Histology of Male Reproductive system (1)

Prof. Dr. Malak A. Al-yawer

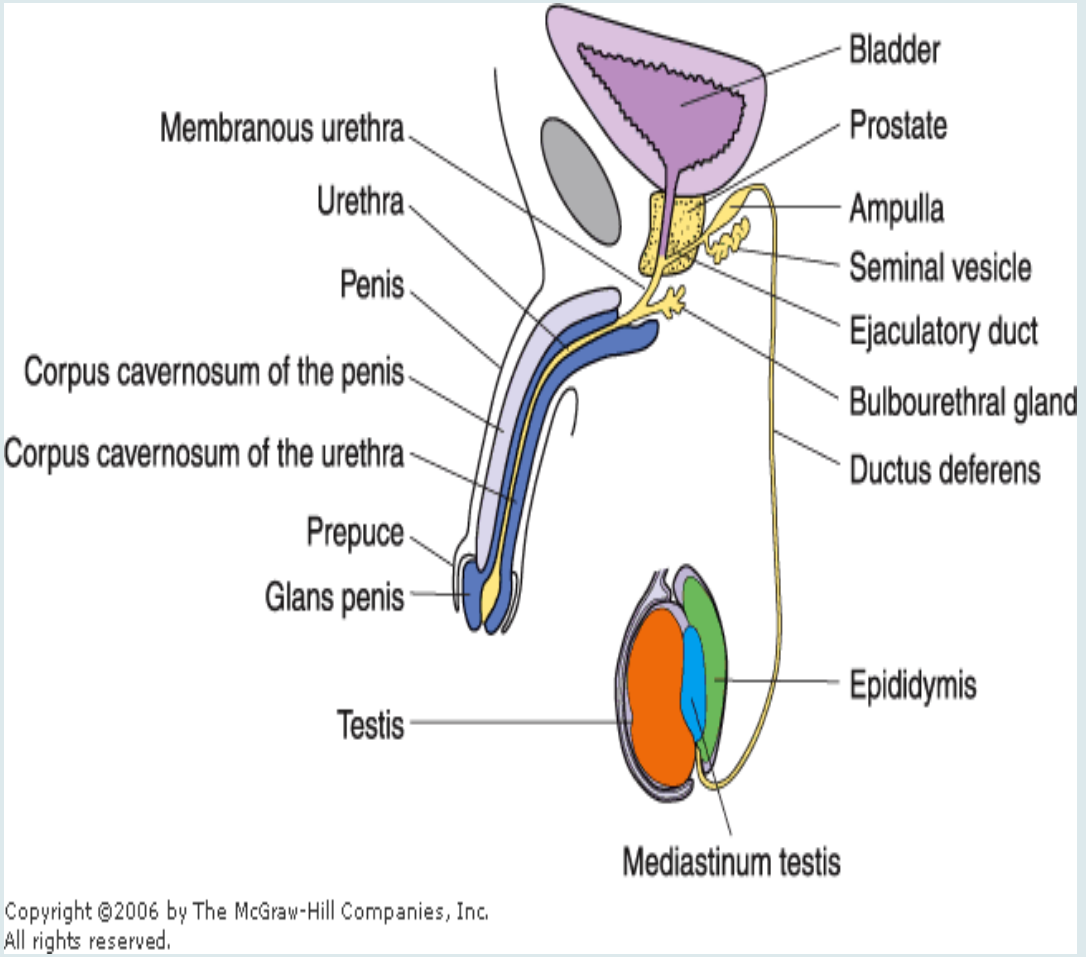
Learning Objectives

- At the end of this lecture, the 2nd medical student will be able to:
- State the organization of the testis
- Define seminiferous tubules and interstitial tissue
- List the components of seminiferous tubules
- List the phases of spermatogenesis
- State the histological characteristics of spermatogonia and distinguish between its two types
- State the histological characteristics of primary & secondary spermatocytes
- State the histological characteristics of spermatids
- List the phases of spermiogenesis and state the histological characteristics of each phase
- State the structure and functions of Sertoli cells
- Define blood testis barrier
- List the light and electron microscopic features of leydig cells

