UROGENITAL SYSTEM

#9

ANATOMY

PULSE TEAM

Histology of the male reproductive system

**Starting with the testes.

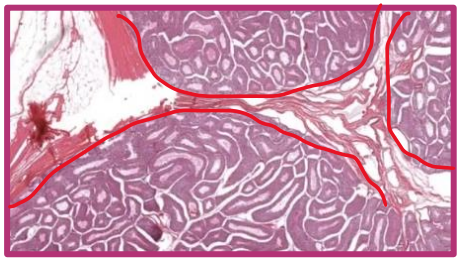
The testes

Histology of the coverings

1. The outer covering is the tunica vaginalis, derived from the peritoneum. This tunic consists of an outer parietal layer lining the scrotum and an inner visceral layer, covering the tunica albuginea on the anterior and lateral sides of the testis.
2. On the inner side, each testis (or testicle) is surrounded by a dense connective tissue capsule of collagen type 1, known as the tunica albuginea which provide support, and which thickens on the posterior side to form what is called a mediastinum. From this fibrous region, septa penetrate the organ and divide it into about 250 pyramidal compartments or testicular lobules.

So, if we look inside one of these lobules, we will find 1-4 tubules called the testicular seminiferous tubules, note also that these tubules are convoluted, thus if we take cross section of one of them it will show multiple circles of the same tubule cause its convoluted.

**Notice the picture showing multiple parts of the same tubule as incomplete circles:



**And now let us get inside these tubules.

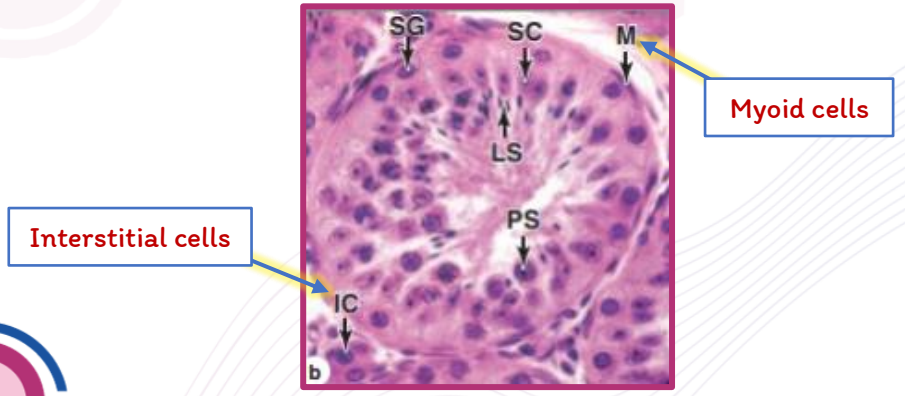
Histology of the seminiferous tubules

These tubules are surrounded by Loose connective tissue and basement membrane for support with muscle cells known as myoid cells which help in contraction and pushing of the cells inside.

Between the circles of the tubule in the picture you will find an interstitial space which have loose reticular CT, fibroblasts, mast cells, macrophages, and a type of cells called interstitial cells of Leydig, these cells will secret steroid testosterone hormone (do not store), by enzymes present in the **smooth ER** and mitochondria. **(same characteristics as adrenal cortical cells)**

Leydig cells (interstitial cells)

These are round cells with **eosinophilic cytoplasm** that get active during the third and fourth months of pregnancy to help in the development of the male secondary characteristics, then regress and become flat quiescent cells resembling fibroblasts until puberty when it will get activated again to the same round cell.



Inside these tubules (inside the circle) you will find somehow what is like a special type of stratified epithelium called germinal or seminiferous epithelium which is also different from the normal epithelium we knew because it consists of different types of cells, it is also worth mentioning that these cells represent the cells of the spermatocytogenesis & another cell called Sertoli (let us talk about them)

Spermatocytogenesis: (spermatogenic epithelium)

What are the steps of this process?

