Male Reproductive System

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lec2

- Describe the anatomy and physiology of male reproductive organs.
- Understand the steps involved in spermatogenesis.
- Describe the structure of sperm, acrosome reaction, and capacitation
- Identify various contraceptive methods in male

- **Anatomy of the Male Reproductive System**

1. **External Genitalia:**

- Penis
- Scrotum (contains the testes)

2. **Internal Reproductive Organs**:

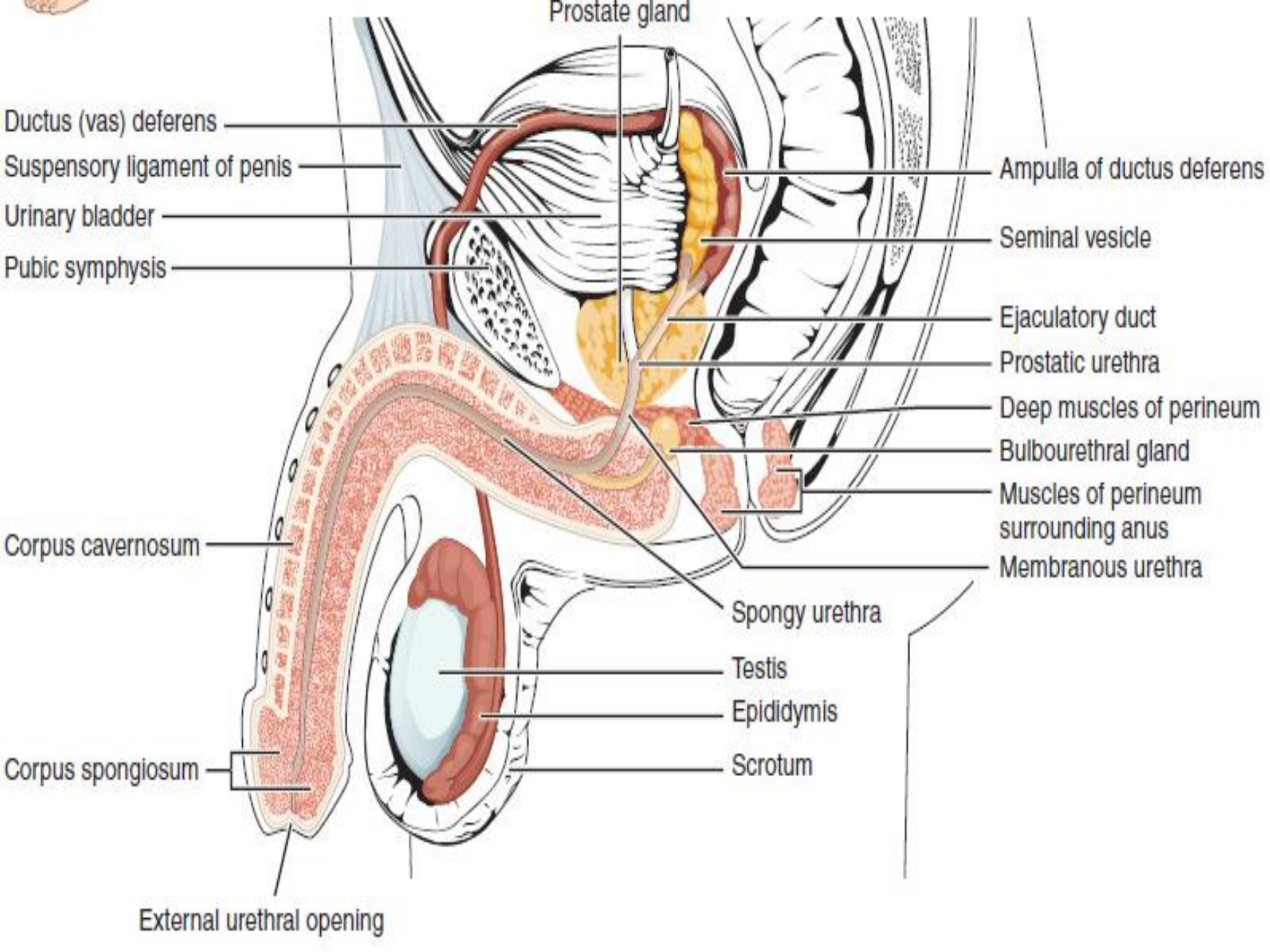
- **Testes**
- **Epididymis**:
- **Vas deferens (ductus deferens)**
- **Ejaculatory ducts:** formed by union of vas deferens and seminal vesicle ducts
- **Urethra**

3. **Accessory Glands:**

- Seminal vesicles
- Prostate gland
- Bulbourethral (Cowper's) glands

4. **Supportive structures:**

- **Spermatic cord:** contains vas deferens, blood vessels, lymphatics, and nerves
- **Cremaster and dartos muscles:** regulate testicular temperature

