Objective	At the end of the course the students will be able to 1. Discuss the sequential nature of fertilization in which ordered changes in the gametes "drive" the process of fertilization toward completion. 2. Explain the role of specialized sperm and egg surface structures in fertilization. 3. Describe how egg and sperm receptors were identified. 4. Explain the current state of knowledge about sperm-egg membrane fusion and how sperm components are incorporated into the egg. 5. Describe Assisted reproductive technology (ART), include the handling of eggs and/or embryos, methods like • in vitro fertilization (IVF), • gamete intrafallopian transfer (GIFT), • pronuclear stage tubal transfer (PROST), • tubal embryo transfer (TET), and • zygote intrafallopian transfer (ZIFT).
Further learning opportunities	Pre implantation genetic diagnosis
Key Competencies	On successful completion of the course the students will have skill in various assisted reproductive technologies
Target Student	1st MBBS Students
Duration	30hrs Every September 2021– January 2021 & February – August 2022
Theory Session	10hrs
Practical Session	20hrs
Assessment Procedure	Multiple choice questions

A short course on

ASSISTED REPRODUCTIVE TECHNOLOGY (ART) for medical undergraduates



PARTICIPANT HAND BOOK -2022

BIHER SLIMS

Human Fertilization

Human fertilization is the union of a human egg and sperm, usually occurring in the ampulla of the fallopian tube. The result of this union is the production of a zygote cell, or fertilized egg, initiating prenatal development. The process of fertilization involves a sperm fusing with an ovum. The most common sequence begins with ejaculation during copulation, follows with ovulation, and finishes with fertilization. Various exceptions to this sequence are possible, including artificial insemination, in vitro fertilization, external ejaculation without copulation, or copulation shortly after ovulation. Upon encountering the secondary oocyte, the acrosome of the sperm produces enzymes which allow it to burrow through the outer jelly coat of the egg. The sperm plasma then fuses with the egg's plasma membrane, triggering the sperm head to disconnect from its flagellum as the egg travels down the Fallopian tube to reach the uterus.

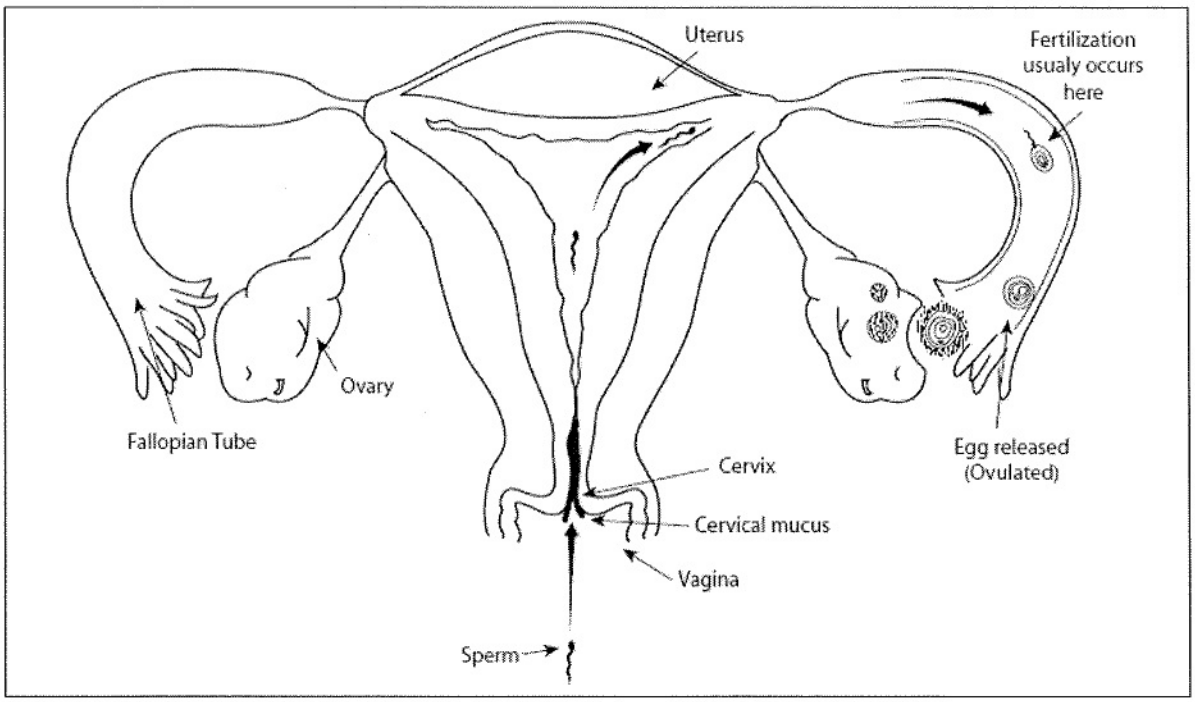
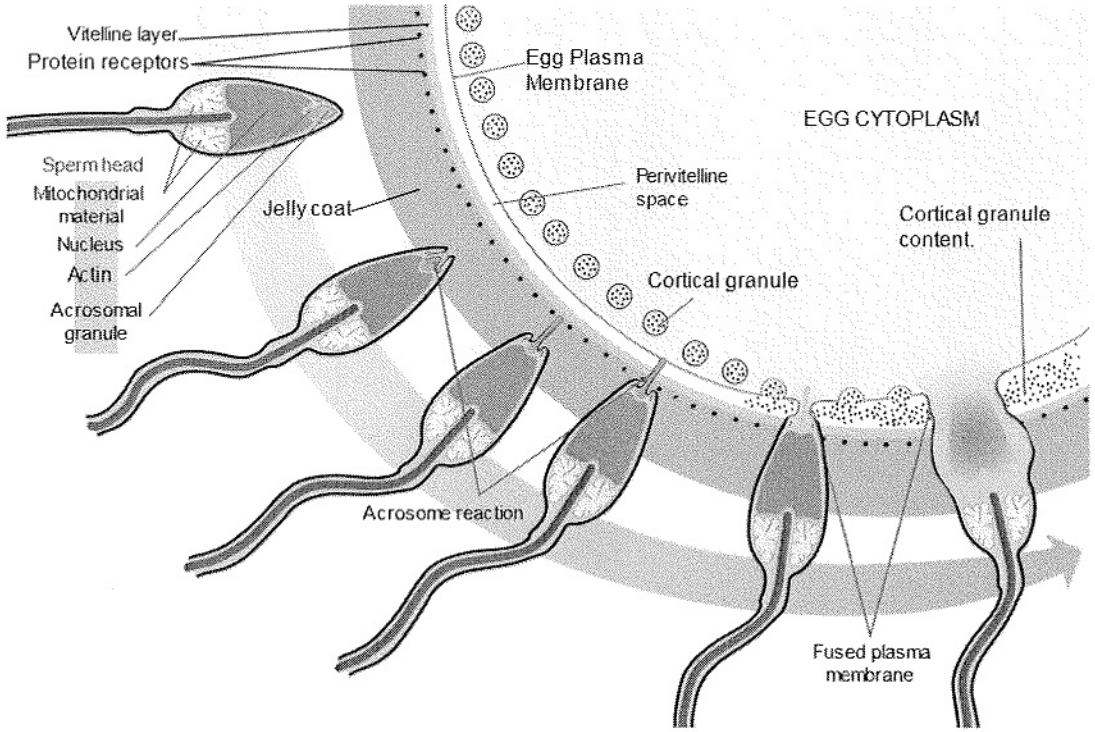


Fig.1 Normal fertilization – sperm approaching the ovum & fertilization happens in uterine tube



Events in fertilization

The stages of fertilization can be divided into four processes: 1) sperm preparation, 2) sperm-egg recognition and binding, 3) sperm-egg fusion and 4) fusion of sperm and egg pronuclei and activation of the zygote.

Events of Fertilization:
1. Activation of sperm and ovum:

The sperms can fertilize an ovum only they are able to secrete the chemical hyaluronidase and possess a surface protein called antifertilizin (composed of acidic amino acid). The ovum secretes a chemical named fertilizin (composed of glycoprotein = mono saccharides + amino acids). It mixes with the water to form egg water which attracts the sperms of its own species.

2. Penetration of sperm:

The fertilizin of an egg interacts with the anti fertilizin of sperm of the same species. This attraction between fertilizin and antifertilizin makes the sperms stick to the egg surface. The process of acquiring the capacity to fertilize the egg by the sperm is called capacitation. In this process, the membrane surrounding the acrosome of the sperm breaks and releases its contents, the sperm lysin. It is the chemical substance present in the sperm's acrosome.

The ovum is surrounded by three membranes such as corona radiata, zona pellucida and the vitelline membranes. At first the sperm passes through corona radiata to reach zona pellucida. There it releases the enzyme hyaluronidase or sperm lysin from its acrosome (Fig. 3(B).8).

