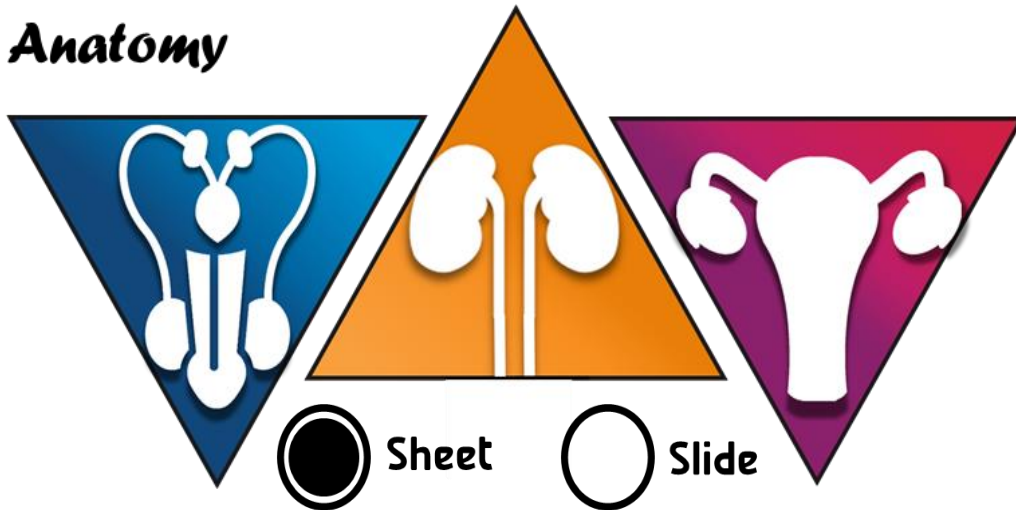




Urogenital system

Anatomy



Number:

- Histology 2

Done by:

- Dana Alsulaibi

Corrected by:

- Ensherah Mokheemer

Doctor:

- Ahmed Salman

This lecture may appear long and scary, however it is full of pictures so don't worry. Any picture mentioned by the doctor is included here, you don't have to go back to the slides in red s what the slides have but not mentioned by the doctor. Good luck

Objectives of this lecture:

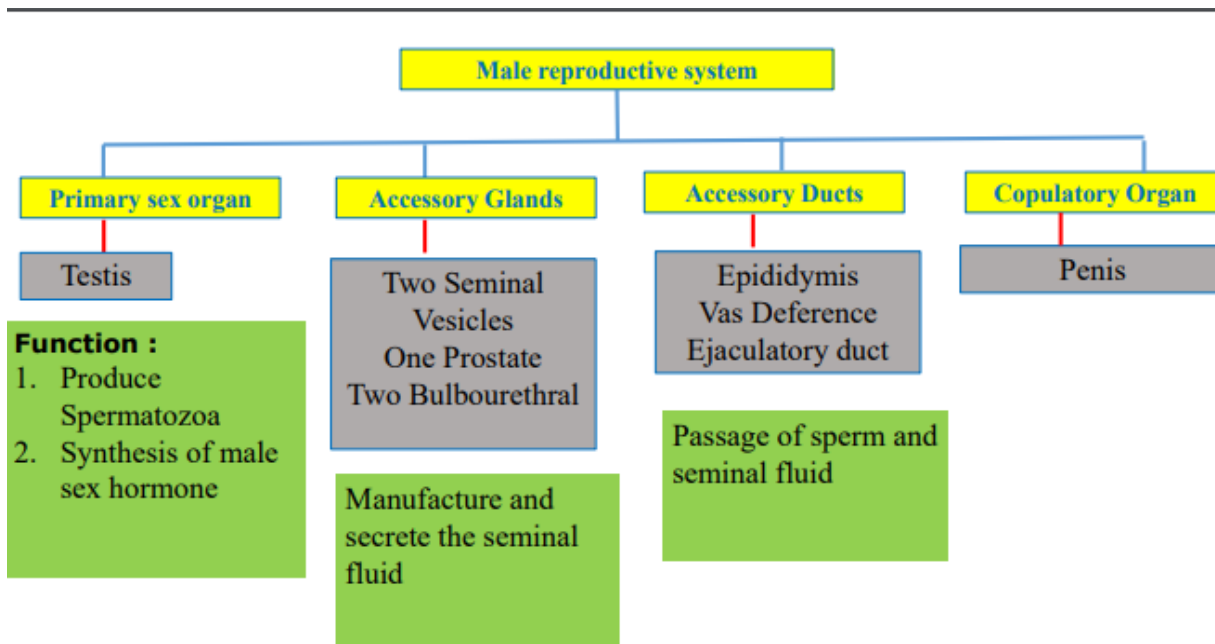
- Identify the components and functions of the male reproductive system.
- Identify the histological structure of the testis.
- Describe the histological structure of blood testes barrier.
- Describe the histological structure of male genital ducts.
- Identify the histological structure of the accessory male genital glands.

Let' begin

The male reproductive system consists of::

- Primary sex organ: paired testis
- Secondary sex organs:
 - 1) Genital ducts (Epididymis, Vas Deference and Ejaculatory duct)
 - 2) Accessory glands (the paired seminal vesicles, the single prostate gland and two bulbourethral glands)
- The penis

The doctor read everything in the following diagram:



Testis

- Located outside the body cavity, in the scrotum
- Ovoid in shape
- Covered by tunica vaginalis (visceral and parietal layers) on its anterolateral surface
- Functions:

1-Production of the spermatozoa

2-Production of the male sex hormones (testosterone)

The following in red is from the slides

Capsule and mediastinum

- Covered by dense irregular collagenous connective tissue capsule (tunica albuginea)
- The tunica albuginea thickens along the posterior surface to form the mediastinum testis
- Fibrous septa project from the mediastinum testis and form pyramid shaped lobules

Lobules

- Each contains 1-4 seminiferous tubules
- Each seminiferous tubule forms a lobe that ends in a short straight tubule
- Seminiferous tubules are surrounded by extensive capillary bed

The testis consists of two parts, the covering and the parenchyma

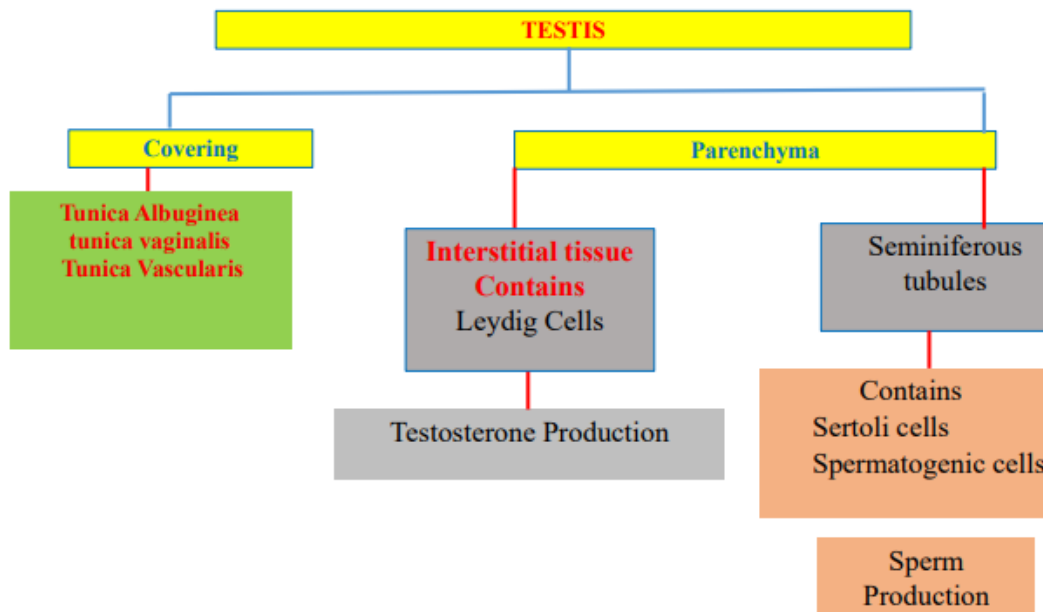
The covering has three layers

The outer covering is called Tunica Vaginalis, then comes Tunica Albuginea which is a capsule surrounding the testis and then the last layer, Tunica Vascularis (plexus of blood vessels).