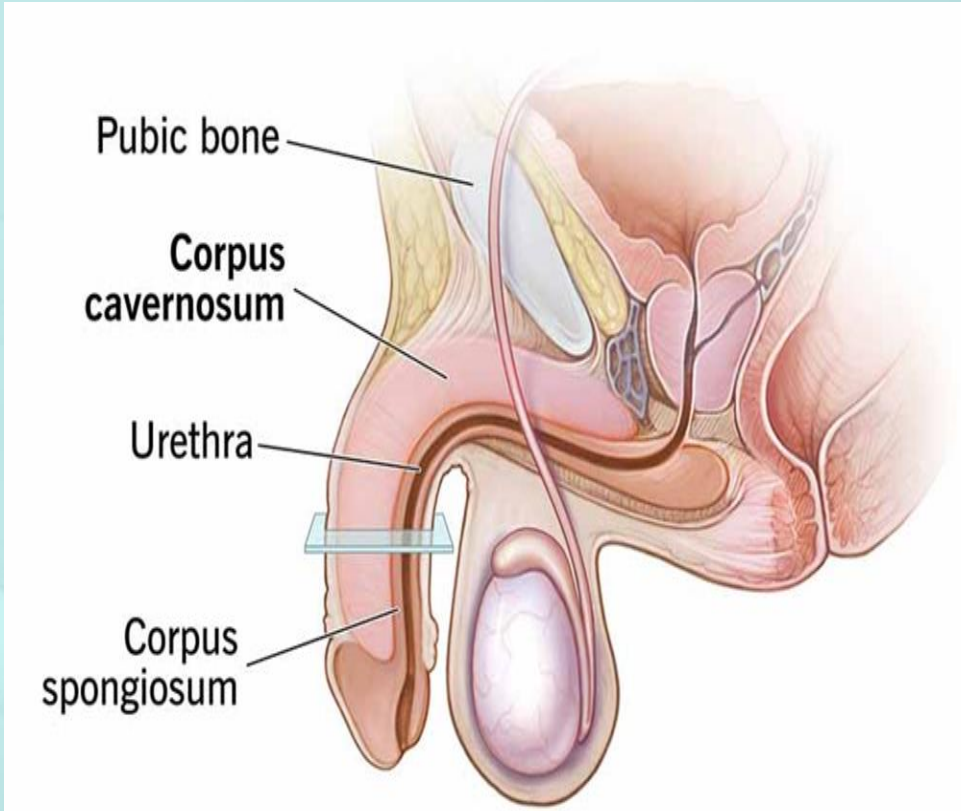

Prostate gland
Ductus (vas) deferens
Suspensory ligament of penis
Urinary bladder
Pubic symphysis
Ampulla of ductus deferens
Seminal vesicle
Ejaculatory duct
Prostatic urethra
Deep muscles of perineum
Bulbourethral gland
Muscles of perineum surrounding anus
Membranous urethra
Corpus cavernosum
Spongy urethra
Testis
Epididymis
Scrotum
Corpus spongiosum
External urethral opening

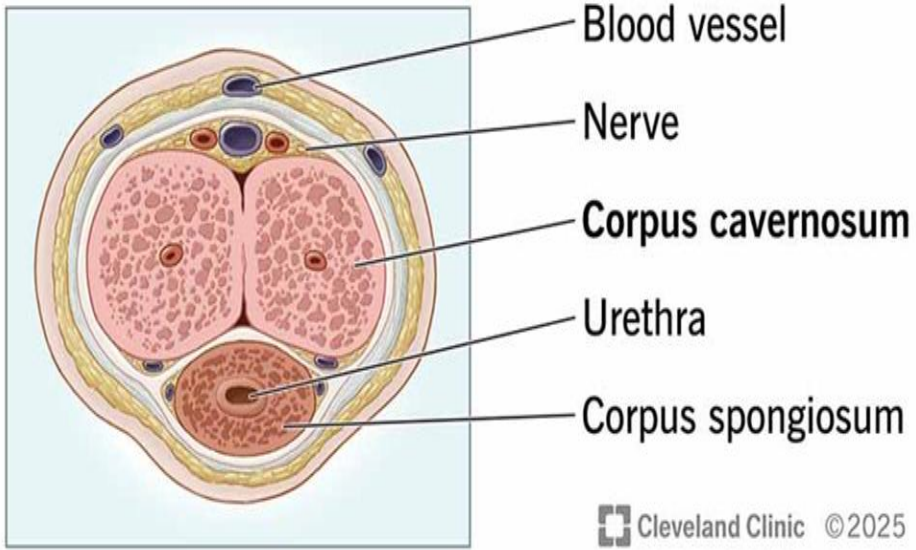
Penis:

The penis is composed of **three erectile bodies**:

- **Two corpora cavernosa** (dorsal) responsible for most of penile rigidity during erection.
- **One corpus spongiosum** (ventral), which surrounds the urethra and keeps it open during ejaculation.

  - Erectile tissue filled with vascular sinusoids; during erection, blood flow increases while venous outflow decreases



