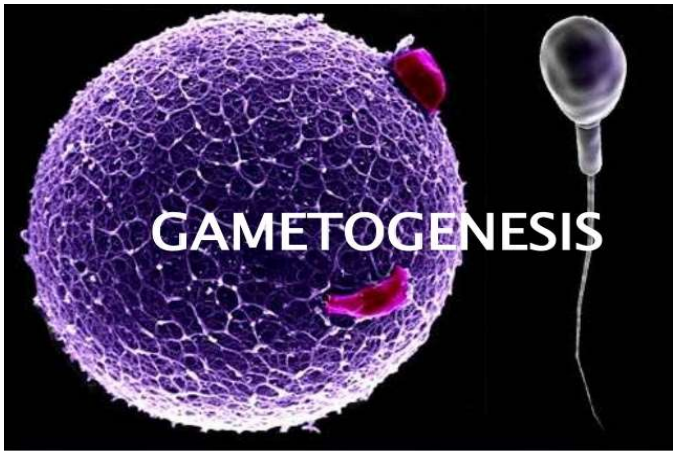
The University Of Jordan
Faculty Of Medicine



Gametogenesis

DR. AHMED SALMAN

ASSOCIATE PROFESSOR OF ANATOMY AND HISTOLOGY

Gametogenesis

It is the process of production of mature male and female gametes from immature ones inside the gonads (Testis and ovary)

It includes change in the cytoplasm and nucleus

Cytoplasm: is increased in the ovum but decreased in the sperm

Nucleus : Undergo meiotic division to reduce the number of chromosomes to half number

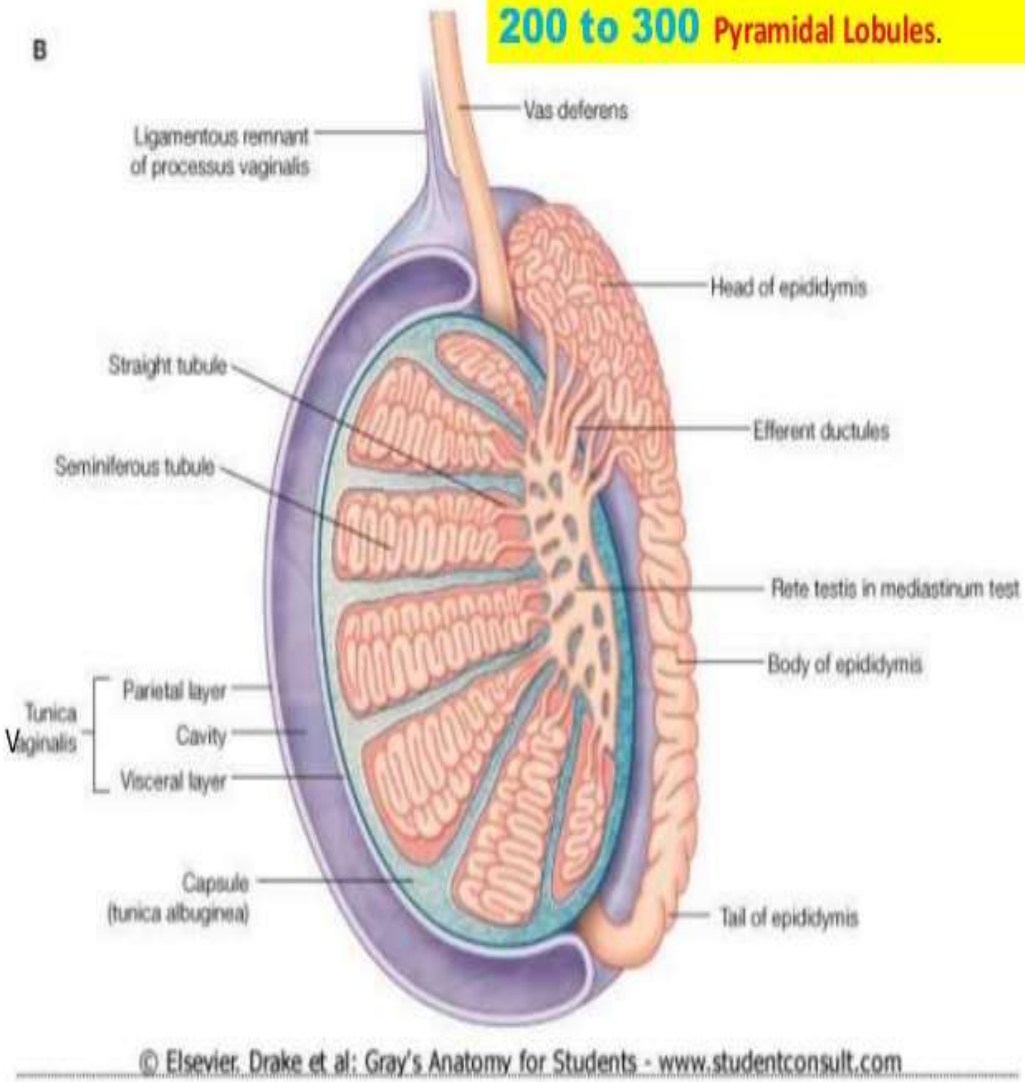
1-Spermatogenesis

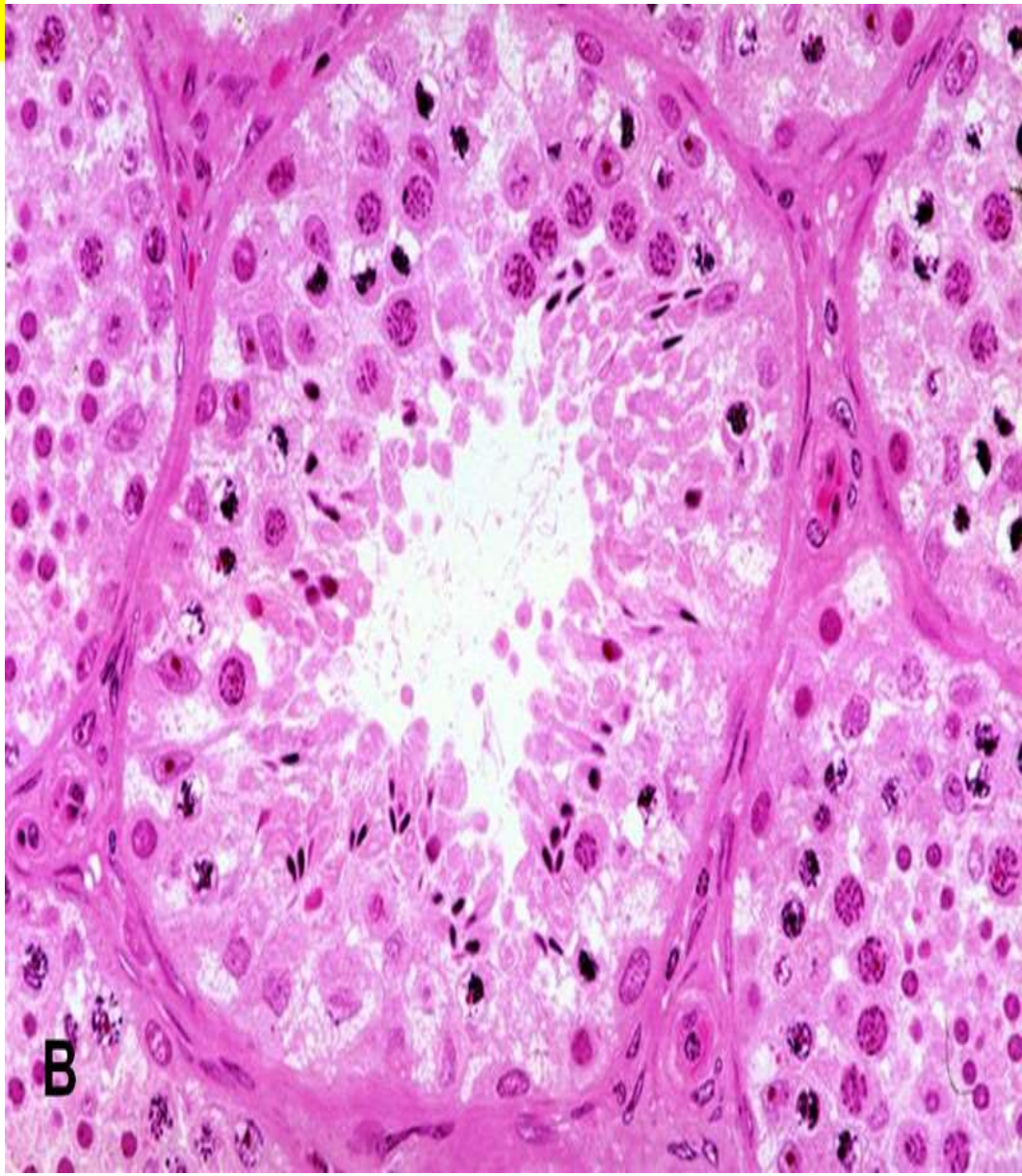
Definition: it is a process by which primitive male germ cells (spermatogonia) are transformed into spermatozoa (sperms).

Site and onset of spermatogenesis: it occurs in the seminiferous tubules of the testis from puberty till old age.

Spermatogenesis has 4 stages and each cycle gives rise to 4 spermatozoa.

200 to 300 Pyramidal Lobules.





The 4 stages of Spermatogenesis :

1. Proliferation:

-**Spermatogonia:** which contain diploid number of chromosomes (44+XY) divide by ***mitosis*** into ***daughter spermatogonia,*** which still contains (44 + XY).

- Proliferation increases the *number* of the spermatogonia

2. Growth:

- The ***daughter spermatogonia*** enlarge to form ***primary spermatocytes***, which are the largest germ cells in the seminiferous tubules.

- Growth increases the size of the spermatogonia.

