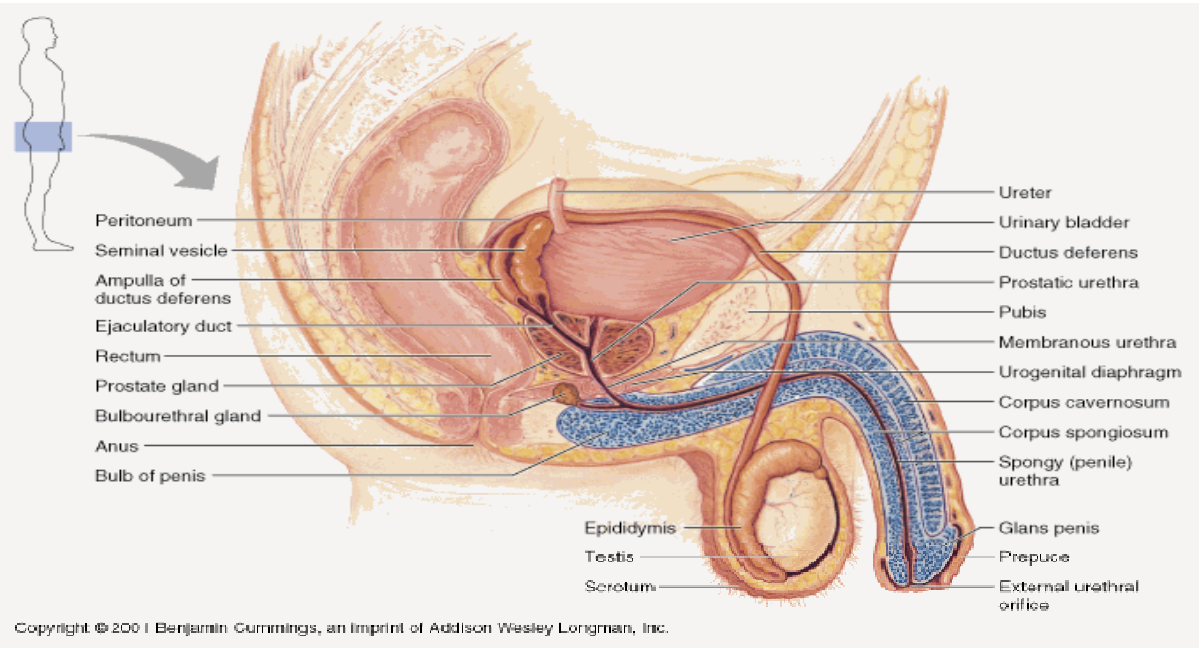


MALE REPRODUCTIVE SYSTEM

Mythology and history

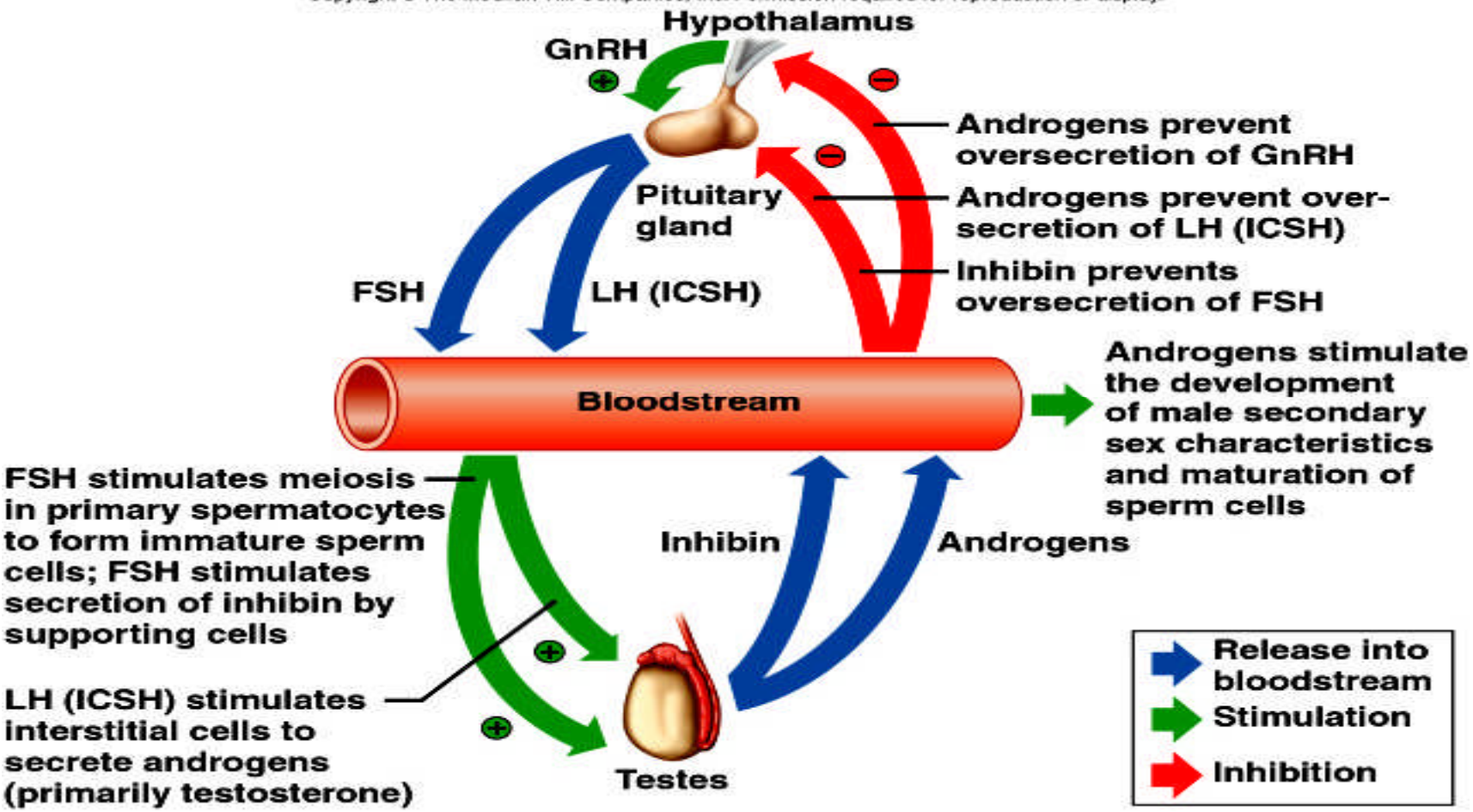
In Greek mythology, Priapus or Priapos ,was a minor rustic fertility god, protector of livestock, fruit plants, gardens and male genitalia. Priapus is marked by his absurdly oversized, permanent erection, which gave rise to the medical term priapism

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

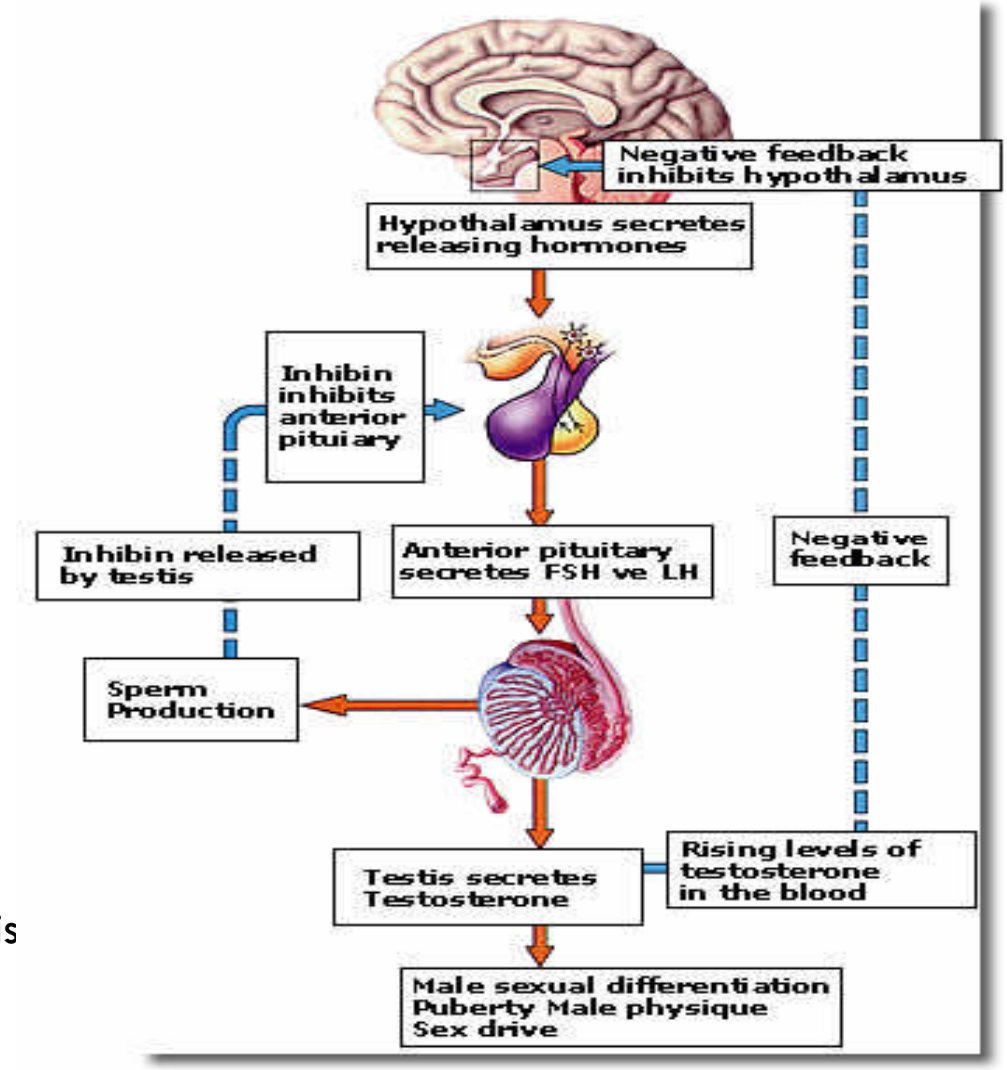


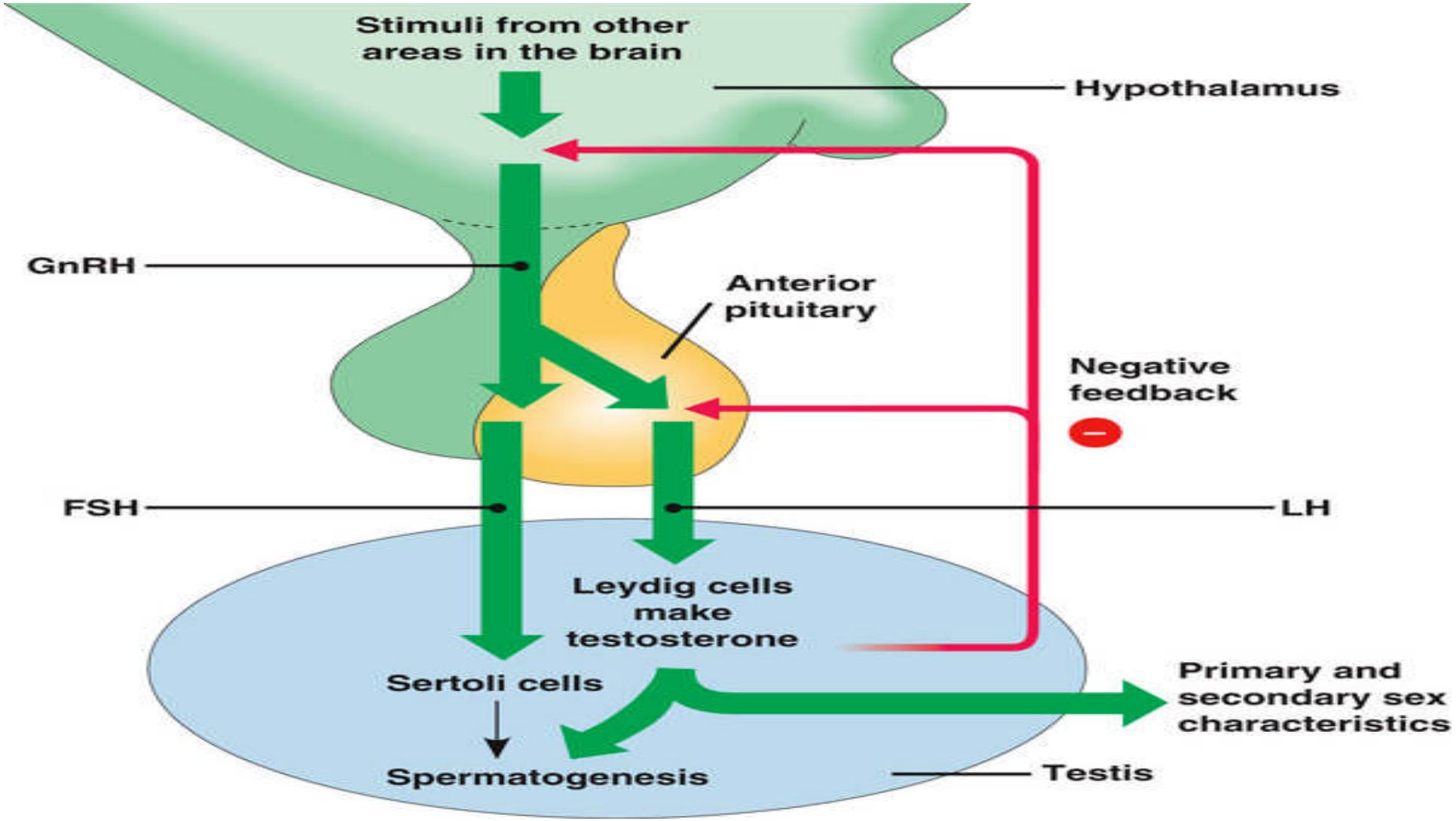
Hormonal Control of Male Reproductive Functions

