

Teacher: Dr Gouri

**Course: Zoology Hons. 6th
sem**

Paper: Developmental Biology

**Unit 5 – Implications of
Developmental
Biology (ART)**

In vitro fertilization (IVF)

Definition:

In vitro fertilization (IVF) is commonly performed procedure of **Assisted Reproductive Technology (ART)** to treat infertility, in which the fertilization of oocytes is done outside the female body in the laboratory dish. For IVF, the eggs and sperms of the parents are retrieved and made to fertilize in vitro in the culture dish to obtain embryos which undergo cleavage and then they are transferred in the uterine cavity for implantation and complete gestation. The babies born using this technology are commonly called **Test-tube babies**. The basic steps of IVF are super-ovulation, oocyte aspiration, insemination, fertilization, embryo culture and embryo transfer.

History :

The first successful attempt of IVF was done by Charles Thibault and Louis Dausier using rabbit sperms. For humans the technique was developed by RG Edwards and PC Steptoe. RG Edwards was awarded with Nobel Prize in 2010 for the same. The first test tube baby Louise Brown was born on 25 July 1978, in England.

IVF Candidate/ Need of IVF:

It is usually needed for a couple who may have infertility problems due to variety or reasons.

1. Some causes of female infertility are tubal infertility, nonfunctional ovaries and uterus, endometriosis and immunological problems etc.

3. IVF is also beneficial for the couples who have family history of genetic abnormalities. Presence of deleterious genes can be tested during pre-implantation diagnosis of the in-vitro fertilized embryos.
4. IVF is also done to obtain zygotes with desired genetic characteristics for experimental purpose, and also to study early embryonic development.

IVF Procedure:

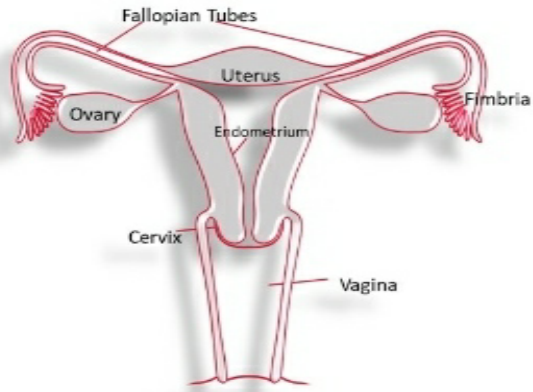
1. **Stimulation and monitoring of ovary:** the ovaries are stimulated to produce a large number of mature follicle (Super-ovulation). This is achieved by administering gonadotropin or clomiphene treatment. Superovulation is done to obtain large number of oocytes for fertilization in-vitro, which has limited success rate. (Under normal physiological condition a woman ovulates one egg during each cycle) Development of follicles and time of ovulation is monitored by clinical tests.
2. **Oocyte aspiration:** the oocytes at metaphase II stage are retrieved from Graafian follicles by using ultrasound guided laparoscopy aided needle aspiration (trans vaginal oocyte retrieval).
3. **Insemination and fertilization in-vitro:** the semen is collected from the male partner or frozen semen is also used. Healthy sperms are selected and processed for in-vitro capacitation. a total of 10,000 to 50,000 motile sperms are added to 1ml mature oocytes culture. After insemination, the oocytes are examined microscopically to find the presence of two pronuclei and two polar bodies is evidence of successful fertilization. Fertilized eggs are cultured for a day or two.

4. **Embryo Culture**- the fertilized oocytes are cultured invitro in sterile medium for 1-2 days to obtain pre-embryo with normal early development upto 32 –cell stage. These pre-embryos are placed back into the uterus of recipient for implantation and subsequent growth by the technique called Embryo Transfer(ET).
5. **Embryo Transfer (ET)** – after embryo culture, the embryos are introduced into the uterine cavity for implantation using a catheter called Embryo Transfer (ET). The transfer of morula or blastocyst into the fallopian tube is called **Intra Fallopian Transfer (IFT)** and into the uterus is called **Intra Uterine Transfer (IUT)**. The embryo when transferred in the cleavage stage has better chance of implantation. In case implantation fails, assisted hatching of embryo from its zona pellucida layer is done and inserted in the uterus. the remaining embryos are cryopreserved to be used again for ET if abortion occurs. The embryos can be transferred after IVF in the uterus of another woman who acts as surrogate mother.

Thus treatment of infertility through in-vitro fertilization and embryo transfer (IVF-ET) has gained much popularity, although it is used as last resort for carefully selected patients.