The parenchyma consists of seminiferous tubules and interstitial tissue

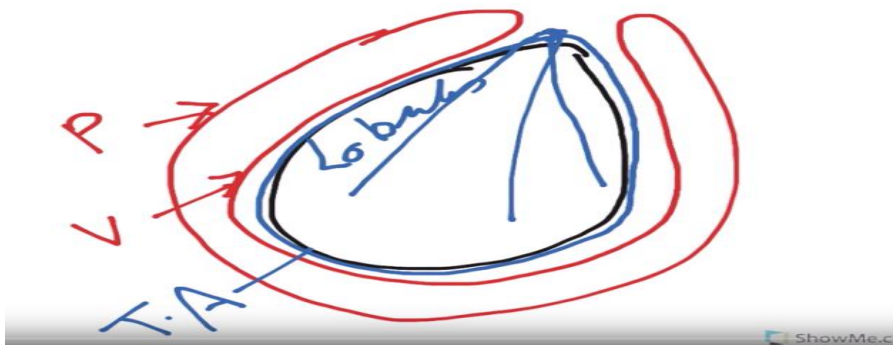
The seminiferous tubules function is sperm production. They contain Sertoli cells and spermatogenic cells.

The interstitial tissue's function is testosterone production. It contains Leydig cells



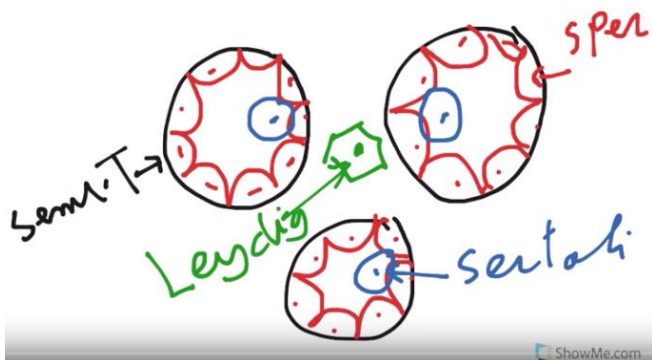
As we said before, the testis is covered by a fibrous capsule called tunica albuginea, above it is the tunica vaginalis which has 2 layers, outer parietal layer and inner visceral layer.

The tunica albuginea (inner capsule) sends trabecula/ septa inside the testis and divides it into lobules, this septa starts from the posterior superior aspect of the testis which is called Rete Testis .



Each lobe of the testis has 1 to 4 seminiferous tubules, these are lined from the inside with different types of spermatogenic cells which produce sperms. Sertoli cells are found between spermatogenic cells in the seminiferous tubules.

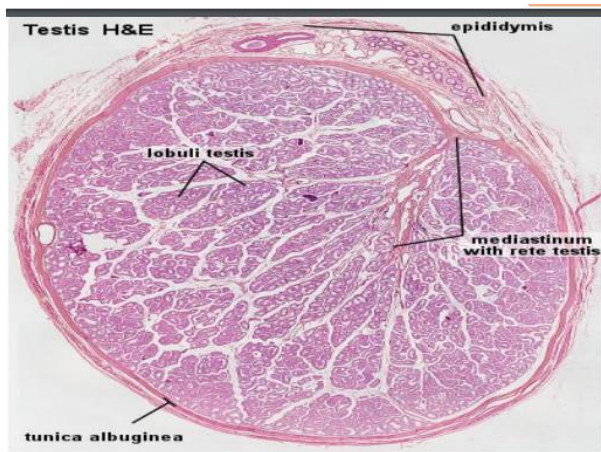
In between seminiferous tubules there is a space called the interstitial tissue, composed of connective tissue and another type of cells called Leydig cells, which produce testosterone.



You can see in this section the tunica albuginea capsule, and the septa sent from it (white lines) with the lobules in between.

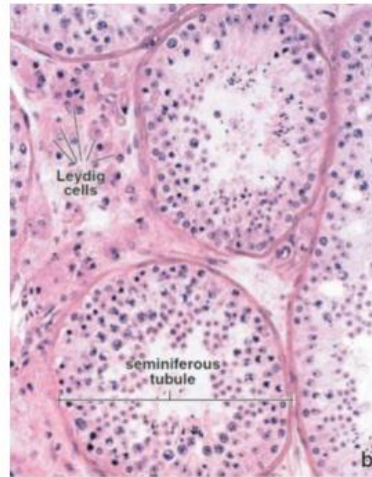
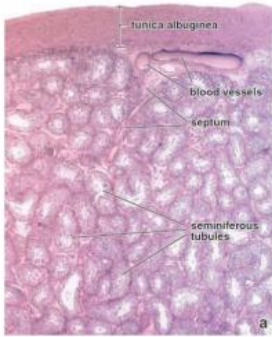
Each lobule has small ducts, these ducts collect at the posterior superior aspect to form mediastinum of the testis/ rete testis.

You can also spot the epididymis at the posterior superior aspect of the testis.



Testis – Interstitial tissue

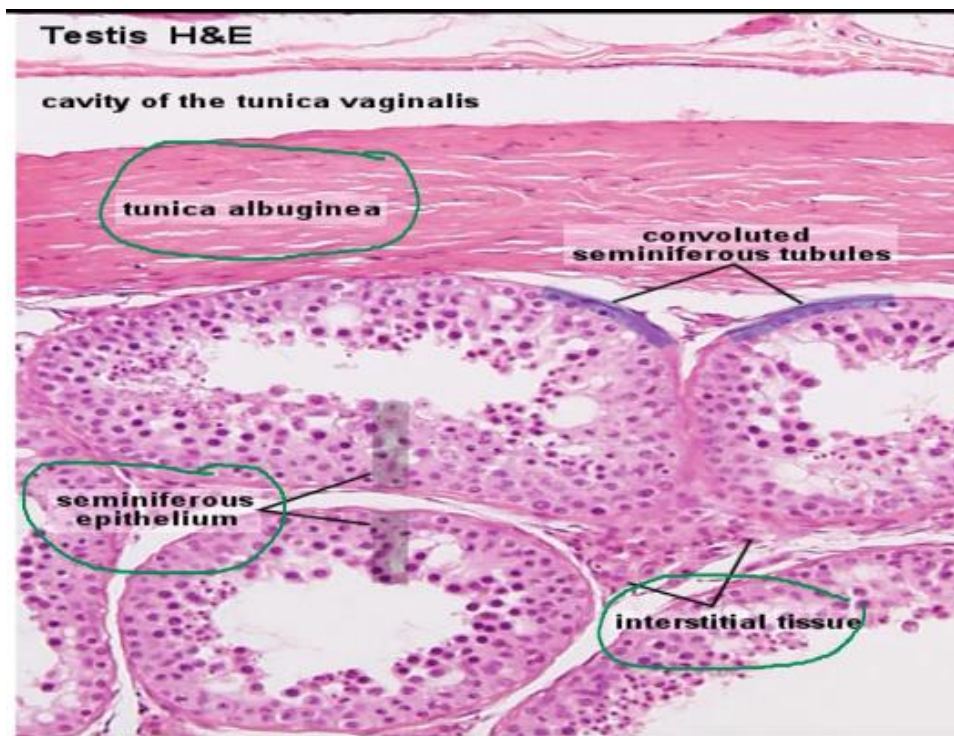
- Loose connective tissue between the seminiferous tubules
- Contains the interstitial cells of Leydig



on the left :Here we can see the tunica albuginea, and the septa giving us lobules, in these lobules are the seminiferous tubules

On the right : the seminiferous tubules contain Spermatogenic and Sertoli cells, between the tubules are Leydig cells .