3. Maturation:

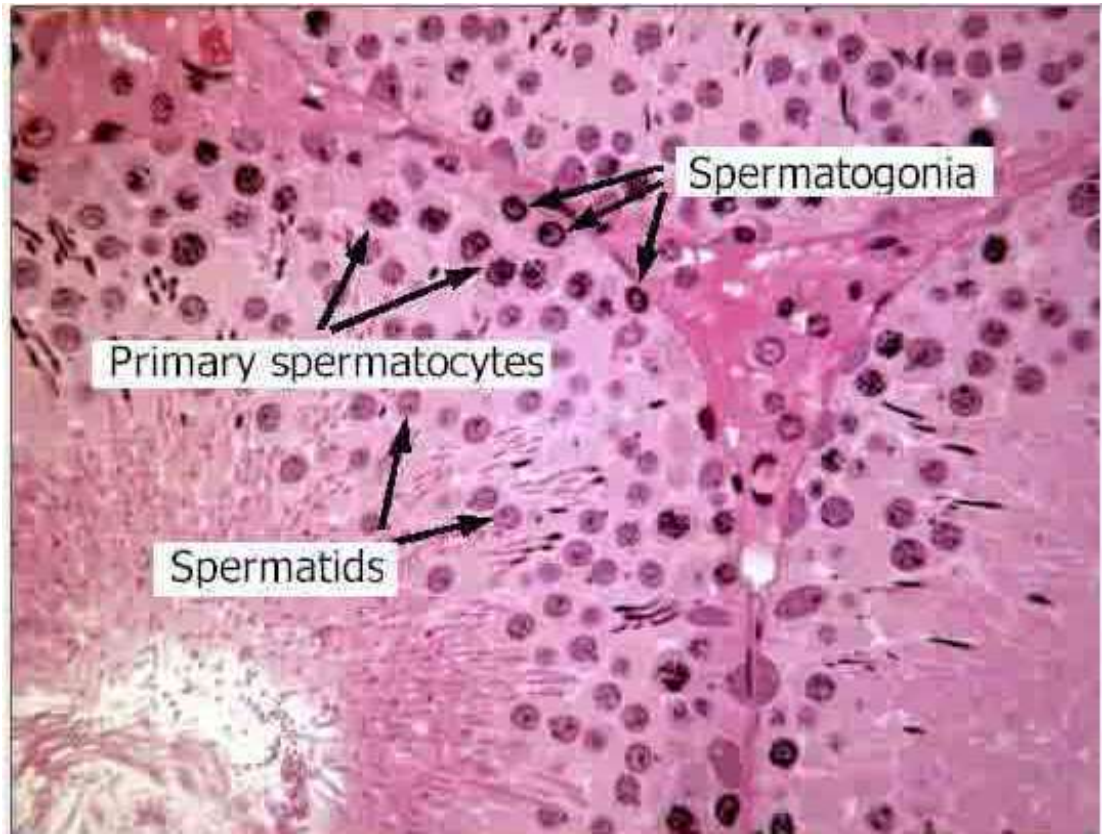
-It consists of ***2 successive*** maturation divisions (meiosis I and meiosis II).

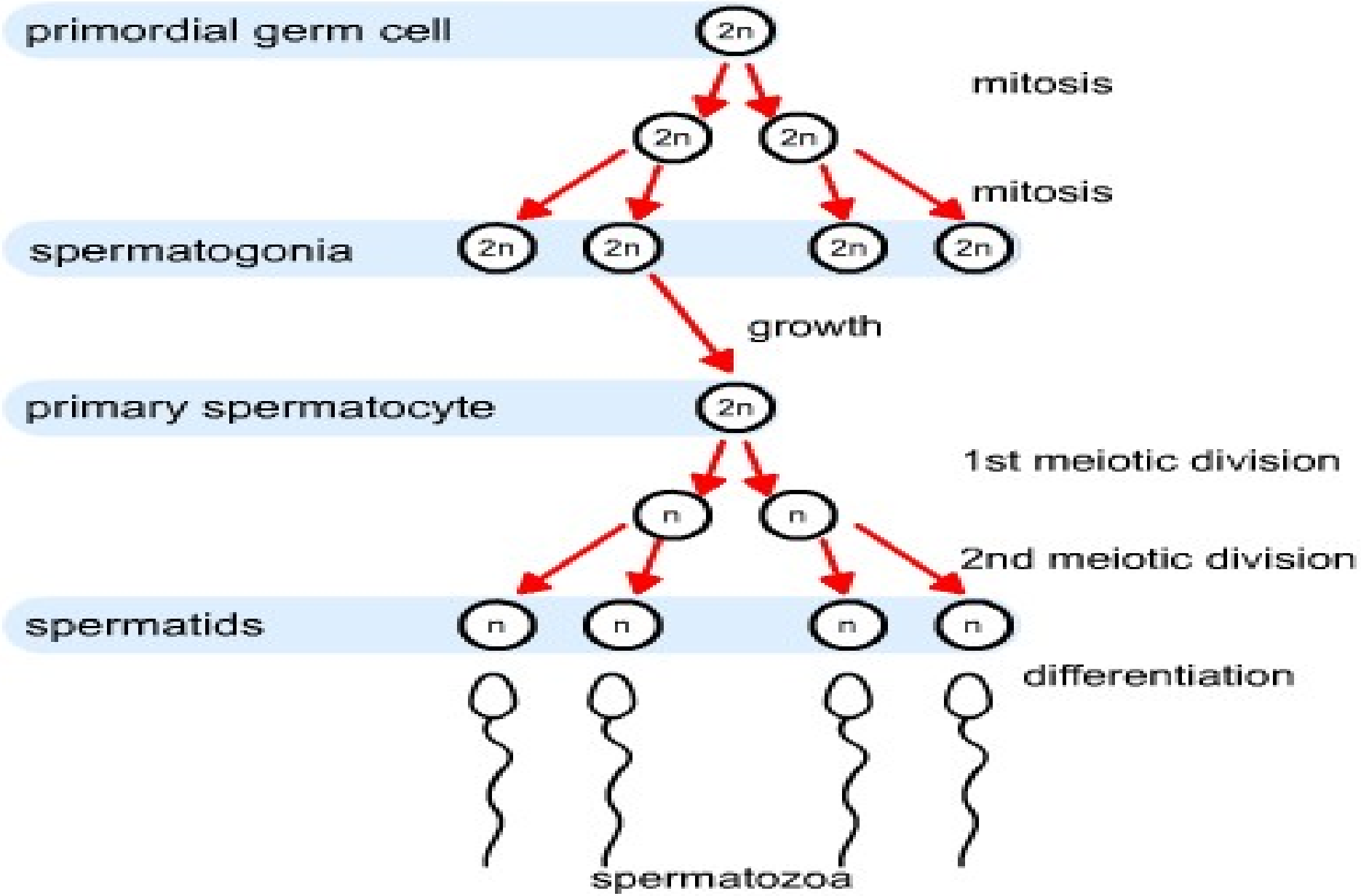
a) First maturation division (meiosis I):

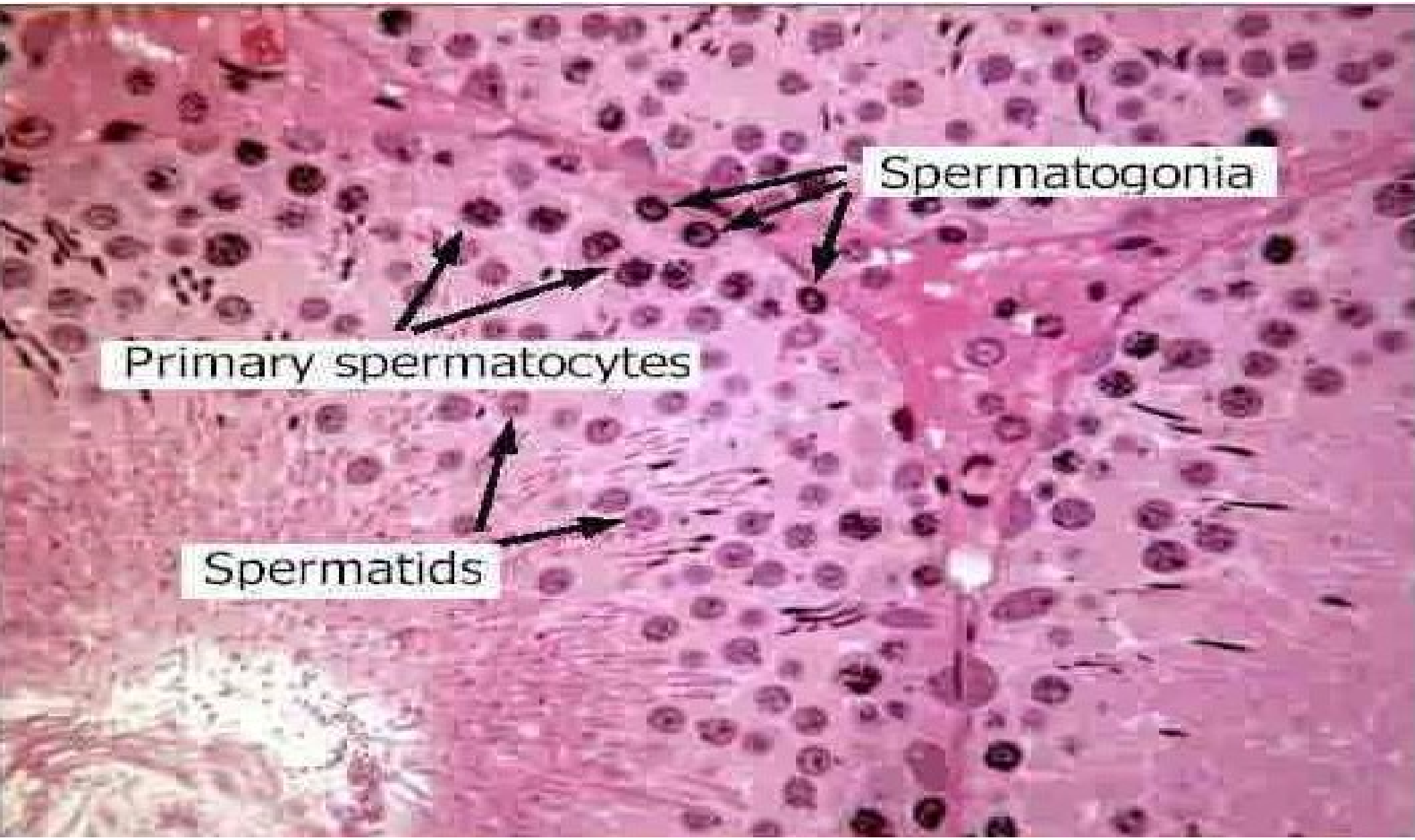
- Primary spermatocytes divide by meiosis to produce 2 secondary spermatocytes
- Each contains haploid number of chromosomes (22+x or 22+y).
- Meiosis I reduces the number of chromosomes from diploid into haploid.