1. This whole process starts from a single progenitor germ cell known as **spermatogonia** (oval, dark nucleus) which present near the border, in which the doctor mention that this type of cell has 23 chromosomes (1n), HOWEVER, the book mentioned the same type of cells as 46 chromosomes (2n).

2. This germ cell will give rise to more germ cells and another cell known as **spermatogonium A** (oval, pail) which will divide many times in a mitotic clonal way and give more spermatogonium A, until it give another type known as **spermatogonium B** (spherical, pail) which will only divide one time in a mitotic way to give another cell called **primary spermatocyte** which the doctor acknowledge to be the first cell to have 46 ch, HOWEVER, the book acknowledge all of the cells we mention to have 46 chromosomes (44 + XY).

3. The **primary spermatocyte** (largest, spherical, euchromatic nuclei) will replicate its DNA then start a miotic division (miosis 1) giving 2 **secondary spermatocytes** which will have 23 chromosomes. (22 + X or 22 + Y).

**secondary cells cannot be seen cause it divide into other cells quickly

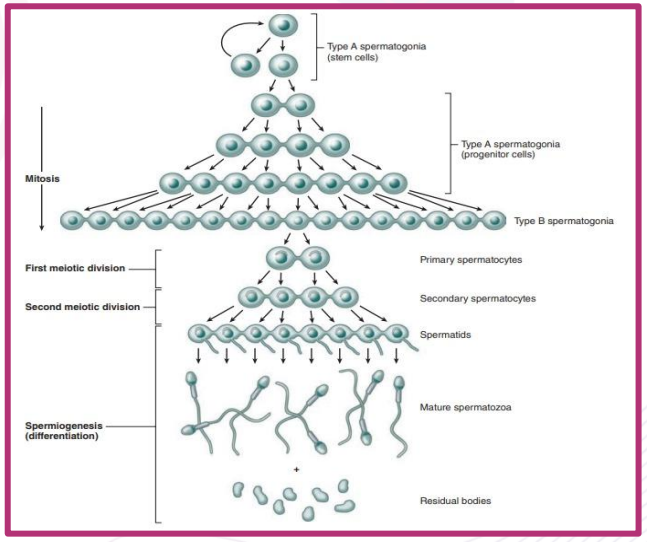
4. Then the **secondary spermatocyte** continues the miotic division (miosis 2) giving 4 **spermatid** cells which have 23 chromatids.

**chromatids considered to be chromosomes also by the book

5. The resulting **spermatid** will continue with a morphological change giving the **sperms (spermatozoa)** that will then get carried to the next part of the testes, then the epididymis.

- **Spermatocytogenesis**: the whole process.
- **Spermatogenesis**: the process from the spermatogonia until the spermatid stage, which have mitosis & miosis.
- **Spermiogenesis**: the temperature sensitive stage in which the spermatids change into spermatozoa by the help of testosterone. (no division)

**Note that all the cells of the same time are connected somehow to share nutrients.



**More Histology picture in the next pages

Another type of cells is found inside the tubules as a part of the epithelium and is known as Sertoli, but does not result from the dividing process, although its important for the spermatocytogenesis process.

Sertoli cells:

Describe them:

- Tall columnar irregular epithelial cells with ovoid or triangular, euchromatic nucleus, and a prominent nucleolus, which also nourish the spermatogenic cells and divide the seminiferous tubules into two compartments (basal and adluminal), cells of the spermatogenic lineage are closely associated with the extended surfaces of Sertoli cells and depend on them for metabolic and physical support.

- The outlines of Sertoli cells surrounding the spermatogenic cells are very poorly defined, so each Sertoli cell can support 30-50 developing germ cells equally.

- Ultrastructurallly, Sertoli cells are seen to contain abundant SER, some rough ER, well-developed Golgi complexes, numerous mitochondria, and lysosomes.

