

## THE TESTES

### General Features:

- They are two ovoid glands, found in the cavity of the scrotum.
- They develop retroperitoneally in the abdominal cavity; and then descend to the scrotum, carrying parietal and visceral layers of the peritoneum (the tunica vaginalis), that partially covers the testis on its anterior and lateral surfaces.
- The temperature within the scrotum is 2-3 centigrade below body temperature, which is essential for sperm production.
- They are compound tubular glands of both exocrine (production of a holocrine secretion, the sperms) and endocrine function (secretion of male sex hormone, testosterone).
- The testes are formed of stroma and parenchyma.

### Coverings Of The Testis:

- The Scrotum: is a pouch of thin skin and incomplete thin layer of smooth muscle (Dartos Muscle).
- The Tunica Vaginalis: is a pouch of peritoneum, which is pushed in the scrotum during the descent of the testis. It partially covers the testis on its anterior and lateral surfaces. It is formed of visceral layer (covering the testis) and a parietal layer (lining the scrotum), a thin film of serous fluid in between the two layers protects the testis and facilitates its movement.
- Tunica albuginea:(fibrous capsule) covering the testes and the tunica vasculosa (vascular connective tissue) lining the albuginea.

### I- The stroma of the testes is formed of:

- Tunica Albuginea: It is a thick and dense connective tissue capsule, covering the surface of the testis. It is thickened posteriorly, to form the mediastinum testis.
- Septa: They are incomplete fibrous septa, arise from the mediastinum testis, to divide the testis into about 250 conical testicular lobules (lobuli testis) which intercommunicate with one another. Each lobule contains 1-3 seminiferous tubules, with the Leydig cells in-between.
- Tunica Vasculosa: It is a highly vascular connective tissue that lines the albuginea and septa.

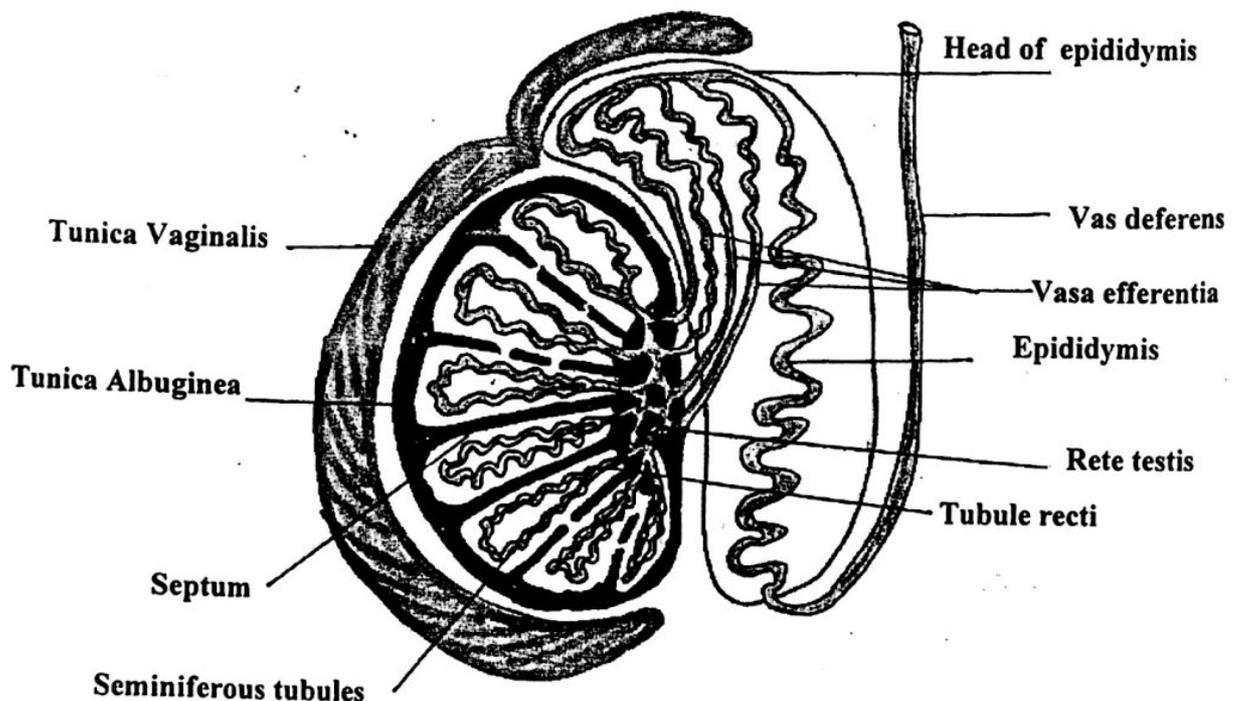
## II- The parenchyma of the testes is formed of:

- Seminiferous tubules, for the production of sperms.
- Leydig cells, for secretion of testosterone.

### THE SEMINIFEROUS TUBULES

#### General Characteristics :

- < They are convoluted tubules (tortuous course) with narrow lumens, about 30-70 cm long and 150 - 250  $\mu\text{m}$  in diameter.
- < They are lined by highly specialized stratified epithelium (germinal epithelium), called the spermatogenic epithelium, which rests on a clear basement membrane (basal lamina).
- < The spermatogenic epithelium is made of a proliferating population of differentiating spermatogenic cells (endodermal) and a stable population of supporting (Sertoli) cells (mesodermal).
- < Connective tissue close to tubules contains fibroblasts & myoid cells resemble smooth muscle cells. These myoid cells generate a gentle peristaltic waves that pass along the tubules help the movement of spermatozoa and testicular fluid through the tubules to excretory duct system .



**Diagram of Testis & Excretory ducts**

Names only

## THE SPERMATOGENIC CELLS & SPERMATOZOA

Spermatogenic cells are spermatogonia, primary Spermatocytes, secondary spermatocytes and spermatids.

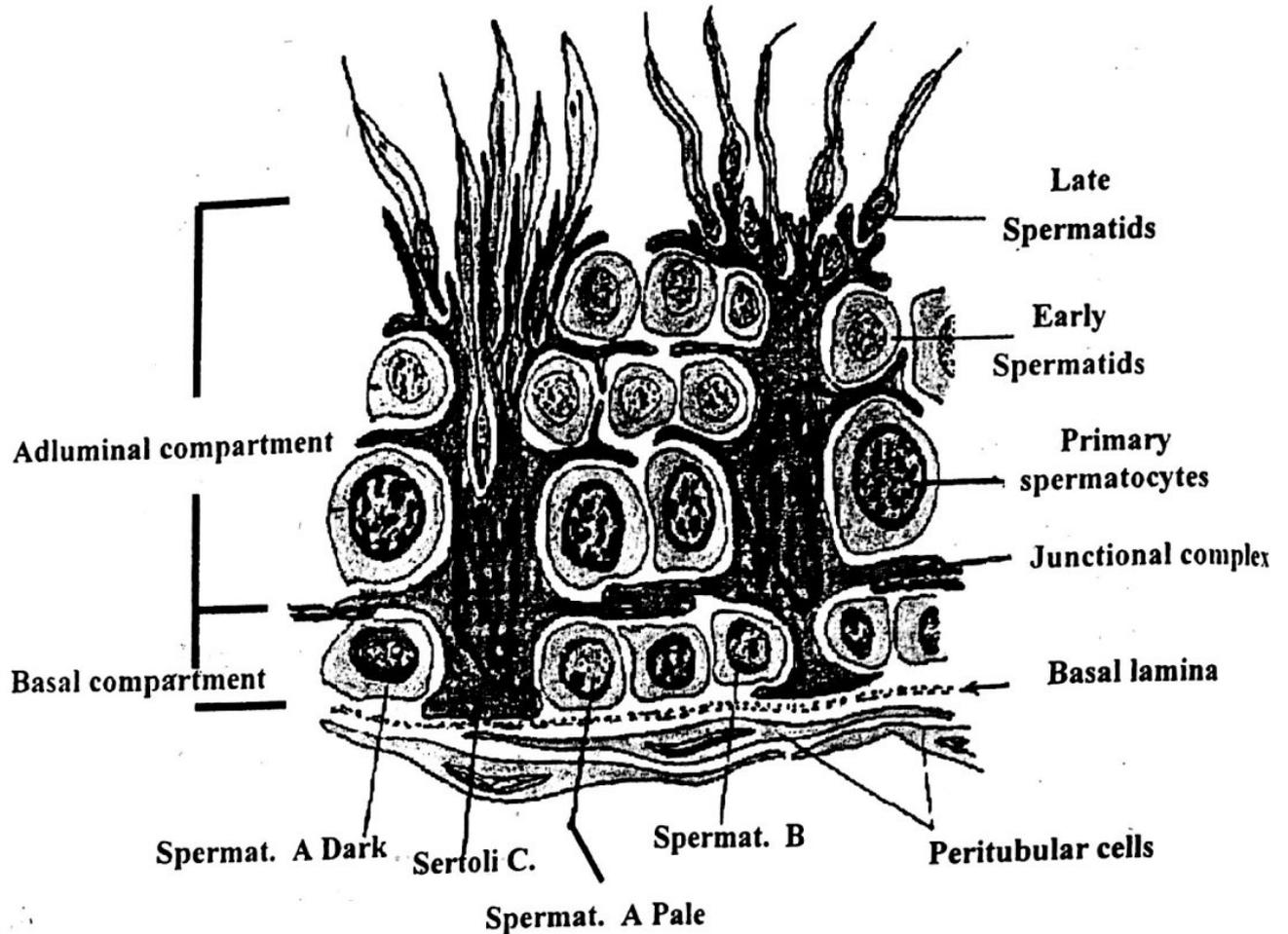
### 1- Spermatogonia:

- They are the **initial germ cells**, arranged in one or two layers lying on the **basement membrane** (basal lamina).
  - The cells are **small in size, round in shape** and the nuclei have **diploid number of chromosomes & diploid amount of DNA**.
  - By repeated mitosis they are **differentiated into two types of cells**:
    - a- Spermatogonia A : are dark & pale types, 1/2 of them remain as reserve cells, while the cells of the other 1/2 **divide** to give type B cells. They have **spherical nuclei with fine chromatin granules** and one or two **nucleoli** near the nuclear envelope.
    - b- Spermatogonia B: They have **larger and lighter-stained nuclei** with only a **single centrally placed nucleolus**. At puberty under the effect of **FSH** they undergo **mitotic activity** and grow to give **primary spermatocytes**, that migrate toward the middle zone of the seminiferous epithelium.
- 2- Primary spermatocytes: They are **large cells (largest cells)** with **large vesicular nuclei**. The nuclei have **diploid number of chromosomes** and **tetraploid amount of DNA (4N)**. They enter the **1<sup>st</sup> meiotic division** to give secondary spermatocytes.
- 3- Secondary spermatocytes : They are **smaller cells** with **haploid number of chromosomes** (The homologous chromosomes have separated and the number is reduced by half, but the cells contain the **diploid amount of DNA**). They rarely had seen in sections as they enter the **2<sup>nd</sup> meiotic division** to give spermatids.
- 4- Spermatids : They are **small rounded cells**, lining the lumen of the seminiferous tubule, they contain **haploid number of chromosomes (23 s- chromosome)** and **haploid amount of DNA**. They change to sperms by spermiogenesis.

Spermatozoa: The mature spermatozoa lie free in the lumina of seminiferous tubules. They are **50-60 um in length**. Each **consists of**:

#### ▪ Head:

X It is **5 um** containing the **condensed nucleus** covered on its anterior 2/3 by the **acrosomal cap**, which contains lysosomes that are important for penetration of the ovum at fertilization.