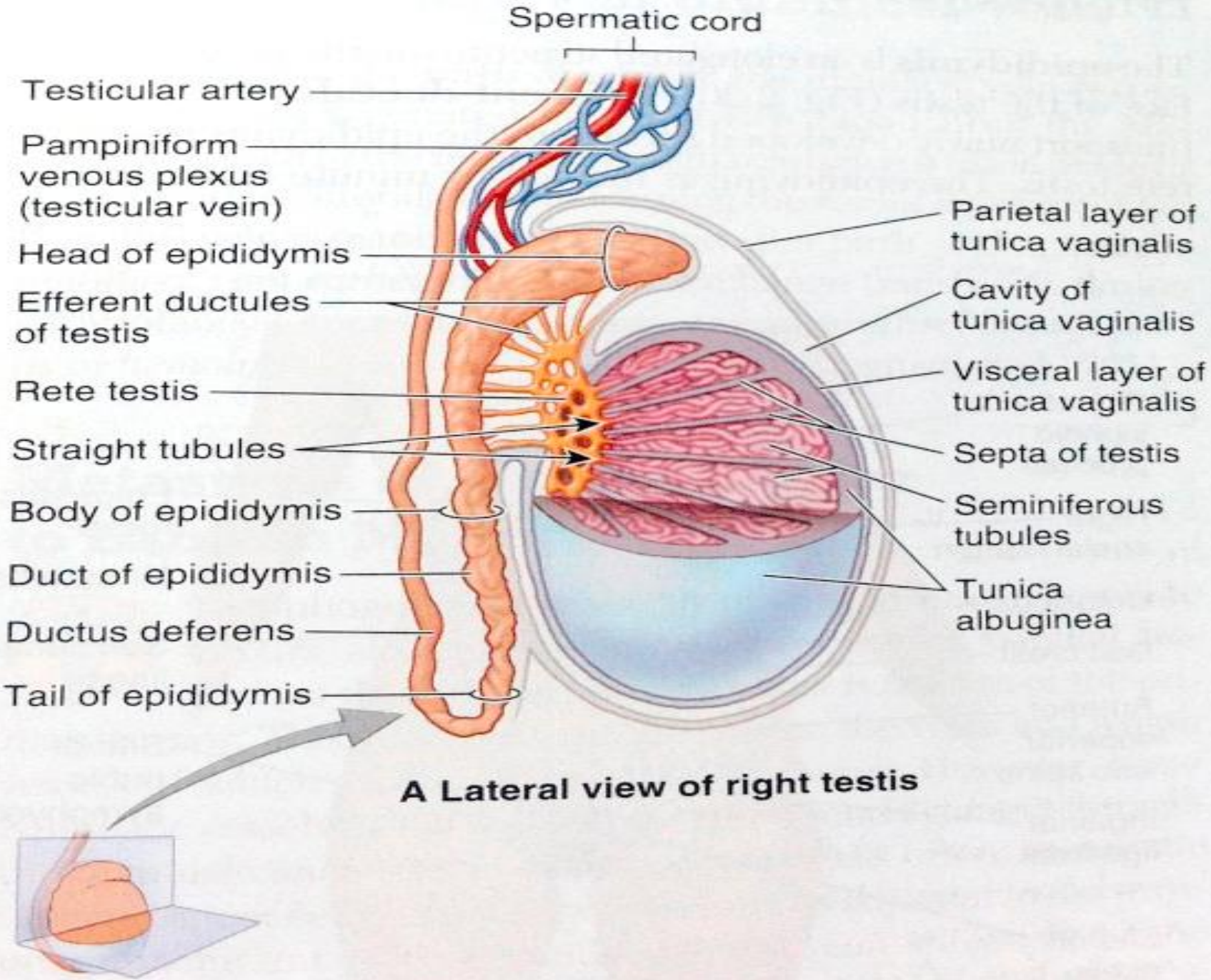


- **Scrotum**
- A **fibromuscular sac** that holds the testes outside the body.
- **Main function:** keep testicular temperature **2–3°C below body temperature** for normal spermatogenesis.
- **Temperature control via:**
  - **Dartos muscle** (skin wrinkling)
  - **Cremaster muscle** (testis elevation)

- **Internal Reproductive Organs**

1. **Testes**

- Each testis is an oval organ located in the scrotum, They are covered by two layers: the **tunica vaginalis** (parietal and visceral layers) and the **tunica albuginea**, a dense connective tissue that forms **septa** dividing the testis into **300–400 lobules**.
- Each testis contains numerous **seminiferous tubules** where sperm are formed. The **seminiferous tubules** are lined with **germ cells** supported by **Sertoli cells**, which extend from the basement membrane to the lumen.
- The ends of these tubules unite to form a network of ducts leading to the epididymis, where sperm mature and are stored.



A Lateral view of right testis

- **Cells of the Testis:**

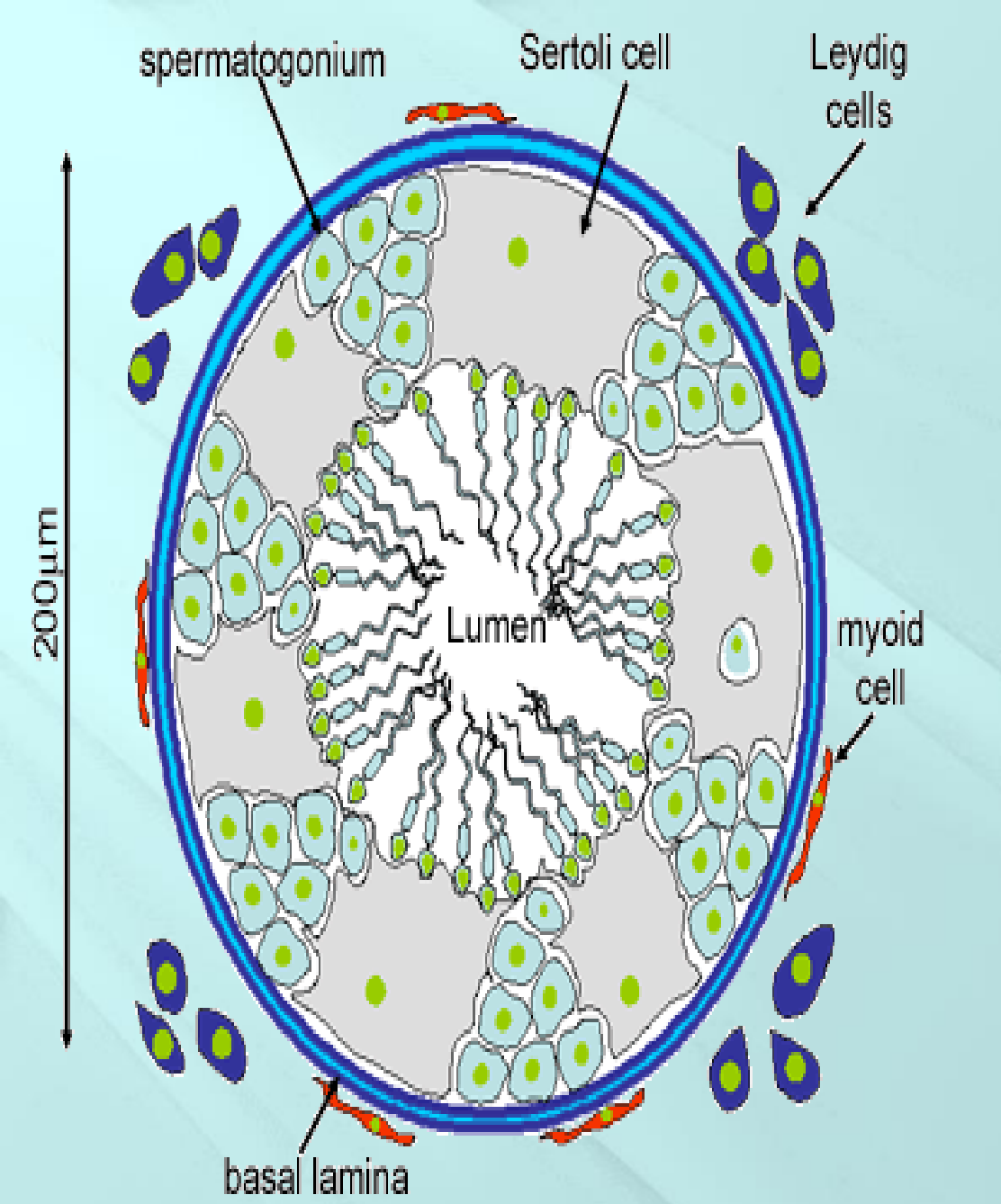
A. **Sertoli (sustentacular) cells**: support and nourish developing sperm, form the **blood-testis barrier**,

