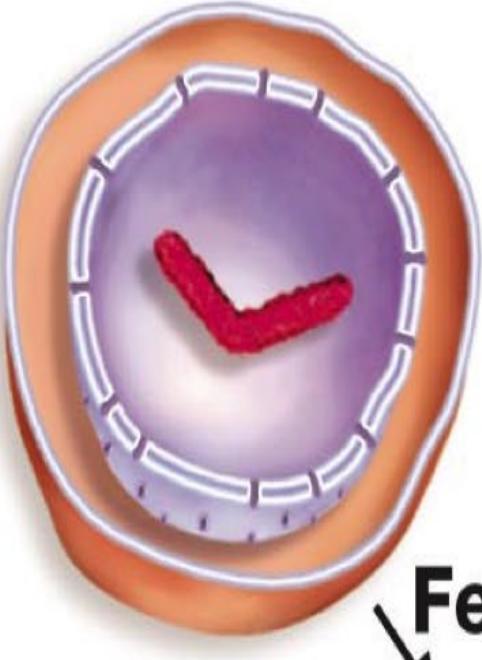


**A359**  
**Developmental Anatomy**  
**and Neuroscience**

**Learning Package 1**  
**Lesson 3**  
**Information Sheet**



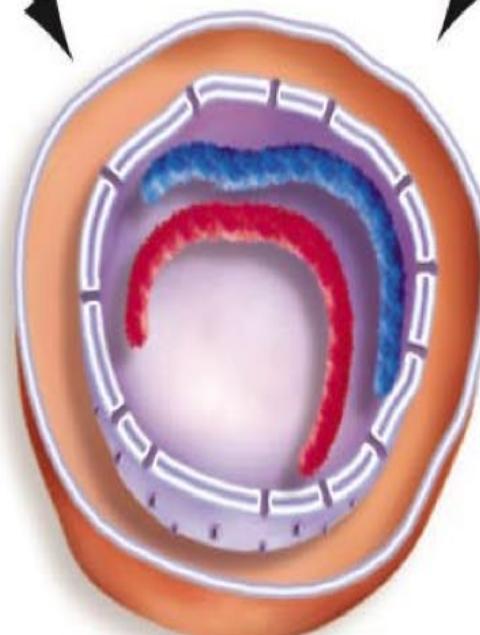
Female  
gamete  
(egg)  
 $(n)$



Male  
gamete  
(sperm)  
 $(n)$



Fertilization



Diploid offspring  
contains homologous  
pair of chromosomes

Zygote ( $2n$ )

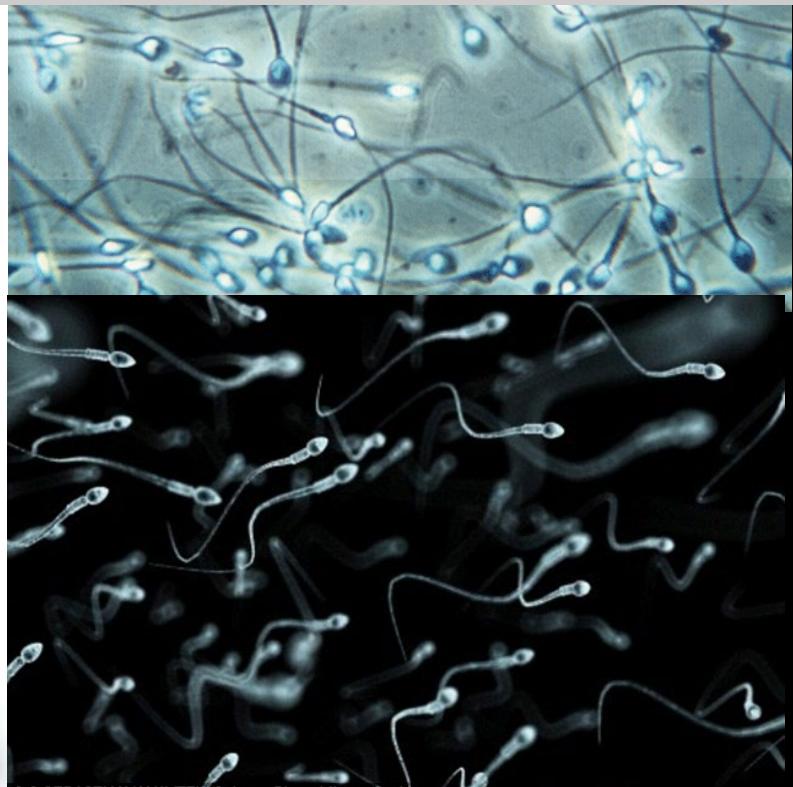
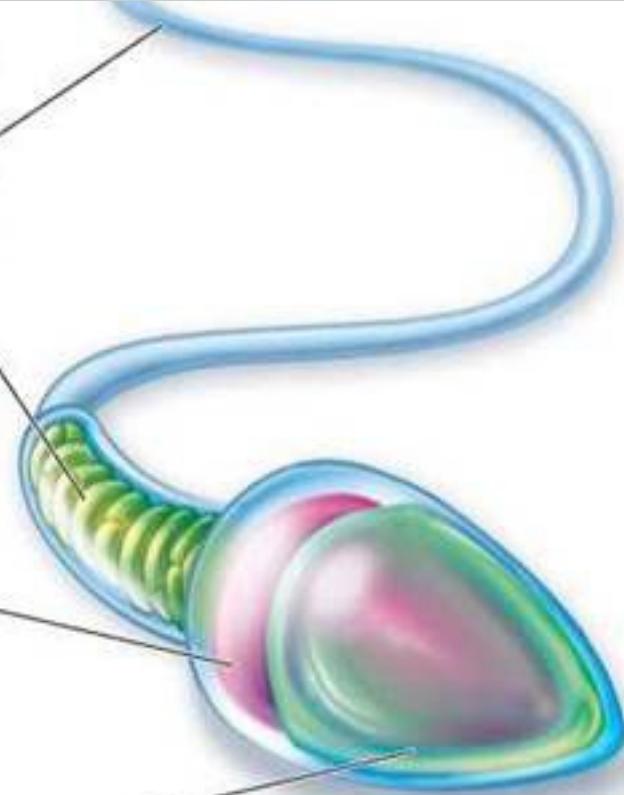
# Anatomical and physiological parts of sperm

The whiplike movements of the tail propel the sperm.

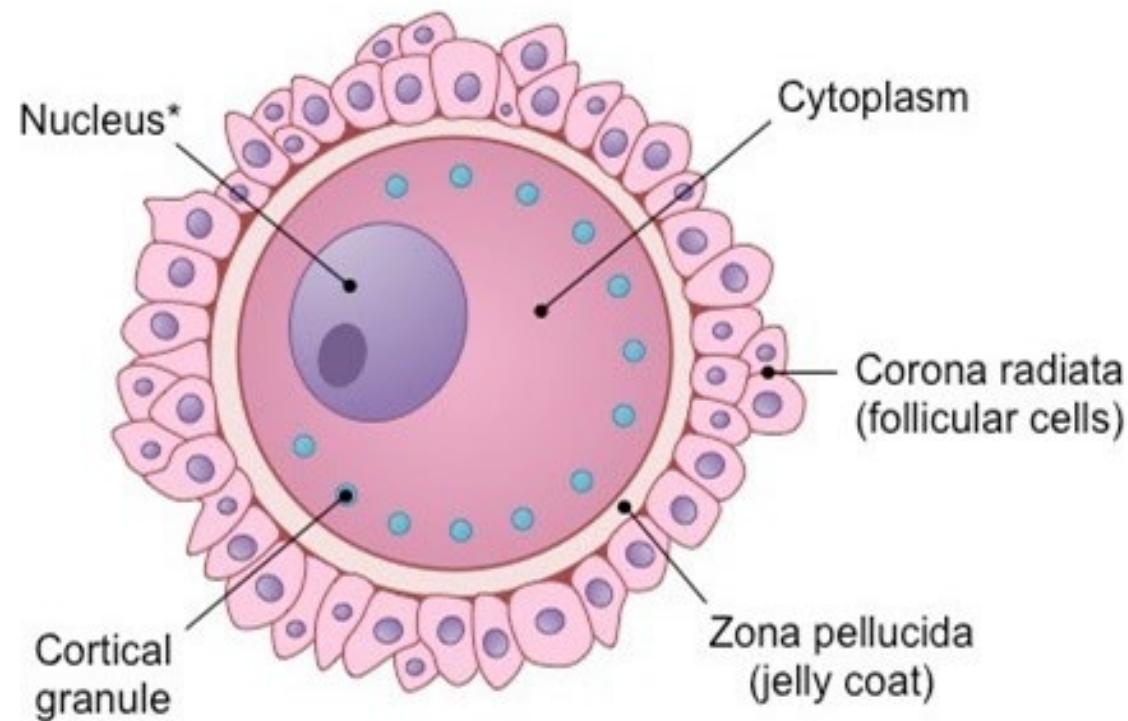
The midpiece contains mitochondria that will provide metabolic energy to fuel the trip to the egg.