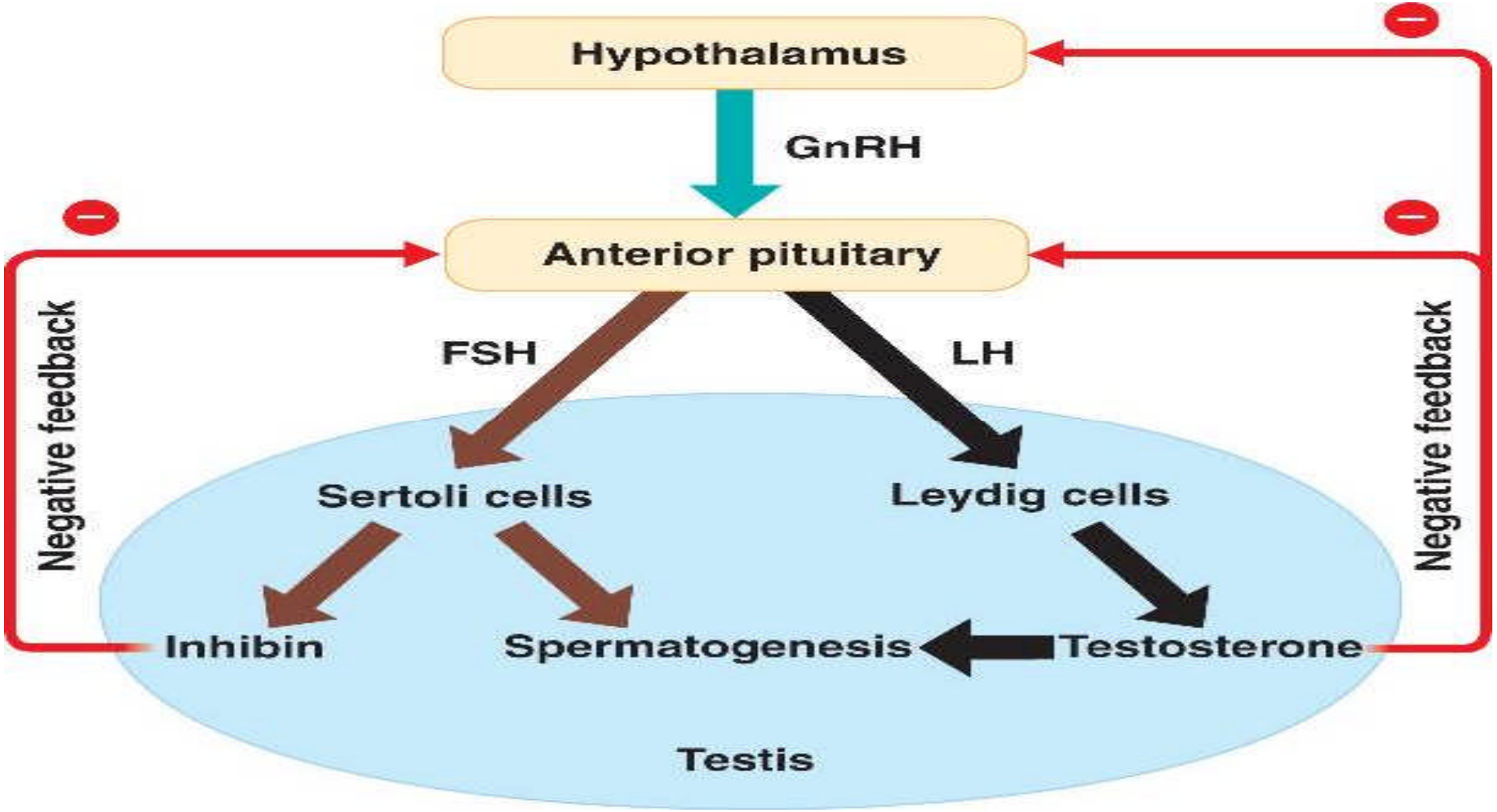
- GnRH, FSH, and LH
- Testosterone

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.




Stimuli from other areas in the brain
Hypothalamus
GnRH
Anterior pituitary
Negative feedback
FSH
LH
Leydig cells make testosterone
Sertoli cells
Primary and secondary sex characteristics
Spermatogenesis
Testis

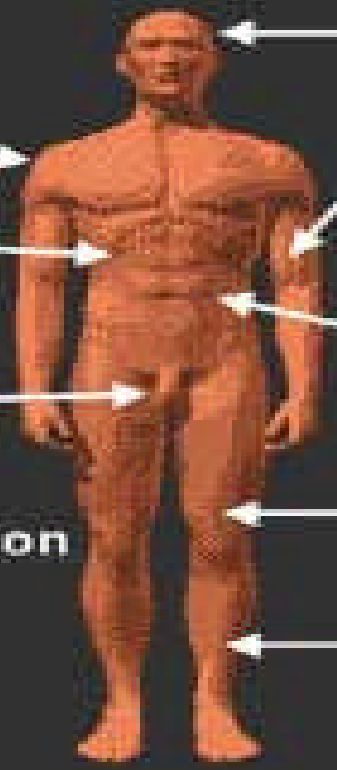

Hypothalamus
GnRH
Anterior pituitary
FSH
LH
Sertoli cells
Leydig cells
Inhibin
Spermatogenesis
Testosterone
Testis
Negative feedback
Negative feedback

Hormones that Affect Male Reproductive Processes

HORMONES THAT AFFECT THE MALE REPRODUCTIVE PROCESSES

HORMONE	SOURCE	ACTION
GnRH	Hypothalamus	Stimulates pituitary gland to secrete the gonadotropins FSH and ICSH
ICSH (LH)	Pituitary	Stimulates interstitial cells (cells of Leydig) in the testes to produce androgens, especially testosterone
FSH	Pituitary	Along with testosterone, stimulates spermatogenic cells in seminiferous tubules to produce sperm
Testosterone	Testes (interstitial cells)	Stimulates developement 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
Inhbin	Testes (Sertoli cells)	Maturing sperm causes Sertoli cells in seminiferous tubules to secrete inhibin, which feeds back to the pituitary, inhibiting its production of FSH

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

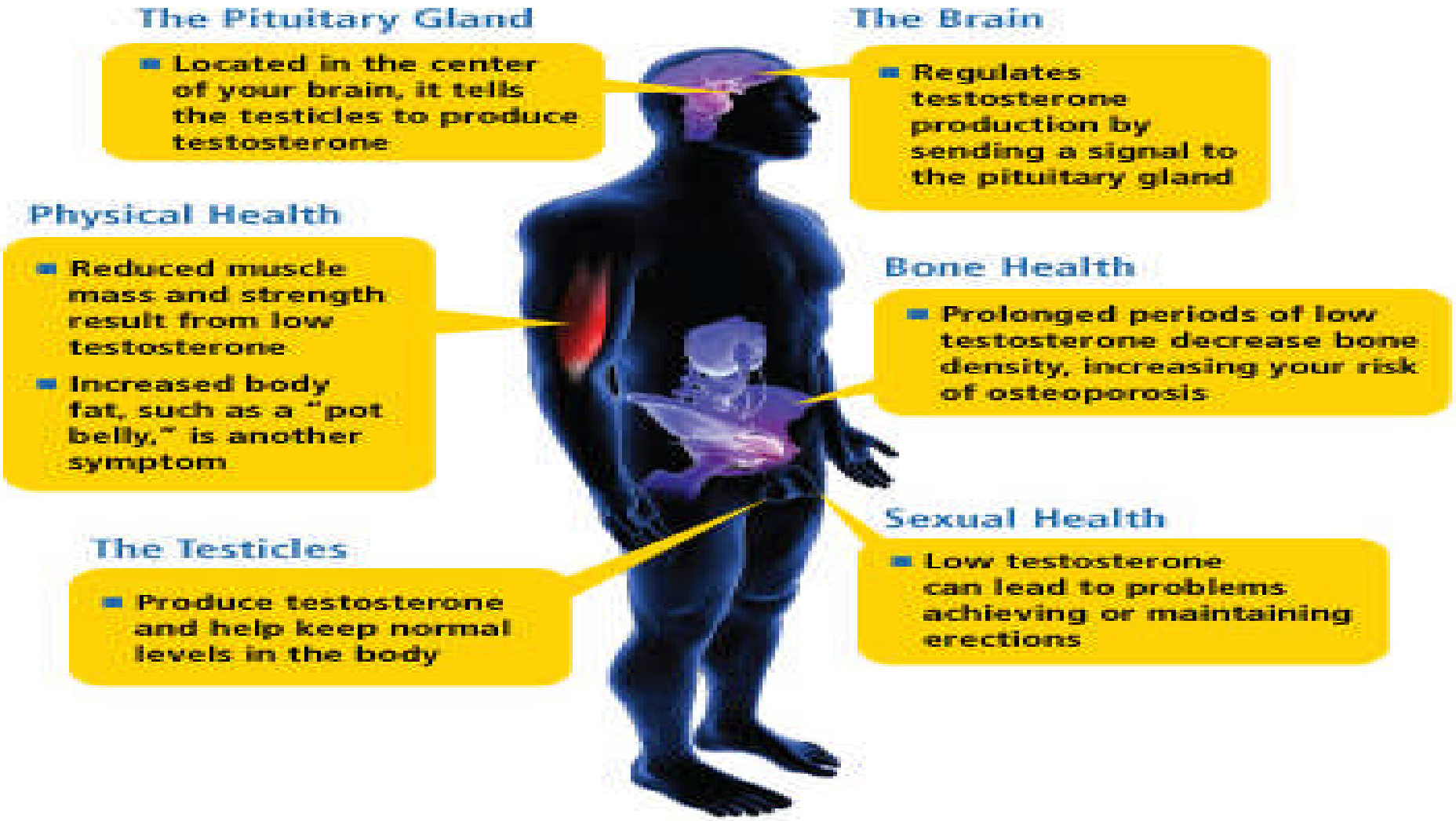
brain
libido, aggression

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.

Indifferent	Male	Female
Gonad	Testis	Ovary
Mullerian duct	Appendix testis	Fallopian tubes
Mullerian duct	Prostatic utricle	Uterus, proximal vagina
Wolffian duct	Rete testis	Rete ovarii
Mesonephric tubules	Efferent ducts	Epoophoron
Wolffian duct	Epididymis	Gartner's duct
Wolffian duct	Vas deferens	
Wolffian duct	Seminal vesicle	
Wolffian duct	Prostate	Skene's glands
Urogenital sinus	Bladder, urethra	Bladder, urethra, distal vagina
Urogenital sinus	Bulbourethral gland	Bartholin's gland
Genital swelling	Scrotum	Labia majora
Urogenital folds	Distal urethra	Labia minora
Genital tubercle	Penis	Clitoris
Prepuce	Foreskin	Clitoral hood
	Bulb of penis	Vestibular bulbs
	Glans penis	Clitoral glans
	Crus of penis	Clitoral crura