## Germinal epithelium (Spermatogenic & Sertoli cells) & Blood-testis barrier

### THE SERTOLI CELLS

#### General Characteristics :

- They are tall pyramidal cells, extending from the basement membrane to the lumen.
- They have indistinct cell boundaries and large pale oval nuclei.
- E.M. shows that the cytoplasm is pale, rich in fat, SER and lysosomes. Microfilaments are found in abundance at the apical cytoplasm.
- The cell membrane, at the apex, shows infoldings, containing the heads of the spermatozoa.

### Functions of the Sertoli cells:

- 1- They have a phagocytic action against the cytoplasmic remnants, left after spermiogenesis.
- 2- They provide support for the spermatogenic cells.
- 3- They supply the spermatogenic cells with nutrition taken from nearby capillaries, as the spermatogenic cells are isolated from blood supply by the testis barrier.
- 4- They are concerned with the uptake and concentration of testosterone, by formation and secretion of androgen binding protein (ABP).
- 5- They secrete inhibin hormone, which inhibits the secretion of FSH (recently, inhibin injections are used as male contraceptive as it inhibits spermatogenesis).
- 6- They secrete the testicular fluid, which carries the non-motile sperms towards the epididymis.
- 7- They form the blood-testis barrier.

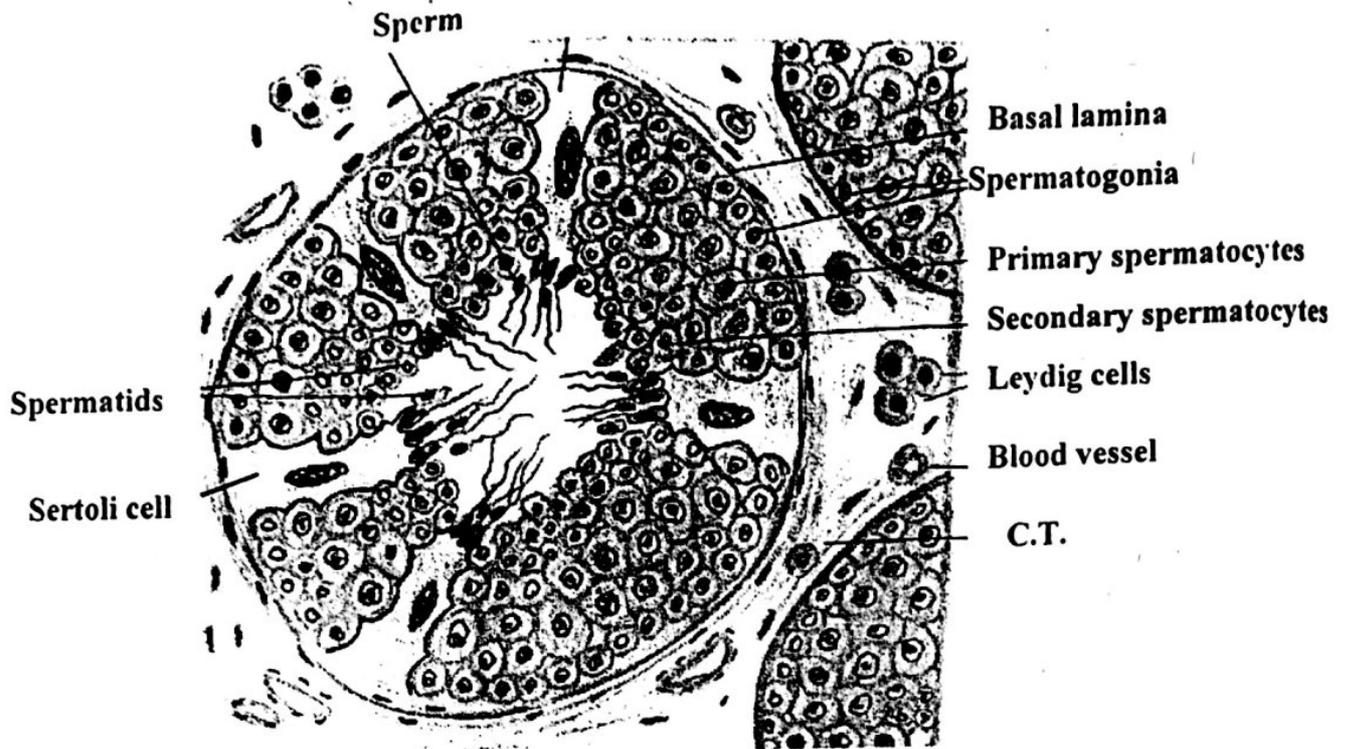
### The blood-testis barrier:

#### 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, vitamins, electrolytes ...etc
- 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).



## Seminiferous Tubule (T.S.)

### LEYDIG ( INTERSTITIAL ) CELLS

#### General Characteristics :

- < They are found in groups between the seminiferous tubules, in the interstitial connective tissue (loose areolar C.T. containing various C.T. cells as macrophages, mast & mesenchymal cells).
- < They are polyhedral with central round nuclei and acidophilic granular cytoplasm.
- < E.M. shows cytoplasm with abundant SER (containing enzymes for synthesis of testosterone), well developed Golgi apparatus, numerous mitochondria with tubular cristae (having enzymes sharing in synthesis of testosterone), rich in fat droplets, and lipochrome pigment. These are features of steroid synthesis as testosterone is a steroid hormone.

#### Functions of Leydig cells:

They form the endocrine portion of the testis, concerned with the production of testosterone. Their function start after puberty under the effect of L. H ( luteinizing hormone ) of anterior pituitary .

**Clinical notes on Testosterone:**

◀ **Nature:** It is a steroid hormone (lipid in nature).

◀ **Function:**

- It stimulates Sertoli cells & spermatogenesis in seminiferous tubules.
- It stimulates and maintains secondary sexual characteristics at puberty. This is including growth of larynx, muscular build and male distribution of hair.
- It maintains structure & function of the ducts and accessory glands.

◀ **Control of Secretion:**

- Secretion of Testosterone by Leydig cells is stimulated by LH of the pituitary & testosterone provides a feedback mechanism controlling pituitary output of luteinizing hormone (LH).
- Sertoli cells secrete androgen-binding protein (ABP) under the influence of testosterone and follicle stimulating hormone (FSH) from the pituitary. Sertoli cells also produce inhibin, which is responsible for the feedback control.

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**EXCRETORY GENITAL DUCTS**

They are tubules that link each testis to the urethra, so convey the spermatozoa and semen to the exterior. They are either intratesticular excretory tubules or extratesticular excretory tubules.

**Intratesticular excretory tubules:**

- The tubuli recti.
- The rete testis.
- The ductus efferentes (vasa efferentia).

**Extratesticular excretory tubules:**

- The ductus epididymis.
- The ductus deferens (vas deferens).
- The ejaculatory ducts.
- The urethra ( prostatic, membranous and penile urethra).

### Intratesticular excretory tubules:

- Tubuli recti: They are the end straight tubules of the seminiferous tubules, lined by Sertoli cells.
- Rete testis: They are branching and anastomosing tubules, in the mediastinum testis, lined by cubical cells.
- Vasa efferentia: They are about 12 tubules arise from the mediastinum testis. They are lined with tall conical ciliated cells, alternating with short secretory cells (festooned epithelium). A thin circular layer of smooth muscle underlies the basal lamina surrounding the ductuli efferentes epithelium.

### Extratesticular excretory tubules:

- The epididymis:  
It is the site of storage and maturation of the sperms. It is formed of head, body and tail. The head is formed of the convolutions of the vasa efferentia, while the body & tail are formed of one long highly convoluted duct.

#### The ductus epididymis

##### General Characteristics :

1- It is a highly convoluted duct, about 6 meters long and 400 um wide. In section, it appears as many ducts, because it is cut several times.

2- It has a wide lumen, full of sperms.