Another section :

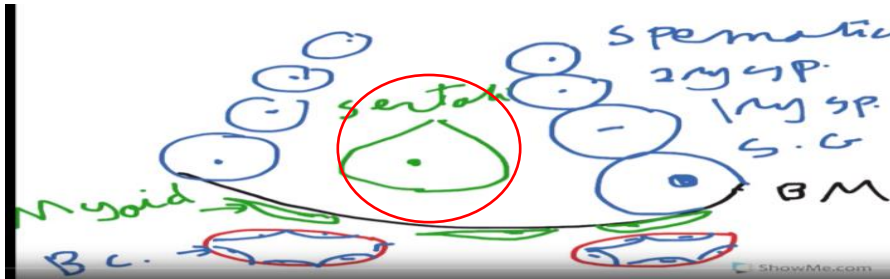


Looking deeper into seminiferous tubules

Surrounding them are blood capillaries. The border of the tubule is formed by basement membrane which is covered with myoid cells on its outer surface . The function of myoid cells is providing peristalsis movement that compresses the tubules and moves the sperm and testicular fluid outside the seminiferous tubule.

Inside the tubule, we can see different cells. From outside to inside (refer to the picture below), you'll see the spermatogonia, then primary spermatocytes, then secondary spermatocytes, and lastly the spermatids.

In the middle between these rows of cells, we can find the **Sertoli cells**



Spermatogenic cell: Male germ cells that replicate and migrate from the basal lamina to the lumen. There are two types of spermatogenic cells in the seminiferous tubule

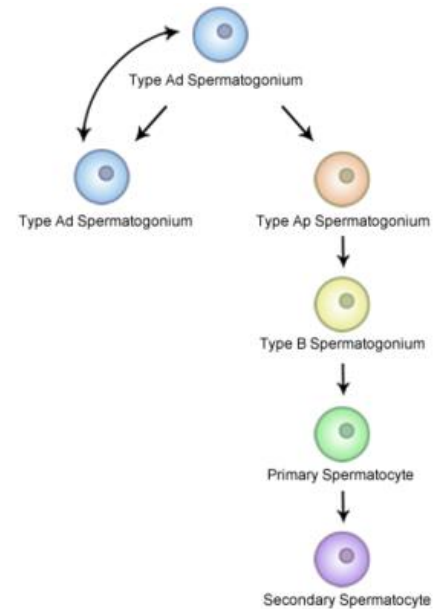
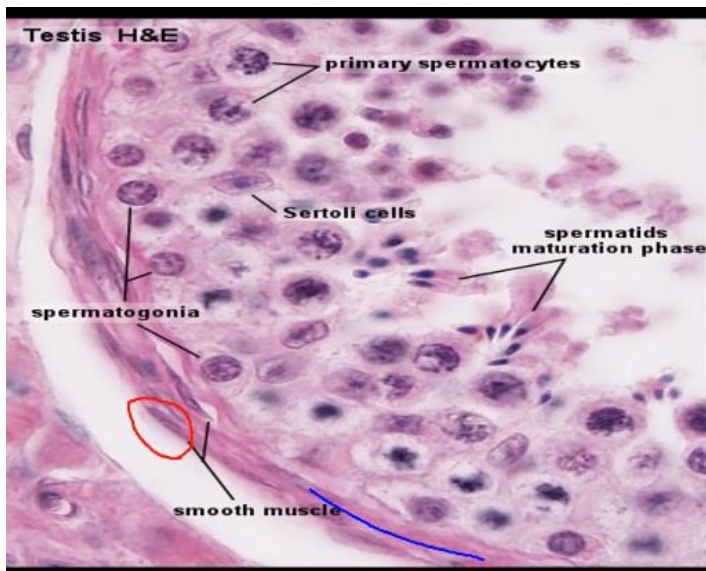
Type A cell: they are divided into two types:

- 1- Type A Dark: These cells are reserve spermatogonial stem cells, which do not usually undergo active mitosis.
- 2- Type A Pale: They transform into type B.

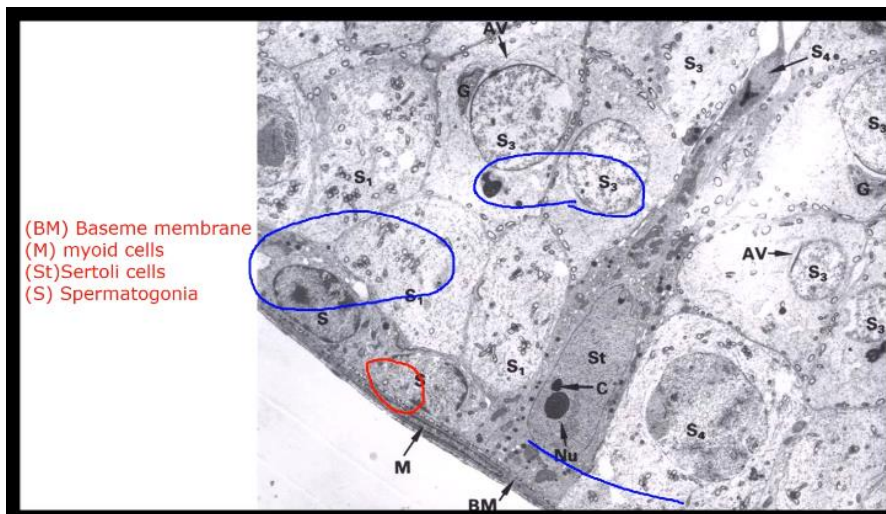
Type B cell: under the effect of FSH hormone, turns into primary spermatocyte

Primary spermatocytes: large cells with 46 chromosomes, under the effect of first mitotic division, turn into secondary spermatocytes.

Secondary spermatocytes: small cells with 23 chromosomes. They have a very short life, so they may not be always be seen in seminiferous tubules. Each secondary spermatocyte under the effect of secondary mitotic division and gives two spermatids.



The doctor mentioned the basement membrane which is covered by myoid cells (circled) in this section. The main function of the myoid cells is to provide peristalsis movement as mentioned above.



Spermatogenic cells: endodermal in origin, give rise to sperms.

Sertoli cell: mesodermal in origin with many functions, one of the most important functions is supporting spermatogenic cells

From Slides :

Seminiferous tubules

Lined by stratified epithelium known as seminiferous epithelium rests on Basement membrane (Basal Lamina)

The epithelium is composed of Two populations of cells:

- Sertoli cells (Mesodermal)
- Spermatogenic cells (Endodermal)

The connective tissue around tubules contains fibroblast and myoid cells

The Myoid cells produce peristalsis waves to help movement of spermatozoa and testicular fluid

Spermatogonia

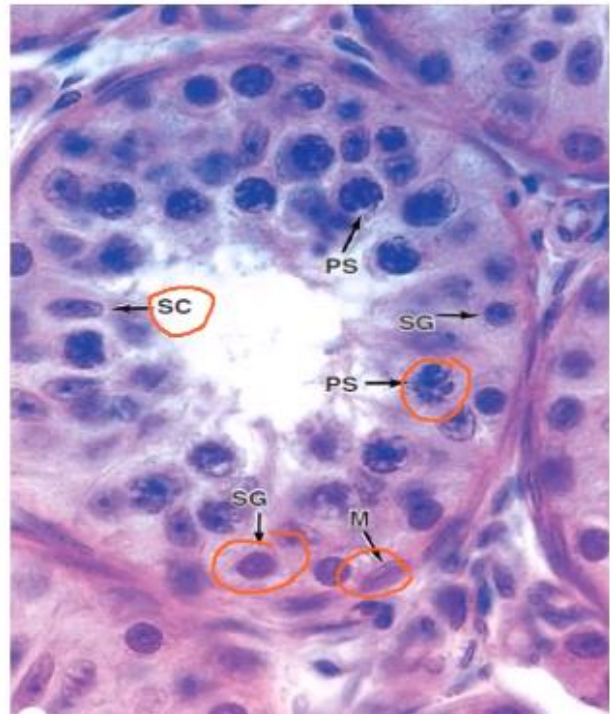
- Initial germ cells
- Rest on the basal lamina and closely associated with Sertoli cell surfaces
- Small rounded cells
- Have diploid number of chromosomes and DNA