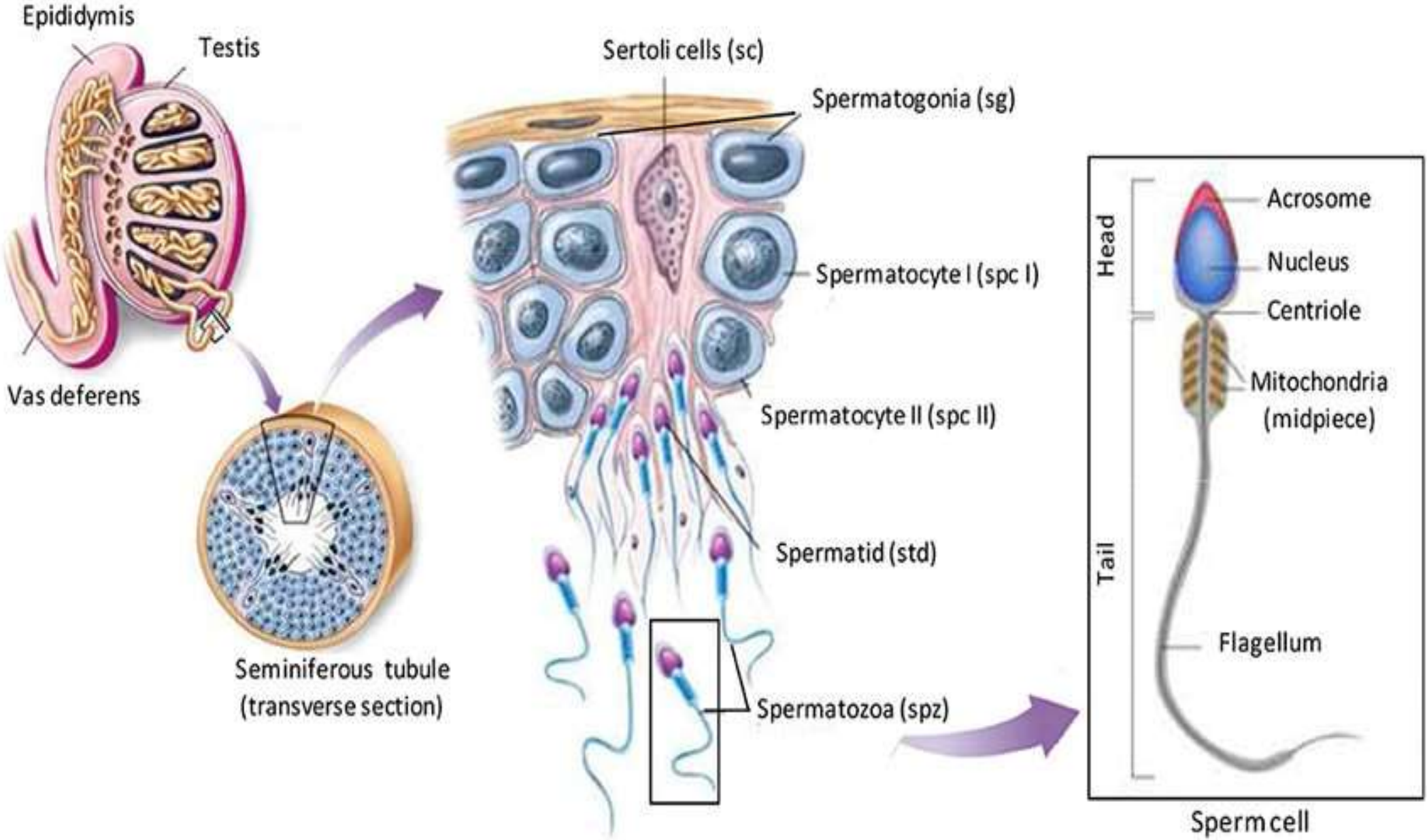
b) Second maturation division (meiosis II)

The Secondary spermatocyte divides into 2 spermatids, each contains the haploid number of chromosomes.




primordial germ cell
2n
mitosis
2n
2n
mitosis
spermatogonia
2n
2n
2n
2n
growth
primary spermatocyte
2n
1st meiotic division
n
n
2nd meiotic division
spermatids
n
n
n
n
differentiation
spermatozoa


Spermatogonia
Primary spermatocytes
Spermatids


Epididymis
Testis
Vas deferens
Seminiferous tubule
(transverse section)
Sertoli cells (sc)
Spermatogonia (sg)
Spermatocyte I (spc I)
Spermatocyte II (spc II)
Spermatid (std)
Spermatozoa (spz)
Head
Tail
Acrosome
Nucleus
Centriole
Mitochondria
(midpiece)
Flagellum
Sperm cell

4. Transformation (spermiogenesis)

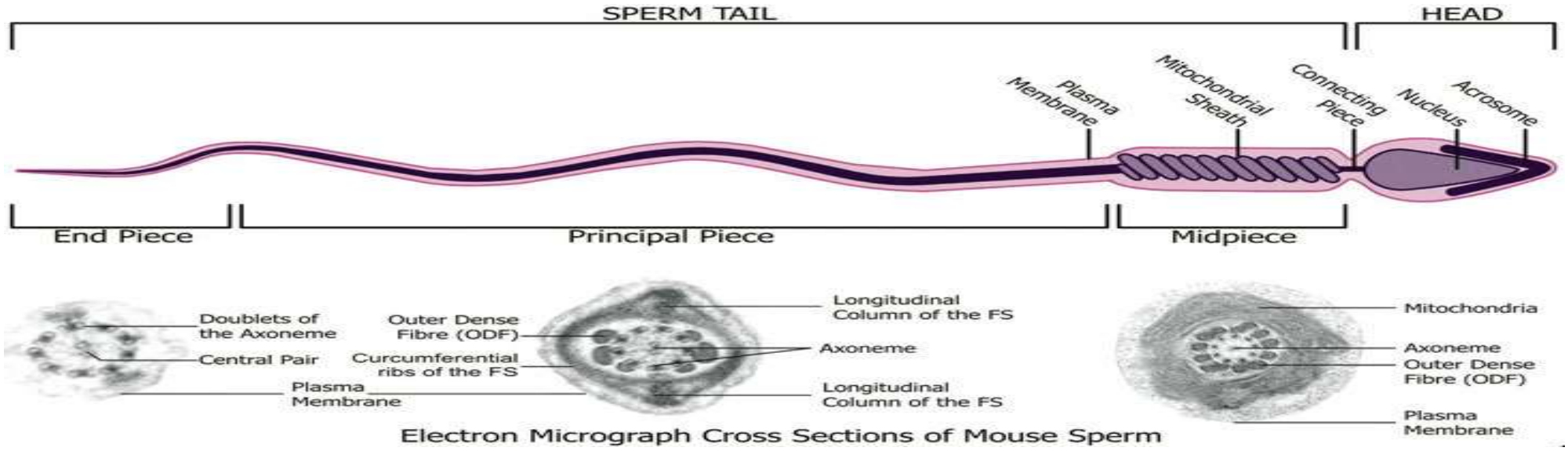
- It is the process by which, the spermatid is transformed into spermatozoon (sperm).
- The sperm consists of 4 parts :-

1-Head :

It contains condensed nucleus covered with acrosomal cap which contains lysosomes and plays role for penetration of ovum.

2-Neck:

It is a containing the centrioles and the connecting piece.



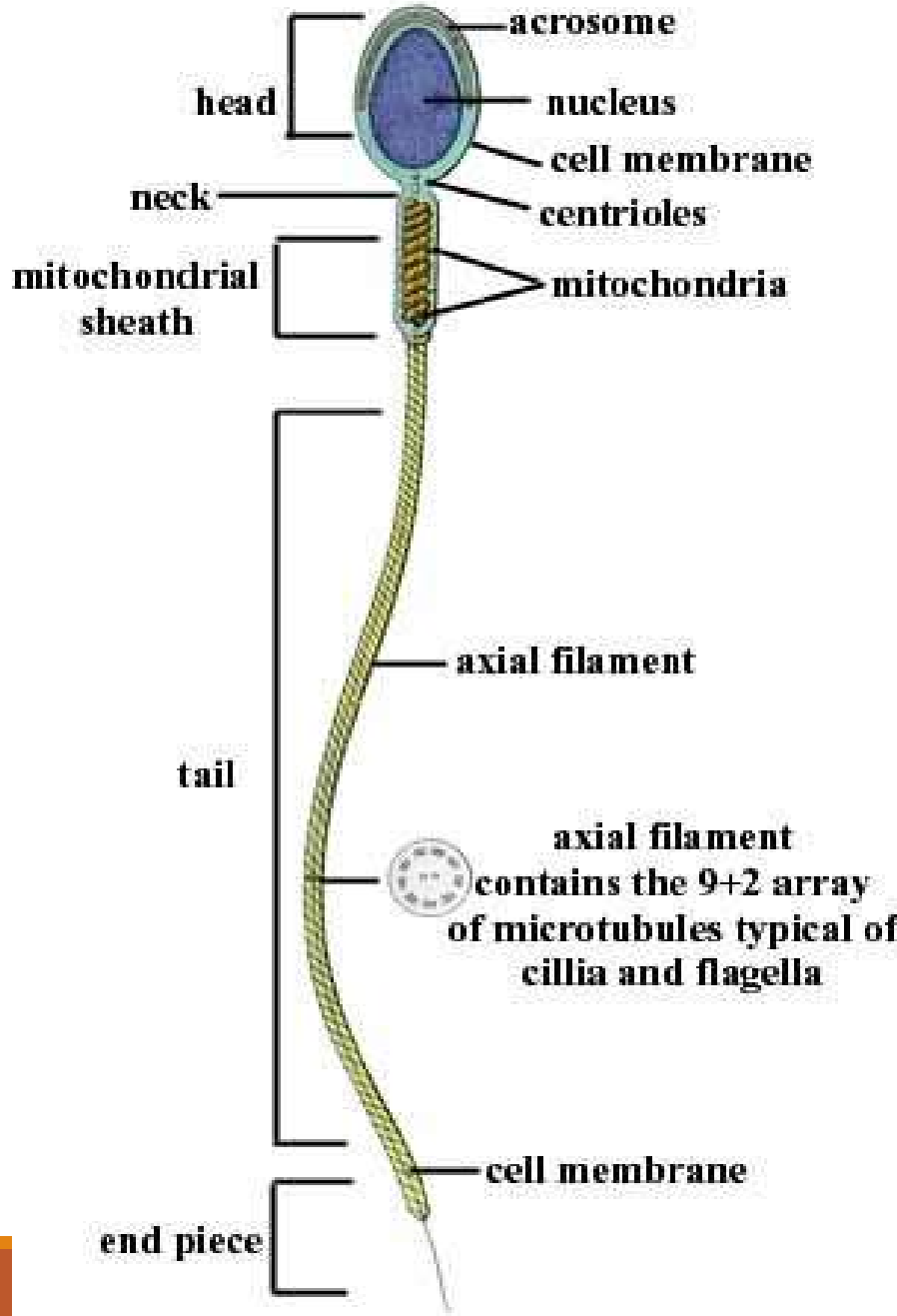
Electron Micrograph Cross Sections of Mouse Sperm

