Spermatogenesis

BY DR. AMJAD SHATARAT

THE UNIVERSITY OF JORDAN

SCHOOL OF MEDICINE

DEPARTMENT OF ANATOMY AND HISTOLOGY

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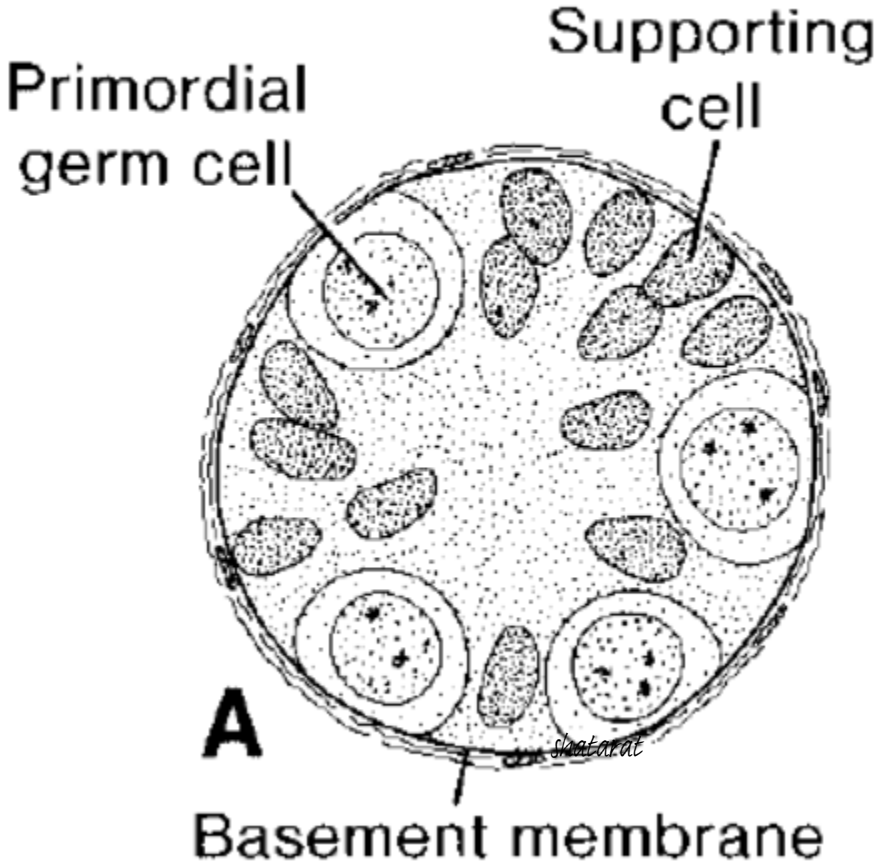


By the end of 5th week,
the PGCs migrate into the **developing testis**
then divide and differentiate into
spermatogonia → stay inactive **inside** ***primitive sex cords***

At birth, the sex cords shows spermatogonia surrounded by **supporting (Sertoli) cells.**

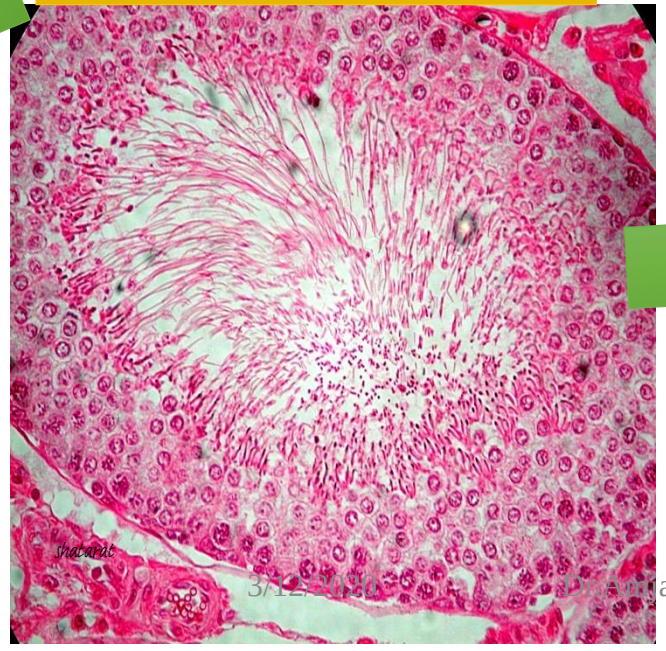
Spermatogonia stay resting during ***childhood within sex cords surrounded by Sertoli cells.***

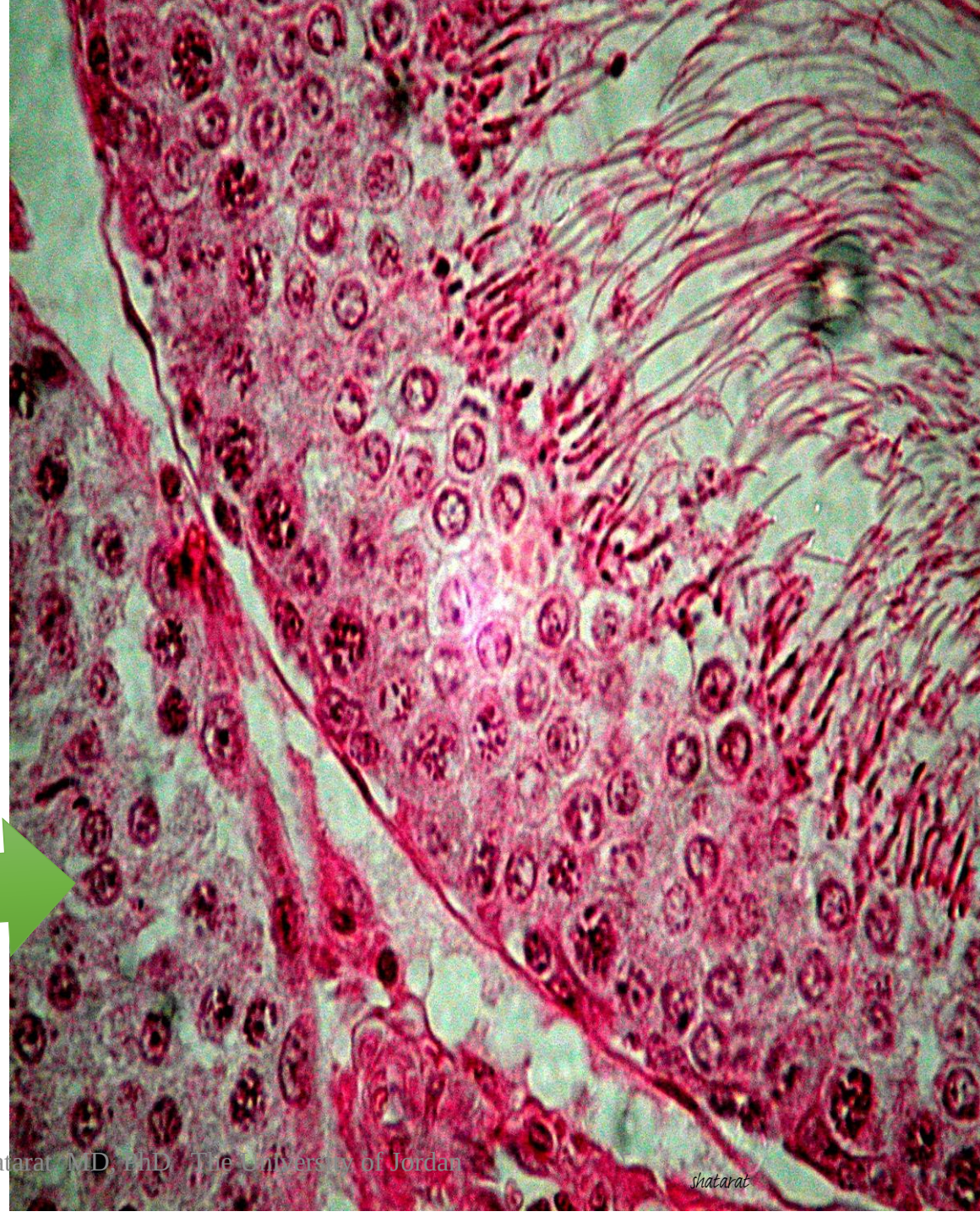
Cross section through primitive sex cords of a newborn boy showing
primordial germ cells and supporting cells

- **Just before puberty,** the sex cords obtains a lumen and becomes **seminiferous tubules**

Many seminiferous tubules are shown In this cross section

One seminiferous tubules is shown In this cross section





- Two types of cells in Seminiferous epithelium
  1. Spermatogenic cells: sperm forming cells (in various stages of maturation)
  2. Sertoli cells :extend from base to lumen ,support, protect and nurish no.1
- Testosteron → secreted by ***Ledig cells*** located in spaces between adjacent tubules.