This enzyme dissolves zona pellucida as a result of which the sperm reaches the plasma membrane of the egg. The above changes on the sperm head are called acrosome reaction.

At the point of contact with the sperm, the egg forms a projection, termed the cone of reception or fertilization cone which receives the sperm. Once one sperm has entered the egg (ovum) the vitelline membrane thickens and is converted into fertilization membrane. This membrane is rigid and never allows other sperms to pass through this membrane. Penetration of the sperm initiates a second maturation division of the ovum and a second polar body is given off.

3. Amphimixis:

A sperm consists of three parts: head, middle piece and tail. Shortly before or after entering the egg, the sperm loses its tail (Fig. 3(B).9). After the sperm enters the egg, the membrane of head and middle piece dissolves, liberating nucleus, centrosome and mitochondria. Now the sperm nucleus enlarges to form the male pronuclear and the nucleus of the ovum becomes female pronuclear.

The male pronuclear moves inwards and then changes its direction to meet the egg nucleus. The initial path is known as penetration path and the second path is known as copulation path. The chromosomes (haploid set) of (he sperm and the chromosomes (haploid set) of the egg or ovum are set free by the breakdown of their nuclear envelops.

Mixing up of the chromosomes of a sperm and an ovum resulting in a diploid zygote nucleus is known as amphimixis or karyogamy. The mother is now said to be pregnant. The centrosome form asters and spindle fibres. The paternal and maternal chromosomes move to lie in the equator of the spindle and the zygote is ready for division by cleavage.

Fertilization has the following significance:

1. Fertilization restores the diploid number of chromosomes, i.e. 46 in human being.

2. It provides stimulus for the ovum to complete its maturation.

3. Fertilization combines the characters of two parents. This brings about recombination of genes and introduces variations.

4. It determines the sex of the embryo in humans.

5. Fertilization introduces the centrioles which are absent in ovum.

6. Fertilization membrane formed after the entry of the sperm prevents the entry of additional sperms.

When Normal fertilization is failed or not possible, fertilization is achieved through various methods which collectively called Assisted Reproductive Technology or ART

ASSISTED REPRODUCTIVE TECHNOLOGY (ART)

Assisted reproductive technology (ART) includes medical procedures used primarily to address infertility. This subject involves procedures such as in vitro fertilization, intracytoplasmic sperm injection (ICSI), cryopreservation of gametes or embryos, and/or the use of fertility medication. When used to address infertility, ART may also be referred to as fertility treatment. ART mainly belongs to the field of reproductive endocrinology and infertility. Some forms of ART may be used with regard to fertile couples for genetic purpose (see preimplantation genetic diagnosis). ART may also be used in surrogacy arrangements, although not all surrogacy arrangements involve ART.

Procedures

With ART, the process of sexual intercourse is bypassed and fertilization of the oocytes occurs in the laboratory environment (i.e., in vitro fertilization).

In the US, the Centers for Disease Control and Prevention (CDC) defines ART to include "all fertility treatments in which both eggs and sperm are handled. In general, ART procedures involve surgically removing eggs from a woman's ovaries, combining them with sperm in the laboratory, and returning them to the woman's body or donating them to another woman." According to CDC, "they do not include treatments in which only sperm are handled (i.e., intrauterine—or artificial—insemination) or procedures in which a woman takes medicine only to stimulate egg production without the intention of having eggs retrieved." In Europe, ART also excludes artificial insemination and includes only procedures where oocytes are handled. The WHO, or World Health Organization, also defines ART this way

Ovulation induction

Ovulation induction is usually used in the sense of stimulation of the development of ovarian follicles by fertility medication to reverse anovulation or oligoovulation. These medications are given by injection for 8 to 14 days. A health care provider closely monitors the development of the eggs using transvaginal ultrasound and blood tests to assess follicle growth and estrogen production by the ovaries. When follicles have reached an adequate size and the eggs are mature enough, an injection of the hormone hCG initiates the ovulation process. Egg retrieval should occur from 34 to 36 hours after the hCG injection.

In vitro fertilization

In vitro fertilisation (IVF) is a form of assist ed reproductive technology (ART). It is a process of fertilisation where an egg is combined with sperm outside the body, in vitro ("in glass"). The process involves monitoring and stimulating a woman's ovulatory process, removing an ovum or ova (egg or eggs) from the woman's ovaries and letting sperm fertilise them in a liquid in a laboratory. After the fertilised egg (zygote) undergoes embryo culture for 2–6 days, it is implanted in the same or another woman's uterus, with the intention of establishing a successful pregnancy.

IVF is a type of assisted reproductive technology used for infertility treatment and gestational surrogacy. A fertilised egg may be implanted into a surrogate's uterus, and the resulting child is genetically unrelated to the surrogate. Some countries have banned or otherwise regulate the availability of IVF treatment, giving rise to fertility tourism. Restrictions on the availability of IVF include costs and age, in order for a woman to carry a healthy pregnancy to term. IVF is generally not used until less invasive or expensive options have failed or been determined unlikely to work.

In July 1978, Louise Brown was the first child successfully born after her mother received IVF treatment. Brown was born as a result of natural-cycle IVF, where no stimulation was made. The procedure took place at Dr Kershaw's Cottage Hospital (now Dr Kershaw's Hospice) in Royton, Oldham, England. Robert G. Edwards was awarded the Nobel Prize in Physiology or Medicine in 2010. The physiologist co-developed the treatment together with Patrick Steptoe and embryologist Jean Purdy but the latter two were not eligible for consideration as they had died and the Nobel Prize is not awarded posthumously.

With egg donation and IVF, women who are past their reproductive years, have infertile male partners, have idiopathic female-fertility issues, or have reached menopause can still become pregnant. After the IVF treatment, some couples get pregnant without any fertility treatments. In 2018, it was estimated that eight million children had been born worldwide using IVF and other assisted reproduction techniques. However, a recent study that explores 10 adjuncts with IVF (screening hysteroscopy, DHEA, testosterone, GH, aspirin, heparin, antioxidants in males and females, seminal plasma, and PRP) suggests that until more evidence is done to show that these adjuncts are safe and effective, they should be avoided.

Terminology

The Latin term in vitro, meaning "in glass", is used because early biological experiments involving cultivation of tissues outside the living organism were carried out in glass containers, such as beakers, test tubes, or Petri dishes. Today, the scientific term "in vitro" is used to refer to any biological procedure that is performed outside the organism in which it would normally have occurred, to distinguish it from an in vivo procedure (such as in vivo fertilisation), where the tissue remains inside the living organism in which it is normally found.

A colloquial term for babies conceived as the result of IVF, "test tube babies", refers to the tube-shaped containers of glass or plastic resin, called test tubes, that are commonly used in chemistry and biology labs. However, IVF is usually performed in Petri dishes, which are both wider and shallower and often used to cultivate cultures.

Indications

IVF may be used to overcome female infertility when it is due to problems with the fallopian tubes, making in vivo fertilisation difficult. It can also assist in male infertility, in those cases where there is a defect in sperm quality; in such situations intracytoplasmic sperm injection (ICSI) may be used, where a sperm cell is injected directly into the egg cell. This is used when sperm has difficulty penetrating the egg. In these cases the partner's or a donor's sperm may be used. ICSI is also used when sperm numbers are very low. When indicated, the use of ICSI has been found to increase the success rates of IVF. According to UK's NICE guidelines, IVF treatment is appropriate in cases of unexplained infertility for women who have not conceived after 2 years of regular unprotected sexual intercourse. In women with anovulation, it may be an alternative after 7–12 attempted cycles of ovulation induction, since the latter is expensive and more easy to control.

Evaluation before IVF

Before starting ART, each patient is evaluated to help maximize her chances for success and a healthy pregnancy. Good preconception health is essential to achieving pregnancy with IVF. Chronic medical conditions such as diabetes, hypertension and asthma should be well controlled before attempting to conceive. In addition, women planning an IVF cycle should optimize their weight. Obesity has been associated with infertility, a reduced chance of success with IVF, and an increase in the risk of miscarriage and preterm birth. Your physician can help you determine your ideal weight and refer you to appropriate resources for weight management.

Blood Tests

General

Prior to starting IVF, the woman's blood type should be verified, and she should be screened for conditions that could affect the health of a pregnancy. Documentation of immunity to rubella (German measles) and varicella (chicken pox) may also require a blood test. Vaccination can be offered before pregnancy if immunity is not present. The patient and her partner will also be tested for hepatitis B and C, HIV and syphilis. An option for couples to consider is Universal Genetic Carrier Screening. This testing offers the additional advantages of identifying before pregnancy couples at risk of having children with genetic diseases. They can then be offered appropriate testing to optimize patient education, counseling, and options for achieving pregnancy. Couples at risk of having children with specific genetic diseases can be counseled about the disease inheritance and course and offered referral for potential interventions, such as preimplantation genetic testing.