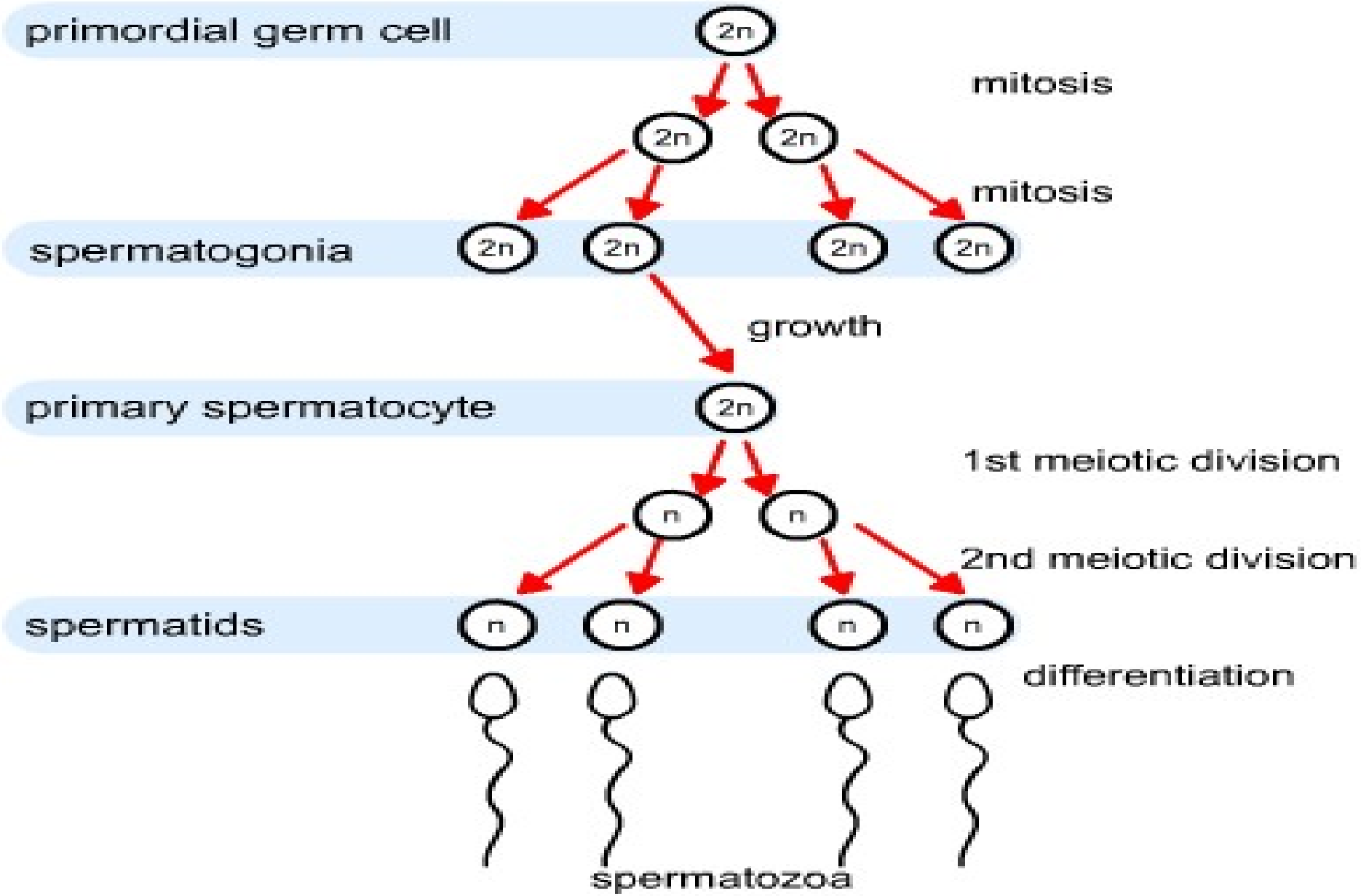
3-Middle piece:

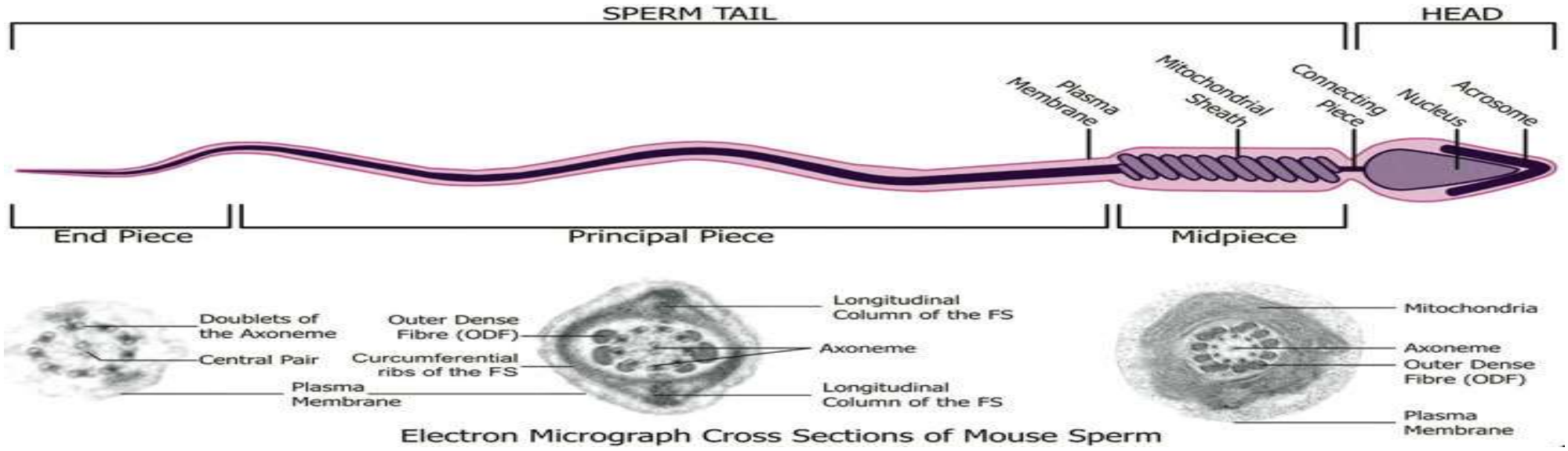
It contains Elongated mitochondrial sheath.

provides energy for motility of the sperm.

4- Tail: is formed only of axial filament responsible for motility of the sperm.

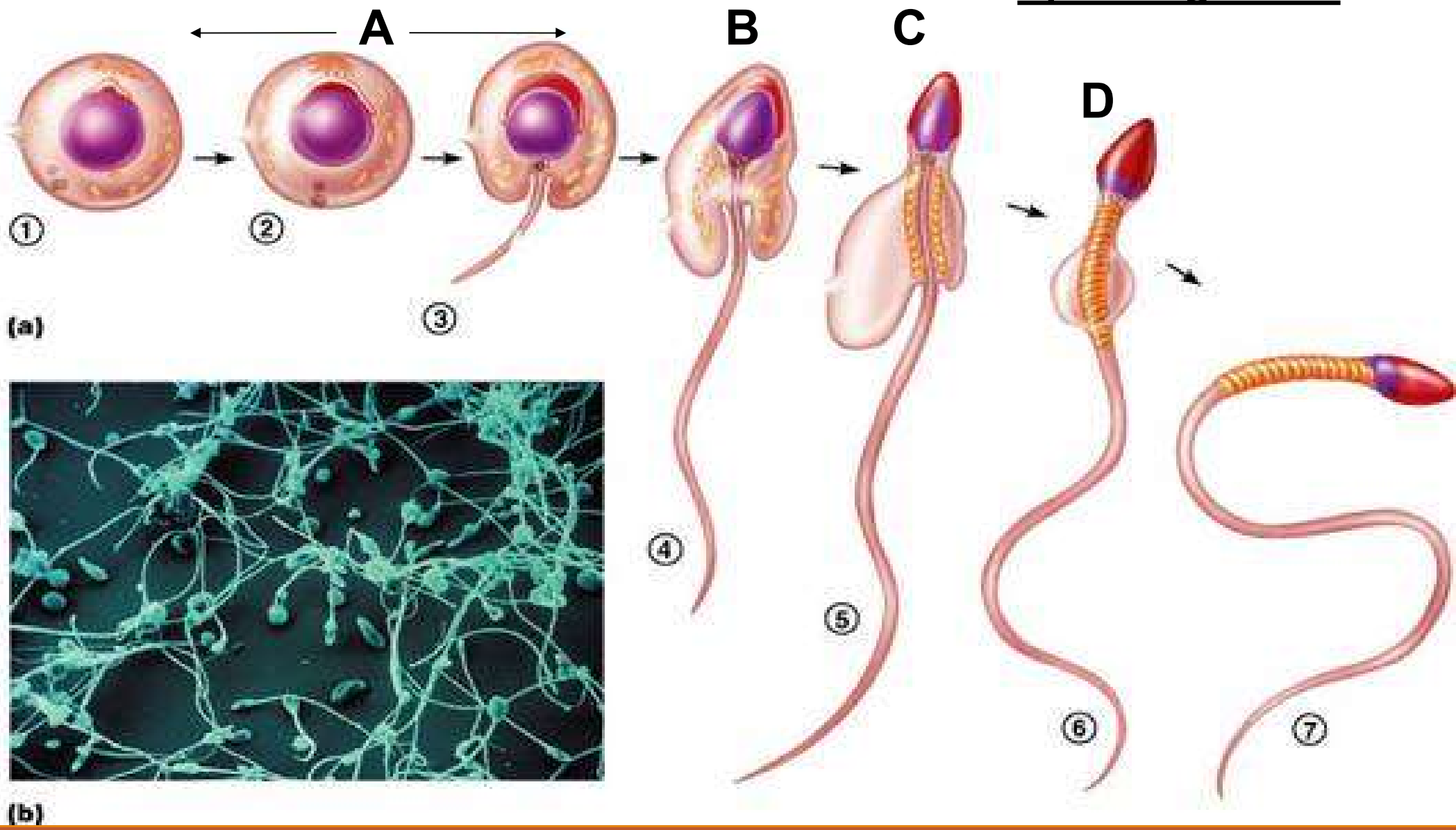



primordial germ cell
2n
mitosis
2n
2n
mitosis
spermatogonia
2n
2n
2n
2n
growth
primary spermatocyte
2n
1st meiotic division
n
n
2nd meiotic division
spermatids
n
n
n
n
differentiation
spermatozoa