Male Reproductive System

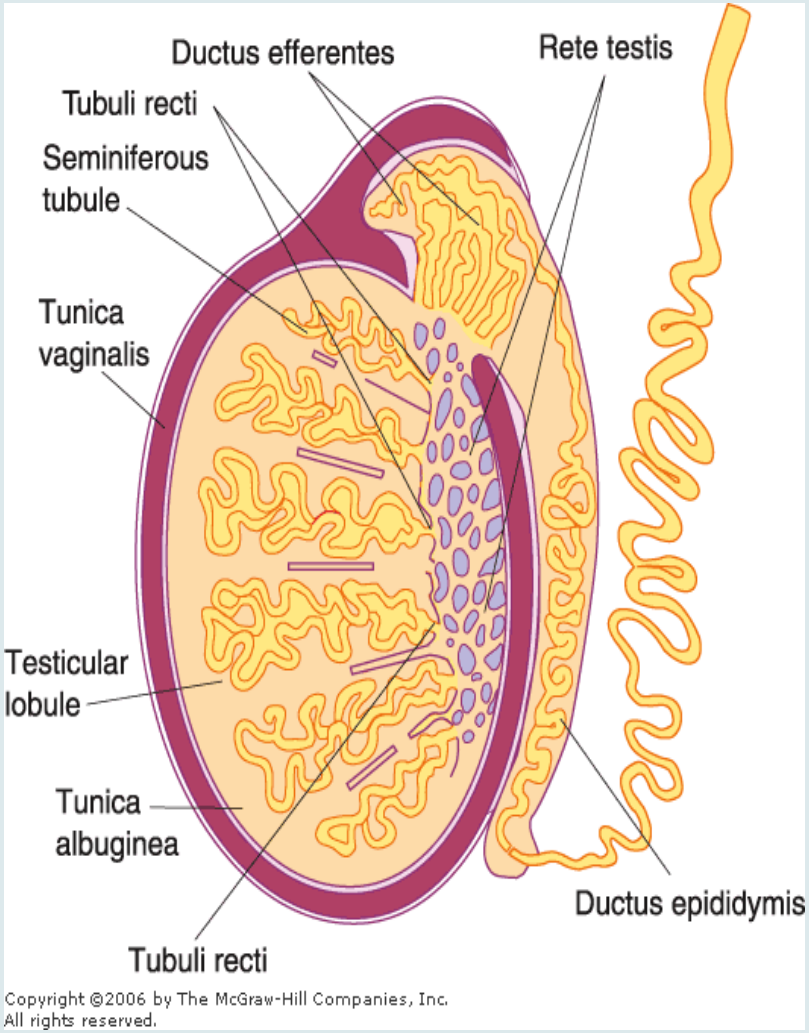
- is composed of the

1. testes
2. genital ducts
3. accessory glands
4. penis



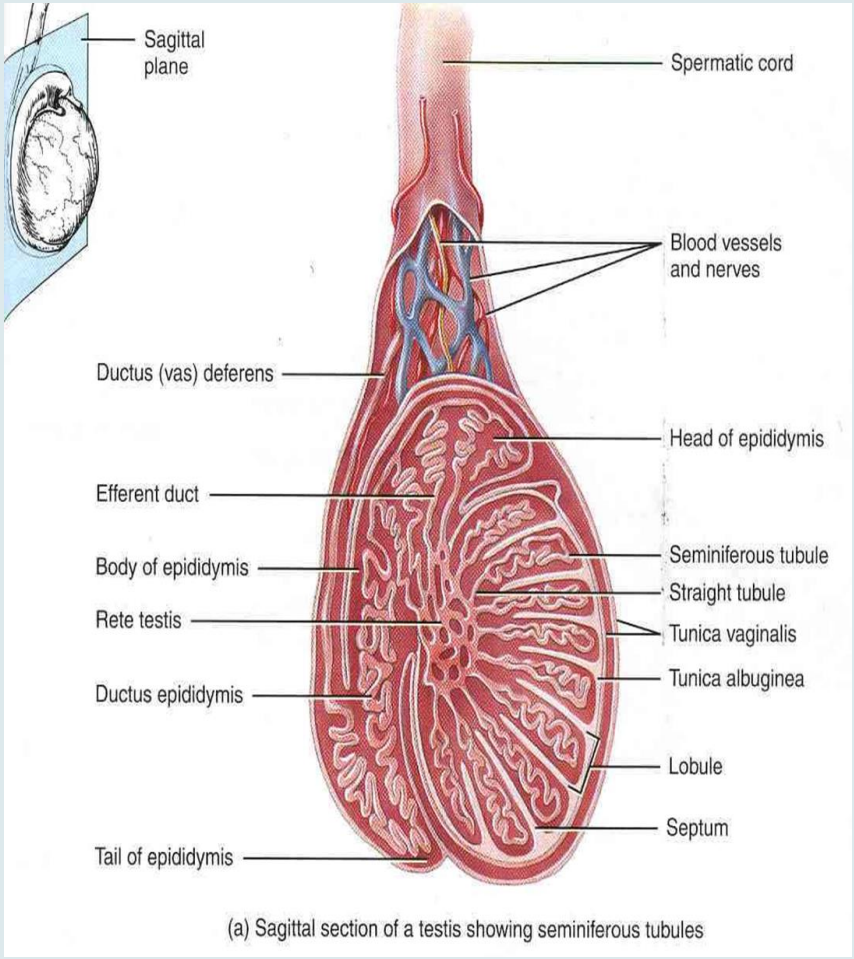
Testes

- Each testis is surrounded by a thick capsule of dense connective tissue, the **tunica albuginea**.
- The tunica albuginea is thickened on the posterior surface of the testis to form the **mediastinum testis**, from which **fibrous septa** penetrate the gland, dividing it into about 250 pyramidal compartments called the **testicular lobules**
- These septa are incomplete, and there is frequent intercommunication between the lobules.
- Each lobule is occupied by **one to four seminiferous tubules** enmeshed in a web of loose connective tissue
- the tunica vaginalis, derived from the peritoneum. The tunic consists of an outer parietal layer and an inner visceral layer, covering the tunica albuginea on the anterior and lateral sides of the testis



Testis

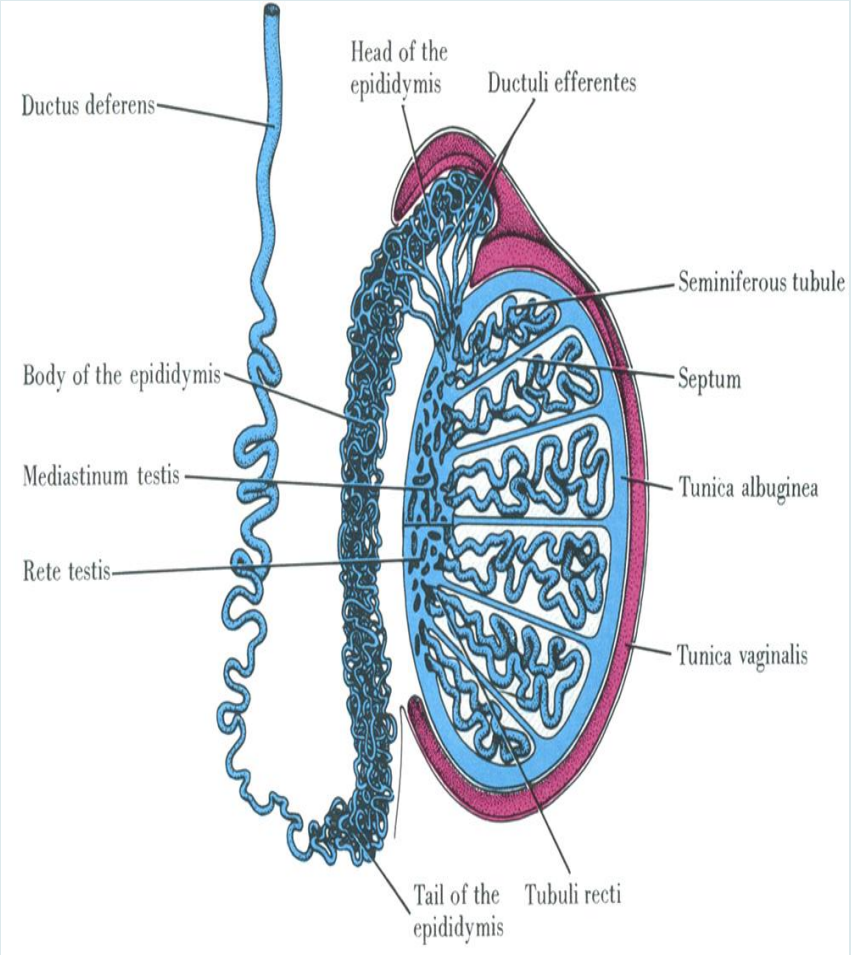
- Straight tubules(tubuli recti)are short segments that connect the seminiferous tubules to an anastomosing labyrinth of epithelium-lined channels, the rete testis.
- About 10 -20 ductuli efferentes connect the rete testis to the cephalic portion of the epididymis