The head contains the father's chromosomes, his genetic contribution to the next generation.

The acrosome, a sac that covers the head of the sperm, contains enzymes that will assist in fertilization.



# Anatomical and physiological parts of the ovum



A typical egg cell is surrounded by two distinct layers – the zona pellucida (jelly coat) and corona radiata.

ZP is a glycoprotein matrix which acts as a barrier to sperm entry.

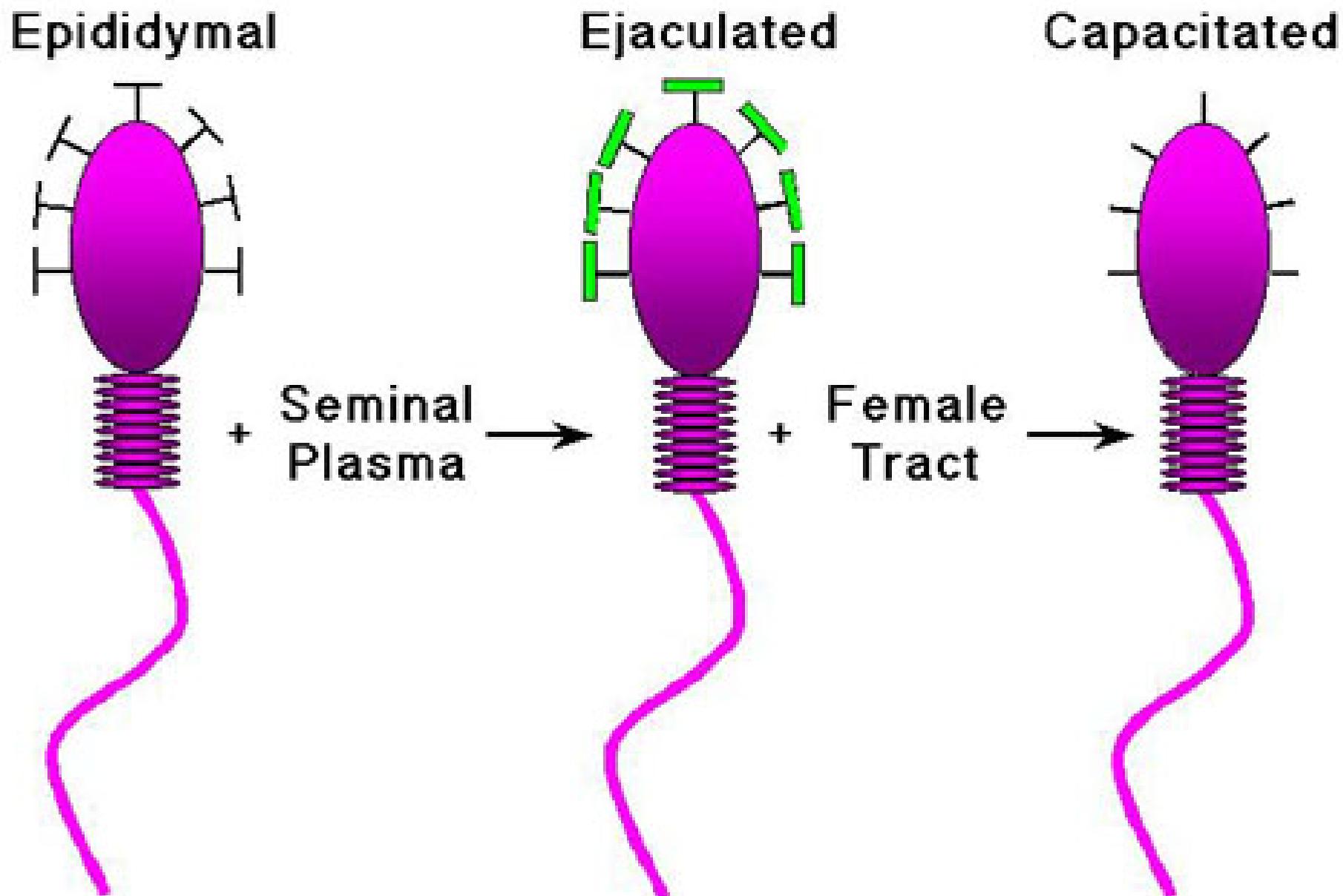
CR is an external layer of follicular cells which provide support and nourishment to the egg cell.

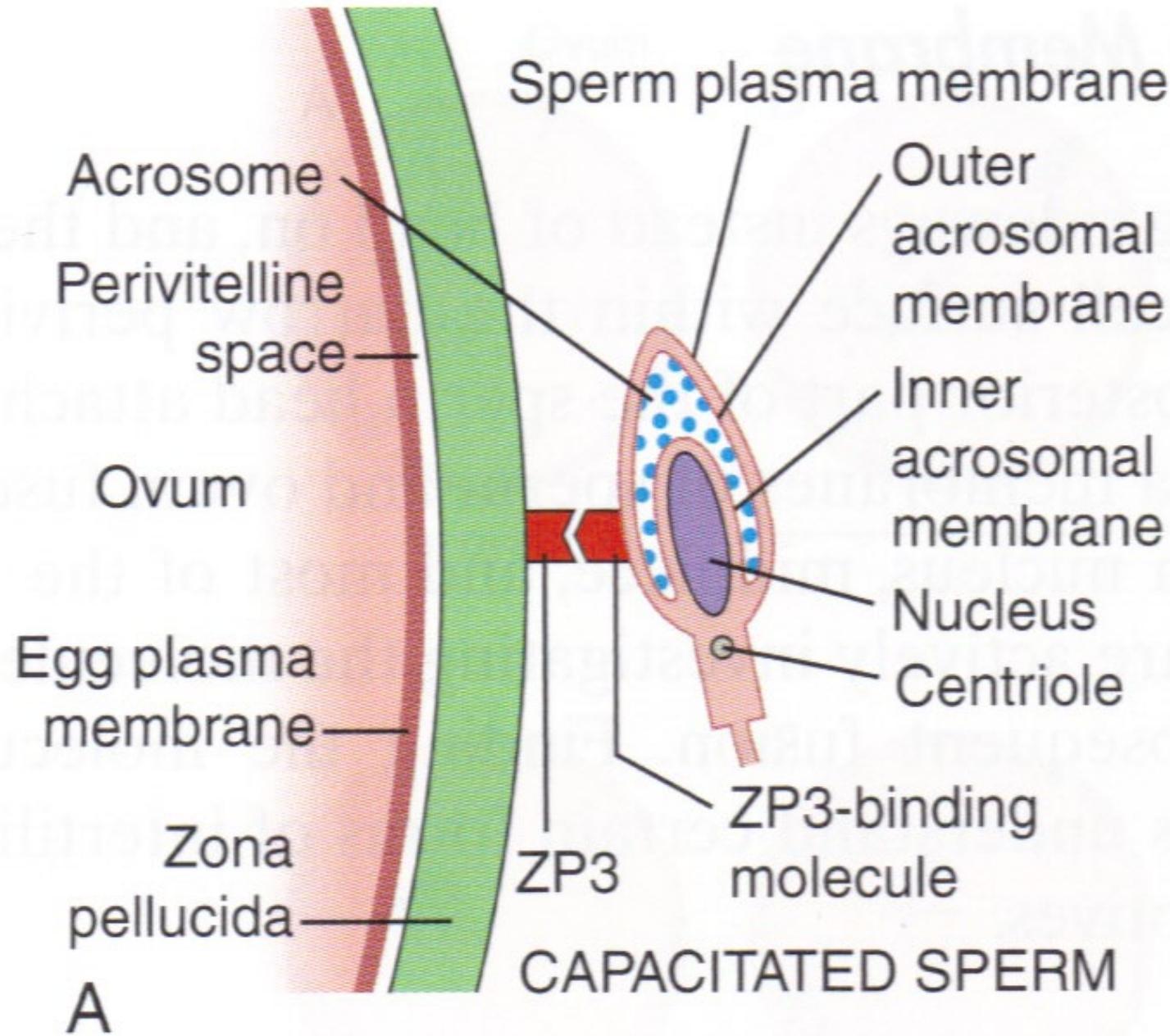
Within the egg cell lies the ooplasm (cytoplasm) which contains centrosome, centriole, mitochondria and cortical granules.

