

Meiosis

DR. HAYTHEM ALI ALSAYIGH

Assistant prof.

Board clinical surgical anatomy

F.I.M.B.S.–MB.CH,B

**College of Medicine –University of
Babylon**

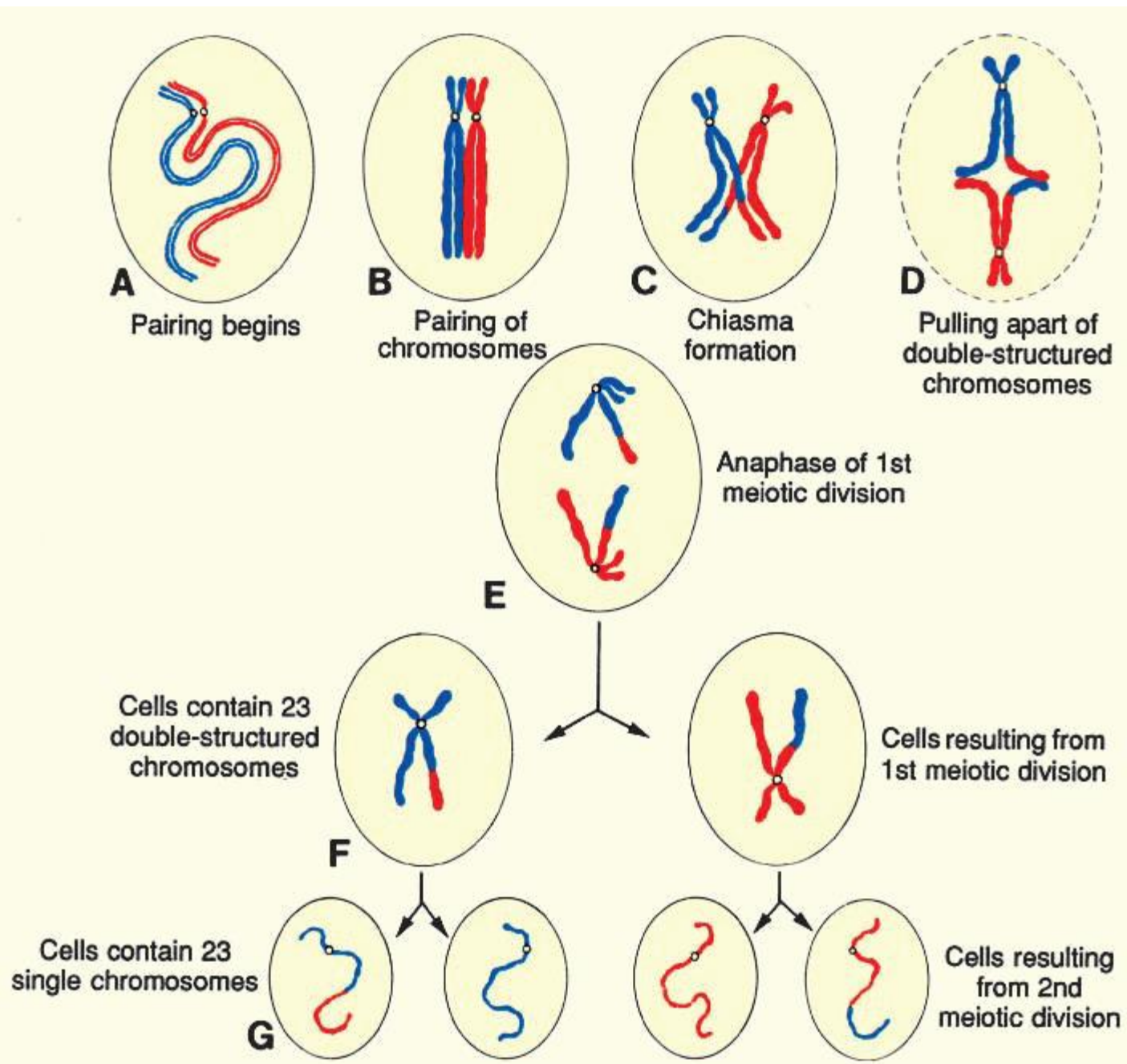
Meiosis

- takes place in the germ cells to generate male and female gametes.
- to reduce the number of chromosomes to the haploid number of 23 chromosome.

Meiosis

Meiosis I:

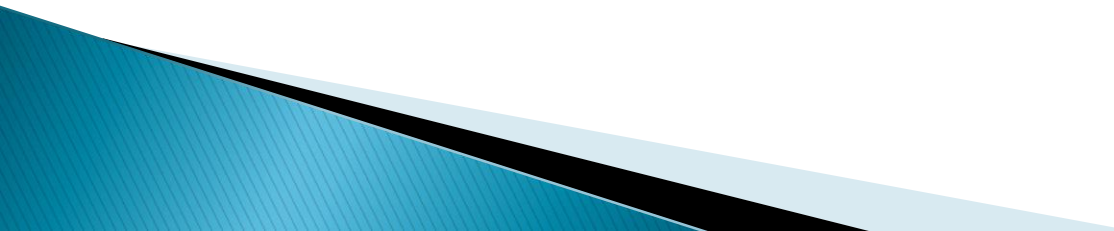
- Similar to mitosis, including the *replication* of the DNA amount to ($2N$).
- In contrast to mitosis, the homologous chr were *paired* in meiosis I by a process called synapsis forming 22 pairs of doubled structured chr (except the 2 sex chr). At the final phase of meiosis I each pair of chr will be separated into each of the daughter cells.
- Therefore each daughter cell contains *haploid 23 doubled* structured chr number with *N* amount of DNA.
- Each chromosome shows two chromatids