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

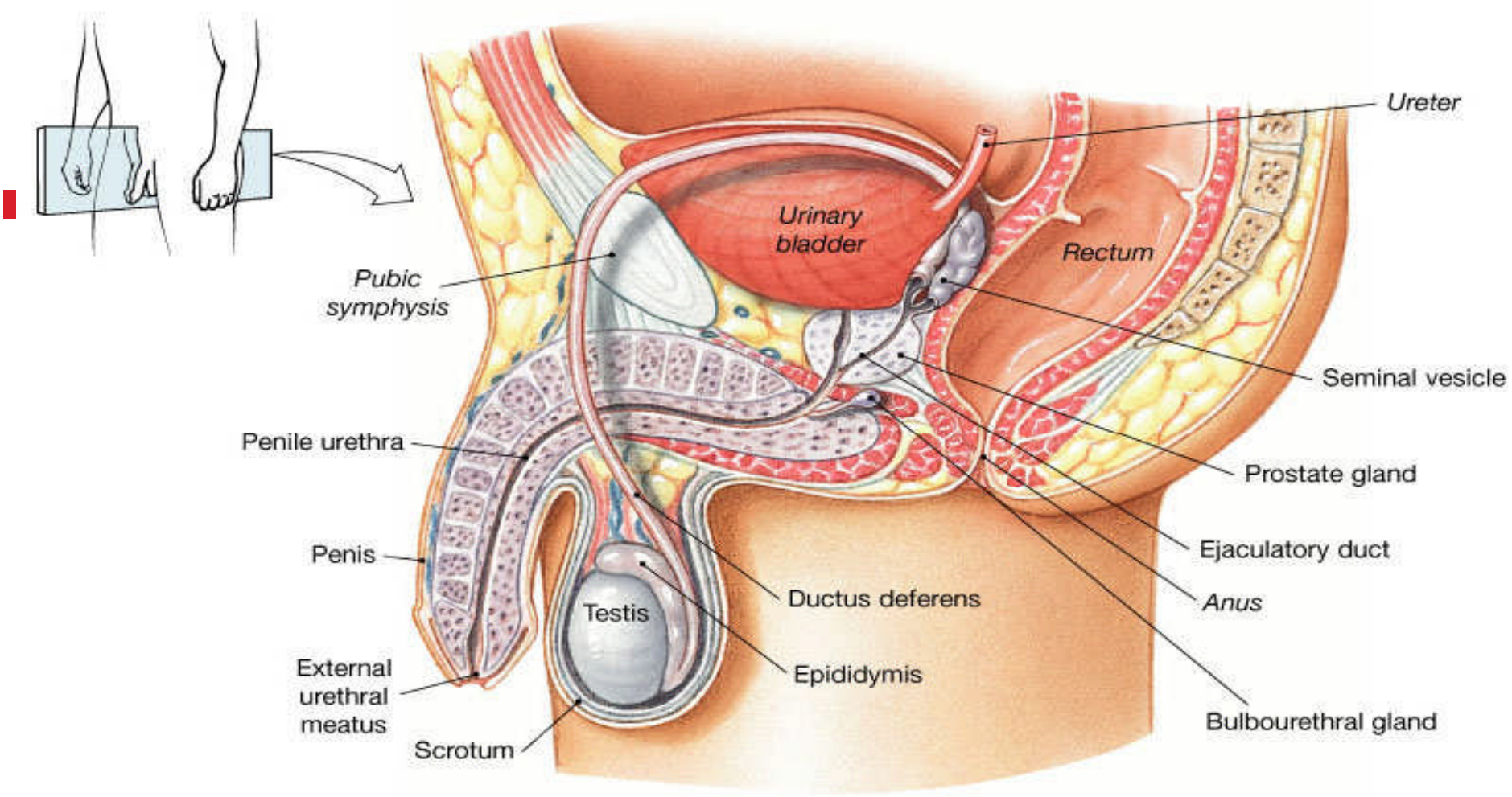
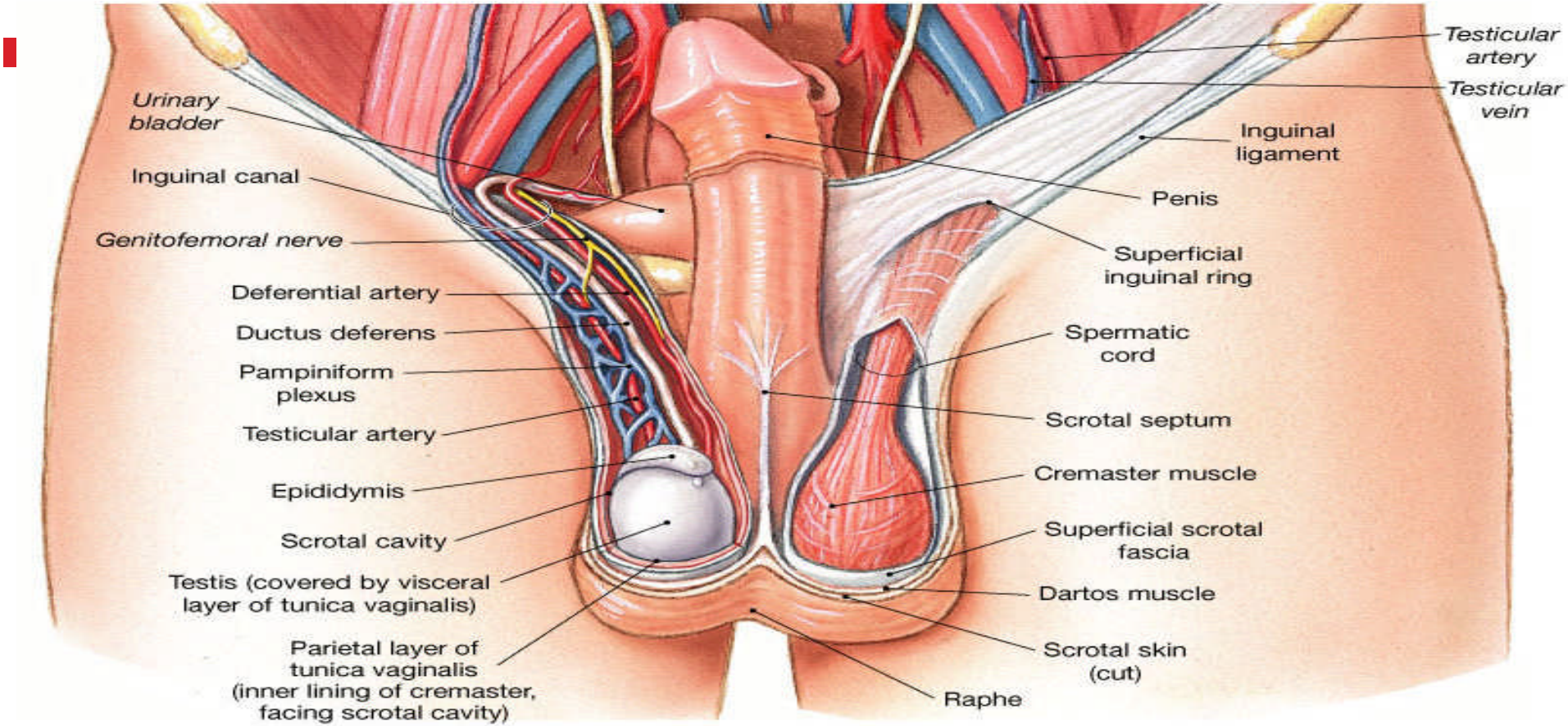

Ureter
Urinary bladder
Rectum
Pubic symphysis
Seminal vesicle
Penile urethra
Prostate gland
Ejaculatory duct
Penis
Anus
Ductus deferens
Testis
Epididymis
External urethral meatus
Bulbourethral gland
Scrotum

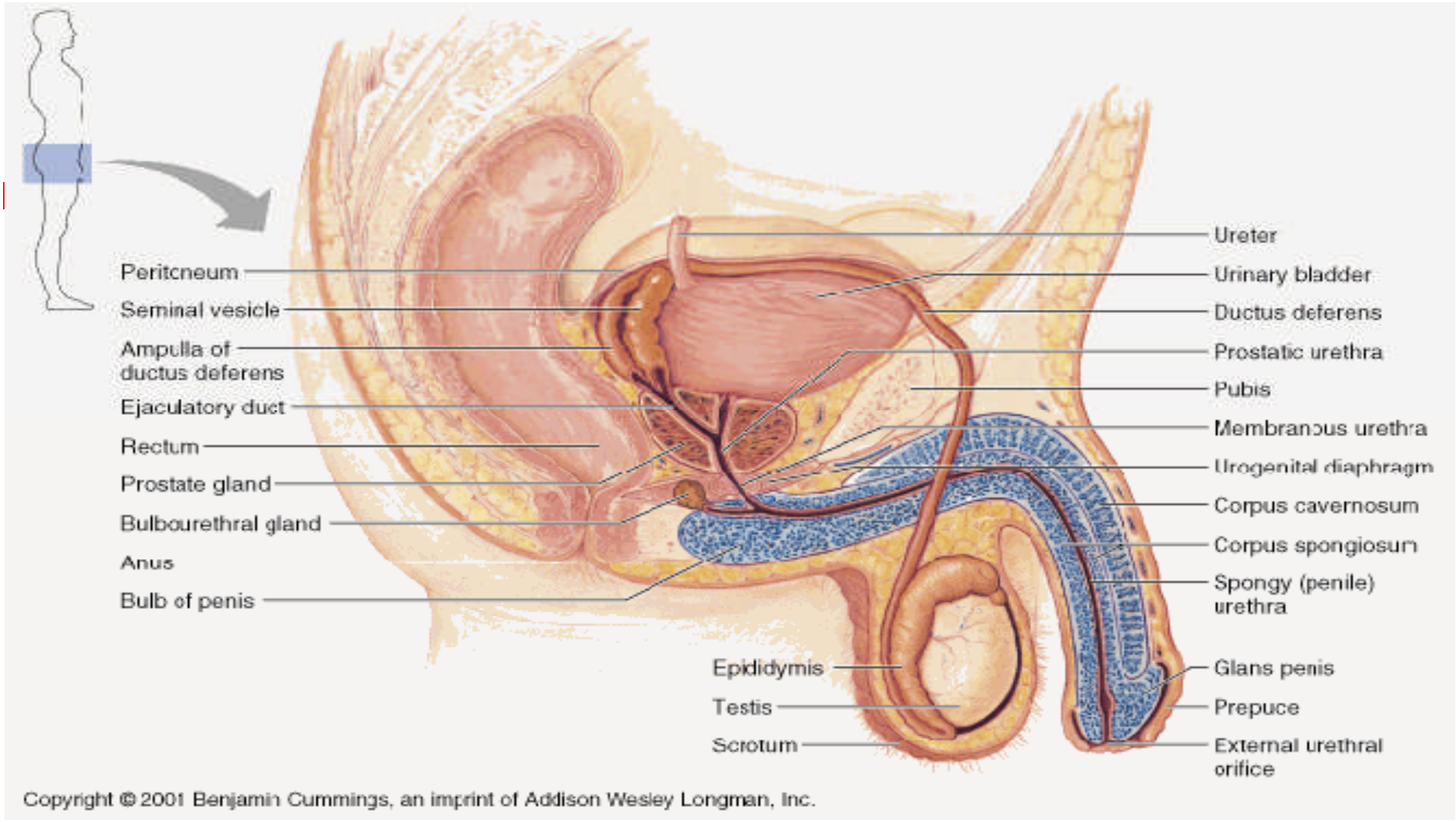
Figure 28.1

The Male Reproductive System in Anterior View

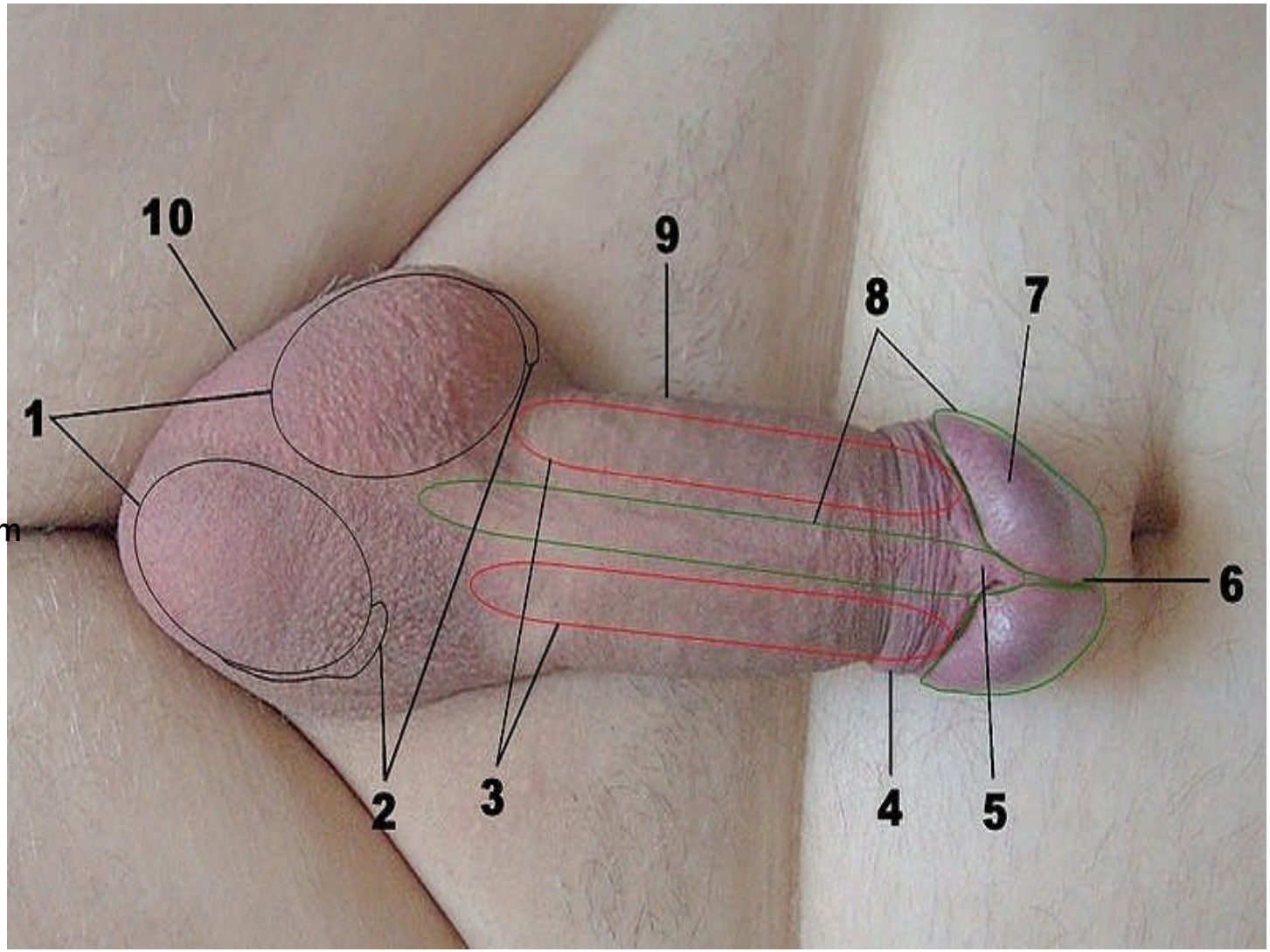


The foreskin has twelve known functions.

