

# GENETICS AND DEVELOPMENTAL BIOLOGY



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# INTRODUCTION

**The fusion between egg and sperm involves a number of different steps.**

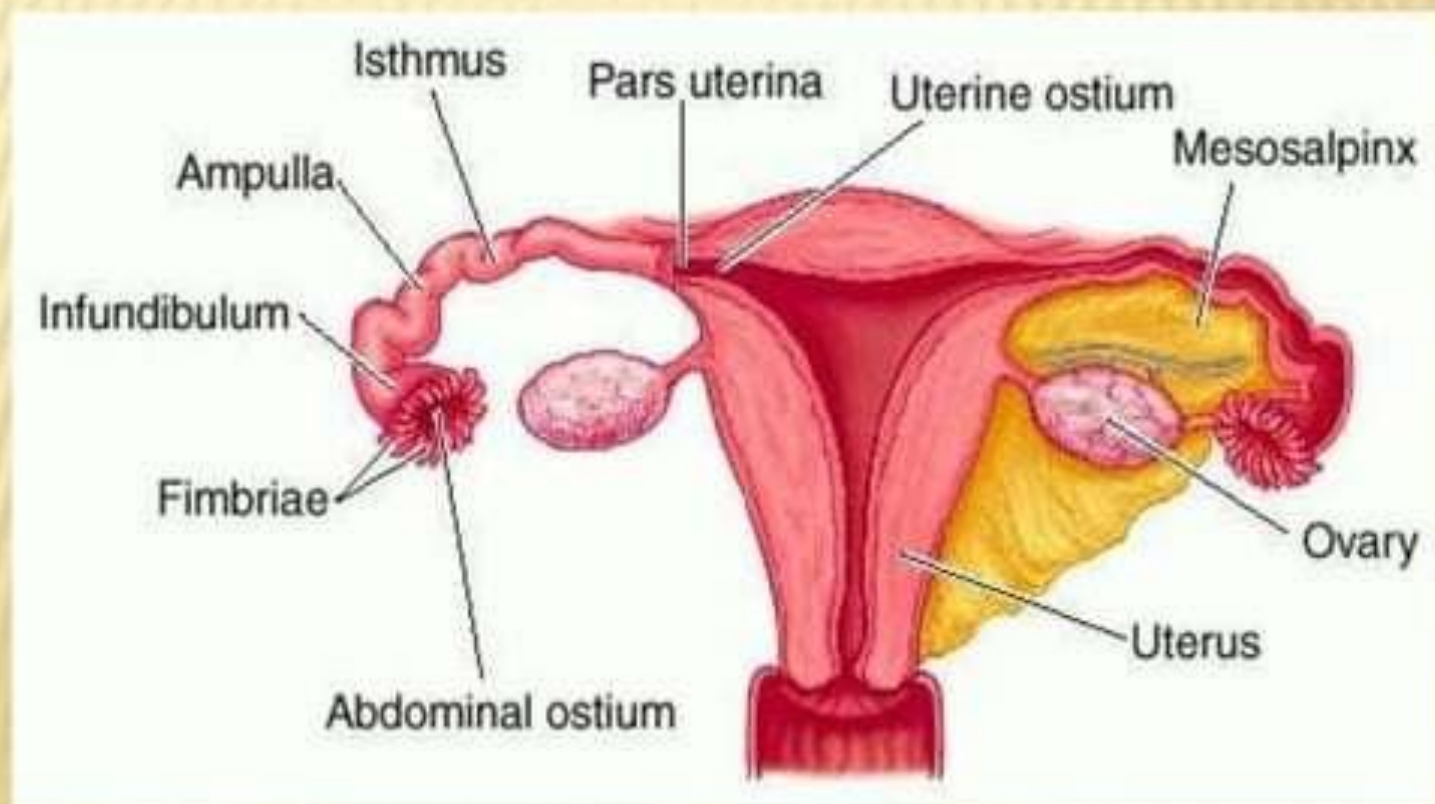
**The egg and sperm must first be brought together , which involves a combination of passive movement and active motility on the part of the sperm.**

**Once the gametes are together , they must recognize each other and make contact.**



**A complex interaction between the male and female gametes to form a zygote.**

**Normally occurs in the ampulla of uterine tubes within 24hrs after ovulation.**



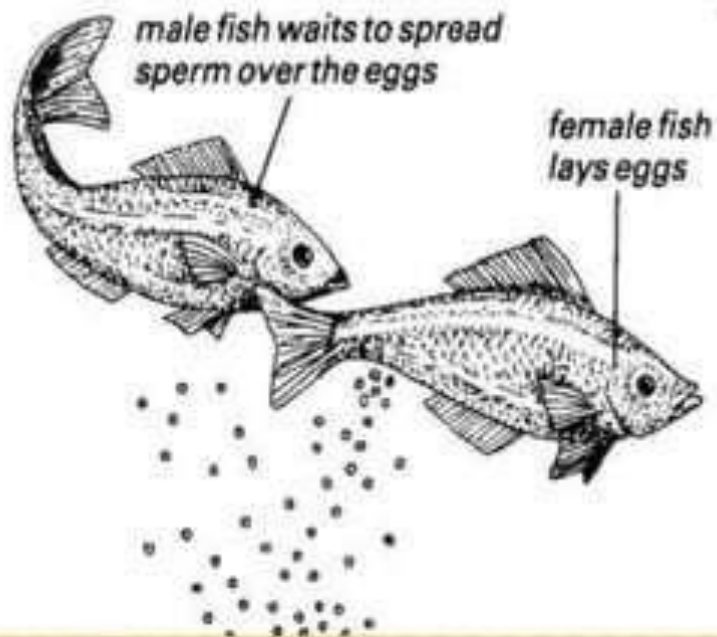
# TYPES OF FERTILIZATION

- 1. External Fertilization**
- 2. Internal Fertilization**

# TYPES OF FERTILIZATION

## 1. EXTERNAL FERTILIZATION

### External Fertilization



## 2. INTERNAL FERTILIZATION

### Internal Fertilization

- Internal fertilization occurs inside the female parent
  - Reptiles (lay many eggs)
  - Birds (lay only a few eggs)
  - Mammals
    - development takes place inside the female body





# EXTERNAL FERTILIZATION

Occurs when both sperm and eggs are deposited into the water.