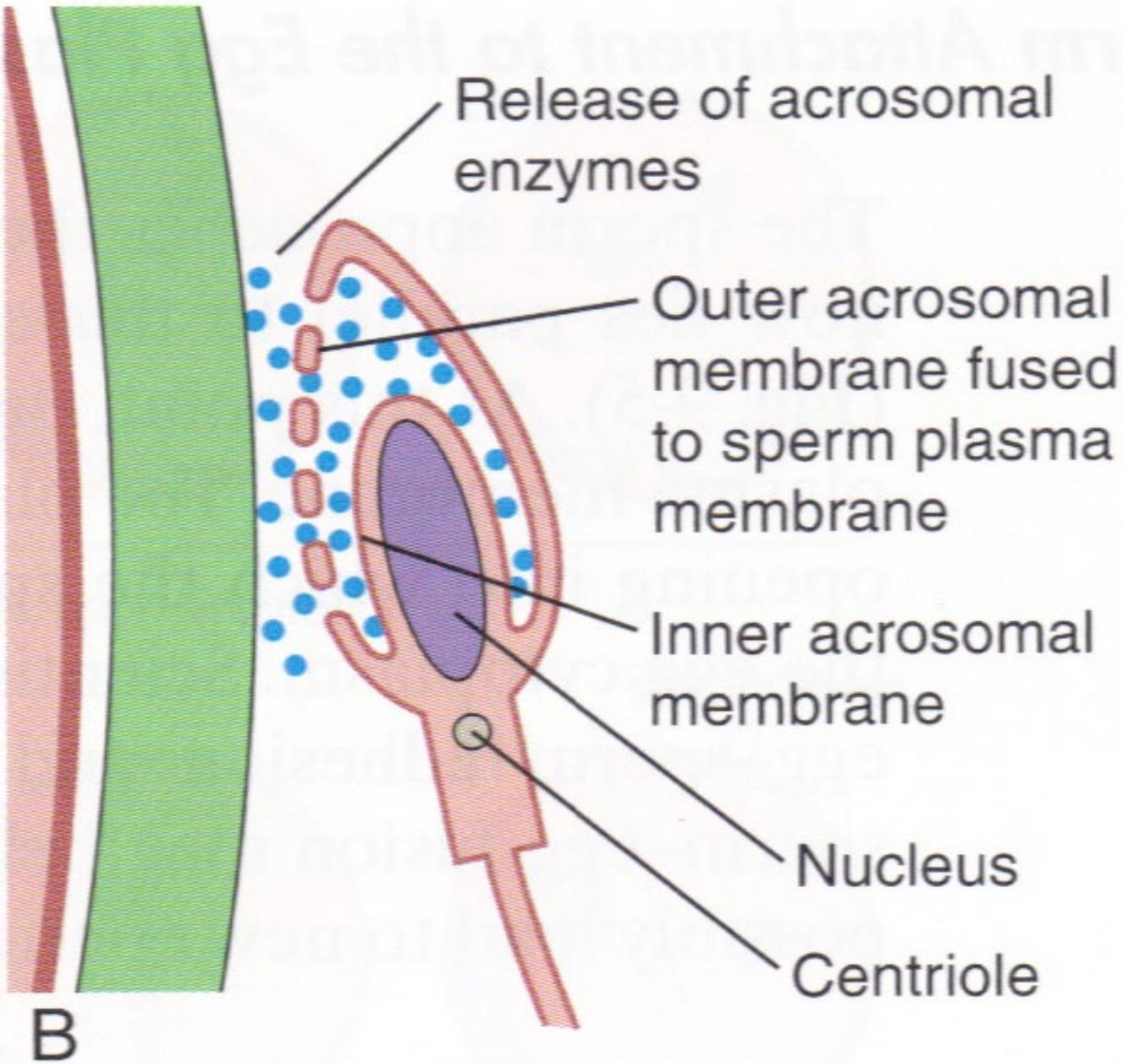
# Sequence of events in the process of fertilization?

- ◉ Preparation of the sperm:
  - Capacitation of human sperm
- ◉ Sperm-zona binding:
  - Receptor-ligand interaction
  - High degree of species specificity
- ◉ Acrosome reaction
  - Enzymatic drill of zona pellucida
  - Acrosin release
- ◉ Sperm egg fusion
  - Fertilin
  - Formation of male pronucleus
  - Formation of diploid nucleus
- ◉ Egg activation:
  - cortical reaction
  - Zona hardening to prevent polyspermy

