MALE REPRODUCTIVE SYSTEM
Mythology and history

In Greek mythology, Priapus or Priapos, was a minor rustic fertility god, protector of livestock, fruit plants, gardens and male genitalia. Priapus is marked by his absurdly oversized, permanent erection, which gave rise to the medical term priapism.
Statuette of Osiris with phallus and amulets

Phallic-Head Plate, Gubbio, Italy, 1536

Polyphallic wind chime from Pompeii; a bell hung from each phallus
The male hormonal control
Hypothalamus

GnRH

Androgens prevent oversecretion of GnRH

Pituitary gland

LH (ICSH)

Androgens prevent oversecretion of LH (ICSH)

Inhibin prevents oversecretion of FSH

Bloodstream

Androgens stimulate the development of male secondary sex characteristics and maturation of sperm cells

FSH stimulates meiosis in primary spermatocytes to form immature sperm cells; FSH stimulates secretion of inhibin by supporting cells

LH (ICSH) stimulates interstitial cells to secrete androgens (primarily testosterone)

Testes

Inhibin

Androgens

Release into bloodstream

Stimulation

Inhibition
Hormonal Control of Male Reproductive Functions

• GnRH, FSH, and LH
• Testosterone

gonadotropin-releasing hormone (GnRH), released by the hypothalamus to stimulate the release of pituitary gonadotropins - follicle-stimulating hormone (FSH) and luteinizing hormone (LH) from the anterior pituitary gland.

In both males and females these two hormones act to promote gametogenesis and androgen/estrogen secretion.
Hormones that Affect Male Reproductive Processes

<table>
<thead>
<tr>
<th>HORMONE</th>
<th>SOURCE</th>
<th>ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>GnRH</td>
<td>Hypothalamus</td>
<td>Stimulates pituitary gland to secrete the gonadotropins FSH and ICSH</td>
</tr>
<tr>
<td>ICSH (LH)</td>
<td>Pituitary</td>
<td>Stimulates interstitial cells (cells of Leydig) in the testes to produce androgens, especially testosterone</td>
</tr>
<tr>
<td>FSH</td>
<td>Pituitary</td>
<td>Along with testosterone, stimulates spermatogenic cells in seminiferous tubules to produce sperm</td>
</tr>
<tr>
<td>Testosterone</td>
<td>Testes (interstitial cells)</td>
<td>Stimulates development of a man’s primary and secondary sex characteristics and affects his sexual behavior; along with FSH, stimulates spermatogenic cells to undergo spermatogenesis; feeds back to hypothalamus and pituitary, where it inhibits GnRH secretion to pituitary and LH production by the pituitary gland</td>
</tr>
<tr>
<td>Inhibin</td>
<td>Testes (Sertoli cells)</td>
<td>Maturing sperm causes Sertoli cells in seminiferous tubules to secrete inhibin, which feeds back to the pituitary, inhibiting its production of FSH</td>
</tr>
</tbody>
</table>
The Influence of Testosterone

- **skin**
  - hair growth, balding, sebum production

- **liver**
  - synthesis of serum proteins

- **male sexual organs**
  - penile growth
  - spermatogenesis
  - prostate growth and function

- **brain**
  - libido, aggression

- **muscle**
  - increase in strength and volume

- **kidney**
  - stimulation of erythropoietin production

- **bone marrow**
  - stimulation of stem cells

- **bone**
  - accelerated linear growth
  - closure of epiphyses
The Pituitary Gland
- Located in the center of your brain, it tells the testicles to produce testosterone

The Brain
- Regulates testosterone production by sending a signal to the pituitary gland

Physical Health
- Reduced muscle mass and strength result from low testosterone
- Increased body fat, such as a "pot belly," is another symptom

Bone Health
- Prolonged periods of low testosterone decrease bone density, increasing your risk of osteoporosis

The Testicles
- Produce testosterone and help keep normal levels in the body

Sexual Health
- Low testosterone can lead to problems achieving or maintaining erections
In short, this is a known list of sex organs that evolve from the same tissue in a human life.