- 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


Hypospadias

Epispadias

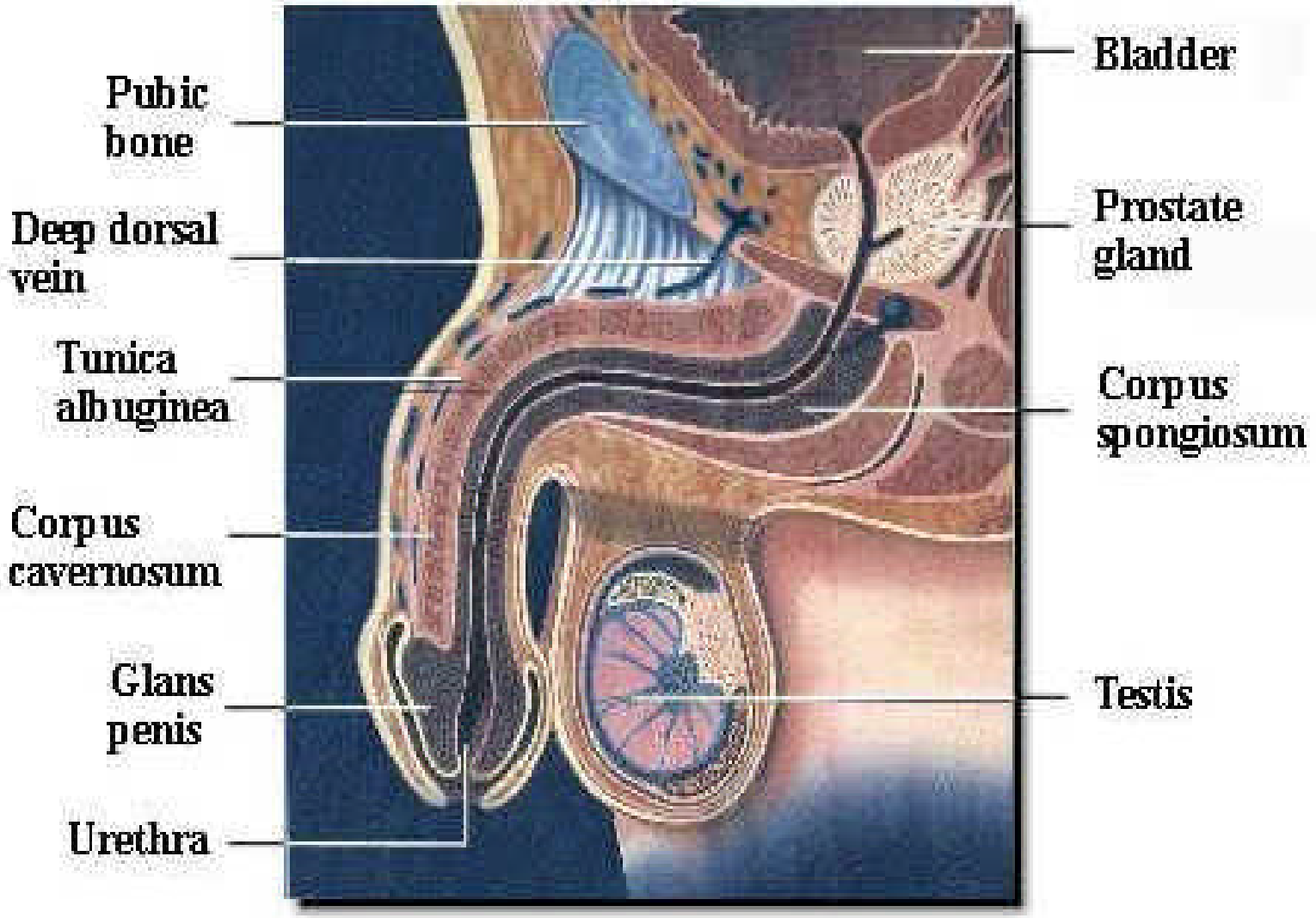
Testes

Epididymis

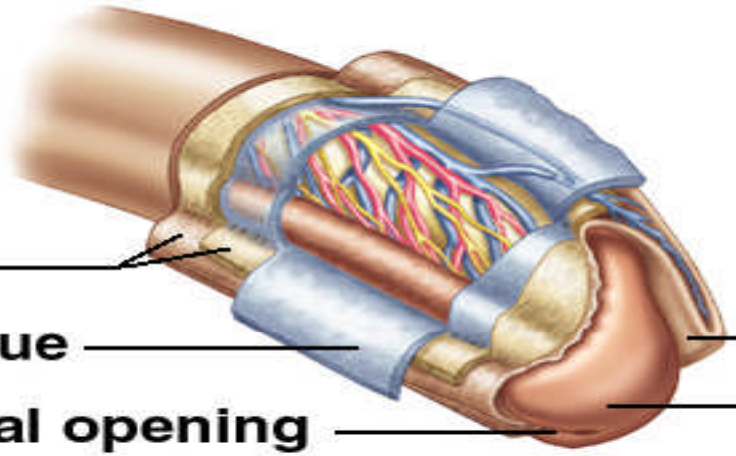
Ductus deferens

Urethra

Penis



Penis Anatomy



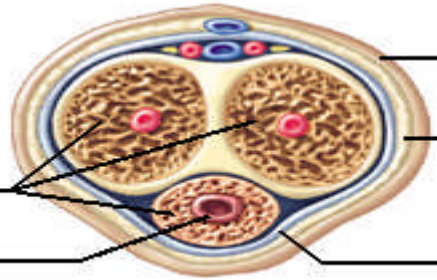
skin layers

connective tissue

a. external urethral opening

prepuce

glans penis



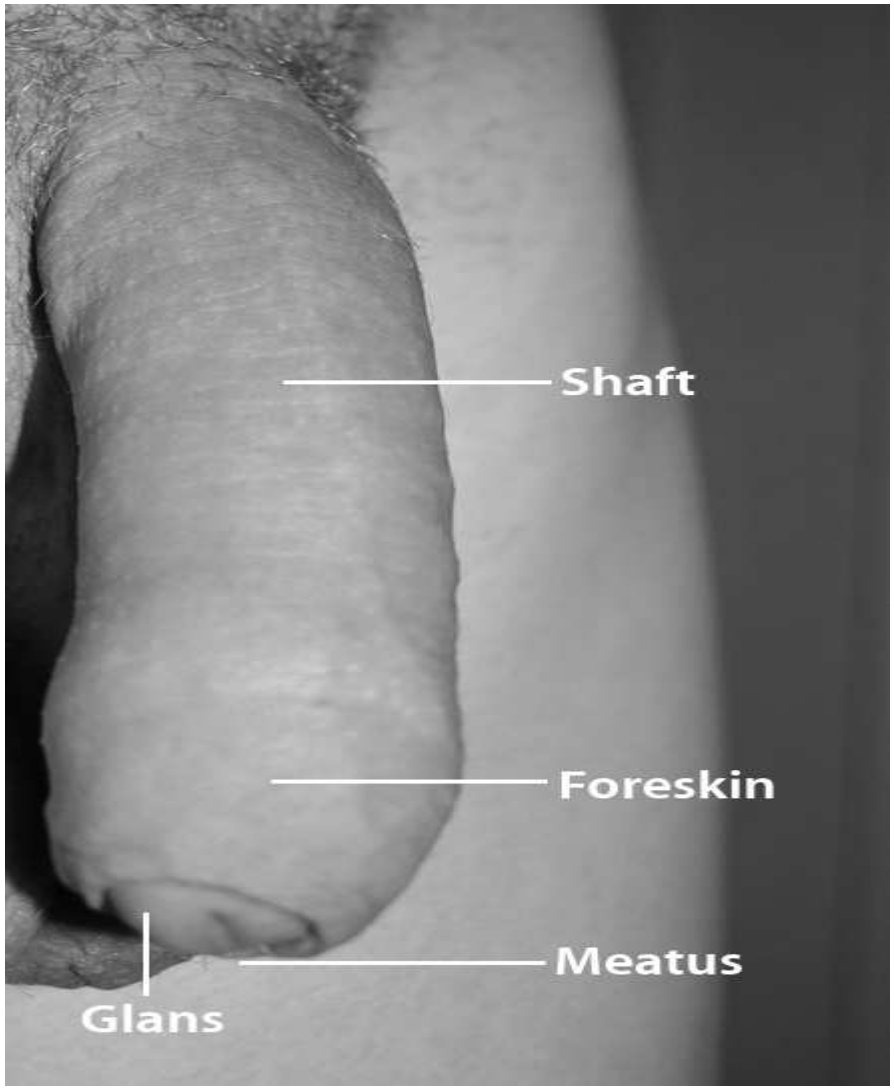
erectile tissue

b. urethra

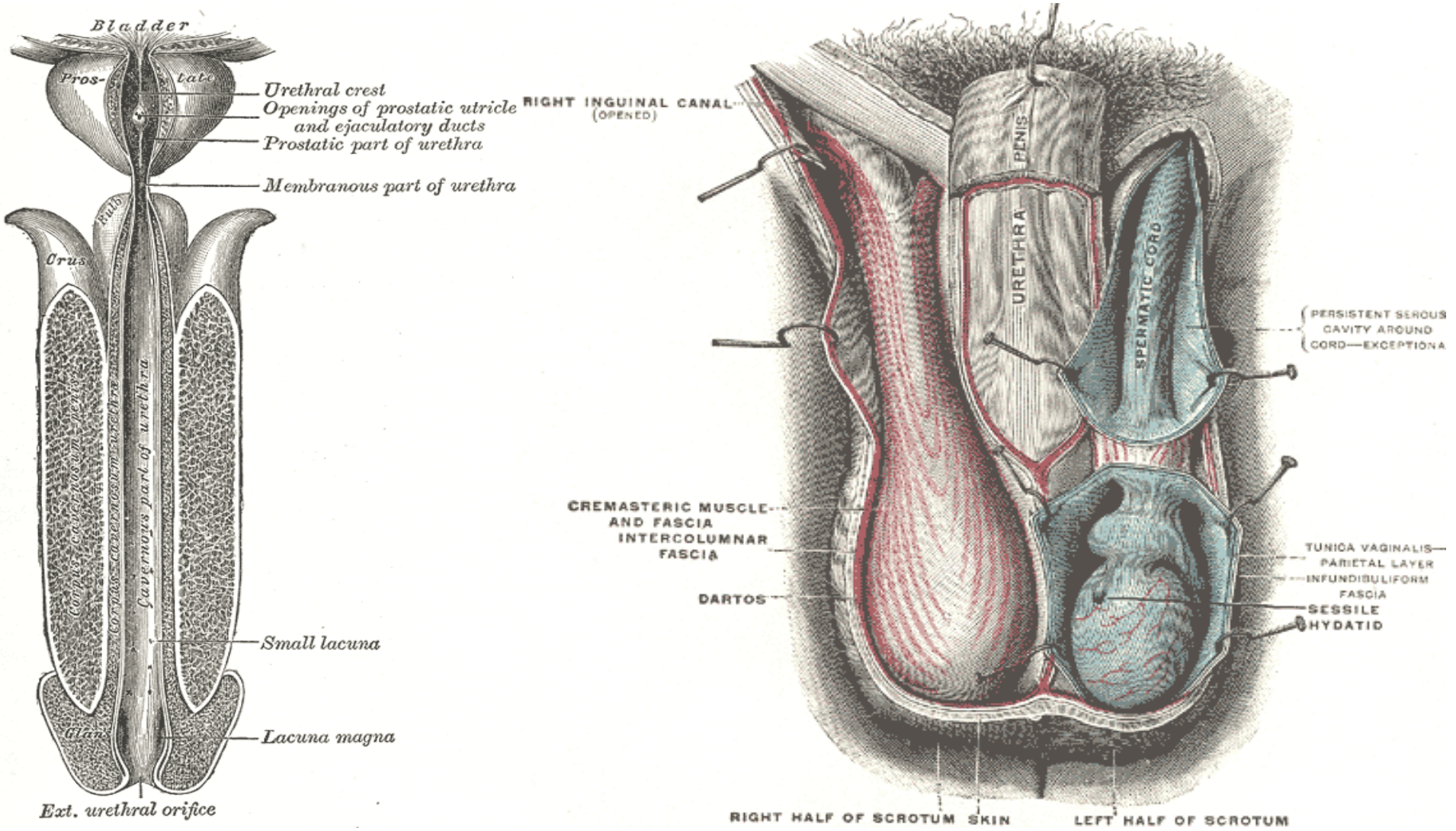
skin

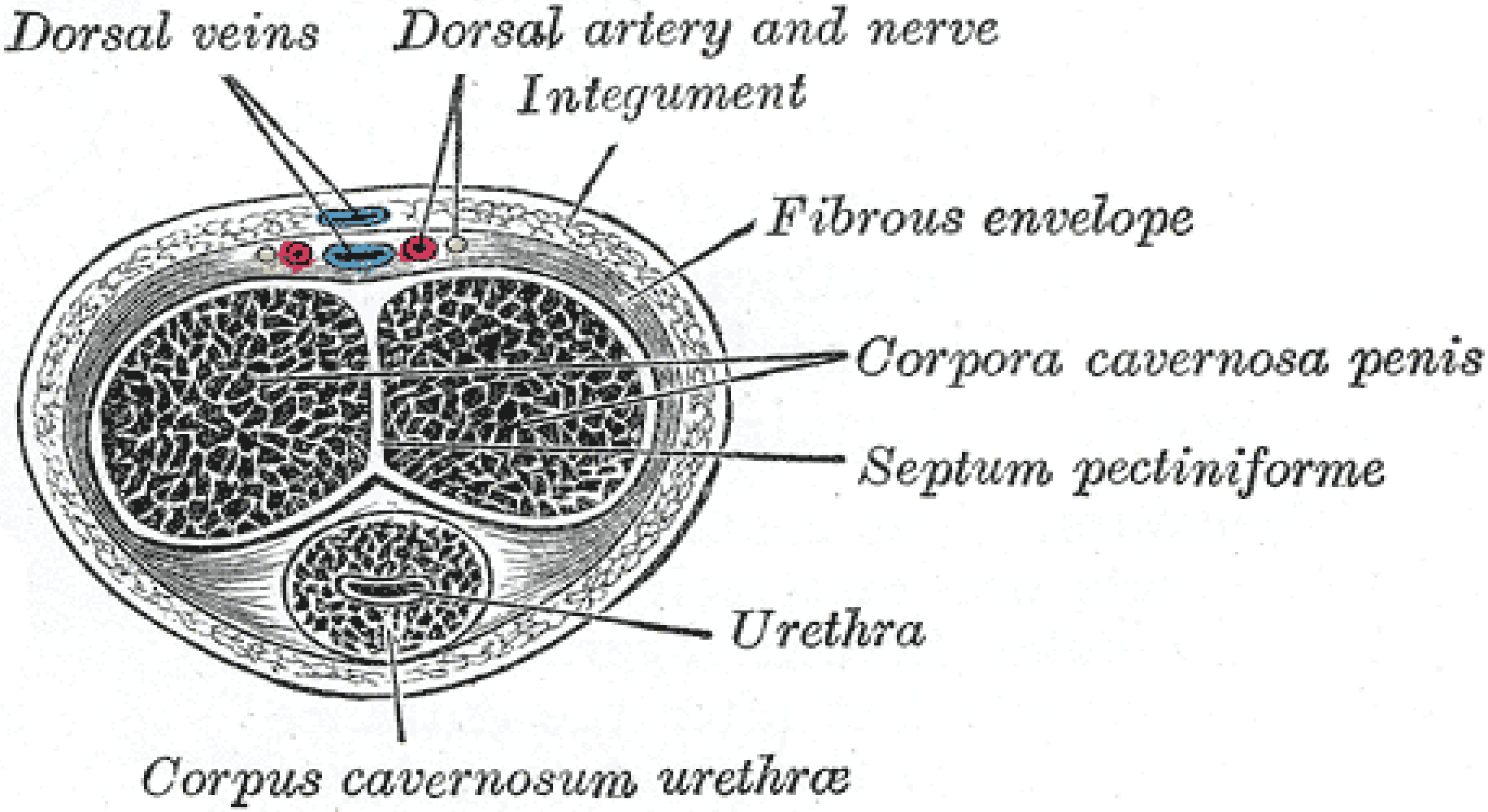
subcutaneous tissue

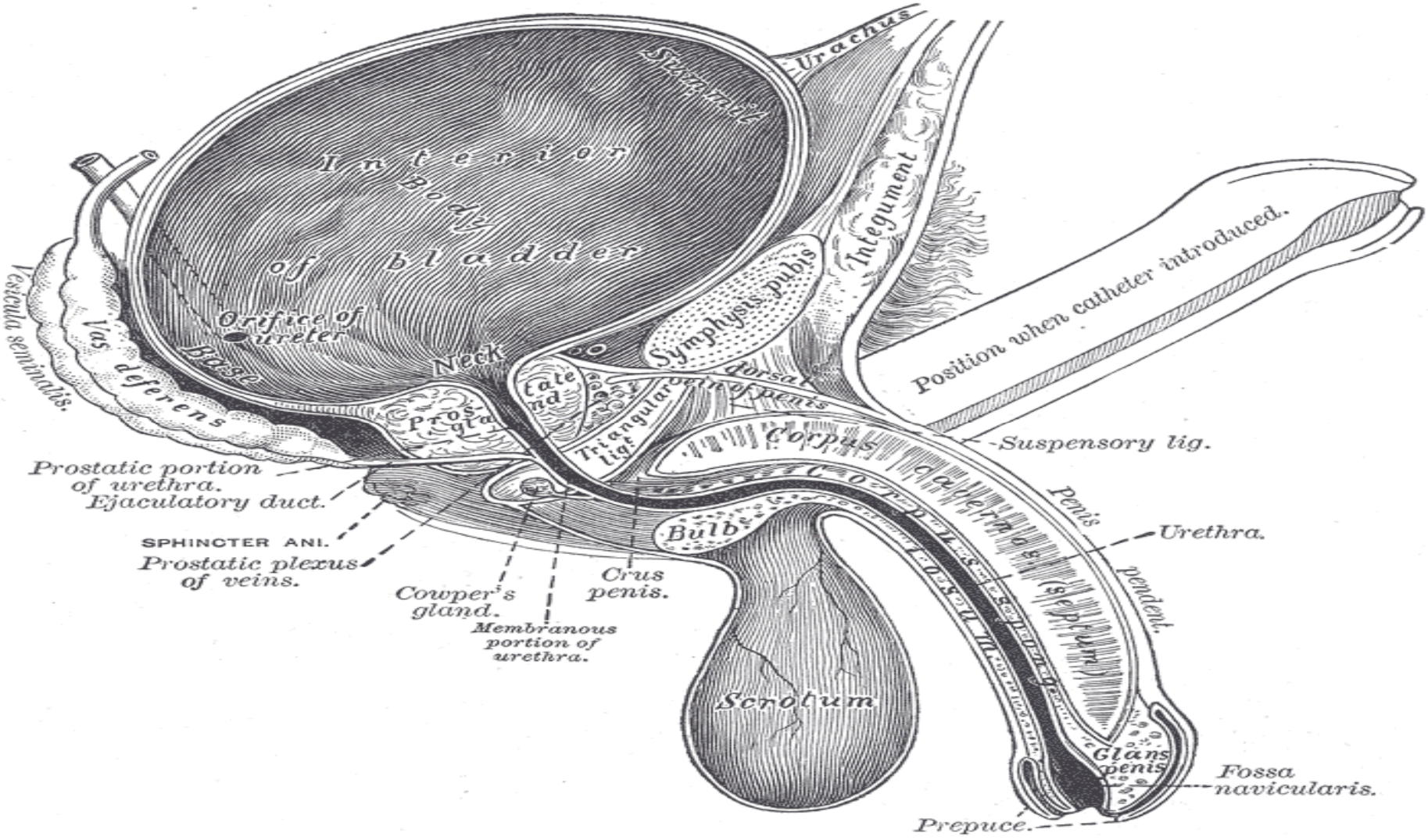
connective tissue



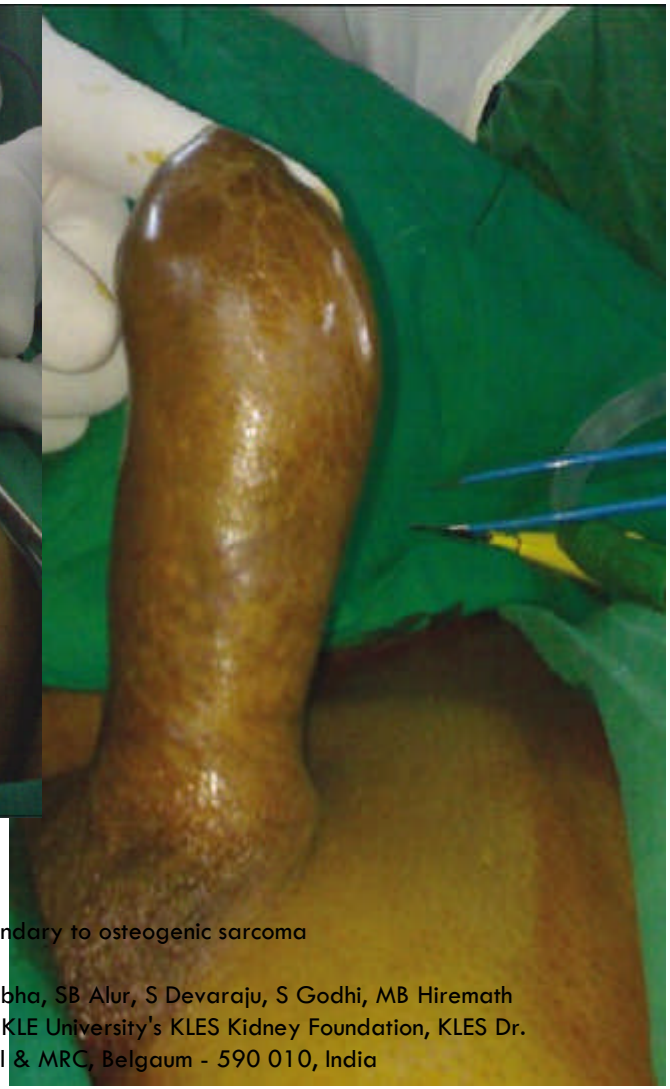
The word "penis" is taken from the Latin word for "tail."


Bladder
Pros-
tate
Urethral crest
Openings of prostatic utricle and ejaculatory ducts
Prostatic part of urethra
Membranous part of urethra
Bulb
Crus
Corpus cavernosum penis
Corpus cavernosum urethræ
Cavernous part of urethra
Small lacuna
Glans