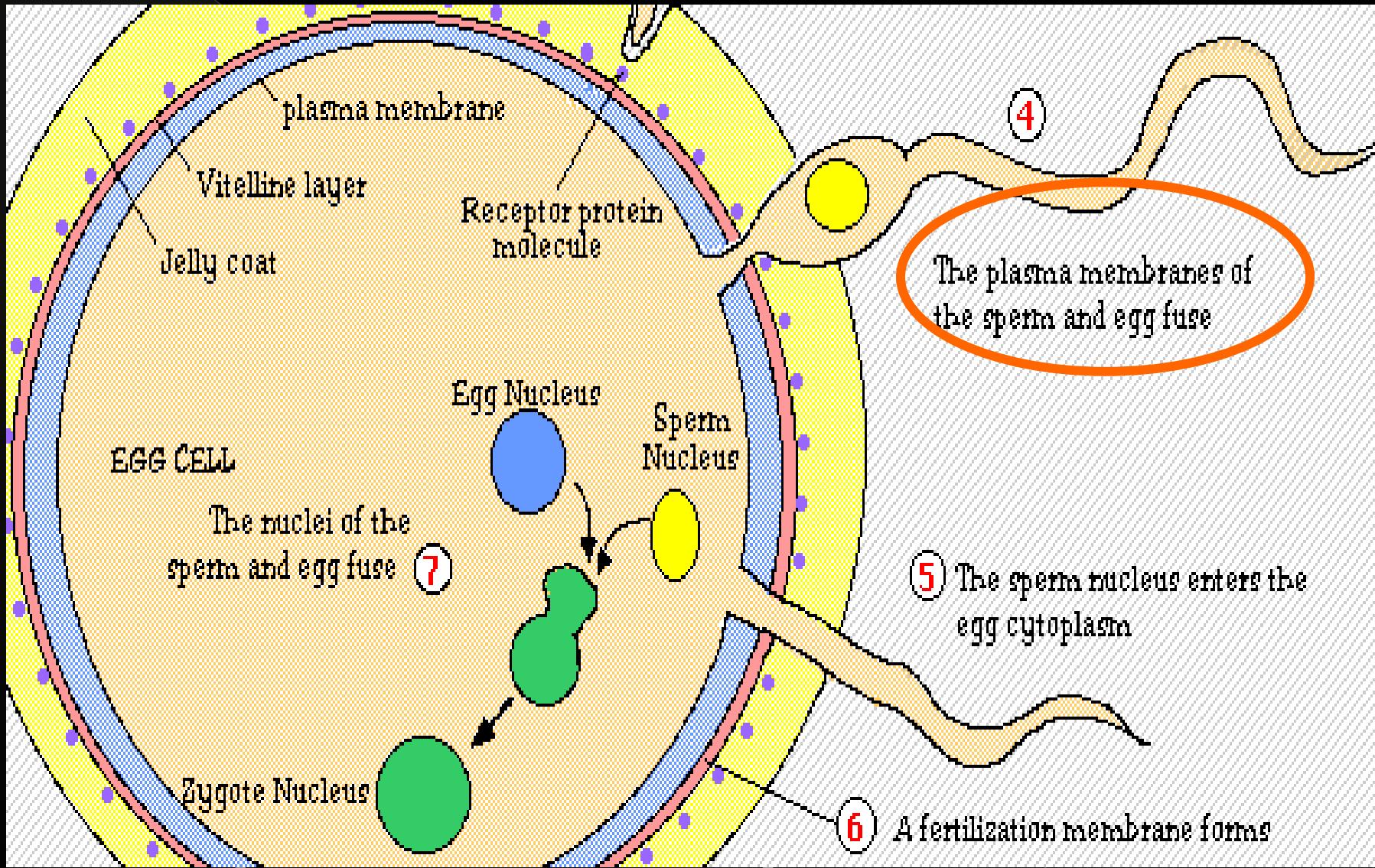
# Effect of Capacitation





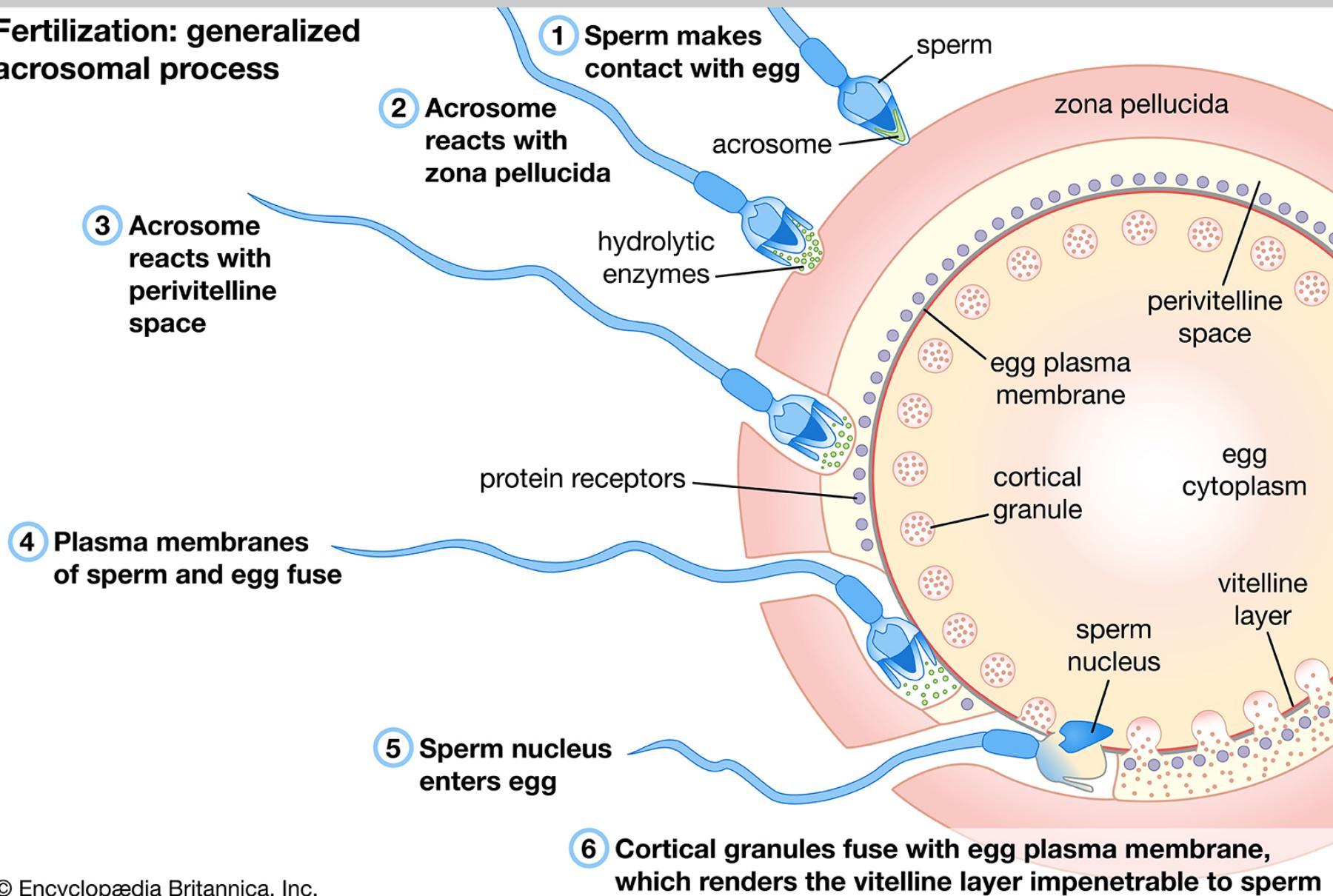


# The process of fertilization: Sperm Egg Fusion

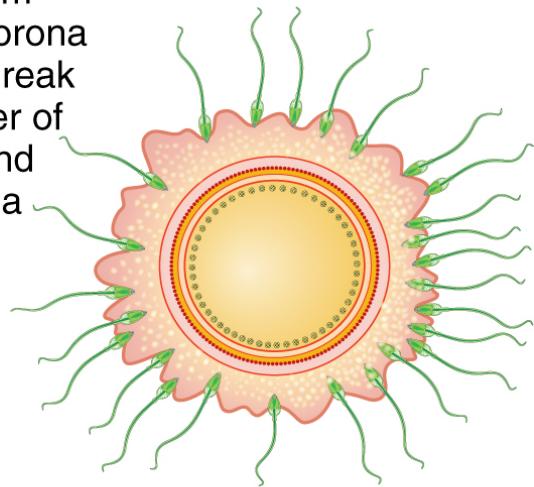


# The process of fertilization: Egg Activation

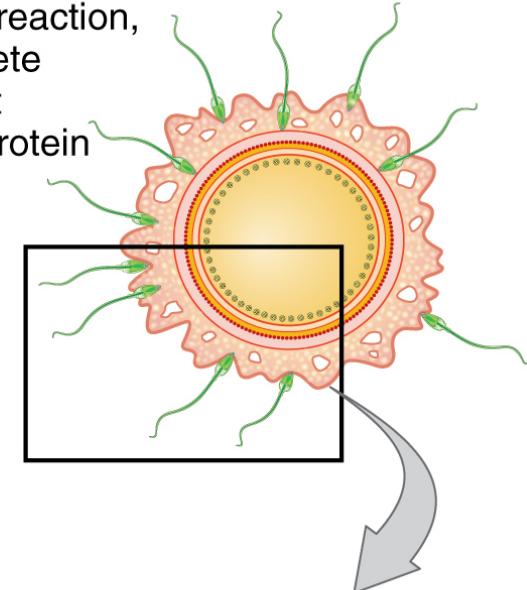
Fertilization: generalized acrosomal process



