



**INSTITUTE OF SCIENCE, NAGPUR**

**Department of zoology**

**Topic**

**MOLECULAR AND CYTOLOGICAL EVENTS IN FERTILIZATION**

**By**

**Dr. J. S. MASKE**

Department of Zoology,  
Institute of Science, Nagpur.

# Presentation outline

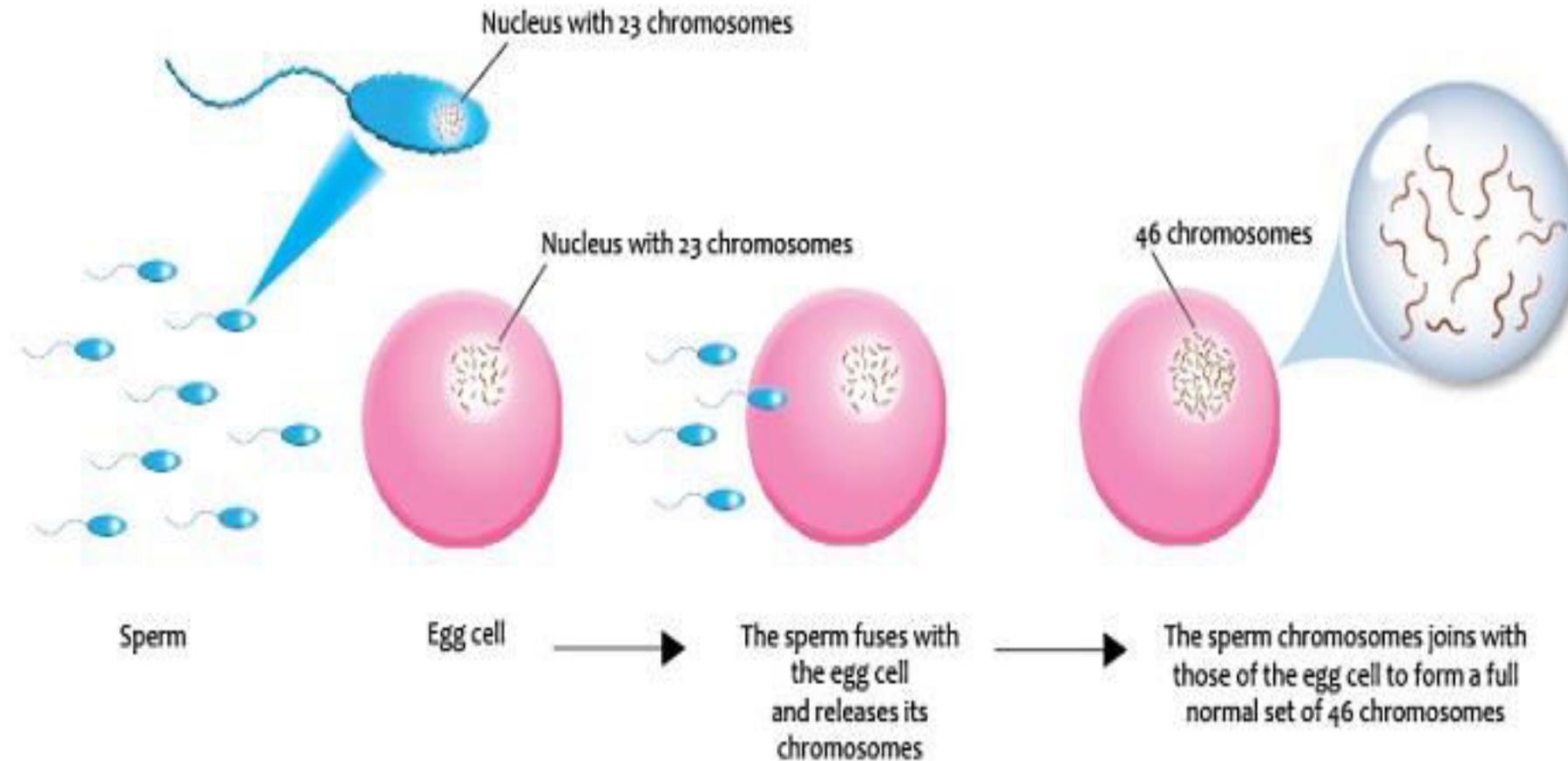
1. INTRODUCTION
2. FERTILIZATION
3. TYPES OF FERTILIZATION
4. SPERMATOGENESIS
5. STRUCTURE OF SPERM
6. OOGENESIS
7. MOLECULAR EVENTS IN FERTILIZATION
8. REFERENCES

# INTRODUCTION

*Our individual body has a limited lifetime. However, through fertilization we are able to continue life as a species. We say fertilization is fusion of male and female gamete to form diploid zygote but we will see there are so many events which takes place for this fusion to actually get completed. Such as spermatogenesis, oogenesis ,capacitation , fertilization cone ,cortical reaction and so on...*

# FERTILIZATION

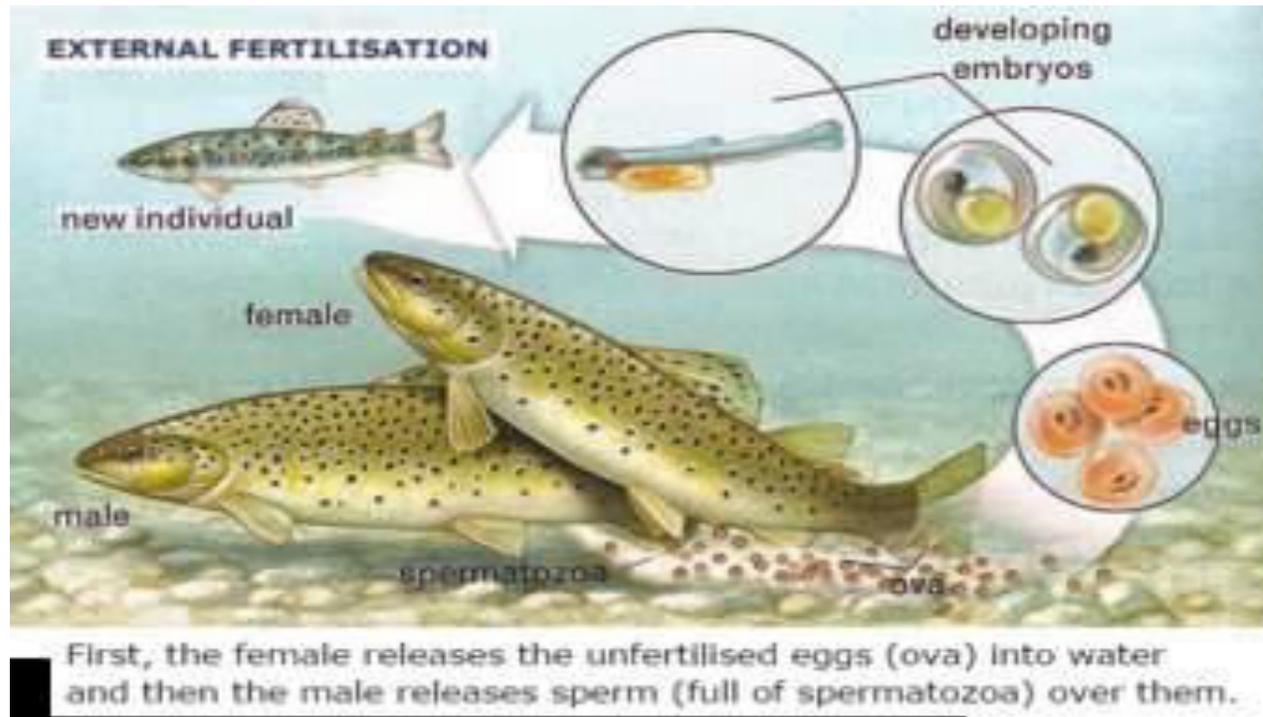
- ▶ Fertilization is the process by which male and female *gametes* are fused together, initiating the development of a new organism.