<table>
<thead>
<tr>
<th>Indifferent</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gonad</td>
<td>Testis</td>
<td>Ovary</td>
</tr>
<tr>
<td>Mullerian duct</td>
<td>Appendix testis</td>
<td>Fallopian tubes</td>
</tr>
<tr>
<td>Mullerian duct</td>
<td>Prostatic utricle</td>
<td>Uterus, proximal vagina</td>
</tr>
<tr>
<td>Wolffian duct</td>
<td>Rete testis</td>
<td>Rete ovarii</td>
</tr>
<tr>
<td>Mesonephric tubules</td>
<td>Efferent ducts</td>
<td>Epoophoron</td>
</tr>
<tr>
<td>Wolffian duct</td>
<td>Epididymis</td>
<td>Gartner’s duct</td>
</tr>
<tr>
<td>Wolffian duct</td>
<td>Vas deferens</td>
<td></td>
</tr>
<tr>
<td>Wolffian duct</td>
<td>Seminal vesicle</td>
<td></td>
</tr>
<tr>
<td>Wolffian duct</td>
<td>Prostate</td>
<td></td>
</tr>
<tr>
<td>Urogenital sinus</td>
<td>Bladder, urethra</td>
<td>Bladder, urethra, distal vagina</td>
</tr>
<tr>
<td>Urogenital sinus</td>
<td>Bulbourethral gland</td>
<td>Bartholin’s gland</td>
</tr>
<tr>
<td>Genital swelling</td>
<td>Scrotum</td>
<td>Labia majora</td>
</tr>
<tr>
<td>Urogenital folds</td>
<td>Distal urethra</td>
<td>Labia minora</td>
</tr>
<tr>
<td>Genital tubercle</td>
<td>Penis</td>
<td>Clitoris</td>
</tr>
<tr>
<td>Prepuce</td>
<td>Foreskin</td>
<td>Clitoral hood</td>
</tr>
<tr>
<td></td>
<td>Bulb of penis</td>
<td>Vestibular bulbs</td>
</tr>
<tr>
<td></td>
<td>Glans penis</td>
<td>Clitoral glans</td>
</tr>
<tr>
<td></td>
<td>Crus of penis</td>
<td>Clitoral crura</td>
</tr>
</tbody>
</table>
The anatomy and abnormalities it self
The male reproductive system

- Two testes
- Scrotum
- Spermatic cords
- Accessory glands
- Penis
- Prepuce
- The male duct system
  - vasa efferentia
  - vas deferens
  - urethra external
Male Reproductive System

- Pathway of spermatozoa
  - Epididymis
  - Ductus deferens (Vas deferens)
  - Ejaculatory duct

- Accessory organs
  - Seminal vesicles
  - Prostate gland
  - Bulbourethral glands
  - Scrotal sac encloses testes
  - Penis
The Male Reproductive System in Anterior View

- Urinary bladder
- Inguinal canal
- Genitofemoral nerve
- Deferential artery
- Ductus deferens
- Pampiniform plexus
- Testicular artery
- Epididymis
- Scrotal cavity
- Testis (covered by visceral layer of tunica vaginalis)
- Parietal layer of tunica vaginalis (inner lining of cremaster, facing scrotal cavity)
- Spermatic cord
- Scrotal septum
- Cremaster muscle
- Superficial scrotal fascia
- Dartos muscle
- Scrotal skin (cut)
- Raphe
- Testicular artery
- Testicular vein
- Inguinal ligament
- Penis
- Superficial inguinal ring
The foreskin has twelve known functions.

- They are: to cover and bond with the synechia so as to permit the development of the mucosal surface of the glans and inner foreskin.
- to protect the infant’s glans from feces and ammonia in diapers.
- to protect the glans penis from friction and abrasion throughout life.
- to keep the glans moisturized and soft with emollient oils.
- to lubricate the glans.
- to coat the glans with a waxy protective substance.
- to provide sufficient skin to cover an erection by unfolding.
- to provide an aid to masturbation and foreplay.
- to serve as an aid to penetration.
- to reduce friction and chafing during intercourse.
- to serve as erogenous tissue because of its rich supply of erogenous receptors.
- to contact and stimulate the G-spot of the female partner.
1. Testicles
2. Epididymis
3. Corpus cavernosa
4. Foreskin
5. Frenulum
6. Urethral opening
7. Glans penis
8. Corpus spongiosum
9. Penis
10. Scrotum
hypospadias
Epispadias
Penis Anatomy

- skin layers
- connective tissue
- prepuce
- glans penis
- external urethral opening

b. urethra
- erectile tissue
- subcutaneous tissue
- connective tissue
- skin
The word "penis" is taken from the Latin word for "tail."
Dorsal veins  Dorsal artery and nerve  Integument

Fibrous envelope

Corpora cavernosa penis  Septum pectiniforme

Urethra

Corpus cavernosum urethrae
Malignant priapism secondary to osteogenic sarcoma

RB Nerli, A Koura, V Prabha, SB Alur, S Devaraju, S Godhi, MB Hiremath
Department of Urology, KLE University’s KLES Kidney Foundation, KLES Dr. Prabhakar Kore Hospital & MRC, Belgaum - 590 010, India
Aphallia (penile agenesis) results from failure of the genital tubercle to develop.