##### 3- Structure:

###### a- Mucosa:

- It is lined by pseudo-stratified columnar epithelium, composed of basal & principal cells. The basal cells are round and undifferentiated apparently serving as precursors of the columnar principal cells. The principal cells possess stereocilia (very long microvilli).

- Lamina propria of thin loose CT.

b- Muculosa: A circular smooth muscle layer surrounds the basement membrane of the epithelium.

c- Adventitia: A connective tissue layer surrounds the outer surface of the duct.

**Functions of the epididymis epithelium :**

- 1- Reabsorption of the testicular fluid.
- 2- Phagocytosis and digestion of degenerate spermatozoa & residual bodies.
- 3- Secretion of nutritive substance, for spermatozoa and immobilin (glycerophospholine for immobilization of sperms, inhibits capacitation of the spermatozoa).

**Differences between Seminiferous Tubule & Duct of Epididymis**

Seminiferous Tubule	Duct of Epididymis
1- It is site of formation of sperms.	1- It is site of storage & maturation of sperms.
2- It is about 50 cm long.	2- It is about 6 meters long.
3- It is about 200 $\mu\text{m}$ in diameter.	3- It is about 400 $\mu\text{m}$ in diameter.
4- It has a narrow lumen.	4- It has a wide lumen.
5- It is lined with Sertoli cells & spermatogenic cells.	5- It is lined with pseudo-stratified epithelium with stereocilia (long microvilli).
6- It has no muscle layer outside the basement membrane.	6- Epithelium is surrounded by smooth muscle. <u>Near</u> the ductus deferens, the muscle layer thickens & becomes three layered similar to ductus deferens.

• **The ductus deferens (Vas deferens):**

It is a long straight thick muscular tube that begins at the tail of the epididymis in the scrotum and ascends within the spermatic cord and passes through the inguinal canal to enter the abdomen. It expands to form the ampulla near its termination then joins the duct of seminal vesicle to form the ejaculatory duct which opens into the prostatic urethra.

It is formed of:

a- Mucosa: It is irregular, slightly folded and formed of:

▪ Epithelium: pseudo-stratified columnar epithelium with stereocilia.

▪ Corium: narrow layer of loose connective tissue.

b- Musculosa: It is thick & dominant feature of ductus deferens formed of three layers of smooth muscle, inner longitudinal, middle circular and outer longitudinal. Each smooth muscle cell of musculosa receives direct sympathetic innervation. Thus, there is muscular contraction of ductus deferens during ejaculation.

c- Adventitia: It is made of thin layer of loose connective tissue.

**Differences between Ureter & Vas deferens**

Ureter	Vas deferens
1- An excretory passage for both urine and semen.	1- An excretory passage for semen.
2- It is long & has thick wall.	2- It is short & has thin wall.
3- The lumen wide & folded.	3- The lumen narrow & less folded
4- Mucosa consists of transitional epithelium & a wide C.T. corium.	4- Mucosa consists of pseudo-st. col. epith. with stereocilia & a narrow C.T. corium.
5- Musculosa is thin, formed of <u>two layers</u> in the upper part (inner longitudinal & outer circular) & <u>three layers</u> in the lower part (inner longitudinal, middle circular & outer longitudinal).	5- Musculosa is thick and prominent formed of <u>three layers</u> (inner longitudinal, middle circular & outer longitudinal).