Step-by-step guide to IVF

Prestimulation Treatment



Evaluation of uterus and ovarian stimulation

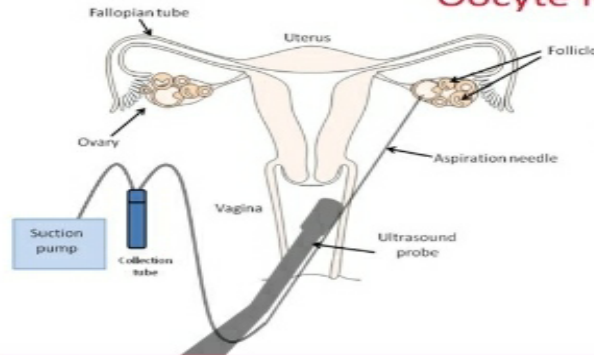
Monitoring Follicle Development

ultrasound and hormone measurements

Oocyte Maturation and hCG

Time of Injections and Egg Retrieval

Oocyte Retrieval



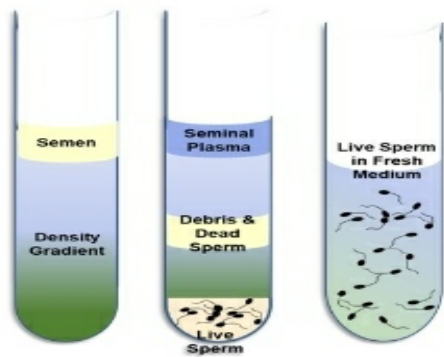
Follicles are drained

Intravenous sedation

Injury and infection are rare

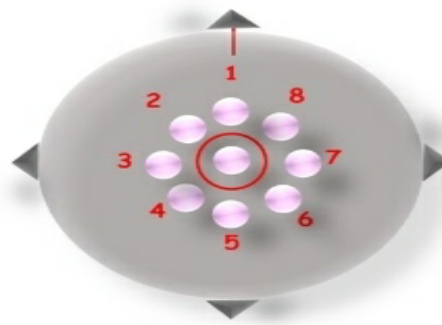
Step-by-step guide to IVF

Semen



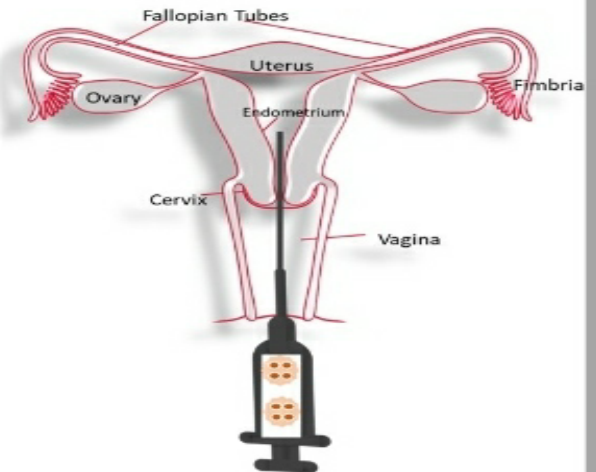
Semen collection protocols differ for IUI and IVF cases

Embryology Lab Procedures



Eggs and sperm in culture medium or the ICSI technique is used

Embryo Transfer



Different combinations or variants of IVF with other technique can also be applied to achieve better results. The other techniques are:

- A. **Intra Cytoplasmic Sperm Injection (ICSI)** – In this method, the sperms are directly introduced into mature oocytes which are retrieved by IVF method. It helps to increase the probability of fertilization. ICSI is used when there is abnormal sperm motility or failure of spermatids to develop into spermatozoa.
- B. **Gamete Intra Fallopian Transfer (GIFT)** - in this technique the gametes (both the egg and sperm) are placed in a fallopian tube so that they will mate naturally. In case the female has immunological problem of sperm rejection or blocked fallopian tubes, the gametes can be placed directly into the female genital tract.
- C. **Zygote Intra Fallopian Transfer (ZIFT)** – it is a combination of IVF and GIFT where the oocytes are collected by IVF and fertilized in-vitro. The zygote is then laproscopically transferred to the fallopian tube. This technique is also known as Tubal Embryo Transfer (TET). This is done for the women who have severe infertility problems.
- D. **Peritoneal/ Pronuclear Stage Tubal Transfer (PROST)**- in this technique the in-vitro fertilized oocyte (zygote) at pronuclear stage is transferred into fallopian tubes of the female. This is a relatively newer method of ART.
- E. **Artificial Insemination (IA)**- spermatozoa from fresh or frozen semen is transferred intravaginally or intracervically into the female genital tract to achieve fertilization.
- F. **Tubal Embryo Stage Transfer (TEST)** – in this technique, a multi cell embryo of 2-cell, 4-cell, 8-cell stage is transferred to fallopian tubes after in-vitro fertilization. Thus TEST is an extension of ZIFT.