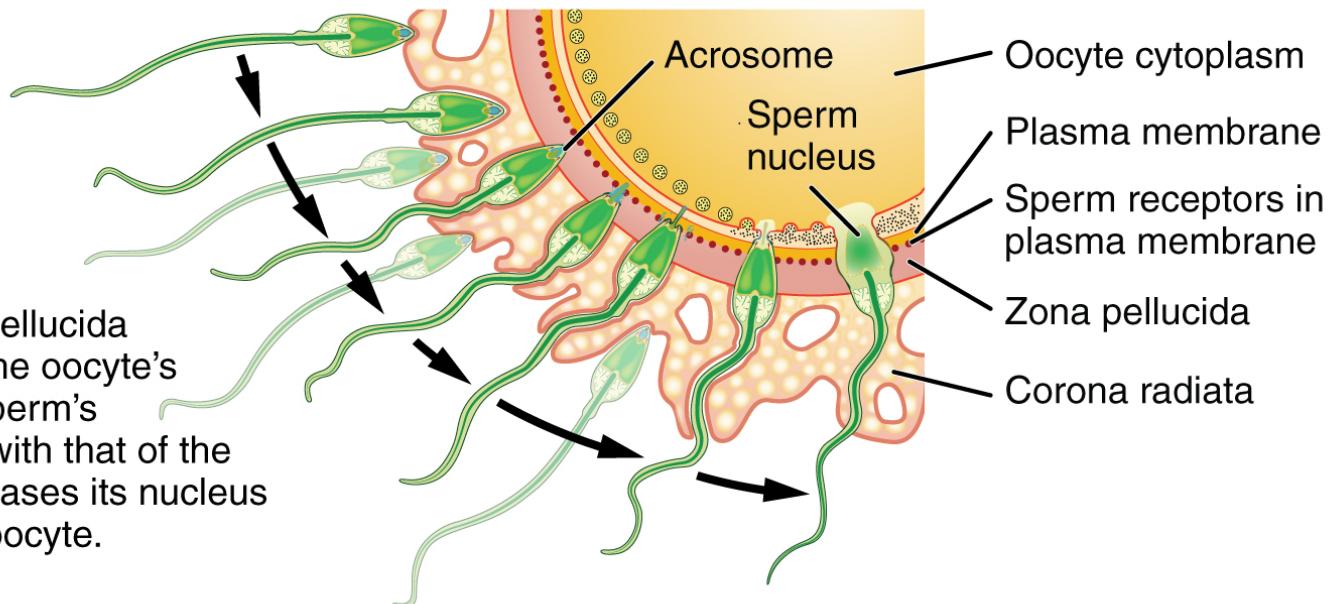
- ① Hundreds of sperm attracted to the corona radiata begin to break through the barrier of granulosa cells and approach the zona pellucida.



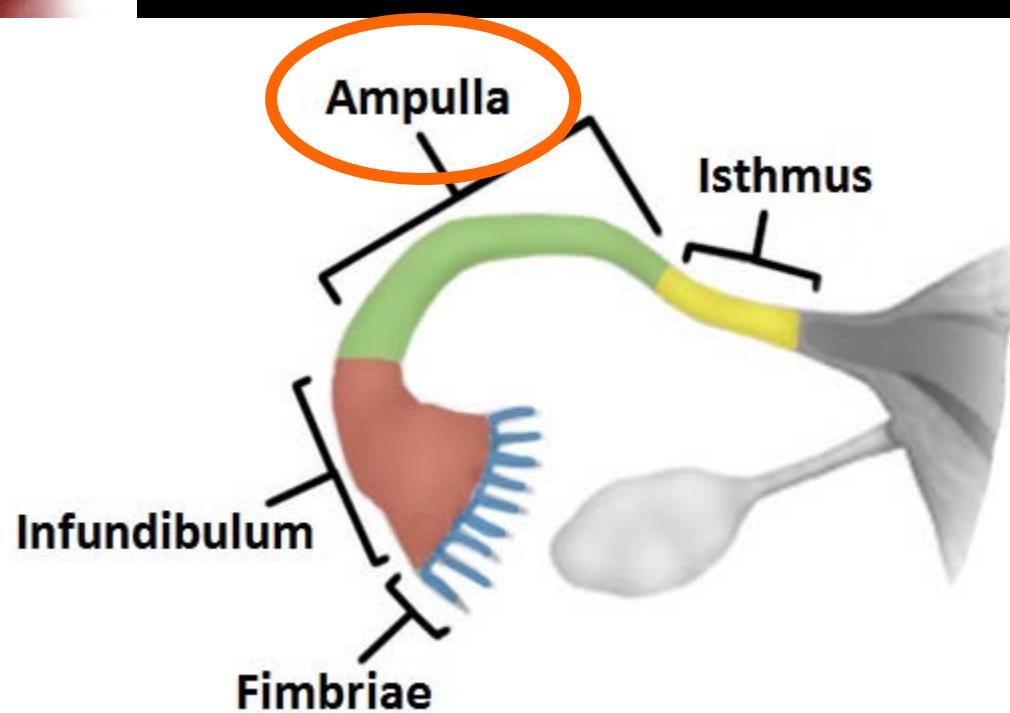
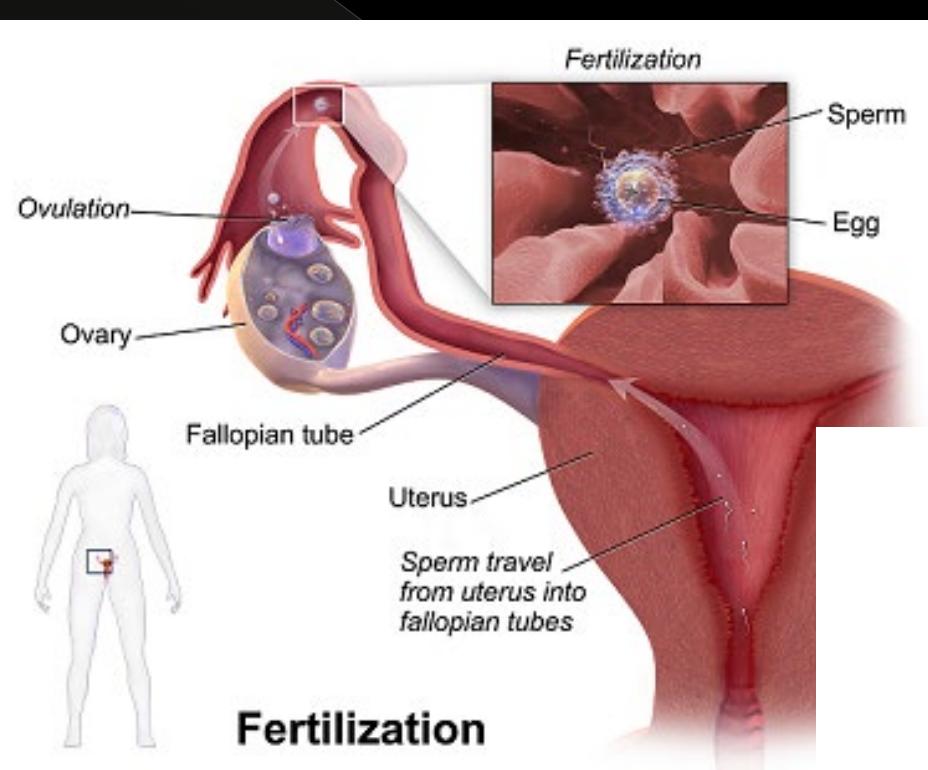
- ② Contact with the zona pellucida triggers the acrosome reaction, causing sperm to secrete digestive enzymes that break down the glycoprotein membrane of the zona pellucida and help to expose the oocyte's plasma membrane.



- ③ A single sperm succeeds in burrowing through the corona radiata and zona pellucida and making contact with the oocyte's plasma membrane. The sperm's plasma membrane fuses with that of the oocyte and the sperm releases its nucleus into the cytoplasm of the oocyte.