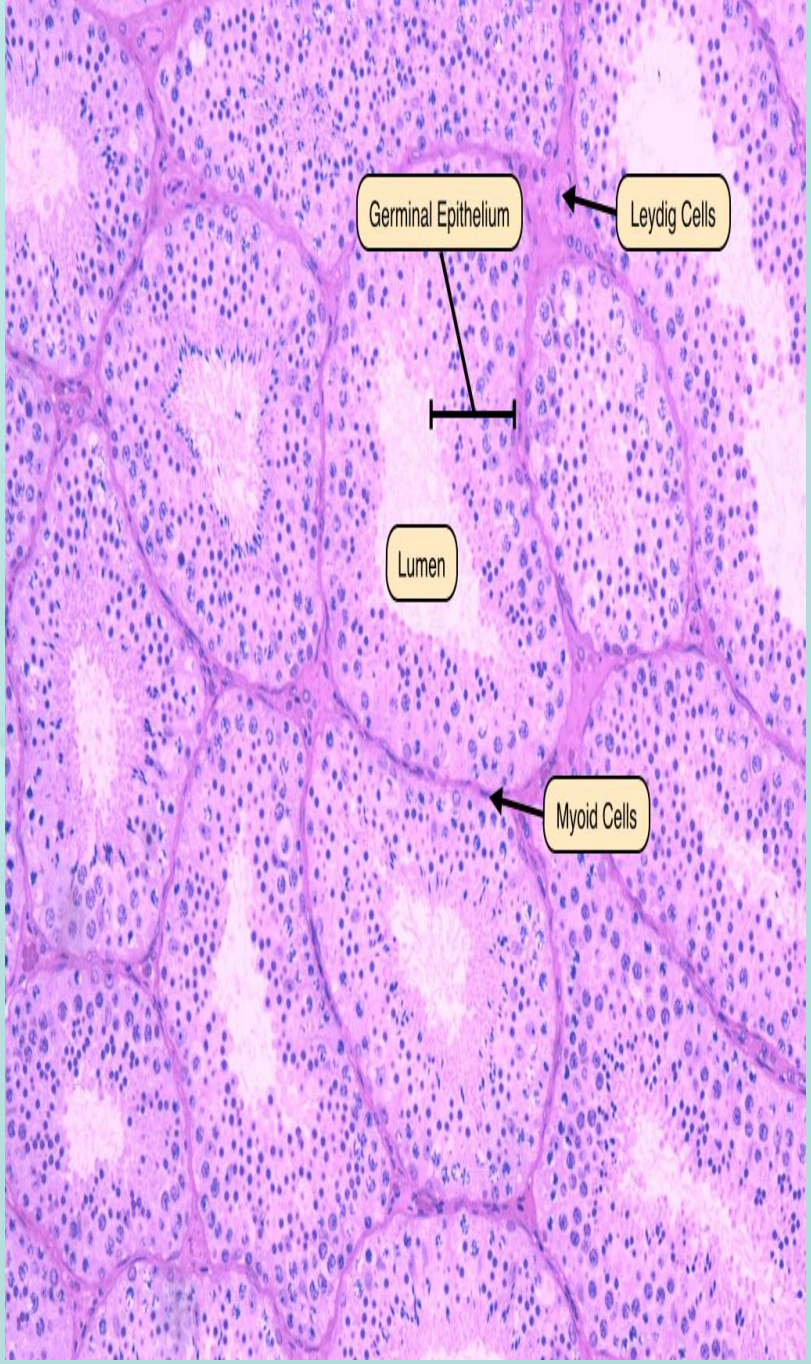
- **Sertoli Cell Secretions**:

1. **Inhibin:** inhibits FSH release to regulate spermatogenesis.
2. **Androgen-Binding Protein (ABP):** keeps high testosterone levels in tubules for sperm maturation.
3. **Fluid:** helps transport sperm through seminiferous tubules.

B. **Leydig (interstitial) cells**:

- located between tubules; secrete testosterone under LH stimulation from pituitary gland.
- Through paracrine communication, **testosterone** diffuses locally to act on neighboring Sertoli cells, **stimulating spermatogenesis and maintaining the blood-testis barrier**.
- This local signaling ensures that high concentrations of testosterone are maintained within the seminiferous tubules, which is essential for normal sperm maturation.


spermatogonium
Sertoli cell
Leydig cells
200µm
Lumen
myoid cell
basal lamina


Germinal Epithelium
Leydig Cells
Lumen
Myoid Cells

Blood-Testis Barrier

- The **blood-testis barrier** is formed by **tight junctions between adjacent Sertoli cells** within the seminiferous tubules.

  It divides the seminiferous epithelium into two compartments:

- **Basal compartment** – contains spermatogonia and early spermatocytes.
- **Adluminal compartment** – contains more advanced germ cells (spermatocytes and spermatids)