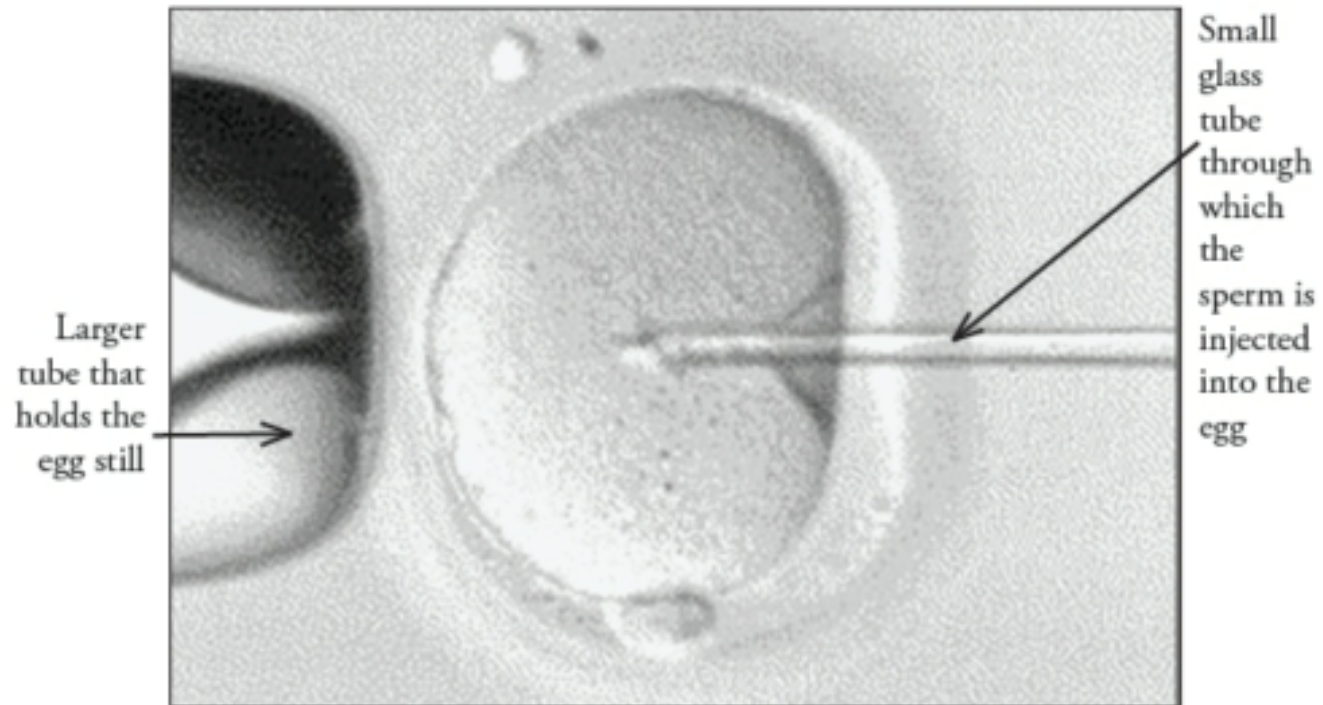
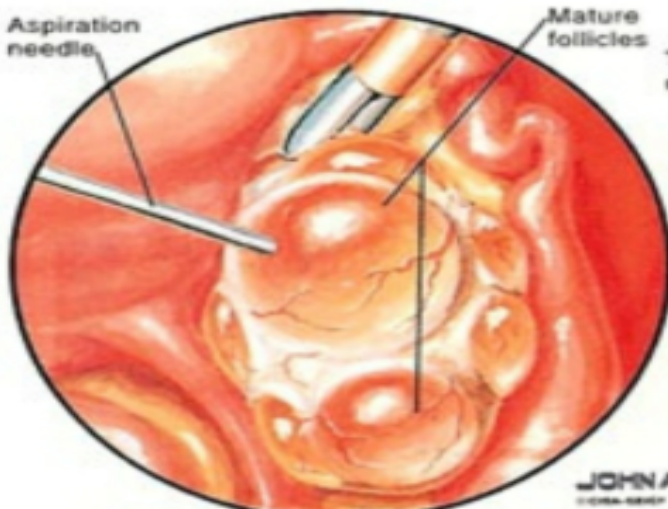
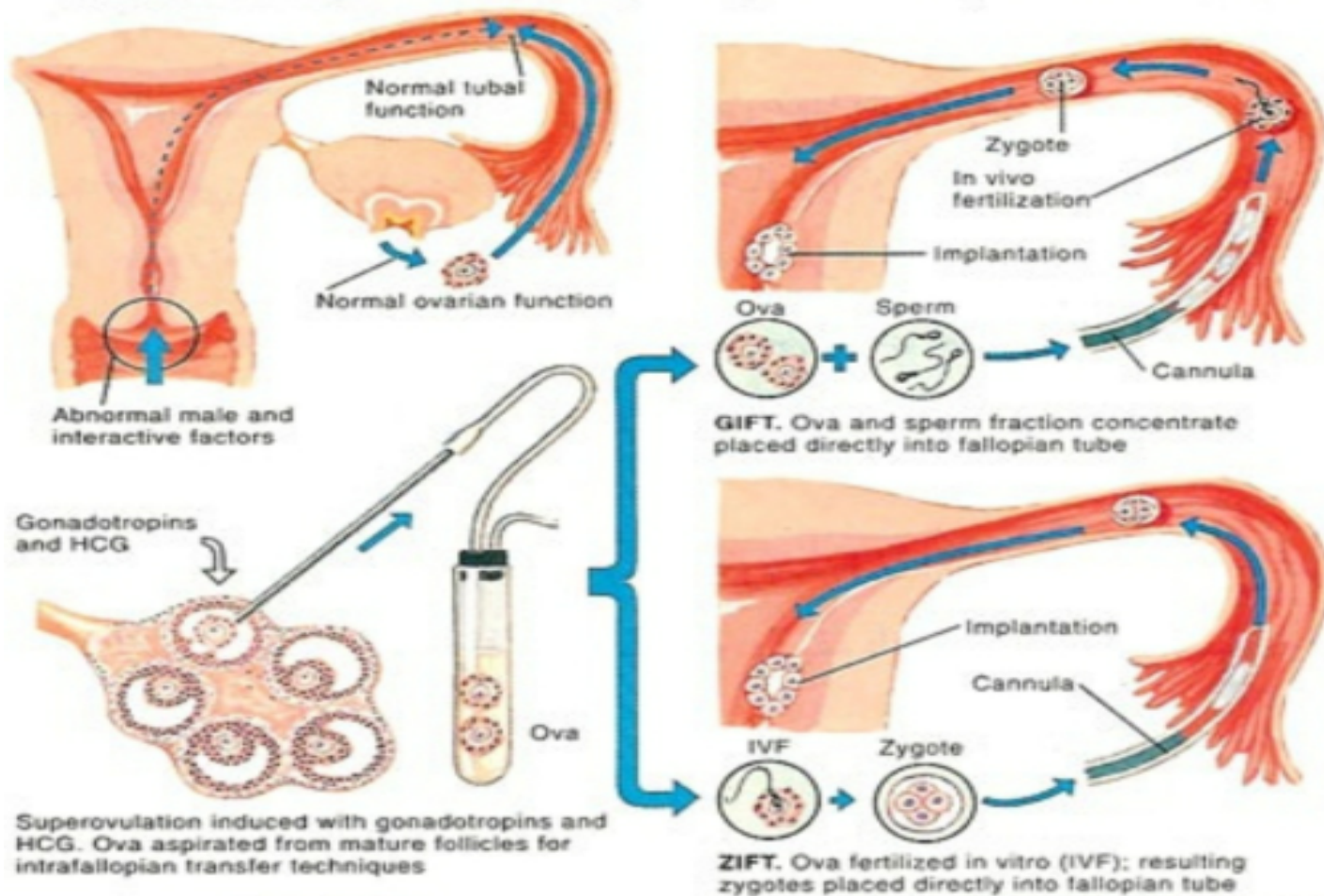


