

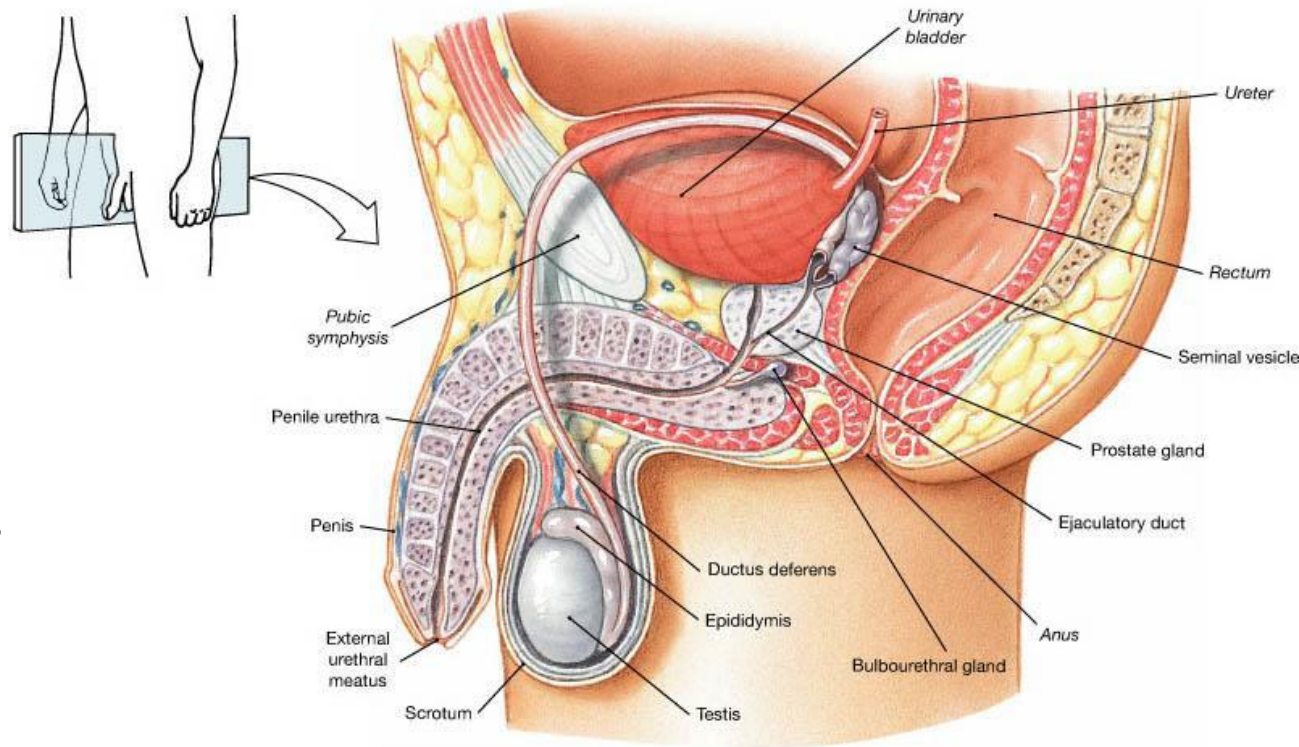


КАЗАНСКИЙ (ПРИВОЛЖСКИЙ) ФЕДЕРАЛЬНЫЙ УНИВЕРСИТЕТ

The Male Reproductive System

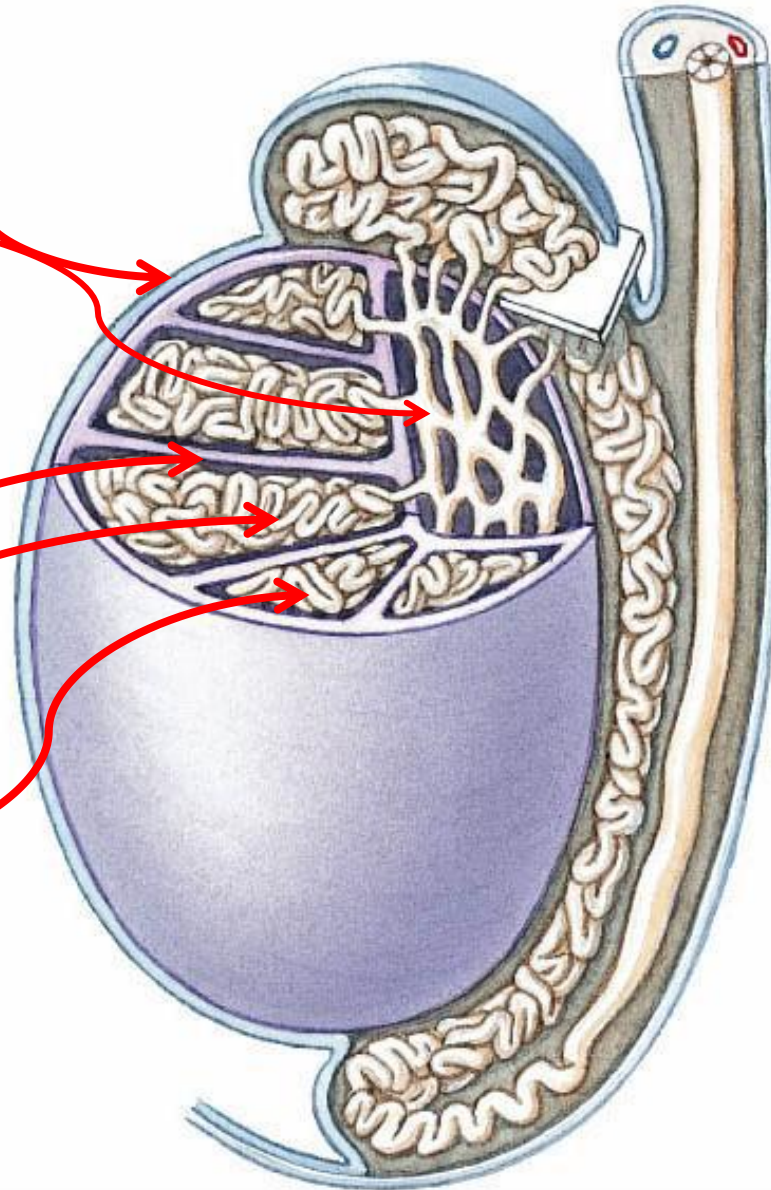
The male reproductive system

- Testes
- Genital ducts
- Accessory sex glands:
 - ✓ seminal vesicles
 - ✓ prostate
 - ✓ bulbourethral glands
- External genitalia:
 - penis



Structure of the Testis

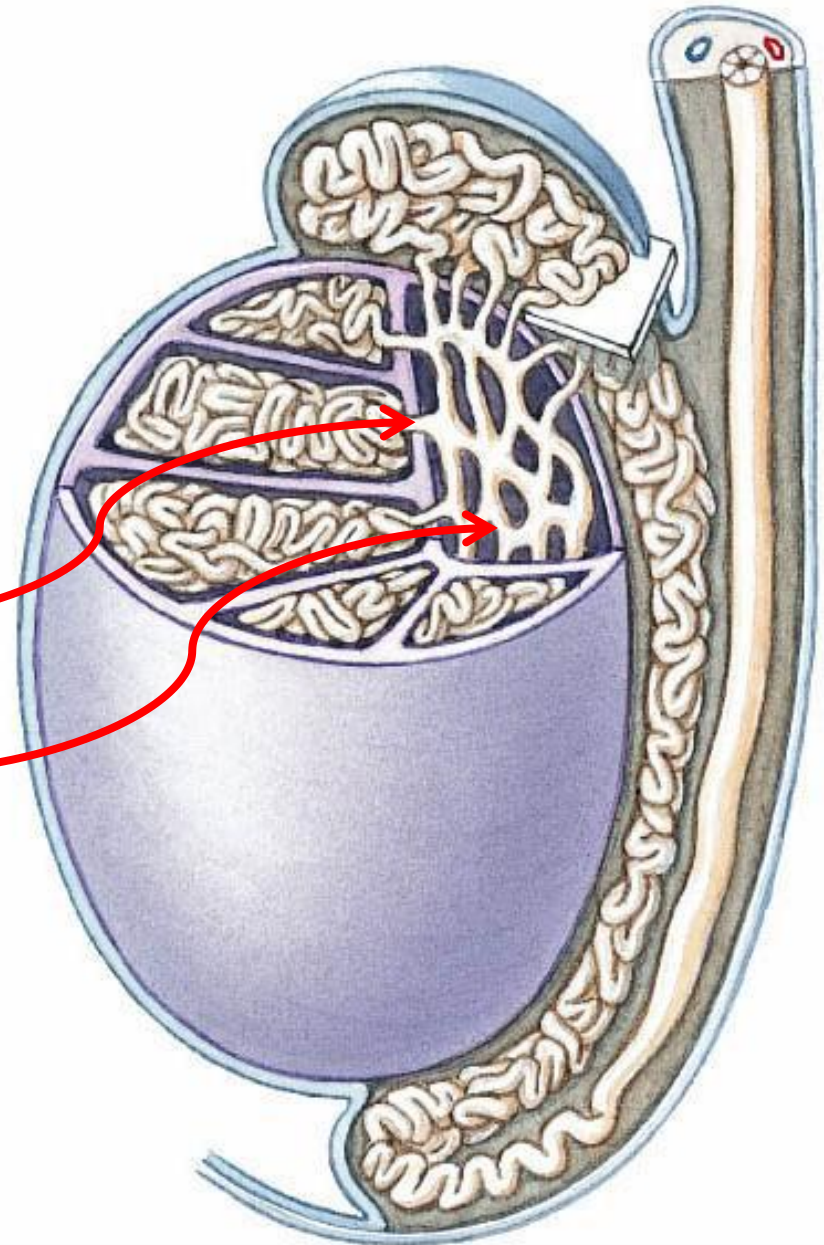
- ✓ **Tunica albuginea** - connective tissue capsule.
- ✓ **Mediastinum testis** - thickening of the tunica albuginea on the posterior surface of testes
- ✓ **Septa** - extensions of the tunica albuginea, dividing each testis into approximately 250 **lobules**
- ✓ Each lobule consists of one to four **seminiferous tubules**, in which sperm are produced



(a) Testis and epididymis

Structure of the Testis

- ✓ Each **seminiferous tubule** is approximately **50 cm long**, within the lobule forms loops.
- ✓ The ends of the loop are called the **straight tubule (tubulus rectus)**.
- ✓ It continues into the **rete testis** - an anastomosing channel system within the mediastinum.