(SG) Spermatogonia

(PS) primary spermatocytes

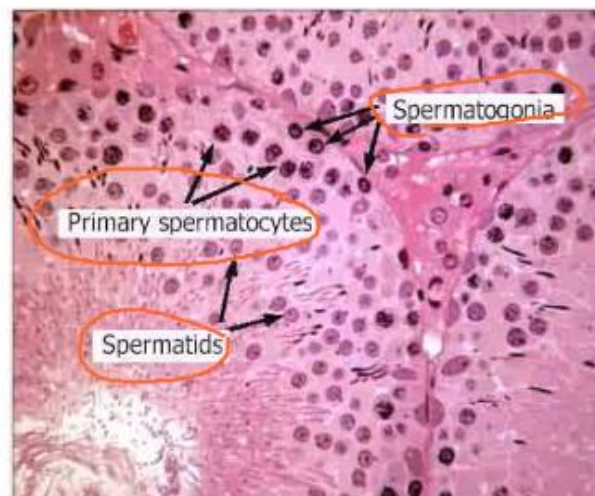
(M) myoid cells

(SC) Sertoli cells



Primary spermatocytes

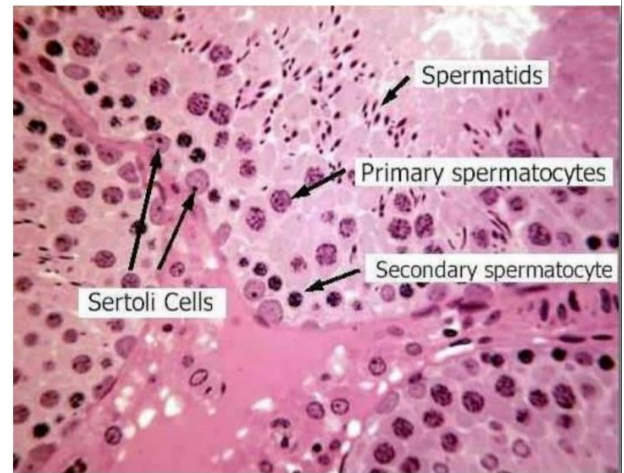
- The largest cells of the seminiferous epithelium
- spherical cells with euchromatic nuclei
- Has 46 chromosomes
- Enter the **first meiotic division to produce secondary spermatocytes**



Notice the spermatogenic cells near the basement membrane of the seminiferous tubule. These give rise to primary spermatocytes, which eventually give rise to spermatids.

Secondary spermatocytes

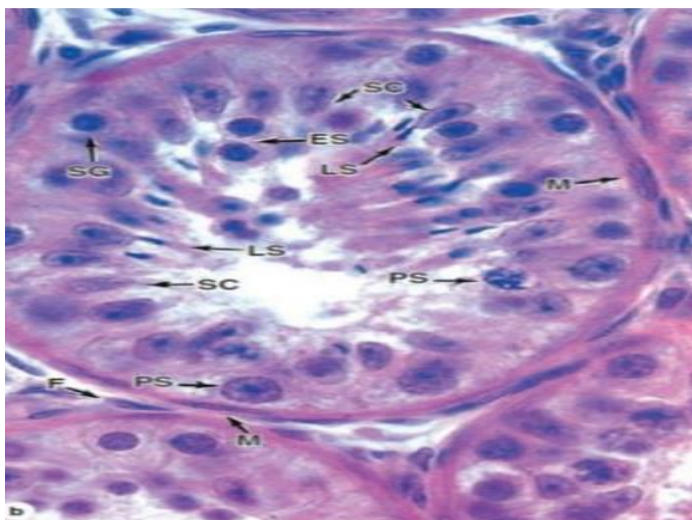
- Derived from the first meiotic division of primary spermatocytes
- Have 23 chromosomes
- Small cells, and because they are very short-lived cells, they are rarely seen in the seminiferous epithelium.
- Immediately enter the second meiotic division, forming two spermatids.



You can notice from the figure above that the primary spermatocytes are larger than secondary spermatocytes.

Spermatids

- Small round cells with small spherical nuclei.
- Result from the second meiotic division of secondary spermatocytes
- Have 23 chromosomes
- Undergo a differentiation process that produces mature sperm.



- (M) myoid cells
- (F) fibroblasts
- (SC) Sertoli cells
- (SG) Spermatogonia
- (PS) primary spermatocytes
- (ES) early spermatids
- (LS) late spermatids

Please follow the key

Spermatozoa:

Mature spermatozoa lie free in Lumina of seminiferous tubules. Each consists of head, neck, middle piece and tail (principal piece + end piece):

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 2 centrioles and the connecting piece, which for the nine fibrous rings surrounding the axoneme

3-Middle piece:

It consists from outwards to inwards:

☐ Plasma membrane.

☐ Elongated mitochondrial sheath for energy supply. (this is what's extra here).

☐ Fibrous sheath.

☐ Axoneme*: nine peripheral pairs of fused microtubules around a central pair of individual microtubules (9 +2).

4- Tail: It consists of:

A- Principal piece: the longest part of the tail consists of:

-Plasma membrane.

- Fibrous sheath.

- Axoneme (9 +2).

B- End piece: the shortest part of the tail consists of:

-Plasma membrane.

- Axoneme (9 +2)

*The axoneme consists of **a pair** of microtubules in the middle surrounded by **9 pair** of microtubules in the periphery, found in the middle, principal and end piece.

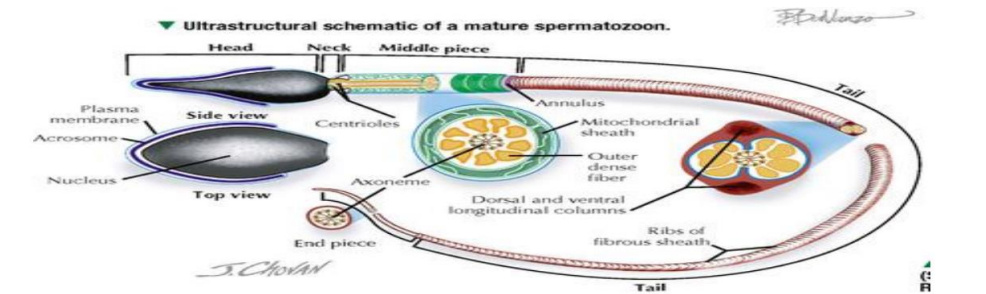
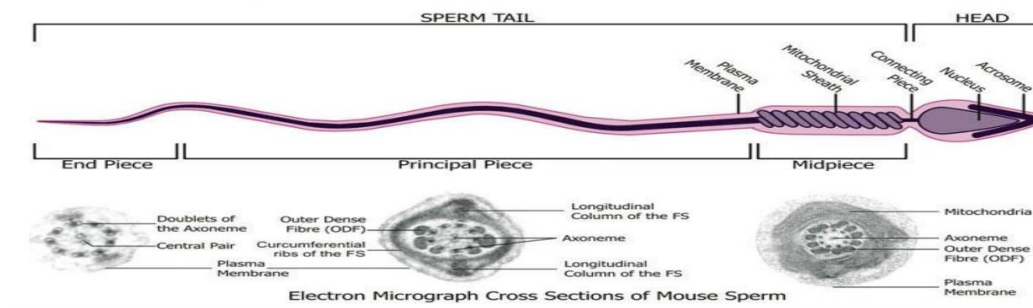
The axoneme is surrounded by a fibrous sheath from its beginning till the end of the principal piece. Hence, if a



cross section is taken through the middle or principal piece you will see 3 structures: the axoneme, the fibrous sheath and the plasma membrane.

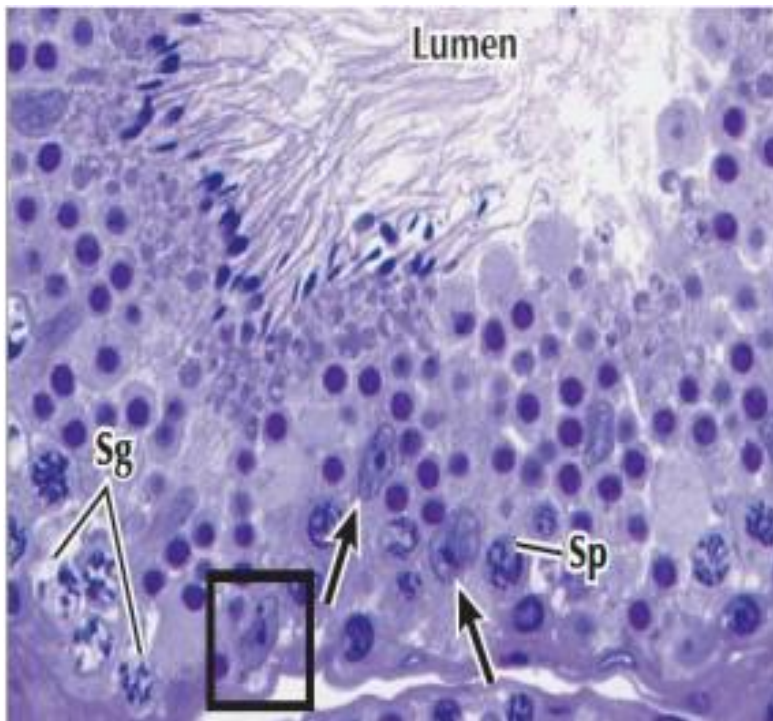
But if you take a section through the end piece, you'll only see the axoneme and plasma membrane. This meaning that the fibrous sheath did not extend to the end piece.