Electron Micrograph Cross Sections of Mouse Sperm

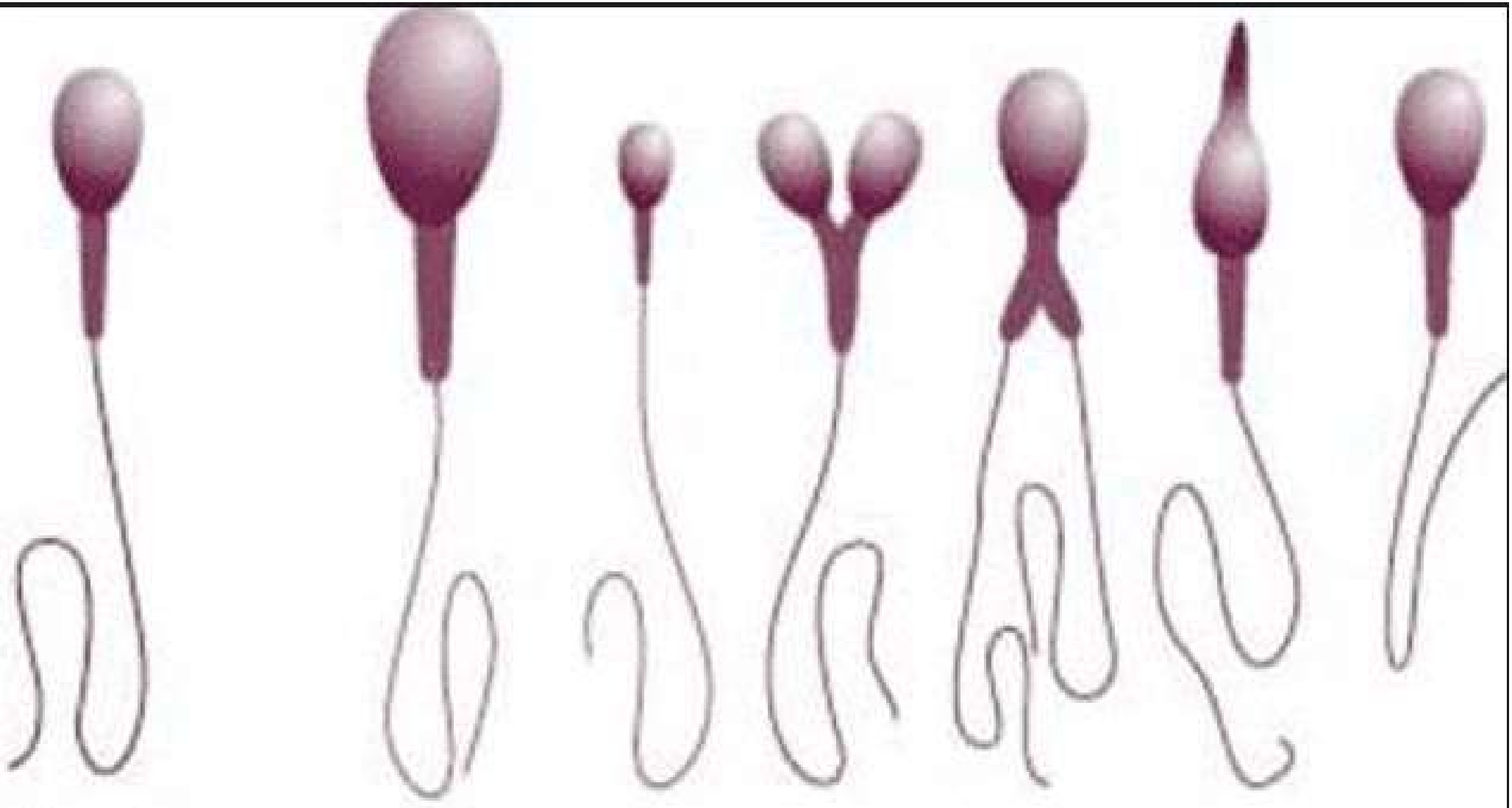
Spermiogenesis



Abnormalities of the sperms:

1. Abnormalities in ***shape*** of the sperms for example (double heads, large head , pin head , taper head , double tails , dwarf sperm).
2. Abnormalities in the ***motility*** (normally it is actively motile).
3. Abnormal sperm ***count*** :

- ***Oligospermia*** : less than 20 million/ml
- ***Azospermia***: complete absence of sperms in the semen
- ***Necrospermia*** : dead sperms in the semen .


Normal
Oval Form
Large
Head
Pin
Head
Two
Head
Abnormal
Tail
Tapered
Head
Bent
Tail

Important data in spermatogenesis:

REED ONLY

- The sperm is about 60 microns in length.
- The cycle of spermatogenesis takes about 60 days in the seminiferous tubules.
- About 600 millions of sperms are present in each ejaculate.
- Active sperms may reach the ampulla of the uterine tube (site of fertilization) 60 minutes after their deposition in the female genital tract.
- Viability of sperms: they do not survive more than 48 hours in the female genital tract.

REED ONLY

WHO 5th Edition Reference Ranges and Cutoffs Including Sperm Concentration, Motility, and Morphology

Parameter	Lower reference limit
Semen volume (ml)	1.5 (1.4–1.7)
Total sperm number (10^6 per ejaculate)	39 (33–46)
Sperm concentration (10^6 per ml)	15 (12–16)
Total motility (PR + NP, %)	40 (38–42)
Progressive motility (PR, %)	32 (31–34)
Vitality (live spermatozoa, %)	58 (55–63)
Sperm morphology (normal forms, %)	4 (3.0–4.0)
Other consensus threshold values	
pH	≥7.2
Peroxidase-positive leukocytes (10^6 per ml)	<1.0
MAR test (motile spermatozoa with bound particles, %)	<50
Immunobead test (motile spermatozoa with bound beads, %)	<50
Seminal zinc (μmol/ejaculate)	≥2.4
Seminal fructose (μmol/ejaculate)	≥13
Seminal neutral glucosidase (mU/ejaculate)	≥20

2- Oogenesis

Oogenesis includes two processes

I-Maturation of primitive germ cell into mature ovum contains haploid number of chromosomes

II- Maturation of follicular cells around oocyte into mature follicle to protect the ovum and hormone production

Site and onset of oogenesis: It begins in the cortex of the ovary during the intrauterine life and arrested, then reactivated at puberty and continues till menopause.

During fertile period ,one mature ovum is developed in the ovary (Rt. or Lt.) every 28 days

DIAGRAM

Stages of oogenesis:

I-Prenatal events of oogenesis:

it includes 3 events

1-Proliferation:

It increases the **number** of oogonia

Time : during the early fetal life (Intrauterine)

All oogonia proliferate by mitosis to form many daughter oogonia (44+xx).

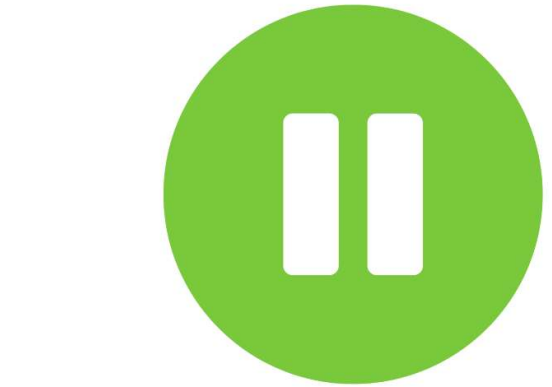
2. Growth:

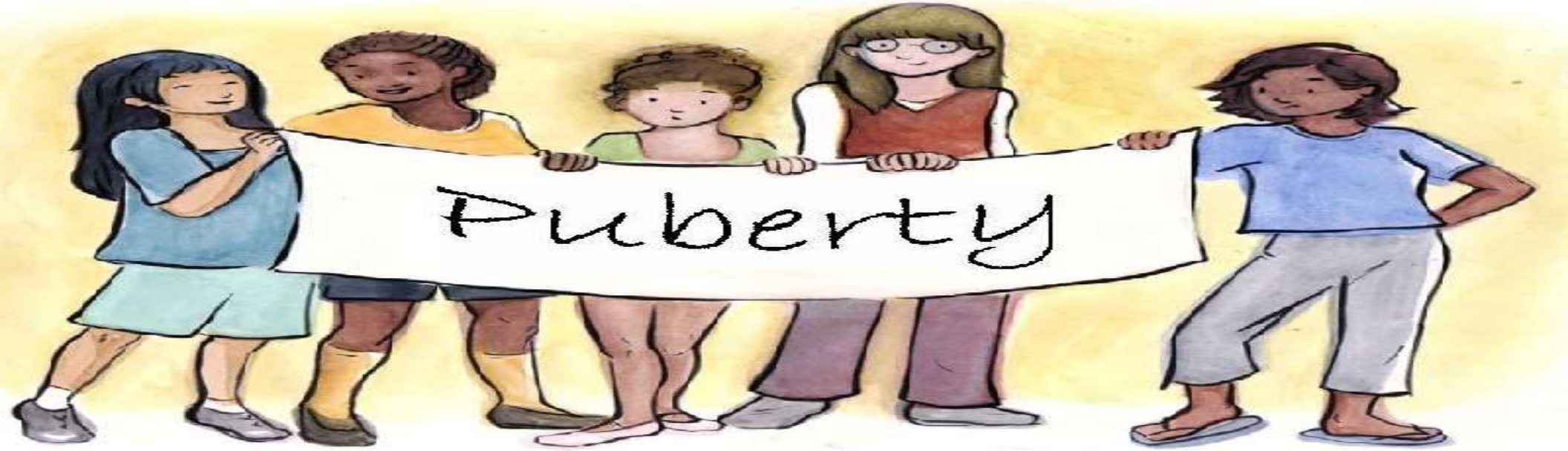
Increases the **size** of oogonia

Daughter oogonia enlarge to form **primary oocytes** (still 44+xx).

3.Beginning of first maturation division (meiosis I):

- All primary oocytes enter the prophase of the first meiotic division
- Then arrested under the effect of **oocyte maturation inhibitor (O.M.I)** secreted by the follicular cells
- At birth the ovary contains only primary oocytes but no oogonia at all.





II. Postnatal events of oogenesis:

1. Reactivation of first maturation division (meiosis I, in the ovary).

- Occurs at puberty once every month in either ovary.
- About 20 primary follicles are triggered but only one follicle matures and the rest degenerate forming atretic follicles.

The triggered primary oocyte completes its first meitotic division **(meiosis I)** to produce:

1-Secondary oocyte (haploid chromosomes, 22+x) and takes most of the cytoplasm.

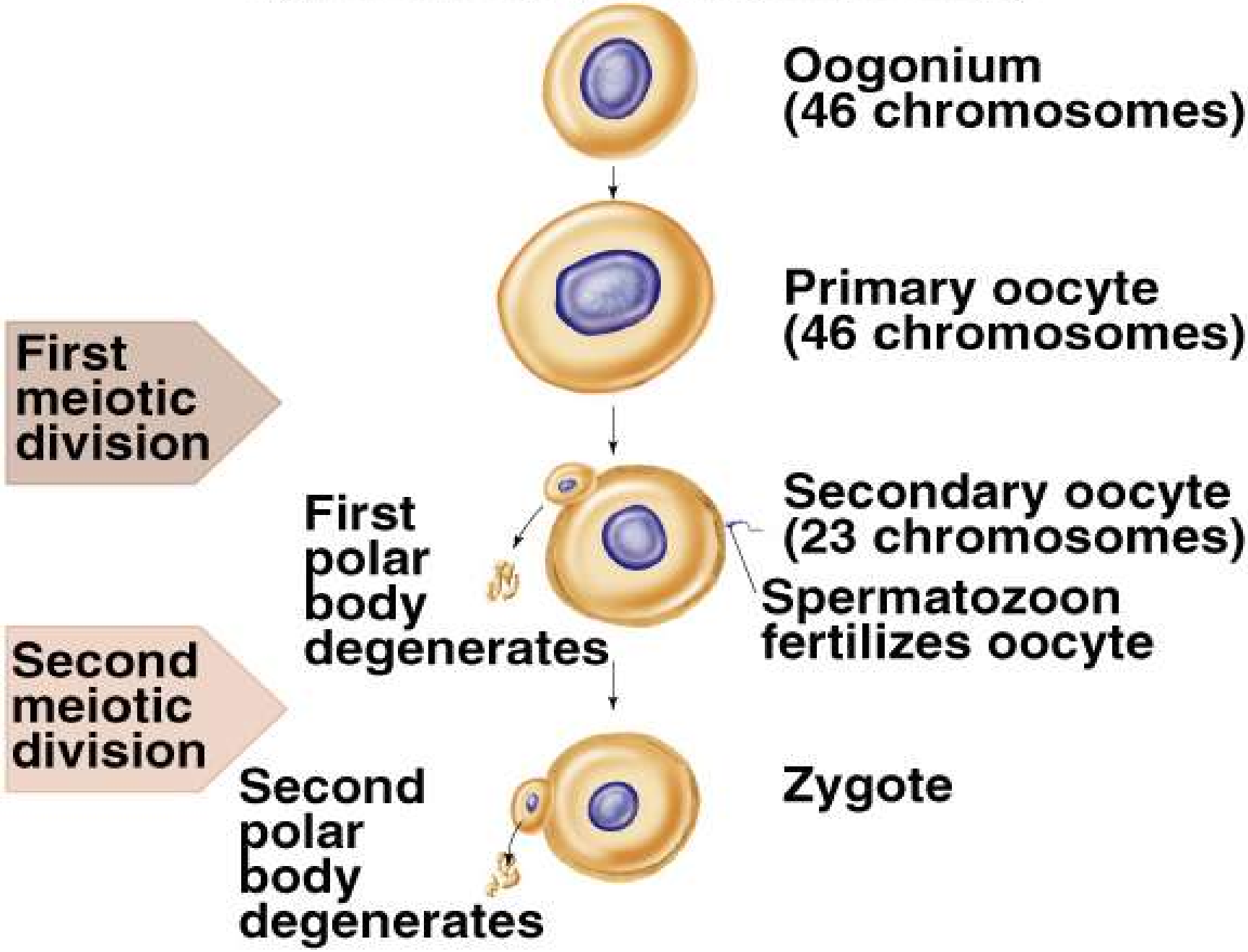
2-First polar body (haploid chromosomes, 22+x) and takes little of the cytoplasm.