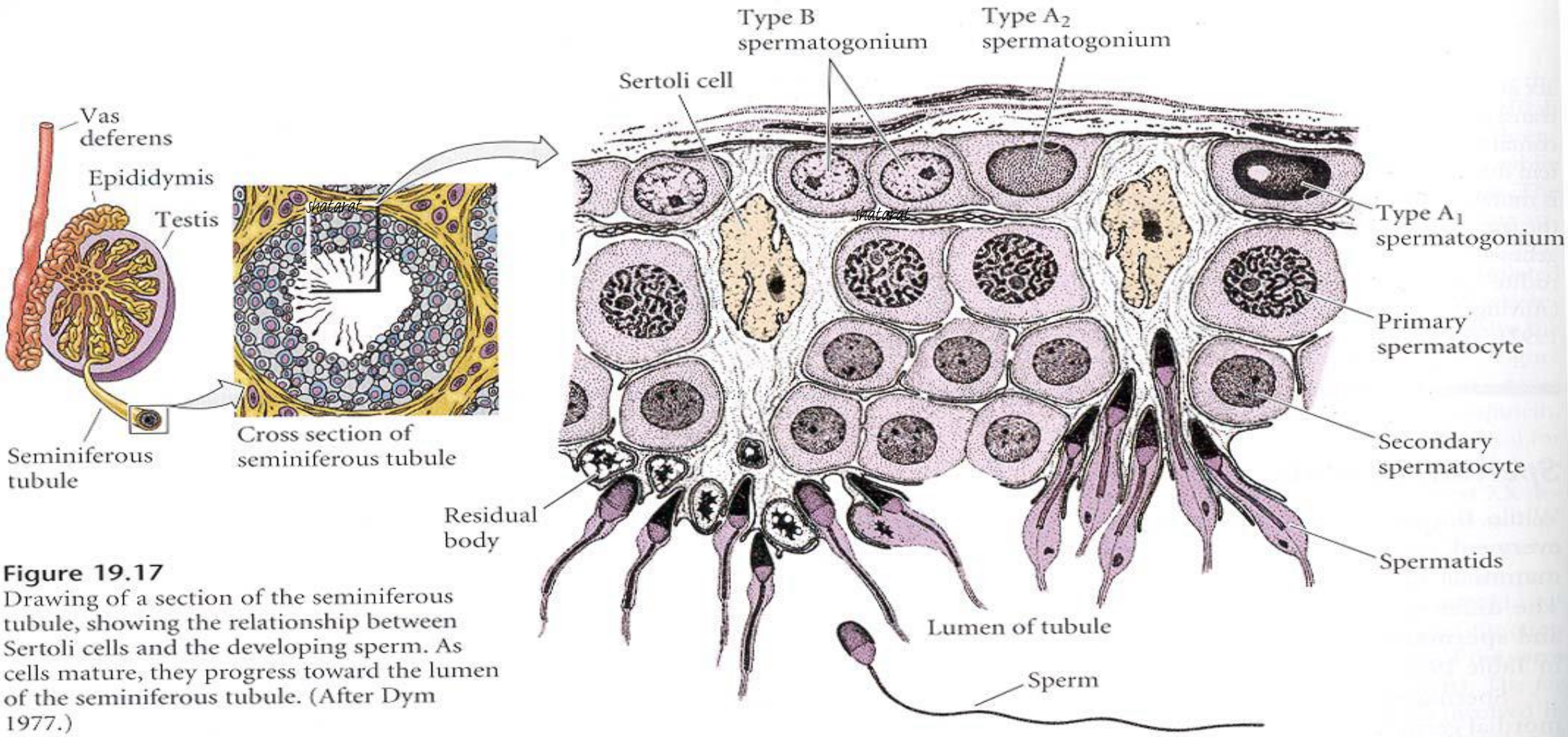


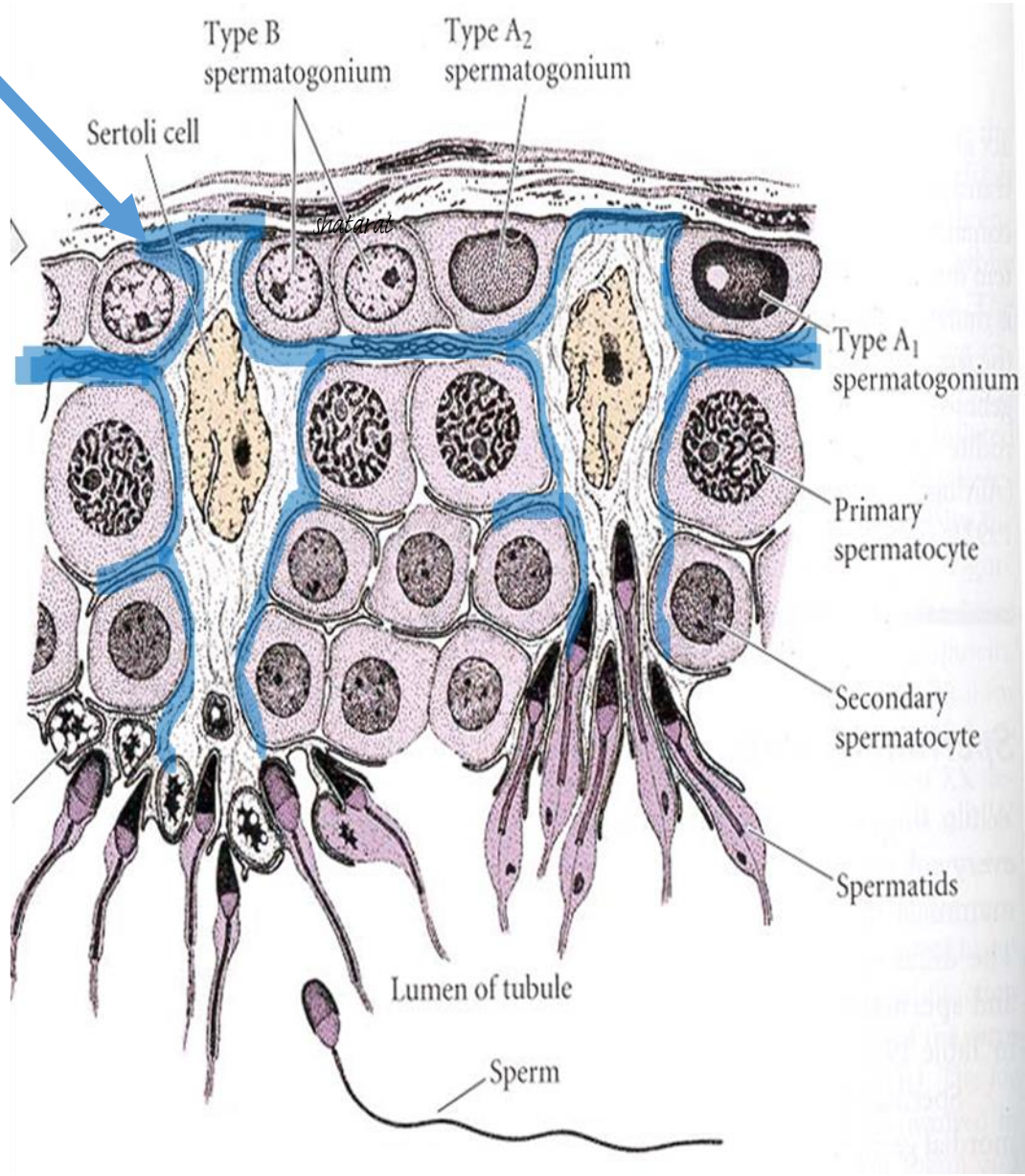
Figure 19.17
Drawing of a section of the seminiferous tubule, showing the relationship between Sertoli cells and the developing sperm. As cells mature, they progress toward the lumen of the seminiferous tubule. (After Dym 1977.)

Sertoli cells or sustentacular cells

- They are Embedded among the spermatogenic cells in the seminiferous tubules
- They extend from the basement membrane to the lumen of the tubule

- Sertoli cells support and protect developing spermatogenic cells in several ways.
  - They nourish spermatocytes, spermatids, and sperm
  - phagocytize excess spermatid cytoplasm as development proceeds
  - control movements of spermatogenic cells and the release of sperm into the lumen of the seminiferous tubule.
  - They also produce fluid for sperm transport
  - They secrete the hormone inhibin, and regulate the effects of testosterone and FSH.

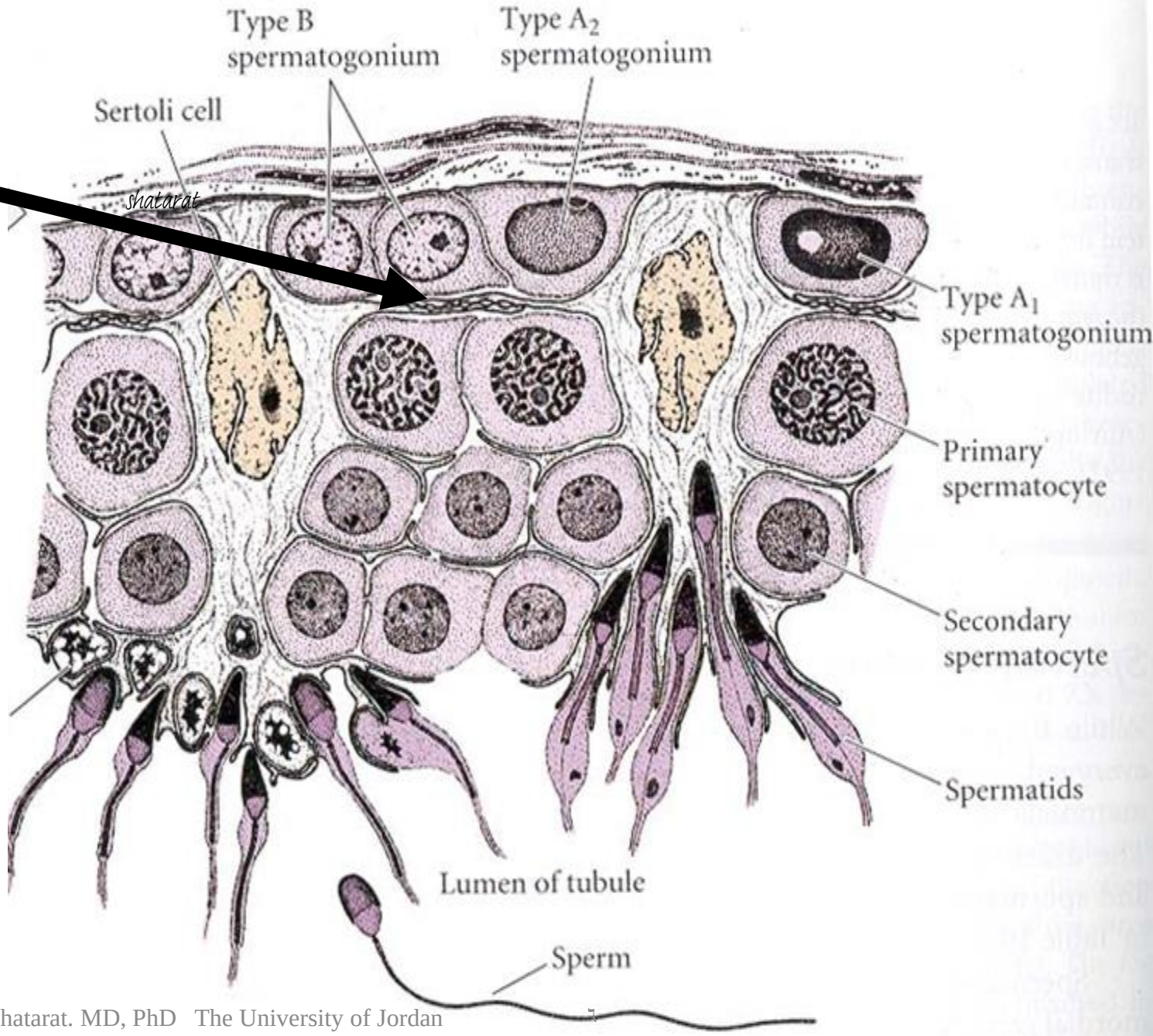
Spermatogonia and spermatids remain embedded in deep recesses of
Sertoli cells throughout their maturation.