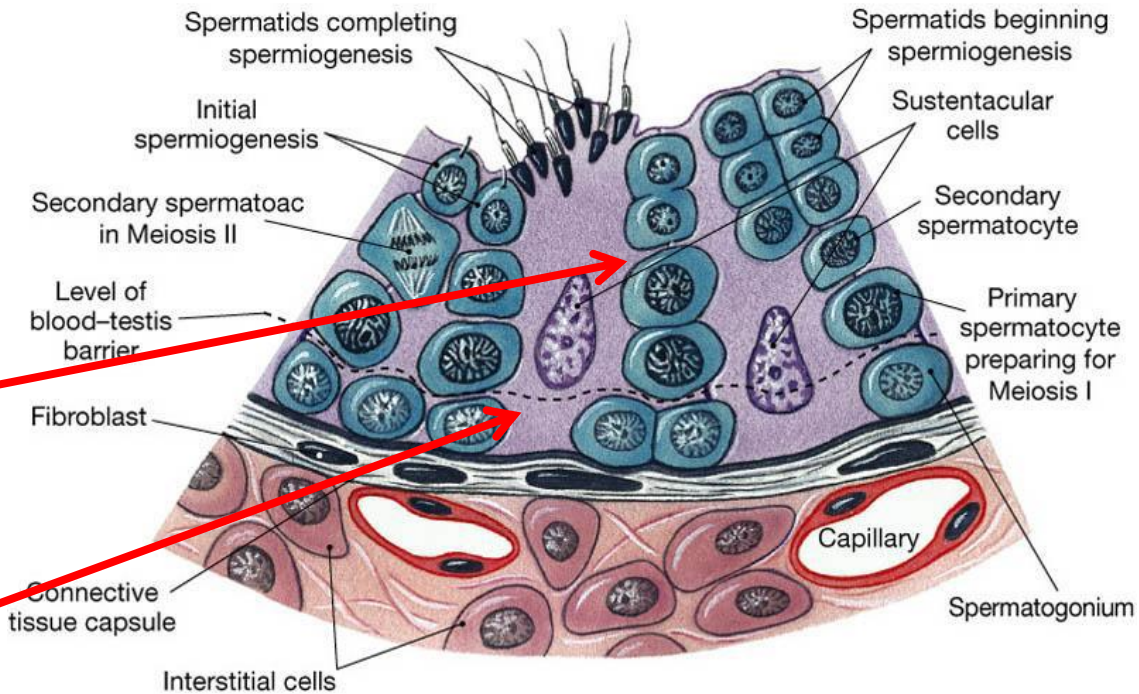
(a) Testis and epididymis

Structure of the Testis

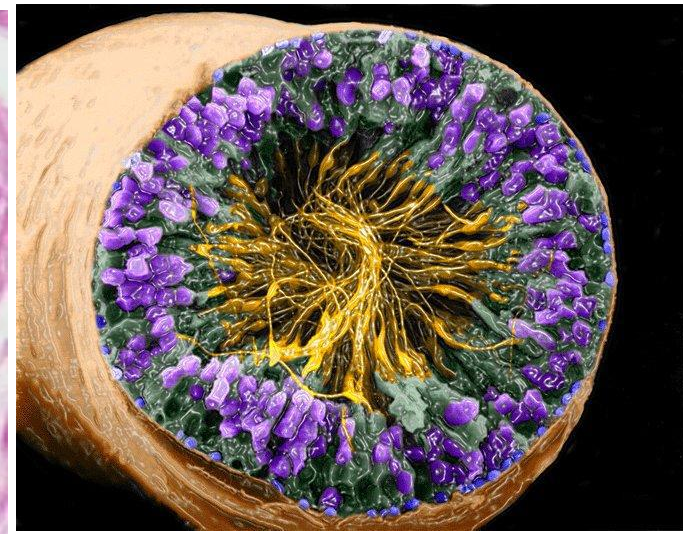
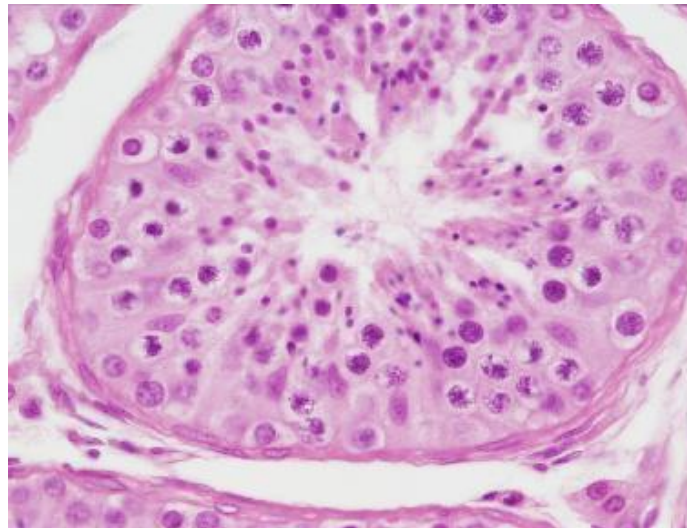
The seminiferous tubules are lined by the **seminiferous epithelium**

Two basic cell populations:

1. **Spermatogenic cells**, which regularly replicate and differentiate into mature sperm.
2. **Sertoli cells**, also known as **supporting cells**.

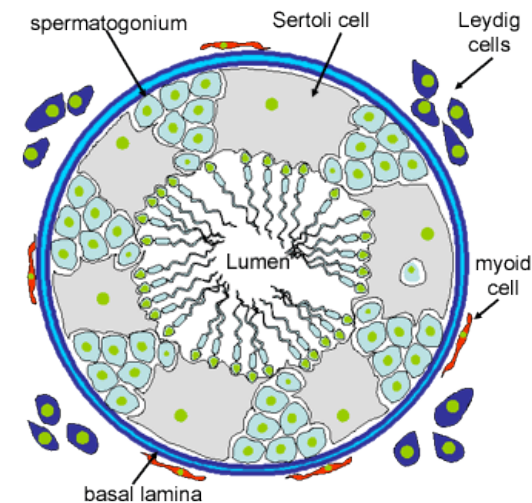
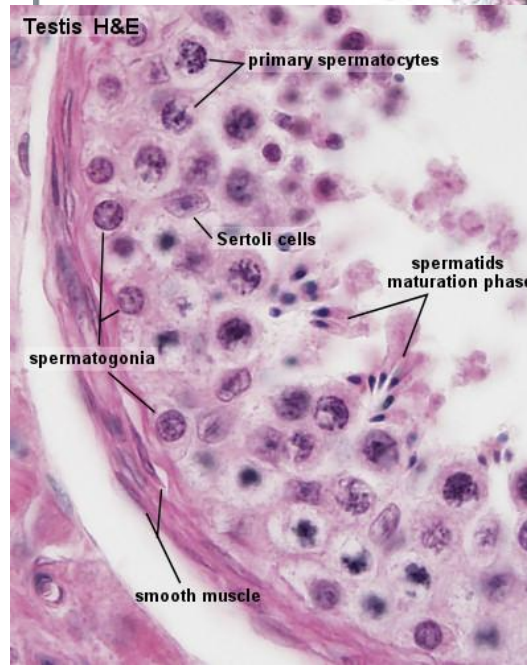
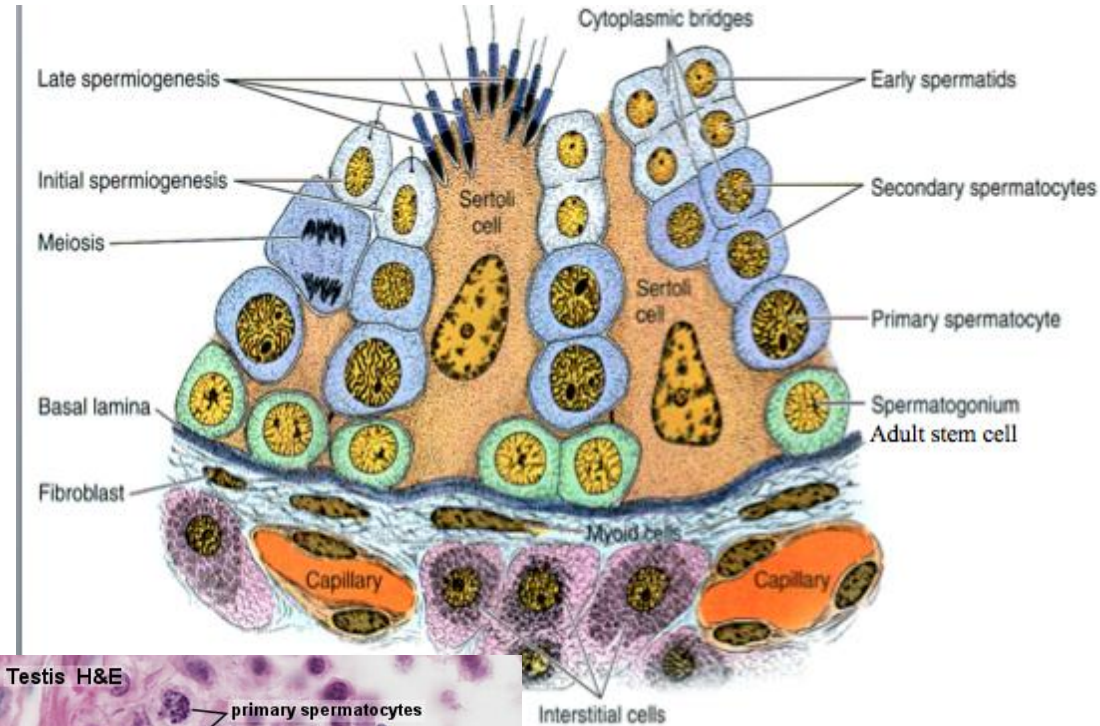


(d) Wall of seminiferous tubule



Spermatogenic cells

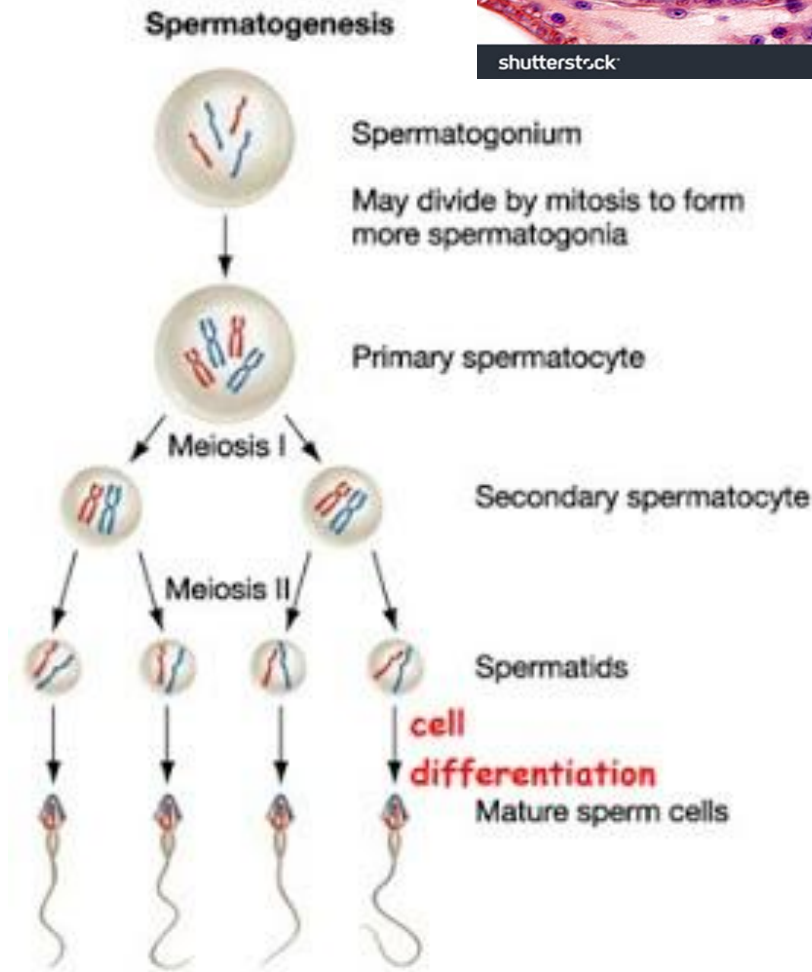
- Derive from the yolk sac and colonize the gonadal ridges during early development
- **Spermatogonia** - the most immature cells, closest to the basal lamina, the only cell type present before puberty
- **Primary spermatocytes** – the largest cells, closer to the lumen, $2n4N$
- **Secondary spermatocytes** – still closer to the lumen, rare on the slides since they immediately undergo second meiotic division, $1n2N$
- **Spermatids** - the most mature cells, next to the lumen, $1n1N$, undergo differentiation to form mature sperm cells