There is the added complication that the gametes of many species mix together.

In external fertilization, large number of both gametes available, although more sperm than eggs.

Ex : FISHES , AMPHIBIANS..

# INTERNAL FERTILIZATION

Occurs when the egg is retained in the body of female , the sperm are deposited there by the male .

In internal fertilization , there are very often very few eggs , but large number of sperms .

Ex : HUMANS , DOGS , CATS..

# IMPORTANT EVENTS

1. **Transport of Oocyte (female gamete)**
2. **Transport of Sperm**
3. **Acrosome reaction**

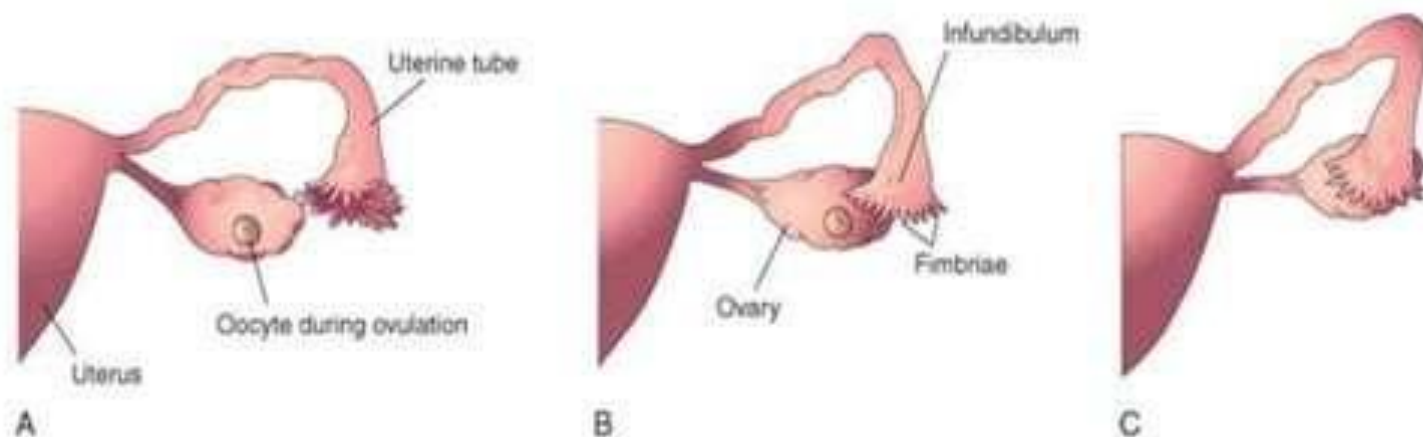


# TRANSPORT OF OOCYTE

## OOCYTE TRANSPORT

- Sweeping movements of fimbriae
- Rhythmic muscular contractions of tube
- Motion of cilia in tubal mucosa
- Fluid currents