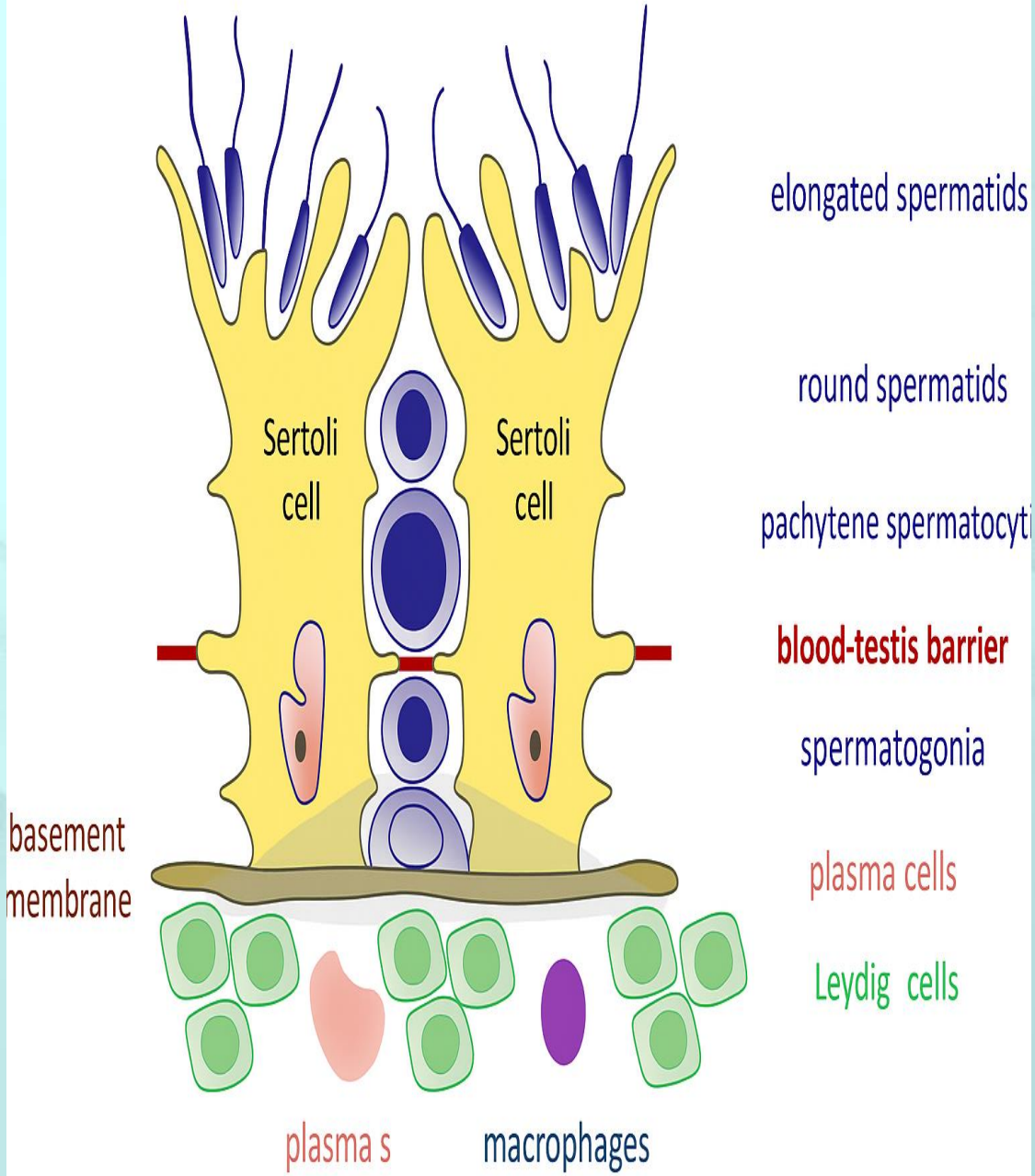
- **Role of Sertoli Cells and the Blood-Testis Barrier**
- **Sertoli cells** support and nourish developing germ cells and form the **blood-testis barrier** through tight junctions. This barrier isolates germ cells from the immune system, creating a protected microenvironment for **spermatogenesis**.
- During sperm development, Sertoli cells briefly open the junctions to let primary spermatocytes pass without immune exposure.

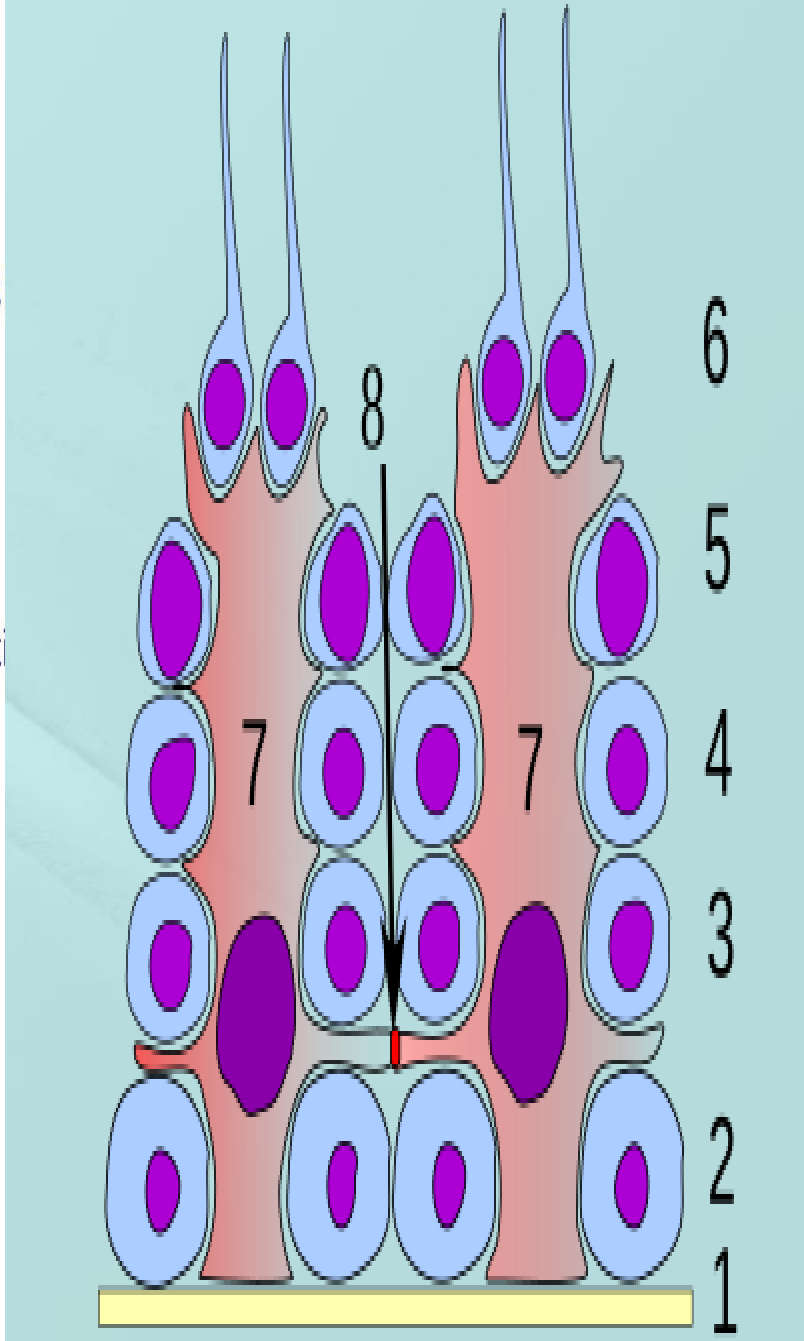
This Barrier:

1. **Restricts** passage of large molecules from blood to the tubule lumen.
2. **Allows** diffusion of **steroid hormones** and certain signaling proteins between Sertoli and **Leydig cells** (paracrine communication).
3. **Protects** developing sperm from **toxins and immune attack**.
4. **Maintains** a special **tubular fluid** composition (low protein and glucose, high in androgens, estrogens, K^+, inositol, and amino acids).