Spermatogenesis

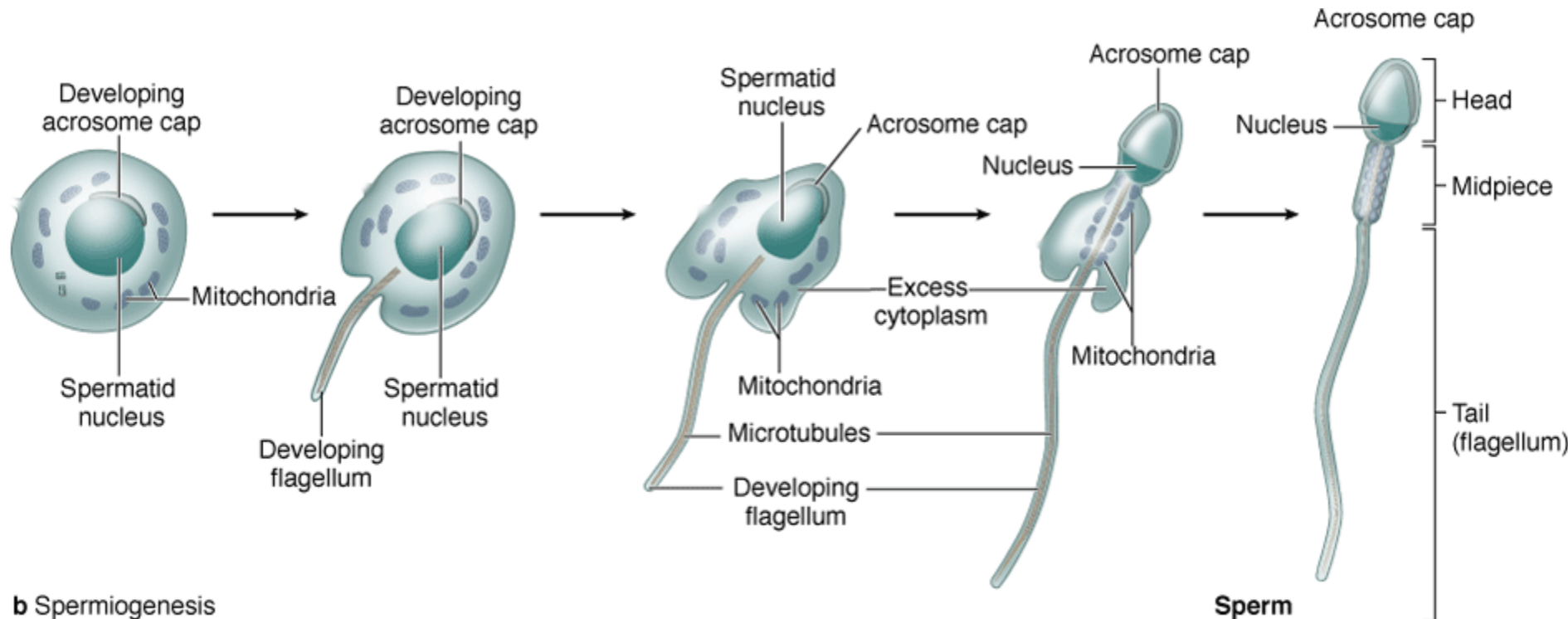
Divided into **three phases**:

- 1. Spermatocytogenesis:**
spermatogonia divide by **mitosis**.
Spermatogonia A remain undifferentiated. **Spermatogonia B** can enter meiosis to form primary spermatocytes.
- 2. Meiosis:** primary spermatocytes undergo two meiotic divisions to reduce both the chromosome number and amount of DNA to produce haploid cells called spermatids
- 3. Spermiogenesis:** spermatids undergo cytodifferentiation into mature spermatozoa



Spermiogenesis

- **Nuclear condensation:** thickening and reduction of the nuclear size, condensation of the nuclear contents
- **Formation of acrosome:** a cap above the nucleus containing enzymes that play an important role in the penetration of the zona pellucid of the oocyte
- **Formation of flagella:** migration of centrioles backwards and mitochondria to the midpiece of tail
- **Discarding** the excess of cytoplasm

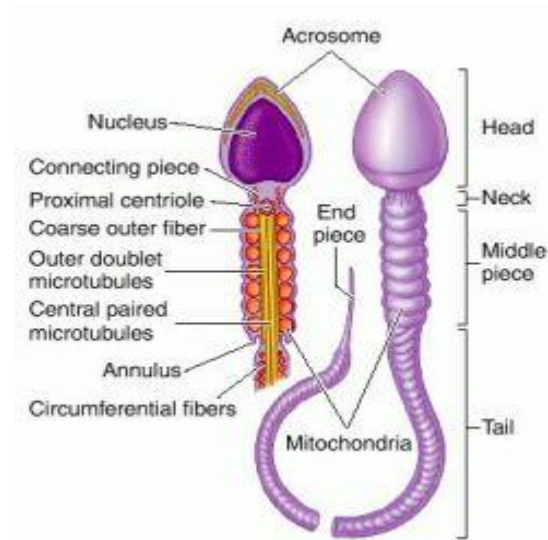
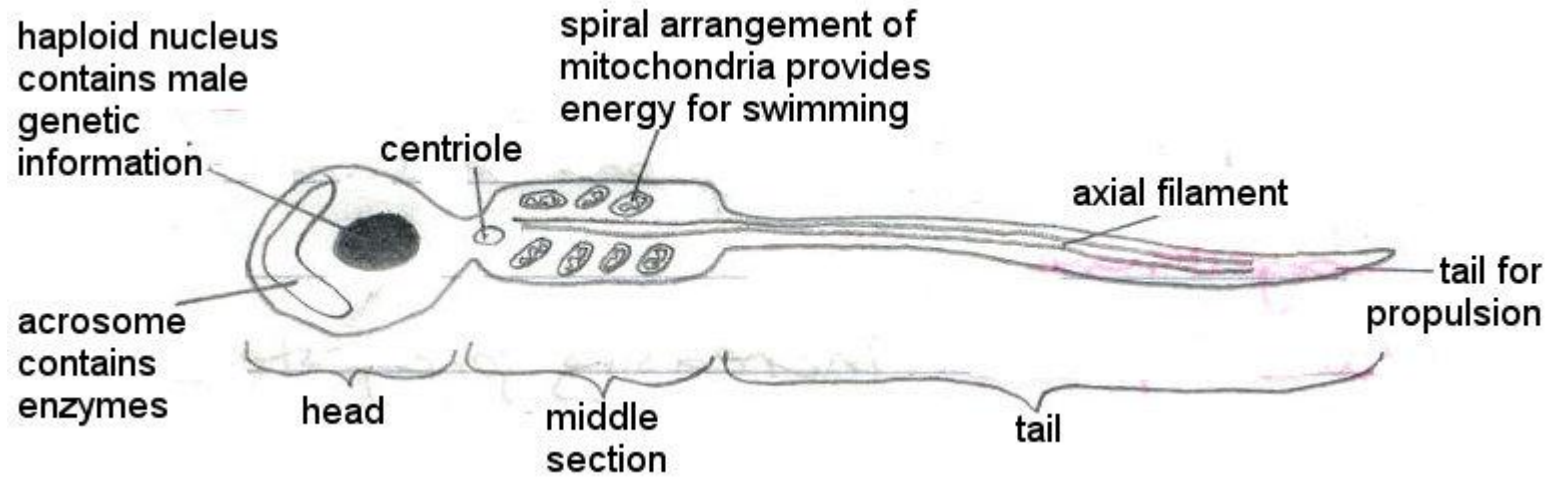


b Spermiogenesis

Mitosis of spermatogonia	16 days	Formation of primary spermatocytes
Meiosis I	22-24 days	Division of primary spermatocytes with formation of secondary spermatocytes
Meiosis II	Several hours	Division of secondary spermatocytes with formation of spermatids
Spermiogenesis	24 days	Differentiation of spermatids into the spermatozoa
Total	~64 days	

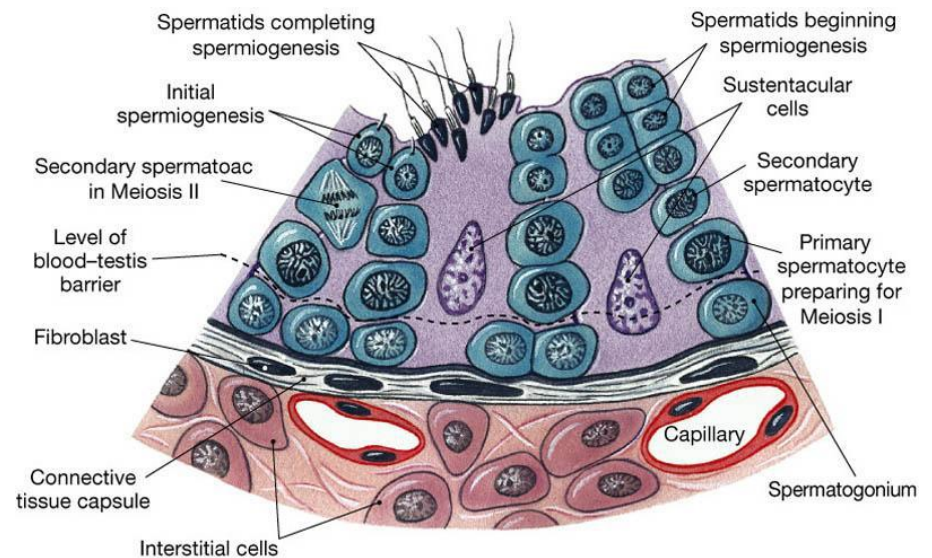
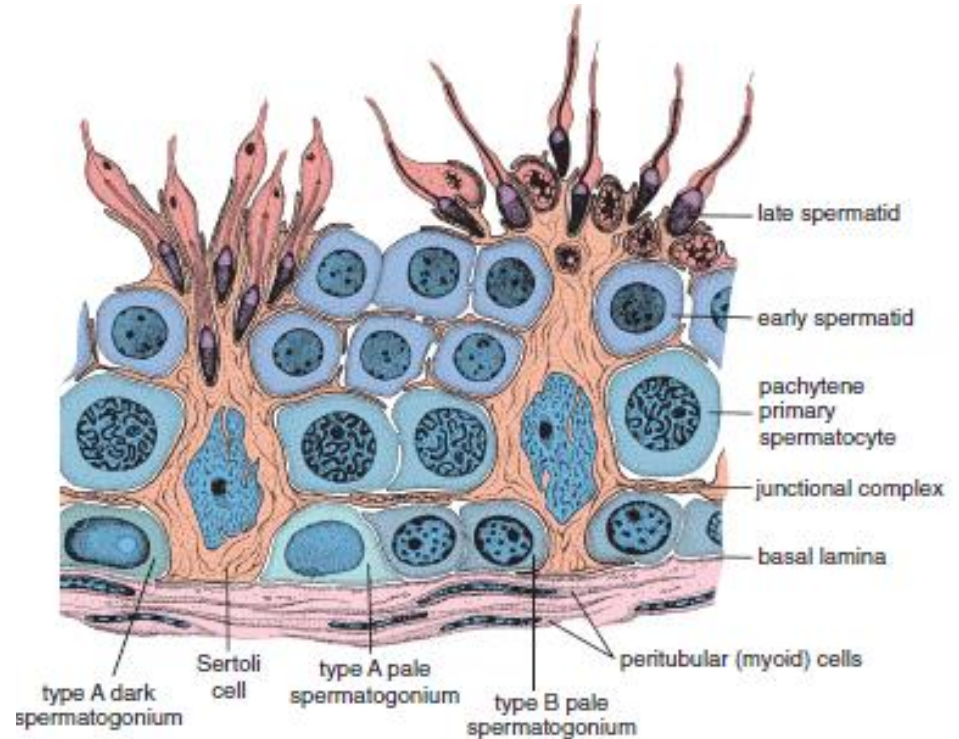