Neighboring Sertoli cells are connected to one another by Tight junctions

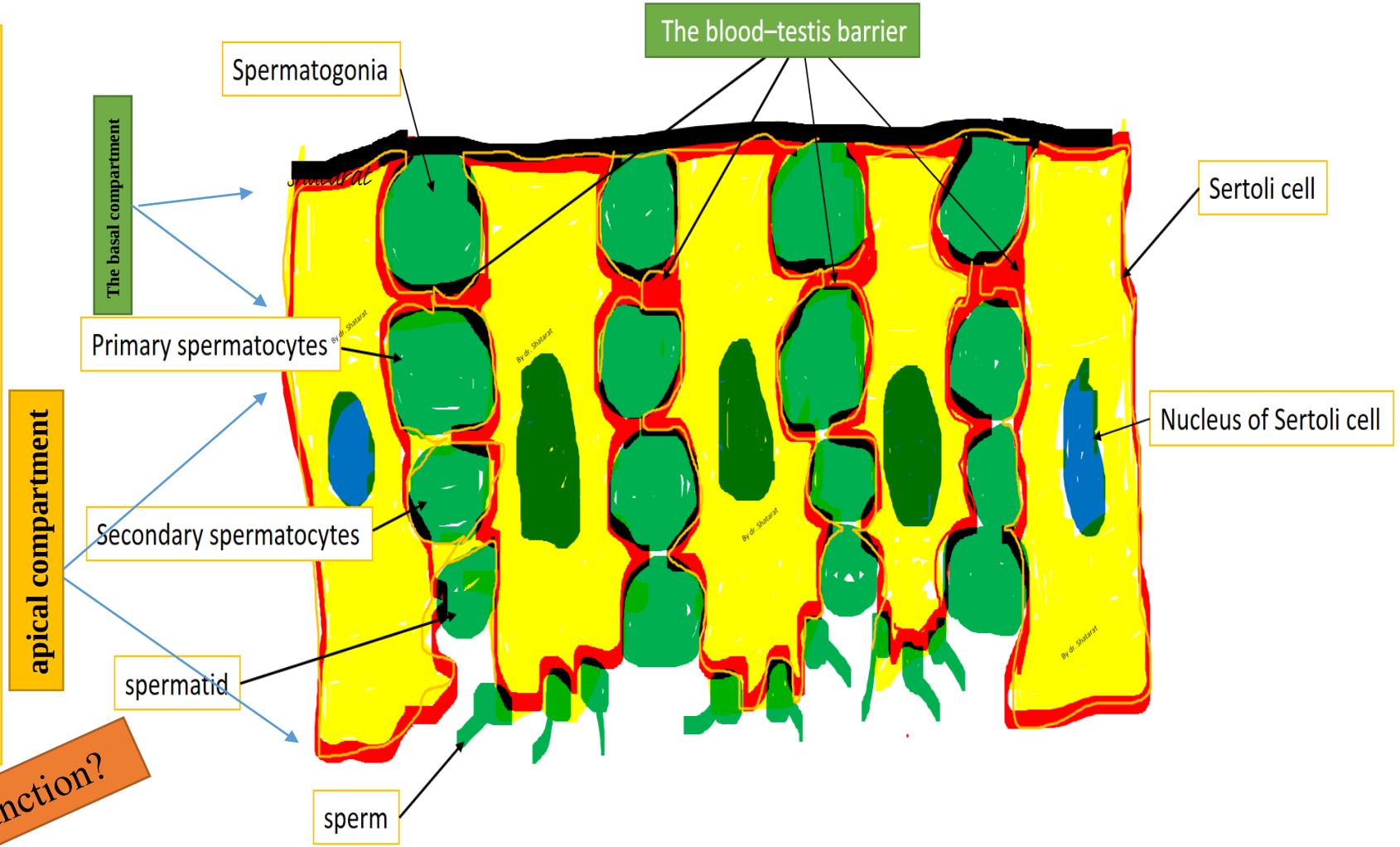
These junctions form an obstruction known as

The blood–testis barrier



The blood–testis barrier (the Sertoli cell seminiferous epithelium barrier)

The blood-testis barrier (BTB) is one of the tightest blood-tissue barriers in the mammalian body. It divides the seminiferous epithelium into the basal and the apical compartments. **Meiosis I , II** and spermiogenesis all take place in a specialized microenvironment behind the BTB in the ***apical compartment***, but **spermatogonial (mitosis)** renewal and differentiation and cell cycle progression up to the spermatocyte stage take place outside of the BTB in the ***basal compartment*** of the epithelium.



Why????

What is its function?

➢ By isolating the developing gametes from the blood, the blood–testis barrier prevents **an immune response against the spermatogenic cell's surface antigens**, which are recognized as foreign" by the immune system

shatarat

Leydig (interstitial) cells

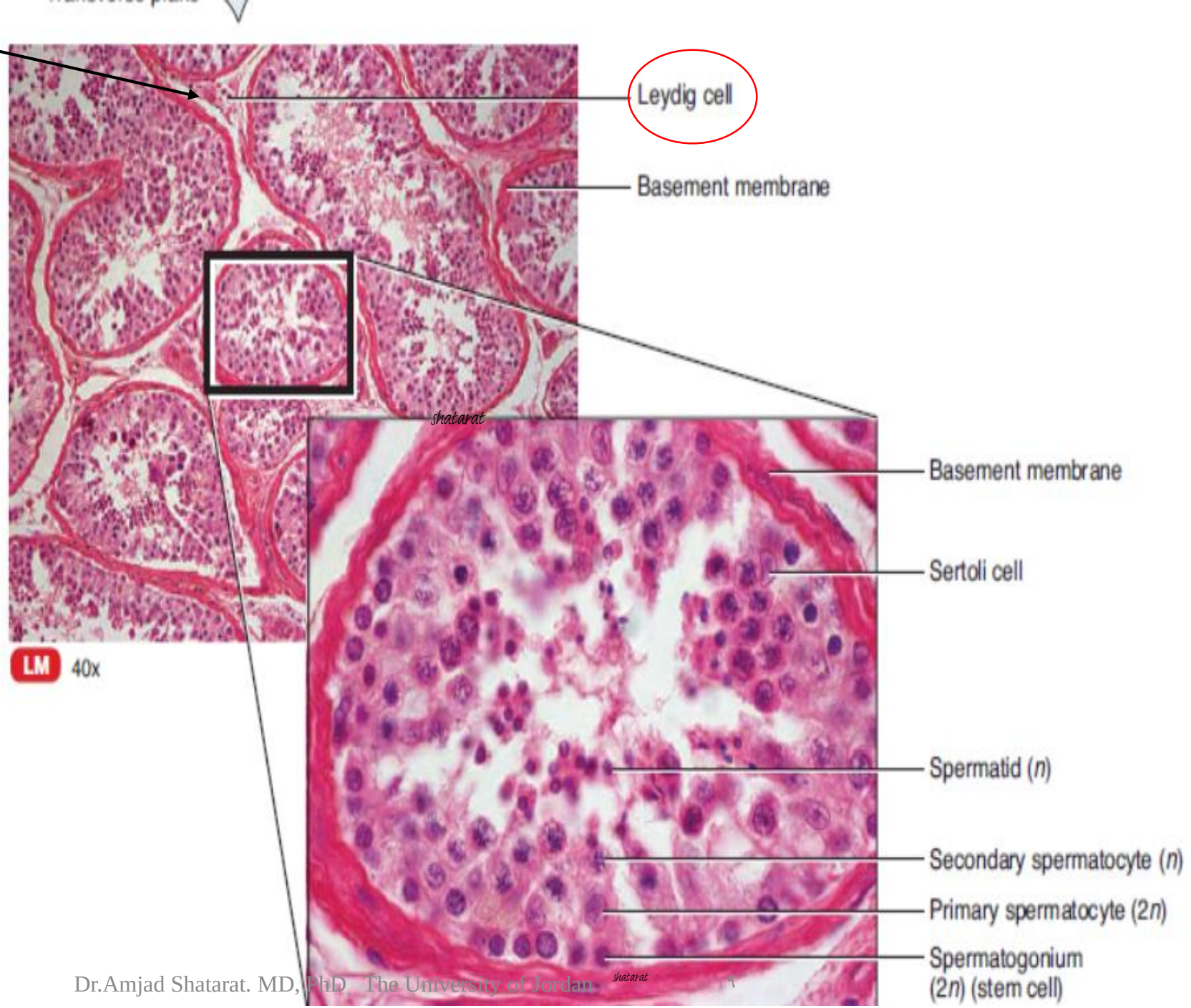
They are Located In the spaces between adjacent seminiferous tubules as clusters of cells

These cells secrete

Testosterone,

the most prevalent androgen.