**N.B.** The spermatic cord is composed of:

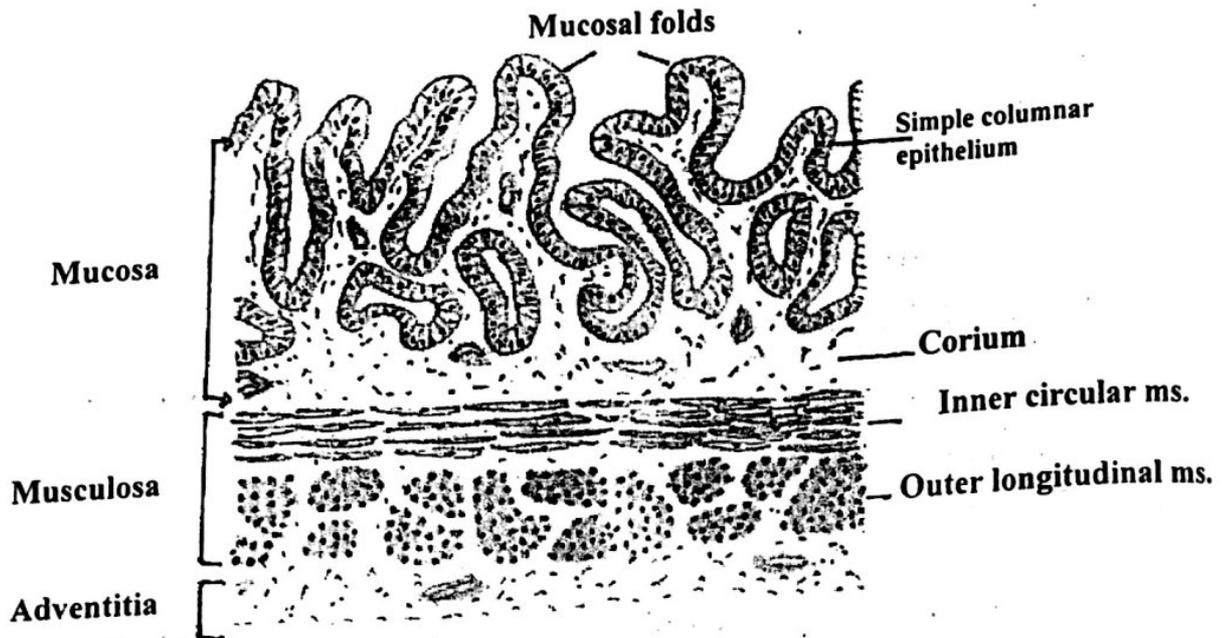
- 1- Vas deferens.
- 2- Testicular artery and vein.
- 3- Nerve fibers.
- 4- Pampiniform plexus of veins.
- 5- Cremaster involuntary striated muscle.

• Ejaculatory duct:

- It is a short, narrow continuation of the ductus deferens beyond the ampulla and joins the duct of the seminal vesicle & empties into the prostatic urethra.
- It is lined by a pseudostratified or simple columnar epithelium.
- It lacks a muscular wall but have instead a layer of fibrous connective tissue.

• The male urethra: is divided into:

- Prostatic urethra: It is about 3-4 cm long, lies within the prostate, lined with transitional epithelium.
- Membranous urethra: It is about 1.5 cm long, extends from the apex of the prostate to the root of the penis, lined with pseudo-stratified columnar epithelium.
- Penile (cavernous) urethra: It is the longest about 15 cm long, lined with stratified columnar epithelium, which changes to stratified squamous at the opening (fossa navicularis).



**Seminal vesicle**

### MALE ACCESSORY SEX GLANDS

They are the seminal vesicles, prostate and bulbourethral glands.