# Types Of Fertilization

## 1-External Fertilization:

External fertilization is a male organism's sperm fertilizing a female organism's egg outside of the female's body.



## ***2-Internal Fertilization***

Internal fertilization on the other hand, is the occurrence of internal insemination as the mode of combining sperm and egg.

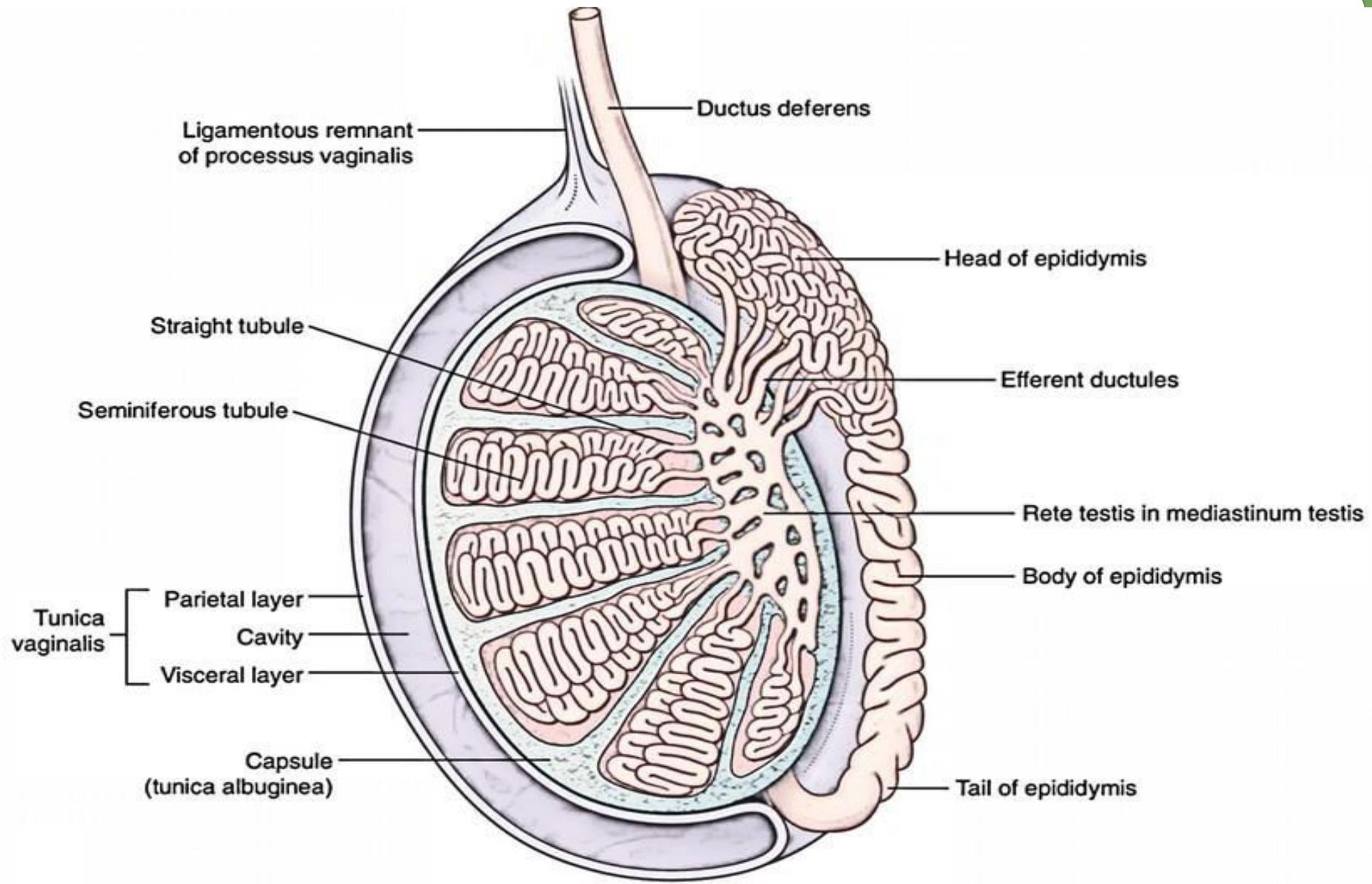


# Spermatogenesis

- ▶ **Spermatogenesis** is the process by which haploid spermatozoa develop from germ cells in the seminiferous tubules of the testis. This process starts with the mitotic division of the stem cells located close to the basement membrane of the tubules. These cells are called spermatogonial stem cells. The mitotic division of these produces two types of cells. Type A cells replenish the stem cells, and type B cells differentiate into spermatocytes. The primary spermatocyte divides meiotically (Meiosis I) into two secondary spermatocytes; each secondary spermatocyte divides into two equal haploid spermatids by Meiosis II. The spermatids are transformed into spermatozoa (sperm) by the process called Spermatogenesis. These develop into mature spermatozoa, also known as sperm cells. Thus, the primary spermatocyte gives rise to two cells, the secondary spermatocytes, and the two secondary spermatocytes by their subdivision produce four spermatozoa.
- ▶ Spermatozoa are the mature male gametes in many sexually reproducing organisms. Thus, spermatogenesis is the male version of gametogenesis, of which the female equivalent is oogenesis. In mammals it occurs in the seminiferous tubules of the male testes in a stepwise fashion.

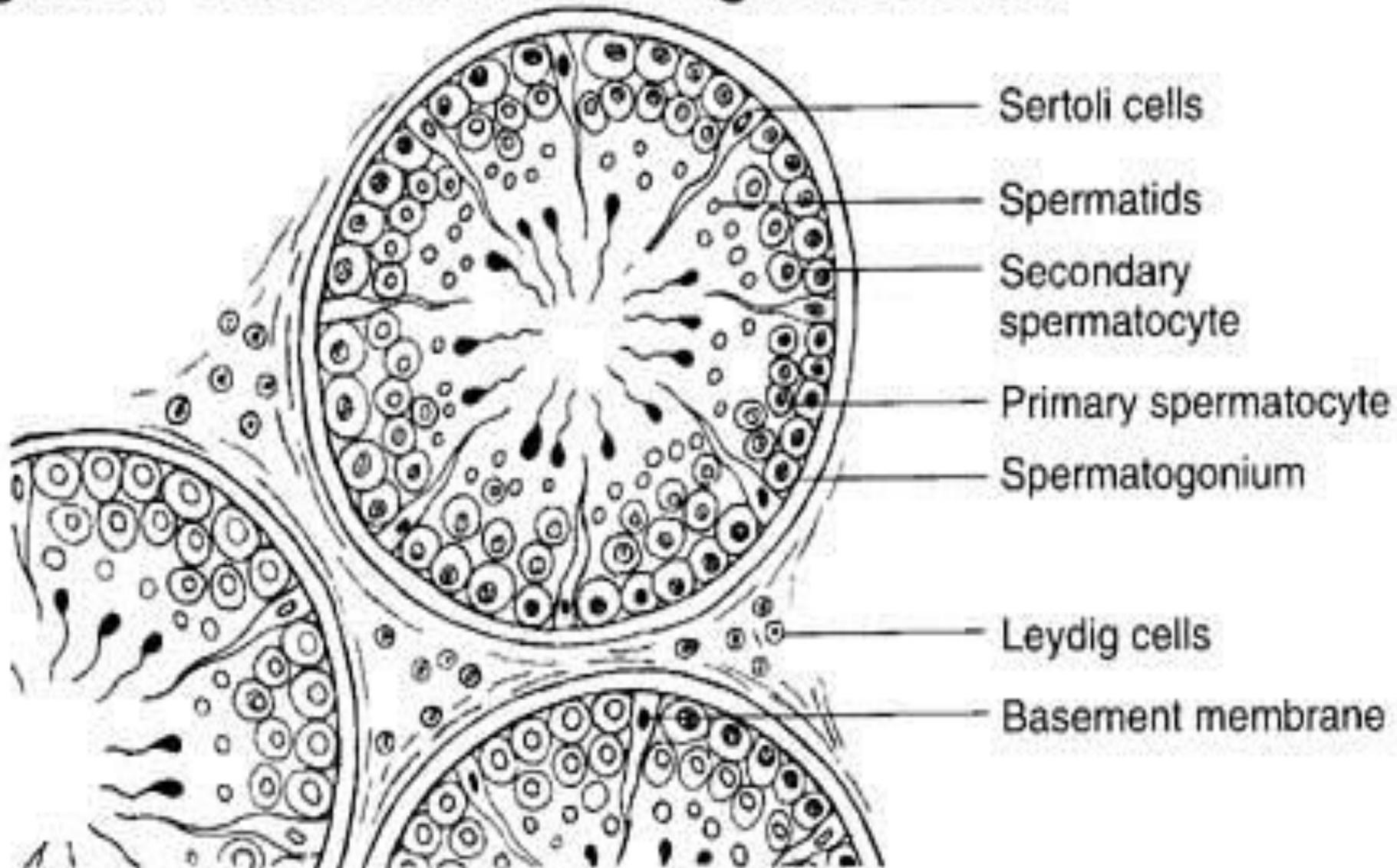
**Spermatogenesis:** Conversion of spermatids into sperms.