Incidence: 1/10,000,000 live male births (only 70 reported cases).

Usually has appearance of well-developed scrotum with bilaterally descended testes, but no penile shaft.

Urethral opening most often on the anal verge adjacent to a small skin tag; otherwise, may be in rectum.

Associated anomalies:
- Cryptorchidism,
- Horseshoe kidney,
- Renal agenesis,
- Imperforate anus.
Bifid penis

Surgically done
Diphallus: duplication of the penis
rare anomaly that may range from small accessory penis to the real deal...times two.
associated anomalies: hypospadias, bifid scrotum, duplicated bladder, renal agenesis/ectopia,
Control of erection

Hypothalamus (conscious control)

Parasympathetic nerves
neurotransmitter- nitric oxide
promotes blood flow into penis
(Viagra- promotes vasodilation)

Control of emission and ejaculation
sympathetic nerves- muscle contraction

• The man whose non-erect penis is smallish will usually achieve about a 100 per cent increase in length during sexual excitement.

• The man whose non-erect penis is on the largish size will probably manage about a 75 per cent increase.

• This means the great majority of penises measure between 15cm and 18cm (6-7 inches) when erect, with the average figure being about 16.5cm (6.5 inches).
A view of the frenulum, foreskin retracted
Penis post ejaculation, notice all the vasculature [veinous]
phemosis
One can more readily infer the examiner’s effort to retract the foreskin in this image. Ecchymoses of unknown origin are conspicuous about 2 cm behind the preputial orifice, and are not ulcerated.
Scrotum

- Skin
- Dartos muscle (smooth)
- Septum
- Cremaster muscle (skeletal)
Scrotum

- **Temperature**
  - Optimal for sperm development is 3°C below body temp (~91°F)
  - Controlled by muscles

- **Spermatic cord**
  - Testicular artery
  - Plexus of veins
  - Nerves
  - vas deferens
The Scrotum

Intrascrotal temperature is kept constant by two sets of muscles:

**Dartos** – smooth muscle that wrinkles scrotal skin. regulate the temperature of the testicles, which promotes spermatogenesis. It does this by expanding or contracting to wrinkle the scrotal skin. Contraction reduces the surface area available for heat loss, thus reducing heat loss and warming the testicles. Conversely, expansion increases the surface area, promoting heat loss and thus cooling the testicles.

**Cremaster** – bands of skeletal muscle that elevate the testes. Its function is to raise and lower the testes in order to regulate the temperature of the testes and promote spermatogenesis. Contraction may also occur during arousal which can prevent injury to the testicles during sex.

In human females, the cremaster muscle is smaller and is found on the round ligament.
Figure 1 – Incision of the tunica albuginea on the left corpus cavernosum. A longitudinal band in the tunica (of about 0.5 cm) is prepared.
Hydrocele in a 40 Year Old man
| Testes |
MALE REPRODUCTIVE SYSTEM

- **TESTIS**

  **TUNICA ALBUGINEA**
  - thick connective tissue capsule
  - connective tissue septa divide testis into 250 lobules
  - each lobule contains 1-4 seminiferous tubules and interstitial connective tissue

  **(1) SEMINIFEROUS TUBULES**
  - produce sperm

  **INTERSTITIAL TISSUE**
  - contains Leydig cells which produce testosterone

  **(2) RECTUS TUBULES**
  **(3) RETE TESTIS**
  **(4) EFFERENT DUCTULES**
  **(5) EPIDIDYMIS**
MALE REPRODUCTIVE SYSTEM

- TESTIS
- EPIDIDYMIS
- TUNICA ALBUGINEA
- Mediastinum containing RETE TESTIS
- LOBULES
Testes (single testis)

Divided into 200-300 wedge shaped lobules.

Testes and ovaries are from the same tissue

Seminiferous tubules:
Cells specialties
1). Leydig cells
2). Spermatogonic cells

Testis
Layers of the testis:

- Tunica vaginalis (peritoneum)
- Tunica albuginea (dense connective tissue)
- Septa radiate from mediastinum testes
- Dividing testes into lobules
- Each has 1-4 tubules (Seminiferous tubules)
• Testes are formed in abdomen and descend into scrotum at 7th month of development

• Temperature in scrotum is slightly lower than in body

• Spermatogenesis (formation of sperm)
  • sperm-forming cells
  • Sertoli cells
  • interstitial cells—produce testosterone

• Process takes about 9 weeks
Testes
The testes have, like the ovaries, two functions:

• they produce the male gametes or spermatozoa,
• they produce male sexual hormone, testosterone, which stimulates the accessory male sexual organs and causes the development of the masculine extragenital sex characteristics.
The testis is surrounded by a thick capsule, the **tunica albuginea**, from which a conical mass of connective tissue, the mediastinum testis, projects into the testis. The tunica albuginea is covered externally by a serosa.