(a) Sagittal section of a testis showing seminiferous tubules

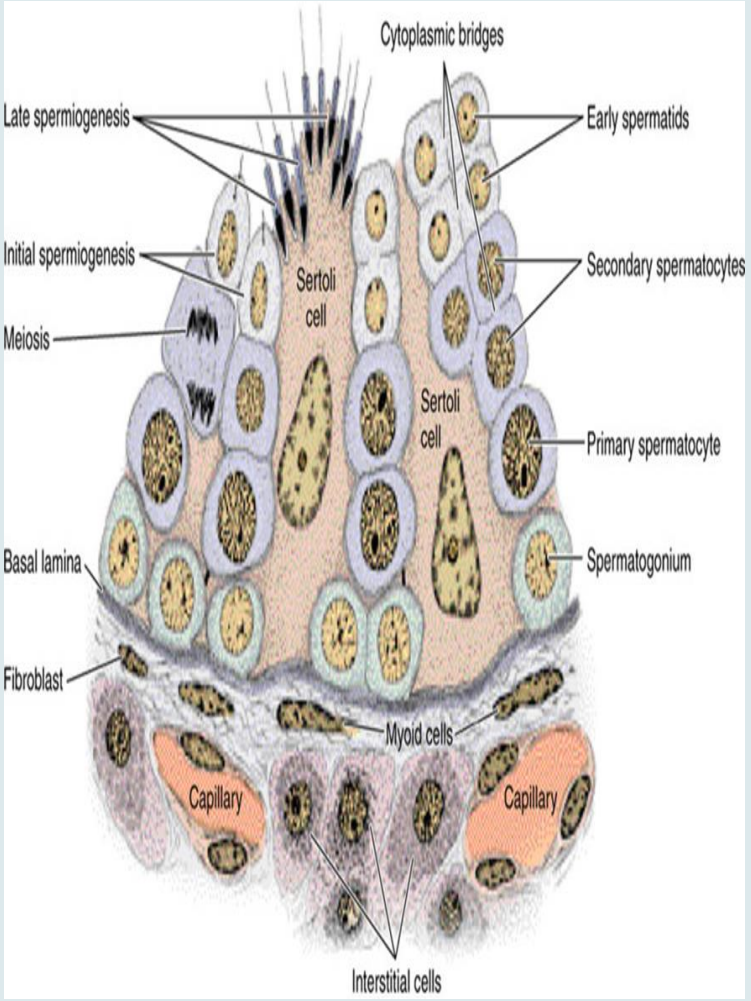
The Seminiferous Tubules

- Each testicle has **250-1000** convoluted seminiferous tubules
  - that measure about 150-250 µm in diameter and 30-70 cm in length.
  - The combined length of the tubules of one testis is about 250 m.



The seminiferous tubules

- ❑ are lined with a complex stratified epithelium called **germinal or seminiferous epithelium**.
- ❑ Their outer wall is surrounded by
- a **well-defined basal lamina** and
- **a fibrous connective tissue** consisting of several layers of fibroblasts. The innermost layer, adhering to the basal lamina, consists of flattened **myoid cells**, which have characteristics of smooth muscle.

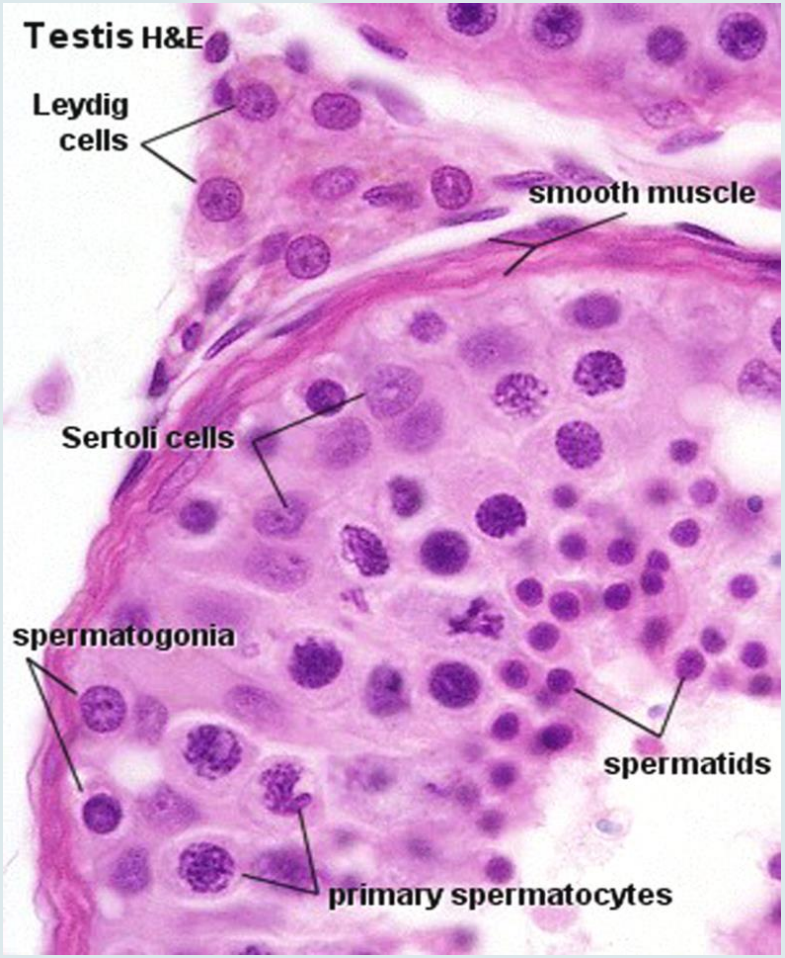


Interstitial tissue

- is a web of loose connective tissue found between the seminiferous tubules
- is rich in blood and lymphatic vessels, nerves, and interstitial cells, also known as Leydig cells.

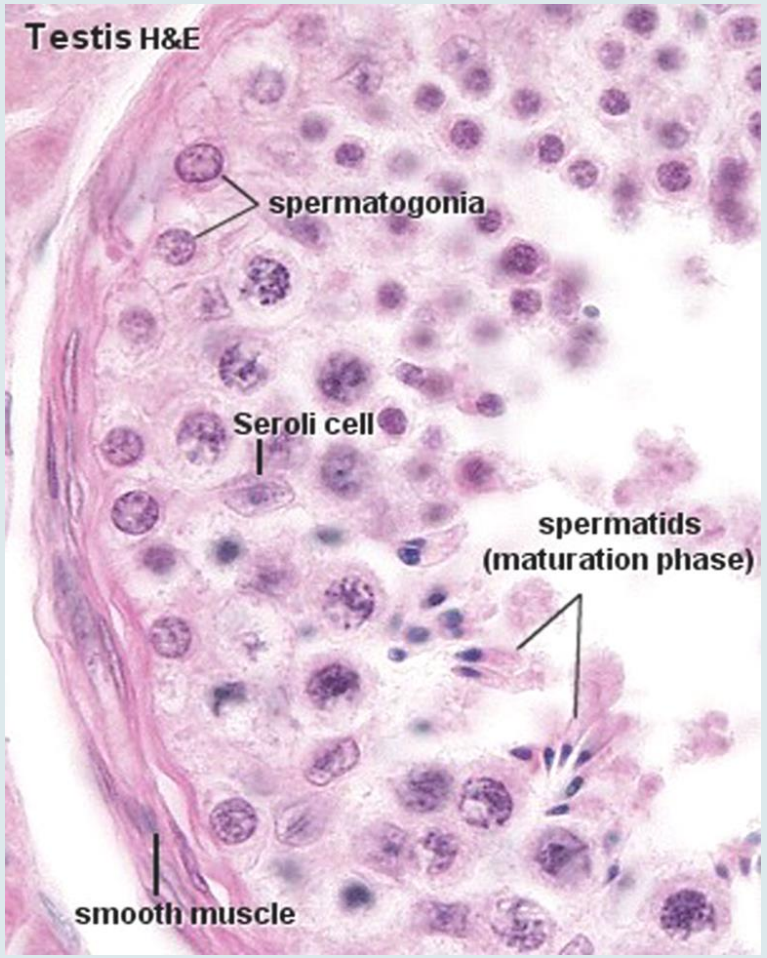
The seminiferous epithelium consists of two types of cells:

- Sertoli, or supporting, cells
- cells that constitute the spermatogenic lineage which are stacked in **four to eight layers**; their function is to produce spermatozoa.