Junctions between them:

1. **Tight occluding junctions** between their basolateral membranes, which form a blood-testis barrier within the seminiferous epithelium. The tightest blood-tissue barrier in mammals, this physical barrier is one part of a system preventing autoimmune attacks against the unique spermatogenic cells.
2. Sertoli cells are also connected and coupled ionically by **gap junctions**, which may help regulate the transient changes in the occluding junctions and synchronize activities in the spermatogenic cells.

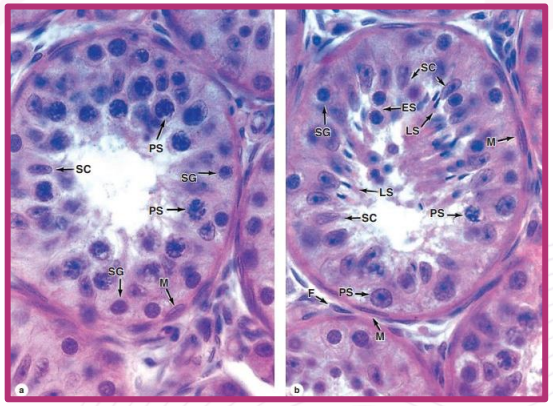
Importance of these cells upon their junctions

A. Support, protection, and nutrition of the developing spermatogenic cells, because spermatocytes, spermatids, and developing sperm are isolated from plasma proteins and nutrients by the blood-testis barrier.

B. Exocrine and endocrine secretion:

- ✓ **Androgen-binding protein** (ABP), which concentrates testosterone to a level required for spermiogenesis, and help deliver them.
- ✓ Glycoprotein **inhibin B**, which feeds back on the anterior pituitary gland to suppress FSH synthesis and release.
- ✓ In the fetus, Sertoli cells also secrete a glycoprotein called **müllerian-inhibiting substance** (MIS) that causes regression of the embryonic müllerian (paramesonephric ducts) which originally gives rise to female ducts, so this MIS will inhibit these ducts so the male ducts can develop, and if the MIS is absent the female ducts will persist.

C. Phagocytosis: During spermiogenesis, excess cytoplasm shed as residual bodies is phagocytosed and digested by Sertoli cell lysosomes, cause no proteins from sperm normally pass back across the blood-testis barrier.



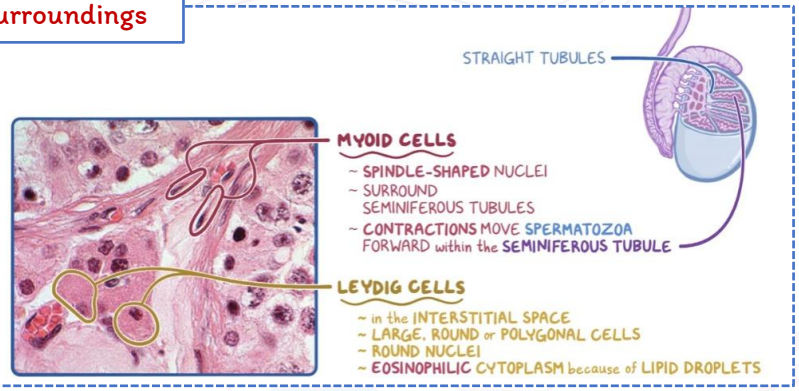
*SC: Sertoli
*M: Myoid
*SG: Spermatogonium
*PS: primary spermatocyte
*ES & LS: Early & Late spermatids

Note that there are 2 types of spermatids: Early (round and small), Late (pointed)

Also remember that you cannot see Secondary spermatocytes.