The axoneme and plasma membrane are the common structures between middle, principal and end piece



Sertoli cells

- Mesodermal in origin
- Resistant to heat, x-irradiation, infection and malnutrition
- The most numerous cells in the epithelium before puberty and reduced (make up to 10 % of the cell population) after puberty because of the increase in germ cells (spermatogenic) which take priority.
- Have plasma membrane receptors for follicular stimulating hormone (FSH)



LM: Tall columnar epithelial cells

Indistinguishable borders due to complex basal, lateral and apical cell margins as it surrounds the adjacent germ cells, (simply put by the doctor is that the borders are indistinguishable because of the close relationship with the small spermatogenic cells)

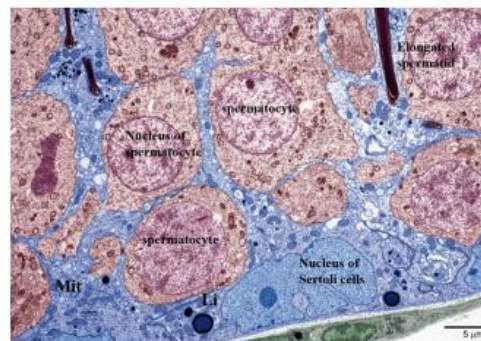
In slides but not mentioned by doctor: Each has euchromatic nucleus usually ovoid with a prominent nucleolus. Extend through the full thickness of the epithelium

The doctor skipped this slide

Sertoli cells

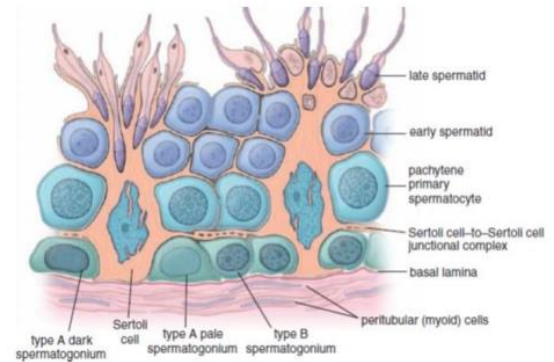
EM:

- Have complex apical and lateral processes that surround adjacent germ cells.
- Have an extensive SER and a well-developed RER, Lysosomes
- Abundant cytoskeleton (microfilaments and microtubules)
- Euchromatic nucleus, basally located and has with a large, centrally positioned nucleolus.



Sertoli cells are bound to each other and to the germ cells by several types of cell-cell junctions

- **Sertoli-basal lamina junctions:** Hemidesmosomes.
- **Sertoli-germ cell junctions:** Desmosome.
- **Sertoli-Sertoli junctions:** Gap junctions or Tight junctions.



Functions of Sertoli cells

1. Supporting cells. Sertoli cells surround and physically support the developing germ cells.

2. Phagocytic cells Sertoli cells phagocytize and digest the residual bodies released in the last stage of spermiogenesis.

3. Secretory cells.

- The testicular fluid carries non motile sperm to epididymis.
- Androgen-binding protein (ANP) which concentrates testosterone to a level required for spermiogenesis, is promoted by follicle-stimulating hormone (FSH).
- Inhibin which inhibits the secretion of FSH (recently, inhibin injections are used as male contraceptive as it inhibits spermatogenesis).
- Anti-mullerian hormone that causes regression of the embryonic müllerian ducts.
Extra: The müllerian ducts are the progenitors of the upper female genital tract. so, this helps in the development of the male genital system

4. Nutrition They supply the spermatogenic cells with nutrition taken from nearby capillaries, as the spermatogenic cells are isolated from blood supply by the testis barrier.

5. Formation of blood-testis barrier

The blood-testis barrier:

General Features: It is the barrier that controls the passage of tissue fluids, from outside to the inside of the seminiferous tubule.

It is formed by the tight junctions between the basal parts of the Sertoli cells, thus subdividing the lumen of the seminiferous tubule into a basal and an adluminal compartment.

Each compartment has a separate distinct population of spermatogenic cells.

The basal compartment: extends from the basal lamina of germinal epithelium to the tight junction (containing spermatogonia).

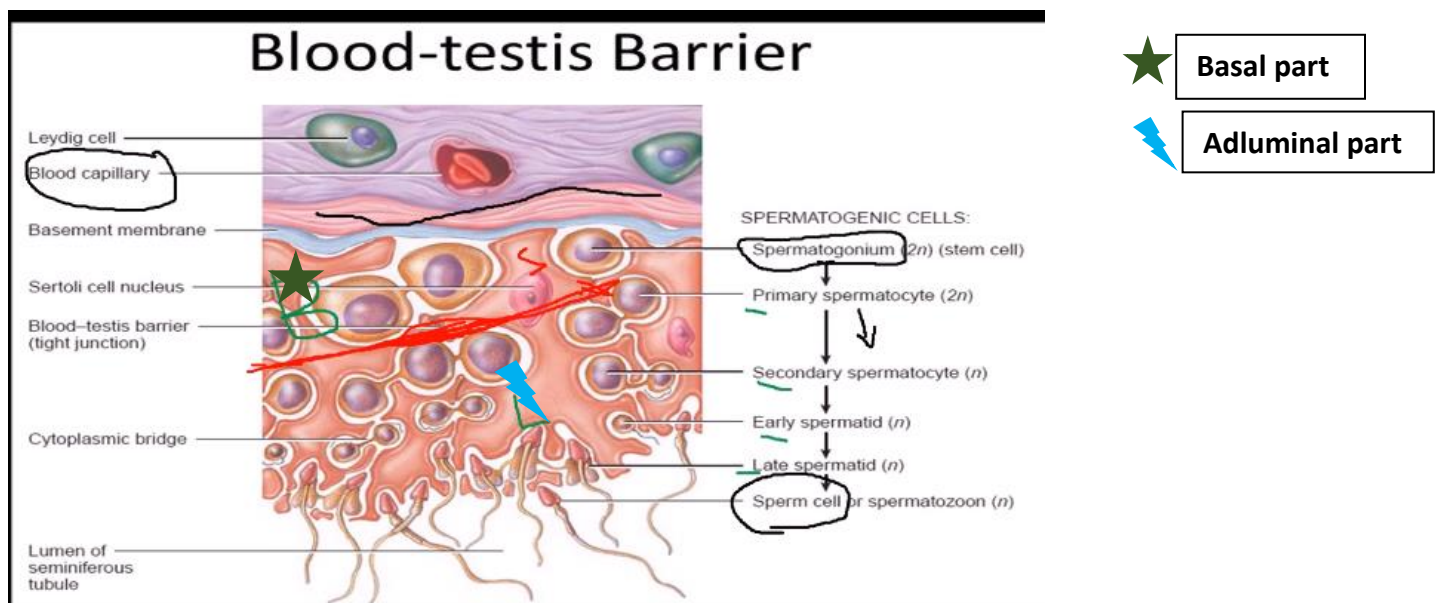
The adluminal compartment extends between the tight junctions and the lumen of the tubule. It contains primary, secondary spermatocytes and spermatids.

Functions of the blood-testis barrier

1- It allows the passage of useful materials needed for spermatogenesis as hormones (Testosterone), vitamins, electrolytes, ...

2- It prevents the entrance of damaging substances as antigens, antibodies and toxins.