Ovarian Reserve Testing

As women age they have a decreased ability to conceive and an increased risk of miscarriage. The reproductive potential of the ovaries, termed ovarian reserve, represents the number of oocytes available for potential fertilization at that point in time and may be assessed by serum tests or ultrasonography. The presence of decreased ovarian reserve predicts future response to ovarian stimulation. The results of ovarian reserve tests should be considered in the context of the patient's age. Ovarian reserve tests are good predictors of response to ovarian stimulation, but poor results do not necessarily predict inability to achieve a live birth.

Anti-Mullerian Hormone Test (AMH): AMH levels remain relatively stable throughout the menstrual cycle and can be assessed on any day of the menstrual cycle. An AMH value less than 1.0 can predict a low response to stimulation.

Day 2-5 Levels of FSH, and Estradiol: Follicle stimulating hormone values greater than 10 IU/L are associated with a less robust response to ovarian stimulation. Estradiol serves as an aid for interpreting FSH results. Basal estradiol levels typically should be less than 60–80 pg/mL; elevated estradiol levels may have a suppressive effect on FSH levels and may be indicative of decreased ovarian reserve.

Ultrasonographic assessment of the antral follicle count: determines the number of follicles that measure 2–10 mm in both ovaries. Low antral follicle count may be defined as fewer than 5–7

follicles and is associated with poor response to ovarian stimulation. However, antral follicle count is a relatively poor predictor of future ability to become pregnant.

Semen

A semen analysis should be reviewed. Changes in sperm quality may occur over time that could affect IVF success. Semen parameters can help determine whether standard insemination of eggs or intracytoplasmic sperm injection (ICSI) may be advised.

Uterus

The uterus is usually evaluated prior to an IVF. Three methods can be used: a hysterosalpingogram, a saline infusion sonohysterography or a hysteroscopy.

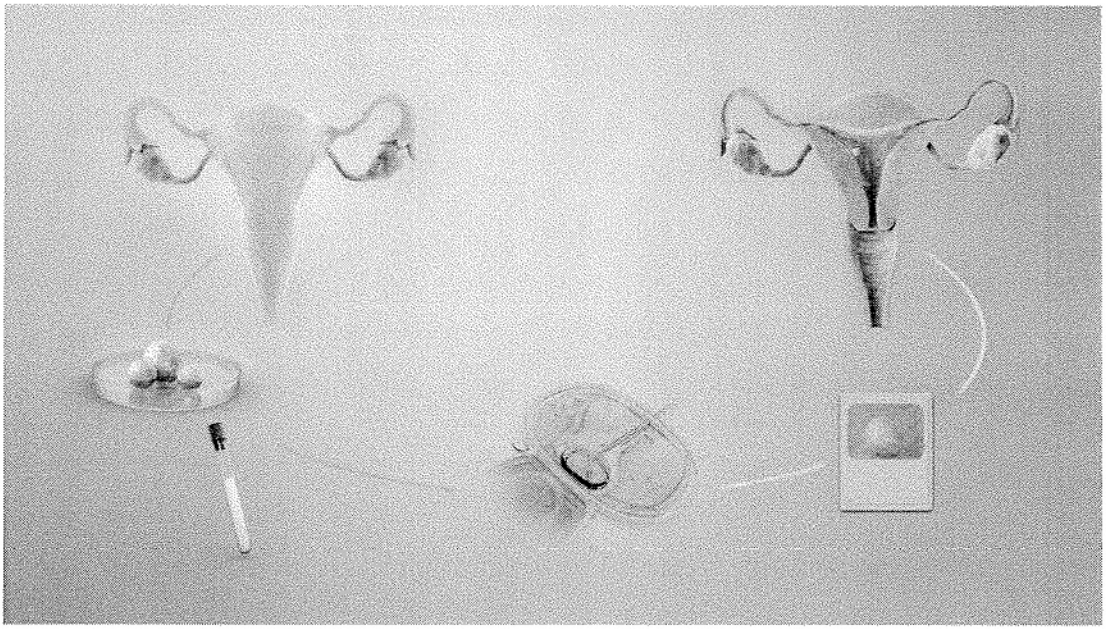
Prior to IVF, a trial or "mock" transfer may be done. The purpose of this procedure is to determine the length and direction of the uterus. This enables the physician to anticipate any difficulties with the embryo transfer.

Steps of IVF Treatment

In vitro fertilization is the technique of letting fertilization of the male and female gametes (sperm and egg) occur outside the female body.

Techniques usually used in in vitro fertilization include:

- **Transvaginal ovum retrieval (OVR)** is the process whereby a small needle is inserted through the back of the vagina and guided via ultrasound into the ovarian follicles to collect the fluid that contains the eggs.
- **Embryo transfer** is the step in the process whereby one or several embryos are placed into the uterus of the female with the intent to establish a pregnancy.



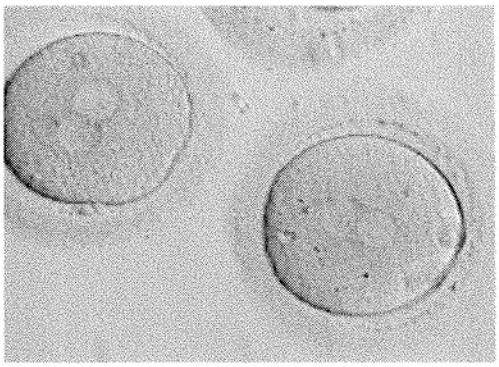
Less commonly used techniques in in vitro fertilization are:

- **Assisted zona hatching (AZH)** is performed shortly before the embryo is transferred to the uterus. A small opening is made in the outer layer surrounding the egg in order to help the embryo hatch out and aid in the implantation process of the growing embryo.

- **Intracytoplasmic sperm injection (ICSI)**
  Intracytoplasmic sperm injection (ICSI) is beneficial in the case of male factor infertility where sperm counts are very low or failed fertilization occurred with previous IVF attempt(s). The ICSI procedure involves a single sperm carefully injected into the center of an egg using a microneedle. With ICSI, only one sperm per egg is needed. Without ICSI, you need between 50,000 and 100,000. This method is also sometimes employed when donor sperm is used.

- **Autologous endometrial coculture** is a possible treatment for patients who have failed previous IVF attempts or who have poor embryo quality. The patient's fertilized eggs are placed on top of a layer of cells from the patient's own uterine lining, creating a more natural environment for embryo development.
- **In zygote intrafallopian transfer (ZIFT),** egg cells are removed from the woman's ovaries and fertilized in the laboratory; the resulting zygote is then placed into the fallopian tube.
- **Cytoplasmic transfer** is the technique in which the contents of a fertile egg from a donor are injected into the infertile egg of the patient along with the sperm.

- **Egg donors** are resources for women with no eggs due to surgery, chemotherapy, or genetic causes; or with poor egg quality, previously unsuccessful IVF cycles or advanced maternal age. In the egg donor process, eggs are retrieved from a donor's ovaries, fertilized in the laboratory with the sperm from the recipient's partner, and the resulting healthy embryos are returned to the recipient's uterus.
- **Sperm donation** may provide the source for the sperm used in IVF procedures where the male partner produces no sperm or has an inheritable disease, or where the woman being treated has no male partner.
- **Preimplantation genetic diagnosis (PGD)** involves the use of genetic screening mechanisms such as fluorescent in-situ hybridization (FISH) or comparative genomic hybridization (CGH) to help identify genetically abnormal embryos and improve healthy outcomes.
- **Embryo splitting** can be used for twinning to increase the number of available embryos.



Fertilized oocytes showing two nuclei.

Pre-implantation genetic diagnosis

A pre-implantation genetic diagnosis procedure may be conducted on embryos prior to implantation (as a form of embryo profiling), and sometimes even of oocytes prior to fertilization. PGD is considered in a similar fashion to prenatal diagnosis. PGD is an adjunct to ART procedures, and requires in vitro fertilization to obtain oocytes or embryos for evaluation. Embryos are generally obtained through blastomere or blastocyst biopsy. The latter technique has proved to be less deleterious for the embryo, therefore it is advisable to perform the biopsy around day 5 or 6 of development. Sex selection is the attempt to control the sex of offspring to achieve a desired sex in case of X chromosome linked diseases. It can be accomplished in several ways, both pre- and post-implantation of an embryo, as well as at birth. Pre-implantation techniques include PGD, but also sperm sorting.