"Extra pictures from osmosis"

Surroundings



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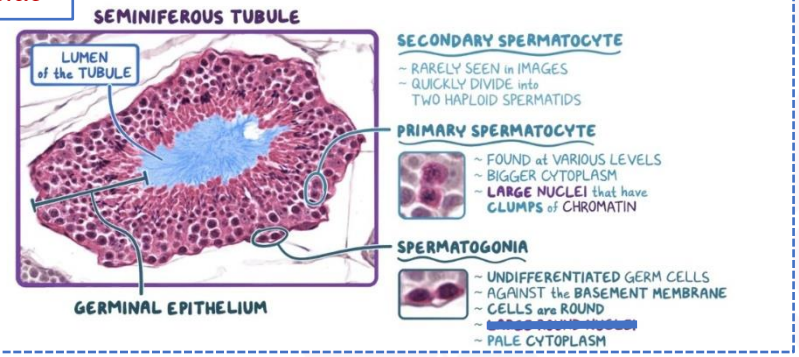

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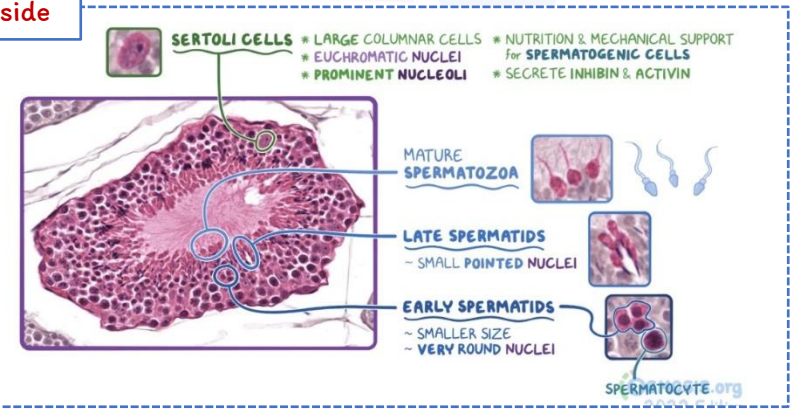


**And now let us get to the other parts of the testes.

Histology of the intratesticular ducts (pictures next page)

➜ The intratesticular ducts all of which carry spermatozoa and liquid from the seminiferous tubules to the duct of the epididymis are:

The straight tubules (or tubuli recti):

× Lined with **simple cuboidal epithelium**, and initially by Sertoli cells.

**(At the end of seminiferous tubule, the spermatogenic lineage disappears except for Sertoli cells, then at the beginning of the tubuli recti, the Sertoli cells start to disappear).

The rete testis:

× An interconnected network of channels lined with **cuboidal epithelium**, which is found posteriorly (mediastinum), it drains in the efferent ductules (20 efferent tubules)

**(The loops of seminiferous tubules join the rete testis by the short straight tubules).

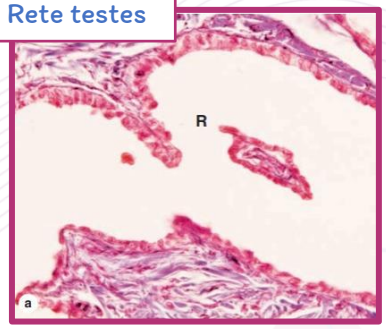
The efferent ductules:

× About 20 efferent ductules lined by an **unusual epithelium** (complex):
× In which there are 2 groups:
A. Non-ciliated cuboidal cells.
B. Taller columnar ciliated cells.

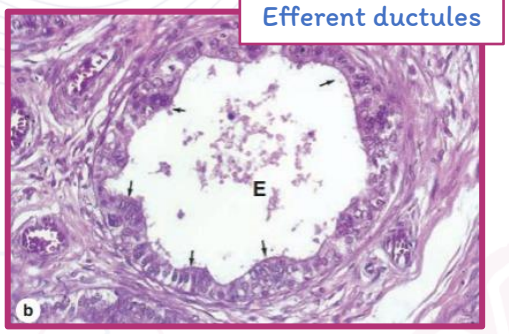
And this will give the tissue a characteristic of scalloped appearance, which means that the non-ciliated cells absorb some of the fluid secreted by the Sertoli cells of seminiferous tubules, and along with the ciliary activity of the other type will create a fluid flow, which carries sperm passively out of the testis toward the epididymis.