3- It prevents the passage of sperms from the seminiferous tubule to the blood stream and the formation of antibodies against them (autoimmune disease). Because spermatogenesis begins after puberty, the newly differentiating germ cells, would be considered "foreign cells" by the immune system.



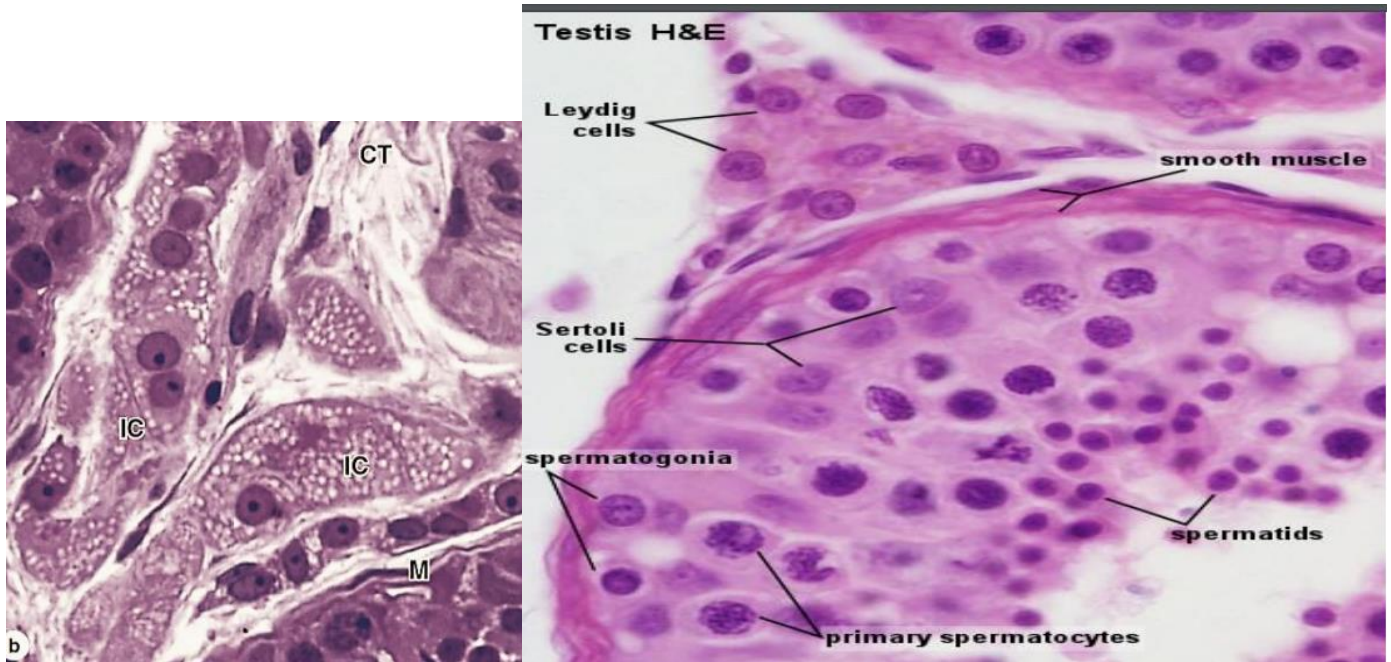
The first line from the top is the basement membrane, the line drawn below it represents the blood-testis barrier (tight junctions).

Interstitial cells of Leydig: They are found in groups between seminiferous tubules in the interstitial connective tissue.

- Constitute 3% of cells in the interstitium after puberty
- Tend to decrease with age, so testosterone production too decreases with age
- Mesodermal in origin.
- Large rounded or polygonal cells with central nucleus and acidophilic cytoplasm.
- Rich in small lipid droplets and lipochrome pigment.

E.M : • It has abundant SER, well developed Golgi apparatus, mitochondria.

• **Function:** Secrete testosterone under the effect of L.H of pituitary gland



Testosterone secretion

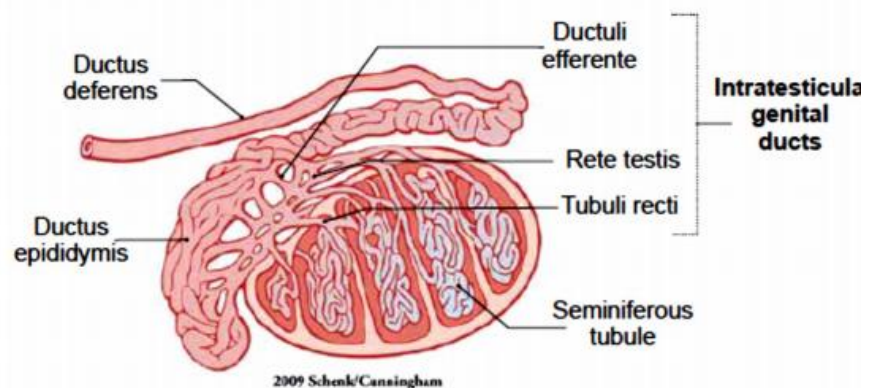
In adult males: Begins when the hypothalamus produces gonadotropin releasing hormone which goes to the pituitary gland. The pituitary gland then releases the Luteinizing hormone at puberty.

In embryonic phase: placenta secretes gonadotropin which stimulates interstitial cells to synthesize the testosterone needed for development of the ducts and glands of the male reproductive system. The embryonic interstitial cells are very active during the third and fourth months of pregnancy it then regresses and become inactive cells until puberty.

Genital ducts

Intratesticular ducts:

- Straight tubules (tubuli recti), Come from the seminiferous tubules
- Rete testis, a collection of straight tubules
- Efferent ductules (ductuli efferenti), attached to epididymes



Excretory genital ducts:

- The epididymis, empties into vas deference
- The ductus (or vas) deferens. Empties into urethra
- The urethra.

Accessory glands

- Paired seminal vesicles
- Single prostate gland
- Two bulbourethral glands

The epididymis

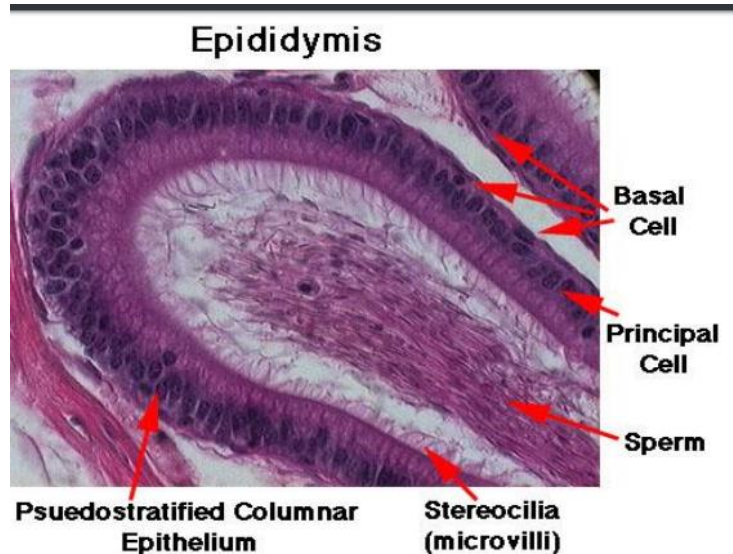
Single tube about 20 feet (6 meters) long, highly coiled, consists of head, body and tail.