Spermatogenesis

- Is the process of production of spermatozoa
- Includes
  - Spermatogonial Phase (Mitosis)
  - Spermatocyte Phase (Meiosis)
  - Spermatid Phase (Spermiogenesis)

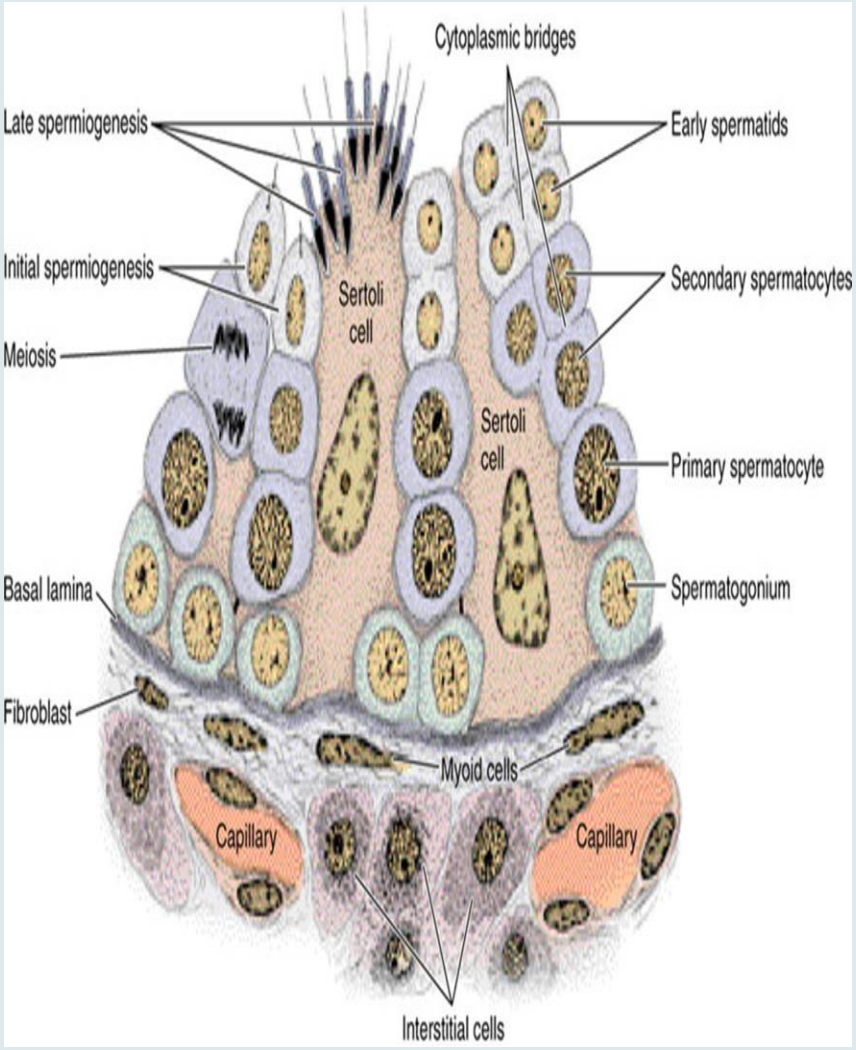


Spermatogonia

- Spermatogonium is a primitive germ cell small in size about 12 µm in diameter, situated next to the basal lamina of the epithelium
- At sexual maturity, spermatogonia begin dividing by mitosis, producing successive generations of cells. The newly formed cells can follow one of two paths:

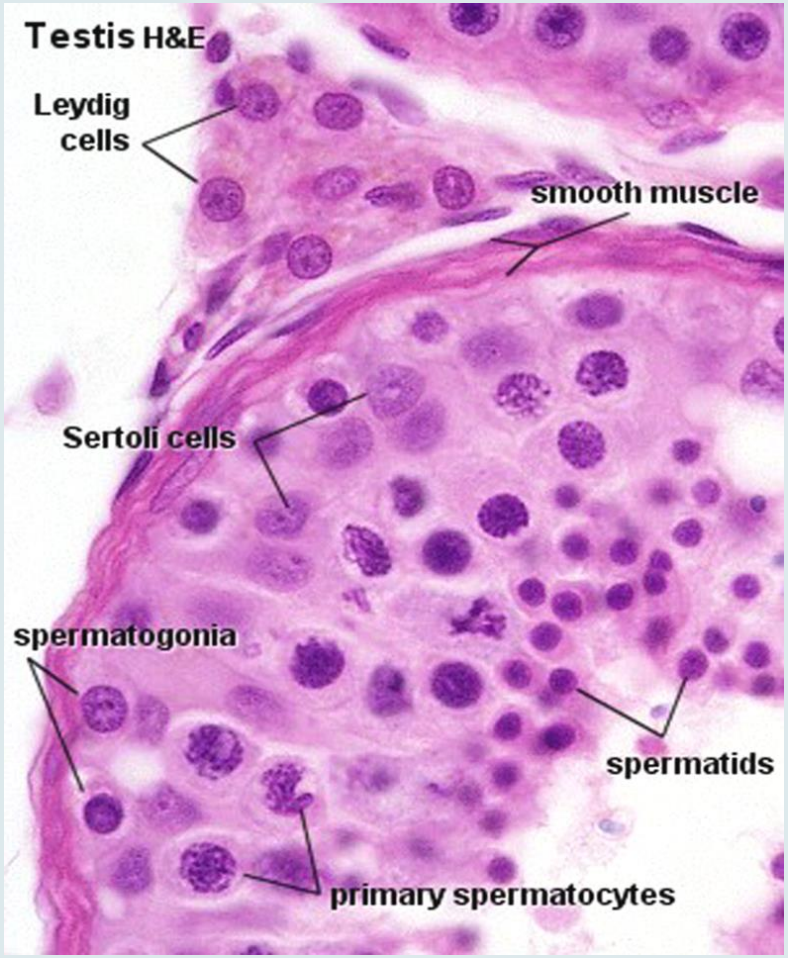
➢ they can continue dividing as stem cells, also called type A spermatogonia, or

➢ they can differentiate during progressive mitotic cycles to become type B spermatogonia which are progenitor cells that will differentiate into primary spermatocytes .



Primary spermatocytes

- The primary spermatocyte has 46 (44 + XY) chromosomes and 4N of DNA.
- Soon after their formation, these cells enter the prophase of the first meiotic division.
- Because this prophase takes about 22 days, the majority of spermatocytes seen in sections will be in this phase.
- The primary spermatocytes are the **largest cells of the spermatogenic lineage** and are characterized by the presence of chromosomes in various stages of the coiling process within their nuclei