In addition, there is A thin layer of **circularly oriented smooth muscle cells** in the walls of efferent ductules that aids in the movement of sperm into the duct of the epididymis.

Rete testes



Efferent ductules



Remember that under any epithelium there is a basement membrane of CT for support.

**After we discuss the testes with its components, let us get out of there and discuss the excretory ducts and glands.

Excretory ducts (Extra testicular)

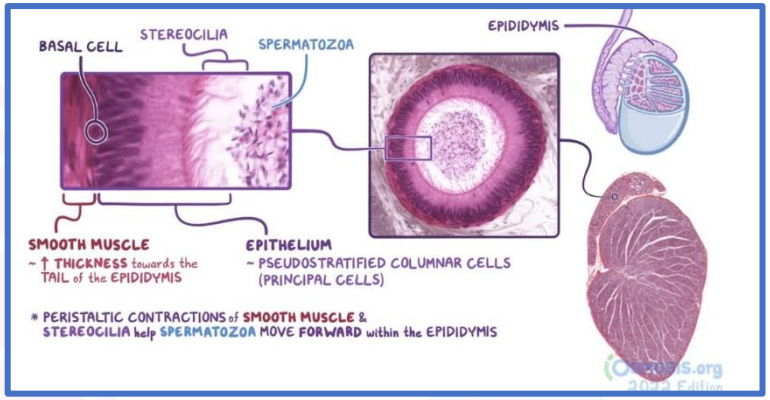
➔ The excretory genital ducts are those of the epididymis, the ductus deferens (vas deferens), and the urethra. They transport sperm from the scrotum to the penis during ejaculation. **(We will discuss only the epididymis & ductus deferens because the urethra is covered in the renal system)**

Ductus Epididymis: 4-6 m in length

× The epididymal duct is lined with **pseudostratified columnar epithelium**, which have the appearance of columnar principal cells, with characteristic long stereocilia small round stem cells, and basal cells.

**(The principal cells remove most of the water and residual bodies entering the epididymis with the sperm and secrete various products, greatly changing the fluid in which sperm are suspended, with the cilia also helping in transporting)

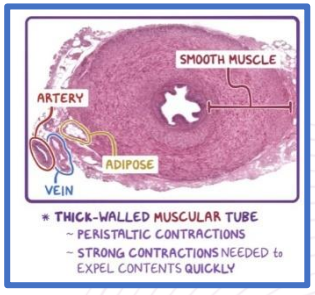
× The epididymal duct is surrounded by a thin, **circular layer of smooth muscle cells**, HOWEVER, **supplemented in the tail region** with the **addition of inner and outer longitudinal layers**, at ejaculation, peristaltic contractions of these muscle layers rapidly empty stored sperm from this tail region, which is continuous with the ductus deferens.

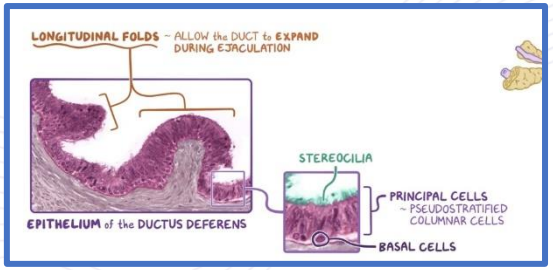


Ductus Deferens (Vas Deferens):

× A long straight tube with a **thick**, muscular wall and a relatively **small lumen**, lined by **pseudostratified columnar epithelium** with some cells having sparse stereocilia, and basal cells.