Lacuna magna
Ext. urethral orifice
RIGHT INGUINAL CANAL (OPENED)
PENIS
URETHRA
SPERMATIC CORD
PERSISTENT SEROUS CAVITY AROUND CORD—EXCEPTIONA
CREMASTERIC MUSCLE AND FASCIA
INTERCOLUMNAR FASCIA
DARTOS
TUNICA VAGINALIS—PARIETAL LAYER
INFUNDIBULIFORM FASCIA
SESSILE HYDATID
RIGHT HALF OF SCROTUM
SKIN
LEFT HALF OF SCROTUM


Dorsal veins
Dorsal artery and nerve
Integument
Fibrous envelope
Corpora cavernosa penis
Septum pectiniforme
Urethra
Corpus cavernosum urethræ

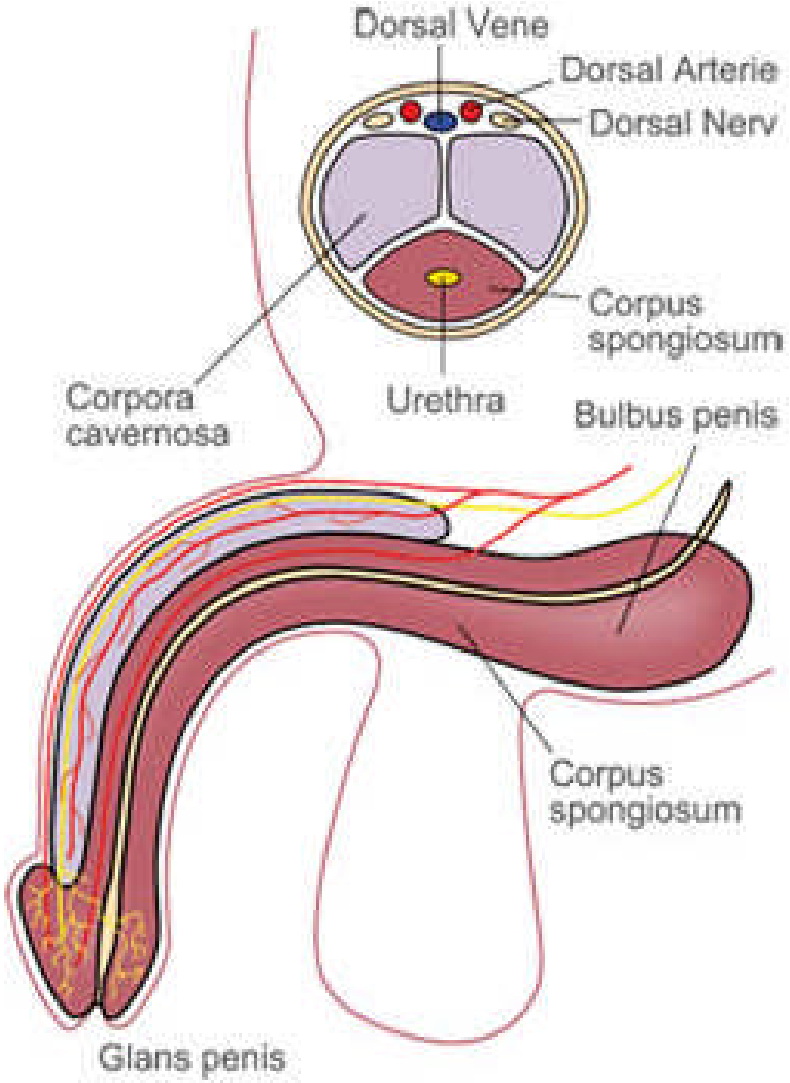

Interior of Body of bladder
Fundus
Urachus
Integument
Position when catheter introduced.
Vesicula seminalis.
Vas deferens
Orifice of ureter
Base
Neck
Prostate gland
Symphysis pubis
Suspensory lig.
Prostatic portion of urethra.
Ejaculatory duct.
SPHINCTER ANI.
Prostatic plexus of veins.
Cowper's gland.
Membranous portion of urethra.
Crus penis.
Bulb
Corpus cavernosum
Penis
Urethra.
pendent.
Scrotum
Glans penis
Fossa navicularis.
Prepuce.