Other assisted reproduction techniques include:

- **Mitochondrial replacement therapy (MRT**, sometimes called mitochondrial donation) is the replacement of mitochondria in one or more cells to prevent or ameliorate disease. MRT originated as a special form of IVF in which some or all of the future baby's mitochondrial DNA comes from a third party. This technique is used in cases when mothers carry genes for mitochondrial diseases. The therapy is approved for use in the United Kingdom.
- **In gamete intrafallopian transfer (GIFT)** a mixture of sperm and eggs is placed directly into a woman's fallopian tubes using laparoscopy following a transvaginal ovum retrieval.
- **Reproductive surgery**, treating e.g. fallopian tube obstruction and vas deferens obstruction, or reversing a vasectomy by a reverse vasectomy. In surgical sperm retrieval (SSR) the reproductive urologist obtains sperm from the vas deferens, epididymis or directly from the testis in a short outpatient procedure.
- By **cryopreservation**, eggs, sperm and reproductive tissue can be preserved for later IVF.

Theoretically, IVF could be performed by collecting the contents from a woman's fallopian tubes or uterus after natural ovulation, mixing it with sperm, and reinserting the fertilised ova into the uterus. However, without additional techniques, the chances of pregnancy would be extremely small. The additional techniques that are routinely used in IVF include ovarian hyperstimulation to generate multiple eggs, ultrasound-guided transvaginal oocyte retrieval directly from the ovaries, co-incubation of eggs and sperm, as well as culture and selection of resultant embryos before embryo transfer into a uterus.

Ovarian hyperstimulation

Ovarian hyperstimulation is the stimulation to induce development of multiple follicles of the ovaries. It should start with response prediction by e.g. age, antral follicle count and level of anti-Müllerian hormone. The resulting prediction of e.g. poor or hyper-response to ovarian hyperstimulation determines the protocol and dosage for ovarian hyperstimulation.

Ovarian hyperstimulation also includes suppression of spontaneous ovulation, for which two main methods are available: Using a (usually longer) GnRH agonist protocol or a (usually shorter) GnRH antagonist protocol. In a standard long GnRH agonist protocol the day when hyperstimulation treatment is started and the expected day of later oocyte retrieval can be chosen to conform to personal choice, while in a GnRH antagonist protocol it must be adapted to the spontaneous onset

of the previous menstruation. On the other hand, the GnRH antagonist protocol has a lower risk of ovarian hyperstimulation syndrome (OHSS), which is a life-threatening complication.

For the ovarian hyperstimulation in itself, injectable gonadotropins (usually FSH analogues) are generally used under close monitoring. Such monitoring frequently checks the estradiol level and, by means of gynecologic ultrasonography, follicular growth. Typically approximately 10 days of injections will be necessary.

Natural IVF

There are several methods termed natural cycle IVF:

IVF using no drugs for ovarian hyperstimulation, while drugs for ovulation suppression may still be used.

IVF using ovarian hyperstimulation, including gonadotropins, but with a GnRH antagonist protocol so that the cycle initiates from natural mechanisms.

Frozen embryo transfer; IVF using ovarian hyperstimulation, followed by embryo cryopreservation, followed by embryo transfer in a later, natural, cycle.

IVF using no drugs for ovarian hyperstimulation was the method for the conception of Louise Brown. This method can be successfully used when women want to avoid taking ovarian stimulating drugs with its associated side-effects. HFEA has estimated the live birth rate to be approximately 1.3% per IVF cycle using no hyperstimulation drugs for women aged between 40 and 42.

Mild IVF is a method where a small dose of ovarian stimulating drugs are used for a short duration during a woman's natural cycle aimed at producing 2–7 eggs and creating healthy embryos. This method appears to be an advance in the field to reduce complications and side-effects for women and it is aimed at quality, and not quantity of eggs and embryos. One study comparing a mild treatment (mild ovarian stimulation with GnRH antagonist co-treatment combined with single embryo transfer) to a standard treatment (stimulation with a GnRH agonist long-protocol and transfer of two embryos) came to the result that the proportions of cumulative pregnancies that resulted in term live birth after 1 year were 43.4% with mild treatment and 44.7% with standard treatment. Mild IVF can be cheaper than conventional IVF and with a significantly reduced risk of multiple gestation and OHSS.

Final maturation induction

When the ovarian follicles have reached a certain degree of development, induction of final oocyte maturation is performed, generally by an injection of human chorionic gonadotropin (hCG). Commonly, this is known as the "trigger shot." hCG acts as an analogue of luteinising hormone, and ovulation would occur between 38 and 40 hours after a single HCG injection, but the egg retrieval is performed at a time usually between 34 and 36 hours after hCG injection, that is, just prior to when the follicles would rupture. This avails for scheduling the egg retrieval procedure at a time where the eggs are fully mature. HCG injection confers a risk of ovarian hyperstimulation syndrome. Using a GnRH agonist instead of hCG eliminates most of the risk of ovarian hyperstimulation syndrome, but with a reduced delivery rate if the embryos are transferred fresh. For this reason, many centers will freeze all oocytes or embryos following agonist trigger.

Egg retrieval

The eggs are retrieved from the patient using a transvaginal technique called transvaginal oocyte retrieval, involving an ultrasound-guided needle piercing the vaginal wall to reach the ovaries. Through this needle follicles can be aspirated, and the follicular fluid is passed to an embryologist to identify ova. It is common to remove between ten and thirty eggs. The retrieval procedure usually takes between 20 and 40 minutes, depending on the number of mature follicles, and is usually done under conscious sedation or general anaesthesia.

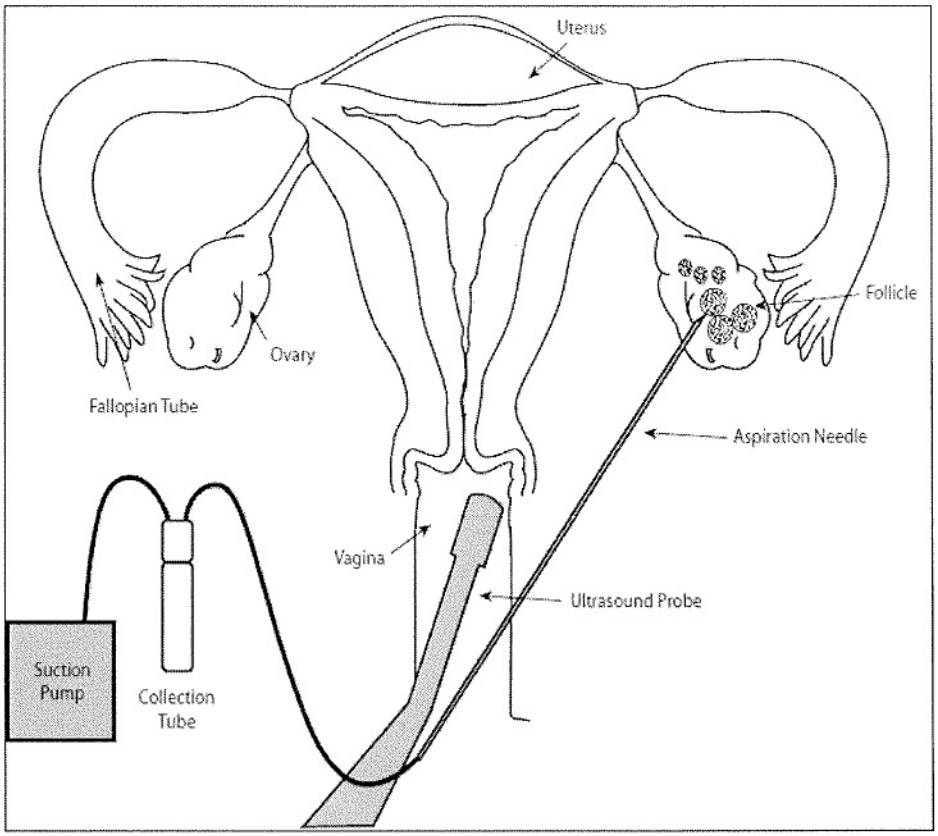


Figure 3. Egg retrieval is usually performed through the vagina with an ultrasound-guided needle.

Egg and sperm preparation

In the laboratory, for ICSI treatments, the identified eggs are stripped of surrounding cells (also known as cumulus cells) and prepared for fertilisation. An oocyte selection may be performed prior to fertilisation to select eggs that can be fertilized, as it is required they are in metaphase II. There are cases in which if oocytes are in the metaphase I stage, they can be kept being cultured so as to undergo a posterior sperm injection. In the meantime, semen is prepared for fertilisation by removing inactive cells and seminal fluid in a process called sperm washing. If semen is being provided by a sperm donor, it will usually have been prepared for treatment before being frozen and quarantined, and it will be thawed ready for use.

Co-incubation

Demonstration of IVF

The sperm and the egg are incubated together at a ratio of about 75,000:1 in a culture media in order for the actual fertilisation to take place. A review in 2013 came to the result that a duration of this co-incubation of about 1 to 4 hours results in significantly higher pregnancy rates than 16 to 24 hours. In most cases, the egg will be fertilised during co-incubation and will show two pronuclei. In certain situations, such as low sperm count or motility, a single sperm may be injected directly into the egg using intracytoplasmic sperm injection (ICSI). The fertilised egg is passed to a special growth medium and left for about 48 hours until the egg consists of six to eight cells.