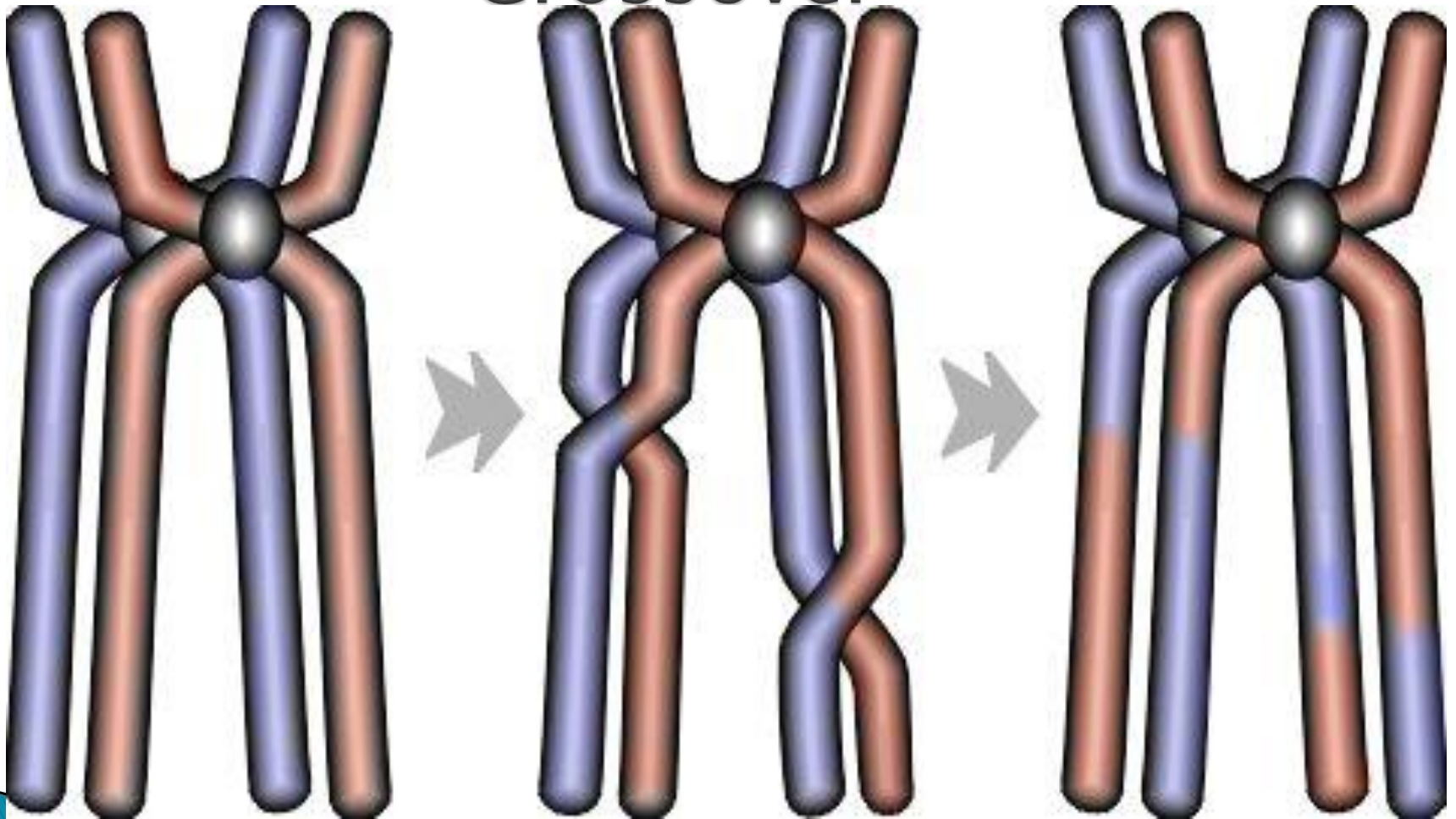
Crossover

- ▶ In meiosis I
- ▶ interchange of segments between the chromatids of a pair of doubled structured chromosome.
- ▶ The point of interchange is temporarily united, therefore during the separation of the homologus pair in the anaphase of meiosis I an *X-like* structure is formed called the *chiasma formation*

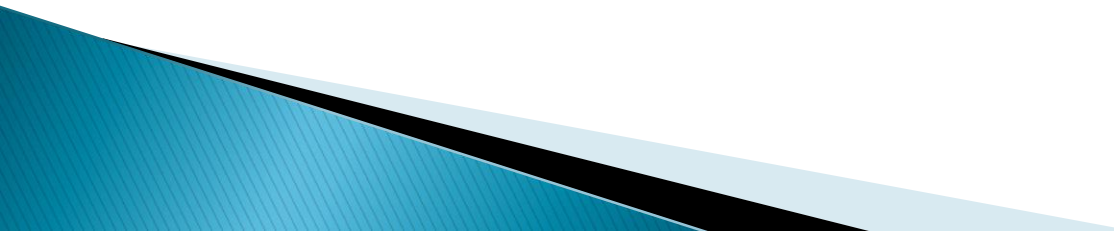
Crossover

- ▶ the interchanged segments break and exchange the positions on the homologous pair after the anaphase.
 - ▶ most frequent between genes that are far apart on a chromosome.
 - ▶ Genetic variability is enhanced through
 - crossover, which redistributes genetic material
 - random distribution of homologous chromosomes to the daughter cells.
- 

Crossover



Meiosis II

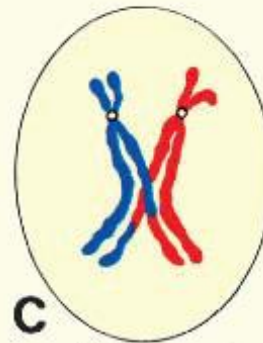
- ▶ No replication of the DNA occur in this step
 - ▶ Result in two daughter cells each of them containing haploid 23 single structured chr number with half amount of DNA.
 - ▶ Each chromosome is derived from a chromatid that results from splitting of the centromere of the doubled structured chr.
- 



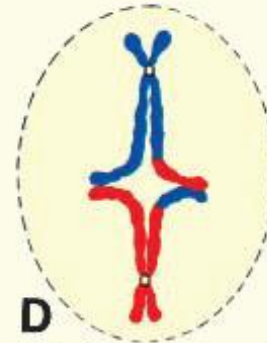
A
Pairing begins



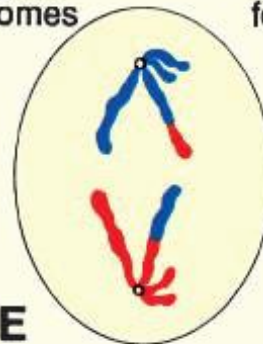
B
Pairing of chromosomes



C
Chiasma formation



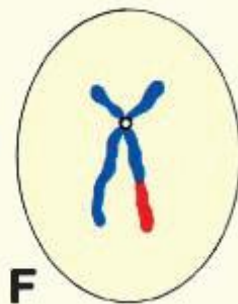
D
Pulling apart of double-structured chromosomes



Anaphase of 1st meiotic division

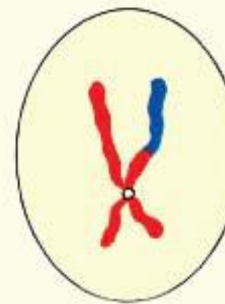
E

Cells contain 23 double-structured chromosomes

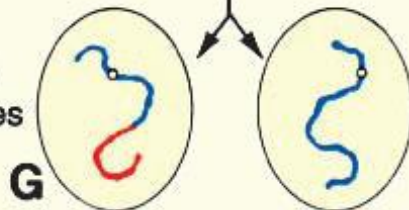


F

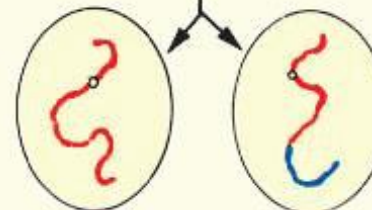
Cells resulting from 1st meiotic division



Cells contain 23 single chromosomes



G



Cells resulting from 2nd meiotic division

Mitosis	Meiosis
occurs in somatic and germ cells.	Occurs in germ cells only.
Does not show crossover.	Crossover seen
The resulting daughter cells contain diploid 46 chr and normal amount of DNA.	The daughter cells contain haploid 23 chr and half DNA amount.

Mitosis	Meiosis I
no pairing of homologous chr.	pairing occurs.
does not show crossover.	crossover seen.
resulting daughter cells contain diploid 46 single structured chr number and normal amount of DNA.	resulting daughter cells contain haploid 23 double structured chr number and normal amount of DNA.
occurs in somatic and germ cells.	occurs in germ cells only.

Mitosis	Meiosis II
the resulting daughter cells contain diploid 46 single structured chr number and normal (N) amount of DNA.	the resulting daughter cells contain haploid 23 single structured chr number and half amount of DNA.
occurs in somatic and germ cells.	occurs in germ cells only.

Meiosis I	Meiosis II
the resulting daughter cells contain haploid 23 double structured chr number and normal amount of DNA.	the resulting daughter cells contain haploid 23 single structured chr number and half (1/2N) amount of DNA.
crossover seen.	does not show crossover.
pairing of homologus chr seen.	the paired homologus chr are separated.