**Spermiation:** It is the process of release of mature sperms from Sertoli cells into the lumen of seminiferous tubule.



**Fig:- testes**

**Figure 3. Cross section through the testis.**



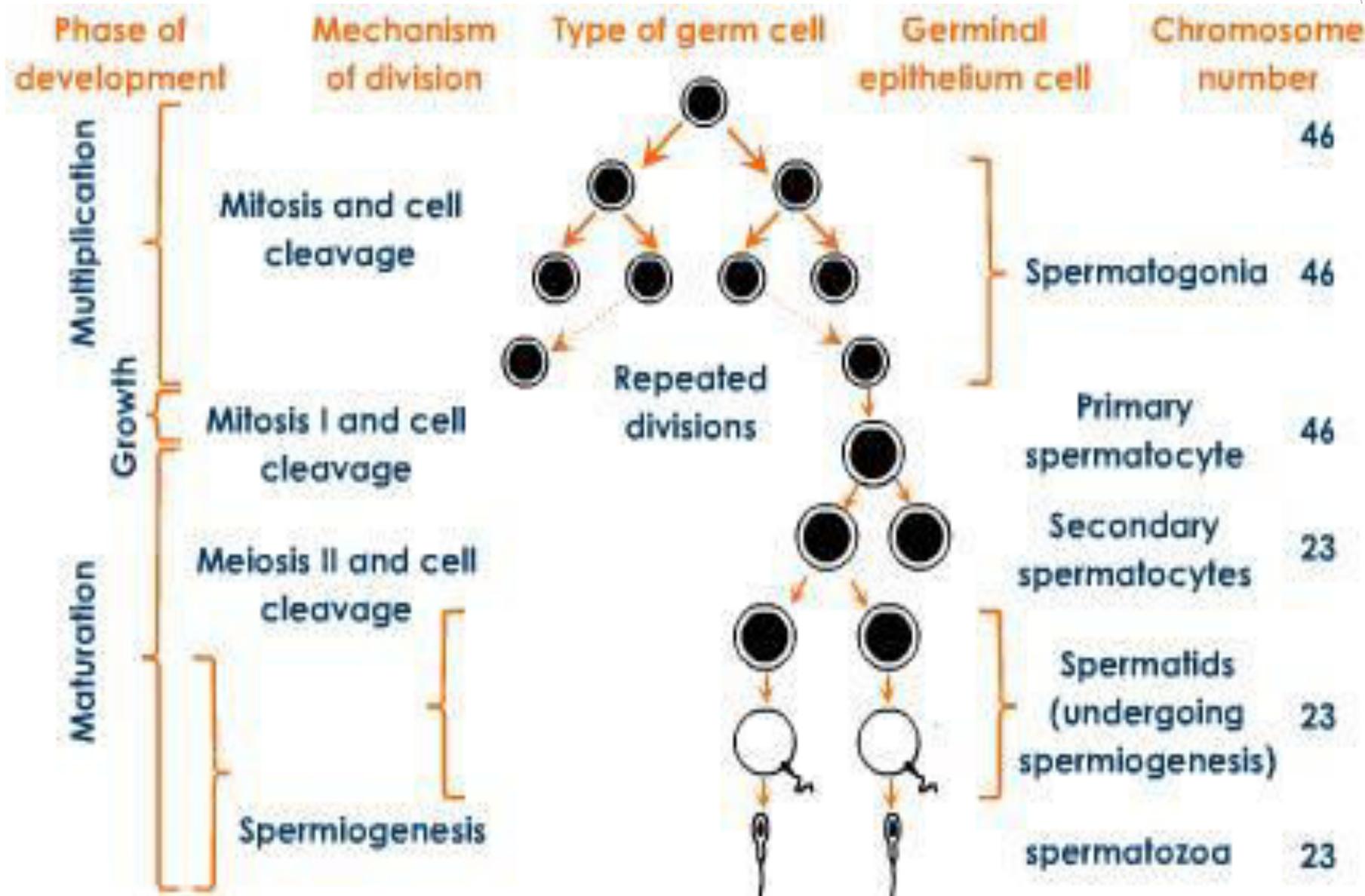
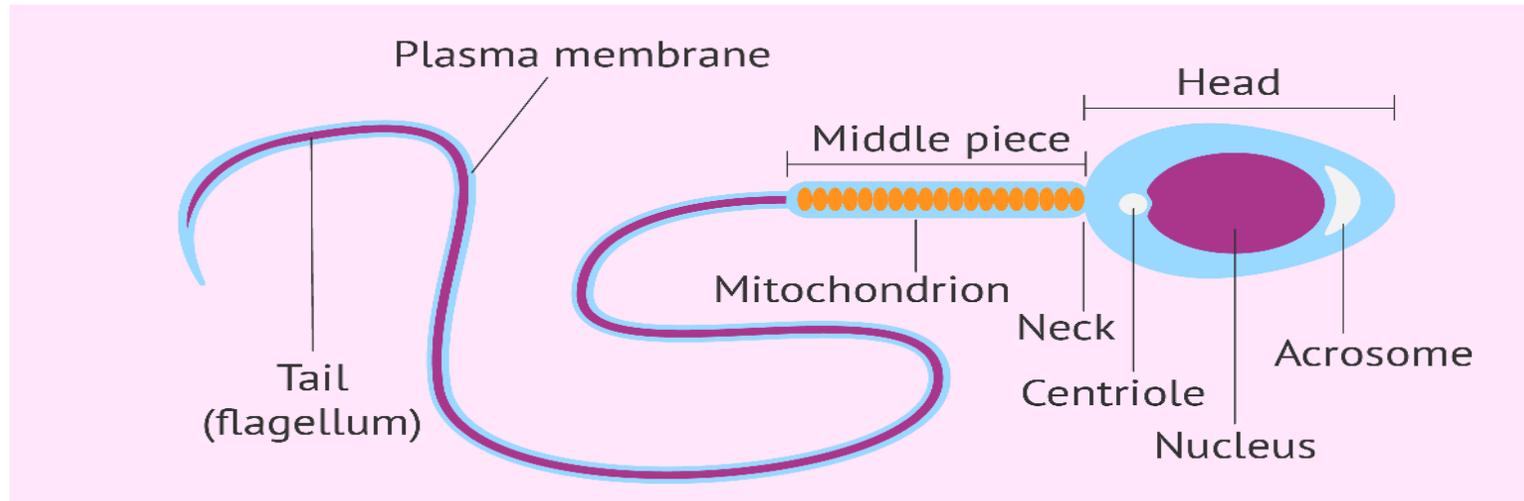


Fig:Spermatogenesis

# Structure of Sperm

- ▶ The mammalian **sperm** cell can be divided in 4 parts: head: it contains the nucleus with densely coiled chromatin fibres, surrounded anteriorly by an acrosome, which contains enzymes used for penetrating the female egg.