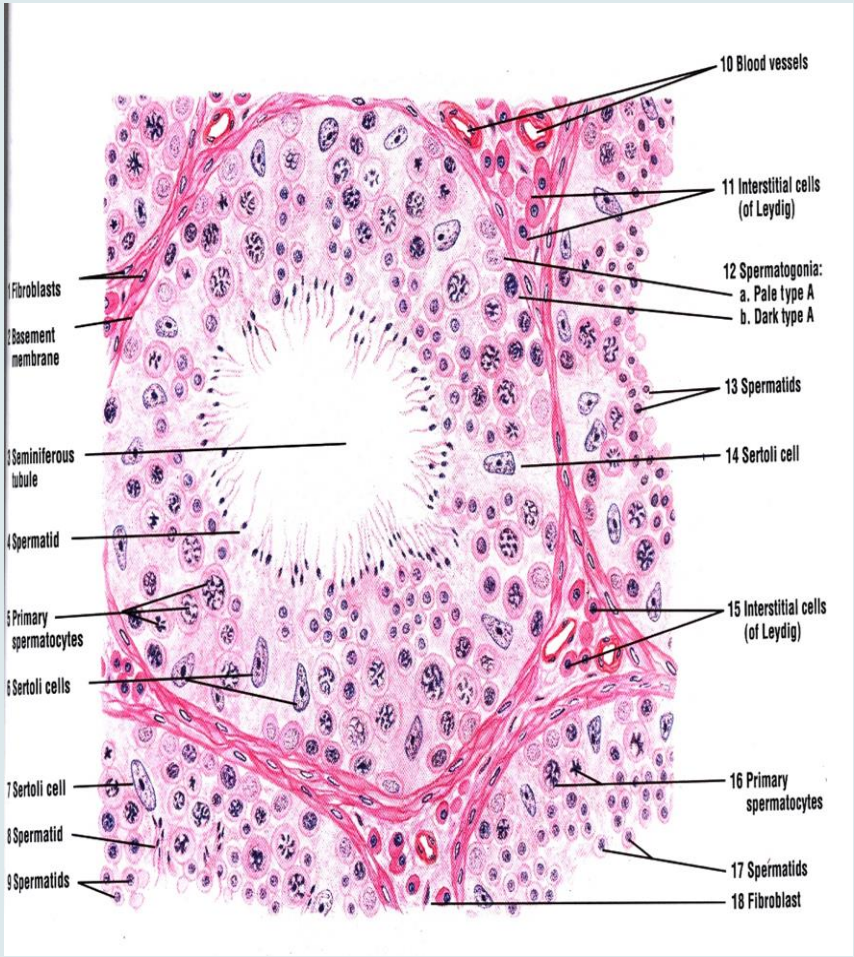


Secondary spermatocytes

- Smaller cells arise from the first meiotic division
- with only 23 chromosomes (22 + X or 22 + Y) & 2N DNA per cell.
- Secondary spermatocytes are difficult to observe in sections of the testis because they are short-lived cells that remain in interphase very briefly and quickly enter into the second meiotic division.

Spermatids

- Each secondary spermatocyte results in two spermatids that contain 23 chromosomes and (1N) DNA
- The spermatids can be distinguished by their small size (7-8 µm in diameter) and by nuclei with areas of condensed chromatin.
- Their position within the seminiferous tubules is close to the lumen
- The cytoplasm of spermatids contains a prominent Golgi complex near the nucleus, mitochondria, a pair of centrioles, free ribosomes, and tubules of smooth endoplasmic reticulum



Spermiogenesis

- spermatids are transformed into spermatozoa. No cell division occurs during this process.
- Spermiogenesis is a complex process that includes

➢ formation of the acrosome

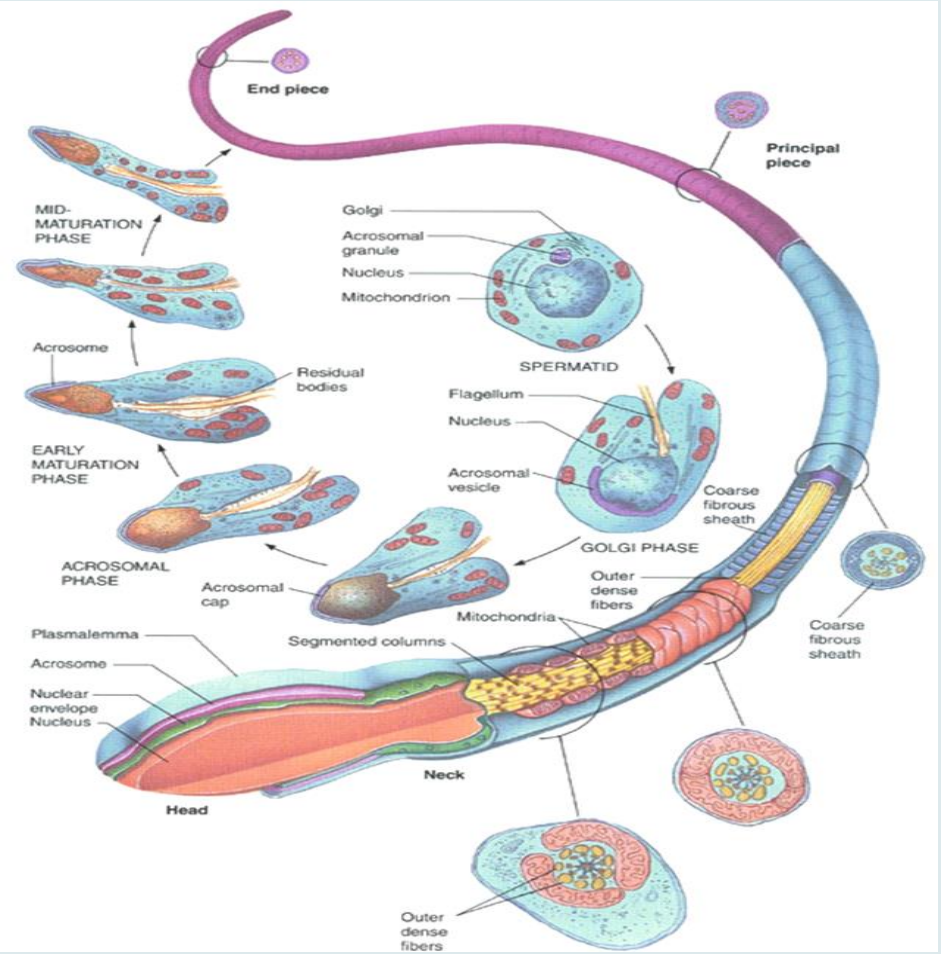
➢ condensation and elongation of the nucleus

➢ development of the flagellum

➢ loss of much of the cytoplasm.

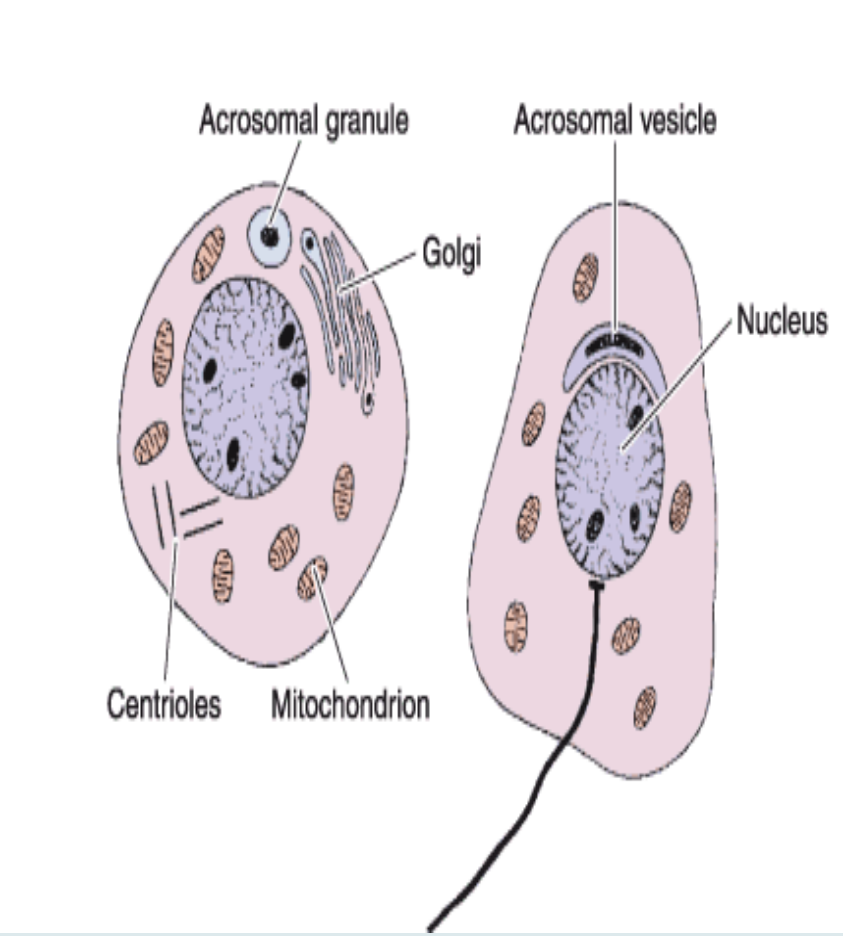
Spermiogenesis can be divided into three phases.