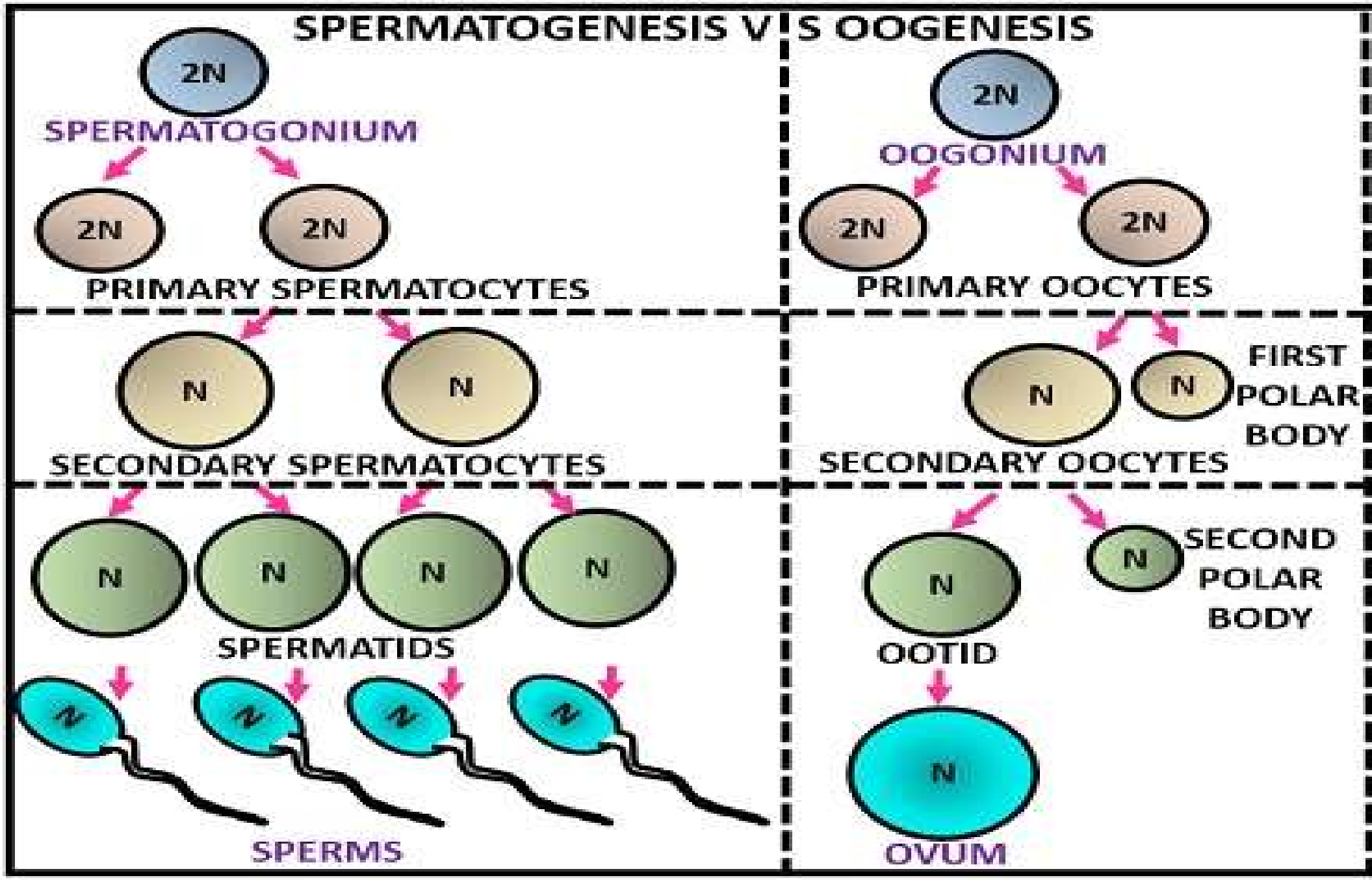
- At the time of ovulation, secondary oocyte is liberated from the ovary and is picked up by the uterine tube.

2.Second maturation division (meiosis II)

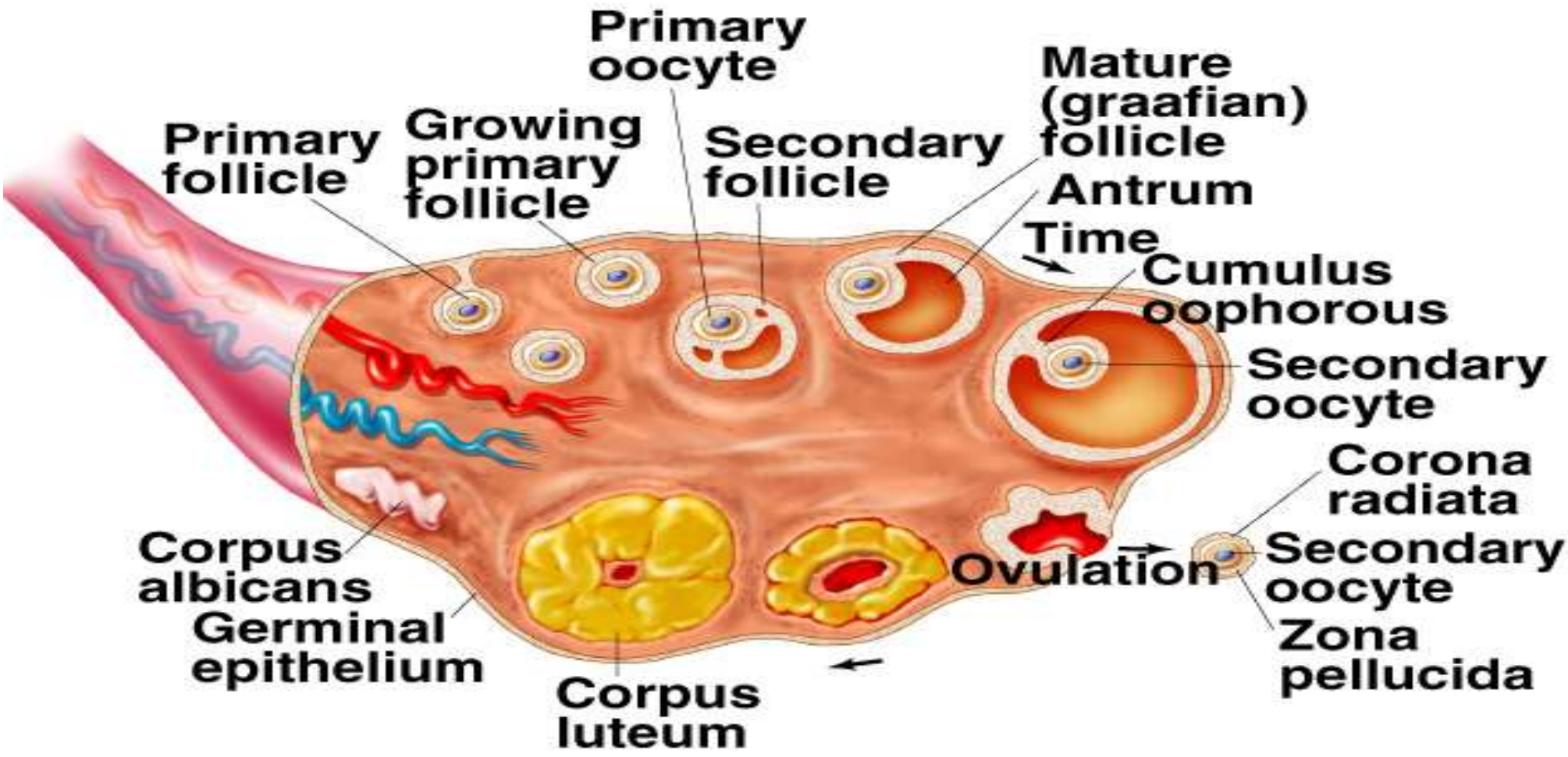
Place : the uterine tube.