- As germ cells mature, they move toward the lumen by passing through the barrier in a controlled way.

BLOOD-TESTIS BARRIER

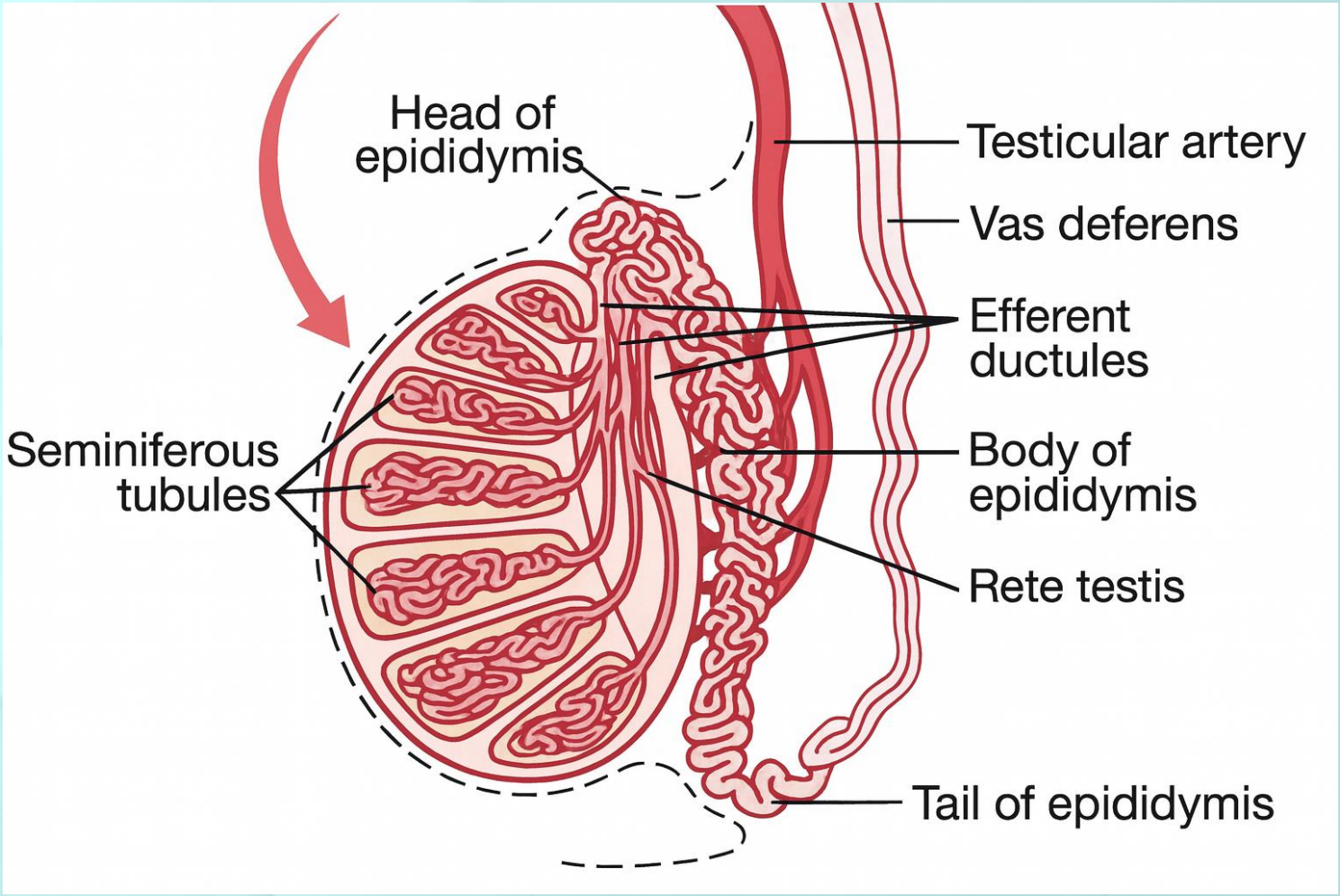




2. Epididymis

- A **highly coiled duct** on the posterior testis (≈6 m when uncoiled).
- Has **head, body, tail** regions.
- **Functions:** sperm **maturation, concentration** (this makes the remaining fluid thicker and richer in sperm)**,** and **storage**.
- Sperm leaving the testis are **immotile**; they gain **motility and fertilizing ability** while passing through the epididymis under **testosterone** and **epididymal secretions**

- The epithelium absorbs testicular fluid and secretes substances (glycoproteins, carnitine, sialic acid) that support sperm metabolism and membrane stability.
- The tail of the epididymis is the main site for storage of mature sperm for several days.
- During ejaculation, sympathetic-induced peristaltic contractions push sperm into the vas deferens.