1. The Golgi Phase
2. The Acrosomal Phase
3. The Maturation Phase



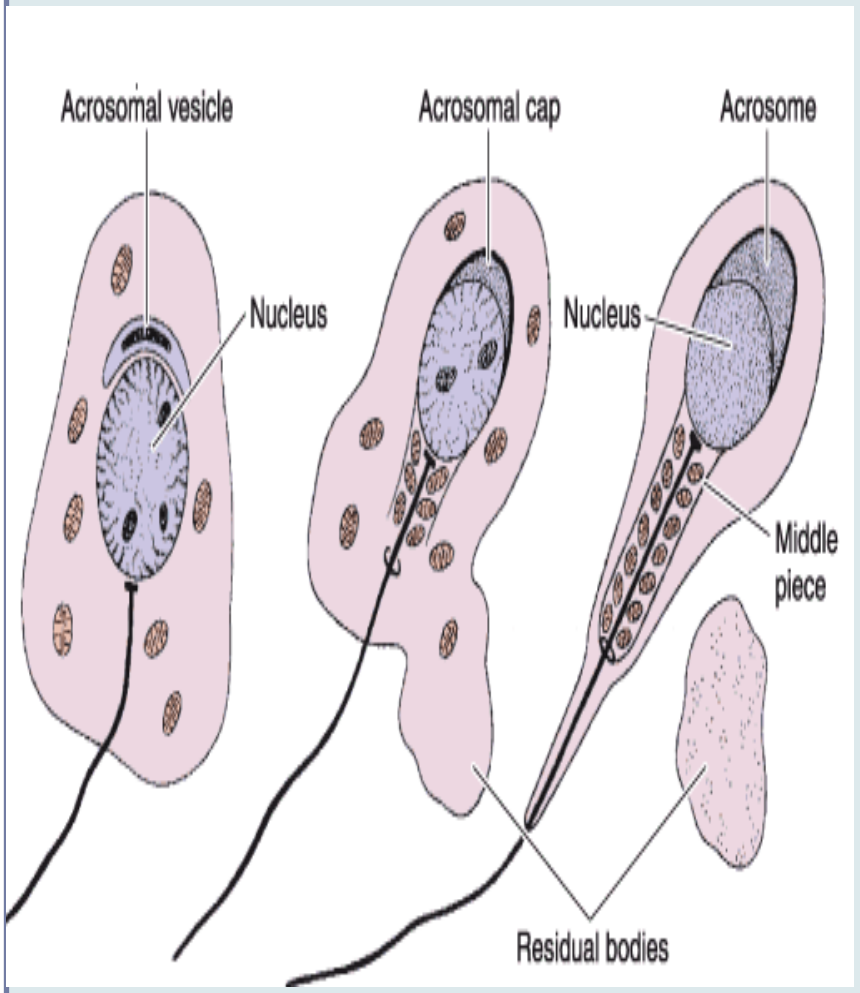
The Golgi Phase

- **Proacrosomal granules** accumulate in the Golgi complex.
- They subsequently coalesce to form a single **acrosomal granule** within a membrane-limited **acrosomal vesicle**.
- The flagellar axoneme begins to form



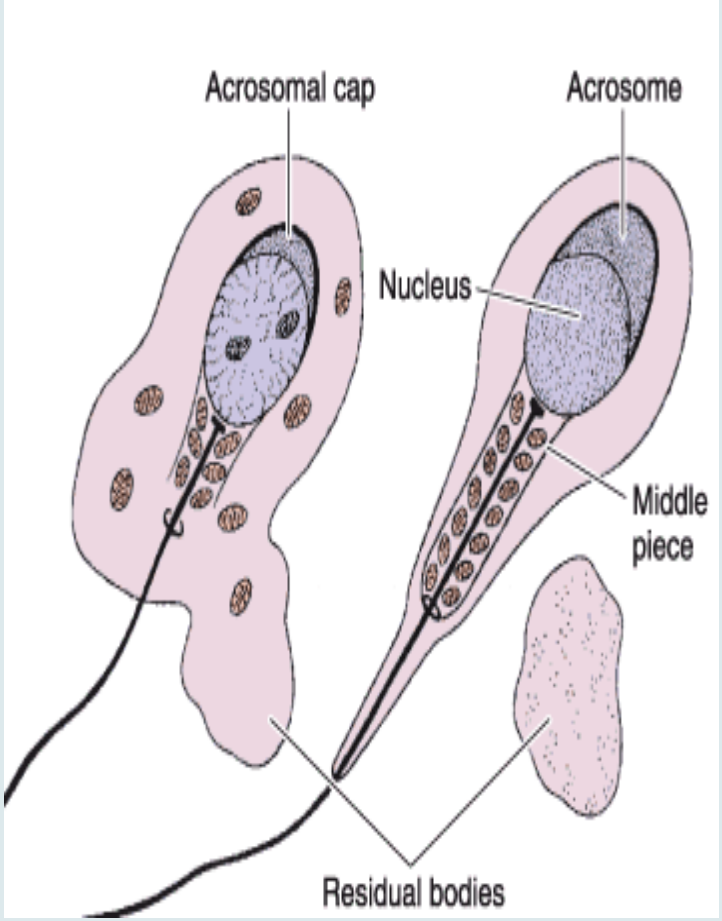
The Acrosomal Phase

- The acrosomal vesicle spreads to cover the anterior half of the condensing nucleus and is then known as the **acrosome**. The acrosome contains several hydrolytic enzymes. It serves as a specialized type of lysosome.
- During this phase of spermiogenesis, **the nucleus of the spermatid becomes oriented** toward the base of the seminiferous tubule, and the axoneme projects into its lumen. In addition, the **nucleus becomes more elongated and condensed** .
- Mitochondria aggregate around the proximal part of the flagellum, forming a thickened region known as the **middle piece**