# Site of human fertilization: Fallopian Tube

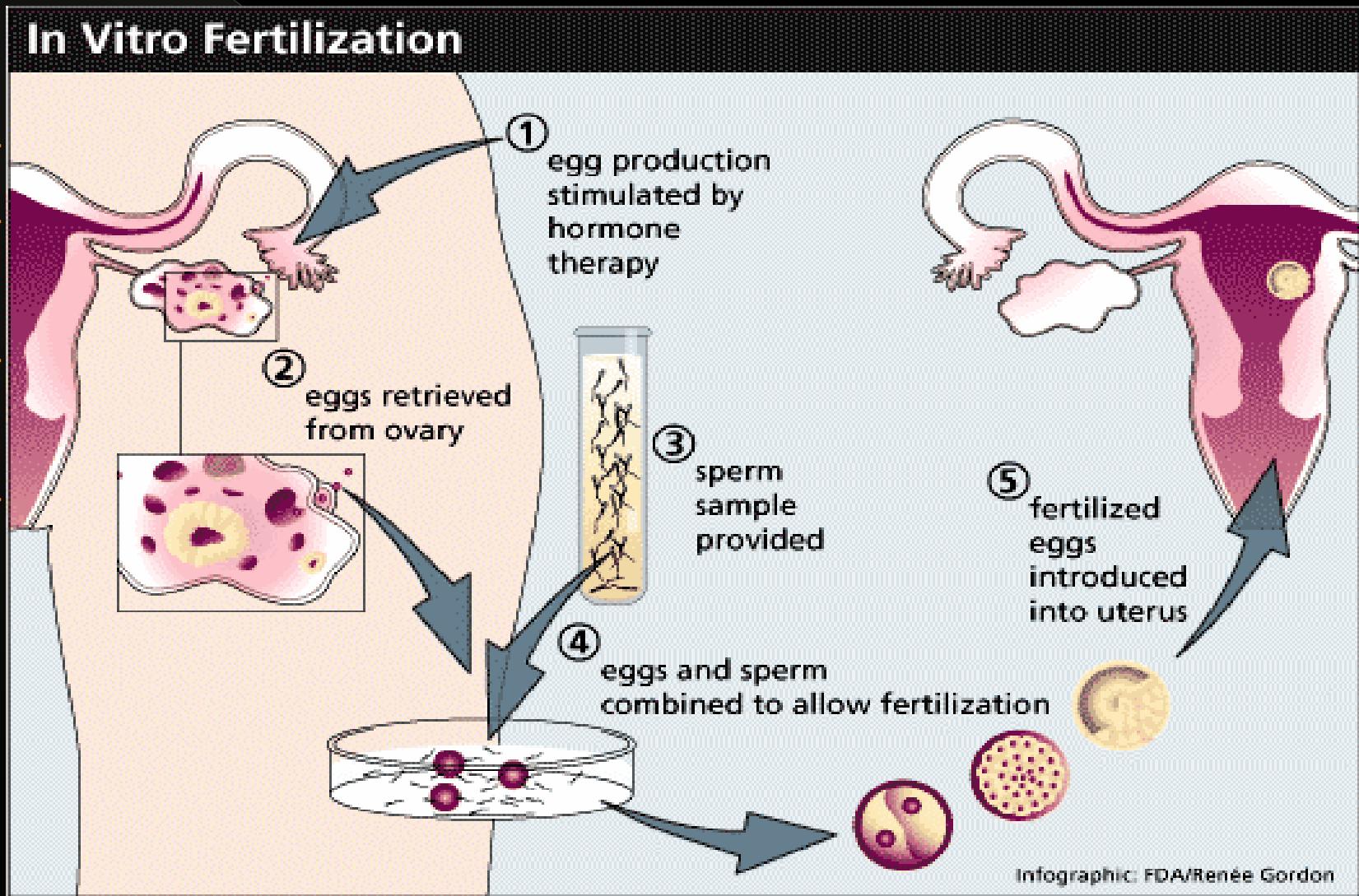


# Assisted Reproductive Therapy

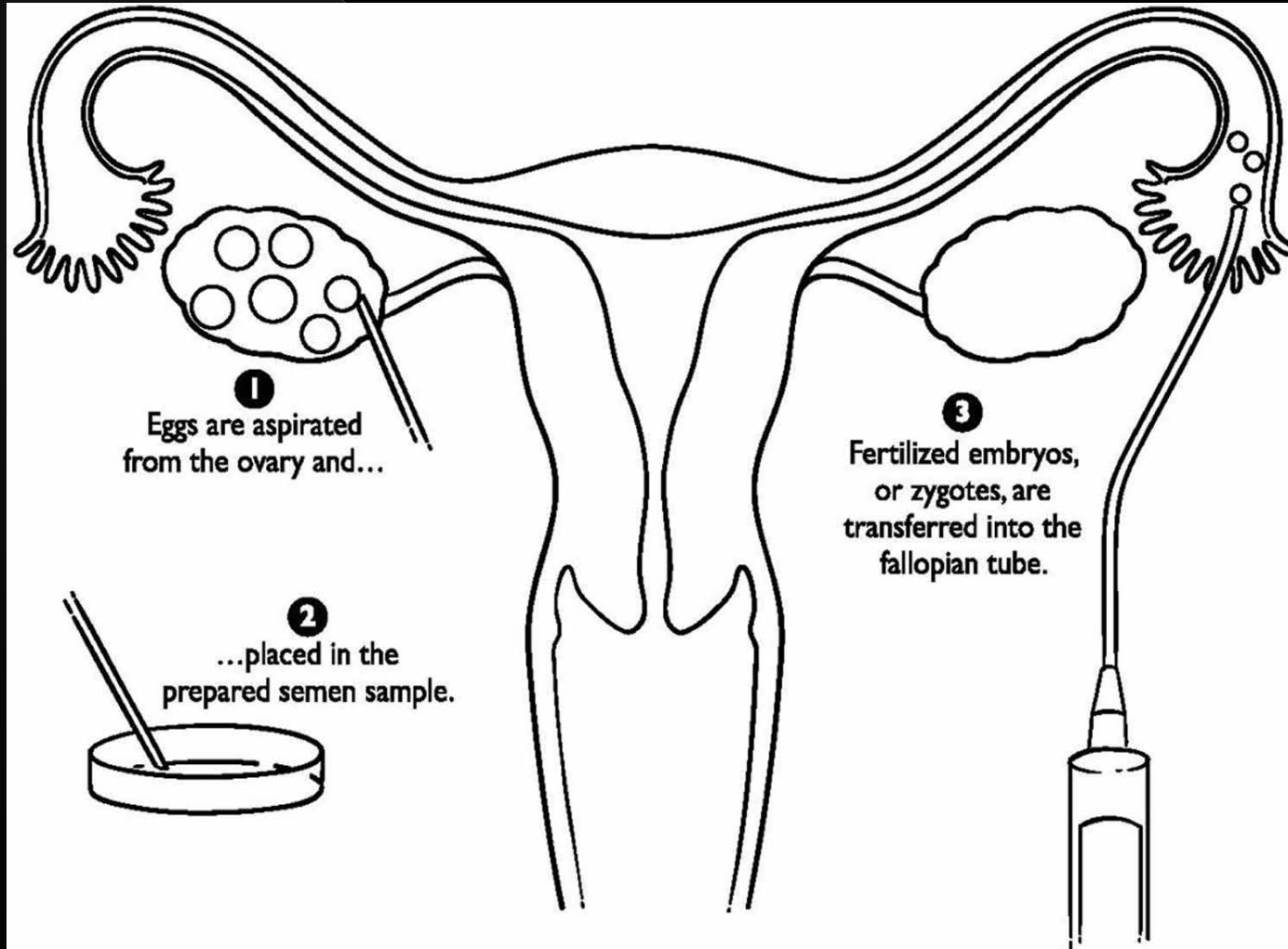
All treatments or procedures that include the in vitro handling of human oocytes and sperm or embryos for the purpose of establishing a pregnancy.