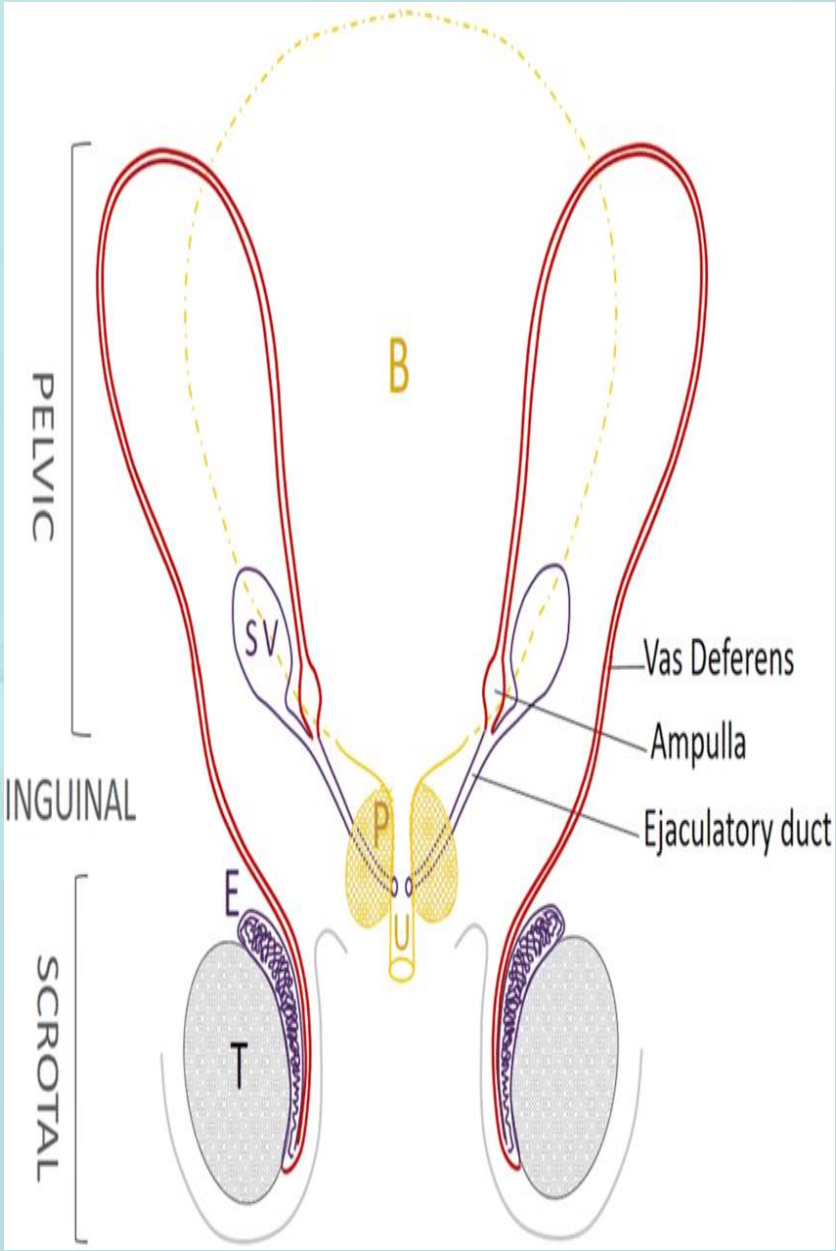

Head of epididymis
Testicular artery
Vas deferens
Efferent ductules
Seminiferous tubules
Body of epididymis
Rete testis
Tail of epididymis

Epididymis

3. Vas (Ductus) Deferens

- A thick-walled, muscular tube (~45 cm long) that connects the epididymis to the ejaculatory duct.
- **Function:**
- **Transport of sperm:** Propels spermatozoa from the epididymis to the ejaculatory duct during ejaculation. Movement is achieved by strong peristaltic contractions of smooth muscle fibers, triggered by sympathetic stimulation.
- Sperm are mixed with secretions from the seminal vesicles and prostate to form semen.

- **Physiological Control of Vas Deferens**
- Sympathetic control:
- Noradrenaline → α-adrenergic receptors → contraction of smooth muscle → sperm emission.
- During ejaculation, the internal urethral sphincter closes to prevent retrograde flow into the bladder.
- **Clinical note** : Vasectomy = surgical cutting or ligation of the vas deferens → prevents sperm transport, but doesn't affect hormone levels or libido.



4. Ejaculatory Duct and Urethra

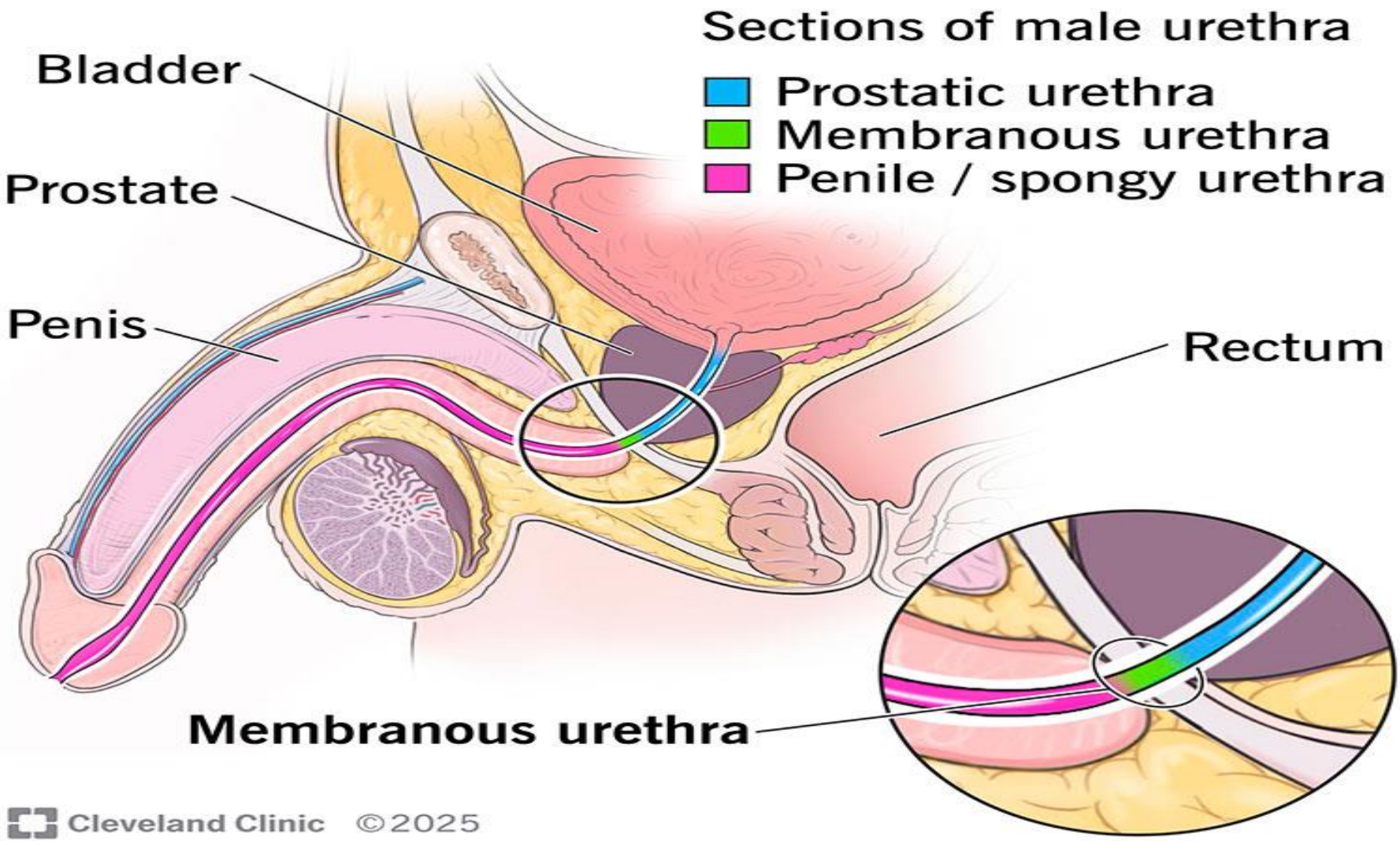
- The vas deferens joins the **duct of seminal vesicle** to form the ejaculatory duct, which empties into the **prostatic urethra**.
- **The male urethra** is a single tube divided into **prostatic**, **membranous**, and **penile parts**.
- **It has a dual function**:

1. It carries urine out of the body.
2. Serves as a passage for semen during ejaculation.

- A sphincter at the bladder neck closes during ejaculation to prevent mixing of urine and semen.