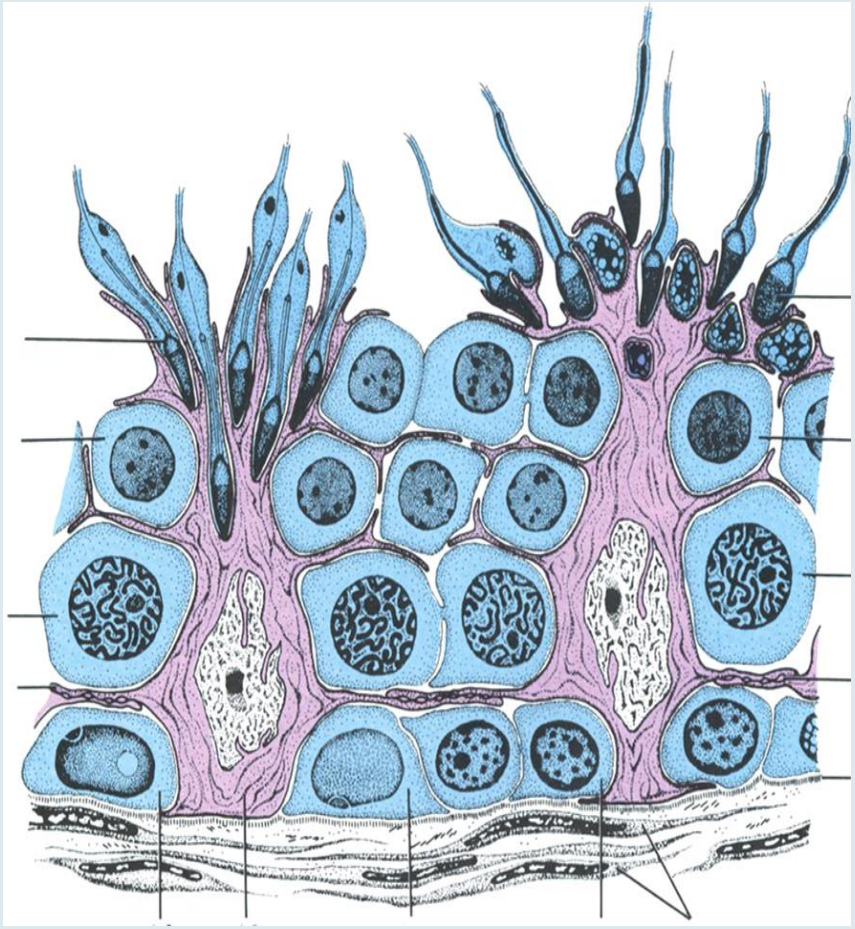
The Maturation Phase

- Residual cytoplasm is shed and phagocytosed by Sertoli cells, and the spermatozoa are released into the lumen of the tubule.



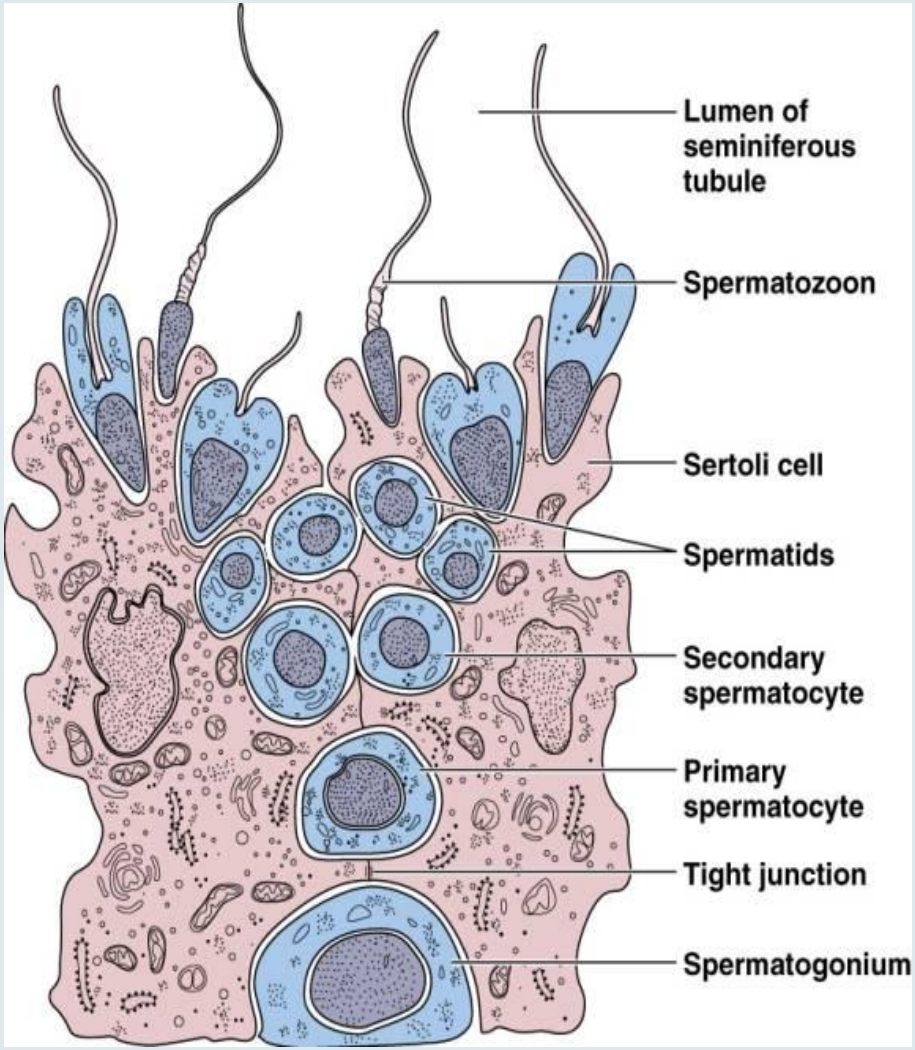
Sertoli cells

- are elongated pyramidal cells that partially envelop cells of the spermatogenic lineage.
- The bases of the Sertoli cells adhere to the basal lamina, and their apical ends frequently extend into the lumen of the seminiferous tubule.
- In the light microscope, the outlines of Sertoli cells appear poorly defined because of the numerous lateral processes that surround spermatogenic cells .