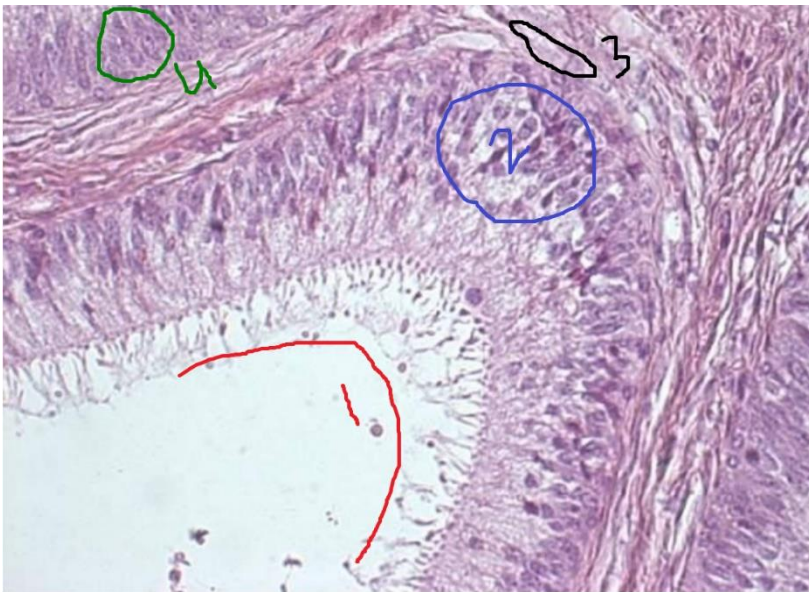
Structure:

- Mucosa: This duct is lined by pseudostratified columnar epithelium composed of rounded basal cells & columnar cells. The cells have long branched microvilli called “stereocilia” which help in the movement of sperms, they move them lightly to prevent the fast exit of sperms in a short period of time from the epididymis. To give time for maturation.
- Musculosa: A circular smooth muscle layer (one layer for slow movement so it can take the time it needs in the epididymis).
- Adventitia: A connective tissue layer.

Function:

- It is site for storage and maturation of the sperms.
- Reabsorption of testicular fluid
- Phagocytosis and digestion of degenerative spermatozoa





In this figure you can see:

- 1- Stereocilia.
- 2- Pseudostratified ciliated columnar epithelium.
- 3- Single muscular layer.
- 4- Connective tissue from outside.

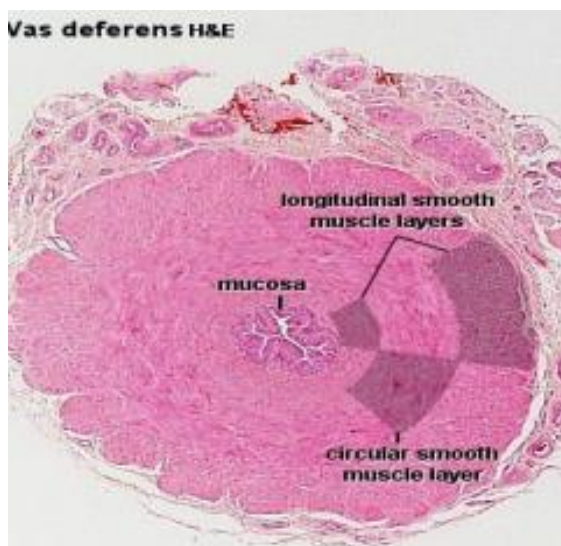
Vas Deferens

Mucosa is irregular, it is lined by a pseudostratified columnar epithelium cell with stereocilia. The lamina propria is unusually rich in elastic fibers.

Musculosa is well developed (up to 1.5 mm thick) and consists of a thick circular layer of smooth muscle between thinner inner and outer longitudinal layers. so, it has 3 layers .it is innervated with sympathetic innervation for sperm ejaculation

Adventitia: A connective tissue layer

Notice that the stereo cilia in vas deferens is very few and the muscular layer is more developed compared to the epididymis, Because the vas deferens is needed to contract and ejaculate the spermatozoa . (We don't need slow movement).

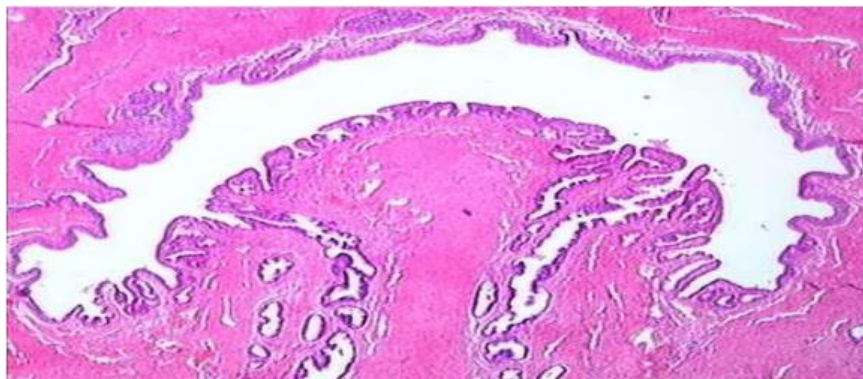


The doctor said the Vas deferens section can slightly resemble the ureter section. However, he'll show the differences in the lab.

The ejaculatory ducts

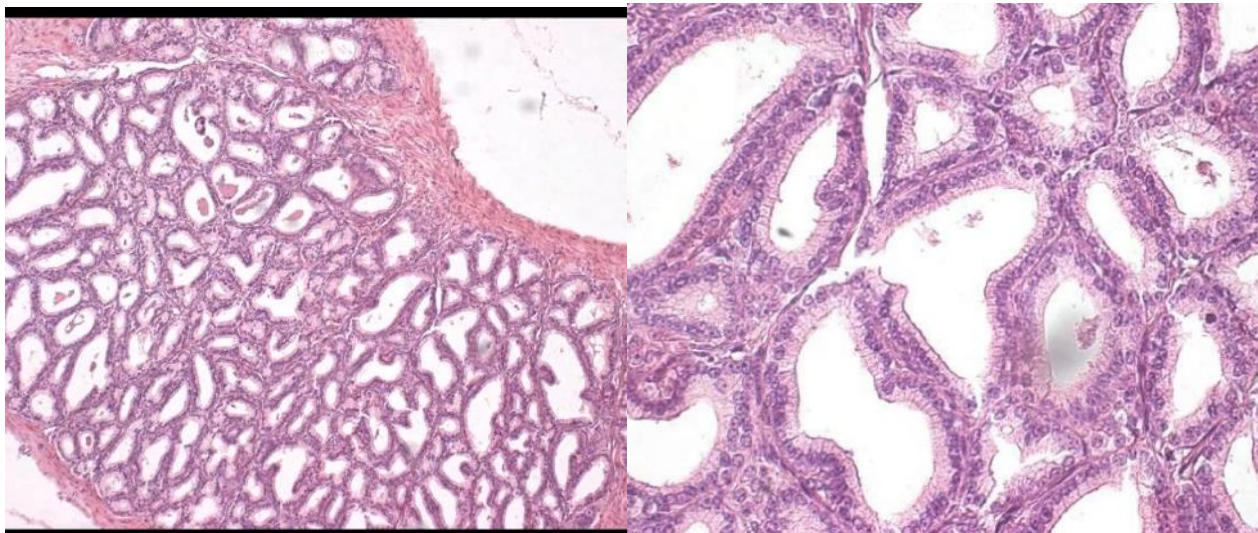
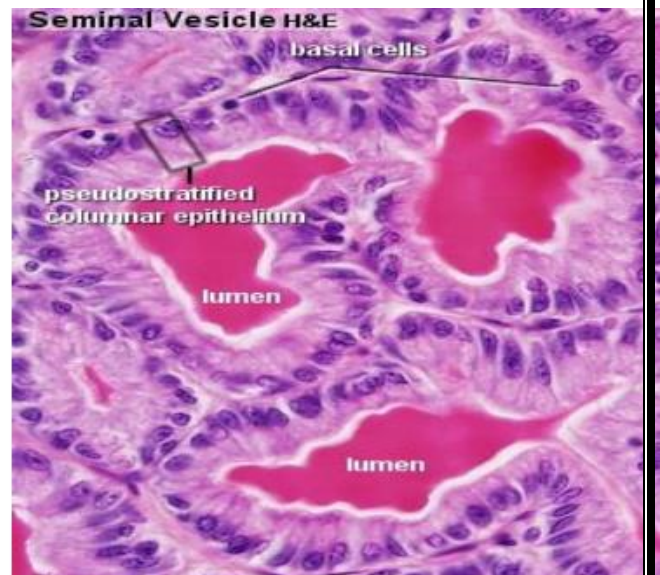
It is formed by the union of the ampulla of the vas deferens with the seminal vesicle & opens in the prostatic urethra through the prostate gland

Histology: simple or pseudostratified columnar epithelium (secretory in function), no muscular coats needed as it goes through the prostate gland.