× The very thick muscularis consists of **3 layers (longitudinal inner and outer layers and a middle circular layer)**, which produce strong peristaltic contractions during ejaculation, which rapidly move sperm along this duct from the epididymis. **(Same as the muscles of the epididymis tail)**





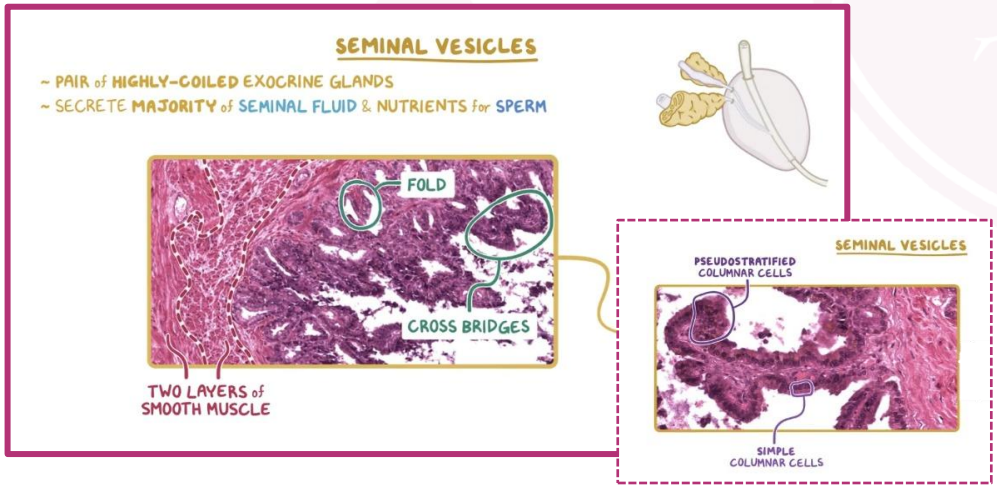
Accessory glands

→ The accessory glands of the male reproductive tract produce secretions, which become mixed with sperm during ejaculation to produce semen and are essential for reproduction, and they are the seminal vesicles (or glands), the prostate gland, and the bulbourethral glands.

The seminal vesicles (gland):

- Thin, **complex folds (tortuous)**, which fill much of the lumen, which are lined with **simple columnar or pseudostratified columnar** epithelial cells rich in secretory granules. (doctor mention cuboidal also)
- The lamina propria contains **elastic fibers** and is surrounded by **2 layers smooth muscle (with inner circular and outer longitudinal layers)**, which empty the gland into the ejaculatory ducts during ejaculation.

the seminal vesicles produce a yellowish secretion, Fluid from seminal vesicles typically makes up about 70% of the ejaculate.



The prostate gland: (picture next page)

- The prostate consists of 30-50 tubuloacinar glands lined with simple to pseudostratified columnar epithelium embedded in a dense fibromuscular (muscles & **elastic fibers**) stroma in which smooth muscle also contracts at ejaculation as the seminal vesicles.
- Produce a fluid that contains a complex mixture of exosomes, various glycoproteins, enzymes, and small molecules, such as prostaglandins, and is stored until ejaculation.
- Ducts from individual glands all empty into the prostatic urethra, which runs through the center of the prostate.
- The normal prostate gland is often divided most simply into three major zones surrounding the urethra:

A. The peripheral zone, with about 70% of the organ's tissue, contains the **prostate's main glands** with the **longest ducts** into the prostatic urethra.

B. The central zone comprises 25% of the gland's tissue and contains the **periurethral submucosal** glands with somewhat **shorter** ducts.

C. The transition zone occupies about 5% of the prostate volume, contains the **periurethral mucosal** glands, and like the central zone surrounds only the superior portion of the urethra.

**The prostate & the seminal vesicles are Dependent on testosterone & androgen.

× There is a concretion, called **corpora amylacea**, containing primarily deposited glycoproteins and keratan sulfate, may become more numerous with age but seem to have no physiologic or clinical significance.