Spermatozoa



Sertoli Cells

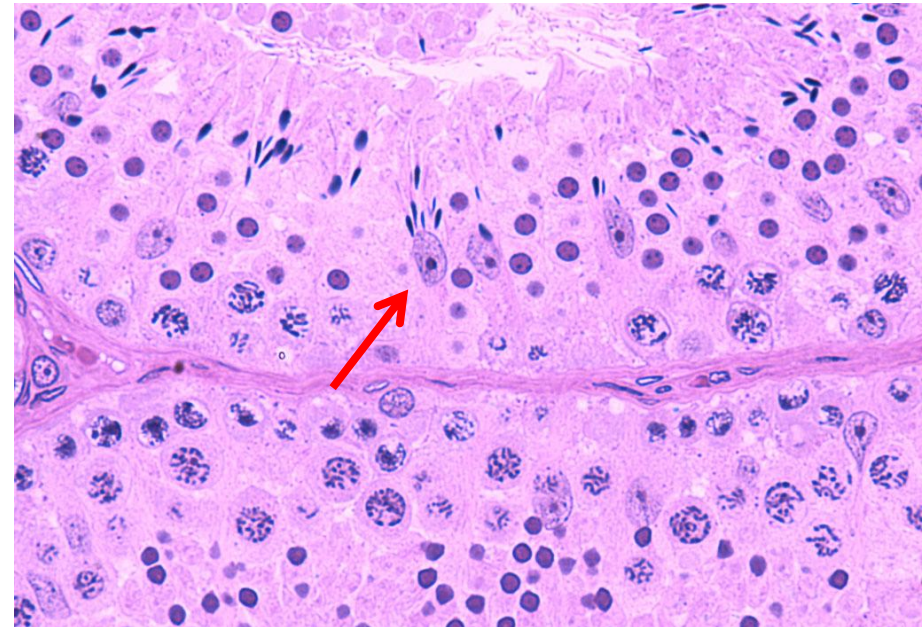
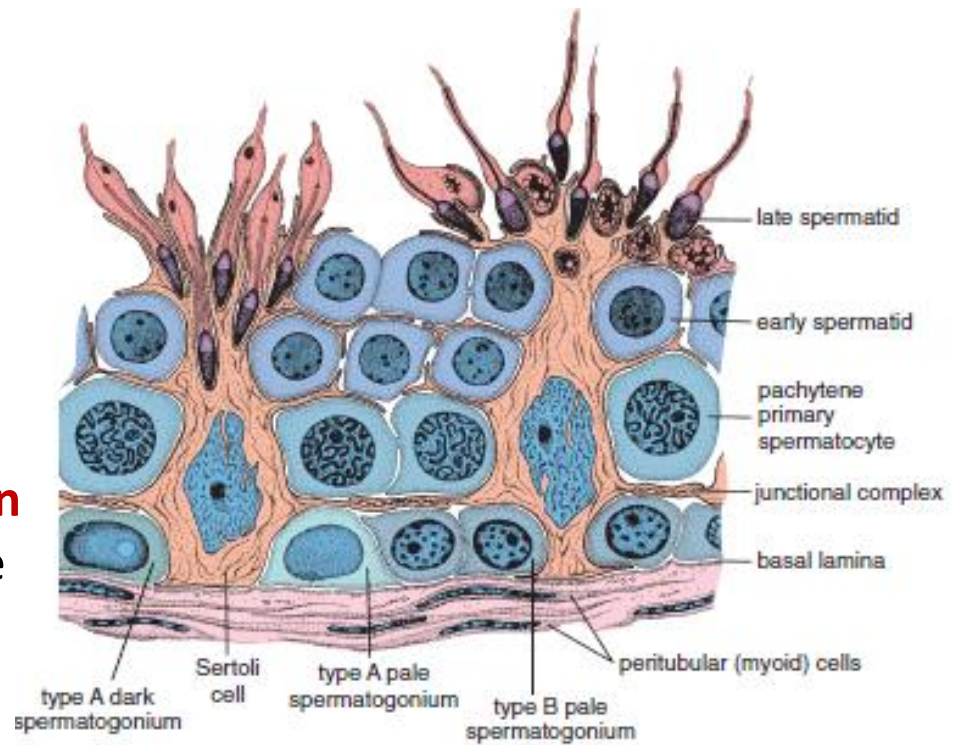
- Extend from the basal lamina to the lumen
- Have cytoplasmic infoldings embracing the developing spermatogenic cells
- Neighboring cells are connected by occluding junctions forming the **blood–testis barrier**.



(d) Wall of seminiferous tubule

Sertoli Cells functions:

- **Support** for spermatogenic cells
- **Nutrition** and metabolite exchange for the spermatogenic cells
- Secretion of **fluid for sperm transport**
- Secretion of **Androgen-binding protein (ABP)** which concentrates testosterone in the luminal compartment of the seminiferous tubule (essential for normal maturation of the developing sperm)
- Secretion of **Inhibin**, that inhibits follicle-stimulating hormone (FSH) release from the anterior pituitary gland.
- **Phagocytosis** of residual bodies shed by the maturing spermatozoa
- Blood-testis barrier **protects** from autoimmune attack



Blood Testis Barrier

- **Formed by** tight junctions between the Sertoli cells
- **Divides** the spermatogenic epithelium into two compartments:

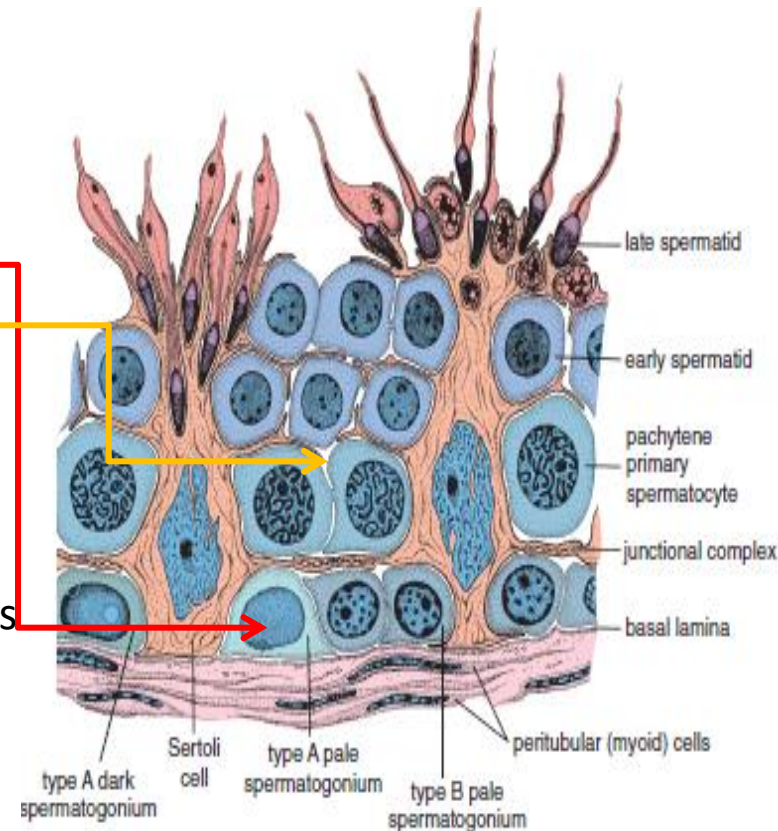
- **basal** (only spermatogonia)
- **adluminal** (other spermatogenic types)

- **Protects** developing sperm cells from autoimmune response

Spermatozoa and spermatogenic cells possess molecules that are unique to these cells and can be recognized as “foreigners” by the immune system.

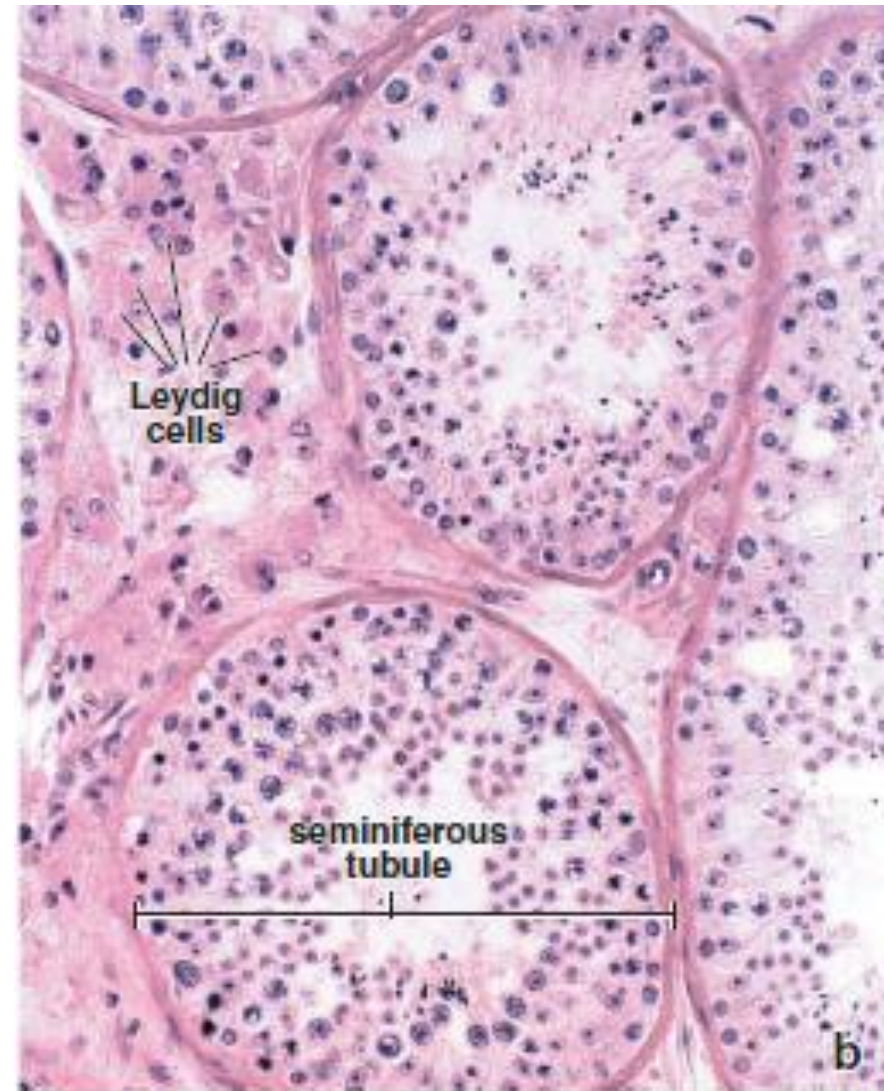
Autoimmune response will cause sterility.

- **Protects** developing sperm cells from harmful substances from circulation (toxins, drugs, etc.)