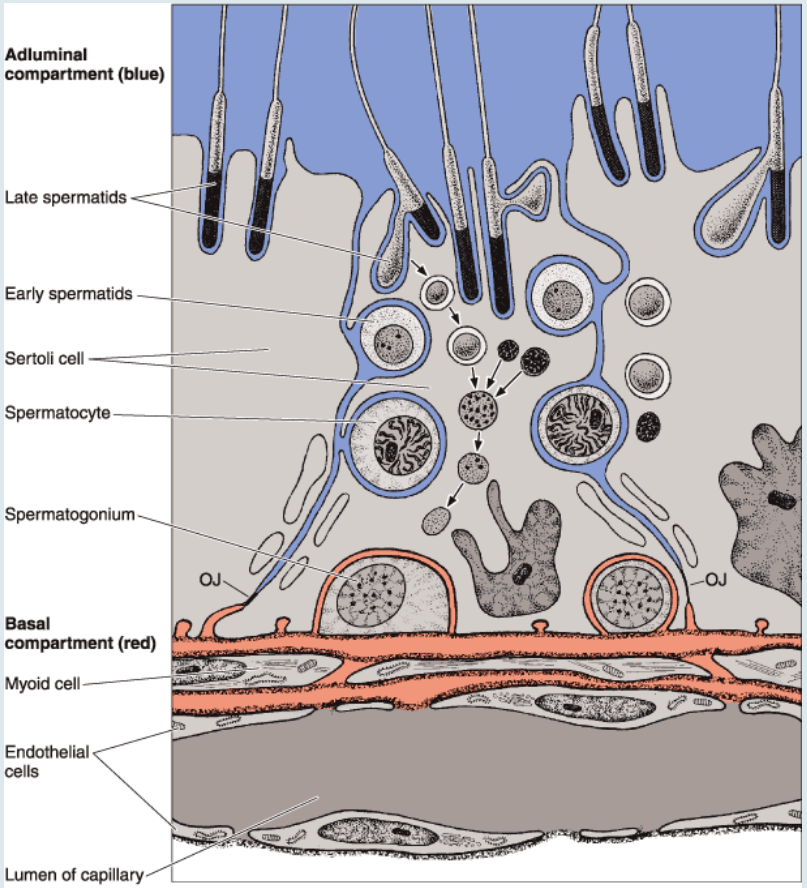
Setoli cells

- with the electron microscope, these cells contain abundant smooth endoplasmic reticulum, some rough endoplasmic reticulum, a well-developed Golgi complex, and numerous mitochondria and lysosomes.
- The nucleus, which is often triangular in outline, possesses numerous infoldings and a prominent nucleolus; it exhibits little heterochromatin



Blood testis barrier

- Adjacent Sertoli cells are bound together by occluding junctions at the basolateral part of the cell, forming a blood testis barrier.
- The spermatogonia lie in a basal compartment that is situated below the barrier.
- some of the cells resulting from division of spermatogonia somehow traverse these junctions and come to lie in the adluminal compartment situated above the barrier.



- **Sertoli cells** are also connected by **gap junctions** that provide **ionic and chemical coupling of the cells**; this may be important in coordinating the cycle of the seminiferous epithelium described above.

- **Sertoli cells** in humans and in other animals do not divide during the reproductive period.
- They
  - are extremely resistant to adverse conditions such as infection, malnutrition, and x-irradiation
  - have a much better rate of survival after these insults than do cells of the spermatogenic lineage

Sertoli cells have several functions

- ❑ Support, protection, and nutritional regulation of the developing spermatozoa.
- ❑ Phagocytosis.
- ❑ Secretion.
- ✓ Sertoli cells continuously secrete **a fluid** that flows in the direction of the genital ducts and is used for sperm transport.
- ✓ Secretion of an **ABP(androgen binding protein**) by Sertoli cells is under the control of follicle-stimulating hormone (FSH) and testosterone and serves to concentrate testosterone in the seminiferous tubule, where it is necessary for spermatogenesis.
- ✓ Sertoli cells can convert testosterone to estradiol.
- ✓ They also secrete a peptide called **inhibin**, which suppresses synthesis and release of FSH in the anterior pituitary gland

Sertoli cells have several functions

- ❑ Production of the anti-müllerian hormone.
- acts during embryonic development to promote regression of the müllerian (paramesonephric) ducts in the male fetus; testosterone fosters the development of structures derived from the Wolffian (mesonephric) ducts.

❑ The blood testis barrier. The existence of a barrier between the blood and the interior of the seminiferous tubules accounts for the fact that few substances from the blood are found in the testicular fluid. The testicular capillaries are fenestrated and permit passage of large molecules.

The interstitial tissue of the testis

- The spaces between the seminiferous tubules in the testis are filled with connective tissue, nerves, fenestrated capillaries, and lymphatic vessels.
- The connective tissue consists of various cell types, including

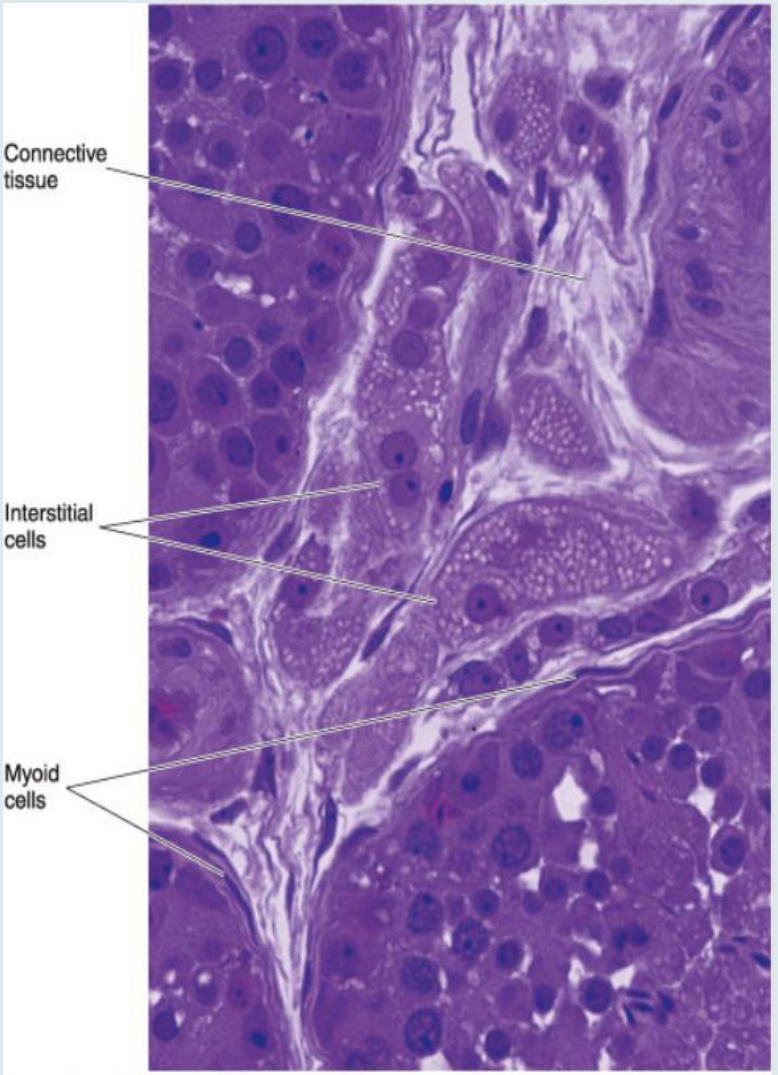
✓ Fibroblasts

✓ undifferentiated connective cells

✓ mast cells

✓ Macrophages

✓ interstitial, or Leydig cells of the testis which become apparent during puberty ; it is either rounded or polygonal in shape and has a central nucleus and an eosinophilic cytoplasm rich in small lipid droplets . They have the characteristics of steroid-secreting cells. These cells produce the male hormone testosterone by enzymes present in mitochondria and in the smooth endoplasmic reticulum.



Summary

- Each testis is divided into about 250 lobules and each lobule is occupied by 1-4 seminiferous tubules
- Straight tubules(tubuli recti) connect the seminiferous tubules to the rete testis and about 10 -20 ductuli efferentes connect the rete testis to the cephalic portion of the epididymis
- The seminiferous tubules are lined with a germinal or seminiferous epithelium.
- The seminiferous epithelium consists of cells that constitute the spermatogenic lineage and Sertoli cells
- Spermatogenesis includes spermatogonial, spermatocyte and spermatid Phase
- Spermiogenesis can be divided into Golgi, acrosomal and maturation phases
- Blood testis barrier is formed by occluding junctions between adjacent Sertoli cells
- interstitial, or Leydig cells of the testis have the characteristics of steroid-secreting cells i.e. production of testosterone