- It occurs in the uterine tube only **if fertilization occurs.**
- The secondary oocyte (22+x) divides to produce a mature ovum (22+x) and a second polar body, which is non- functional and degenerates.
- If not fertilized within 12 - 24 hours after ovulation it degenerates




SPERMATOGENESIS VS OOGENESIS
2N
SPERMATOGONIUM
2N
2N
PRIMARY SPERMATOCYTES
2N
OOGONIUM
2N
2N
PRIMARY OOCYTES
N
N
SECONDARY SPERMATOCYTES
N
N
FIRST POLAR BODY
SECONDARY OOCYTES
N
N
N
N
SPERMATIDS
N
OOTID
N
SECOND POLAR BODY
N
OVUM
SPERMS

Ovarian Follicles

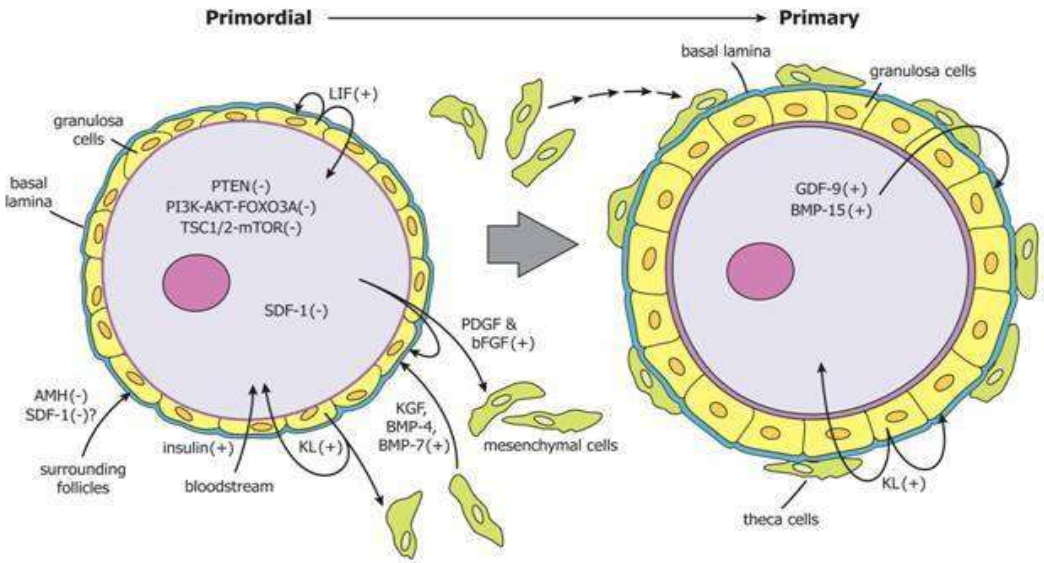


1- Primordial follicle

They composed of primary oocyte (arrested in first mitotic division) surrounded by a single layer of flat follicular cells

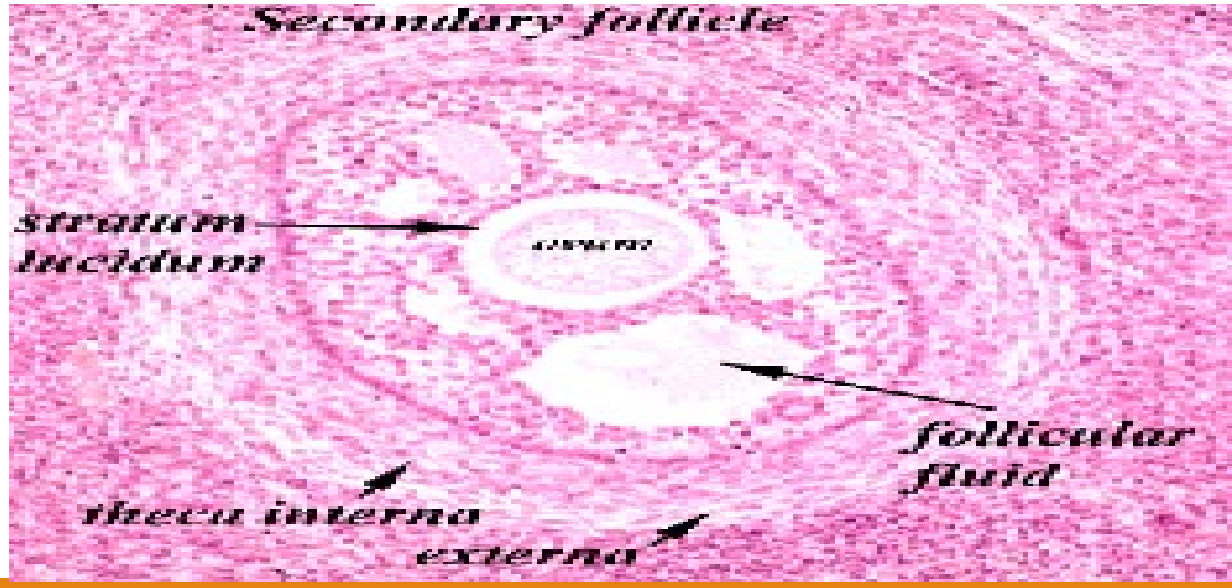
2- Primary follicles:

- It starts at puberty under effect of **FSH** of pituitary gland
- The follicular cells of primordial follicle become cuboidal
- The follicular cells proliferate forming many layers of **granulosa cells** around the primary oocyte
- The **granulosa cells** deposit glycoprotein substance which surrounds the oocyte to form **zona pellucida.**
- **Theca folliculi** cells develop around the primary follicle from the surrounding stromal cells of the ovary.



3- Secondary follicles:

- Granulose cells secrete fluid which form small irregular spaces, between granulosa cells .
- These spaces later unite to form a single cavity called **follicular antrum** which fluid is called **liquor folliculi** , containing estrogen hormone secreted by granulosa cells
- The appearance of follicular antrum with the theca cells differentiate into theca interna (cellular vascular layer) and theca externa (fibrous layer)



4- Graafian follicle

The wall of the Graafian follicle (tertiary follicle) is made of :

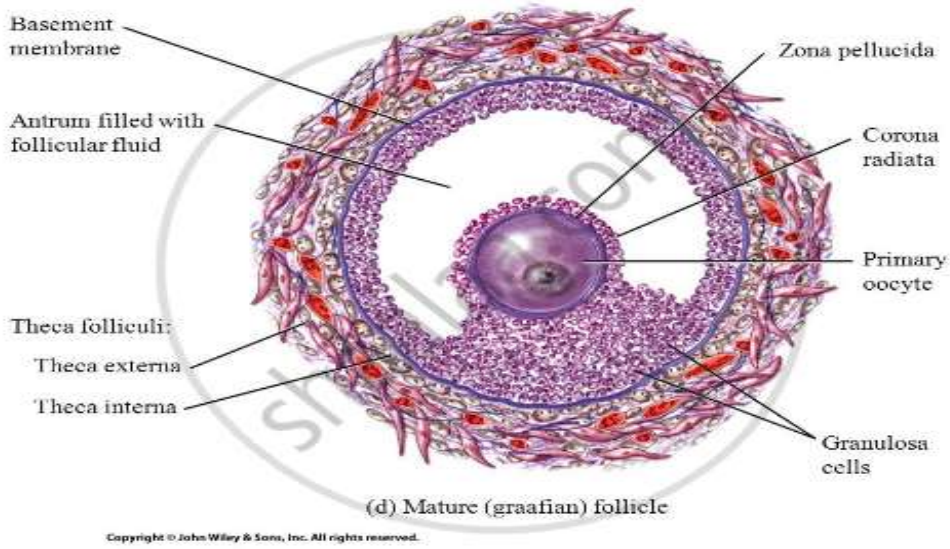
A. **Zona granulosa** (membrana granulosa): formed of 3-4 layers of polyhedral cells lining the central cavity.