An androgen is a hormone that promotes the development of masculine characteristics. Testosterone also promotes a man's libido (sexual drive).



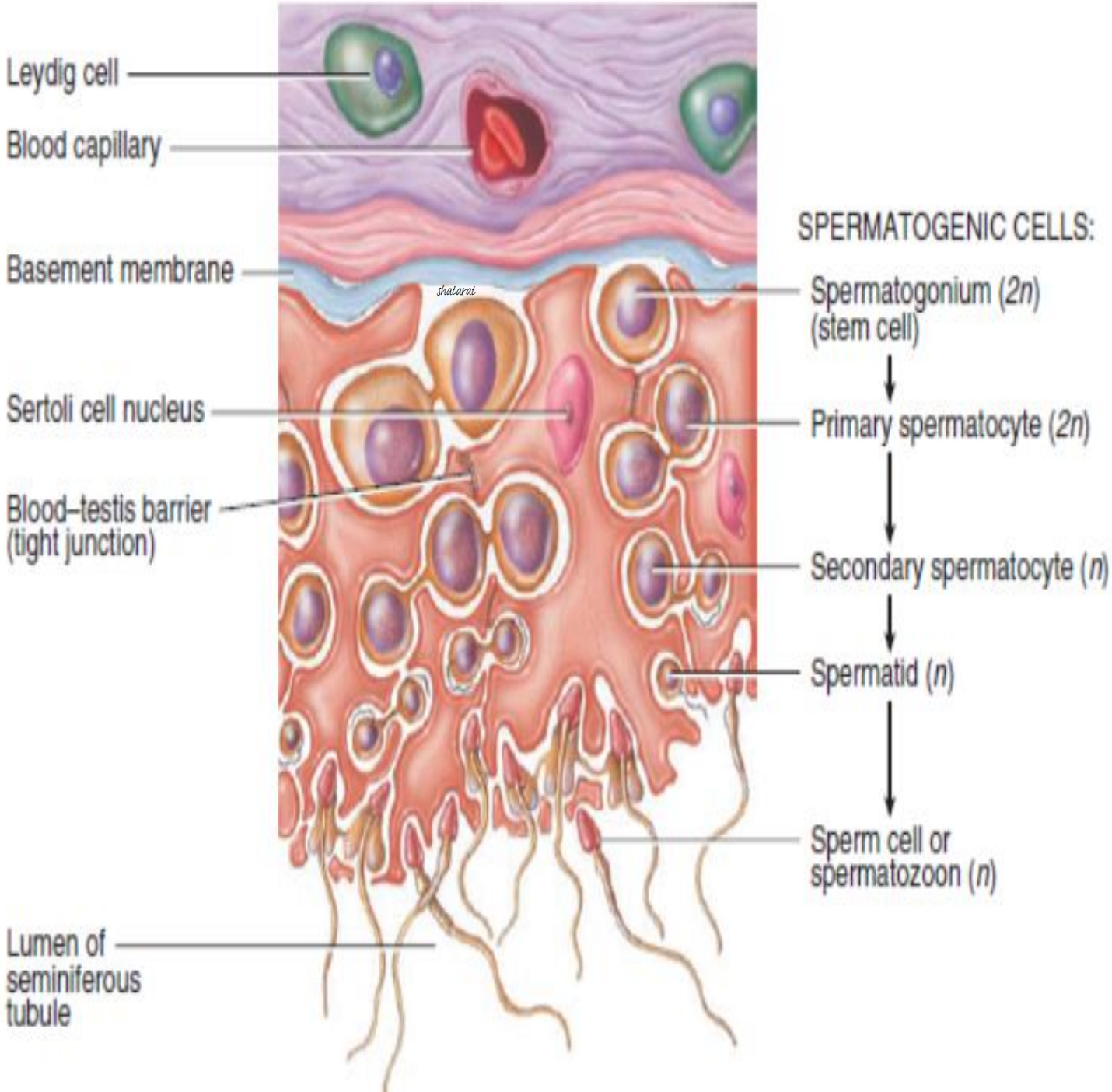
SPERMATOGENESIS

Spermatogenesis

occurs in the seminiferous tubules

Cells start to mature on the outside and move inward (towards the lumen) as the become mature sperm

Spermatogonia are the most primitive cells
They differentiate as primary spermatocyte → secondary → spermatid → sperm are released into lumen



➢Spermatogenesis **begins at puberty** when stem cells ***(Spermatogonia)*** influenced by testosterone enter the cell cycle and differentiate into

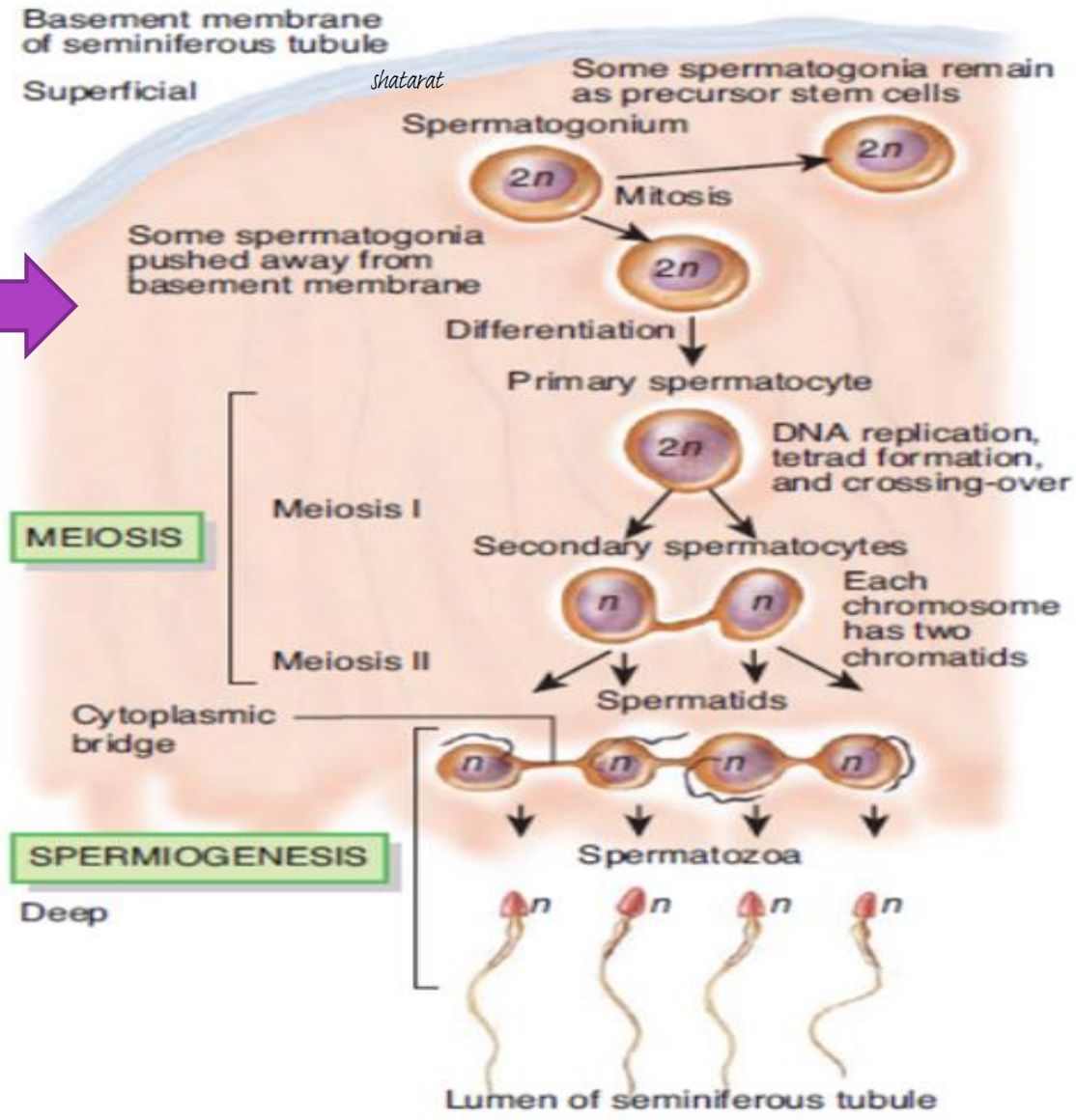
1ry spermatocytes at regular intervals

Spermatogenesis occurs in 3 phases:

1- Spermatogonial phase: Stem cells (***Spermatogonia)*** divide by **mitosis** and finally give **1ry spermatocytes**

2-Spermatocyte phase: 1ry spermatocyte undergo **meiosis** to give early **spermatid**