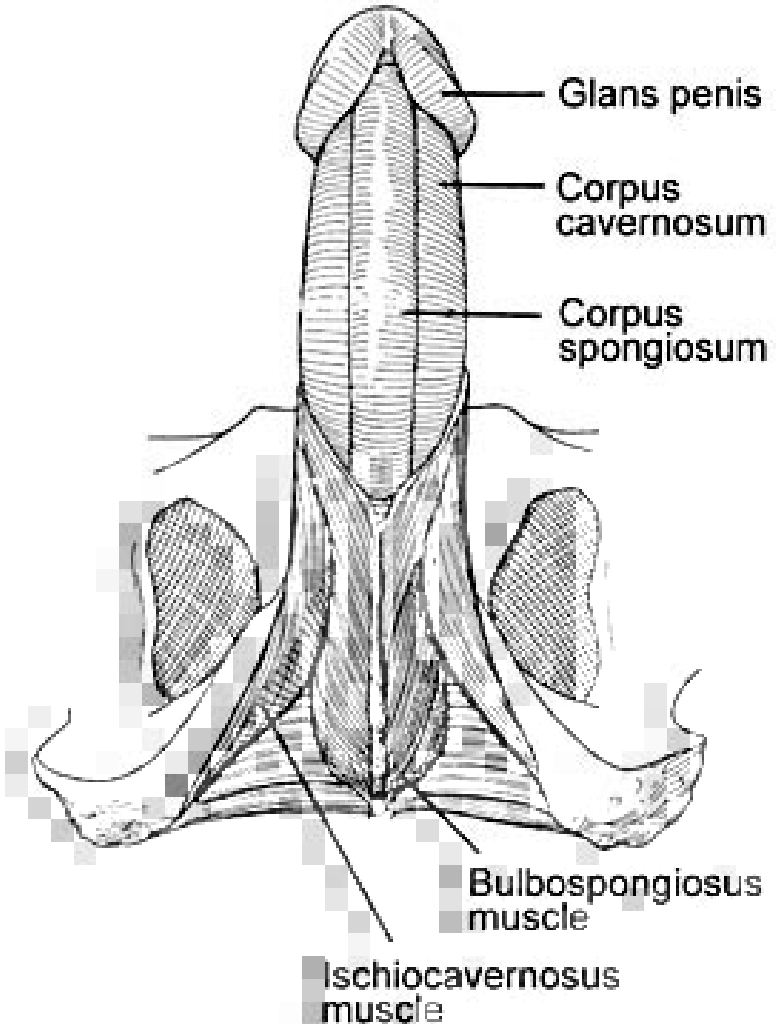
priapism

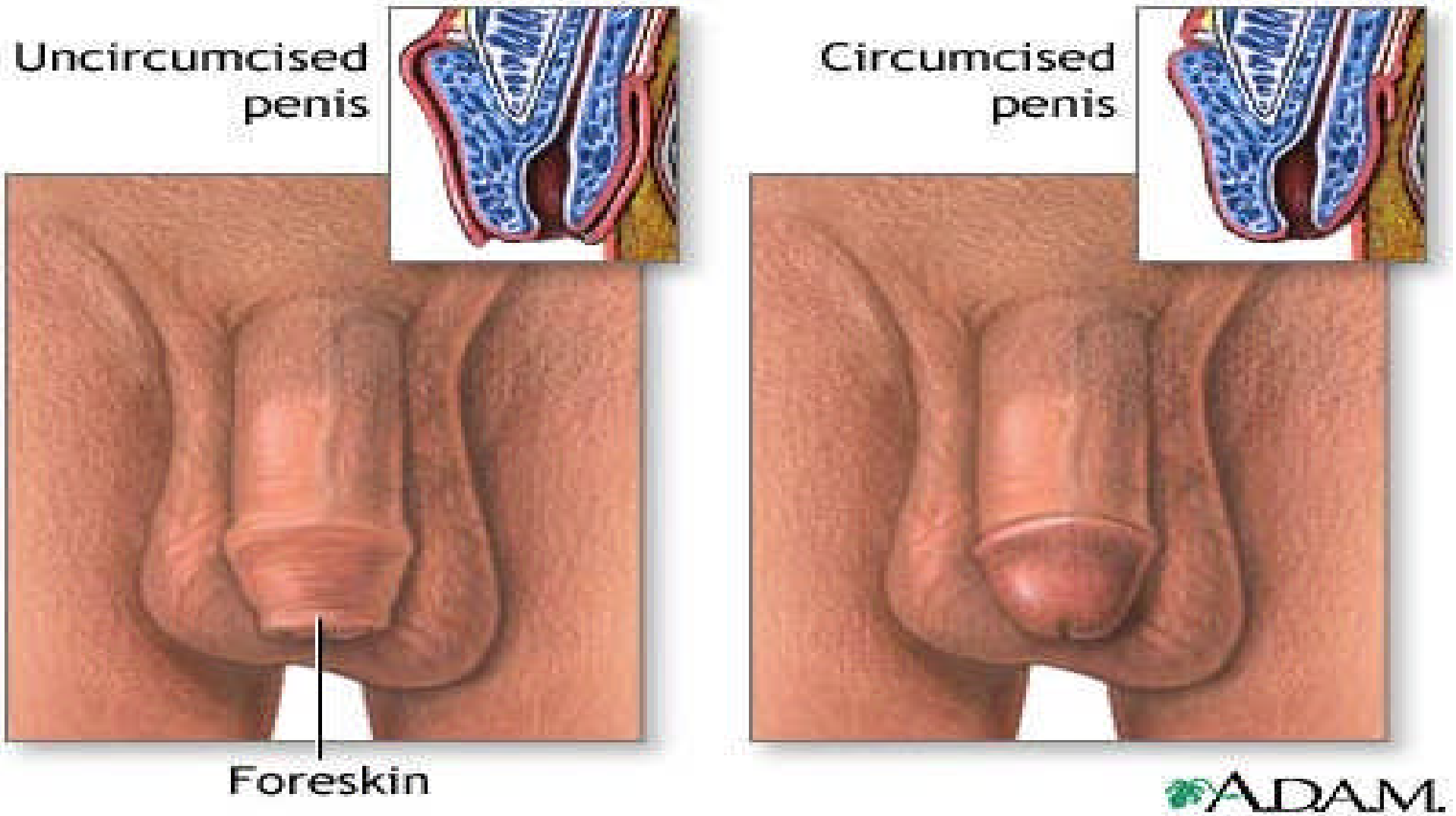


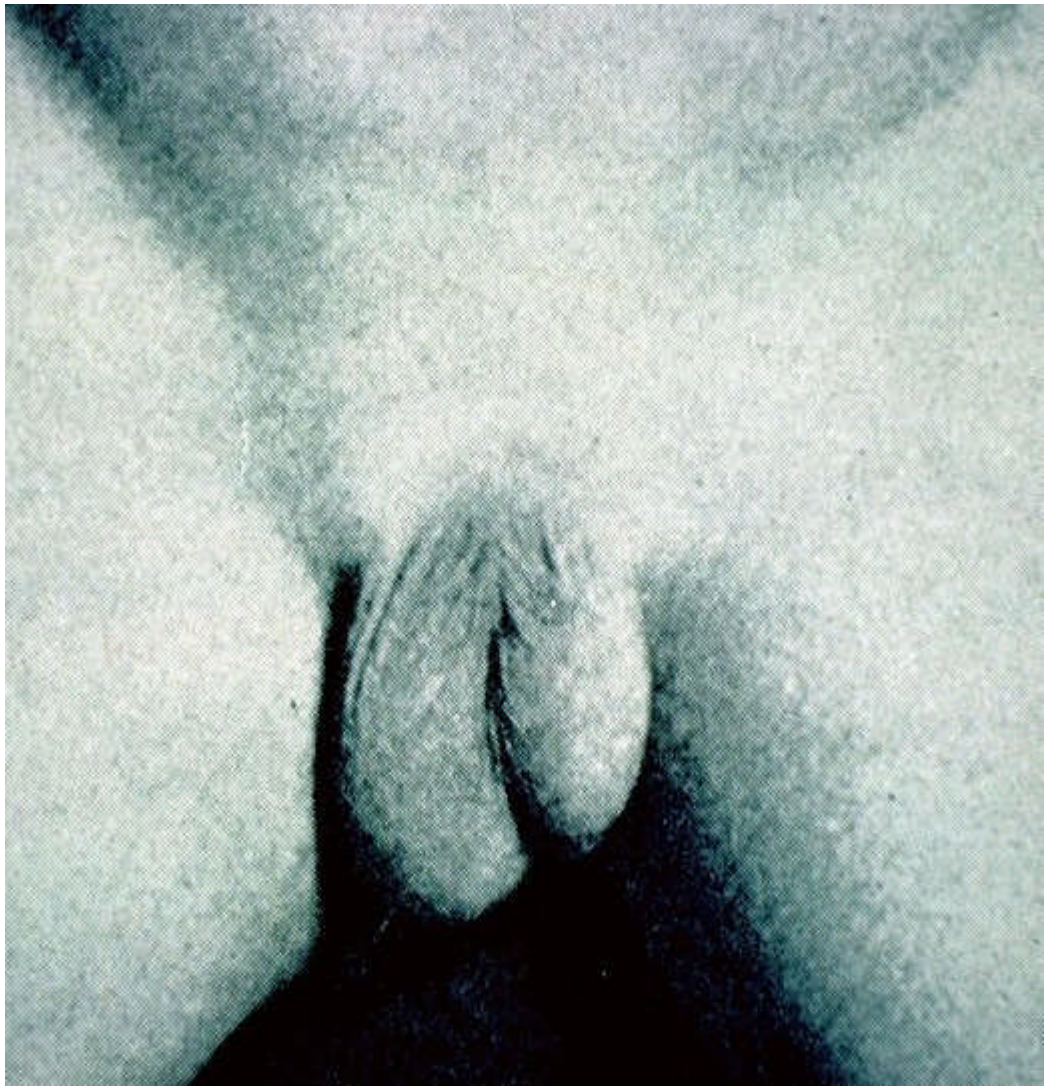
Malignant priapism secondary to osteogenic sarcoma

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


Dorsal Vene
Dorsal Arterie
Dorsal Nerv
Corpus spongiosum
Corpora cavernosa
Urethra
Bulbus penis
Corpus spongiosum
Glans penis


Glans penis
Corpus cavernosum
Corpus spongiosum
Bulbospongiosus muscle
Ischiocavernosus muscle


Uncircumcised penis
Foreskin
Circumcised penis
A.D.A.M.

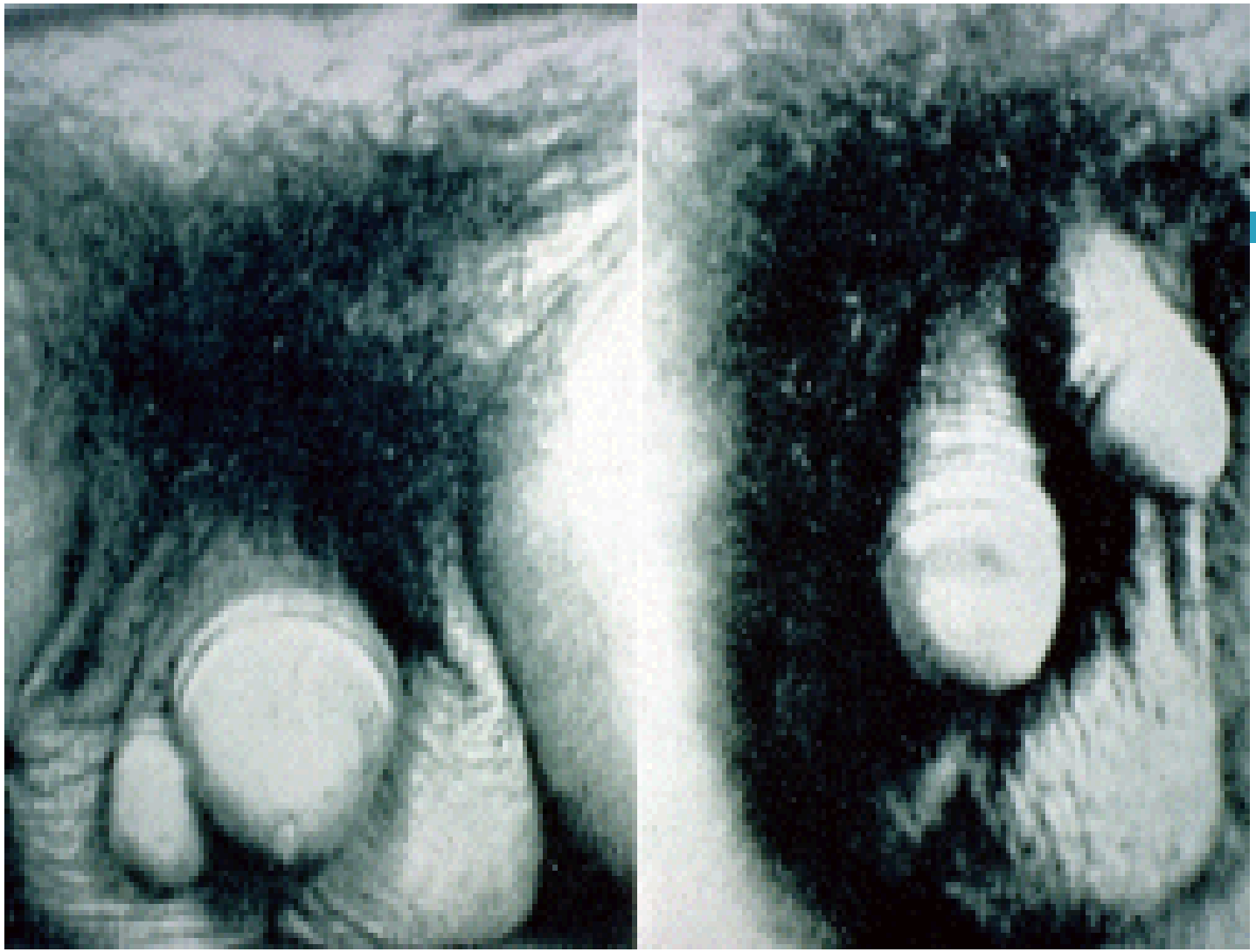


Aphallia (penile agenesis) results from failure of the genital tubercle to develop
incidence: 1/10,000,000 live male births (only 70 reported cases)
usually has appearance of well-developed scrotum with bilaterally descended testes, but no penile shaft

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
Surgic
ally
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

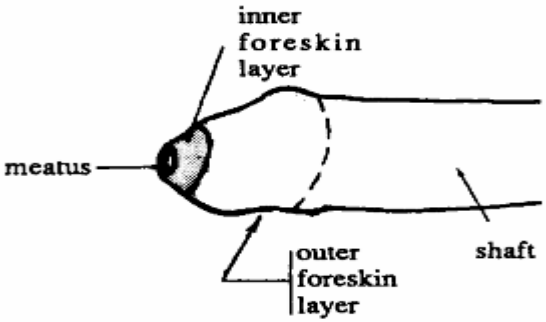
sympathetic nerves- muscle contraction

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

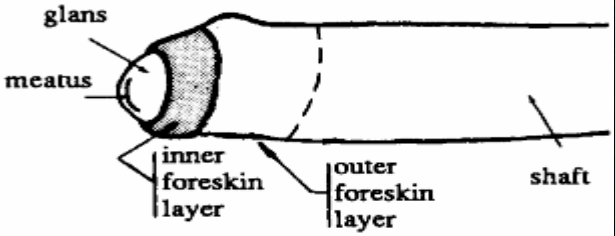
•The man whose non-erect penis is on the largish size will probably manage about a 75 per cent increase.