# Oogenesis

- ▶ **Oogenesis** is the process of formation of ovum or egg which takes place in female. it is a discontinuous process.
- ▶ **Structure of human egg**
- ▶ The **egg cell**, or **ovum** (plural **ova**), is the female reproductive cell (gamete) in oogamous organisms. The egg cell is typically not capable of active movement, and it is much larger (visible to the naked eye) than the motile sperm cells. When egg and sperm fuse, a diploid cell (the zygote) is formed, which rapidly grows into a new organism.

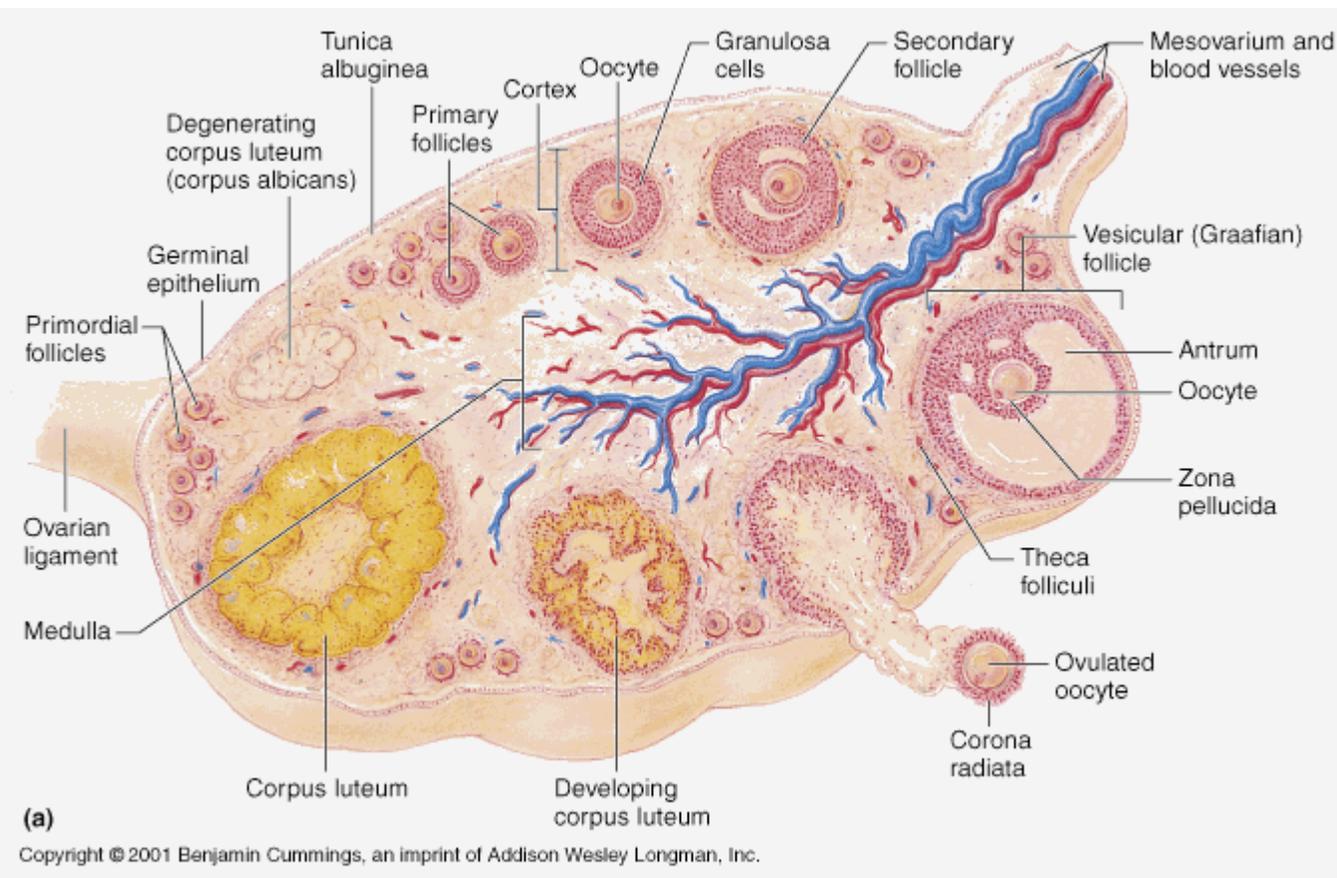