In gamete intrafallopian transfer, eggs are removed from the woman and placed in one of the fallopian tubes, along with the man's sperm. This allows fertilisation to take place inside the woman's body. Therefore, this variation is actually an in vivo fertilisation, not in vitro.

Embryo culture

The main durations of embryo culture are until cleavage stage (day two to four after co-incubation) or the blastocyst stage (day five or six after co-incubation). Embryo culture until the blastocyst stage confers a significant increase in live birth rate per embryo transfer, but also confers a decreased number of embryos available for transfer and embryo cryopreservation, so the cumulative clinical pregnancy rates are increased with cleavage stage transfer. Transfer day two instead of day three after fertilisation has no differences in live birth rate. There are significantly higher odds of preterm birth (odds ratio 1.3) and congenital anomalies (odds ratio 1.3) among births having from embryos cultured until the blastocyst stage compared with cleavage stage.

Embryo selection

Laboratories have developed grading methods to judge ovocyte and embryo quality. In order to optimise pregnancy rates, there is significant evidence that a morphological scoring system is the best strategy for the selection of embryos. Since 2009 where the first time-lapse microscopy system for IVF was approved for clinical use, morphokinetic scoring systems has shown to improve to pregnancy rates further. However, when all different types of time-lapse embryo imaging devices, with or without morphokinetic scoring systems, are compared against conventional embryo assessment for IVF, there is insufficient evidence of a difference in live-birth, pregnancy, stillbirth or miscarriage to choose between them. Active efforts to develop a more accurate embryo selection analysis based on Artificial Intelligence and Deep Learning are underway. Embryo Ranking Intelligent Classification Assistant (ERICA), is a clear example. This Deep Learning software substitutes manual classifications with a ranking system based on an individual embryo's predicted genetic status in a non-invasive fashion. Studies on this area are still pending and current feasibility studies support its potential.

Embryo transfer

The number to be transferred depends on the number available, the age of the woman and other health and diagnostic factors. In countries such as Canada, the UK, Australia and New Zealand, a maximum of two embryos are transferred except in unusual circumstances. In the UK and according to HFEA regulations, a woman over 40 may have up to three embryos transferred, whereas in the US, there is no legal limit on the number of embryos which may be transferred, although medical associations have provided practice guidelines. Most clinics and country regulatory bodies seek to minimise the risk of multiple pregnancy, as it is not uncommon for multiple embryos to implant if multiple embryos are transferred. Embryos are transferred to the patient's uterus through a thin, plastic catheter, which goes through her vagina and cervix. Several embryos may be passed into the uterus to improve chances of implantation and pregnancy.

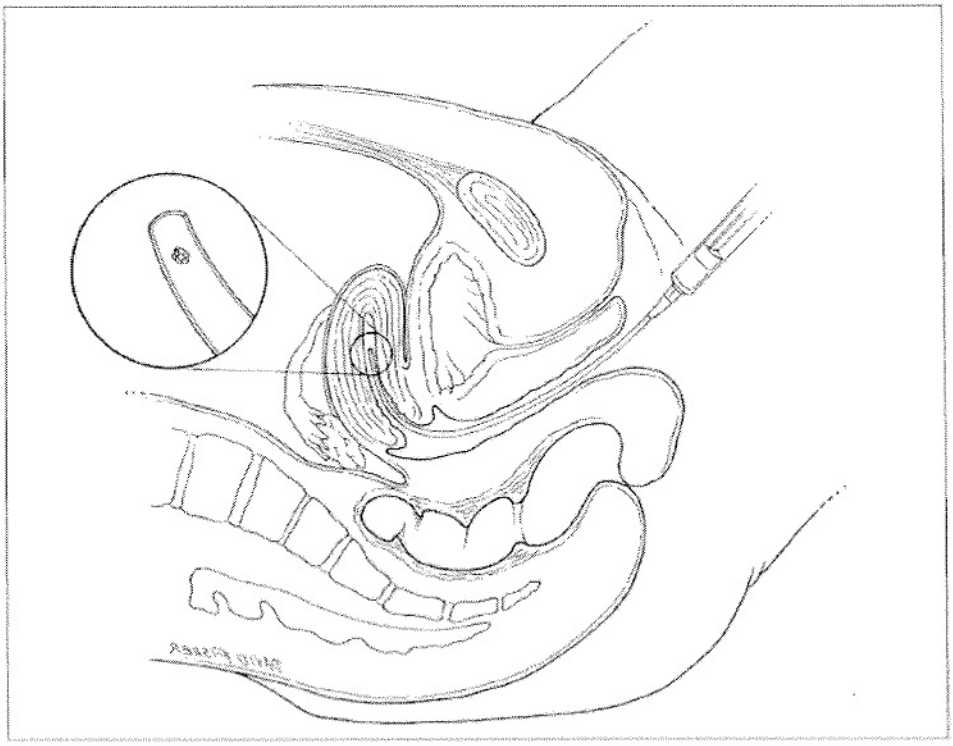


Figure 7. Embryo transfer is performed through the cervix.

Luteal support

Luteal support is the administration of medication, generally progesterone, progestins, hCG, or GnRH agonists, and often accompanied by estradiol, to increase the success rate of implantation and early embryogenesis, thereby complementing and/or supporting the function of the corpus luteum. A Cochrane review found that hCG or progesterone given during the luteal phase may be associated with higher rates of live birth or ongoing pregnancy, but that the evidence is not conclusive. Co-treatment with GnRH agonists appears to improve outcomes, by a live birth rate RD of +16% (95% confidence interval +10 to +22%). On the other hand, growth hormone or aspirin as adjunctive medication in IVF have no evidence of overall benefit.

Expansions

There are various expansions or additional techniques that can be applied in IVF, which are usually not necessary for the IVF procedure itself, but would be virtually impossible or technically difficult to perform without concomitantly performing methods of IVF.

Preimplantation genetic screening or diagnosis

Preimplantation genetic screening (PGS) or preimplantation genetic diagnosis (PGD) has been suggested to be able to be used in IVF to select an embryo that appears to have the greatest chances

for successful pregnancy. However, a systematic review and meta-analysis of existing randomised controlled trials came to the result that there is no evidence of a beneficial effect of PGS with cleavage-stage biopsy as measured by live birth rate. On the contrary, for women of advanced maternal age, PGS with cleavage-stage biopsy significantly lowers the live birth rate. Technical drawbacks, such as the invasiveness of the biopsy, and non-representative samples because of mosaicism are the major underlying factors for inefficacy of PGS.

Still, as an expansion of IVF, patients who can benefit from PGS/PGD include:

Couples who have a family history of inherited disease

Couples who want prenatal sex discernment. This can be used to diagnose monogenic disorders with sex linkage. It can potentially be used for sex selection, wherein a fetus is aborted if having an undesired sex.

Couples who already have a child with an incurable disease and need compatible cells from a second healthy child to cure the first, resulting in a "saviour sibling" that matches the sick child in HLA type.

PGS screens for numeral chromosomal abnormalities while PGD diagnosis the specific molecular defect of the inherited disease. In both PGS and PGD, individual cells from a pre-embryo, or preferably trophectoderm cells biopsied from a blastocyst, are analysed during the IVF process. Before the transfer of a pre-embryo back to a woman's uterus, one or two cells are removed from the pre-embryos (8-cell stage), or preferably from a blastocyst. These cells are then evaluated for normality. Typically within one to two days, following completion of the evaluation, only the normal pre-embryos are transferred back to the woman's uterus. Alternatively, a blastocyst can be cryopreserved via vitrification and transferred at a later date to the uterus. In addition, PGS can significantly reduce the risk of multiple pregnancies because fewer embryos, ideally just one, are needed for implantation.

Cryopreservation

Cryopreservation can be performed as oocyte cryopreservation before fertilisation, or as embryo cryopreservation after fertilisation.

The Rand Consulting Group has estimated there to be 400,000 frozen embryos in the United States in 2006. The advantage is that patients who fail to conceive may become pregnant using such embryos without having to go through a full IVF cycle. Or, if pregnancy occurred, they could return

later for another pregnancy. Spare oocytes or embryos resulting from fertility treatments may be used for oocyte donation or embryo donation to another woman or couple, and embryos may be created, frozen and stored specifically for transfer and donation by using donor eggs and sperm. Also, oocyte cryopreservation can be used for women who are likely to lose their ovarian reserve due to undergoing chemotherapy.