Fertilized oocyte reaches uterine lumen in 3-4 days

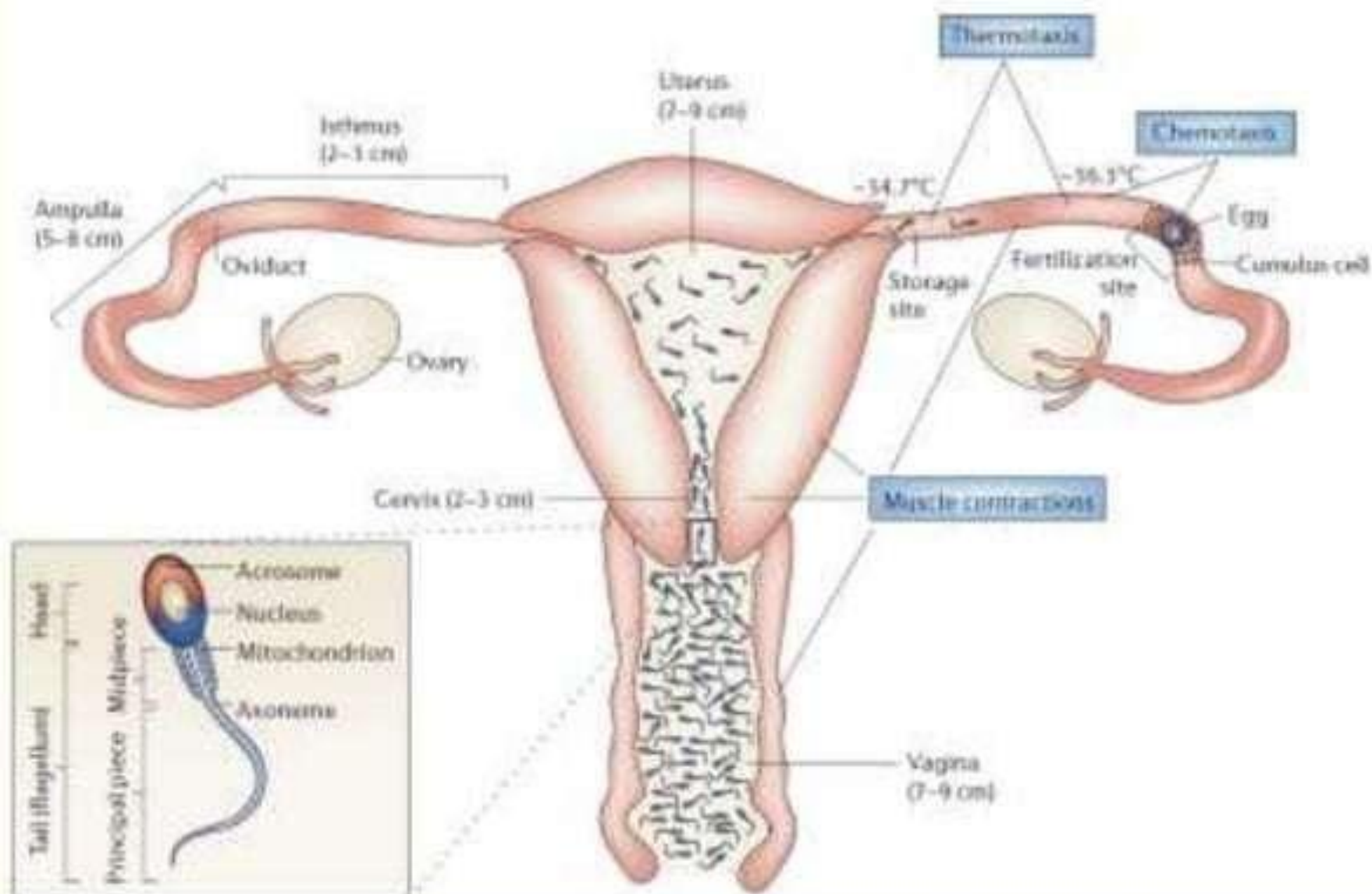


# TRANSPORT OF SPERM

Human sperm are deposited into the anterior vagina and they quickly contact cervical mucus and enter the cervix.



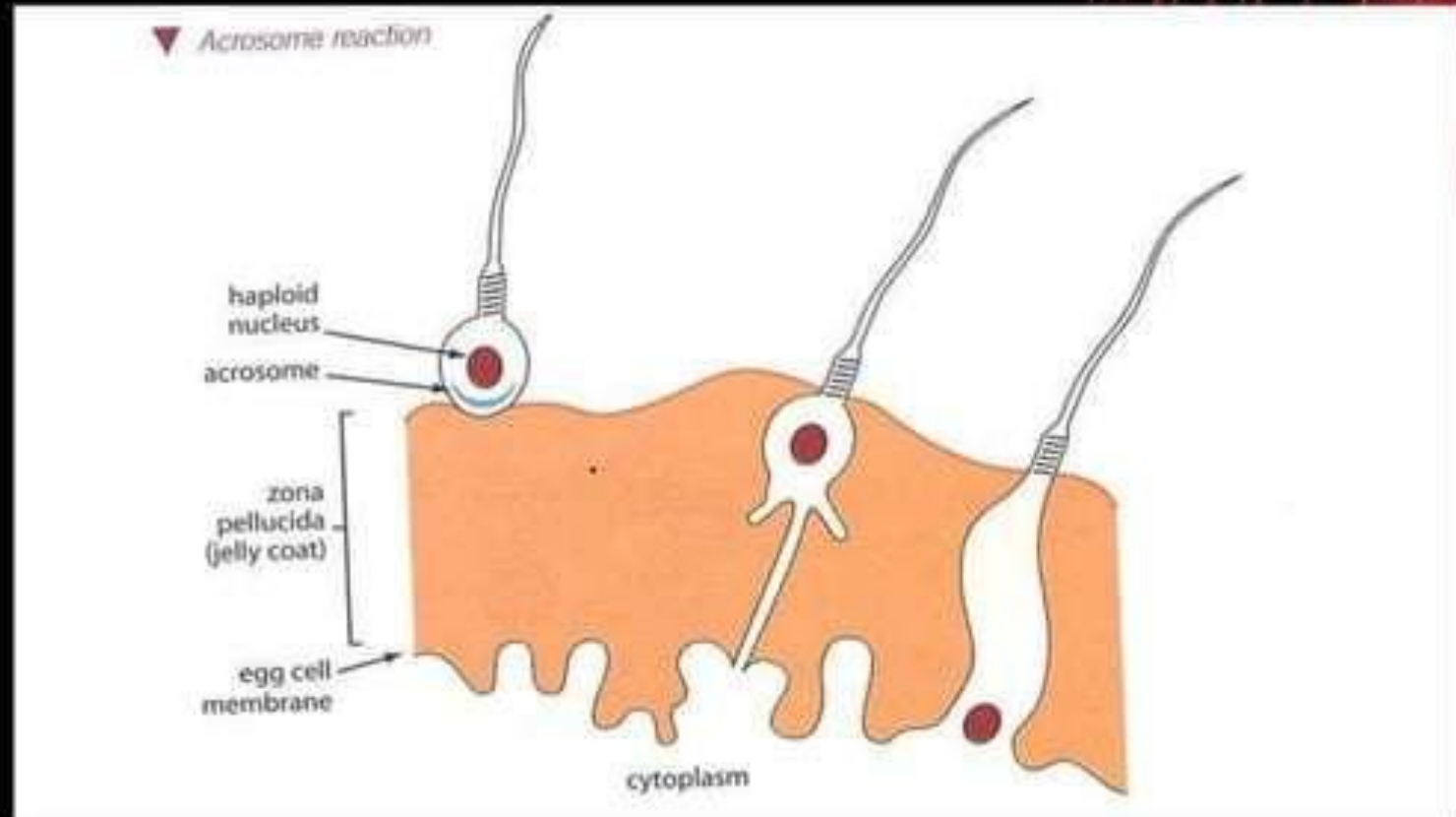
# SPERM TRANSPORTATION





# REACTION OF ACROSOME

## Acrosome reaction



The acrosome reaction is a crucial step during gamete interaction in all species, including man.

It allows spermatozoa to penetrate the zona pellucida and fuse with the oocyte membrane.

Spermatozoa unable to undergo the acrosome reaction will not fertilize intact oocytes.

# STEPS IN FERTILIZATION

1. Attraction between sperm and egg
2. Gamete contact in mammals
3. Sperm entry and Gamete fusion
4. Formation of Zygote
5. Implantation



## ATTRACTION BETWEEN GAMETE

The egg attracts the sperm by releasing potent chemo attractant signals that both direct the sperm to the egg and increase sperm activity.

Such signals are often species - specific and are usually timed to coincidence with egg maturity , to prevent unproductive interactions between gametes.