The Seminal Vesicle

- **in slide not mentioned by the doctor:** Each seminal vesicle consists of one coiling tube (about 15cm long).
- **Mucosa** shows thin, branched folds. The epithelium is variable appearing columnar or pseudostratified columnar secretory epithelium.
- **Muscularis** consists of inner circular and outer longitudinal layers of smooth muscle.
- **Adventitia** : A thin fibroelastic connective tissue layer
- **Functions** The secretion of the seminal vesicles is thick, yellowish, alkaline fluid rich in protein, fructose and vitamin C, these are of importance for nutrition and production of energy for sperms.



Notice it doesn't have any cilia

The prostate

It has a **capsule** surrounding it from outside, this capsule sends trabeculae to divide the gland into lobules.

The parenchyma : is formed by several glands inside with ducts.

Details from slides in red :

It is formed of 30-50 compound tubulo-alveolar glands surrounding prostatic urethra, from which numerous ducts drain independently into the prostatic urethra.

The gland is made of stroma and parenchyma.

1- Stroma: It is made of capsule and trabeculae formed of fibromuscular C.T. rich in smooth muscle collagenous and elastic fibers

2-Parenchyma: It is made of 30-50 glands arranged concentrically around the prostatic urethra. The acini are arranged in 3 levels.

The gland is arranged into 3 layers surrounding the urethra from inside to outside:

(1) Periurethral glands (mucosal) – smallest, around urethra

(2) Submucosal glands surround the periurethral tissue

(3) Main Prostatic Glands (external, proper)–outer largest portion of gland; provide most prostatic secretion.

***The glandular epithelium** differs greatly within the gland may be simple or pseudostratified columnar or low cuboidal or squamous (could be anything).

***The acini and ducts** are lined with simple columnar epithelium

In slide Not read by the doctor: The secretory cells are slightly acidophilic and secretory granules may be visible in the cytoplasm.

Functions: It secretes a thin milky alkaline secretion, which gives the characteristic smell. The secretion is rich in acid phosphatase

Clinical notes on the prostate:

The mucosal and submucosal glands enlarge after the age of 40 causing pressure on the urethra and difficulty in micturition, condition known as senile prostate.

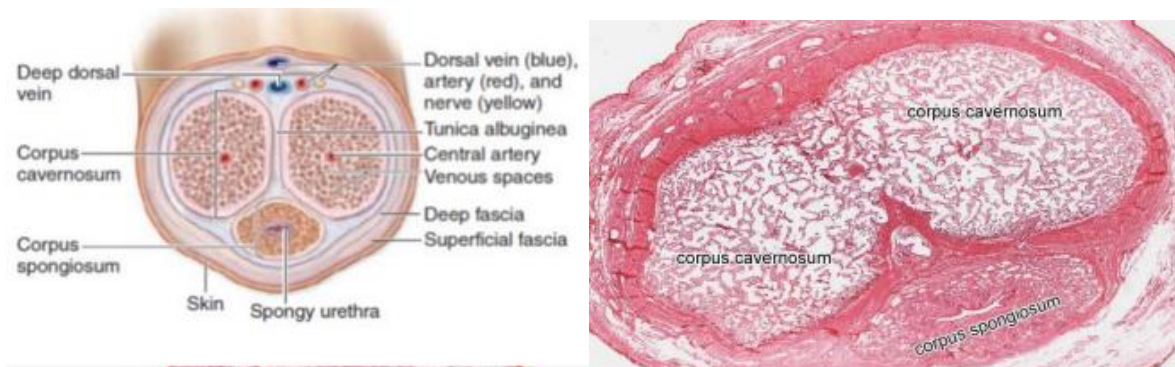
Carcinoma of the prostate affects the outer glands. It is diagnosed by presence of high levels of acid phosphatase in plasma

Prostatic concretions (**corpora amylacea**), which look like onions are thought to result from condensation of secretory material in acini. They increase with advance of age and may become calcified.

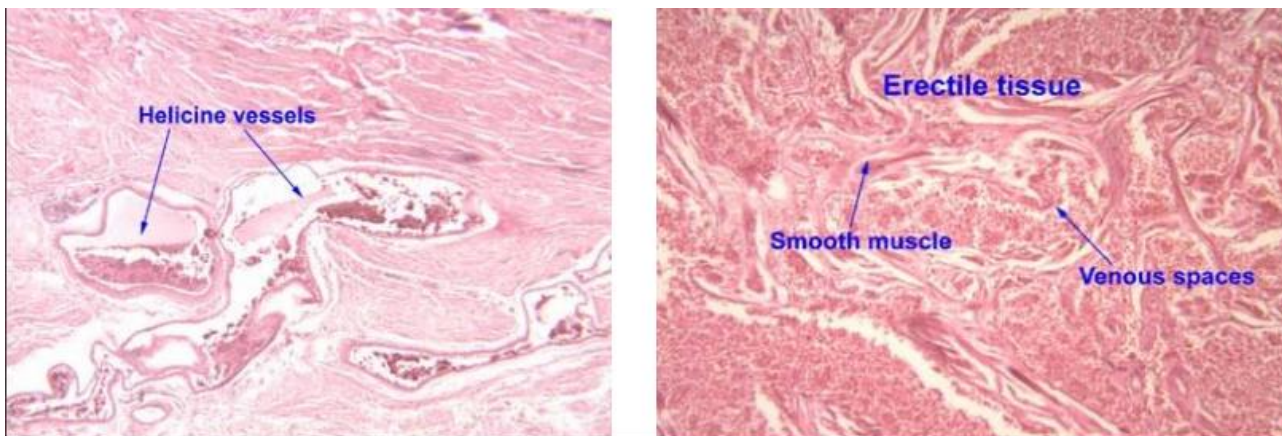


The penis

- Composed of 3 cylindrical masses of erectile tissue:
- 2 dorsal corpora cavernosa.
- Ventral corpus spongiosum surrounds the urethra and expands at its end forming the glans penis.
- Dense fibroelastic layer, tunica albuginea, binds the three masses together as well as forming a capsule around each one.
- Covered by thin skin.
- The tunica albuginea of Corpora spongiosum is thinner and more elastic because the urethra passes through it



The erectile tissue is supplied by helicine arteries, these are colloid vessels, it has smooth muscle cells, and venous spaces to accommodate the amount of blood flowing during erection.



Summary:

We discussed the testis, which is composed of tunica albuginea, a thick capsule surrounding the testis and dividing it into lobules. Each lobule contains seminiferous tubules with basement membrane lined by myoid cells on its wall from the outside. It is full of germ cells and has Sertoli cells between these cells. The main function of seminiferous tubules is spermatogenesis. In between seminiferous tubules we have interstitial cells of Leydig which synthesize testosterone.

We also discussed the blood testis barrier. Below the basement membrane of seminiferous tubules are blood vessels and above it is germ cells with Sertoli cells in between. The junctions between Sertoli cells and themselves form the blood testis barrier. Thus, the seminiferous tubule is divided to basal part and luminal part. The basal part contains spermatogenic cells and the luminal part contains primary spermatocytes, secondary spermatocytes and spermatids.

The function of the barrier is allowing the passage of nutrition from the blood into seminiferous tubules and prevention of passage of toxins from the blood into the tubules. It also prevents sperms from entering the blood and causing autoimmune disease.

Summary of lining epithelia and muscle coat of the male genital tract:

The epididymis: pseudostratified columnar epithelium with long stereocilia + single circular muscle layer.

The vas deferens: pseudostratified columnar epithelium with short stereocilia + 3 muscular layers.

Ejaculatory duct: pseudostratified columnar epithelium + no muscular coats.

Seminal vesicles: columnar or pseudostratified columnar epithelium + inner circular and outer longitudinal layer of smooth muscle.

We talked about prostate gland which has 3 layers of gland. These are periurethral gland, submucosal gland and main prostatic gland. A characteristic feature of prostate gland is corpus amyloacea which are concentrated secretory vesicles.

Lastly, the penis has 3 columns, 2 corpora cavernosa and 1 corpora spongiosum which contains the urethra. 3 of them are lined with tunica albuginea. Blood supply is by helicine vessels. The erectile tissue/penis is full of smooth muscle and venous spaces.