Polar Bodies

- ▶ During meiosis , primary oocyte gives rise to four daughter cells, each with $22+1$ X chromosomes, only one develops into a mature gamete (the mature oocyte); the other three, the **polar bodies**, which degenerate during subsequent development.
- ▶ Similarly, one primary spermatocyte gives rise to four daughter cells; two with $22+1$ X chromosomes and two with $22+1$ Y chromosomes, all these four develop into mature gametes (spermatozoa).

Polar Bodies

Primary oocyte
after DNA
replication

These cells contain
46 double-structured
chromosomes

Primary spermatocyte
after DNA replication

First Maturation Division

Secondary
oocyte

23 double-structured
chromosomes

Secondary
spermatocyte

Second Maturation
Division

23 single
chromosomes

(22 + X)

(22 + Y)

Mature
oocyte
(22 + X)

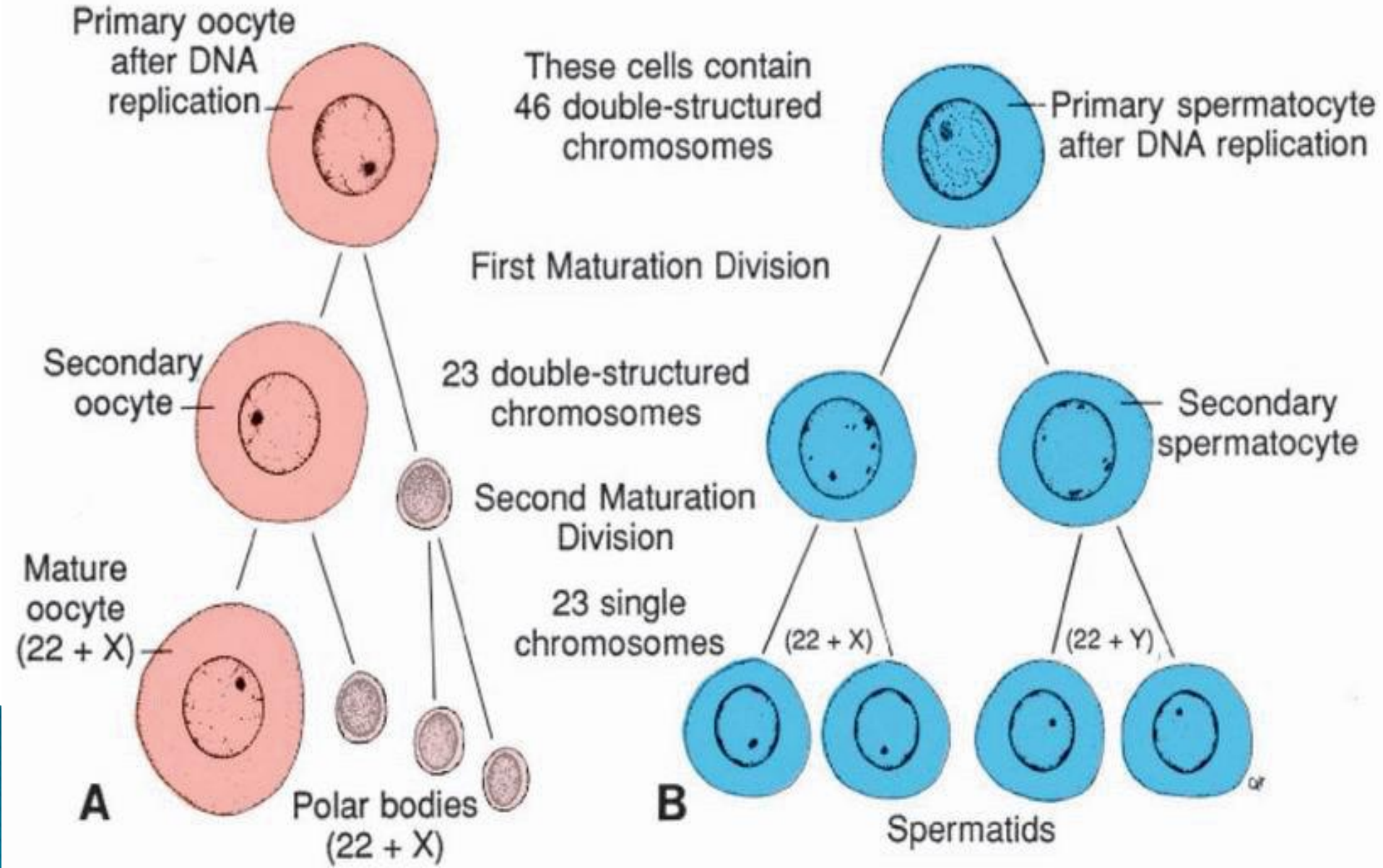
A

Polar bodies
(22 + X)

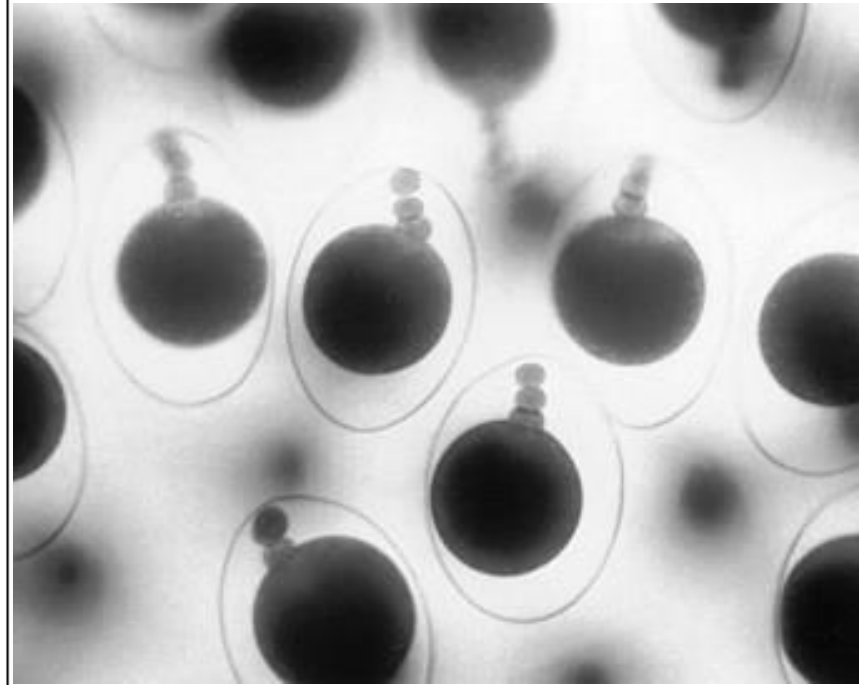
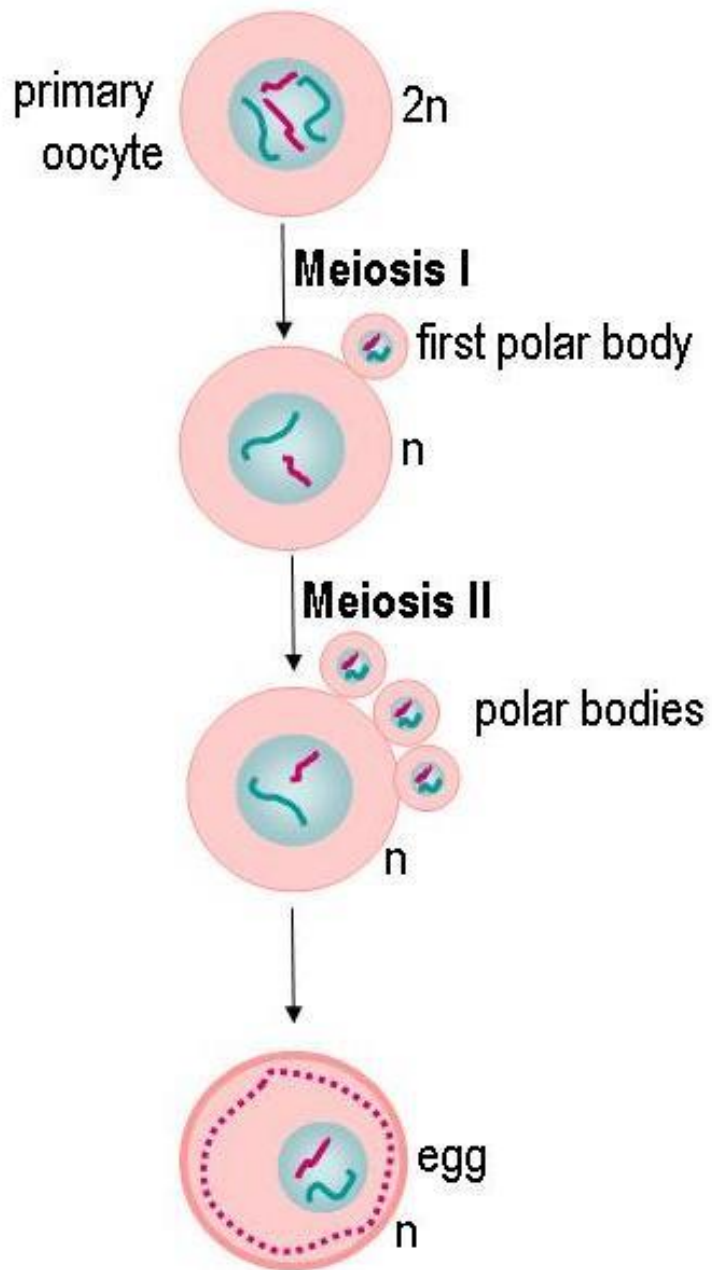
B