Fig:-Internal structure of ovary

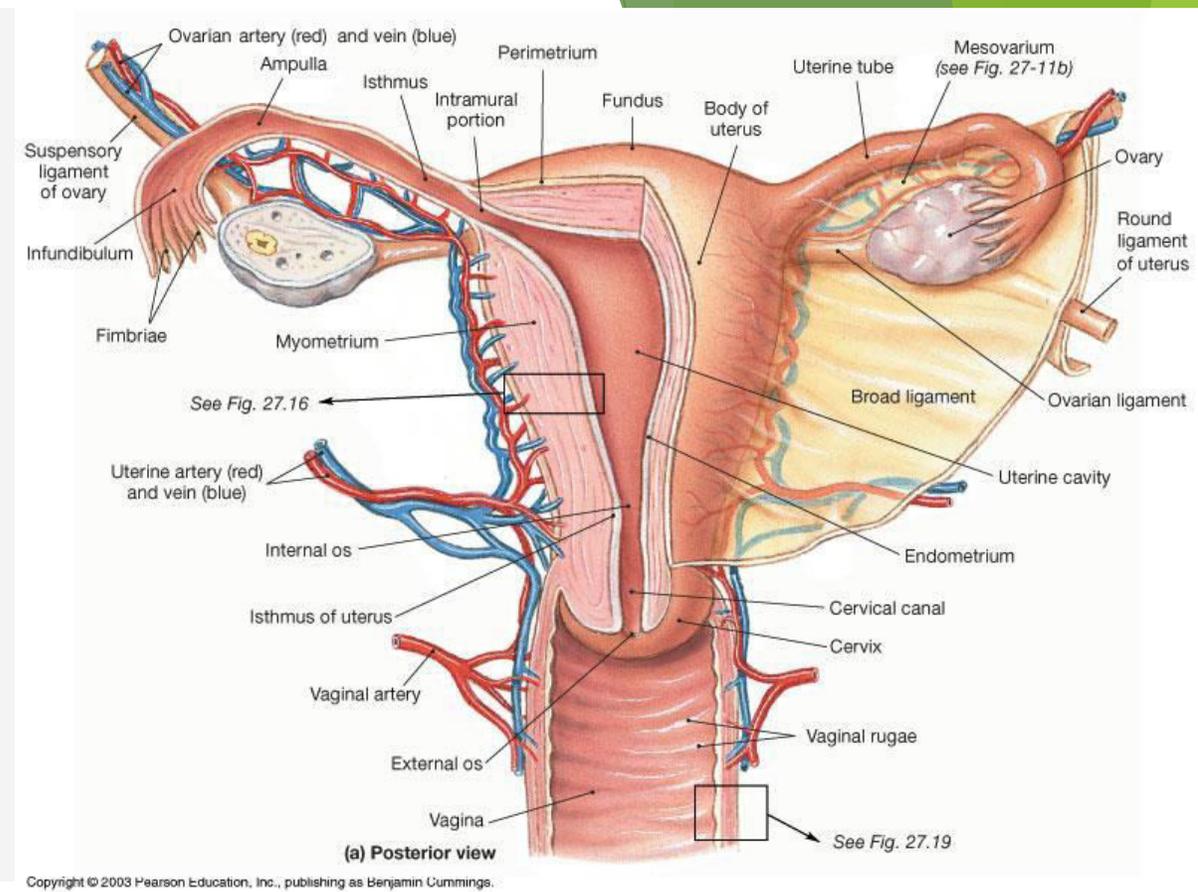


Fig:-female reproductive organ

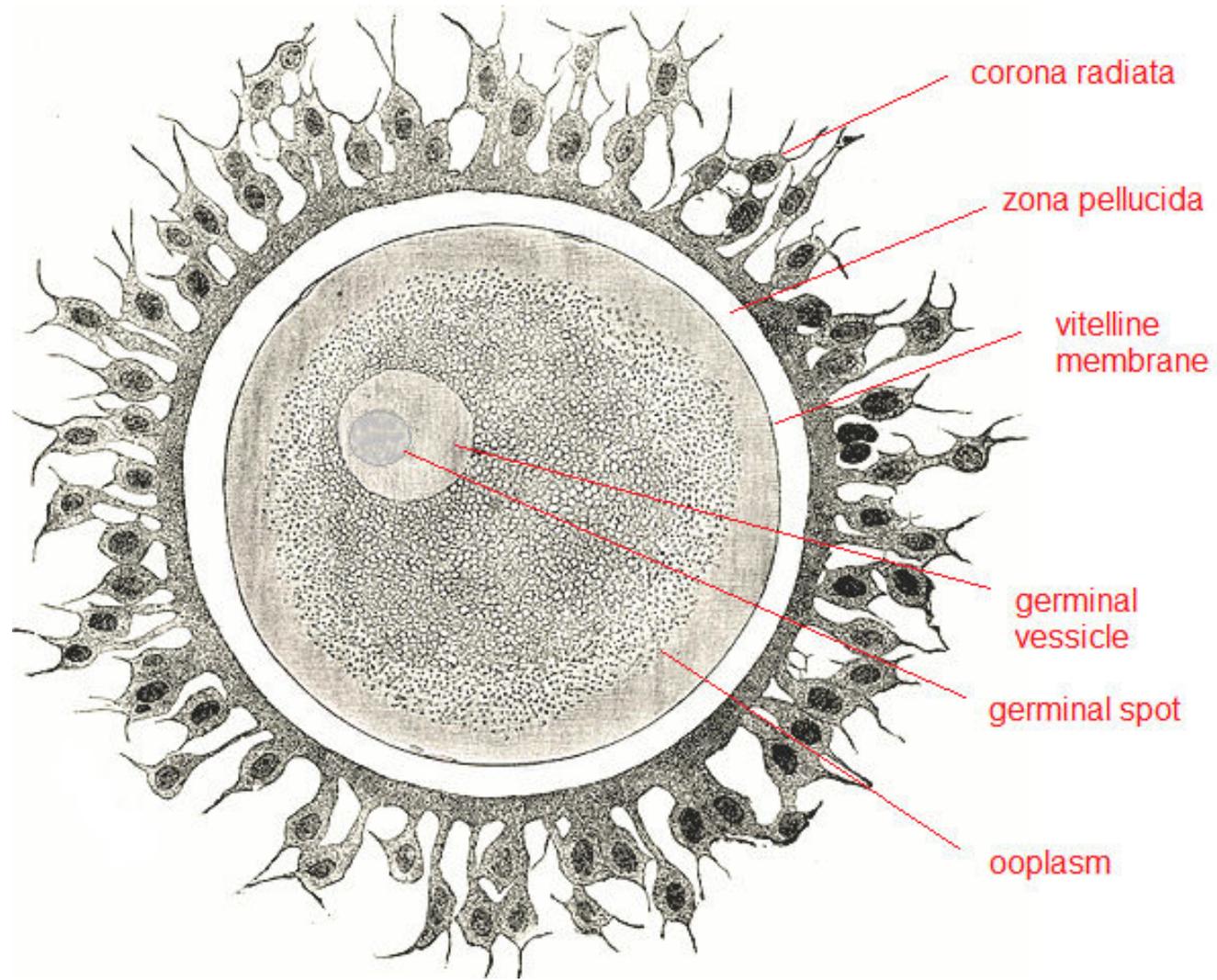


Fig:-structure of human egg

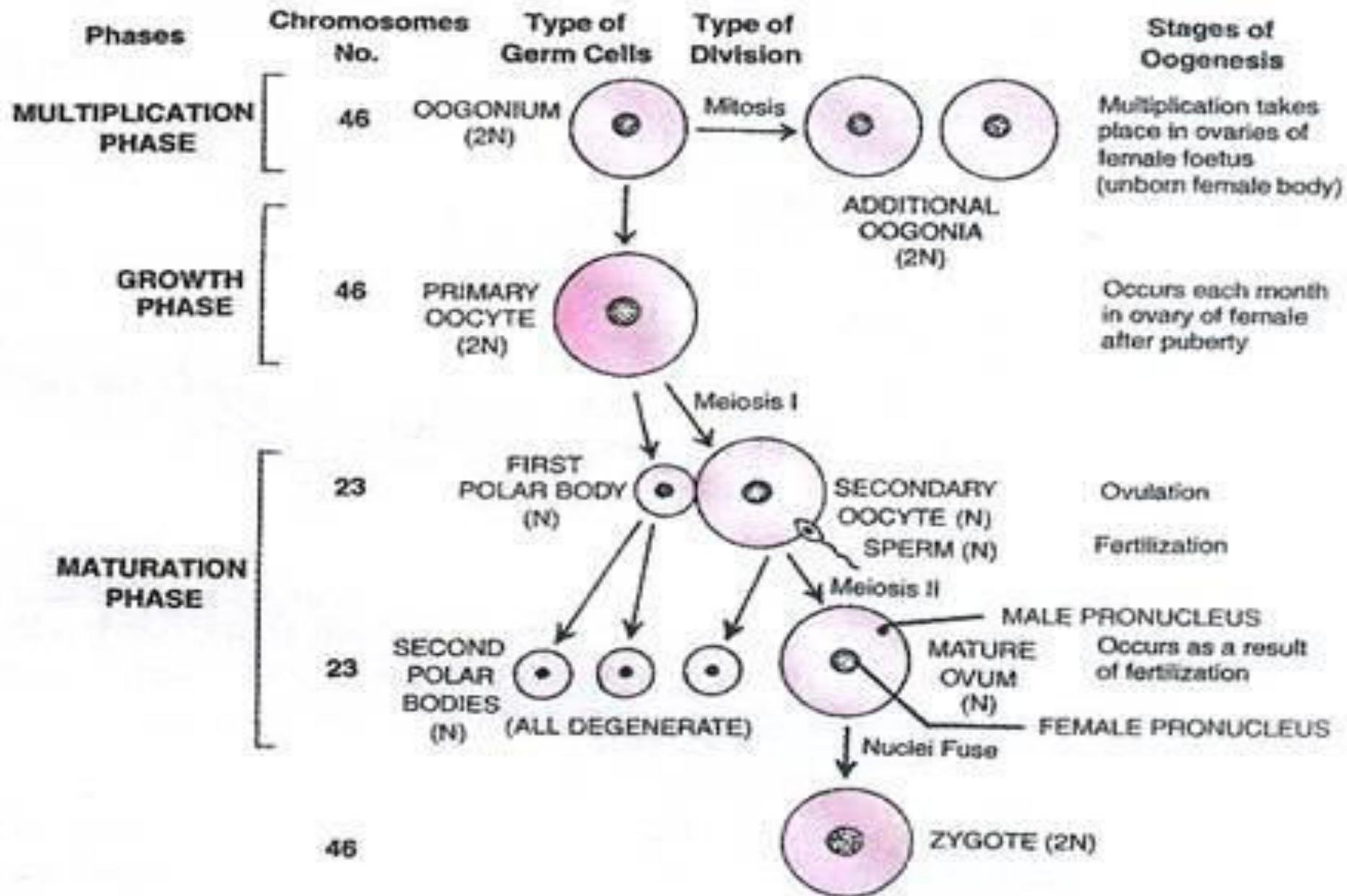
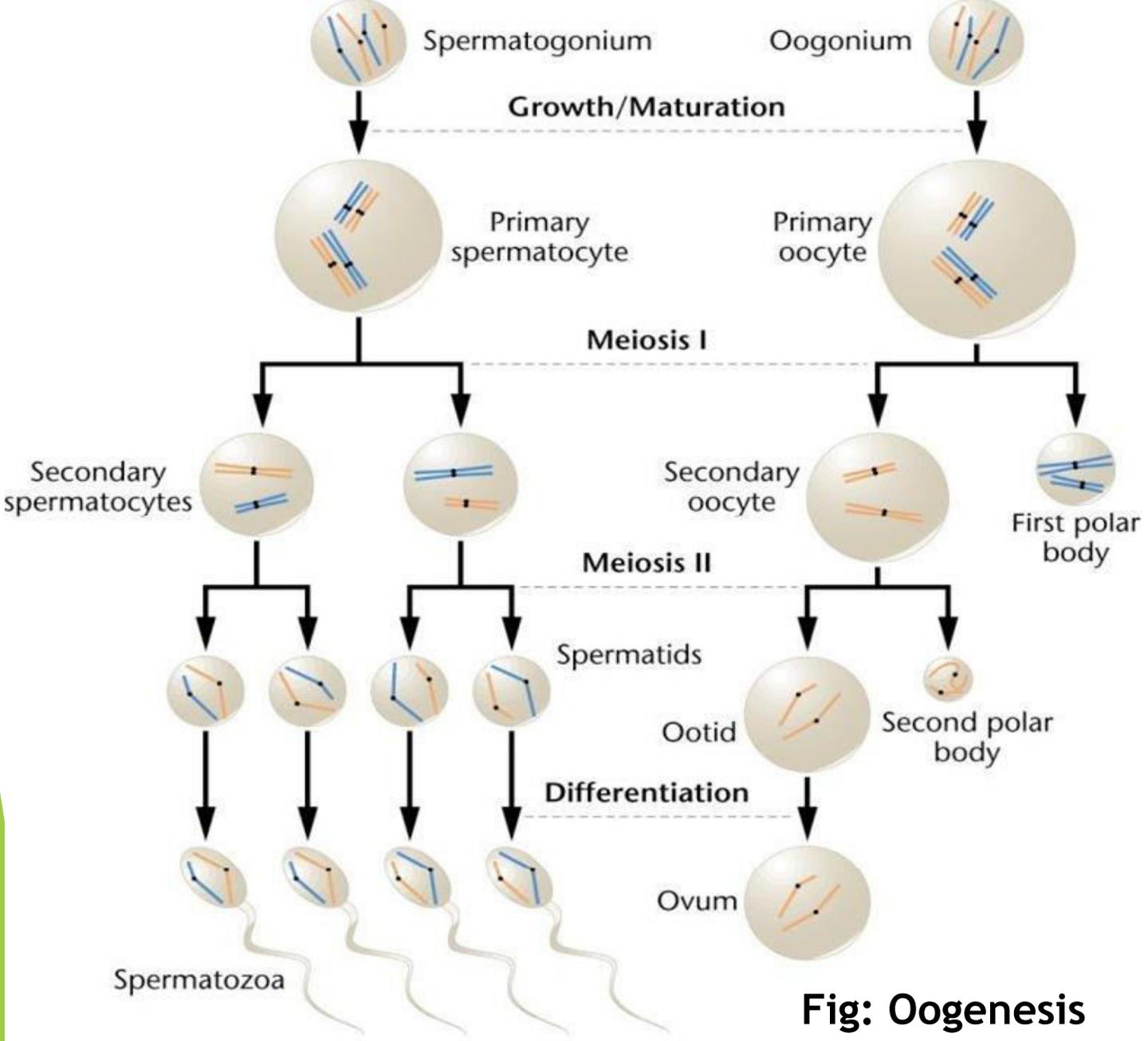


Fig. 3.18. Stages in oogenesis (diagrammatic).



**Fig: Spermatogenesis**

**Fig: Oogenesis**

**Fig: Structure of human egg**

# Molecular Events in Fertilization

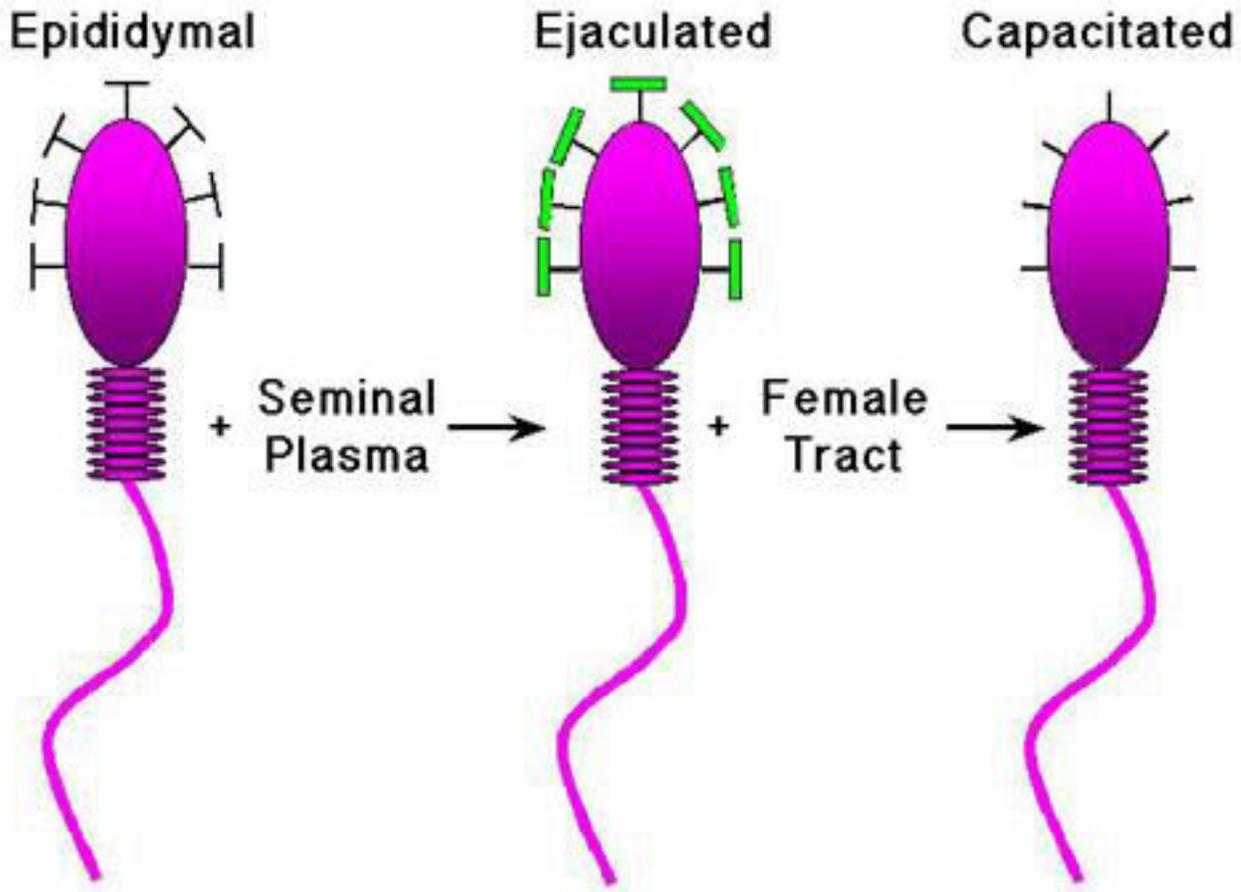
## ► Step 1: Approach of sperm

1. *The sperms move at the rate of 1-4mm/min.*
2. *In 1 ejaculation about 3-3.5ml of semen is deposited in vagina (200-300million sperms).*
3. *Helps in motility of sperms:-*
  - i) *Lashing movement of tail*
  - ii) *Prostaglandins(chemicals) are responsible for causing contraction in the vaginal part and uterine wall.*
4. *Act as a barrier:-*
  - i) *The thick endometrium*
  - ii) *Acidic ph in the female reproductive tract.*
  - iii) *Phagocytes in female reproductive tract.*
5. *Capacitation:- When the sperms attain functional maturity in female reproductive tract is called as Capacitation.*