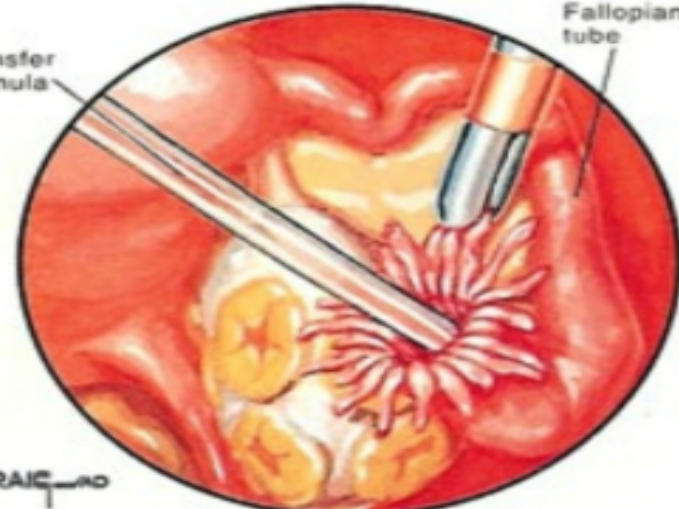
Figure 5. Intracytoplasmic sperm injection (ICSI), in which a sperm is injected directly into an egg to facilitate fertilization.

Ref: American society for Reproductive medicine
FAQs

Gamete Intrafallopian Transfer (GIFT) and Zygote Intrafallopian Transfer (ZIFT)



Laparoscopic aspiration of ova from mature follicles



Laparoscopic catheterization of fallopian tube for transfer of gametes or zygotes

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