Chemo attraction is crucial in aquatic environments but may also be used in species that utilize internal fertilization.

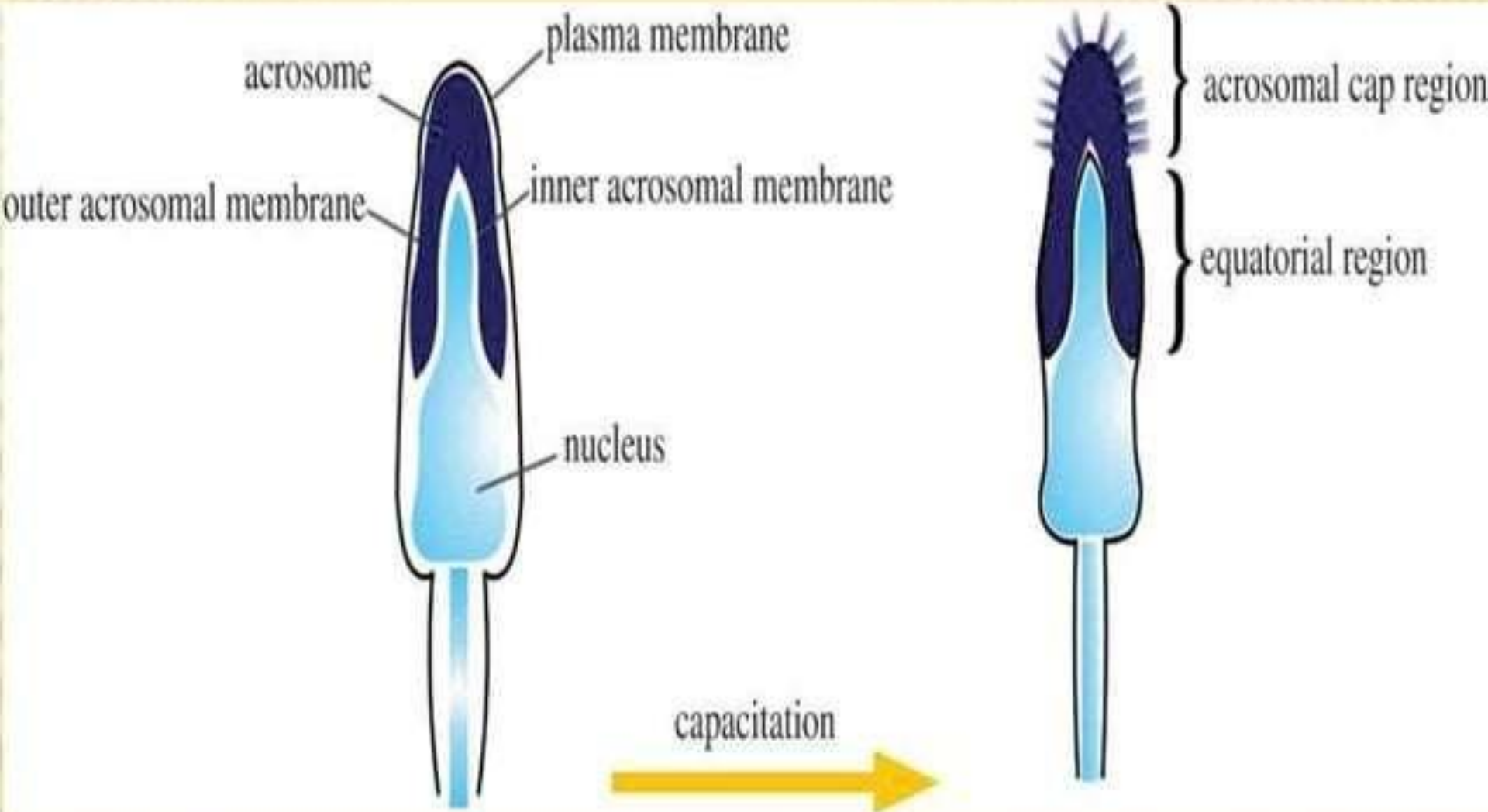
# GAMETE CONTACT

**In mammals , surface properties of the sperm membrane must be modified in order for the sperm to interact with the zona pellucida , a process termed capacitation.**

**Interaction with the zona pellucida induces the acrosomes reaction and the sperm can penetrate this layer and contact the membrane.**



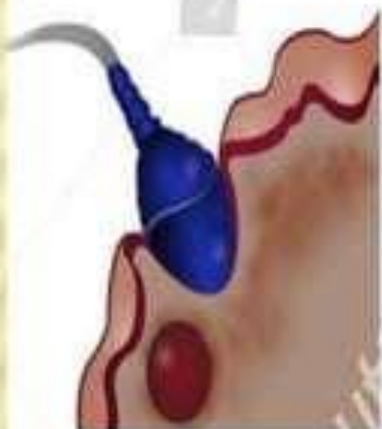
# CAPACITATION



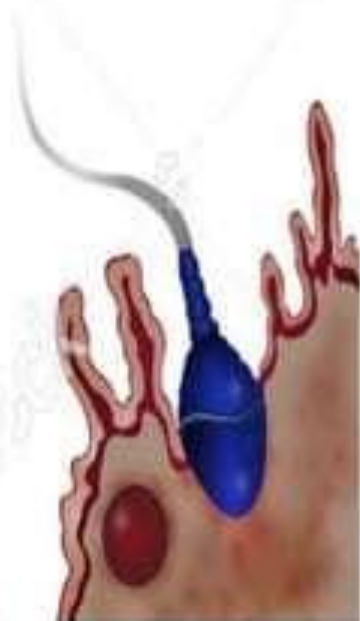


# SPERM ENTRY

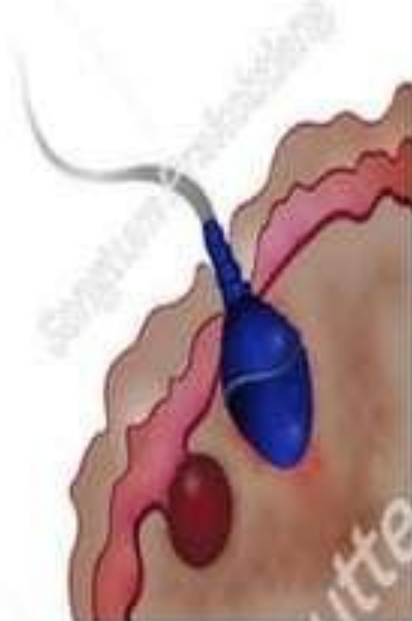
Stages of sperm entry into the ovum during fertilization.