Leydig Cells

- ✓ **Leydig cells** (interstitial cells) are located *outside the seminiferous tubules*
- ✓ **The main function - secretion of testosterone and other androgens:**
 - In the **embryo** - essential for the normal **development of the gonads** in the male fetus
 - At **puberty** is responsible for **the initiation of sperm production**, accessory sex gland secretion, and development of secondary sex characteristics.
 - In the **adult** is essential **for the maintenance of spermatogenesis**, secondary sex characteristics, ducts, and accessory sex glands

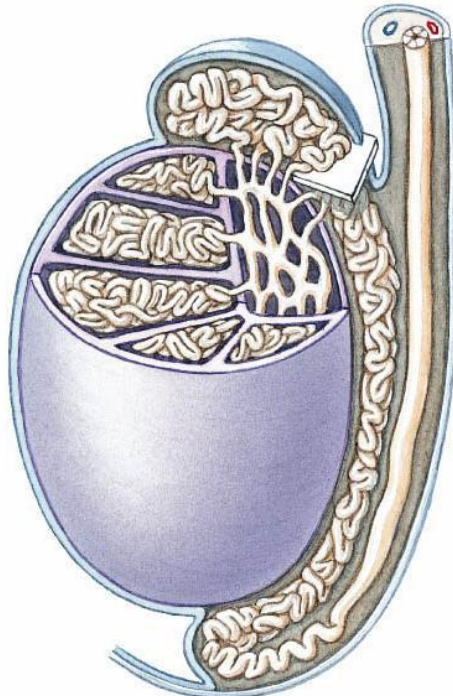


Spermatic Ducts

Newly formed sperm cells travel through a series of ducts to reach the urethra

Intratesticular ducts:

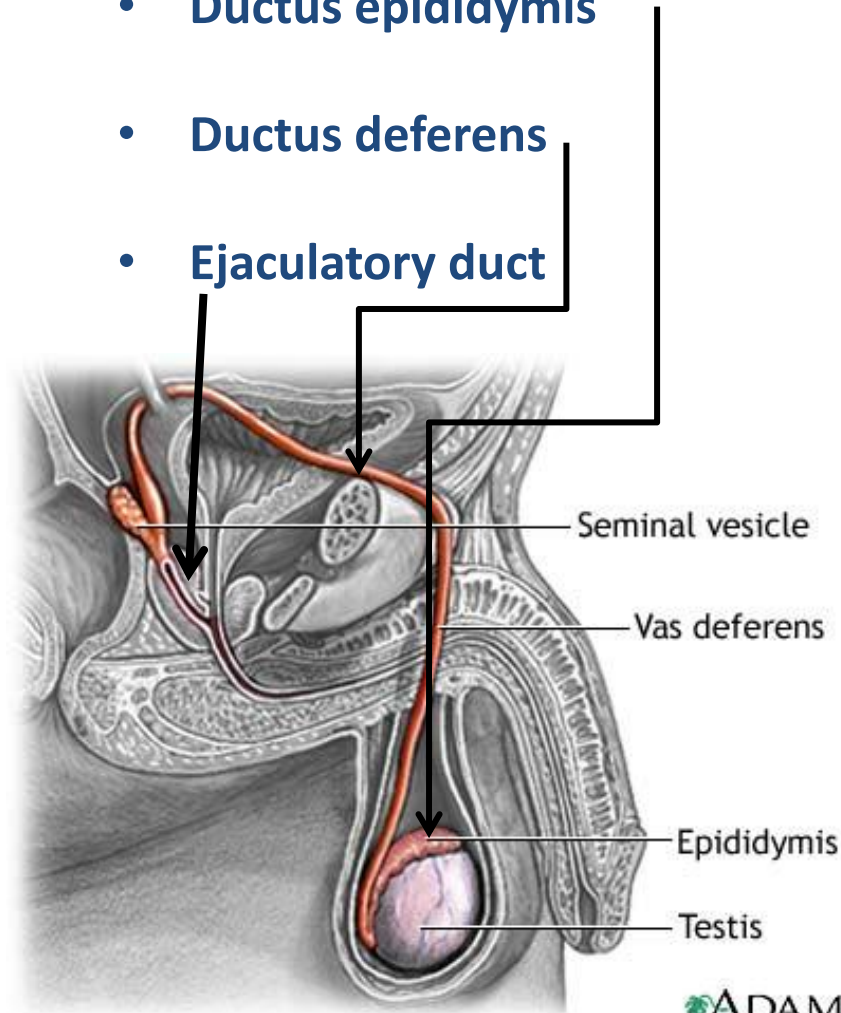
- **Straight tubules** – Sertoli cells, simple cuboidal epithelium
- **Rete testis** – low cuboidal epithelium
- **Efferent ductules** – simple cuboidal (absorption of fluid) and ciliated columnar cells (sweeping of sperm cells to the epididymis)



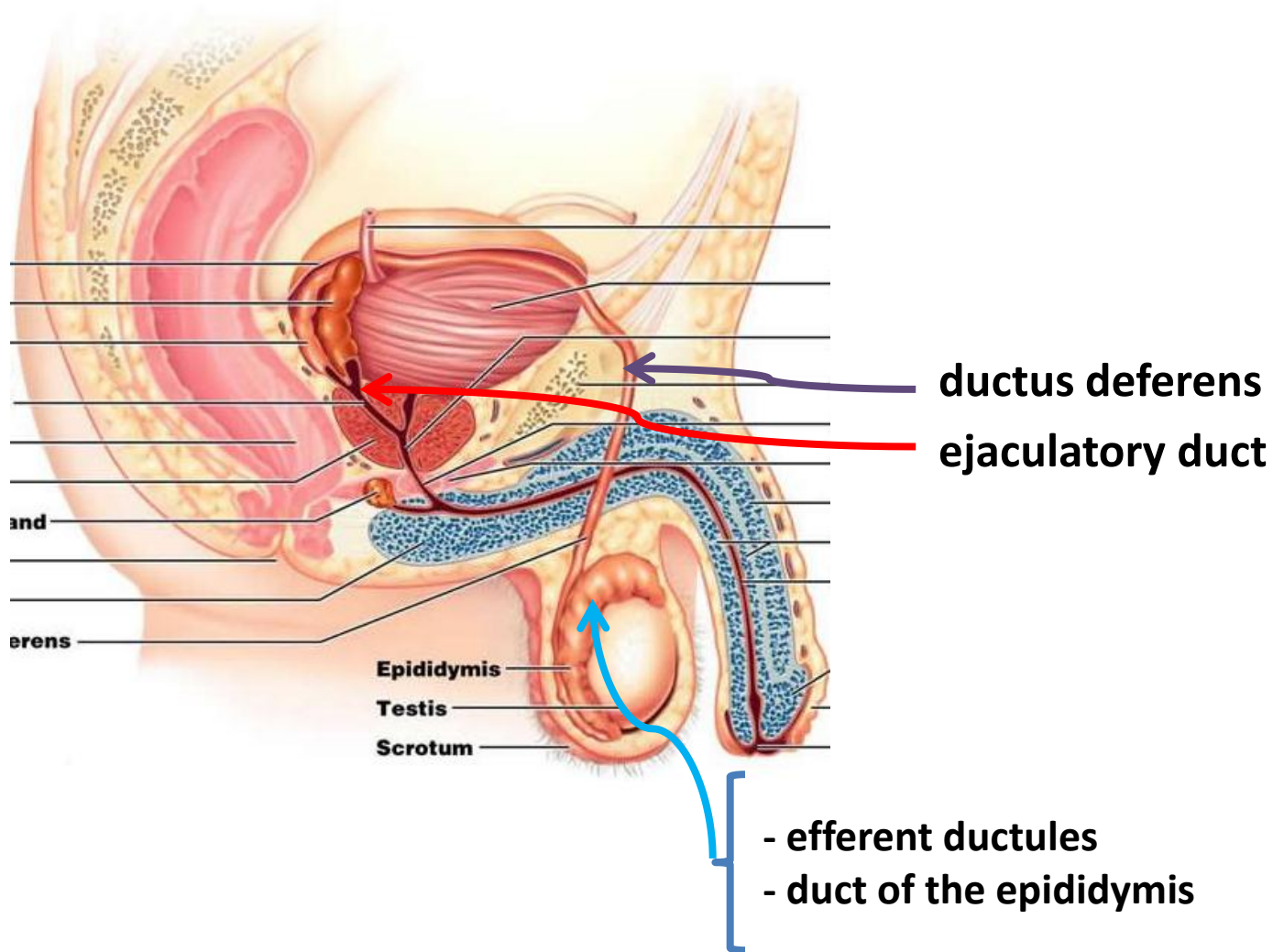
(a) Testis and epididymis

Excretory ducts:

- **Ductus epididymis**
- **Ductus deferens**
- **Ejaculatory duct**

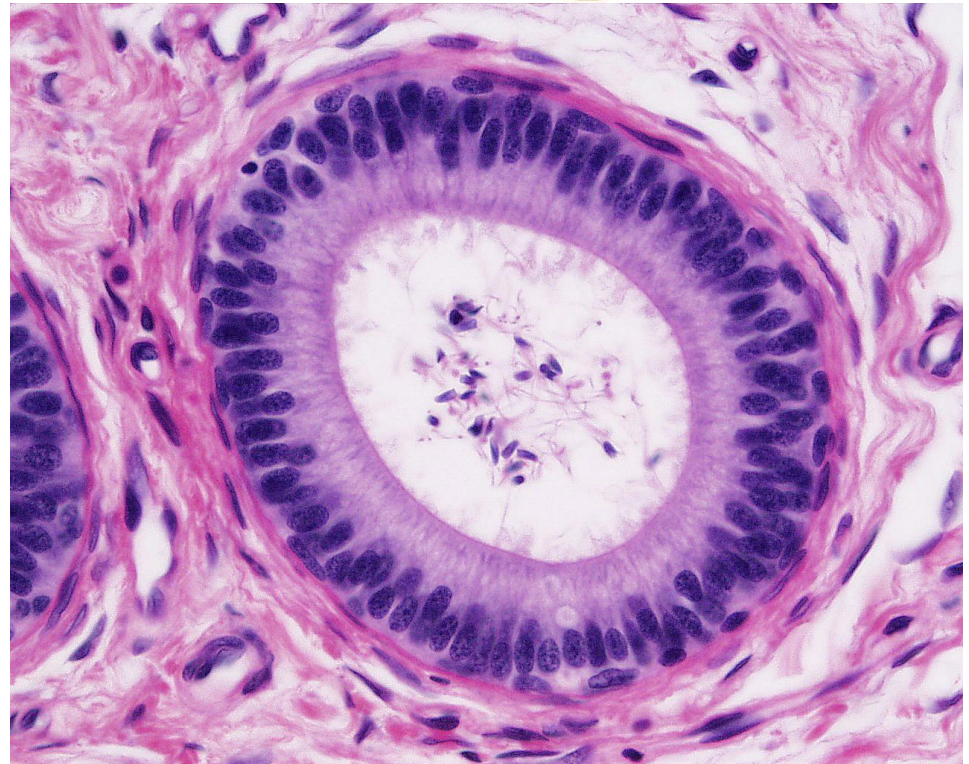
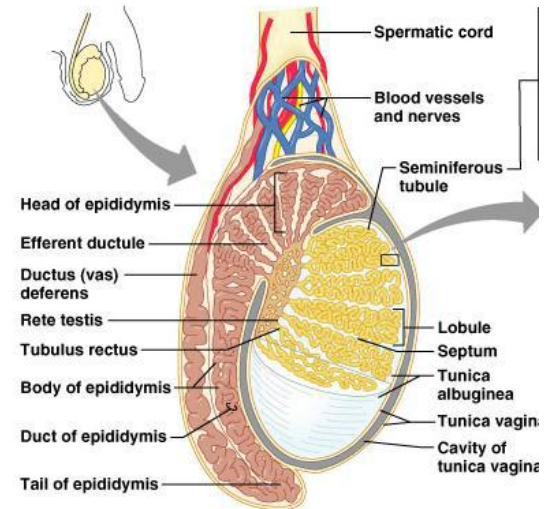