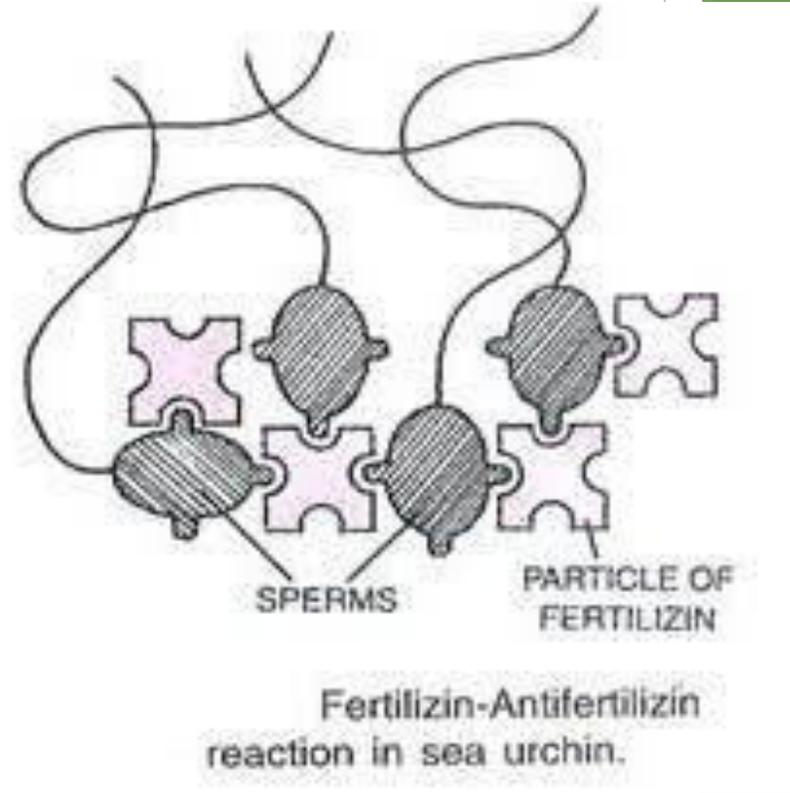
*Two important changes takes place are:-*

- 1- *Removal of sterols and glycoprotein from acrosome membrane.*
- 2- *Calcium are taken in so that the activity of sperms increases,hence swims faster.*

# Effect of Capacitation



step1



Step 2

## **Step 2:- Fertilizin- Anti fertilizin reaction**

- 1- Fertilizin is secreted by ovum. It is a chemical which has spermophilic sites and anti fertilizin is a substance secreted by sperms.
- 2- Fertilizin and anti fertilizin reaction helps to maintain specificity of a species.
- 3- It is also helpful to thinout the no.of sperms.

## **Step 3:- Release of sperm lysins**

- 1- Sperm lysins are basically lytic enzyme.
- 2- There are 3 lytic enzymes:-
  - i) Corona penetrating enzyme
  - ii) Hyanuronidase
  - iii) Acrosin (dissolve zona pellusida)

## **Step 4:- Formation of fertilization cone**

- 1- When sperm interact with egg or secondary oocyte it dissolves corona radiate and zona pellucida and reaches upto the vetalline membrane.
- 2- The egg membrane produces a conical structure called as fertilization cone.
- 3- The nucleus can be introduced from sperm into the ova.

## **Step 5:- Start of meiosis II**

- 1- The sperm with ruptured acrosome touches the vitelline membrane and get activated i.e. now meiosis II is complete.
- 2- The egg from female gamete is ready to get the nucleus from sperms.
- 3- The above division resulted into complete cytoplasm retained with egg and little cytoplasm go with second polar body .