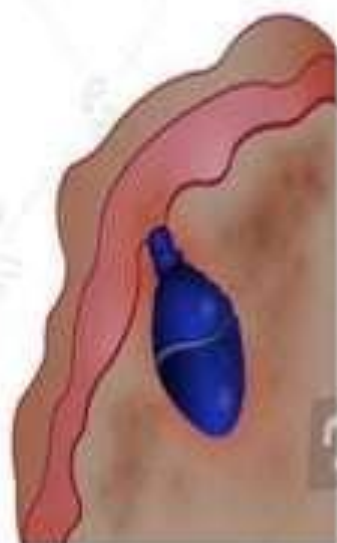
1 The sperm squeezes through cells left over from the follicle



2 Proteins on the sperm head bind to egg receptors



3 A fertilization envelope forms



4 The sperm nucleus enters the egg cytoplasm

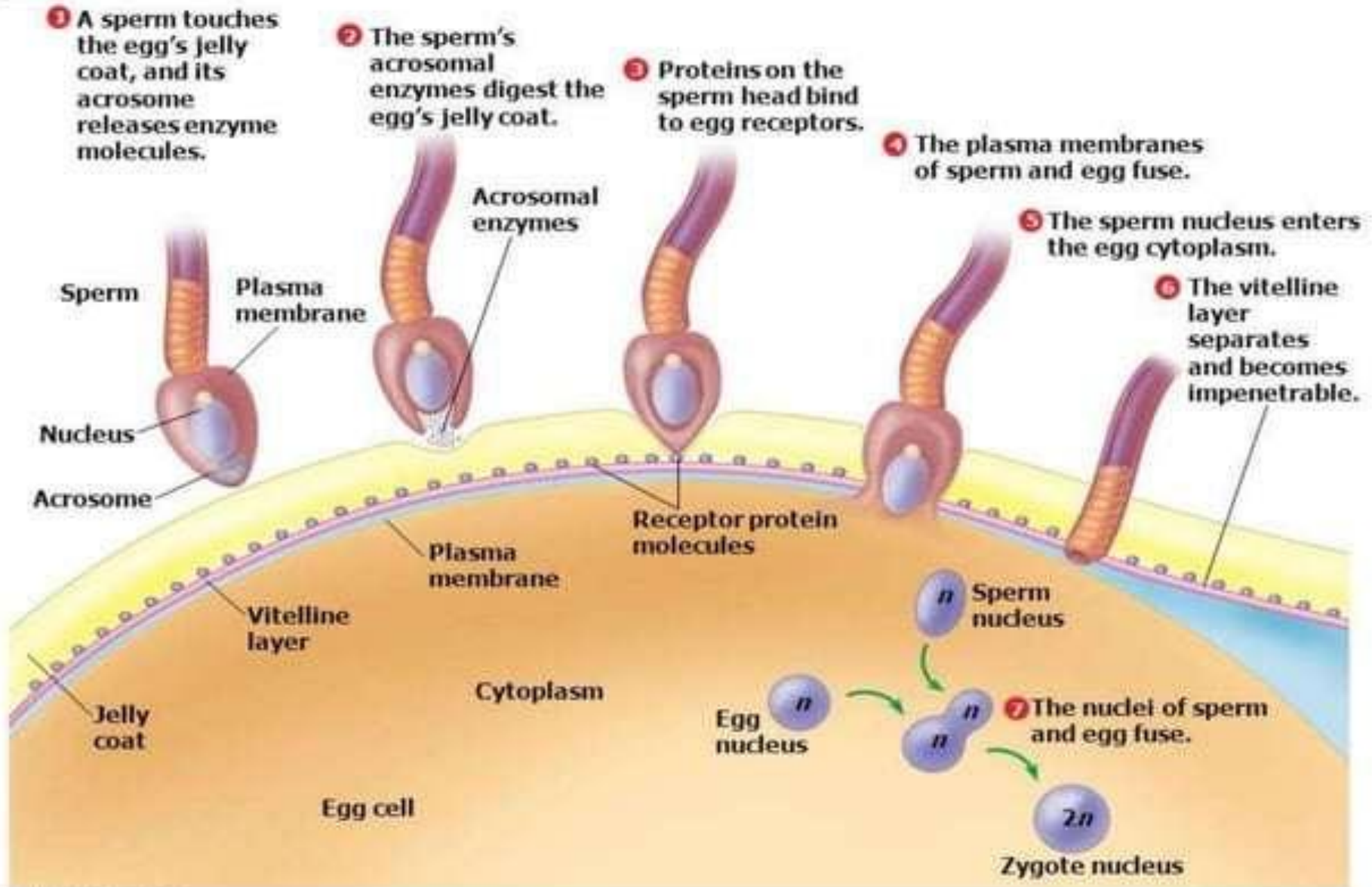
# GAMETE FUSION

After penetrating the protective layer of the egg, the sperm and egg plasma membrane fuse together, allowing the sperm nucleus to enter the egg cytoplasm.

Membrane fusion may require specific fusogenic protein carried by the sperm & exposed by the release of the acrosomal vesicle.

# CHANGES IN EGG CYTOPLASM

Figure 27.9C





# ZYGOTE

After entry , most of the sperm breaks down , leaving the nucleus and centriole.

The nucleus decondenses and the centriole initiate an aster of microtubules that contact the egg nucleus.