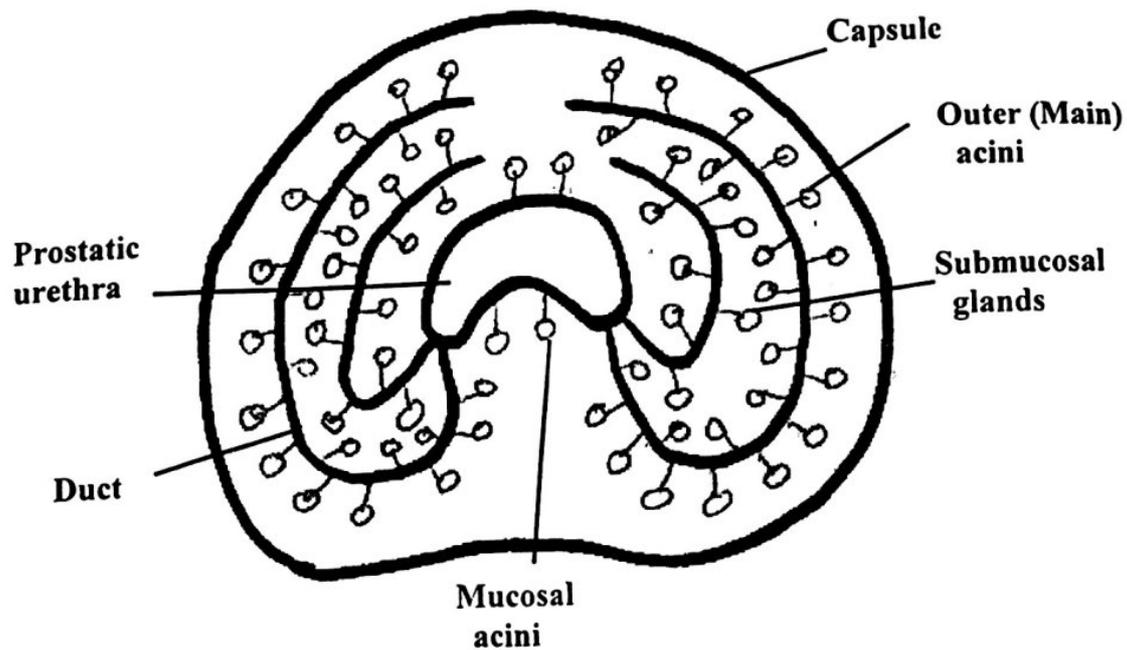
- The seminal vesicles:

They are two highly tortuous tubes. The duct of each, unites with the terminal end of the vas deferens, to form the ejaculatory duct. It is formed of:

- 1- Mucosa: It is highly folded and lined by pseudo-stratified columnar secretory epithelium or columnar and surrounded with loose connective tissue corium.
- 2- Muscularis: It is made of inner circular & outer longitudinal layers of smooth muscle.
- 3- Adventitia: It is made of thin fibroelastic C.T. surrounding the seminal vesicles.

#### 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.



**Diagram of Prostate gland**

• **The prostate:**

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 fibers. The stroma surrounds the urethra where the muscle fibers form the internal sphincter of the bladder.
- 2- **Parenchyma:** It is made of 30-50 glands arranged concentrically around the prostatic urethra. The acini are arranged in 3 levels:
  - a- **Mucosal groups (around the urethra):** They open into the urethra by short ducts.
  - b- **Submucosal groups (outside the mucosal glands):** They open into the urethra by two ducts.
  - c- **Outer (main) groups, found underneath the capsule:** Their acini are larger than those of the previous groups. They open by two ducts, into the urethra.

### < Structure:

- The acini and ducts are lined with simple columnar epithelium. The glandular epithelium differs greatly in glands & even within a single-alveolus. It is usually simple or pseudo-stratified columnar but may be low cuboidal or squamous.
- E.M. shows cytoplasm with well developed Golgi bodies, rich in RER and lysosomes.
- The epithelium rests on an indistinct basal lamina and on a layer of C.T. that contains elastic fibers, capillaries and smooth muscles that aids in the discharge of prostatic fluid at ejaculation.
- Both the prostate and seminal vesicles depend on testosterone for development and functional maintenance.

### Functions :

It secretes a thin milky alkaline secretion, which gives the semen its 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 micturation, a 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 amyloacea) are thought to result from condensation of secretory material in acini. They increase with advance of age and may become calcified .

### • Bulbourethral ( Cowper's) glands:

- They are compound tubulo-alveolar, mucous glands, which open into the beginning of the cavernous urethra.
- The glandular epithelium varies from simple cuboidal to simple columnar depending on the functional state and may be flattened in distended alveoli

### Functions :

They produce a clear, viscid fluid in response to erotic stimulation & may have a lubricating function for the penile urethra.

### • Littre glands:

- These are intra-mucosal and extra-mucosal simple-branched tubular glands which open into the urethra.
- They secrete mucus to lubricate the urethra.