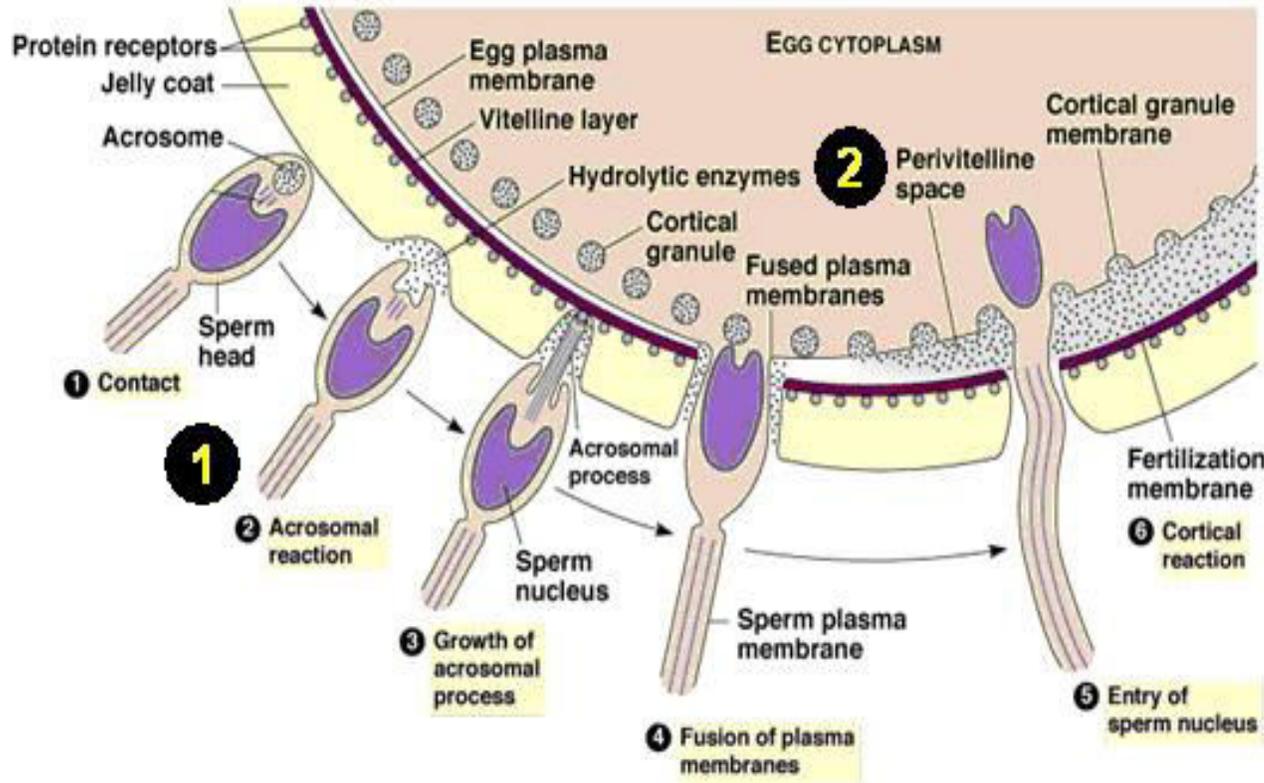


Fig:- Step 3

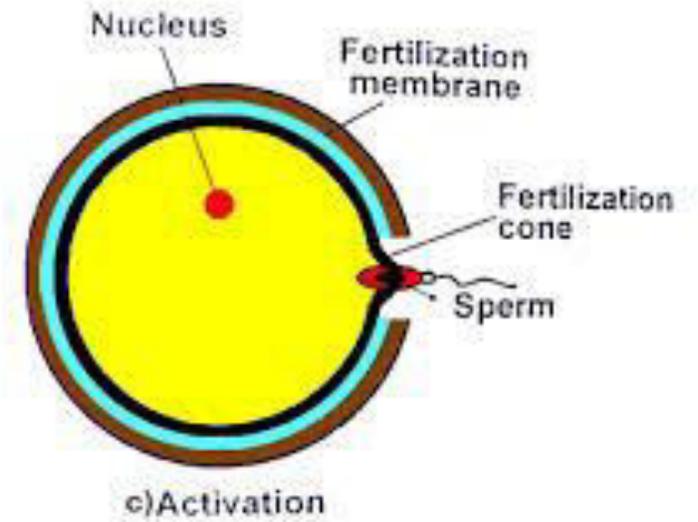


Figure 36.10bc

Fig:-fertilization cone

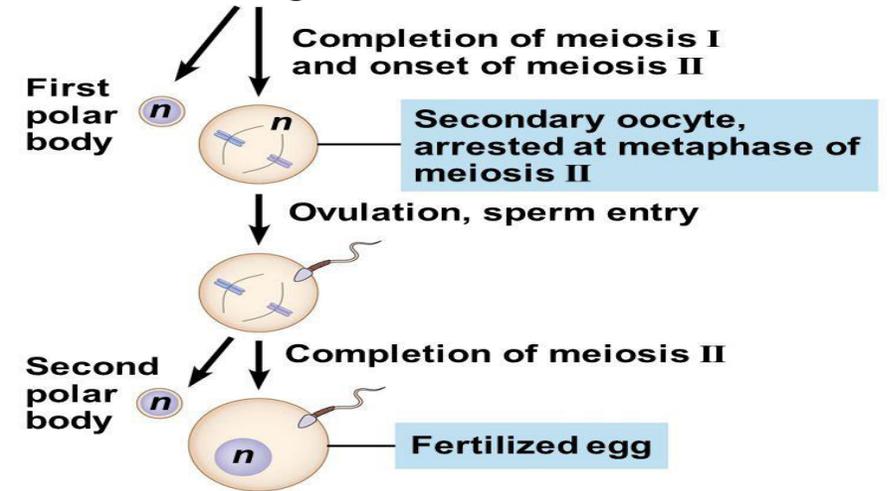


Fig:-start of meiosis II

## **Step 6:- Cortical reaction or Formation of fertilization membrane**

- 1- The cortical granules get attached to the inner side of vitelline membrane and this vitelline membrane are lined by cortical granules are known as fertilization membrane.
- 2- Fertilization membrane prevents polyspermy.

## **Step 7:- Fusion of Gametic Nuclei**

- 1- The nucleus from sperms( $n$ ) and the nucleus from egg( $n$ ) undergoes copulation to form synkaryon ( $2n$ ).
- 2- The path followed by nucleus of sperm is called copulation path. This path decides the axis of cleavage of zygote.

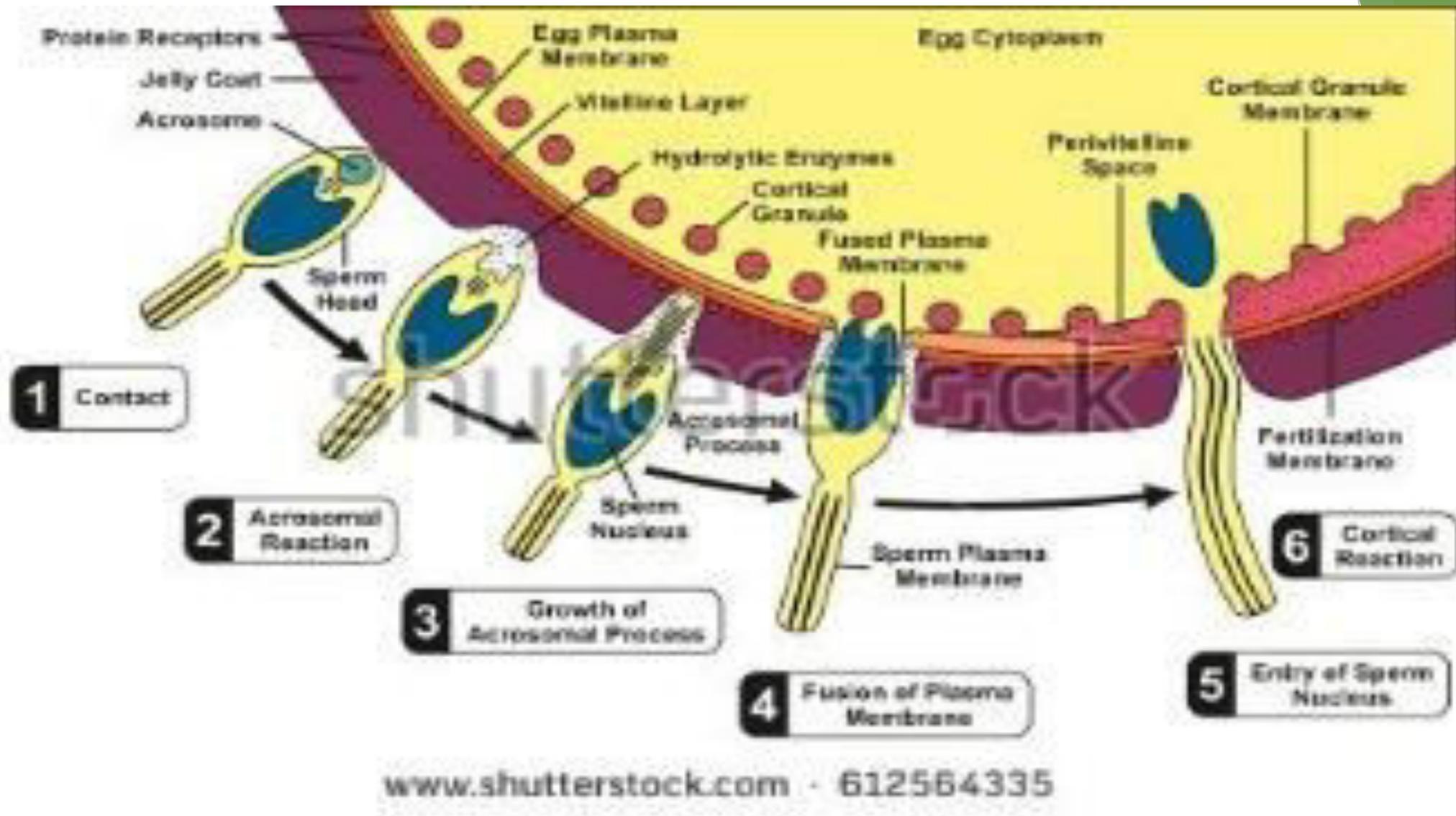


Fig:- Step  
6

# Significance of fertilization

1. It results in the fusion of 2 gametes. This result into genetic variation.
2. Meiosis II starts when egg comes in contact with sperm.
3. During meiosis complete cytoplasmic content is retained by the egg.
4. Species specific diploid no.of chromosome is attained.
5. Metabollic activity increases due to mitochondrian activity is high and the oxygen uptake is increases.
6. Fertilization membrane prevents polyspermy.

## *Conclusion*

Fertilization is fusion of male and female gamete to form diploid zygote but we have seen there are so many events or steps takes place for this fusion to actually get completed.

# REFERENCES

1. P.S. VERMA AND V.K AGARWAL. CHORDATE EMBRYOLOGY, published by S. CHAND
2. SCOTT F. GILBERT ,DEVELOPMENTAL BIOLOGY,published by sinauer Associates
3. [www.ncbi.nlm.nih.gov](http://www.ncbi.nlm.nih.gov)

THANK YOU