These techniques include In Vitro Fertilization(IVF), Gamete Intrafallopian Transfer, Zygote Intrafallopian Transfer, Intracytoplasmic Sperm Injection, Assisted Hatching.

# ART: In Vitro Fertilization



# ART: Zygote intrafallopian transfer

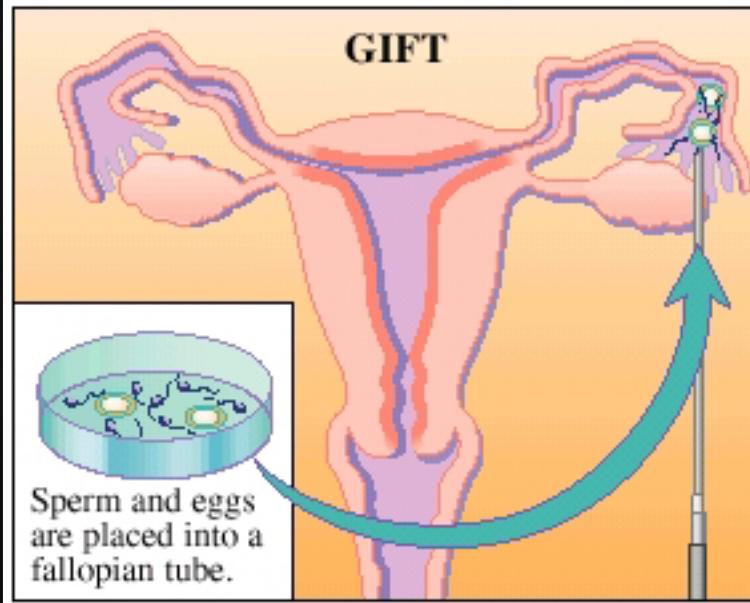


Egg and sperm are fertilized in vitro and then the zygote placed in the fallopian tube.

# ART: Gamete intrafallopian transfer

## GIFT

With GIFT, sperm and eggs are placed in a fallopian tube to allow fertilization in the natural site. The woman must have at least one normal, open fallopian tube.



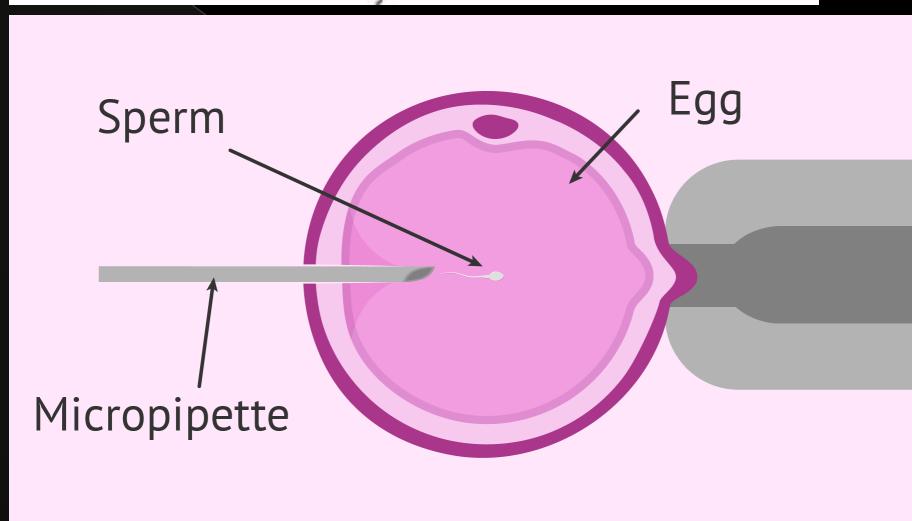
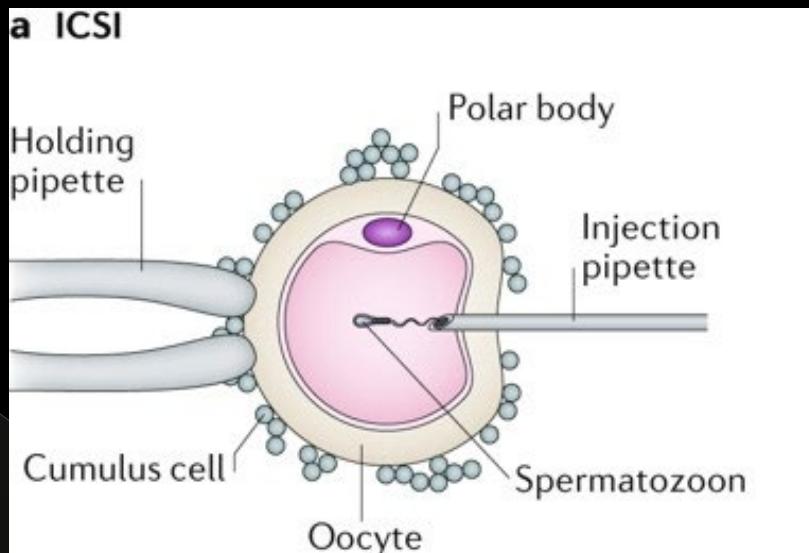
Egg and sperm mixture placed surgically into fallopian tube.

# ART: Intracytoplasmic Sperm Injection

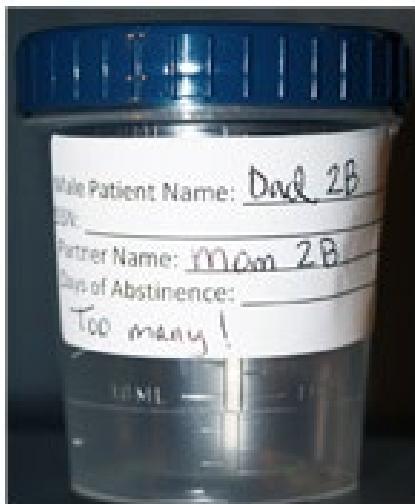
Injection of single mature immobilized normal spermatozoa into the cytoplasm of a mature metaphase II oocyte is known as intracytoplasmic sperm injection (ICSI).

## Indications:

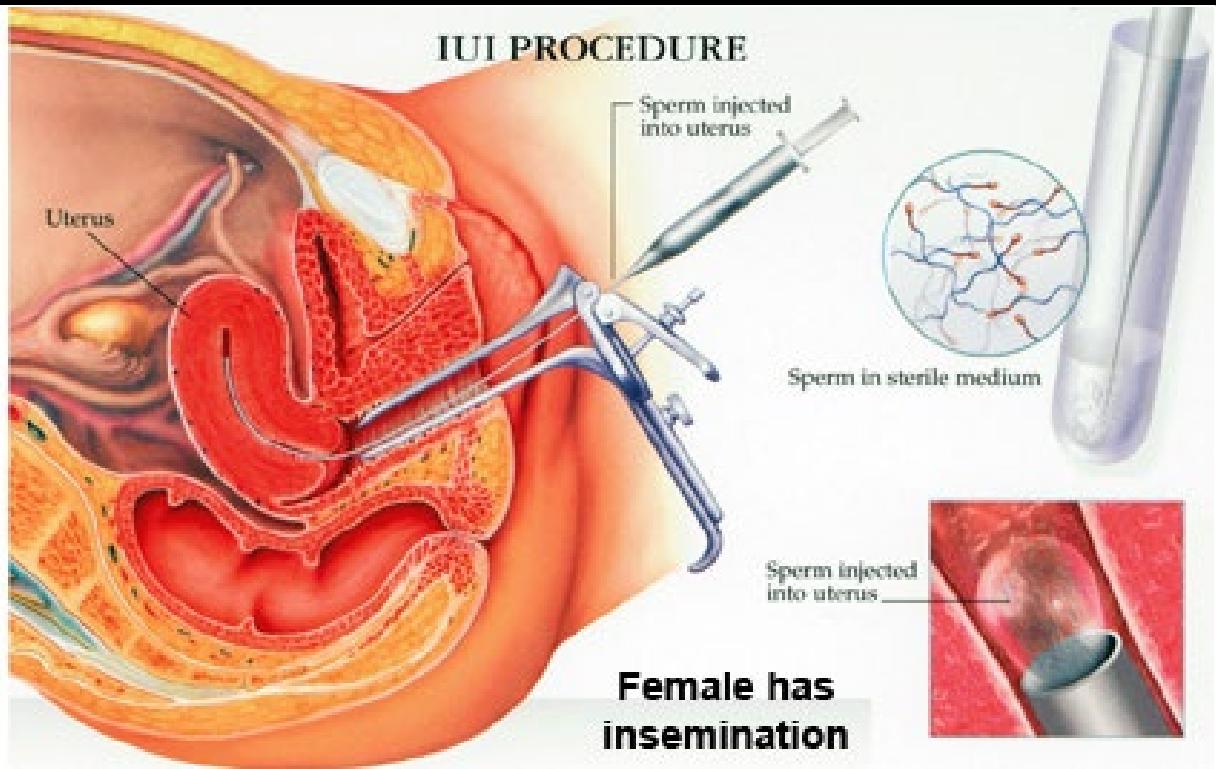
- Couples who have suffered from recurrent failure of fertilization due to disorder at functional level of gametes.
- Severe oligospermia where sperm count is less than 5 million/ml.