3-Spermiogenesis phase: transformation of spermatid **into mature Sperm**



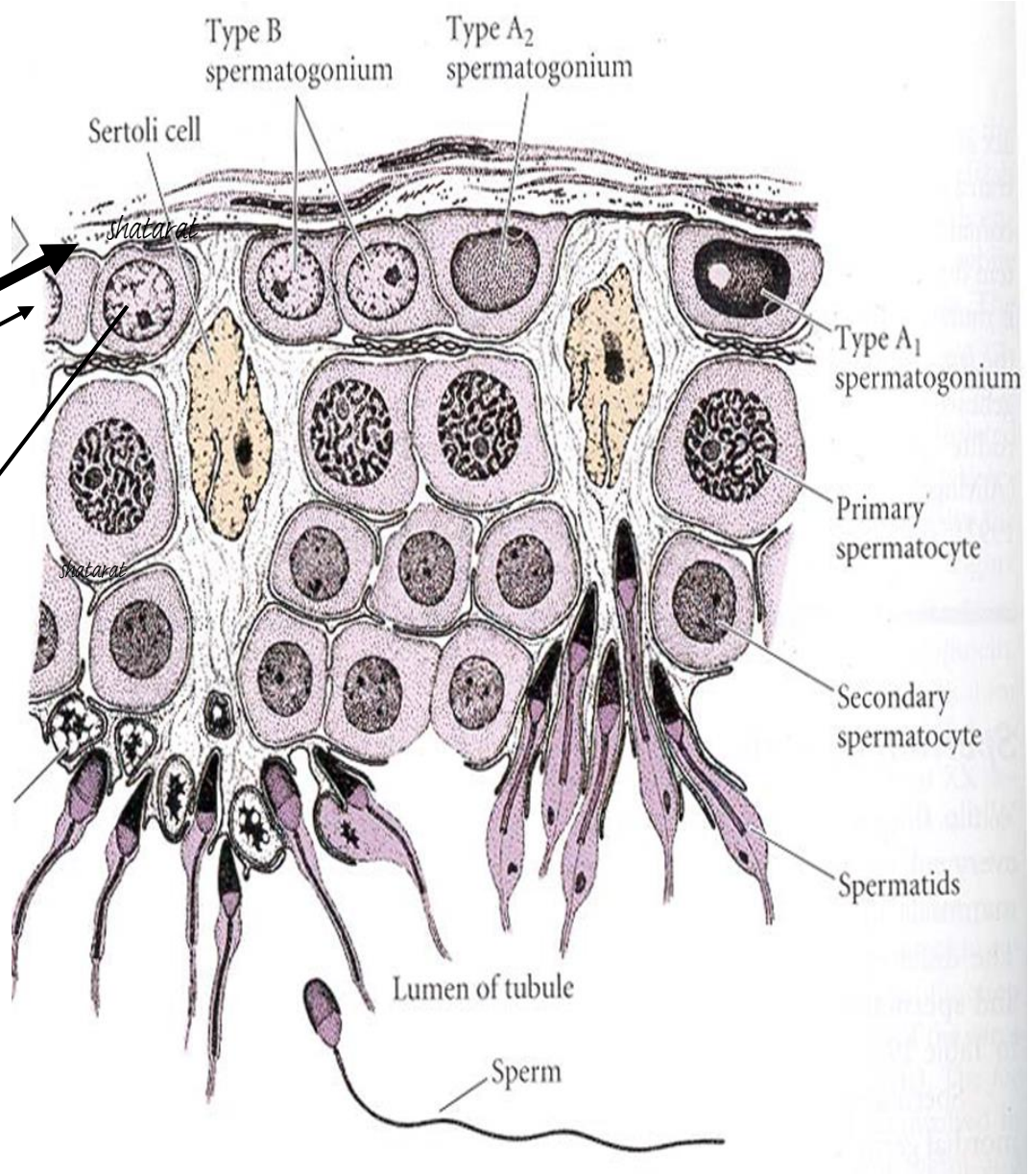
1- Spermatogonial phase

In humans, spermatogenesis takes 65–75 days

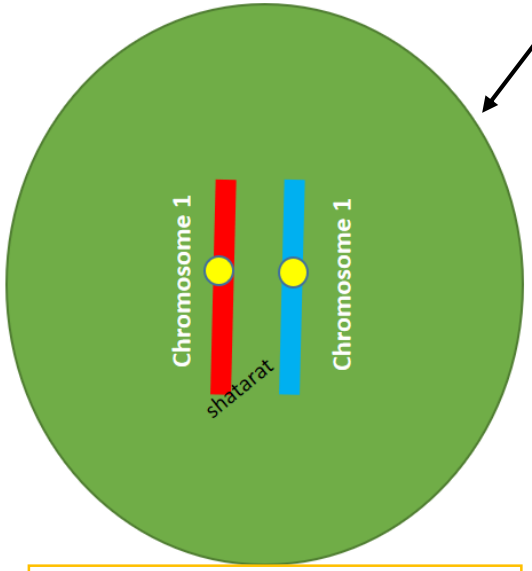
It begins with the **spermatogonia,** which are diploid (2n) cell.

- Spermatogonia act as stem cells, How???

when they undergo **mitosis**, ***some*** spermatogonia ***remain*** near the ***basement membrane of the seminiferous tubule*** in an undifferentiated state to serve ***as a reservoir*** of cells for future cell division and subsequent sperm production.



spermatogonium



2n, **Single** structured

However

The rest of the spermatogonia lose contact with the basement membrane, squeeze through the tight junctions of

the blood–testis barrier (the Sertoli cell seminiferous epithelium barrier)

And undergo developmental changes,
and differentiate into
primary spermatocytes

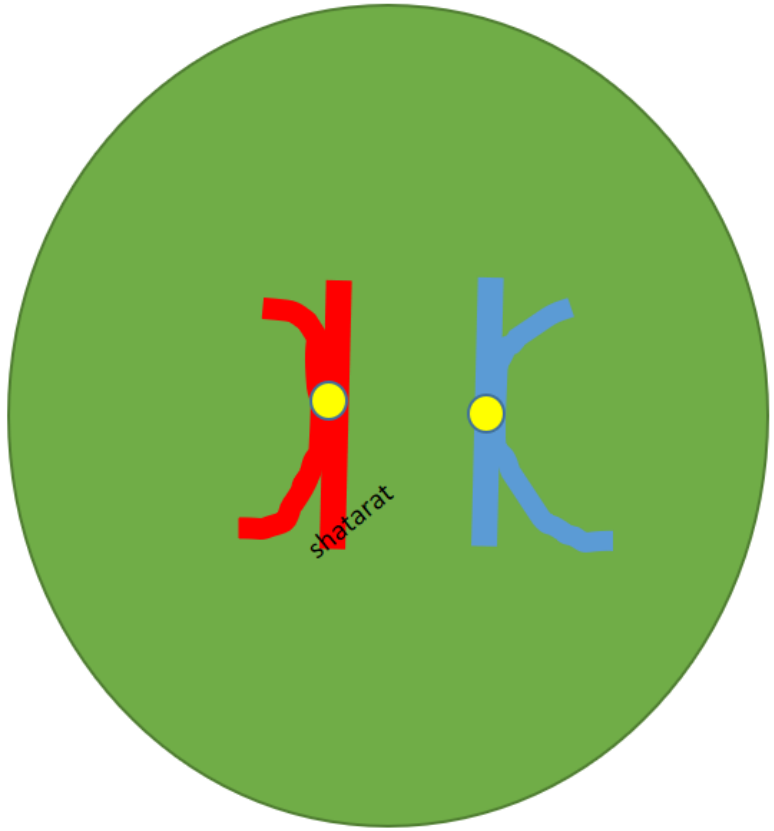
2-Spermatocyte phase

Spermatogonium gives off

Primary spermatocyte
Which is like spermatogonium, is a diploid (2n);
that is, it has
46 chromosomes

Each primary spermatocyte replicates its DNA and begins **meiosis**

Primary spermatocytes

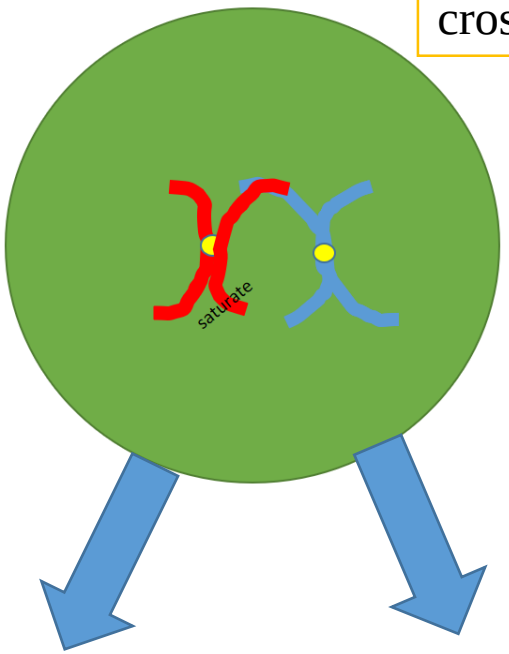


2n, **Double** structured

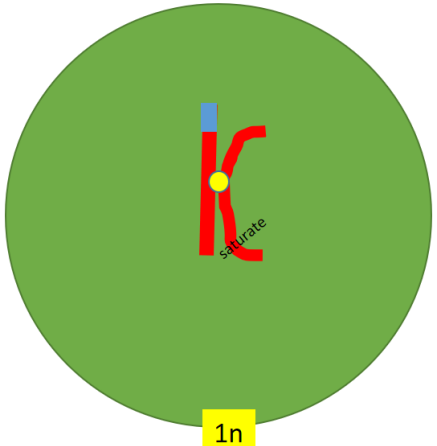
In meiosis I, homologous pairs of chromosomes line up at the metaphase plate, and crossing-over occurs