Spermatids

or



Oogenesis

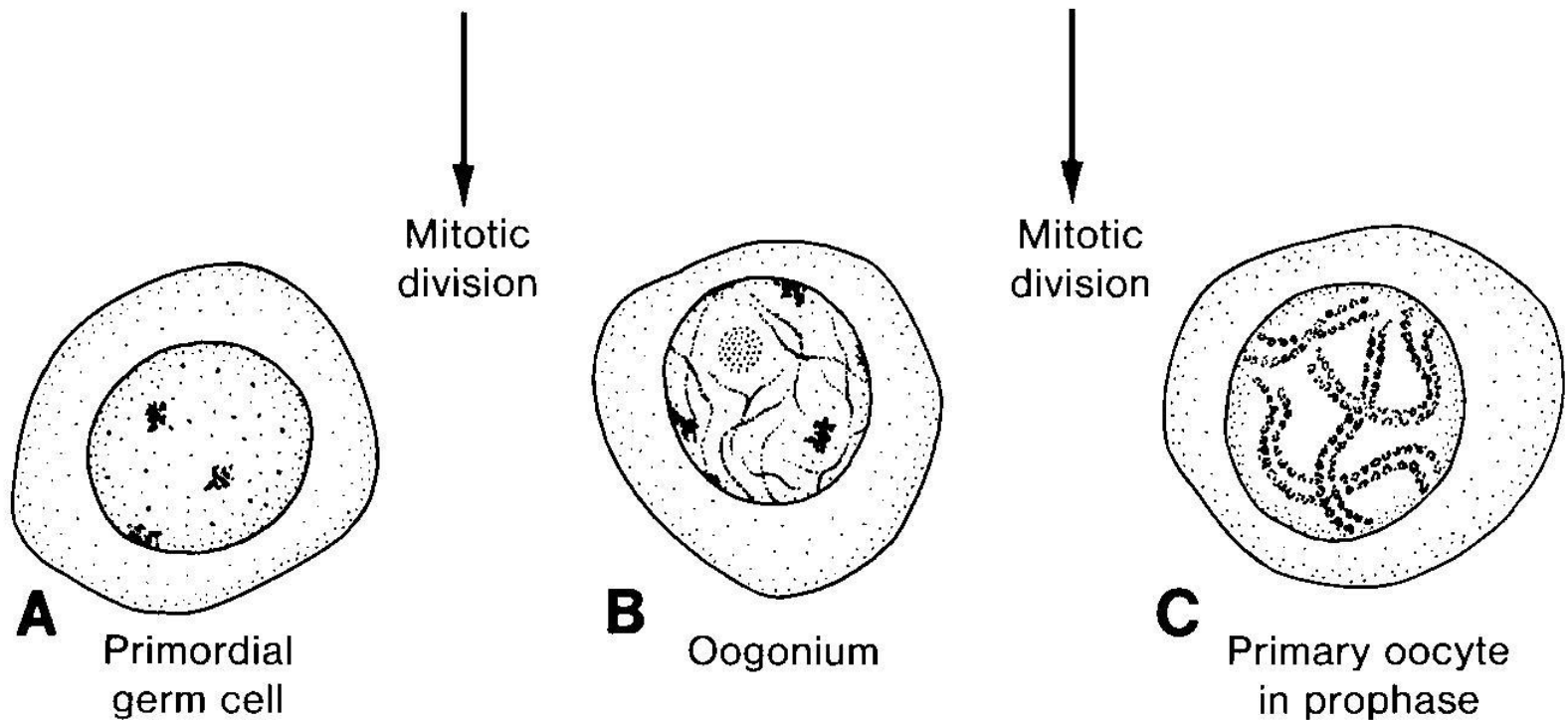


Oogenesis

➤ Prenatal changes:

□ PGC → oogonia $\xrightarrow{\text{mitosis}}$ cluster of cells

3rd month

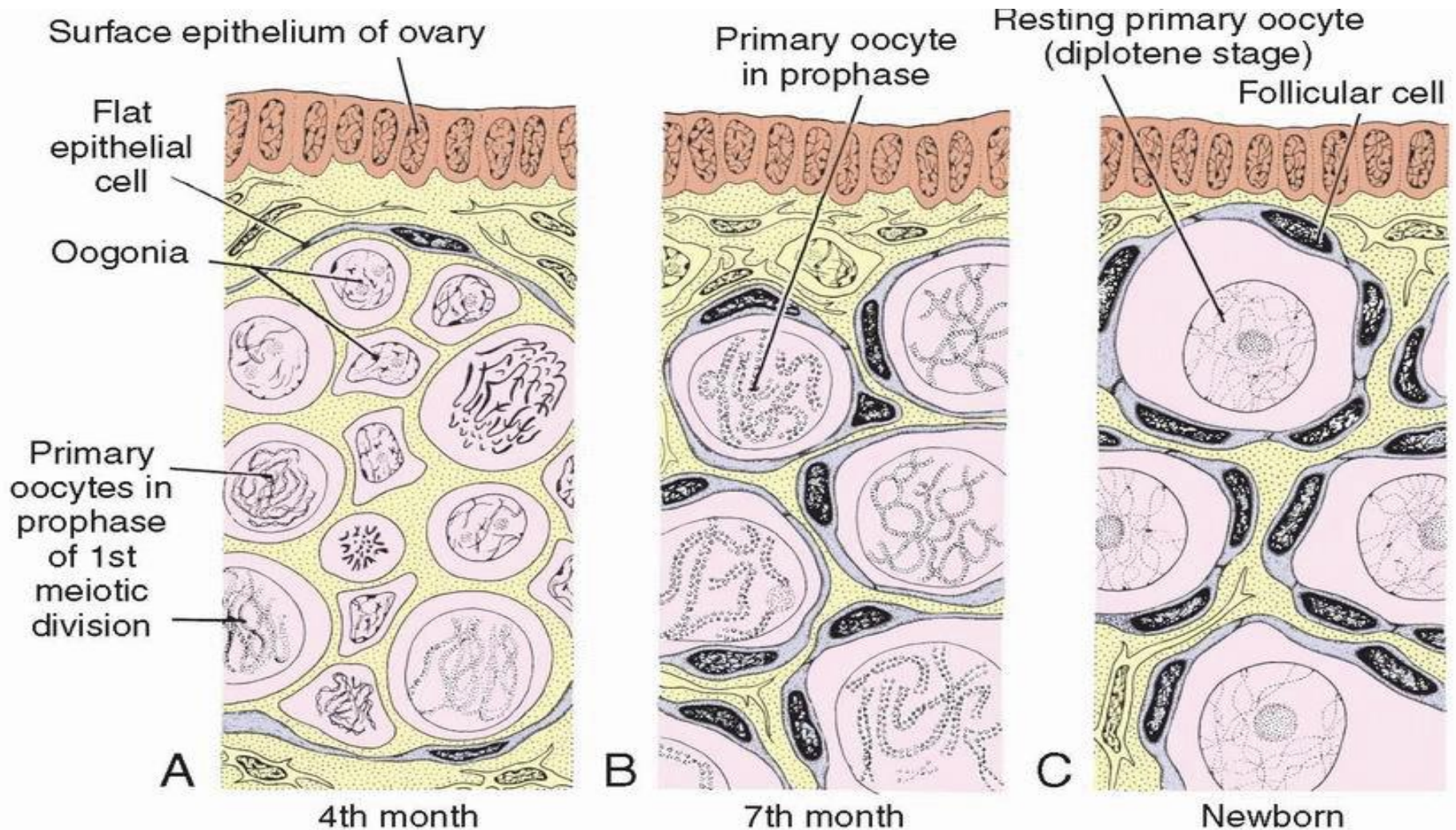


Oogenesis

- Prenatal changes: mitosis 3rd month
- ❑ PGC → oogonia → cluster of cells
 - ❑ Some arrested in **prophase M I** and form *primary oocyte*
 - ❑ At the 5th month they reach 7 million
 - ❑ Then cell death occur even for the pri oocyte
 - ❑ At the 7th month → degeneration of most of the oogonia
 - ❑ Each remaining pri oocytes → surrounded by a single layer of flat follicular epithelial cells forming *the primordial follicle*
 - ❑) Near birth all primary oocyte started **prophase M I** but **enter diplotene stage by OMI** ((secreted by fol cells))
at birth pri oocyte number = 600,000 to 800,000.

Oogenesis

➤ Prenatal changes:



Oogenesis

➤ Postnatal changes:

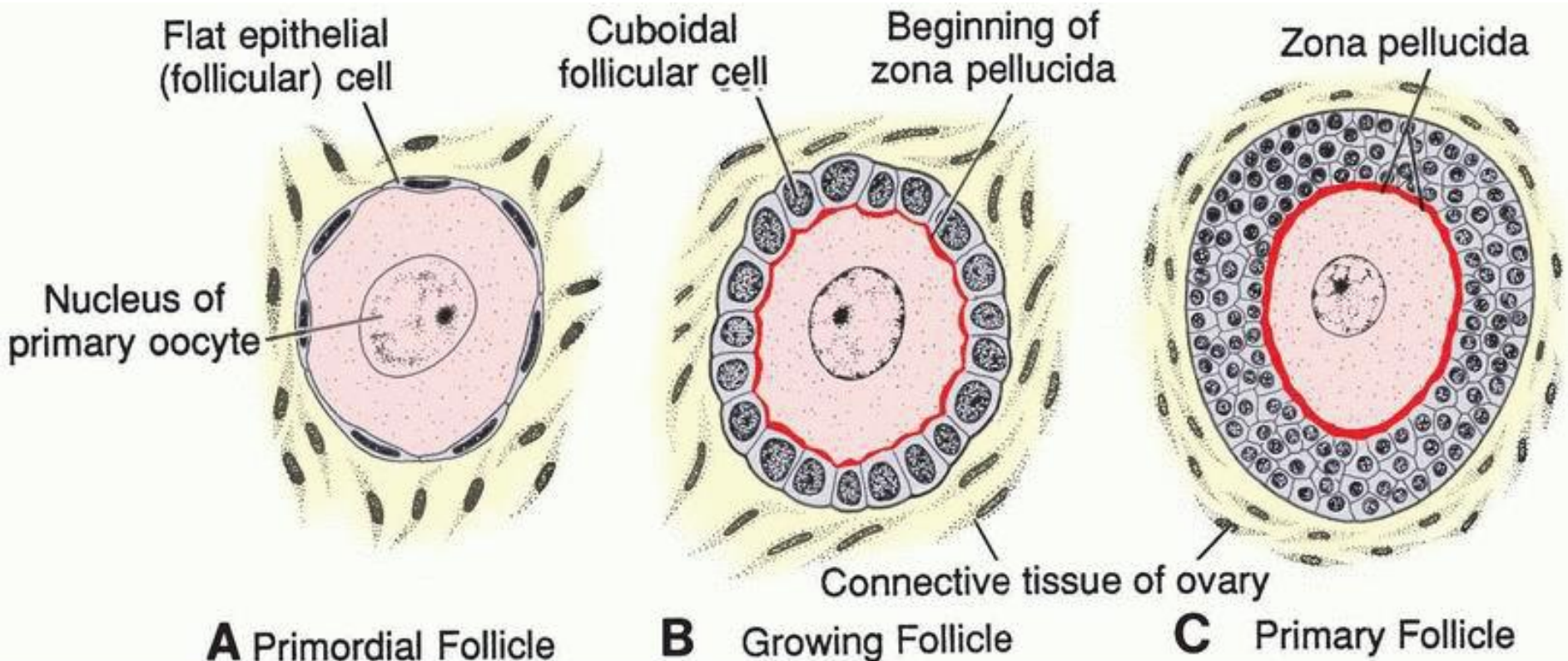
- ❑ primary oocytes degenerate during childhood
- ❑ About 200,000 – 400,000 oocytes reach puberty
- ❑ Fewer than 500 oocytes will be ovulated
- ❑ At puberty, 15–20 primordial follicles begin maturation in each monthly ovarian cycle, usually only one reach maturity and the other degenerate

❑ *Stages of maturation:*

1. *primary (preantral) follicle*
2. *Secondary (antral) follicle* the longest
3. *Preovulatory (graafian) follicle* (37 hr before ovulation)