From the mediastinum, delicate fibrous septa radiate towards the tunica albuginea and divide the parenchyma of the testis into about 300 lobuli testis.

Each lobule contains 1-4 convoluted seminiferous tubules (about 150-300 µm in diameter, 30-80 cm long).

Interstitial tissue between the convoluted tubules is continuous with a layer of loose vascular connective tissue, the tunica vasculosa testis, which is found beneath the tunica albuginea.

Each seminiferous tubule continues near the mediastinum into a straight tubule, a tubulus rectus. The straight tubules continue into the rete testis, a labyrinthine system of cavities in the mediastinum.
The Structure of the Testes

Figure 28.4
The Epididymus

Figure 28.9
Bulbourethral Glands (Cowper’s Glands)

- Pea-sized glands inferior to the prostate
- Produce thick, clear, alkaline mucus prior to ejaculation that neutralizes traces of acidic urine in the urethra
Contents of Semen

- Typical ejaculate = 2-5 ml fluid
  - Contains between 20 – 100 million spermatozoa per ml
- Seminal fluid
  - A distinct ionic and nutritive glandular secretion
MALE REPRODUCTIVE SYSTEM

- TESTIS

  TUNICA VAGINALIS
  TUNICA ALBUGINEA
  SEMINIFEROUS TUBULES

  SEMINIFEROUS EPITHELIUM
  - complex stratified epithelium
    containing two basic cell populations:

  (1) SPERMATOGENIC CELLS
  (2) SERTOLI CELLS
TESTIS H&E
SEMINIFEROUS TUBULES

SEMINIFEROUS TUBULES

INTERSTITIAL CONN. TISSUE
The Seminiferous Tubules

Figure 28.5a, b

Seminiferous tubule containing spermatids completing spermiogenensis
Seminiferous tubule containing spermatids beginning spermiogenensis
Seminiferous tubules containing spermatozoa about to be released into the lumen

(a)
Dividing spermatocytes
Spermatogonia
Interstitial cells
Sustentacular cells
Connective tissue capsule
Heads of maturing spermatozoa

(b)
Dividing spermatocytes
Sperms
Sustentacular cell
Capillary
Spermatozoa
Interstitial cells
Spermatogonium
Male reproductive tract

- Testes produce mature spermatozoa
- Sperm enter epididymus
  - Elongated tubule with head, body and tail regions
  - Monitors and adjusts fluid in seminiferous tubules
  - Stores and protects spermatozoa
  - Facilitates functional maturation of spermatozoa
MALE REPRODUCTIVE SYSTEM

• TESTIS

SEMINIFEROUS TUBULES

SEMINIFEROUS EPITHELIUM

- complex stratified epithelium containing two basic cell populations:

1) SPERMATOGENIC CELLS
   - stem cells which regularly replicate and differentiate into mature sperm as they migrate toward the lumen

2) SERTOLI CELLS
   - nonreplicating physical support cells

INTERSTITIAL CONNECTIVE TISSUE

1) LEYDIG CELLS
   - produce and release testosterone
The Seminiferous Tubules

- Spermatids completing spermiogenesis
- Initial spermiogenesis
- Secondary spermatocyte in meiosis II
- Luminal compartment
- Level of blood-testis barrier
- Basal compartment
- Connective tissue capsule
- Interstitial cells
- Sustentacular cells
- Secondary spermatocyte
- Primary spermatocyte preparing for meiosis I
- Capillary
- Spermatogonium
- Fibroblast
- Lumen
- Spermatids beginning spermiogenesis
- (c)
Function of the Seminal Vesicles

Each seminal vesicle is a tortuous, loculated tube lined with a secretory epithelium that secretes a mucoid material containing an abundance of fructose, citric acid, and other nutrient substances, as well as large quantities of prostaglandins and fibrinogen.

During the process of emission and ejaculation, each seminal vesicle empties its contents into the ejaculatory duct shortly after the vas deferens empties the sperm.

This adds greatly to the bulk of the ejaculated semen, and the fructose and other substances in the seminal fluid are of considerable nutrient value for the ejaculated sperm until one of the sperm fertilizes the ovum.