Spermatic ducts



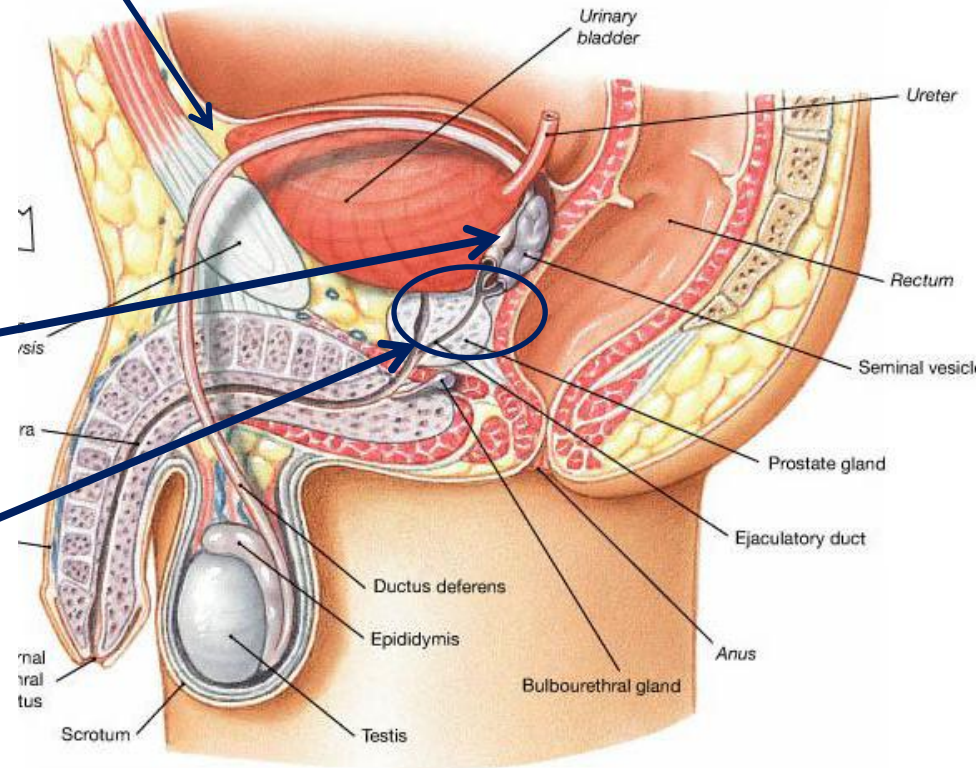
Epididymis

- ✓ Contains the **efferent ductules** and the **duct of the epididymis**
- ✓ Lined by the **pseudostratified epithelium**, cells are characterized by **stereocilia**
- ✓ Cells are capable of both **absorption** and **secretion**
- ✓ **Smooth muscle cells** underlie the BM help to propel spermatozoa toward the ductus deferens
- ✓ A site of **spermatozoa maturation**

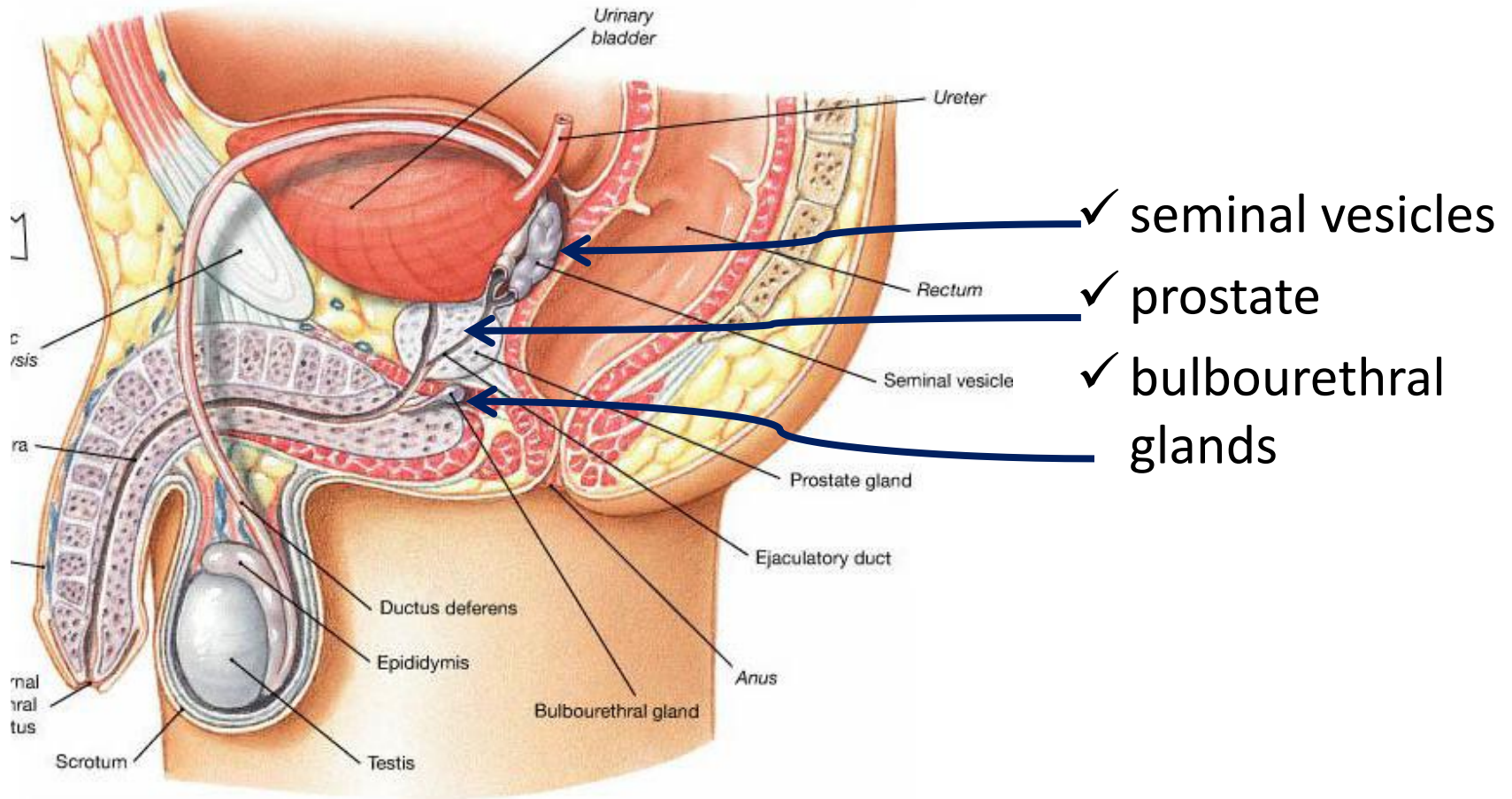


Ductus Deferens and Ejaculatory Duct

- DD is the longest part of the excretory system
- A direct continuation of the tail of the epididymis
- Within the spermatic cord through the inguinal canal ascends into the abdominal cavity
- **Pseudostratified columnar epithelium**, few stereocilia, longitudinal folds
- **Three layers of smooth muscles** – peristaltic contraction during **ejaculation**
- Distal end forms the **ampulla of ductus deferens**
- The ampulla joins the **duct of the seminal vesicle**, continues through the prostate gland as the **ejaculatory duct** and empties into the prostatic urethra.

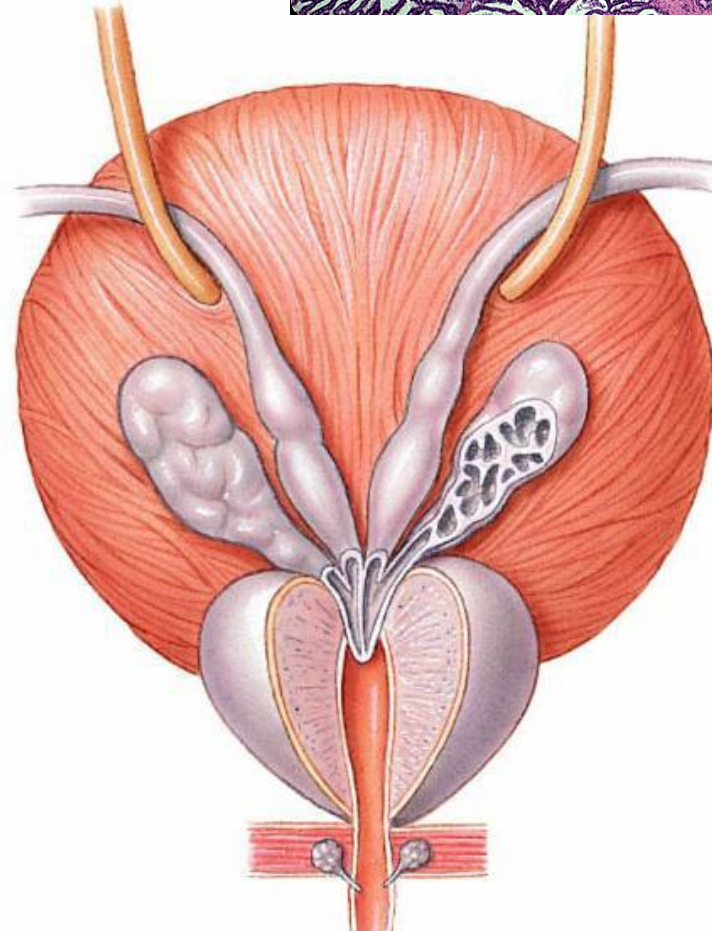
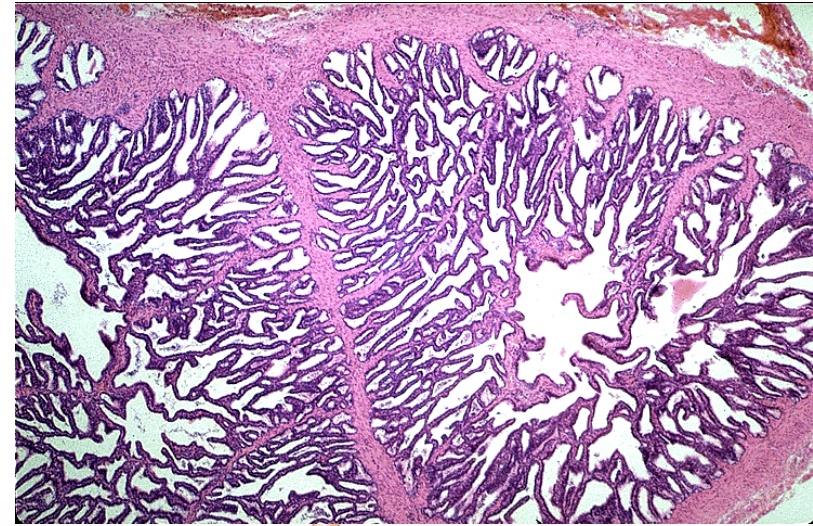