# ART: Intra uterine insemination

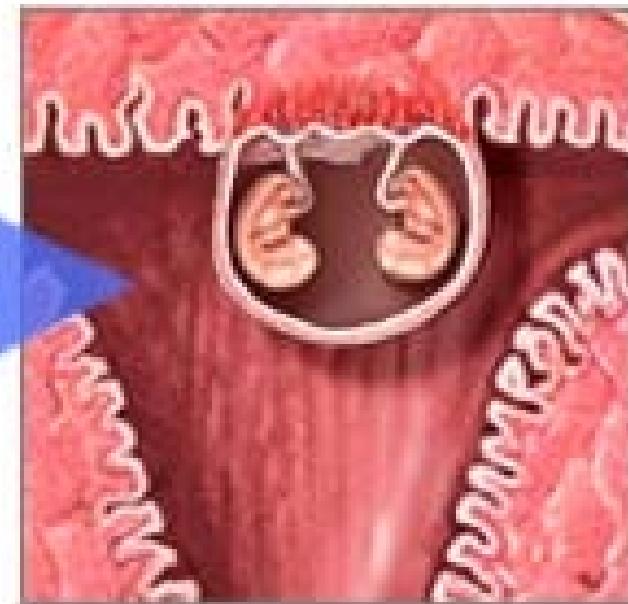
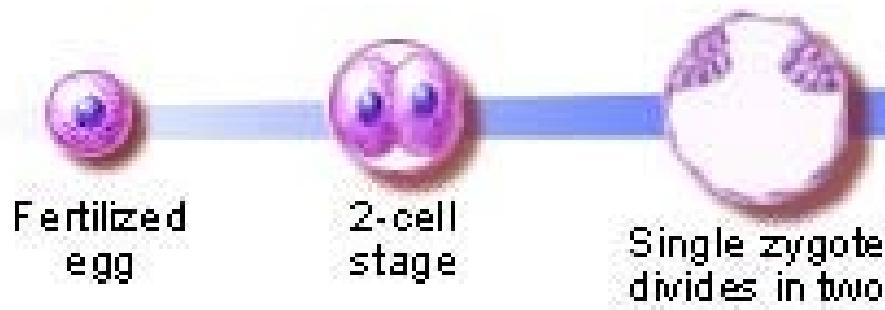


Male has a date  
with the cup

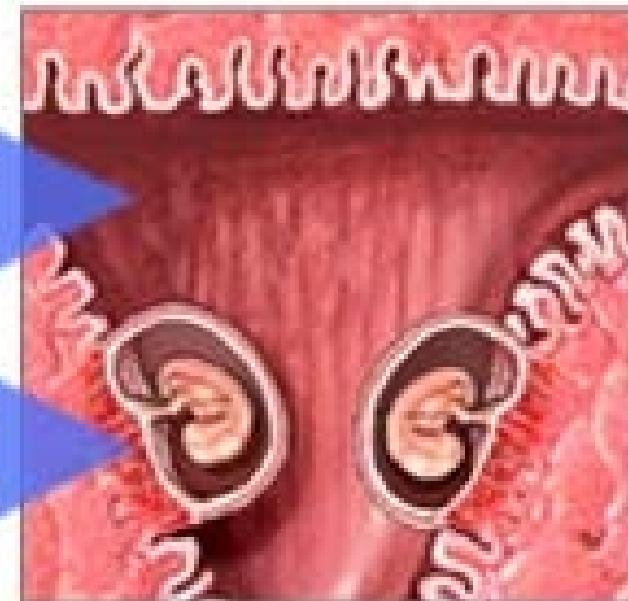
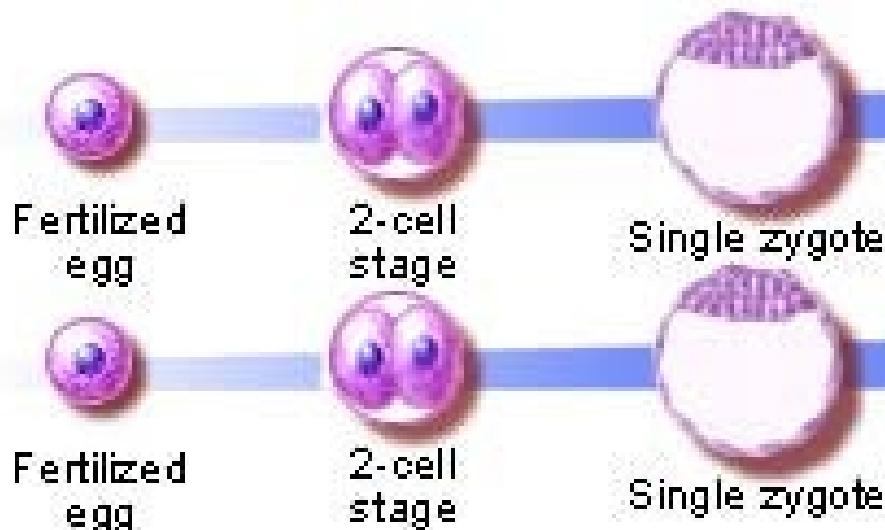


Introducing sperm into the uterus or cervix artificially without sex.

## Identical (monozygotic) twins



## Fraternal (dizygotic) twins



By the end of this learning package, students should be able to:

**Competent:**

- Identify the male and female reproductive organs.
- Describe the functions of the male and female reproductive organs.
- Identify the key events and hormones involved in the female reproductive cycle.
- Identify anatomical parts of the sperm and ovum that are important during the fertilization process.
- Explain what the term “Fertilization” means, in the human context.
- Describe the normal fertilization process including capacitation, acrosome reaction, binding and fusion.
- Identify the key events and developmental changes of the embryo and post implantation embryo such as morula and blastocyst followed by implantation, placentation and gastrulation.
- List the 3 germinal layers and the fate/outcome of these layers.
- Describe the key developmental events in the fetus during the 3 trimesters.
- Describe common developmental defects that can occur in the fetus.

**Proficient:**

- Explain how the endocrine system is related to the male and female reproductive systems.
- Describe some common ART methods and relate how they assist the fertilization process.
- Explain the process of implantation of the blastocyst.
- Explain the role of the placenta in pregnancy.
- Explain the abnormalities/defects that can occur during embryological development.

**Advanced:**

- Assess infertility, its causes and relate to the basic anatomy of male and female reproductive systems.
- Assess what problems might occur during implantation based on the understanding of the key events mentioned above.
- Explain the clinical significance of each trimester.
- Postulate the effects of toxic agents (e.g. alcohol) on each trimester
- Explain the likely consequences of ART such as multiple births and their complications.
- Explain the procedures such as PGD and PGS when undergoing ART techniques and their likely ethical concerns/risks.