•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).

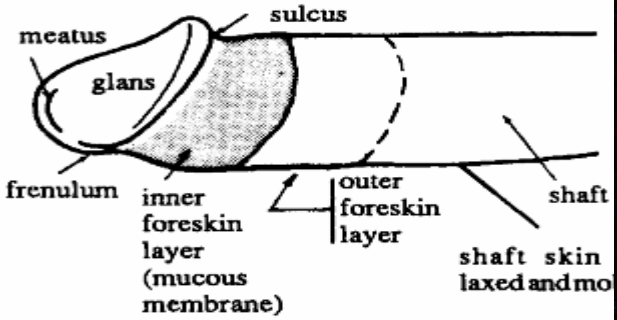
Erection begins

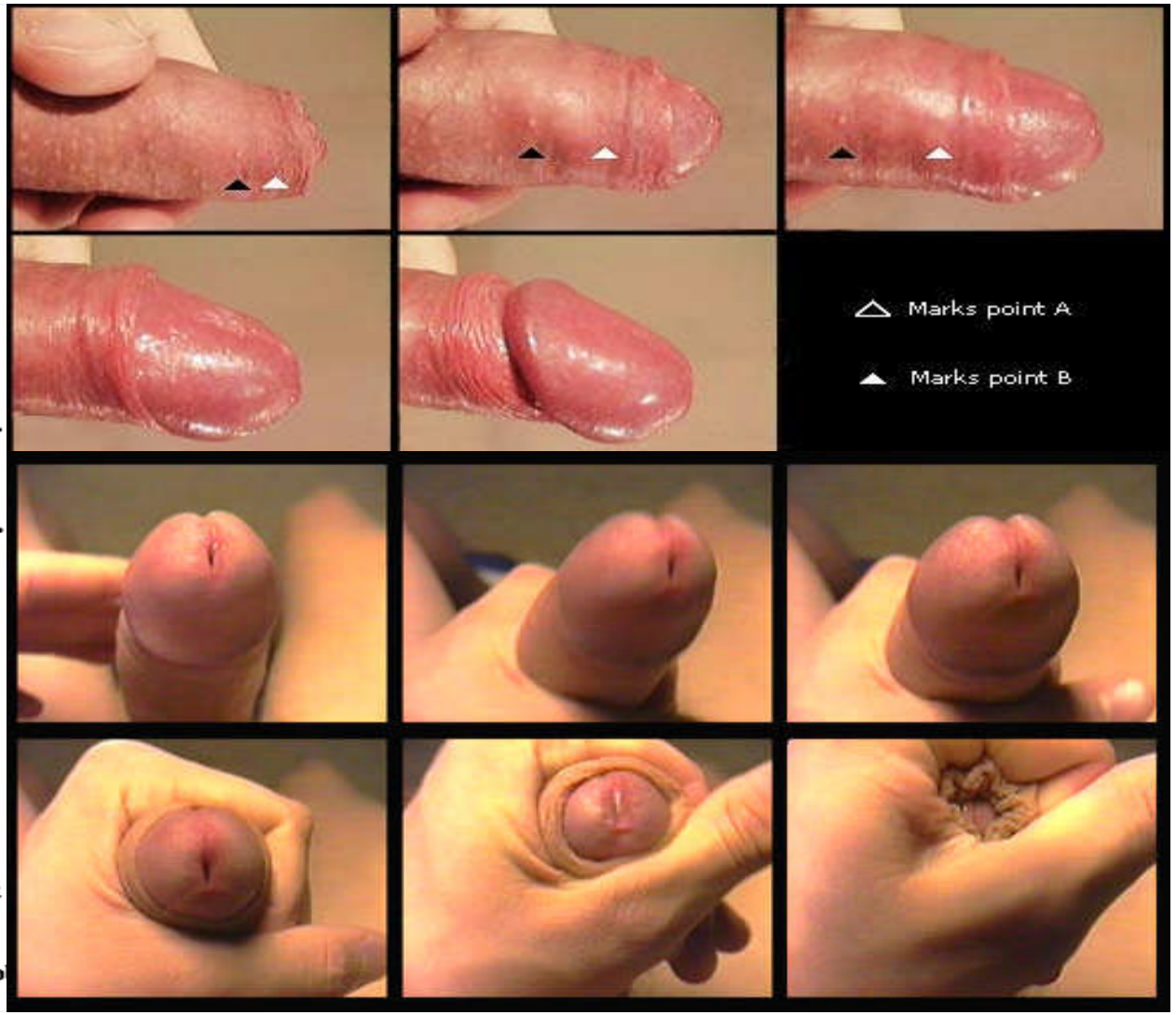


Erection continues

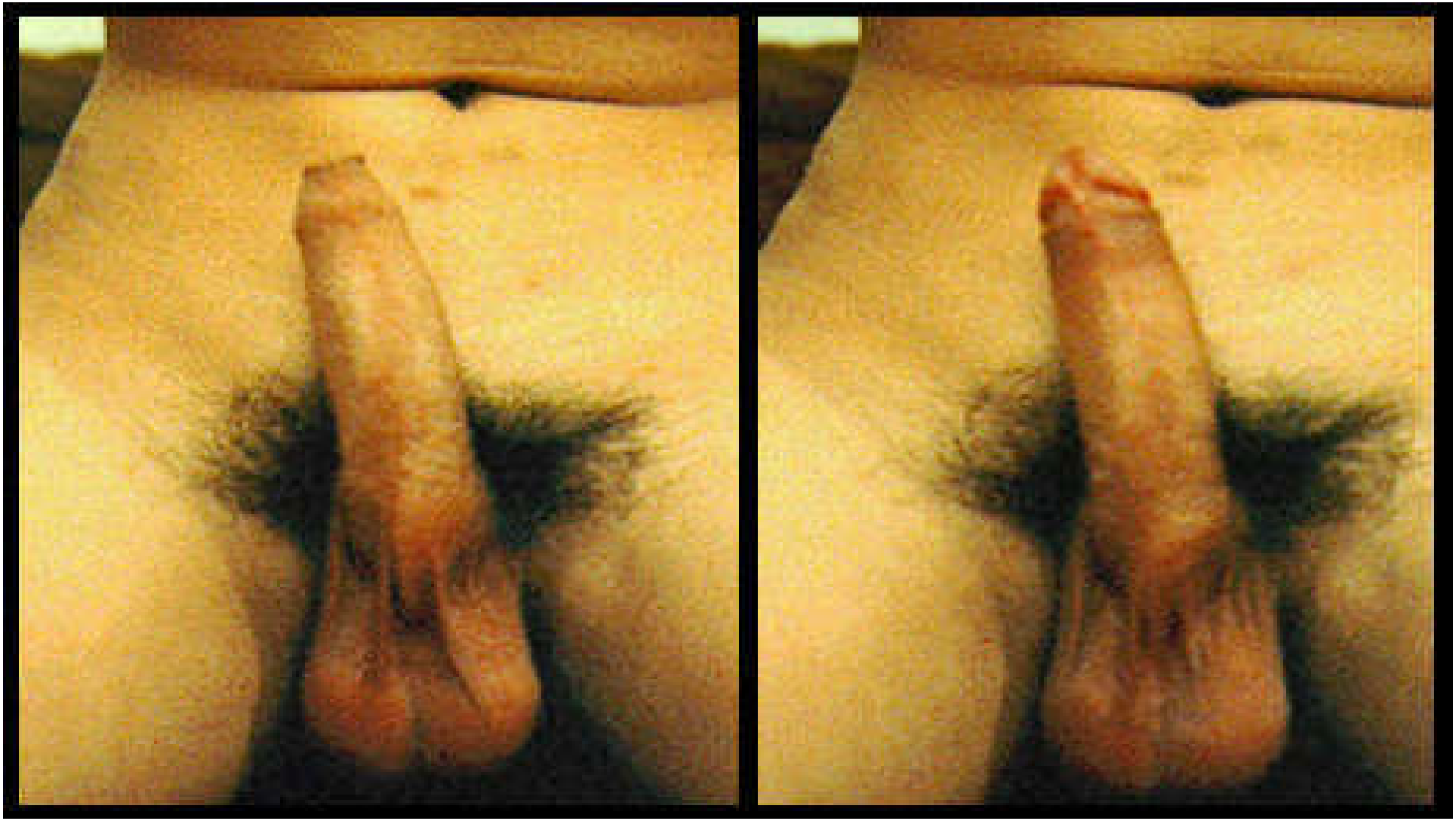


Erection complete

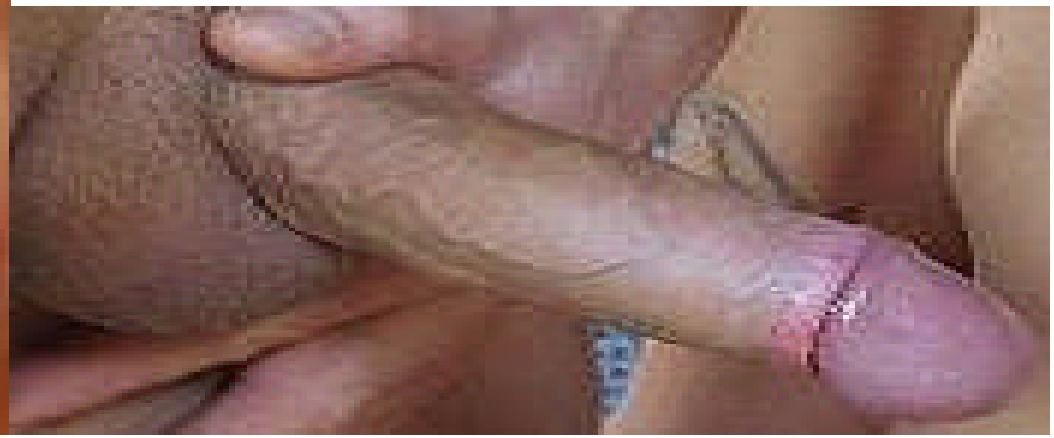




A view of the frenulum, foreskin retracted



Penis post ejaculation, notice all the vasculature [veinous]

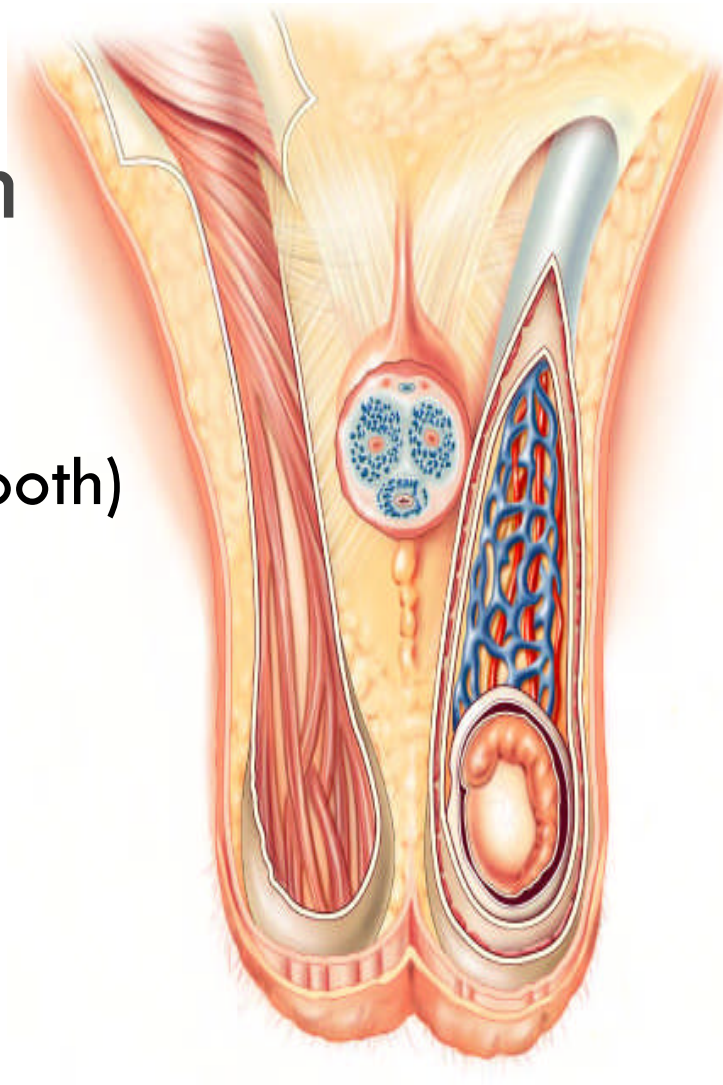


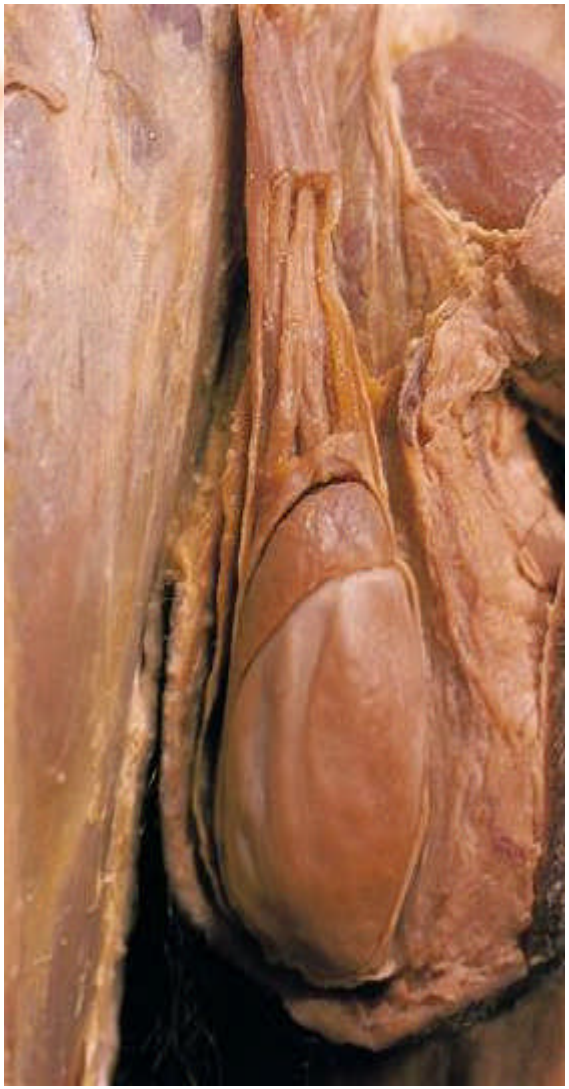

phemosis

[redacted] 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.