Accessory Genital Glands



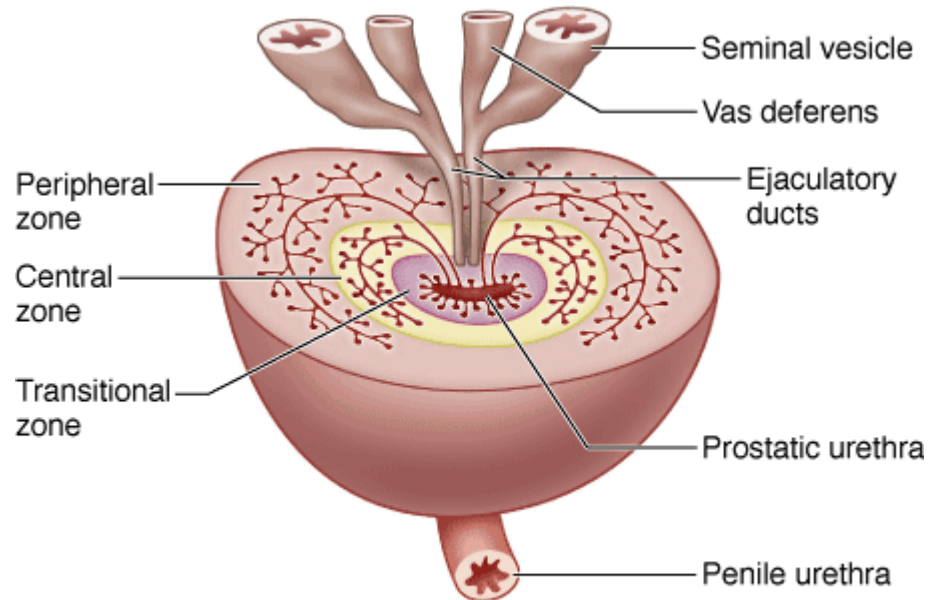
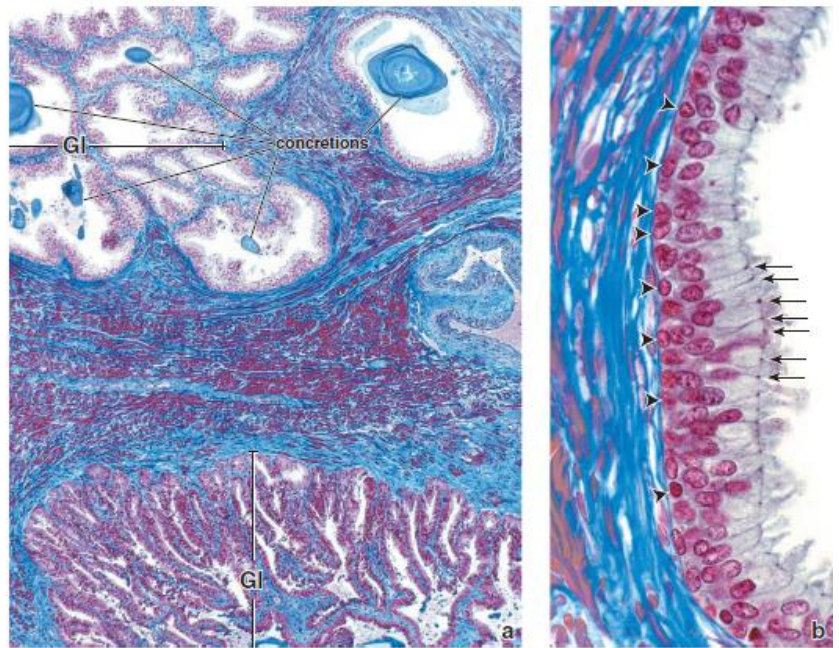
Seminal vesicles

- Highly coiled tubes
- Many folds in the mucosa
- Smooth muscle contract during ejaculation
- The secrete is **rich in fructose**, and other simple sugars, amino acids, citrate and prostaglandins
- Fluid of seminal vesicles is the principal **metabolic substrate** for sperm cells
- *70% of human ejaculate*
- Under the control of testosterone



PROSTATE GLAND

- Surrounds the origin of the urethra
- Consists of 30 to 50 **tubuloalveolar glands** arranged in three concentric layers:
 - an inner **mucosal layer**,
 - an intermediate **submucosal layer**,
 - a **peripheral layer**
- The mucosa is folded, epithelium from tall cuboidal to pseudostratified columnar
- Surrounded by fibromuscular capsule with smooth muscle cells that contract during ejaculation
- secrete a clear fluid rich in citric acid and acid phosphatase, that contributes to the formation of seminal fluid
- Ducts open into the prostatic urethra
- **Corpora amilacea** – glycoprotein spheres in the gland's lumen. Enlarge and calcify with age.



Source: Mescher AL: *Junqueira's Basic Histology: Text and Atlas, 12th Edition*: <http://www.accessmedicine.com>

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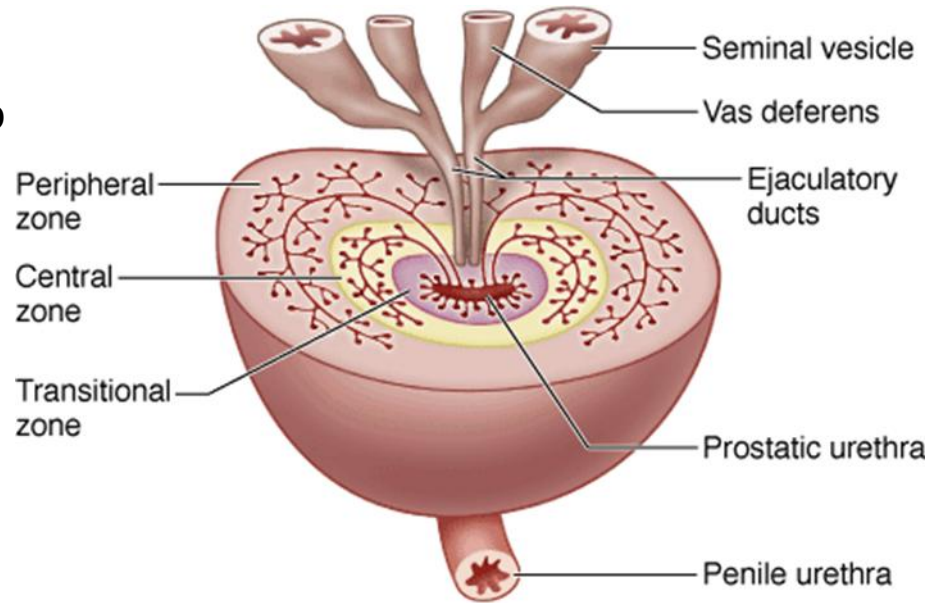
PROSTATE GLAND

The **adult prostatic parenchyma** is divided into four anatomically and clinically distinct zones:

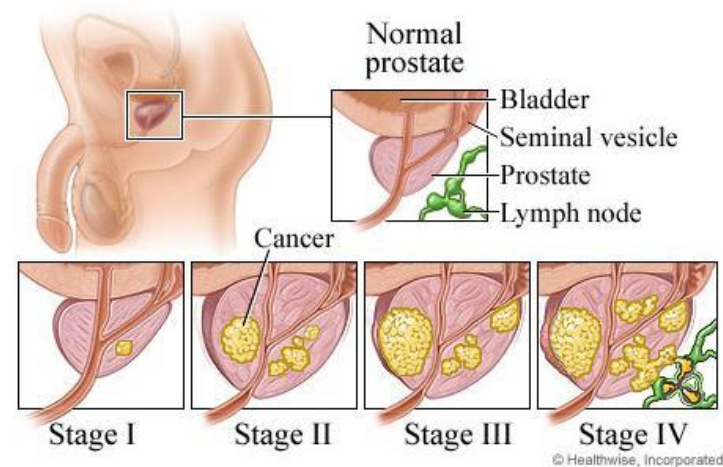
1. The **central zone**
2. The **peripheral zone**
3. The **transitional zone**

The **peripheral zone** comprises 70% of the glandular tissue of the prostate. It surrounds the central zone and occupies posterior and lateral parts of the gland.

Most prostatic carcinomas arise from the peripheral zone of the prostate gland. The peripheral zone is palpable during digital examination of the rectum. This zone is also the most susceptible to inflammation.



Source: Mescher AL: *Junqueira's Basic Histology: Text and Atlas, 12th Edition*: <http://www.accessmedicine.com>
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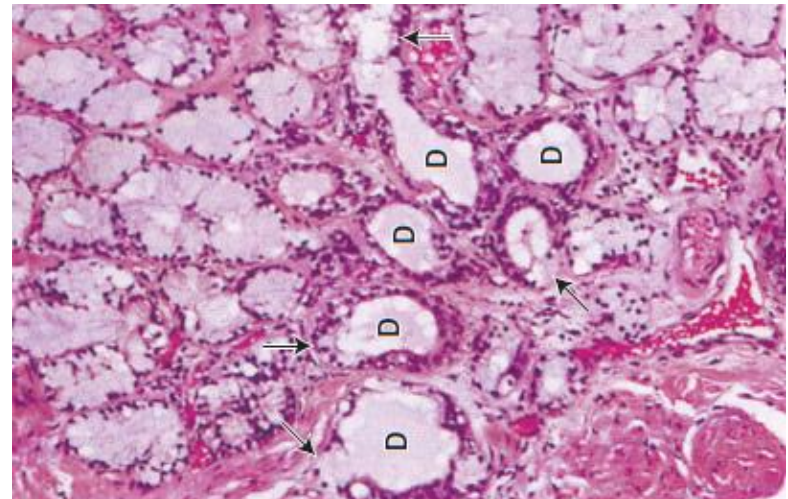
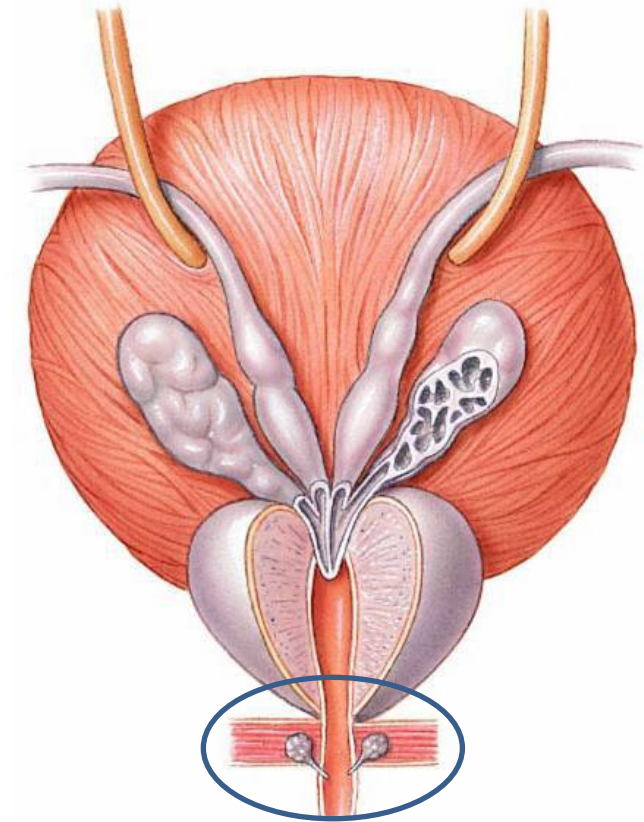


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Bulbourethral Glands

- ✓ The paired **bulbourethral glands (Cowper's glands)** are pea-sized structures located in the urogenital diaphragm
- ✓ The glands are compound **tubuloalveolar glands** that structurally resemble **mucus secretory glands**
- ✓ The clear, mucus-like glandular secretion contains considerable amounts of galactose and galactosamine, galacturonic acid, sialic acid.