**Prostaglandins are believed to aid fertilization in two ways:**

1. by reacting with the female cervical mucus to make it more receptive to sperm movement
2. by possibly causing backward, reverse peristaltic contractions in the uterus and fallopian tubes to move the ejaculated sperm toward the ovaries (a few sperm reach the upper ends of the fallopian tubes within 5 minutes)
SPERMATOGENESIS

- Seminiferous tubules
  - Contain spermatogonia
    - Stem cells involved in spermatogenesis
  - Contain sustentacular cells
    - Sustain and promote development of sperm
Hormonal Factors That Stimulate Spermatogenesis

We shall discuss the role of hormones in reproduction later, but at this point, let us note that several hormones play essential roles in spermatogenesis. Some of these are as follows:

1. **Testosterone**, secreted by the Leydig cells located in the interstitium of the testis, is essential for growth and division of the testicular germinal cells, which is the first stage in forming sperm.
Maturation of Sperm in the Epididymis

After formation in the seminiferous tubules, the sperm require several days to pass through the 6-meter-long tubule of the epididymis.

*Sperm removed from the* seminiferous tubules and from the early portions of the epididymis are nonmotile, and they cannot fertilize an ovum.

However, after the sperm have been in the epididymis for some 18 to 24 hours, they develop the capability of motility, even though several inhibitory proteins in the epididymal fluid still prevent final motility until after ejaculation.
2. Luteinizing hormone, secreted by the anterior pituitary gland, stimulates the Leydig cells to secrete testosterone.

3. Follicle-stimulating hormone, also secreted by the anterior pituitary gland, stimulates the Sertoli cells; without this stimulation, the conversion of the spermatids to sperm (the process of spermiogenesis) will not occur.

4. Estrogens, formed from testosterone by the Sertoli cells when they are stimulated by follicle-stimulating hormone, are probably also essential for spermiogenesis.

5. Growth hormone (as well as most of the other body hormones) is necessary for controlling background metabolic functions of the testes.

Growth hormone specifically promotes early division of the spermatogonia themselves; in its absence, as in pituitary dwarfs, spermatogenesis is severely deficient or absent, thus causing infertility.
Storage of Sperm. The two testes of the human adult form up to 120 million sperm each day.

A small quantity of these can be stored in the epididymis, but most are stored in the vas deferens.

They can remain stored, maintaining their fertility, for at least a month. During this time, they are kept in a deeply suppressed inactive state by multiple inhibitory substances in the secretions of the ducts.

Conversely, with a high level of sexual activity and ejaculations, storage may be no longer than a few days.

After ejaculation, the sperm become motile, and they also become capable of fertilizing the ovum, a process called maturation.

*The Sertoli cells and the* epithelium of the epididymis secrete a special nutrient fluid that is ejaculated along with the sperm.

This fluid contains hormones (including both testosterone and estrogens), enzymes, and special nutrients that are essential for sperm maturation.
Spermatogenesis
• SPERMATOGENESIS

THREE PHASES:
(1) Spermatogonial Phase (Mitosis)
(2) Spermatocyte Phase (Meiosis)
(3) Spermatid Phase (Spermiogenesis)

- acrosome formation; golgi granules fuse to form acrosome that contains hydrolytic enzymes which will enable the spermatozoa to move through the investing layers of the oocyte

- flagellum formation; centrioles and associate axoneme (arrangement of microtubules in cilia)

- changes in size and shape of nucleus; chromatin condenses and shedding of residual body (cytoplasm)
MALE REPRODUCTIVE SYSTEM

- SPERMATOGENESIS
  SPERMATOGENIA → 1º SPERMATOCYTE → 2º SPERMATOCYTE → SPERMATIDS

SERTOLI CELLS:
- columnar with adjoining lateral processes
- extend from basal lamina to lumen
- Sertoli-Sertoli junctions divide seminiferous tubules into basal and adluminal compartments
Spermiogenesis and Spermatozoon Structure

Figure 28.8

- Spermatid (week 1)
  - Nucleus
  - Mitochondria
  - Golgi apparatus
  - Acrosomal vesicle

- Acrosomal cap
  - Shed cytoplasm

- Middle piece (5 μm)
  - Neck (1 μm)
  - Head (5 μm)

- Tail (55 μm)
  - Fibrous sheath of flagellum

- Mitochondrial spiral
  - Centrioles
  - Nucleus
  - Acrosomal cap

Spermatozoon (week 5)
• SPERMATOGENESIS

THREE PHASES:

(1) Spermatogonial Phase (Mitosis)
- spermatogonia proliferate by mitotic divisions to provide stem cells and cells which will proceed through spermatogenesis (1º spermatocytes)