By 2022, many centers have adopted embryo cryopreservation as their primary IVF therapy, and perform few or no fresh embryo transfers. The two main reasons for this have been better endometrial receptivity when embryos are transferred in cycles without exposure to ovarian stimulation and also the ability to store the embryos while awaiting the results of pre-implantation genetic testing.

The outcome from using cryopreserved embryos has uniformly been positive with no increase in birth defects or development abnormalities.

Other expansions

Intracytoplasmic sperm injection (ICSI) is where a single sperm is injected directly into an egg. Its main usage as an expansion of IVF is to overcome male infertility problems, although it may also be used where eggs cannot easily be penetrated by sperm, and occasionally in conjunction with sperm donation. It can be used in teratozoospermia, since once the egg is fertilised abnormal sperm morphology does not appear to influence blastocyst development or blastocyst morphology.

Additional methods of embryo profiling. For example, methods are emerging in making comprehensive analyses of up to entire genomes, transcriptomes, proteomes and metabolomes which may be used to score embryos by comparing the patterns with ones that have previously been found among embryos in successful versus unsuccessful pregnancies.

Assisted zona hatching (AZH) can be performed shortly before the embryo is transferred to the uterus. A small opening is made in the outer layer surrounding the egg in order to help the embryo hatch out and aid in the implantation process of the growing embryo.

In egg donation and embryo donation, the resultant embryo after fertilisation is inserted in another woman than the one providing the eggs. These are resources for women with no eggs due to surgery, chemotherapy, or genetic causes; or with poor egg quality, previously unsuccessful IVF cycles or advanced maternal age. In the egg donor process, eggs are retrieved from a donor's ovaries, fertilised in the laboratory with the sperm from the recipient's partner, and the resulting healthy embryos are returned to the recipient's uterus.

In oocyte selection, the oocytes with optimal chances of live birth can be chosen. It can also be used as a means of preimplantation genetic screening.

Embryo splitting can be used for twinning to increase the number of available embryos.

Cytoplasmic transfer is where the cytoplasm from a donor egg is injected into an egg with compromised mitochondria. The resulting egg is then fertilised with sperm and implanted in a womb, usually that of the woman who provided the recipient egg and nuclear DNA. Cytoplasmic transfer was created to aid women who experience infertility due to deficient or damaged mitochondria, contained within an egg's cytoplasm.

Leftover embryos or eggs

Further information: Embryo donation and Egg donor

There may be leftover embryos or eggs from IVF procedures if the woman for whom they were originally created has successfully carried one or more pregnancies to term. With the woman's or couple's permission, these may be donated to help other women or couples as a means of third party reproduction.

In embryo donation, these extra embryos are given to other couples or women for transfer with the goal of producing a successful pregnancy. The resulting child is considered the child of the woman who carries it and gives birth, and not the child of the donor, the same as occurs with egg donation or sperm donation.

Typically, genetic parents donate the eggs to a fertility clinic or where they are preserved by oocyte cryopreservation or embryo cryopreservation until a carrier is found for them. Typically the process of matching the embryo(s) with the prospective parents is conducted by the agency itself, at which time the clinic transfers ownership of the embryos to the prospective parents.

In the United States, women seeking to be an embryo recipient undergo infectious disease screening required by the U.S. Food and Drug Administration (FDA), and reproductive tests to determine the best placement location and cycle timing before the actual Embryo Transfer occurs. The amount of screening the embryo has already undergone is largely dependent on the genetic parents' own IVF clinic and process. The embryo recipient may elect to have her own embryologist conduct further testing.

Alternatives to donating unused embryos are destroying them (or having them implanted at a time where pregnancy is very unlikely),keeping them frozen indefinitely, or donating them for use in

research (which results in their unviability). Individual moral views on disposing leftover embryos may depend on personal views on the beginning of human personhood and definition and/or value of potential future persons and on the value that is given to fundamental research questions. Some people believe donation of leftover embryos for research is a good alternative to discarding the embryos when patients receive proper, honest and clear information about the research project, the procedures and the scientific values.

Risks

The majority of IVF-conceived infants do not have birth defects. However, some studies have suggested that assisted reproductive technology is associated with an increased risk of birth defects. Artificial reproductive technology is becoming more available. Early studies suggest that there could be an increased risk for medical complications with both the mother and baby. Some of these include low birth weight, placental insufficiency, chromosomal disorders, preterm deliveries, gestational diabetes, and pre-eclampsia (Aiken and Brockelsby).

In the largest U.S. study, which used data from a statewide registry of birth defects, 6.2% of IVF-conceived children had major defects, as compared with 4.4% of naturally conceived children matched for maternal age and other factors (odds ratio, 1.3; 95% confidence interval, 1.00 to 1.67). ART carries with it a risk for heterotopic pregnancy (simultaneous intrauterine and extrauterine pregnancy). The main risks are:

Genetic disorders

Low birth weight. In IVF and ICSI, a risk factor is the decreased expression of proteins in energy metabolism; Ferritin light chain and ATP5A1.

Preterm birth. Low birth weight and preterm birth are strongly associated with many health problems, such as visual impairment and cerebral palsy. Children born after IVF are roughly twice as likely to have cerebral palsy.

Sperm donation is an exception, with a birth defect rate of almost a fifth compared to the general population. It may be explained by that sperm banks accept only people with high sperm count.

Current data indicate little or no increased risk for postpartum depression among women who use ART.

Usage of assisted reproductive technology including ovarian stimulation and in vitro fertilization have been associated with an increased overall risk of childhood cancer in the offspring, which may be caused by the same original disease or condition that caused the infertility or subfertility in the mother or father.

That said, In a landmark paper by Jacques Balayla et al. it was determined that infants born after ART have similar neurodevelopment than infants born after natural conception.

Partner-assisted reproduction (Reciprocal IVF)

Reciprocal IVF was first introduced in Spain in 2009. Reciprocal IVF, Partner-assisted reproduction , reception of oocyctes from partner (ROPA), shared motherhood, partner IVF or co-IVF is a method of family building that is used by couples who both possess female reproductive organs. The method uses in vitro fertilization (IVF), a method that means eggs are removed from the ovaries, fertilized in a laboratory, and then one or more of the resulting embryos are placed in the uterus to hopefully create a pregnancy. Reciprocal IVF differs from standard IVF in that two women are involved: the eggs are taken from one partner, and the other partner carries the pregnancy. In this way, the process is mechanically identical to IVF with egg donation. Using this process ensures that each partner is a biological mother of the child. Usually lesbian couples opt this methods and a study published in February 2018 found a 60% live birth rate in a group of 120 lesbian couples who underwent reciprocal IVF

Artificial womb

An artificial uterus (or artificial womb) is a device that would allow for extracorporeal pregnancy by growing a fetus outside the body of an organism that would normally carry the fetus to term.

An artificial uterus, as a replacement organ, would have many applications. It could be used to assist male or female couples in the development of a fetus. This can potentially be performed as a switch from a natural uterus to an artificial uterus, thereby moving the threshold of fetal viability to a much earlier stage of pregnancy. In this sense, it can be regarded as a neonatal incubator with very extended functions. It could also be used for the initiation of fetal development. An artificial uterus could also help make fetal surgery procedures at an early stage an option instead of having to postpone them until term of pregnancy.

In 2016 scientists published two studies regarding human embryos developing for thirteen days within an ecto-uterine environment. Currently, a 14-day rule prevents human embryos from being kept in artificial wombs longer than 14 days. This rule has been codified into law in twelve countries. In 2022 fetal researchers at the Children's Hospital of Philadelphia published a study showing they had grown premature lamb fetuses for four weeks in an extra-uterine life support system.

Components

An artificial uterus, sometimes referred to as an 'exowomb', would have to provide nutrients and oxygen to nurture a fetus, as well as dispose of waste material. The scope of an artificial uterus (or "artificial uterus system" to emphasize a broader scope) may also include the interface serving the function otherwise provided by the placenta, an amniotic tank functioning as the amniotic sac, as well as an umbilical cord.

Nutrition, oxygen supply and waste disposal

A woman may still supply nutrients and dispose of waste products if the artificial uterus is connected to her. She may also provide immune protection against diseases by passing of IgG antibodies to the embryo or fetus.

Artificial supply and disposal have the potential advantage of allowing the fetus to develop in an environment that is not influenced by the presence of disease, environmental pollutants, alcohol, or drugs which a human may have in the circulatory system. There is no risk of an immune reaction towards the embryo or fetus that could otherwise arise from insufficient gestational immune tolerance. Some individual functions of an artificial supplier and disposer include:

Waste disposal may be performed through dialysis.