Membranous urethra

Intermediate urethra



5. Accessory Glands

A. Seminal Vesicles

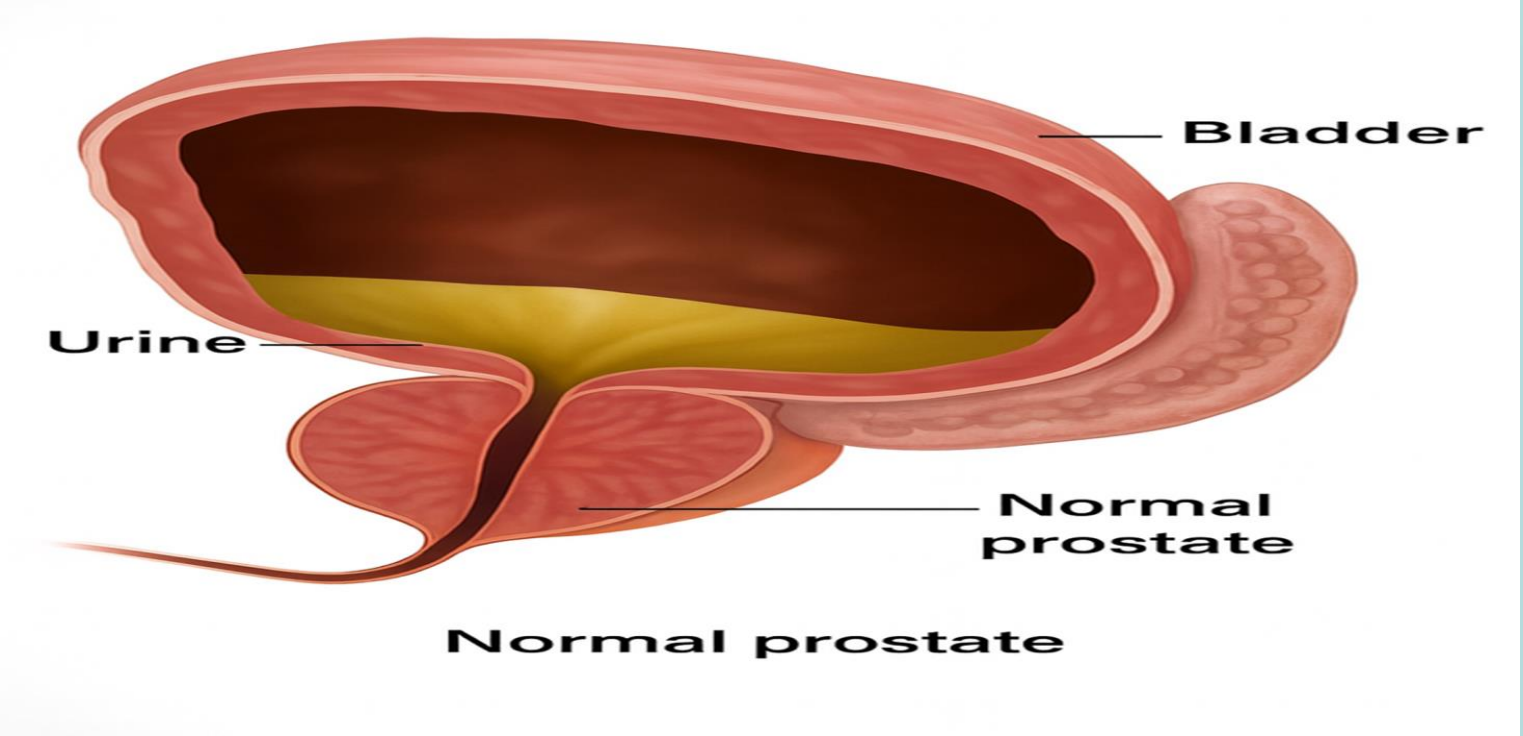
- Paired glands behind the bladder; add ~60% of semen. Secrete alkaline fluid with:

1. **Fructose** → energy for sperm.
2. **Prostaglandins** → enhance sperm motility/transport.
3. **Seminogelin**→ aids semen coagulation.

- The secretions from seminal vesicles mix with sperm in the ejaculatory ducts before entering the urethra.
- **Function** is under testosterone control and stimulated during sympathetic activity at ejaculation.

B. Prostate Gland

- A single gland located below the bladder and surrounding the upper part of the urethra (prostatic urethra).
- Contains numerous secretory alveoli lined by columnar epithelium that open into small ducts.
- Secretion is released into the urethra during ejaculation by sympathetic stimulation and contribute about 30% of total semen volume.



Normal prostate

- **The prostatic fluid is alkaline, which:**

A. **Neutralizes the acidic vaginal** environment, protecting sperm.

B. **Improves sperm motility and viability**.

C. **Rich in enzymes such as Prostate-Specific Antigen (PSA)** → liquefies semen after coagulation .

D. **Citrate, calcium, and phosphate ions** → provide nutrients for sperm.

E. **Zinc** → stabilizes sperm chromatin(protects sperm DNA integrity)

- **Physiological Role of Prostate:**

1. Maintains **optimal pH (≈7.5)** for sperm function.
2. Ensures **sperm activation and motility**.
3. Liquefies semen 15–30 minutes after ejaculation → aids sperm release in the female tract.

- **Clinical Notes**

- **PSA** is used as a **marker** for prostate health.
- **Prostatitis** or **benign prostatic hypertrophy (BPH)** may obstruct urine and semen flow.

c. **Bulbourethral (Cowper's) glands:** secrete mucus for lubrication and neutralization of urethral acidity.