(2) Spermatocyte Phase (Meiosis)
- diploid cells (2n) created in spermatogonial phase give rise to haploid cells (1n)
  - Meiosis I (reduction division) & Meiosis II (equatorial division)
  - 1º spermatocytes enter Meiosis I to form 2º spermatocytes which then enter Meiosis II and result in spermatids

(3) Spermatid Phase (Spermiogenesis)
- spermatid differentiation into spermatozoa
MALE REPRODUCTIVE SYSTEM

• SPERMIOGENESIS

  Mature sperm 60µm long and acquire full motility in epididymis

(1) HEAD
    - nucleus and acrosome

(2) NECK
    - centriole and connecting piece

(3) TAIL
    - middle piece
      (axoneme, outer dense fibers, mitochondrial sheath)
    - principal piece
      (axoneme, outer dense fibers, fibrous sheath)
    - end piece
      (axoneme)
MALE REPRODUCTIVE SYSTEM

- SPERMIOGENESIS

God! I'm knackered, How far is it to the Fallopian tubes?

A long way, we've only just passed the tonsils!
Spermiogenesis: Spermatids to Sperm

1. Spermatid nucleus
2. Golgi apparatus, Acrosomal vesicle
3. Centrioles, Microtubules, Flagellum
4. Mitochondria
5. Acrosome, Nucleus
6. Excess cytoplasm
7. Midpiece, Head, Tail
MALE REPRODUCTIVE SYSTEM

• HORMONAL REGULATION OF MALE REPRODUCTIVE FUNCTION

HYPOTHALAMUS REGULATES ACTIVITY OF ANTERIOR PITUITARY (ADENOHYPOPHYSIS)

ADENOHYPOPHYSIS SYNTHESIZES HORMONES (LH and FSH) THAT MODULATE ACTIVITY OF SERTOLI AND LEYDIG CELLS

Luteinizing Hormone (LH): stimulates testosterone production by Leydig cells

Follicle Stimulating Hormone (FSH): stimulates production of sperm in conjunction with testosterone by regulating activity of Sertoli cells

SERTOLI CELLS STIMULATED BY FSH AND TESTOSTERONE RELEASE ANDROGEN BINDING PROTEIN WHICH BINDS TESTOSTERONE; THEREBY INCREASING TESTOSTERONE CONCENTRATION WITHIN THE SEMINIFEROUS TUBULES AND STIMULATING SPERMATOGENESIS
MALE REPRODUCTIVE SYSTEM

- Efferent Ductules

Connect Retestis with Epididymis

Irregular luminal appearance due to tall ciliated cells and short non-ciliated cells

Ciliated cells beat toward Epididymis; thin layer of smooth muscle also aids movement into Epididymis
MALE REPRODUCTIVE SYSTEM

- EPIDIDYMIS
  RECEIVES EFFERENT DUCTULES
  DIVIDED INTO HEAD, BODY, AND TAIL
  PSEUDOSTRATIFIED EPITHELIUM CONSISTING
  OF PRINCIPAL AND BASAL CELLS
  SMOOTH MUSCLE IN HEAD AND TAIL
  CONTRACT SPONTANEOUSLY; SMOOTH
  MUSCLE IN TAIL REQUIRES SYMPATHETIC
  INNERVATION FOR CONTRACTION
EPIDIDYMIS

STEREOCILIA

MATURE SPERM
MALE REPRODUCTIVE SYSTEM

- VAS DEFERENS

  CONNECTS EPIDIDYMIS WITH SEMINAL VESICLES
  PSEUDOSTRATIFIED COLUMNAR EPITHELIUM
  SMOOTH MUSCLE ARRANGED IN 3 LAYERS
  SMOOTH MUSCLE CONTRACTION VIA SYMPATHETIC STIMULATION DURING EJACULATION
MALE REPRODUCTIVE SYSTEM

• VAS DEFERENS

Ductus Deferens and Ejaculatory Duct
- Runs from the epididymis through the inguinal canal into the pelvic cavity
- Its terminus expands to form the ampulla and then joins the duct of the seminal vesicle to form the ejaculatory duct
- Propels sperm from the epididymis to the urethra
- Vasectomy – cutting and ligating the ductus deferens, which is a nearly 100% effective form of birth control
MALE REPRODUCTIVE SYSTEM

*SEMINAL VESICLES*

- MUCOSA HIGHLY FOLDED
- EPITHELIUM PSEUDO-STRATIFIED
- SECRETIONS ARE HIGH IN FRUCTOSE AND BASIC
- REGULAR SMOOTH MUSCLE CONTRACTS DURING EJACULATION
MALE REPRODUCTIVE SYSTEM