Depends on the species , fusion may occur immediately or may require the completion of meiosis by the egg nucleus.

Female  
gamete  
(egg)  
( $n$ )



Male  
gamete  
(sperm)  
( $n$ )



Fertilization



Zygote ( $2n$ )

Diploid offspring  
contains homologous  
pair of chromosomes



# HORMONES INVOLVED

a) FOLLICLE STIMULATING HORMONE

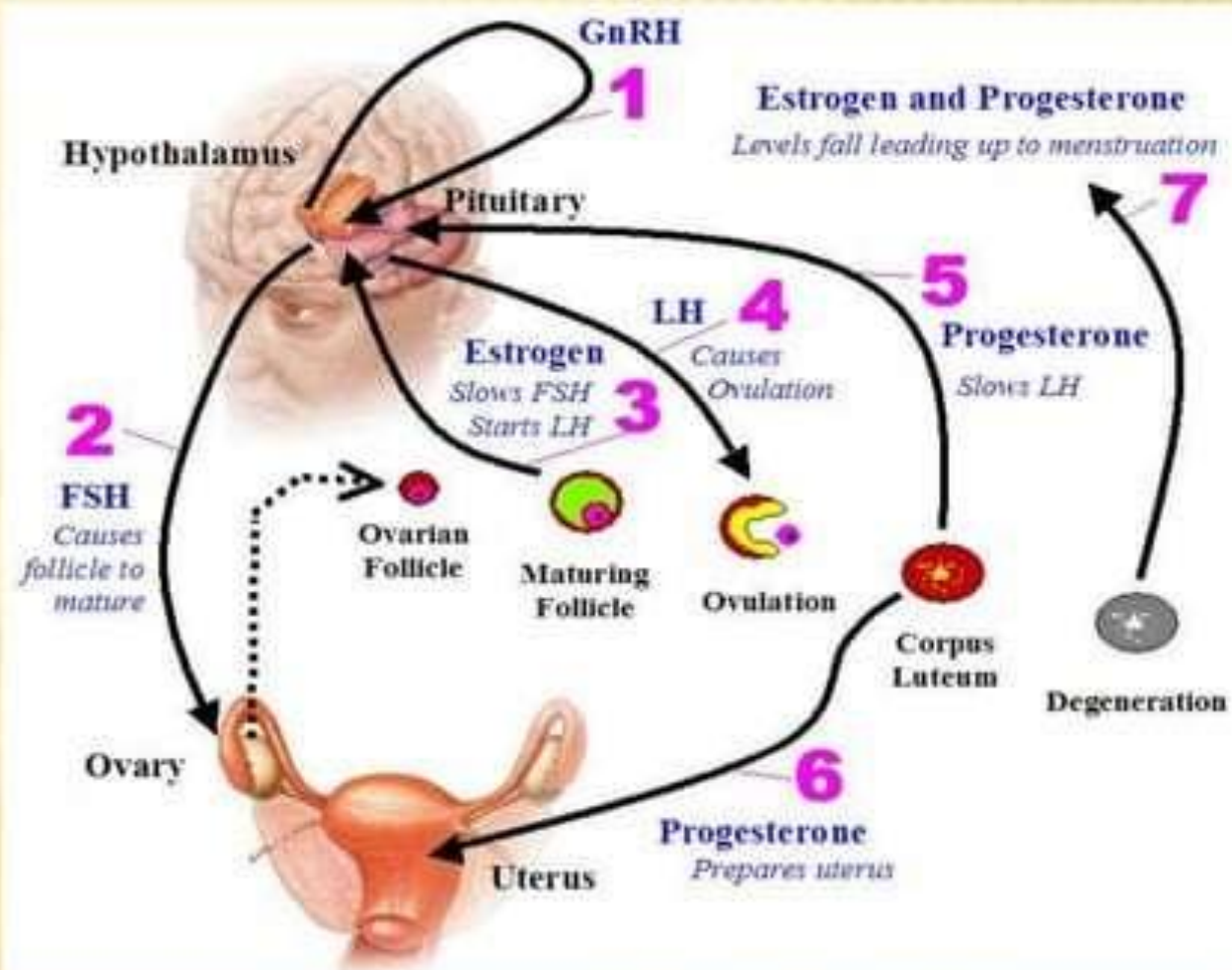
a) LEUTINIZING HORMONE

a) OXYTOCIN

a) TESTOSTERONE

a) OESTROGEN

a) PROGESTERONE





Sex hormones are responsible for driving sexual development (puberty).

The main reproductive hormones are oestrogen and testosterone.

Oestrogen causes eggs to mature in ovaries once a girl hits puberty.

These are then released at regular intervals during the menstrual cycle.

Testosterone stimulates sperm production in males.

Other hormones include:

Follicle stimulating hormone (FSH), causing maturation of an egg in the ovary.

Luteinising hormone (LH) stimulating the release of the egg.

Oestrogen and progesterone are involved in maintaining the uterus lining.