B. **Basement membrane**: on which the granulosa cells rest.

C. **Theca folliculi layer :** formed of outer dense theca externa inner loose vascular theca interna.

D. **Follicular cavity :**filled with follicular fluid secreted by follicular cells and is containing oestrogen

E. **The oocyte :** is surrounded by follicular cell called cumulus oophorus

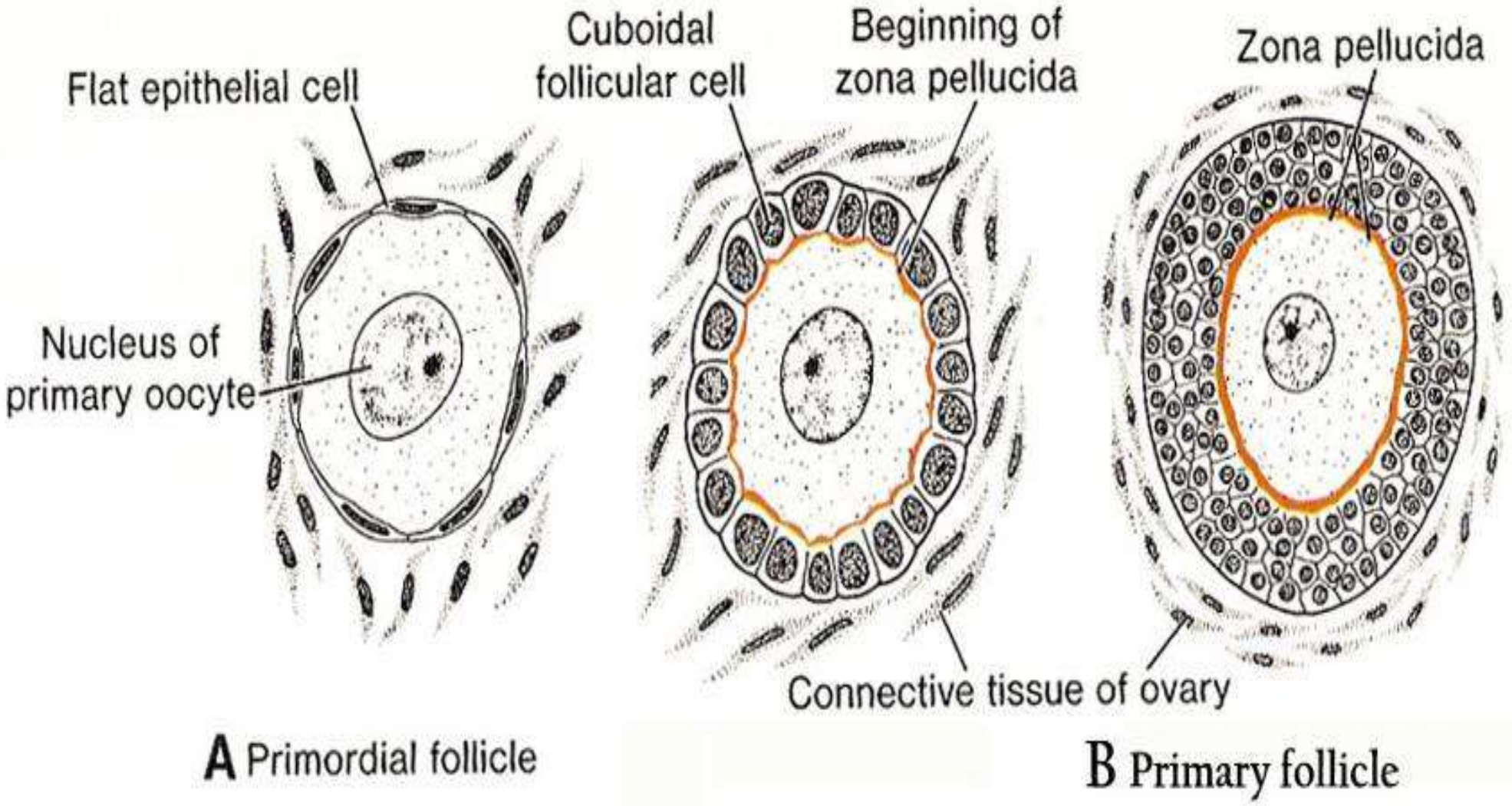


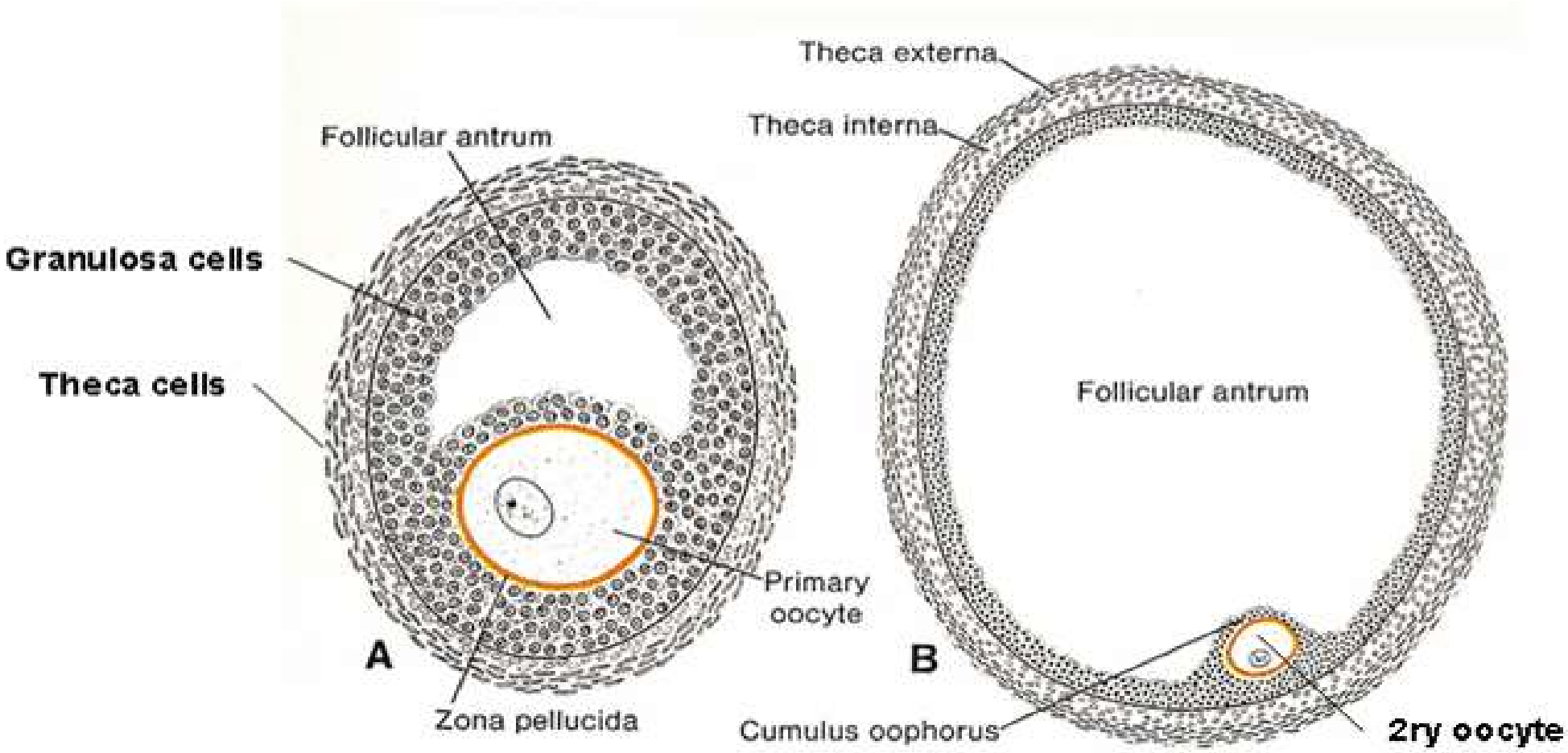
(d) Mature (graafian) follicle

- With **each cycle** , many follicles in both ovaries start to develop , but **only one follicle** successes to reach full maturity , while the remainder becomes **atretic follicles** .
- **At ovulation** , the mature graafian follicle **ruptures** releasing the secondary oocyte , surrounded by the **zona pellucida** & **corona radiata** (cells from the cumulus oophorus) , which is sucked by uterine tube where it lies in its later 1/3 waiting for fertilization .
- **If fertilization occurs** , **second meiosis** is completed in the secondary oocyte with formation of **mature ovum** and a **zygote** is formed.
- **If no fertilization occurs ,** secondary oocyte **dies after 24 – 36 hours** .

Fate of Graafian follicle

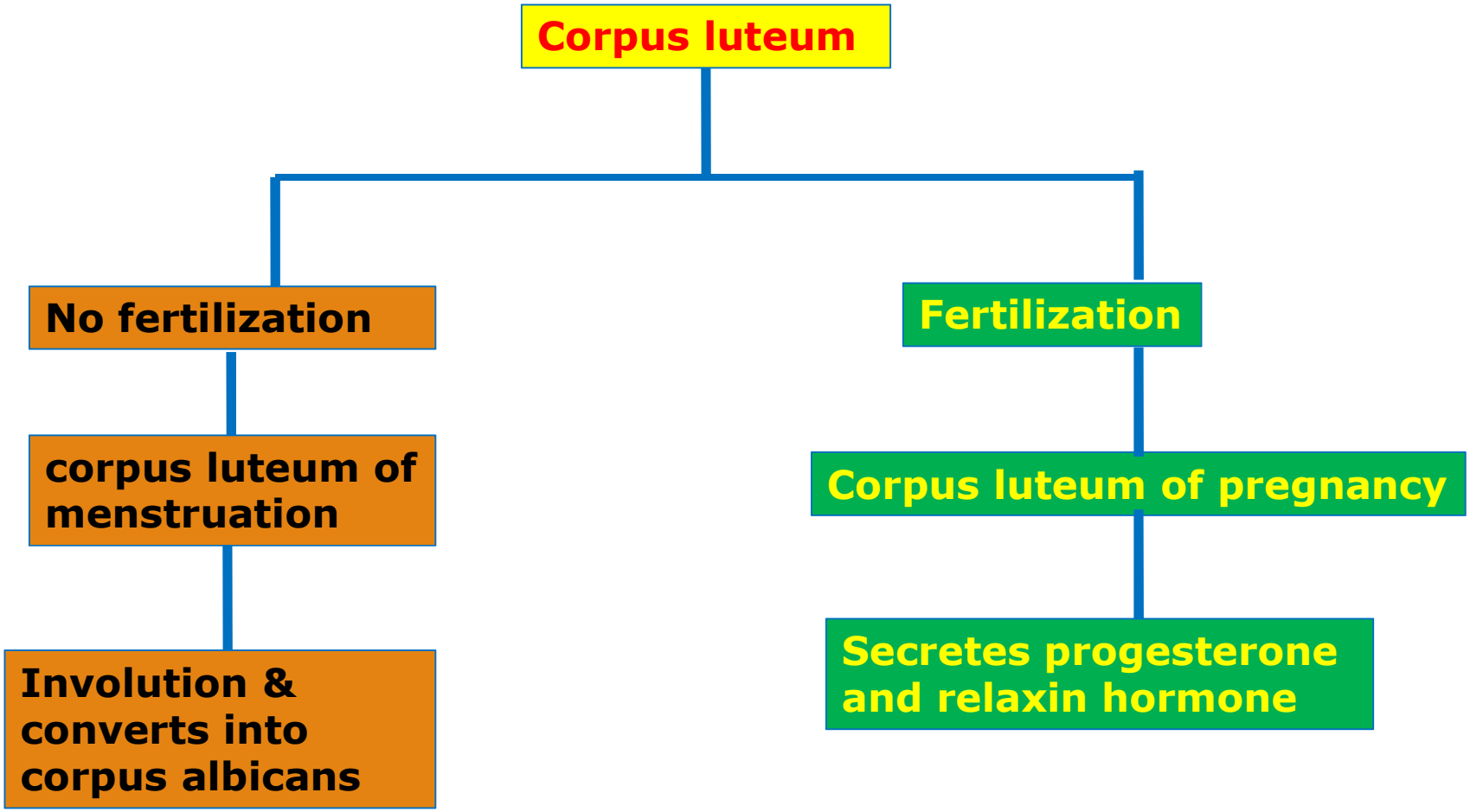
At the time of ovulation it ruptured and release the ovum and it is converted into **Corpus luteum.**


Flat epithelial cell
Nucleus of primary oocyte
Cuboidal follicular cell
Beginning of zona pellucida
Zona pellucida
Connective tissue of ovary
A Primordial follicle
B Primary follicle



C- Secondary follicle

D- Mature Graafian follicle

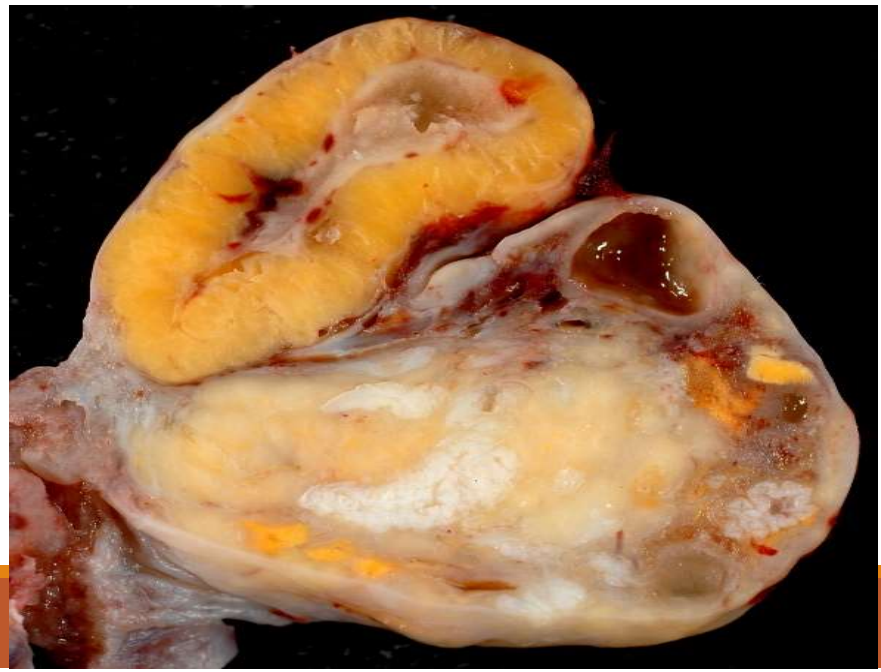

Corpus luteum
No fertilization
corpus luteum of menstruation
Involution & converts into corpus albicans
Fertilization
Corpus luteum of pregnancy
Secretes progesterone and relaxin hormone

The fate of corpus luteum :

1- If **no fertilization** occurs, the corpus luteum is called corpus luteum of menstruation, which stops its function after about 10 days, then it undergoes involution & converts into corpus albicans.

2- If the ovum is **fertilized,** the corpus luteum enlarges and persists as the corpus luteum of pregnancy.

It secretes progesterone and relaxin hormone.



READ ONLY

- In the prenatal life, the ovary contains 2 millions of oogonia.
- At birth the ovary contains 40000 of primary oocytes arrested in the prophase of the first maturation division.
- Only 400 of primary oocytes will mature to secondary oocytes in the whole active reproductive period of the female life.


THANK YOU