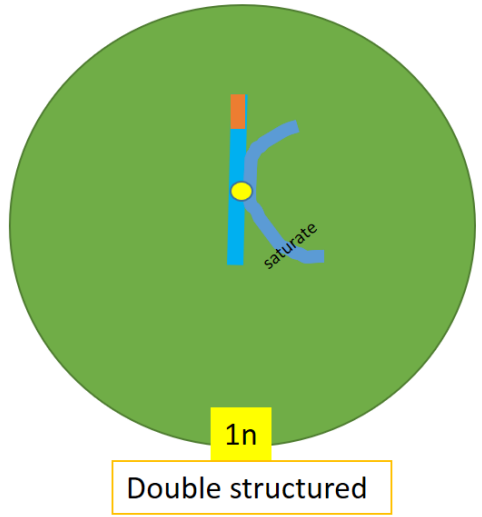
Primary spermatocytes

crossing-over occurs



Then, the meiotic spindle pulls one (duplicated) chromosome of each pair to an opposite pole of the dividing cell

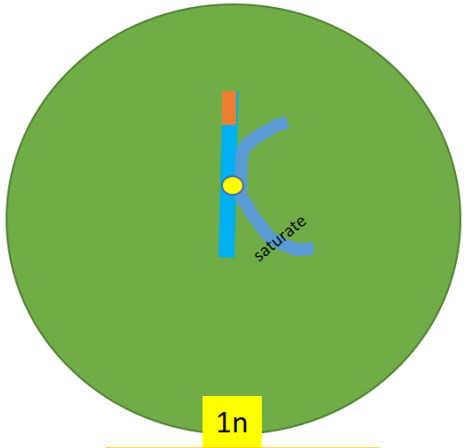


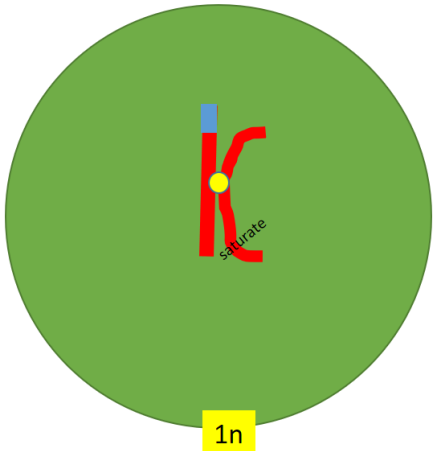


The Two cells which were formed by meiosis I are called

Secondary spermatocytes

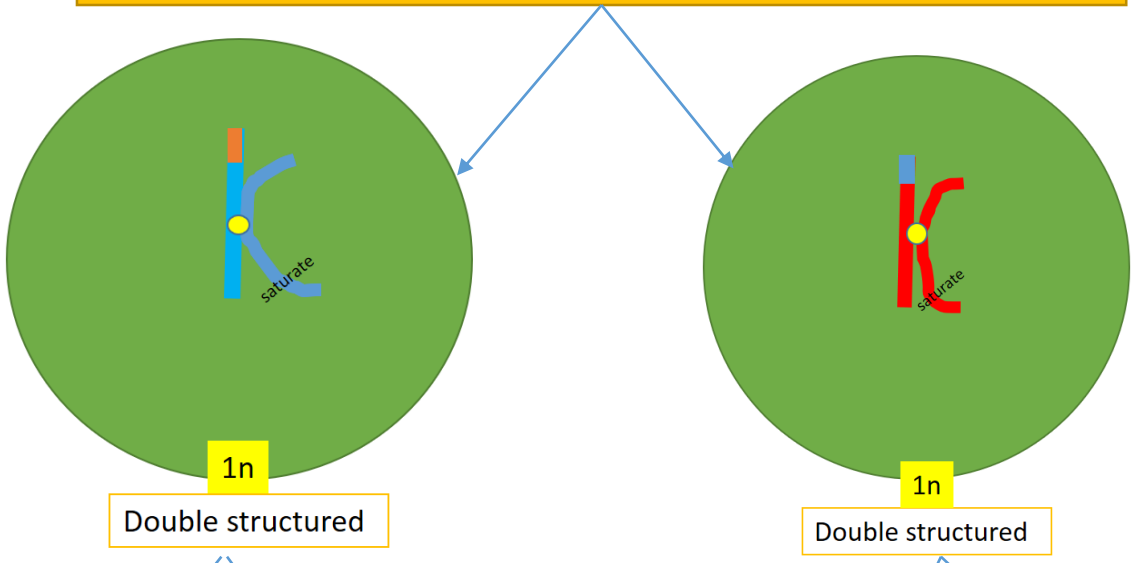
Each secondary spermatocyte has 23 chromosomes, the haploid number (n)



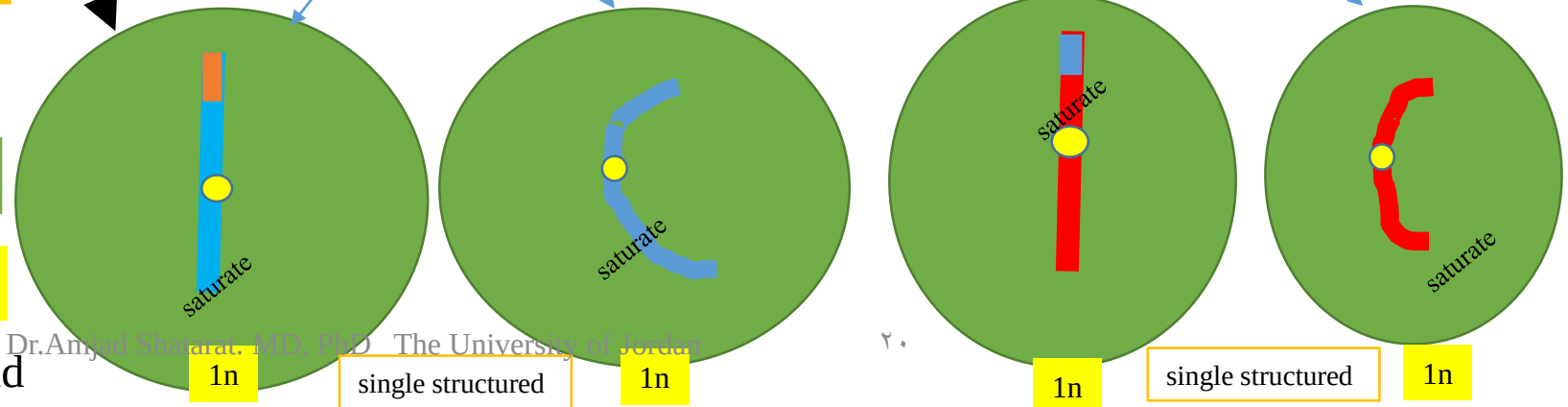


Each chromosome within a secondary spermatocyte, however, is made up of two chromatids (two copies of the DNA) still attached by a centromere. No replication of DNA occurs in the secondary spermatocytes.

In meiosis II, the chromosomes line up along the metaphase plate
and the two chromatids of each chromosome separate.



The four haploid cells resulting from meiosis II are
called spermatids
A single primary spermatocyte therefore produces ***four spermatids*** via two rounds of cell division (meiosis I and meiosis II).



4 spermatids

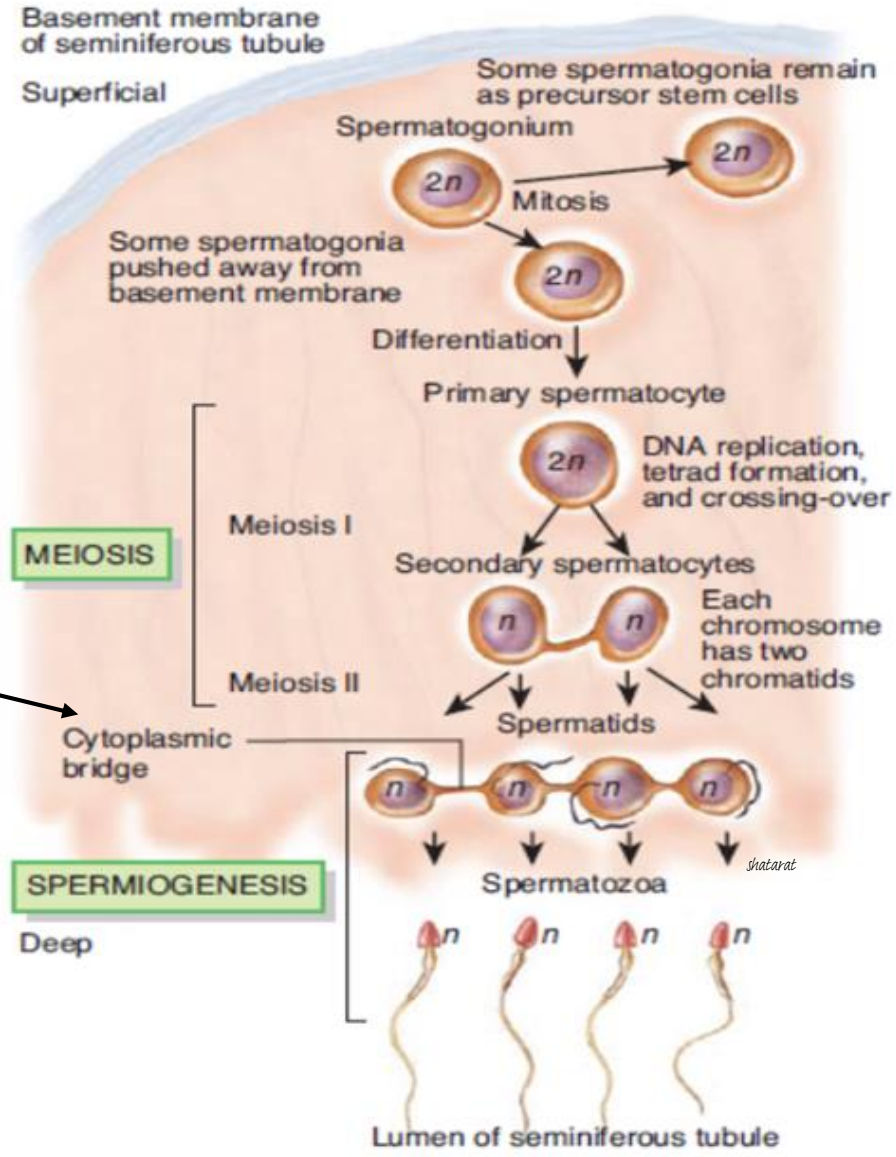
single structured

1n

haploid

A unique process occurs during spermatogenesis.
As spermatogenic cells proliferate, they fail to complete cytoplasmic separation (cytokinesis). The cells remain in contact via cytoplasmic bridges through their entire development