For oxygenation of the embryo or fetus, and removal of carbon dioxide, extracorporeal membrane oxygenation (ECMO) is a functioning technique, having successfully kept goat fetuses alive for up to 237 hours in amniotic tanks. ECMO is currently a technique used in selected neonatal intensive care units to treat term infants with selected medical problems that result in the infant's inability to survive through gas exchange using the lungs. However, the cerebral vasculature and germinal matrix are poorly developed in fetuses, and subsequently, there is an unacceptably high risk for intraventricular hemorrhage (IVH) if administering ECMO at a gestational age less than 32 weeks. Liquid ventilation has been suggested as an alternative method of oxygenation, or at least providing an intermediate stage between the womb and breathing in open air.

For artificial nutrition, current techniques are problematic. Total parenteral nutrition, as studied on infants with severe short bowel syndrome, has a 5-year survival of approximately 20%.

Issues related to hormonal stability also remain to be addressed.

Theoretically, animal suppliers and disposers may be used, but when involving an animal's uterus the technique may rather be in the scope of interspecific pregnancy.

Uterine wall

In a normal uterus, the myometrium of the uterine wall functions to expel the fetus at the end of a pregnancy, and the endometrium plays a role in forming the placenta. An artificial uterus may include components of equivalent function. Methods have been considered to connect an artificial placenta and other "inner" components directly to an external circulation.

Interface (artificial placenta)

An interface between the supplier and the embryo or fetus may be entirely artificial, e.g. by using one or more semipermeable membranes such as is used in extracorporeal membrane oxygenation (ECMO).

There is also potential to grow a placenta using human endometrial cells. In 2002, it was announced that tissue samples from cultured endometrial cells removed from a human donor had successfully grown. The tissue sample was then engineered to form the shape of a natural uterus, and human embryos were then implanted into the tissue. The embryos correctly implanted into the artificial uterus' lining and started to grow. However, the experiments were halted after six days to stay within the permitted legal limits of in vitro fertilisation (IVF) legislation in the United States.

A human placenta may theoretically be transplanted inside an artificial uterus, but the passage of nutrients across this artificial uterus remains an unsolved issue.

Amniotic tank (artificial amniotic sac)

The main function of an amniotic tank would be to fill the function of the amniotic sac in physically protecting the embryo or fetus, optimally allowing it to move freely. It should also be able to maintain an optimal temperature. Lactated Ringer's solution can be used as a substitute for amniotic fluid.

Umbilical cord

Theoretically, in case of premature removal of the fetus from the natural uterus, the natural umbilical cord could be used, kept open either by medical inhibition of physiological occlusion, by anti-coagulation as well as by stenting or creating a bypass for sustaining blood flow between the mother and fetus.

Assessment Procedure

Multiple choice questions based assessment after successful completion of theory and practical sessions

References

- Larsen's Human Embryology, 3rd Edition
- Langman's Human Embryology 9th Edition

Annexure- II

VALUE ADDED COURSE

A short course on Assisted reproductive technology (art) for medical undergraduates

ART01

List of Students Enrolled- February 2022

Sl. No.	Name of the Student	Reg. No
1	AARTHI.A	U16MB251
2	ABILASHA.K	U16MB252
3	ABITHA RAJLIN	U16MB253
4	ADAPALA PRIYANKA	U16MB254
5	ADHITHAYA RAJ .N	U16MB255
6	AJAY .N	U16MB256
7	AKSHYA .R	U16MB257
8	ALLARI KARTHIK ABHIROOP	U16MB258
9	AMAL ASHOK	U16MB259
10	AMIRTHAVARSHNI .R	U16MB260
11	ANANYA SHARMA	U16MB261
12	ANGALAKUDURU DEEPCHAND	U16MB262
13	ANJAN BANERJEE	U16MB263
14	ANWESHA CHATTERJEE	U16MB264
15	ARCHANA .A	U16MB265
16	ARCHITHA.A	U16MB266
17	ARIVUMATHI .R	U16MB267
18	ARJUN.S	U16MB268
19	ASHVANTH KUMAR .A	U16MB269
20	ASMITHA S.V	U16MB270

Sri Lakshmi Narayana Institute of Medical Sciences

Value added course on Anatomy

A Short Course on Assisted Reproductive Technology (Art) for Medical Undergraduates

MCQs on Assisted Reproductive Technology

1. Sperm lysin, the enzymatic substance produced by sperms in mammals is known as
   (a) cryanogamone
   (b) hyaluronic acid
   (c) androgamone
   (d) hyaluronidase

2. What is the role of the The Human Fertilisation and Embryology Authority (HFEA)?

   (a) Issue licences for IVF treatment and inspect licensed premises
   (b) Register and inspect details relating to individual sperm donors for IVF treatment
   (c) Authorise individual sperm donors for IVF treatment
   (d) Register health professionals who can undertake IVF treatment

3. After a sperm has penetrated an ovum in the process of fertilization, entry of further sperms is prevented by

   (a) condensation of yolk
   (b) development of the vitelline membrane
   (c) formation of the fertilization membrane
   (d) development of the pigment coat

4. In the process of fertilization, this is true

   (a) the entry of sperm activates the egg for completing meiosis
   (b) only one sperm reaches the egg and enters it
   (c) only the acrosome of the sperm enters the egg
   (d) two haploid nuclei fuse and immediately divide to produce two nuclei, which are again haploid

5. In rabbits, humans and other placental mammals, fertilization occurs in

   (a) vagina
   (b) ovary
   (c) fallopian tubes
   (d) uterus

6. Which act governs the control of the external fertilisation of an egg, extracted from the ovary, with semen?
   (a) The Human Tissue Act 2004
   (b) The Human Rights Act 1998

(c) The Human Fertilisation and Embryology Act 1990
(d) The Human Organ Transplant Act 1986

7. This is a minute cell which separates from the animal egg during maturation is known as

(a) Primary oogonia
(b) secondary oogonia
(c) primary spermatogonia
(d) polar bodies

8. The nutritive medium for the ejaculated sperms is given by

(a) fallopian tube
(b) uterine lining
(c) seminal fluid
(d) vaginal fluid

9. This helps in the penetration of the egg by the sperm

(a) fertilization membrane
(b) antifertilizin
(c) sperm lysin
(d) fertilizin

10. In a man, sperms move after ejaculation at a rate of nearly

(a) 2 to 4 inches/minute
(b) 2 to 4 mm/minute
(c) 2 to 4 cm/minute
(d) 2 to 4 feet/minute

11. Which Artificial Reproductive Technique can help a lady conceive a child if both her fallopian tubes are blocked?

(a) SUZI
(b) IVF
(c) ZIFT
(d) GIFT

12. Test tube baby implies which of the following techniques?
    (a) IUI
    (b) ICSI
    (c) GIFT
    (d) ZIFT

13. In IVF technique zygote or early embryo is transferred into

    (a) Cervical canal
    (b) Uterus
    (c) Fallopian tube
    (d) Vagina

14. The initial step during fertilization is _____
    a) Penetration of sperm into egg
    b) Fertilizin and antifertilizin reaction
    c) Formation of fertilization membrane
    d) Formation of fertilization cone

15. Fertilization of sperm and ovum takes place in _____
    a) Ampulla of oviduct
    b) Isthmus of oviduct
    c) Fimbriae of oviduct
    d) Uterus

Answer key

Question number	Answer
1.	d
2.	a
3.	c
4.	a
5.	c
6.	c
7.	d
8.	c
9.	c
10.	b
11.	b
12.	d

13.	c
14.	b
15.	a

Roll no: 15
A-ARCHANA

Sri Lakshmi Narayana Institute of Medical Sciences

Value added course on Anatomy

A Short Course on Assisted Reproductive Technology (Art) for Medical Undergraduates

MCQs on Assisted Reproductive Technology

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12/15 B

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C

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A

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   (a) vagina
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   (d) uterus

C

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6

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D

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   (b) 2 to 4 mm/minute
   (c) 2 to 4 cm/minute
   (d) 2 to 4 feet/minute

11. Which Artificial Reproductive Technique can help a lady conceive a child if both her fallopian tubes are blocked?
   (a) SUZI
   (b) IVF
   (c) ZIFT
   (d) GIFT

12. Test tube baby implies which of the following techniques?
   (a) IUI
   (b) ICSI
   (c) GIFT
   (d) ZIFT

13. In IVF technique zygote or early embryo is transferred into
   (a) Cervical canal
   (b) Uterus
   (c) Fallopian tube
   (d) Vagina

14. The initial step during fertilization is _____
   a) Penetration of sperm into egg
   b) Fertilizin and antifertilizin reaction
   c) Formation of fertilization membrane
   d) Formation of fertilization cone

15. Fertilization of sperm and ovum takes place in _____
   a) Ampulla of oviduct
   b) Isthmus of oviduct
   c) Fimbriae of oviduct
   d) Uterus

Abitha Rajilin
R.No.3

Sri Lakshmi Narayana Institute of Medical Sciences

Value added course on Anatomy

A Short Course on Assisted Reproductive Technology (Art) for Medical Undergraduates