- SEMINAL VESICLES

EPITHELIUM PSEUDOSTRATIFIED
MALE REPRODUCTIVE SYSTEM

- PROSTATE

SIMPLE OR PSEUDOSTRATIFIED COLUMNAR EPITHELIUM

30-50 TUBULOALVEOLAR GLANDS WHICH EMPTY INTO URETHRA

PROSTATIC SECRETIONS RICH IN CITRIC ACID, ACID PHOSPHATASE, AND PROTEOLYTIC ENZYMES
MALE REPRODUCTIVE SYSTEM

- PROSTATE

SIMPLE OR PSEUDOSTRATIFIED COLUMNAR EPITHELIUM
MALE REPRODUCTIVE SYSTEM

- PROSTATE

PROSTATIC CONCRETIONS
- precipitation of secretory product
PENIS

ERECTILE BODIES
Sustentacular (Sertoli) cells

- Nurse cells
- Extend from basal lamina to lumen
- Connected to each other by tight junctions
- Nourish spermatogenic cells
- Transport spermatogenic cells
- Phagocytize excess cytoplasm
- Secretions regulate spermatogenesis

24.4c
Spermatogonium
Cytoplasm of Sertoli cell
Spermatozoon
Tails of spermatozoa
Lumen of seminiferous tubule
Varying stages of sperm development
Leydig cell
Sustentacular cells

2 Sertoli cells with associated spermatogenesis cells.
Interstitial (Leydig) cells

- Secretes testosterone
- sER for steroid production
- Controlled by LH from pituitary

24.3b
The Ductus Deferens and Accessory Glands
Accessory glands

- **Seminal vesicles**
  - Active secretory gland
  - Contributes ~60% total volume of semen
  - Secretions contain fructose, prostaglandins, fibrinogen
  - 60% of semen
  - Fructose to nourish sperm
Accessory glands

- **Prostate gland**
  - Secretes slightly acidic prostate fluid

- **Bulbourethral glands**
  - Secrete alkaline mucus with lubricating properties
PROSTATE
Prostate

- Macroscopically the prostate can be divided into lobes.
- In good histological sections it is possible to distinguish three concentric zones, which surround the prostatic part of the urethra.
- The peripheral zone contains large, so-called main glands, whose ducts run posteriorly to open into the urethra.
- The internal zone consists of the so-called submucosal glands, whereas the innermost zone contains mucosal glands.
- This subdivision of the prostate is of clinical importance.
- **With age the prostate becomes enlarged due to benign nodular hyperplasia.**
- The onset age of these hyperplastic changes is 45.
- About 3/4 of the males above 60 are affected of which half will be symptomatic.
- This condition affects the mucosal glands. Cancer of the prostate, which is the second most common malignant tumor in western males, involves the peripheral zone.
During orgasm, sperm is transmitted from the ductus deferens into the male urethra via the ejaculatory ducts, which lie within the prostate gland.

The prostate is sometimes referred to as the "male G-spot".

Some men are able to achieve orgasm solely through stimulation of the prostate gland, such as prostate massage or receptive anal intercourse.

Men who report the sensation of prostate stimulation often give descriptions similar to female's accounts of G-spot stimulation.
Function of the Prostate Gland

The prostate gland secretes a thin, milky fluid that contains calcium, citrate ion, phosphate ion, a clotting enzyme, and a profibrinolysin.

During emission, the capsule of the prostate gland contracts simultaneously with the contractions of the vas deferens so that the thin, milky fluid of the prostate gland adds further to the bulk of the semen.

A slightly alkaline characteristic of the prostatic fluid may be quite important for successful fertilization of the ovum, because the fluid of the vas deferens is relatively acidic owing to the presence of citric acid and metabolic end products of the sperm and, consequently, helps to inhibit sperm fertility.

Also, the vaginal secretions of the female are acidic (pH of 3.5 to 4.0). Sperm do not become optimally motile until the pH of the surrounding fluids rises to about 6.0 to 6.5.

Consequently, it is probable that the slightly alkaline prostatic fluid helps to neutralize the acidity of the other seminal fluids during ejaculation, and thus enhances the motility and fertility of the sperm.
Slide 33 Prostate

Corpora amylacea
Corpora amylacea

Are small hyaline masses of unknown significance found in the prostate gland, neuroglia, and pulmonary alveoli.

They are derived from degenerate cells or thickened secretions and occur more frequently with advancing age.

While their significance is unknown, they can be used to identify these organs microscopically.
Prostate Gland

- Prostate gland
  - Surrounds prostatic urethra
  - 30% of semen
  - Supports sperm
The prostate gland is shaped like an inverted cone and lies just below the neck of the urinary bladder.