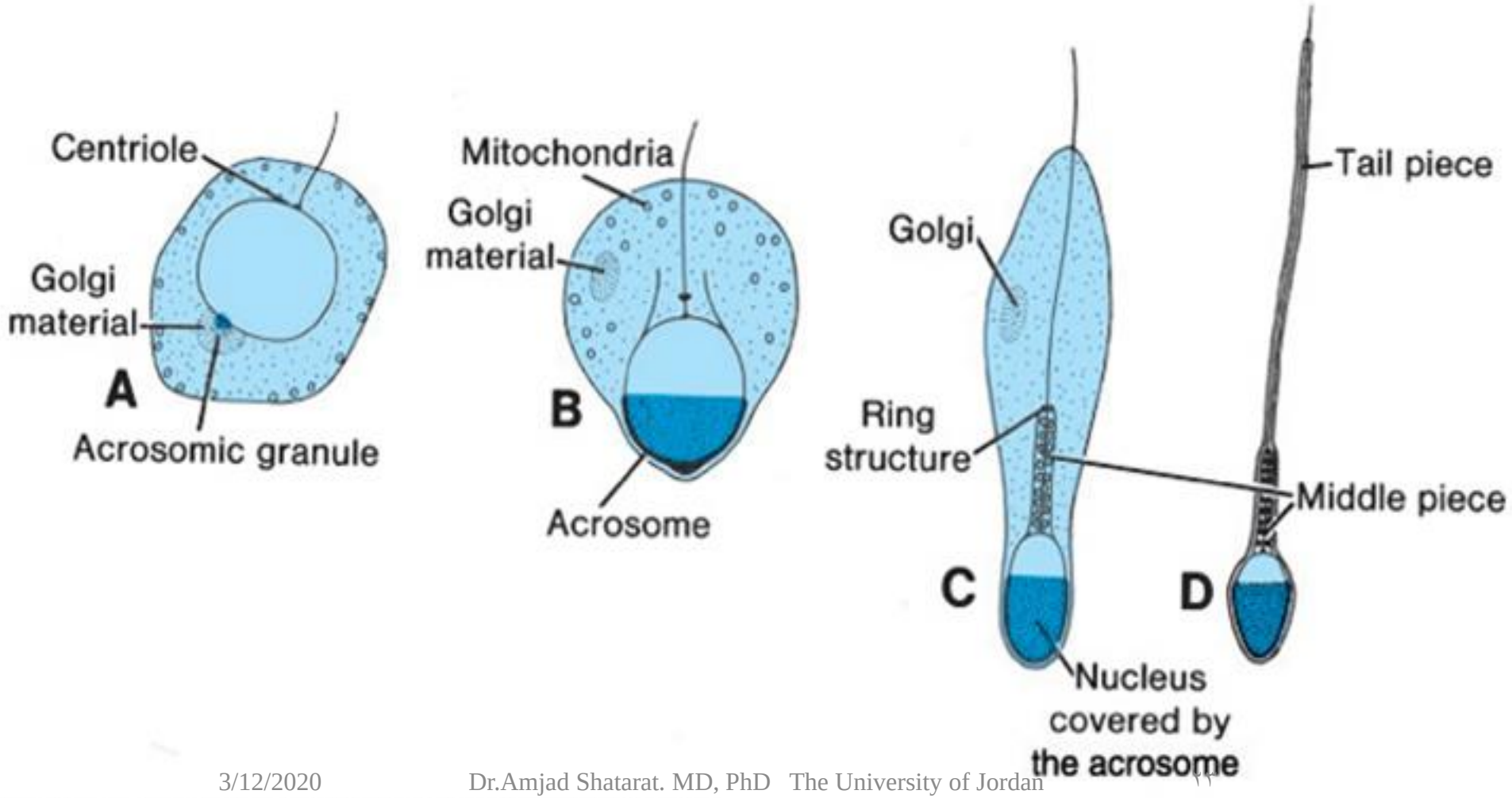
This pattern of development most likely accounts for the synchronized production of sperm in any given area of the seminiferous tubule