Some extra information

- Seminal vesicles produce a yellowish secretion, Fluid from seminal vesicles typically makes up about 70% of the ejaculate and include the following:
  - × **Fructose**, a major energy source for sperm, as well as inositol, citrate.
  - × **Prostaglandins**, which stimulate activity in the female reproductive tract.
  - × **Fibrinogen**, which allows semen to coagulate after ejaculation.
- One clinically important product of the prostate is **prostate-specific antigen** (PSA), which helps liquefy coagulated semen for the slow release of sperm after ejaculation, small amounts of PSA also leak normally into the prostatic vasculature; HOWEVER, elevated levels of circulating PSA indicate abnormal glandular mucosa typically due to prostatic carcinoma or of many prostatic tubuloacinar glands.

*E: Epithelium
*M: Muscle
*LP: Lamina propria
*CA: corpora amylacea

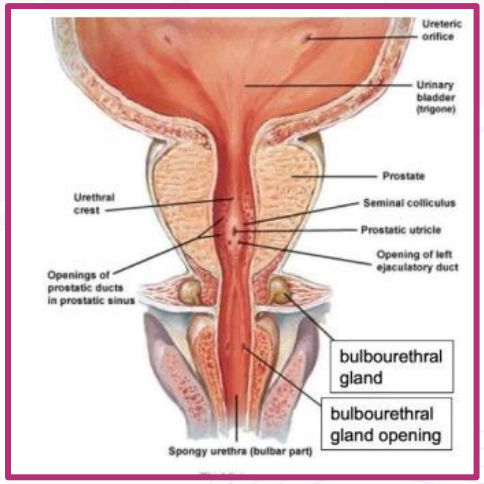
Mucus glands:

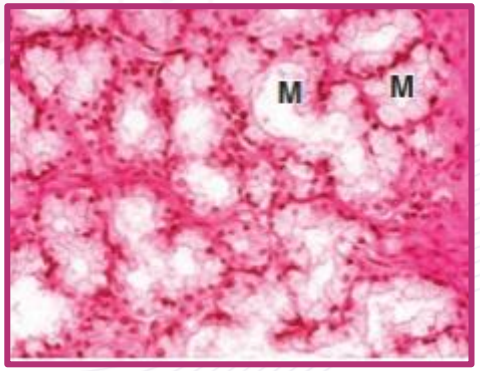
Bulbourethral glands (Cowper's):

× 2 paired round glands, 3-5 mm in diameter, that empty into the proximal part of the penile urethra.
× Each gland has several lobules with tubuloacinar secretory units surrounded by smooth muscle cells and lined by a mucus-secreting **simple columnar epithelium**.
× It is also testosterone dependent.
× During erection, the bulbourethral glands, as well as numerous, very small, and histologically similar urethral glands along the penile urethra, release a clear alkaline mucus-like secretion, which coats and lubricates the urethra in preparation for the imminent passage of sperm.

Littre glands:

× Another small gland Along penile urethra Secrete alkaline mucus, at a lower level than cowper.





The penis

➔ The penis consists of three cylindrical masses of erectile tissue, plus the penile urethra, surrounded by skin.

The cylindrical masses:

× Two of the erectile masses—the **corpora cavernosa**—are dorsal and are each surrounded by a dense fibroelastic layer, the tunica albuginea.

× The last one – **corpus spongiosum** – is ventral and surrounds the urethra, and at its end it expands, forming the glans.

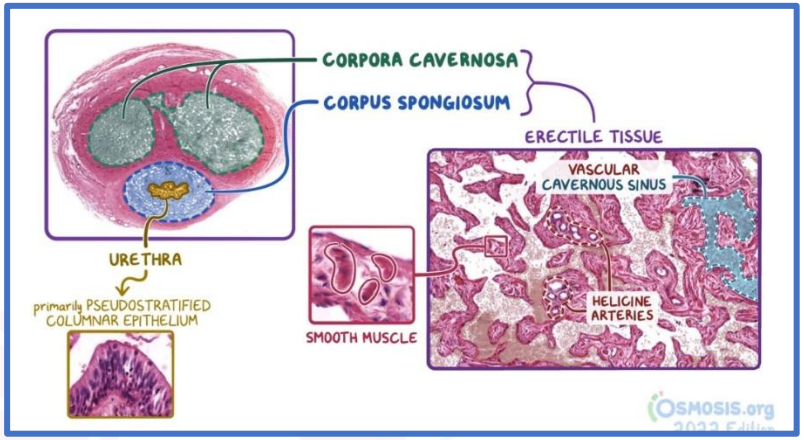
Urethral part:

× Most of the **penile urethra** is lined with **pseudostratified columnar epithelium**, In the **glans** (externally), it becomes **stratified squamous epithelium** continuous with that of the thin epidermis covering the glans surface.

Blood supply:

× **Central arteries** in the corpora cavernosa branch to form **nutritive arterioles** and **small coiling helicine arteries**, which lead to the cavernous vascular spaces of erectile tissue.

× **Arteriovenous shunts** are present between the central arteries and the dorsal veins.



Clinical points

Hydrocele

× An excessive accumulation of serous fluid in one or both sides of the scrotal sac, termed a hydrocele, is the most common cause of scrotal swelling and a condition easily corrected surgically.

****Hydrocele = Accumulation of serous fluid**
****Pyocele = Accumulation of Pus**
****Hematocele = Accumulation of blood**

Cryptorchidism

× The failure of one or both testes to descend from the abdomen, occurs in about 4% of male neonates, but in most of these individuals, the testes move to the scrotum during the first year. Bilateral cryptorchidism causes infertility if not surgically corrected by 2-3 years of age.

Decreased semen quality

× Which is frequently idiopathic (arising from unknown causes), is a major cause of male infertility.

**Common features of poor semen quality include oligospermia (ejaculate volume >2 mL), sperm cell density less than 10-20 million/mL, abnormal sperm morphology, and flagellar defects that impair sperm motility.

Acute or chronic inflammation of the testis (orchitis)

× Frequently involves the ducts connecting this organ to the epididymis. Common forms of orchitis are produced by infective agents such as Chlamydia or Neisseria gonorrhoeae entering the testis from the epididymis or via the lymphatics.

Acute epididymitis

× A result of sexually transmitted infections such as gonorrhea or Chlamydia infection and causes intrascrotal pain and tenderness. Persistent inflammation of the epididymis, such as that associated with gonorrhea infections, includes massive invasion by leukocytes into the infected duct, stimulating fibrosis that obstructs the epididymis and is a common cause of male infertility.

The prostate problems

1. chronic prostatitis, usually involving infectious agents.
2. Nodular hyperplasia or benign prostatic hypertrophy, occurring mainly in the periurethral (central) mucosal glands where it often leads to compression of the urethra and problems with urination.
3. Prostate cancer (adenocarcinoma), the most common cancer in nonsmoking men, occurring mainly in glands of the peripheral zone, and thus urethral manifestations are late cause its in the centre.

Additional information

➔ Changes of the spermatozoa while passing through the epididymis include the following:

■ Development of competence for forward motility.

■ Final modifications within the acrosome هذا الراس تبعه.

■ Importantly, reorganization of the cell membrane surrounding the sperm head, including the addition of cholesterol and other "decapacitation factors", which block the acrosomal reaction, a key event in fertilization.

عملية ال capacitation هي عملية بتتعلق بالانزيمات الموجودة بالرأس واللي بتساعد على اختراق البويضة وتخصيبها ولكن هاي الانزيمات في مراحل تكوين الحيوان المنوي وخروجه بتم تثبيط عملها تحت مسمى decapacitation حتى ييجي الوقت اللي بدخل فيه الحيوان المنوي لتخصيب البويضة وهناك بترجع تتنشط هاي الانزيمات

كل الشكر للموقع الكبير والجميل جدا osmosis.org (أخذت جميع الصور منه) وكتاب Junqueira

صنع هذا التفريغ بكل عناية 😉

The End