Sexual stimulation causes release of this secretion, which constitutes the major portion of the **preseminal fluid and probably serves to lubricate the penile urethra.**



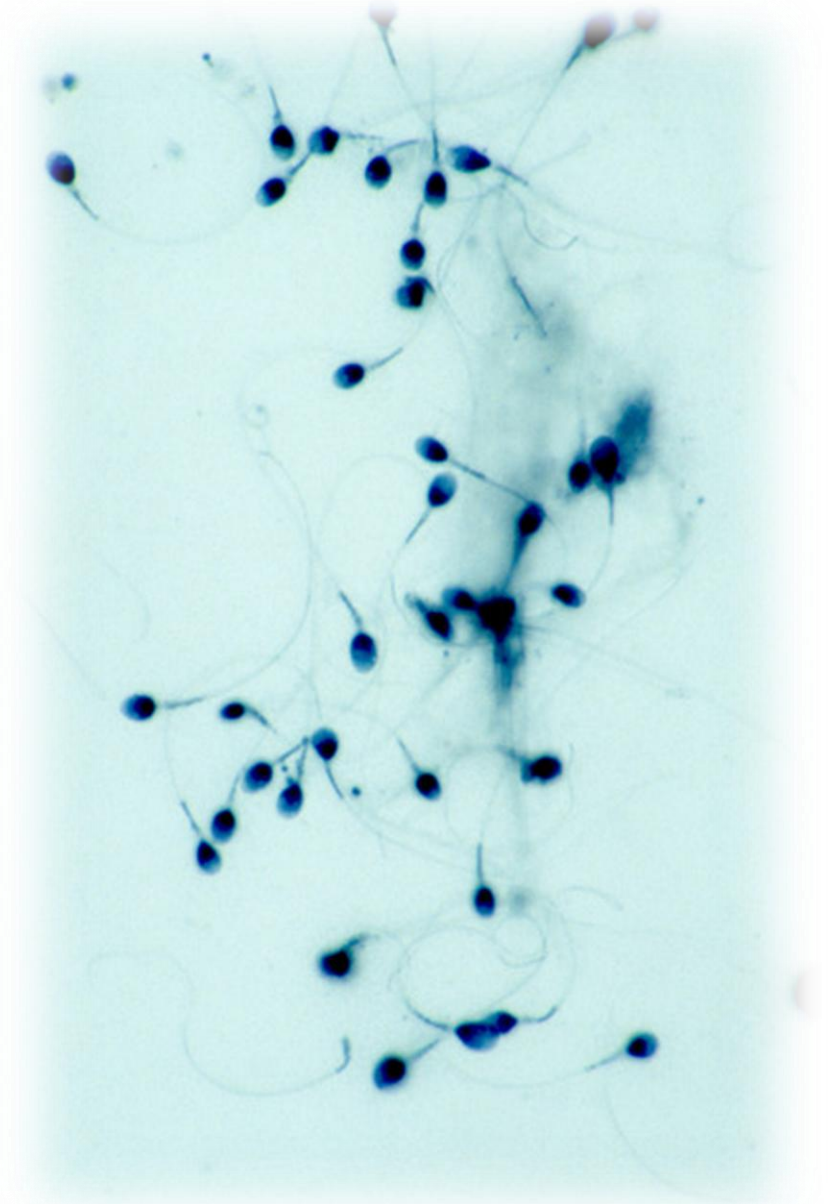
SEMEN

Semen contains **fluids and sperm** from the testis and secretory products from the epididymis, ductus deferens, prostate, seminal vesicles, and bulbourethral glands.

It is alkaline and may help to neutralize the acid environment of the urethra and the vagina.

Semen also **contains prostaglandins** that may influence sperm transit in both the male and female reproductive ducts.

The average ejaculate of semen has a volume of about 3 mL and normally contains up to 100 million sperm per milliliter.



Urethra

✓ Conducts both **urine** and **seminal fluid**

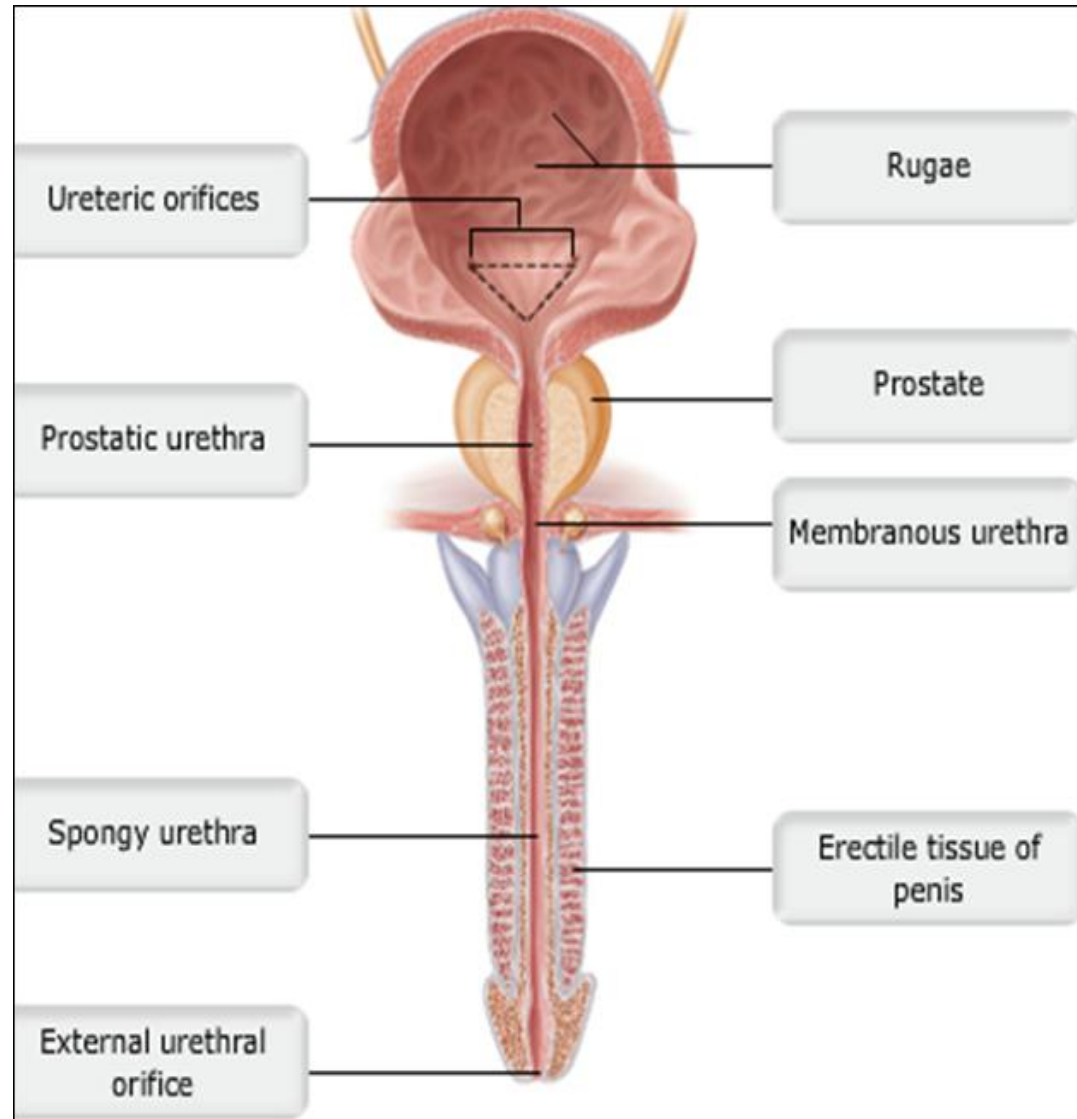
✓ **3 parts:**

1. Prostatic part – surrounded by the prostate, lined by transitional epithelium, receives prostatic and ejaculatory ducts

2. Membranous part – surrounded by skeletal muscles of urogenital diaphragm, which form voluntary external sphincter. Lined by pseudostratified columnar epithelium

3. Spongy part – passes through the corpus spongiosum of the penis, epithelium changes from pseudostratified columnar to stratified squamous towards the distal end (fossa navicularis).

✓ Numerous **glands of Littre** empty mucous secretion into the lumen



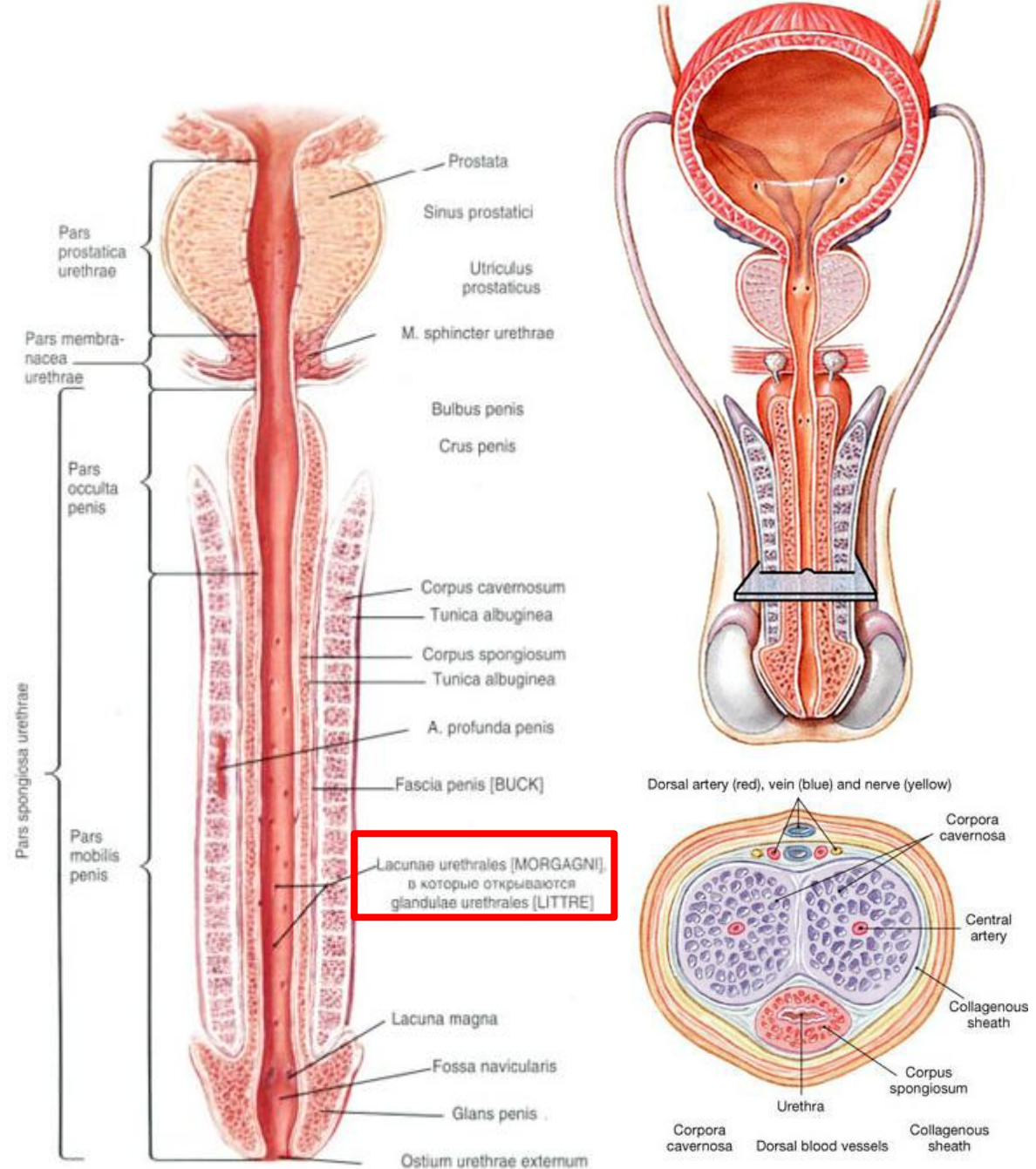
PENIS

Corpora cavernosa (two) – dorsal position, dense CT sheath – **tunica albuginea**

Corpus spongiosum – ventral position, distal end – **glans penis**, penetrated by the urethra

Erectile tissue – numerous interconnecting lacunae, lined by endothelium, surrounded by connective tissue trabeculae

Erection of the penis involves the filling of the vascular spaces of the corpora cavernosa and corpus spongiosum under the parasympathetic stimulation.



PENIS



Thank you for attention