3-Spermiogenesis phase

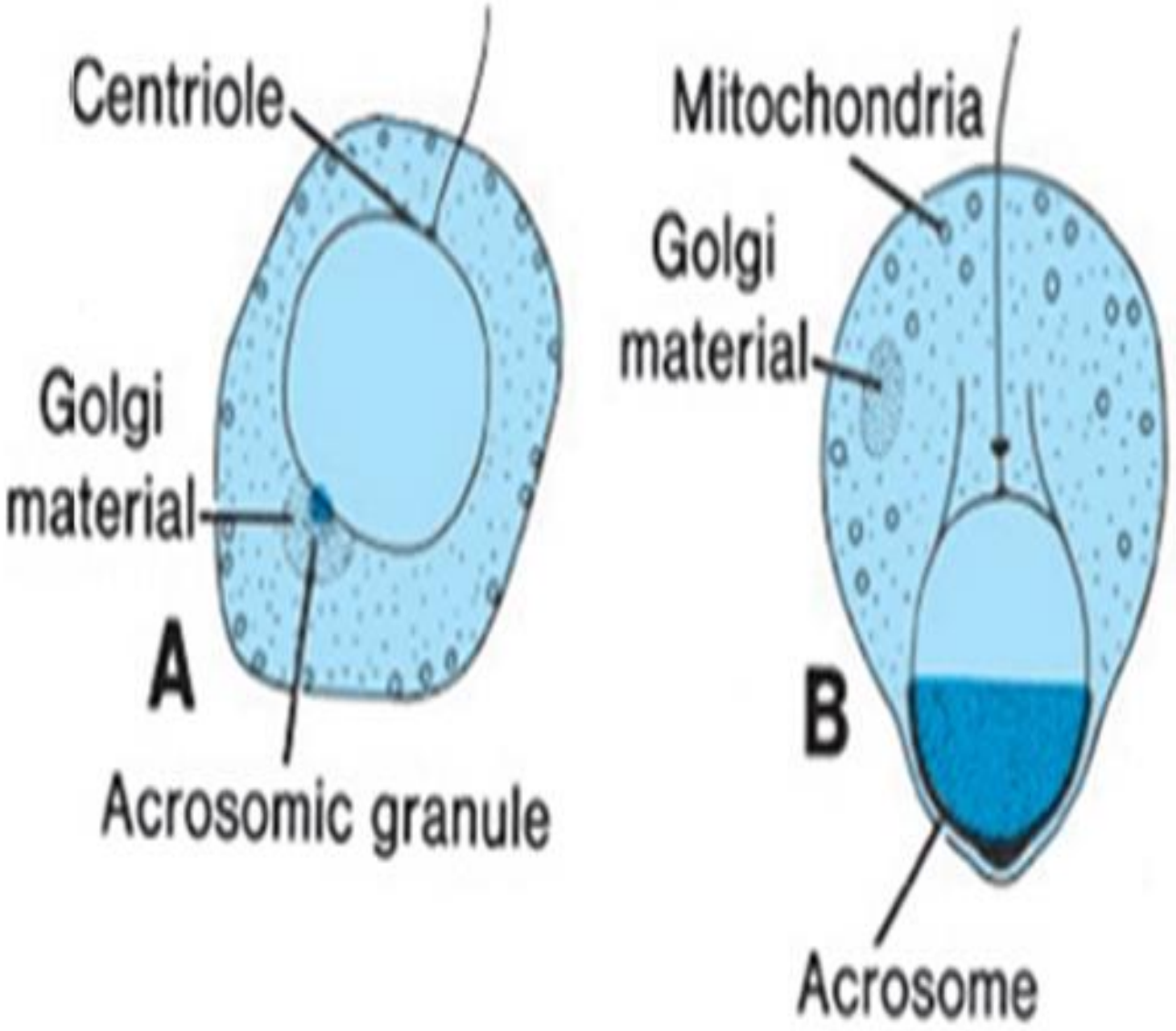
Spermiogenesis phase

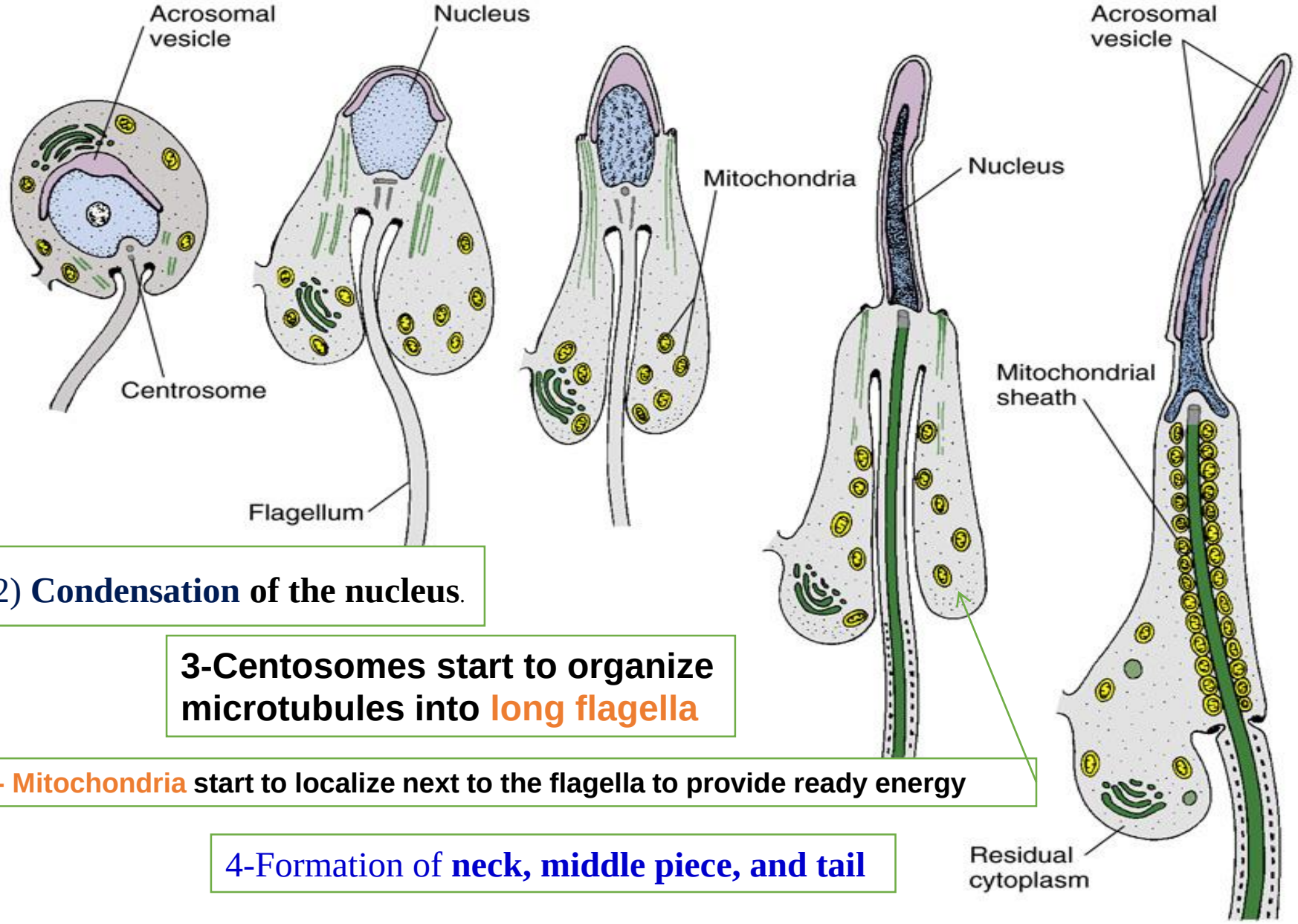
Spermiogenesis is the process in which **spermatids** transform into **spermatozoa** Which ***Includes;***



(1)Formation of the acrosome

The golgi vesicles combine to form an acrosomal vesicle that lies over the nucleus. which covers half of the nuclear surface and contains enzymes to assist in penetration of the egg and its surrounding layers during fertilization.





(2) **Condensation of the nucleus**.

3-Centosomes start to organize microtubules into long flagella

4- Mitochondria start to localize next to the flagella to provide ready energy

4-Formation of **neck, middle piece, and tail**

(5) **Shedding of most of the cytoplasm as residual bodies that are phagocytized by Sertoli cells.**

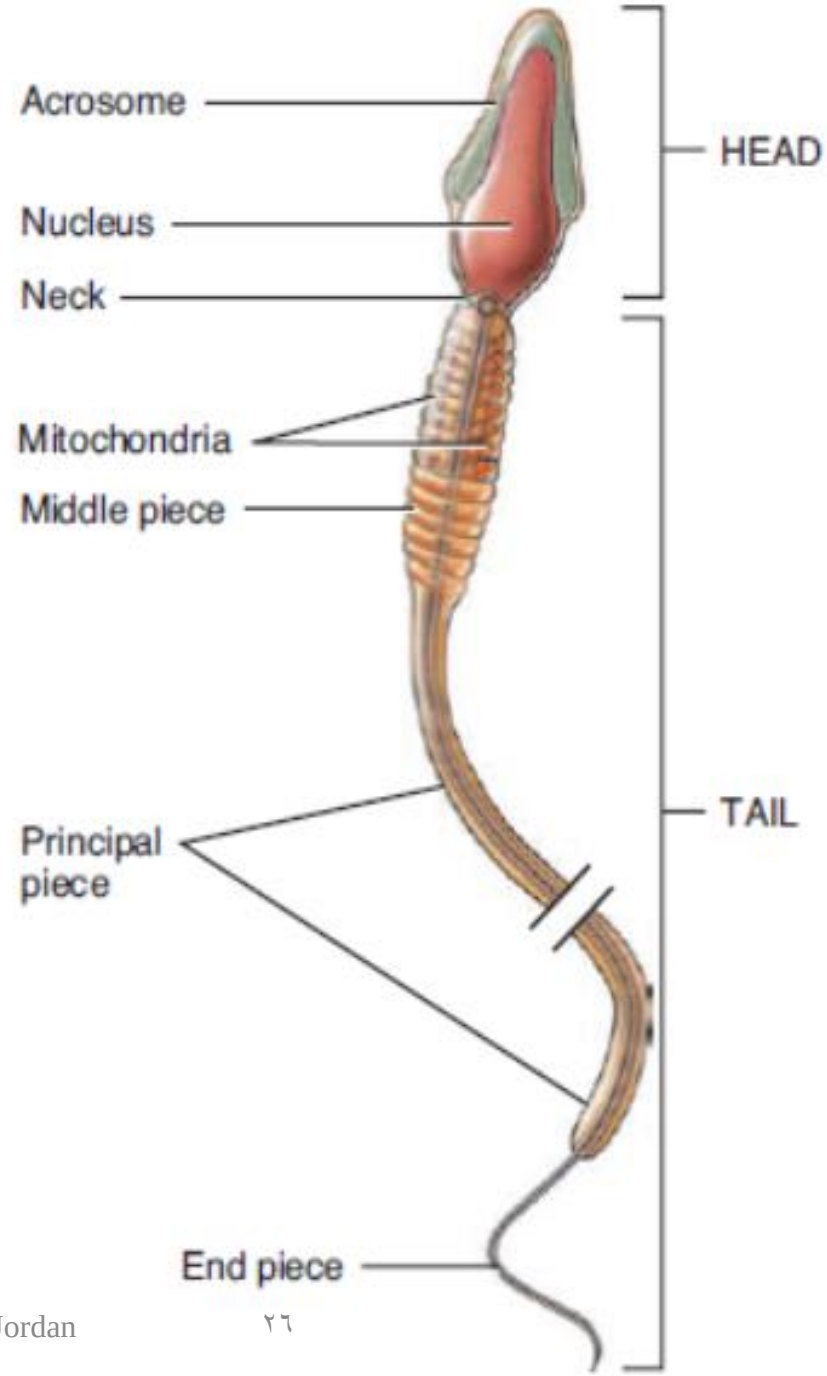
The major parts of a sperm are

the head and the tail

The head of the sperm

1- contains a nucleus with 23 highly condensed chromosomes.
2- the acrosome which is a caplike vesicle filled with enzymes covering the anterior two-thirds of the nucleus is

The tail of a sperm
Is subdivided into four parts:
Neck
middle piece
principal piece
and end piece.
The neck is the constricted region just behind the head that contains centrioles
The middle piece contains mitochondria arranged in a spiral, which provide the energy (ATP) for locomotion of sperm to the site of fertilization and for sperm metabolism.



Although spermatozoa leaving the epididymis are mature, but they remain immobile.

Spermatozoa will become functionally mature when:

1) mixed with secretions of the seminal vesicles,(become mobile
2) exposed to conditions in the female reproductive tract(become capable of fertilization

Each day about 300 million sperm complete the process of spermatogenesis

Semen

Semen (seed) is a mixture of sperm and seminal fluid, a liquid that consists of the secretions of :

- **The seminiferous tubules**
- **Seminal vesicles**
- **Prostate**
- **bulbourethral glands**

Seminal fluid provides sperm with a transportation medium, nutrients, and protection from the hostile acidic environment of the male's urethra and the female's vagina

The volume of semen in a typical ejaculation is 2.5–5 milliliters (mL), with 50–150 million sperm per mL.
When the number falls below 20 million/mL, the male is likely to be infertile

The prostatic secretion gives semen a milky appearance
fluids from the seminal vesicles and bulbourethral glands give it a sticky consistency.
.

Hormones of male

At puberty

Hypothalamus produces

GnRH (Gonadotropin releasing hormone)

GnRH stimulates production of

FHS and LH

by

THE PITUITARY GLAND

➢**LH binds to Leydig cells receptors.**

➢**Leydig** cells secrete **testosterone** that binds to **Sertoli cells** to promote spermatogenesis

Pituitary gland secrets **FSH** which stimulates Sertoli cells **testicular fluid production**