# IMPLANTATION

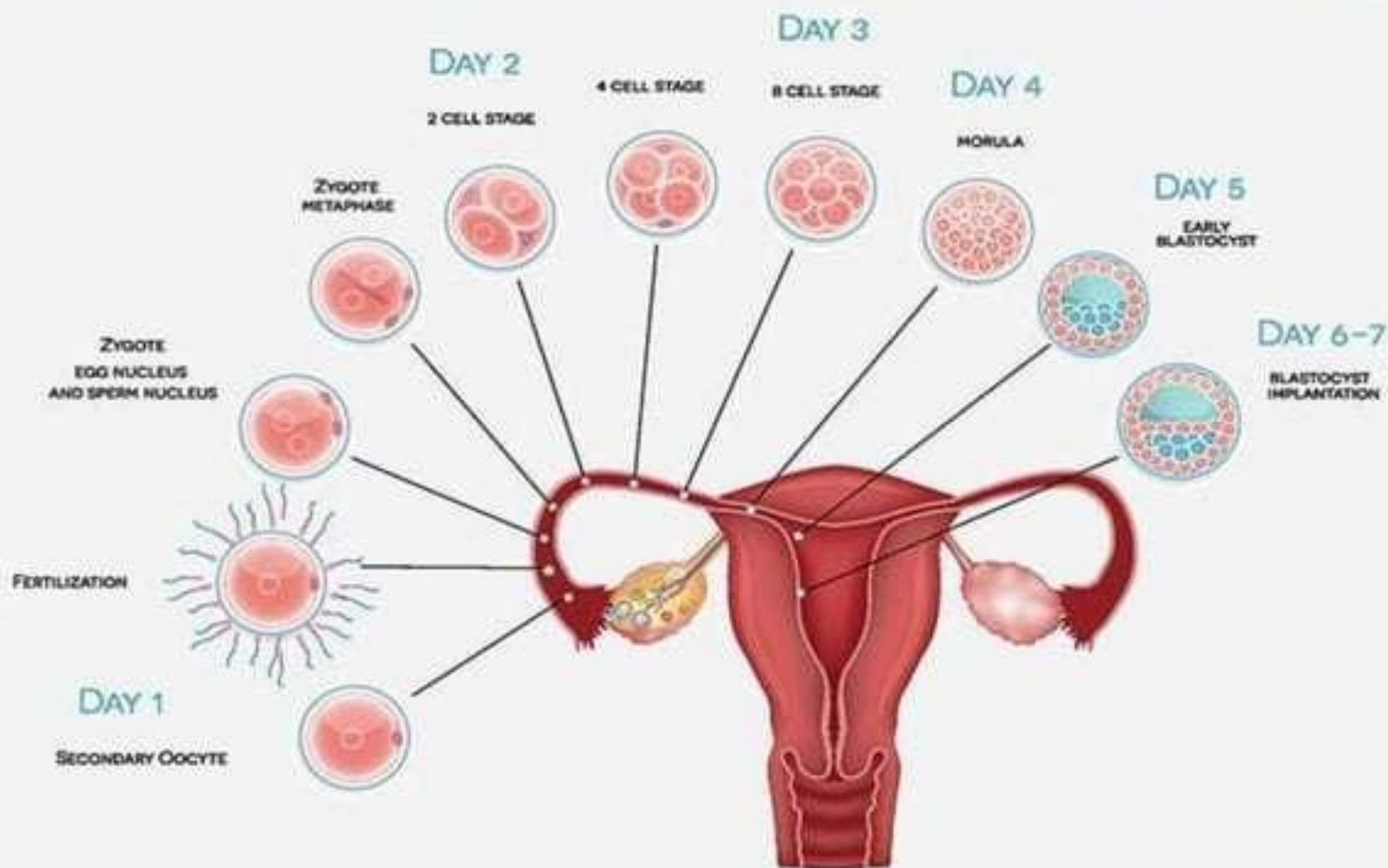
**In humans, implantation is the stage of pregnancy at which the embryo adheres to the wall of the uterus.**

**At this stage of prenatal development, the conceptus is called a blastocyst.**

**It is by this adhesion that the embryo receives oxygen and nutrients from the mother to be able to grow**



# FERTILIZATION AND IMPLANTATION



# FORMATION OF TWIN

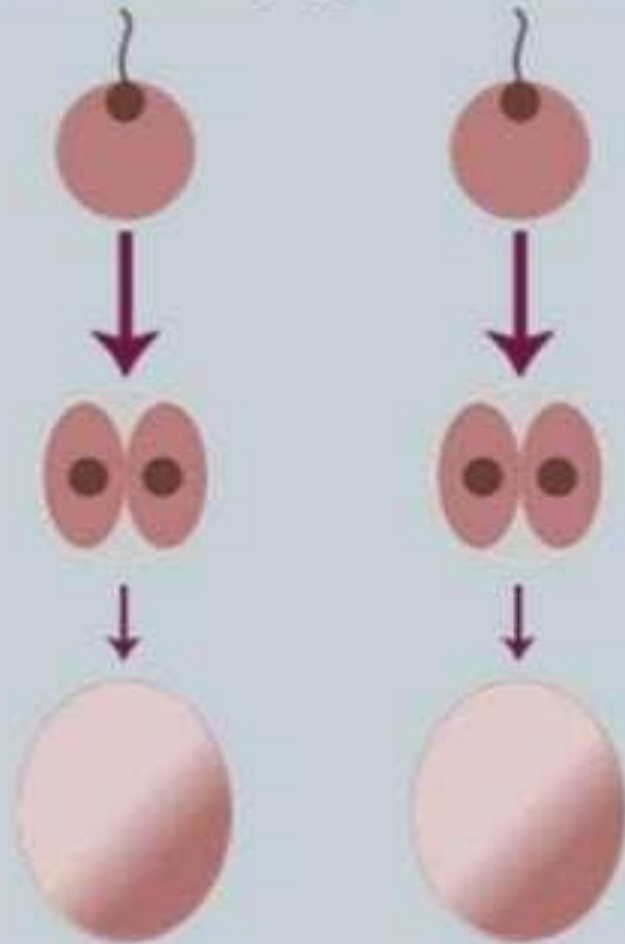
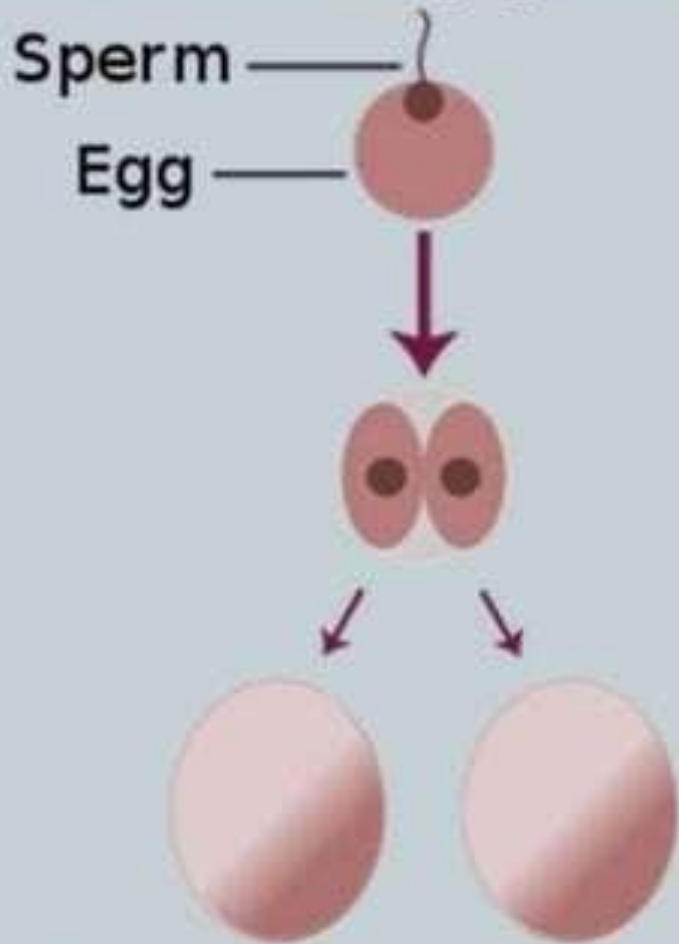
To form identical or monozygotic twins , one fertilized egg (ovum) splits and develops into two babies with exactly the same genetic information.