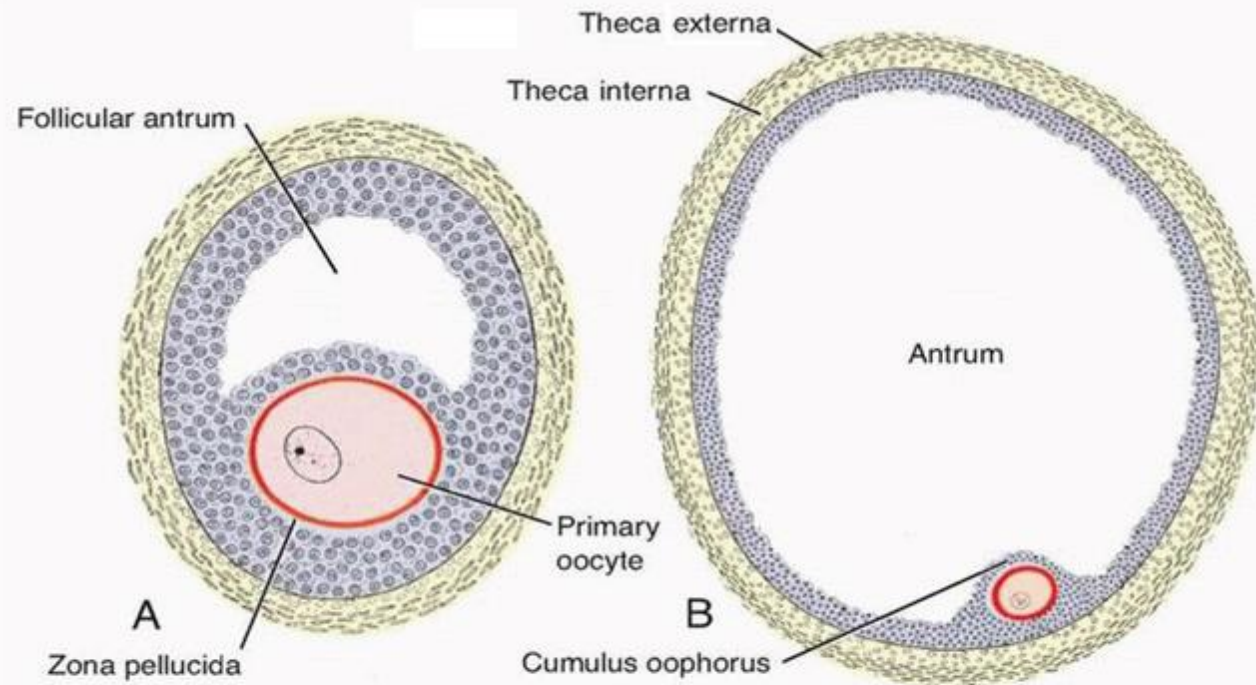
Oogenesis

➤ Postnatal changes:

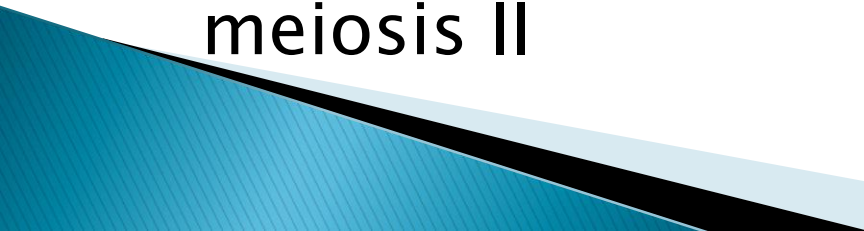


Oogenesis

➤ Postnatal changes:

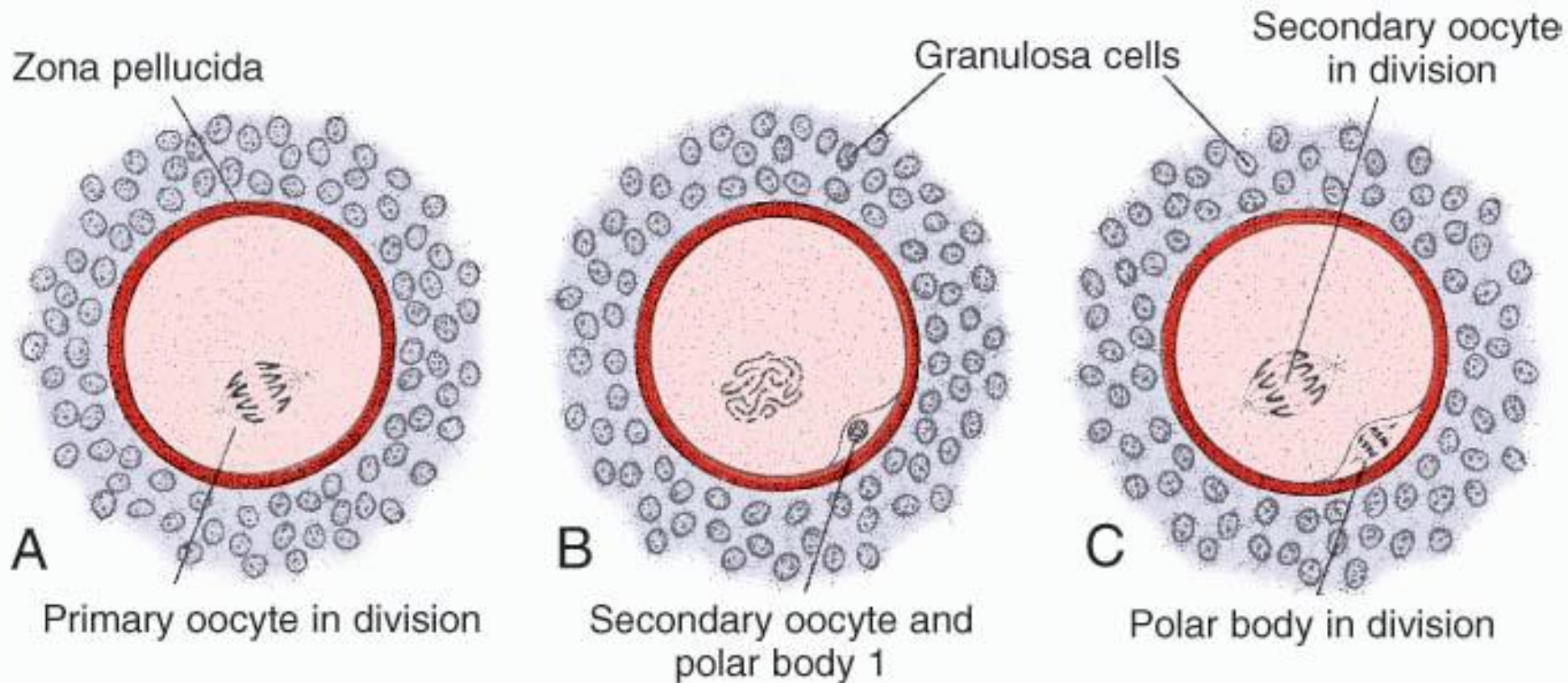


Oogenesis

- Postnatal changes:
 - At maturity, the secondary follicle may be 25 mm in diameter or more.
 - A surge in luteinizing hormone (LH) induces the preovulatory growth phase
 - The primary oocyte of the mature follicle stops the diplotene stage and continues the meiosis I forming two daughter cells
 - The secondary oocyte enters the meiosis II, and ovulation occurs at the metaphase of meiosis II
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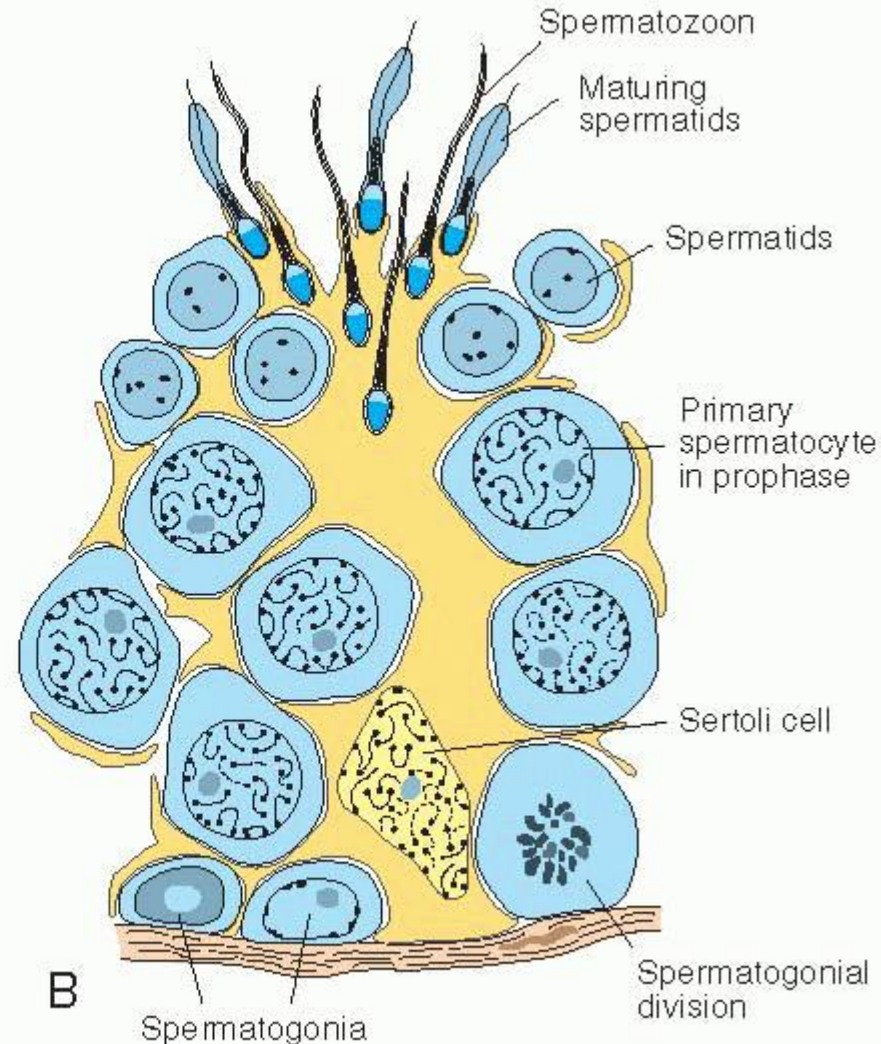
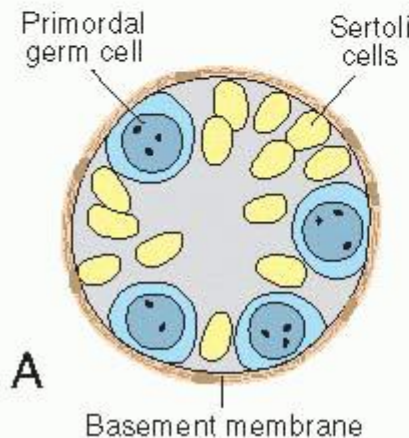
Oogenesis

➤ Postnatal changes:



Spermatogenesis:

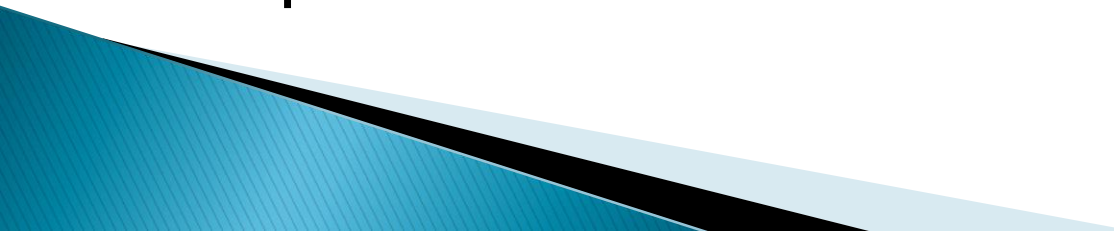
- It involves postnatal changes only, each cycle after puberty last about 74 days
- *childhood*, PGC are localized in the sex cords together with the supporting (Sertoli) cells



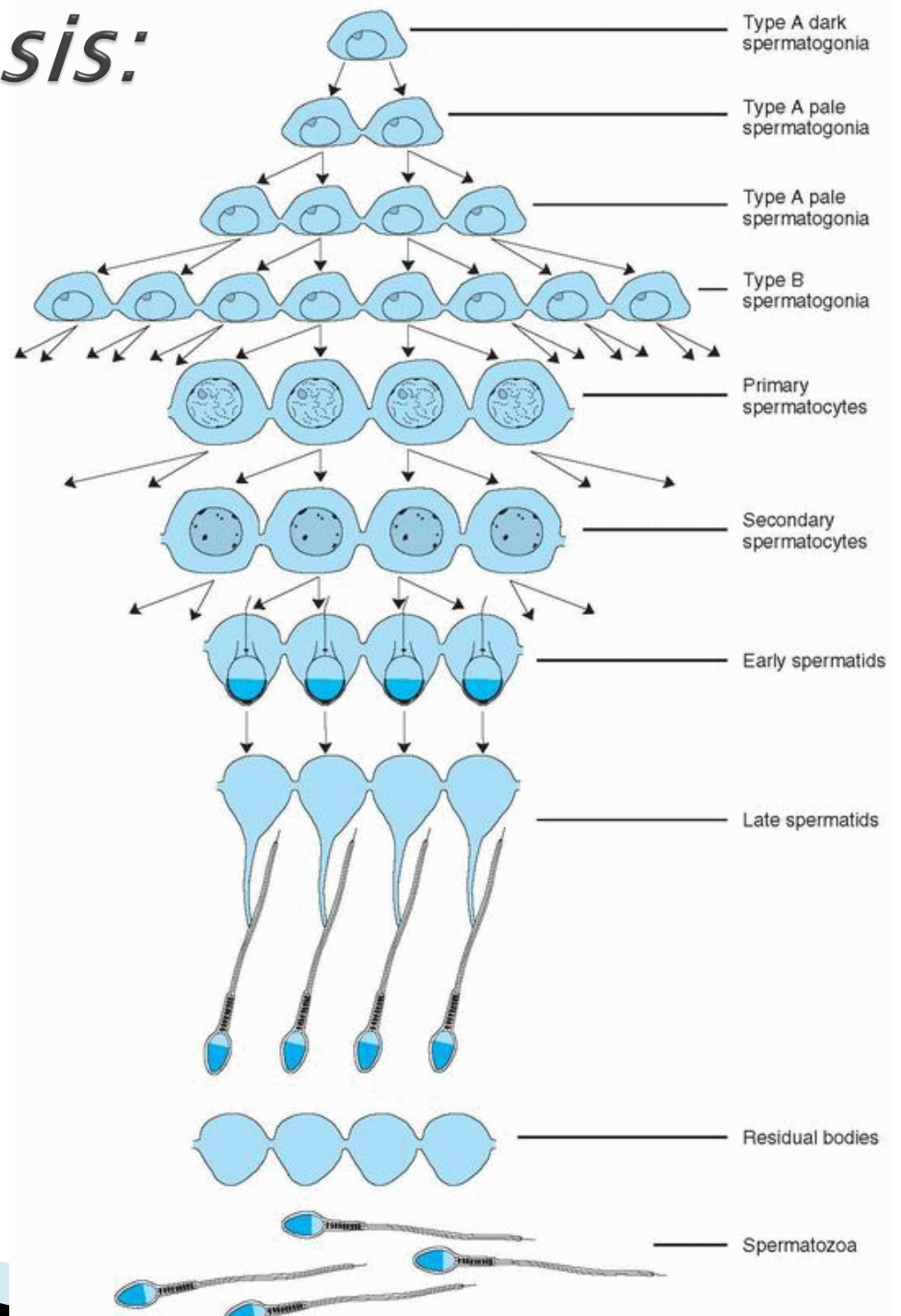
Spermatogenesis:

- Shortly before puberty the sex cord canalized forming the seminiferous tubules.
- PGC Form spermatogonial stem cells.
- spermatogenesis regulated by:
 1. LH ---Leydig cells ---testosterone production--- Sertoli cells to encourage spermatogenesis.
 2. FSH: binding to Sertoli cells stimulates testicular fluid production and synthesis of intracellular androgen receptor proteins
- Also the primordial germ cells differentiate into spermatogonia which are of two types:

Spermatogenesis:

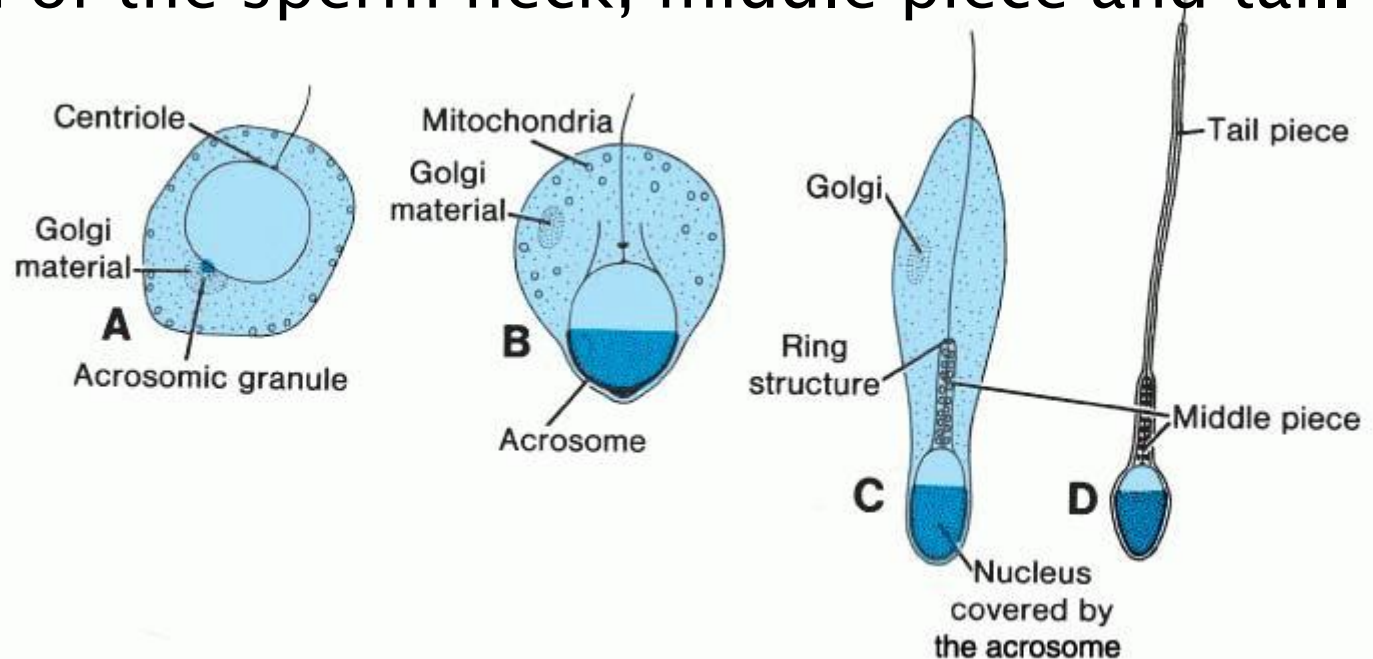
- ❑ Type A:
that divide by mitosis forming more spermatogonia cell reserve.
 - ❑ Type B:
 - Derived from the last division of type A.
 - divide to form the primary spermatocytes (enter prolonged prophase meiosis I (22 days)) resulting in the formation of secondary spermatocytes, these secondary spermatocytes undergo meiosis II forming the haploid spermatids
- 

Spermatogenesis:



Spermatogenesis:

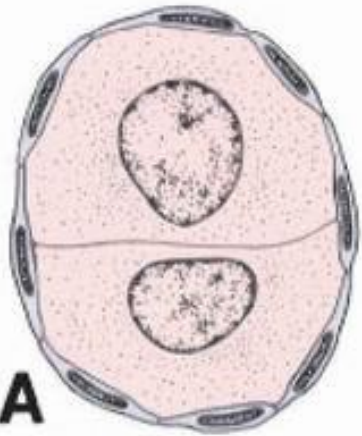
- ❑ The spermatids undergo series of spermiogenesis changes to form the sperms, these changes include:
 - ▶ 1.formation of the acrosomal sac
 - ▶ 2.condensation of the nucleus.
 - ▶ 3.shedding of most of the cytoplasm.
 - ▶ 4.formation of the sperm neck, middle piece and tail.



Spermatogenesis:

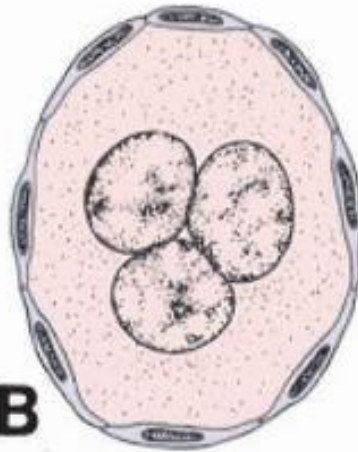
- ❑ The spermatogenesis involves clonal changes by incomplete cytokinesis; in which a chain of differentiating cells derived from one spermatogonia are connected by cytoplasmic bridges. *Only mature sperms are separated from this chain leaving a residual bodies.*

Clinical Correlate



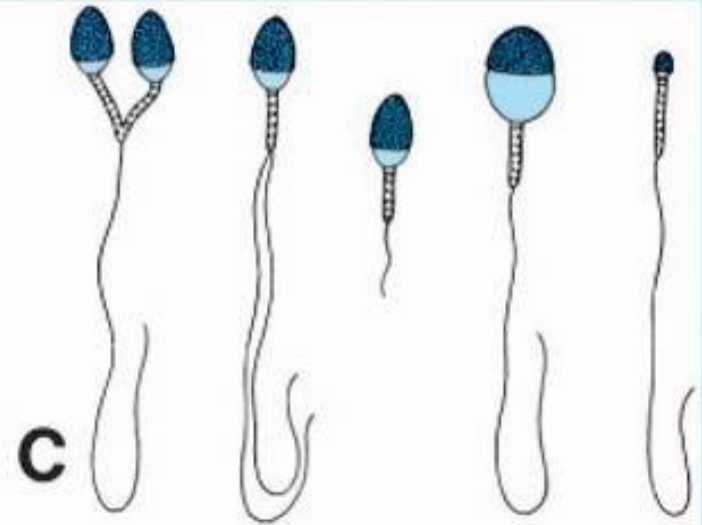
A

Primordial follicle with
two oocytes



B

Trinucleated oocyte



C