MCQs on Assisted Reproductive Technology

14/15

1. Sperm lysin, the enzymatic substance produced by sperms in mammals is known as
   (a) cryanogamone
   (b) hyaluronic acid
   (c) androgamone
   (d) hyaluronidase

D

2. What is the role of the The Human Fertilisation and Embryology Authority (HFEA)?
   (a) Issue licences for IVF treatment and inspect licensed premises
   (b) Register and inspect details relating to individual sperm donors for IVF treatment
   (c) Authorise individual sperm donors for IVF treatment
   (d) Register health professionals who can undertake IVF treatment

A

3. After a sperm has penetrated an ovum in the process of fertilization, entry of further sperms is prevented by
   (a) condensation of yolk
   (b) development of the vitelline membrane
   (c) formation of the fertilization membrane
   (d) development of the pigment coat

C

4. In the process of fertilization, this is true
   (a) the entry of sperm activates the egg for completing meiosis
   (b) only one sperm reaches the egg and enters it
   (c) only the acrosome of the sperm enters the egg
   (d) two haploid nuclei fuse and immediately divide to produce two nuclei, which are again haploid

A

5. In rabbits, humans and other placental mammals, fertilization occurs in
   (a) vagina
   (b) ovary
   (c) fallopian tubes
   (d) uterus

C

6. Which act governs the control of the external fertilisation of an egg, extracted from the ovary, with semen?
   (a) The Human Tissue Act 2004
   (b) The Human Rights Act 1998
   (c) The Human Fertilisation and Embryology Act 1990
   (d) The Human Organ Transplant Act 1986

C

7. This is a minute cell which separates from the animal egg during maturation is known as
   (a) Primary oogonia
   (b) secondary oogonia
   (c) primary spermatogonia
   (d) polar bodies

D

8. The nutritive medium for the ejaculated sperms is given by
   (a) fallopian tube
   (b) uterine lining
   (c) seminal fluid
   (d) vaginal fluid

C

9. This helps in the penetration of the egg by the sperm
   (a) fertilization membrane
   (b) antifertilizin
   (c) sperm lysin
   (d) fertilizin

C

10. In a man, sperms move after ejaculation at a rate of nearly
   (a) 2 to 4 inches/minute
   (b) 2 to 4 mm/minute
   (c) 2 to 4 cm/minute
   (d) 2 to 4 feet/minute

B

11. Which Artificial Reproductive Technique can help a lady conceive a child if both her fallopian tubes are blocked?
   (a) SUZI
   (b) IVF
   (c) ZIFT
   (d) GIFT

B

12. Test tube baby implies which of the following techniques?
   (a) IUI
   (b) ICSI
   (c) GIFT
   (d) ZIFT

D

13. In IVF technique zygote or early embryo is transferred into
   (a) Cervical canal
   (b) Uterus
   (c) Fallopian tube
   (d) Vagina

C

14. The initial step during fertilization is _____
   a) Penetration of sperm into egg
   b) Fertilizin and antifertilizin reaction
   c) Formation of fertilization membrane
   d) Formation of fertilization cone

D

15. Fertilization of sperm and ovum takes place in _____
   a) Ampulla of oviduct
   b) Isthmus of oviduct
   c) Fimbriae of oviduct
   d) Uterus

A

Annexure 5

Student Feedback Form

Course Name: : "A Short Course on Assisted Reproductive Technology (Art) for Medical Undergraduates"

Subject Code: ART01

Name of Student: Ananya Sharma **Roll No.:** 11

We are constantly looking to improve our classes and deliver the best training to you.

Your evaluations, comments and suggestions will help us to improve our performance:

Sl. No.	Particulars	1	2	3	4	5
1	Objective of the course is clear				✓	
2	Course contents met with your expectations				✓	
3	Lecturer sequence was well planned					✓
4	Lectures were clear and easy to understand				✓	
5	Teaching aids were effective					✓
6	Instructors encourage interaction and were helpful				✓	
7	The level of the course				✓	
8	Overall rating of the course	1	2	3	(4)	5

**** Rating: 5 – Outstanding; 4 - Excellent; 3 – Good; 2– Satisfactory; 1 - Not-Satisfactory***

Suggestions if any:

Annexure 5

Student Feedback Form

Course Name: : "A Short Course on Assisted Reproductive Technology (Art) for Medical Undergraduates"

Subject Code: ARTOI

Name of Student: ABITHA **Roll No.:** 03

We are constantly looking to improve our classes and deliver the best training to you.

Your evaluations, comments and suggestions will help us to improve our performance:

Sl. No.	Particulars	1	2	3	4	5
1	Objective of the course is clear					✓
2	Course contents met with your expectations					✓
3	Lecturer sequence was well planned					✓
4	Lectures were clear and easy to understand					✓
5	Teaching aids were effective					✓
6	Instructors encourage interaction and were helpful					✓
7	The level of the course					✓
8	Overall rating of the course	1	2	3	4	(5)

Rating: 5 – Outstanding; 4 - Excellent; 3 – Good; 2– Satisfactory; 1 - Not-Satisfactory

Suggestions if any:

Date: 03-03-2022

From

Dr. Somasekar I Tolanur
Professor and Head,
Department of Anatomy,
Sri Lakshmi Narayana Institute of Medical Sciences,
(BIHER University),
Puducherry - 2.

To

The Dean,
Sri Lakshmi Narayana Institute of Medical Sciences,
(BIHER University),
Puducherry - 2.

Sub: Completion of value-added course: "A Short Course on Assisted Reproductive Technology (Art) for Medical Undergraduates"**– Reg.**

Dear Sir,

With reference to the subject mentioned above, the Department of Anatomy has conducted the value-added course on "A Short Course on Assisted Reproductive Technology (Art) for Medical Undergraduates" during February 2022 for 1st year MBBS Students (2021-2022 Batch). We solicit your kind action to send certificates for the participants whose list is attached with this letter. Also I am attaching the photographs captured during the conduct of the course.

Kind Regards,

Encl: Participants List

Photograph

Annexure- II

VALUE ADDED COURSE

A Short Course on Assisted Reproductive Technology (Art) for Medical Undergraduates

List of Students Enrolled- **February 2022**

Sl. No.	Reg. No	Name of the Student	Sign
1	U16MB251	AARTHI.A	
2	U16MB252	ABILASHA.K	
3	U16MB253	ABITHA RAJLIN	
4	U16MB254	ADAPALA PRIYANKA	
5	U16MB255	ADHITHAYA RAJ .N	
6	U16MB256	AJAY .N	
7	U16MB257	AKSHYA .R	
8	U16MB258	ALLARI KARTHIK ABHIROOP	
9	U16MB259	AMAL ASHOK	
10	U16MB260	AMIRTHAVARSHNI .R	
11	U16MB261	ANANYA SHARMA	
12	U16MB262	ANGALAKUDURU DEEPCHAND	
13	U16MB263	ANJAN BANERJEE	
14	U16MB264	ANWESHA CHATTERJEE	
15	U16MB265	ARCHANA .A	
16	U16MB266	ARCHITHA.A	
17	U16MB267	ARIVUMATHI .R	
18	U16MB268	ARJUN.S	
19	U16MB269	ASHVANTH KUMAR .A	
20	U16MB270	ASMITHA S.V	

A short course on

ASSISTED REPRODUCTIVE TECHNOLOGY (ART) for medical undergraduates

Sri Lakshmi Narayana Institute of Medical Sciences

Affiliated to Bharath Institute of Higher Education & Research

(Deemed to be University under section 3 of the UGC Act 1956)

CERTIFICATE OF MERIT

This is to certify that **ANANYA SHARMA (U16MB261)** has actively participated in the Value Added Course on A Short Course on Assisted Reproductive Technology (Art) for Medical Undergraduates held during February 2022 Organized by Department of Anatomy, Sri Lakshmi Narayana Institute of Medical Sciences, Pondicherry- 605 502, India.

Dr. B Rajesh
Resource person

Ms. Santhi
Resource person

Dr. Somasekar I Tolanur
Co-ordinator

Dr. G Jayalakshmi
Dean

Sri Lakshmi Narayana Institute of Medical Sciences

Affiliated to Bharath Institute of Higher Education & Research

(Deemed to be University under section 3 of the UGC Act 1956)

CERTIFICATE OF MERIT

This is to certify that **ASHVANTH KUMAR .A (U16MB269)** has actively participated in the Value Added Course on A Short Course on Assisted Reproductive Technology (Art) for Medical Undergraduates held during February 2022 Organized by Department of Anatomy, Sri Lakshmi Narayana Institute of Medical Sciences, Pondicherry- 605 502, India.

Dr. B Rajesh
Resource person

Ms. Santhi
Resource person

Dr. Somasekar I Tolanur
Co-ordinator

Dr. G Jayalakshmi
Dean