It is about 5 cm (3 inches) long and 3-4cm wide.

The urethra, which runs from the bladder through the middle of the prostate gland and through the penis, carries urine from the bladder. The smooth muscle of the urethra is the internal urinary sphincter.

Just below the prostate gland is a muscular diaphragm that acts as the external urinary sphincter.

This sphincter, which encircles the urethra, is under both reflex and voluntary control.

Along the back wall of the urethra in the prostate, there is an elevation called the verumontanum, and it is into this elevation that sperm (through the ejaculatory ducts) and spermatic secretions from the seminal vesicles and prostate enter the urethra.
**PS Level ng/mL**

<table>
<thead>
<tr>
<th>PS Level ng/mL</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;4</td>
<td>Normal</td>
</tr>
<tr>
<td>4 to 10</td>
<td>Borderline</td>
</tr>
<tr>
<td>&gt;10</td>
<td>Abnormally High</td>
</tr>
</tbody>
</table>

*Prostate H&E*

- cut tangentially
- cut perpendicular
- columnar epithelium
Ducts

- Epididymis
- Ductus deferens
- Ejaculatory duct
- (urethra)
Epididymis

- Located in scrotum
- Between seminiferous tubules and vas deferens
- ~6 m long
Epididymis

- Pseudostratified columnar epithelium
  - With stereocilia (long microvilli)
  - Smooth muscle
  - Sperm mature and stored

24.6a
Epididymis:

- Epithelial cells
- Nonmotile cilia
- Sperm cells
Ductus (vas) deferens

- From scrotum to pelvis
- Forms ejaculatory duct with seminal vesicle duct
- Empties into prostatic urethra
- Thick muscularis
- Propels sperm during ejaculation
Ductus deferens

- Microscopic anatomy
- Pseudostratified epithelium
- Lamina propria
- Muscularis
  - Inner longitudinal
  - Middle circular
  - Outer longitudinal

24.6b
Urethra

- Shared with urinary system
- Prostatic urethra
- Membranous urethra
- Spongy (penile) urethra

24.8
MALE REPRODUCTIVE SYSTEM

- URETHRA

PROSTATIC, MEMBRANOUS, SPONGY (PENILE)
Urethra
Conveys both urine and semen (at different times)

Consists of three regions
- **Prostatic** – portion surrounded by the prostate
- **Membranous** – lies in the urogenital diaphragm
- **Spongy, or penile** – runs through the penis and opens to the outside at the external urethral orifice
Ejaculation

- Sympathetic activation
- Peristaltic contraction of smooth muscles in ducts and glands - ejaculation
- Constriction of arteries
- ↓ blood pressure in erectile bodies
Brain-Testicular Axis

- **Hormonal regulation of spermatogenesis and testicular androgen production involving the**
  - hypothalamus,
  - anterior pituitary gland,
  - the testes

- **Testicular regulation involves three sets of hormones:**
  - **GnRH**, from the hypothalamus stimulates the pituitary to produce **gonadotropins**:
    - Follicle stimulating hormone (FSH)
    - Luteinizing hormone (LH)
  - **Gonadotropins**, directly stimulate the testes
  - **Testicular hormones**, which exert negative feedback controls
Hormonal Regulation of Testicular Function

- The hypothalamus releases gonadotropin-releasing hormone (GnRH)
- GnRH stimulates the anterior pituitary to secrete FSH and LH
- **FSH stimulates sperm production by** causing sustentacular cells to release androgen-binding protein (ABP)
- ABP prompts spermatogenic cells to bind and concentrate testosterone
- **LH stimulates interstitial cells to release testosterone**
  - Stimulates spermatogenesis
  - Causes secondary sexual characteristics

Feedback inhibition on the hypothalamus and pituitary results from:
- Rising levels of testosterone
- Increased inhibin
Mechanism and Effects of Testosterone Activity

- Testosterone is synthesized from cholesterol.
- It must be transformed to exert its effects on some target cells.
- Prostate — it is converted into dihydrotestosterone (DHT) before it can bind within the nucleus.
- Neurons — it is converted into estrogen to bring about stimulatory effects in certain neurons.
- Testosterone targets all accessory organs and its deficiency causes these organs to atrophy.
Male hormones make their appearance at puberty and induce changes in nonreproductive organs, including:
- Appearance of pubic, axillary, and facial hair
- Enhanced growth of the chest and deepening of the voice
- Skin thickens and becomes oily
- Bones grow and increase in density
- Skeletal muscles increase in size and mass

Testosterone is the basis of libido in both males and females.