To form fraternal or dizygotic twins , two eggs (ova) are fertilized by two sperm and produce two genetically unique children.

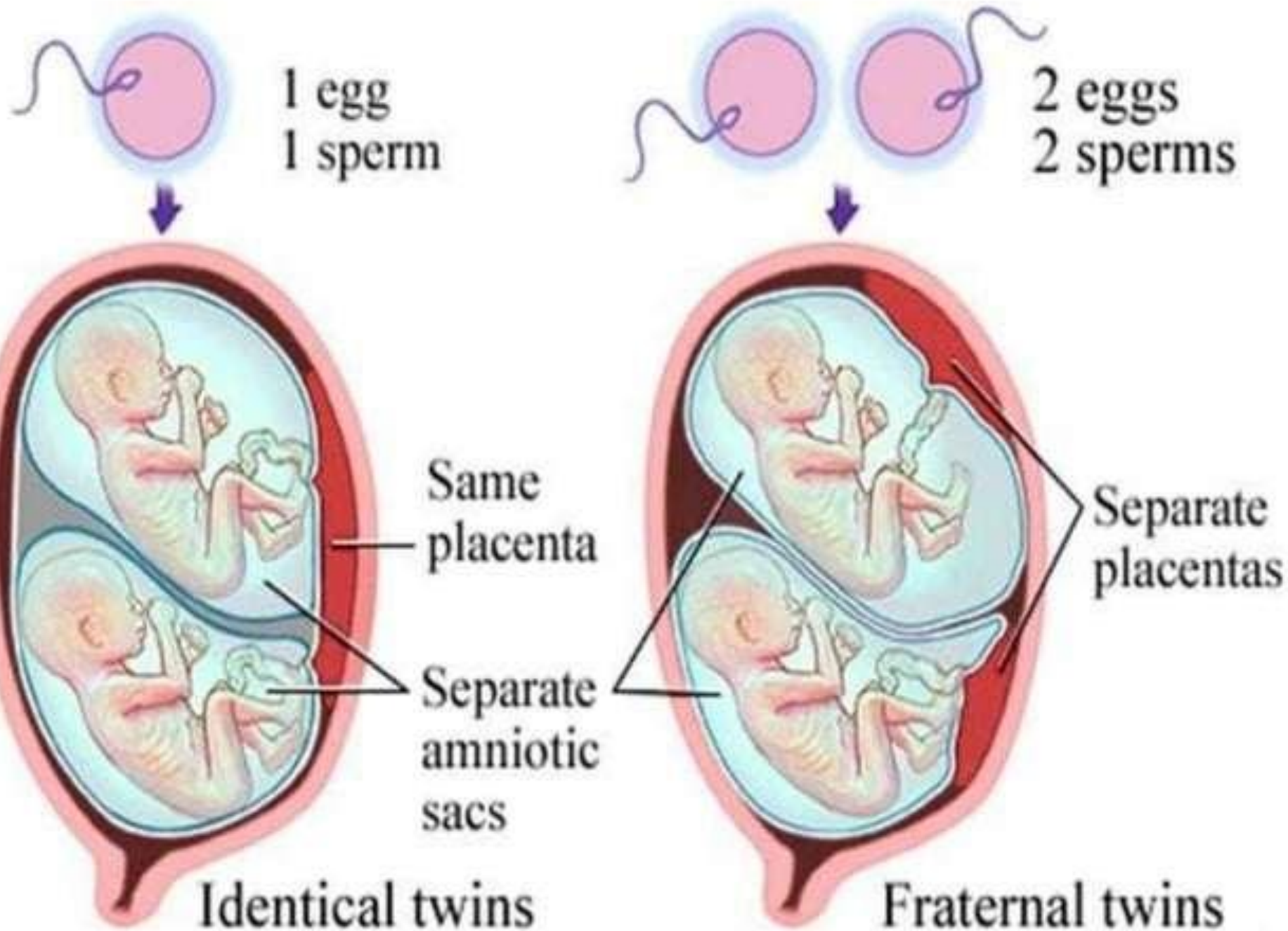
# Identical (Monozygotic)



# Fraternal (Dizygotic)







# Twin Types



Identical twins are always the same gender.

**Identical twins** have 98-99% gene similarity because they both develop from a single sperm and single egg (which splits into two fetuses).



Fraternal twins from mixed race parents!

**Fraternal twins** have 50% gene similarity because they develop from two different sperm and two eggs. Fraternal twins have the same gene similarity as regular siblings.



# CONCLUSION

**Human fertilization is the union of a 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.**





**THANK  
YOU!**