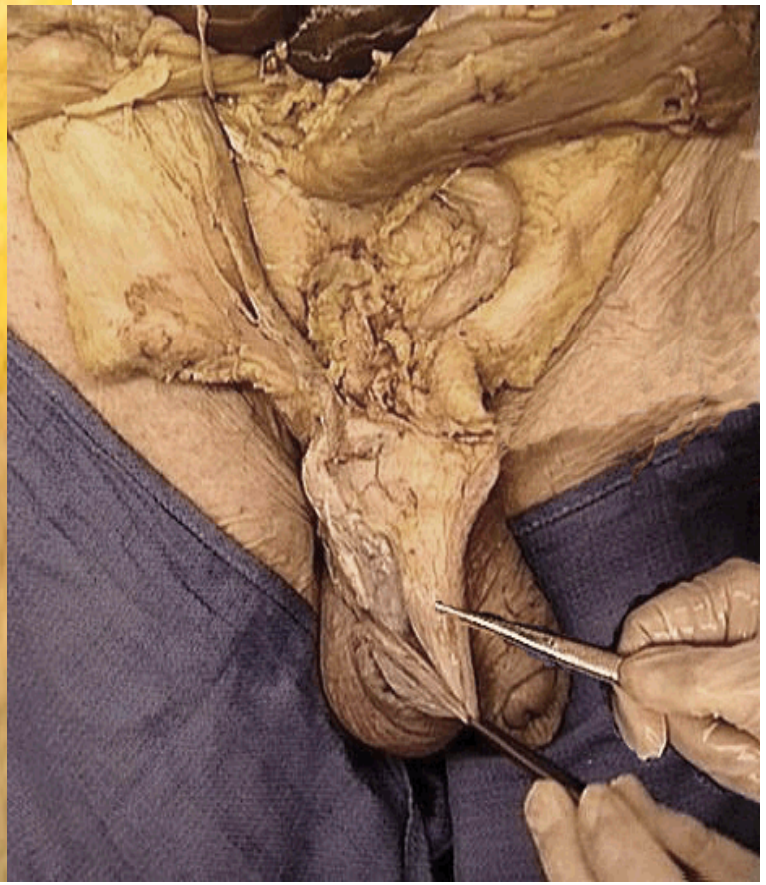
Scrotum

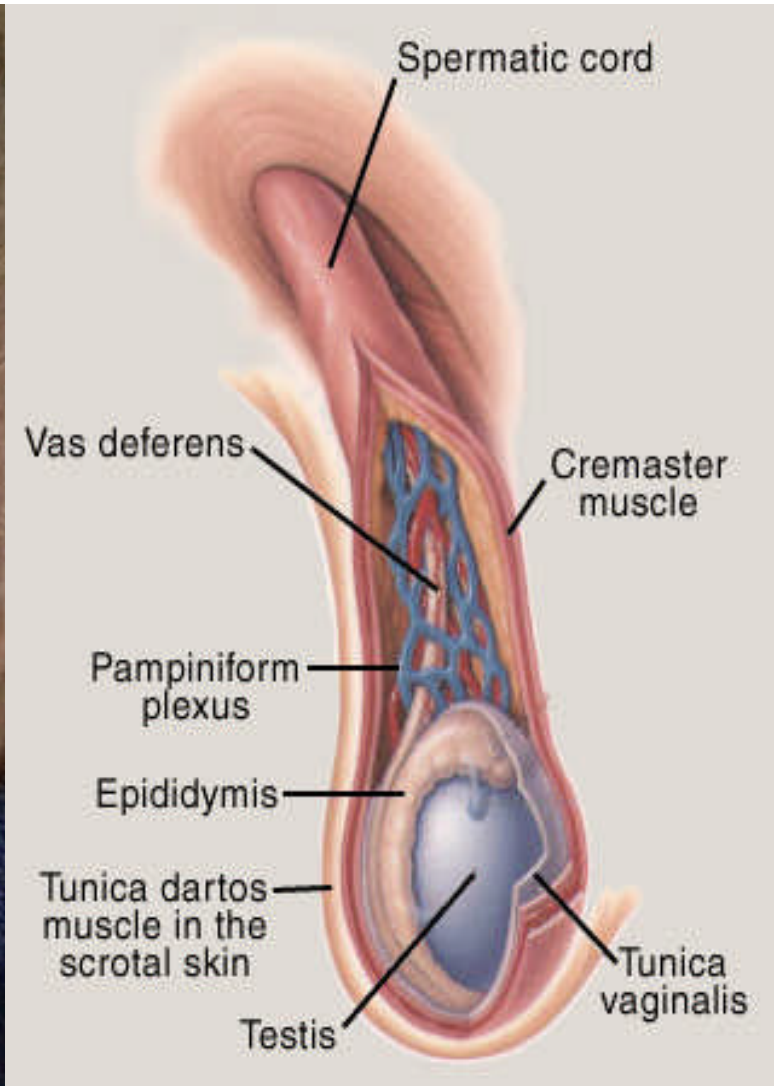
- Skin
- Dartos muscle (smooth)
- Septum
- Cremaster muscle (skeletal)





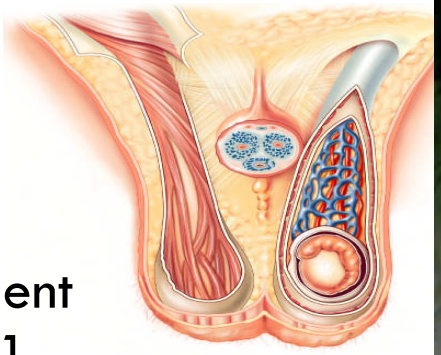
dartos




Spermatic cord
Vas deferens
Cremaster muscle
Pampiniform plexus
Epididymis
Tunica dartos muscle in the scrotal skin
Tunica vaginalis
Testis

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



24.2

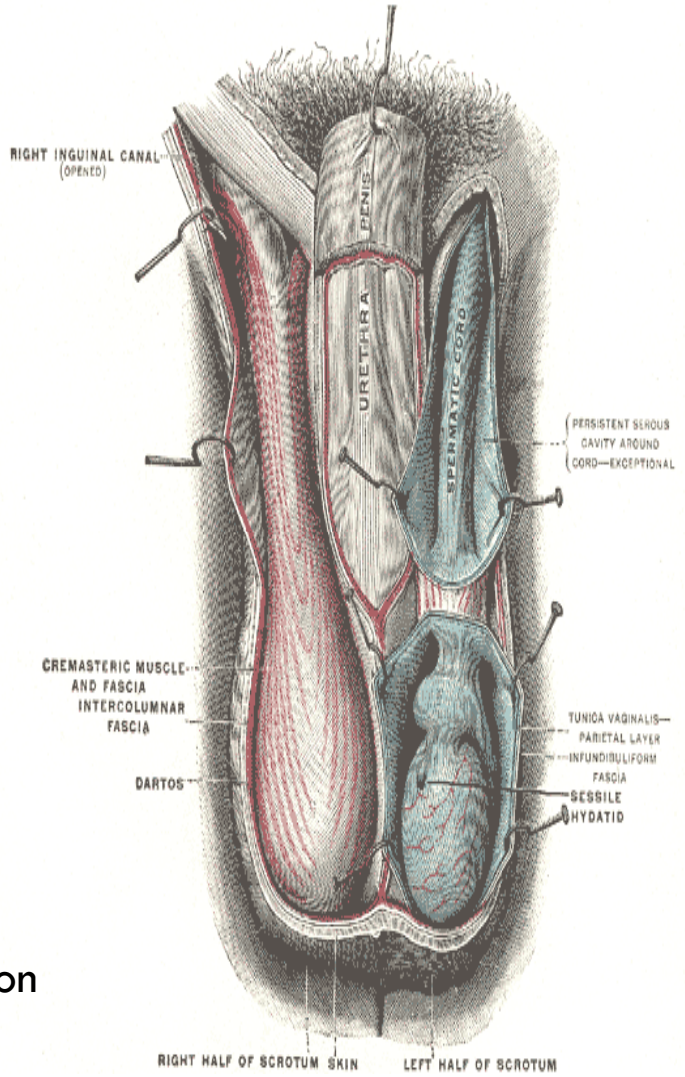
The Scrotum

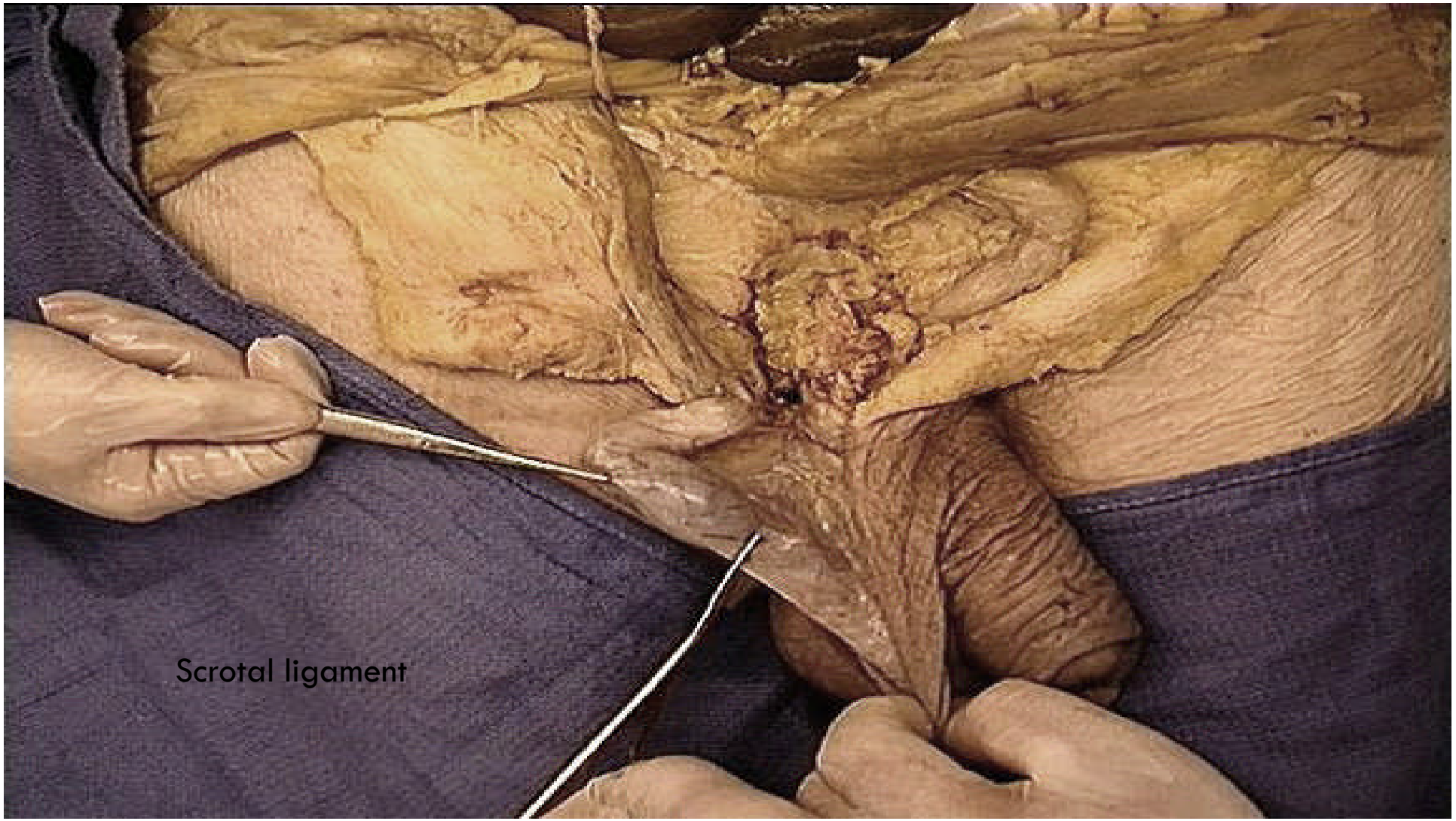
Intrascrotal temperature is kept constant by two sets of muscles:

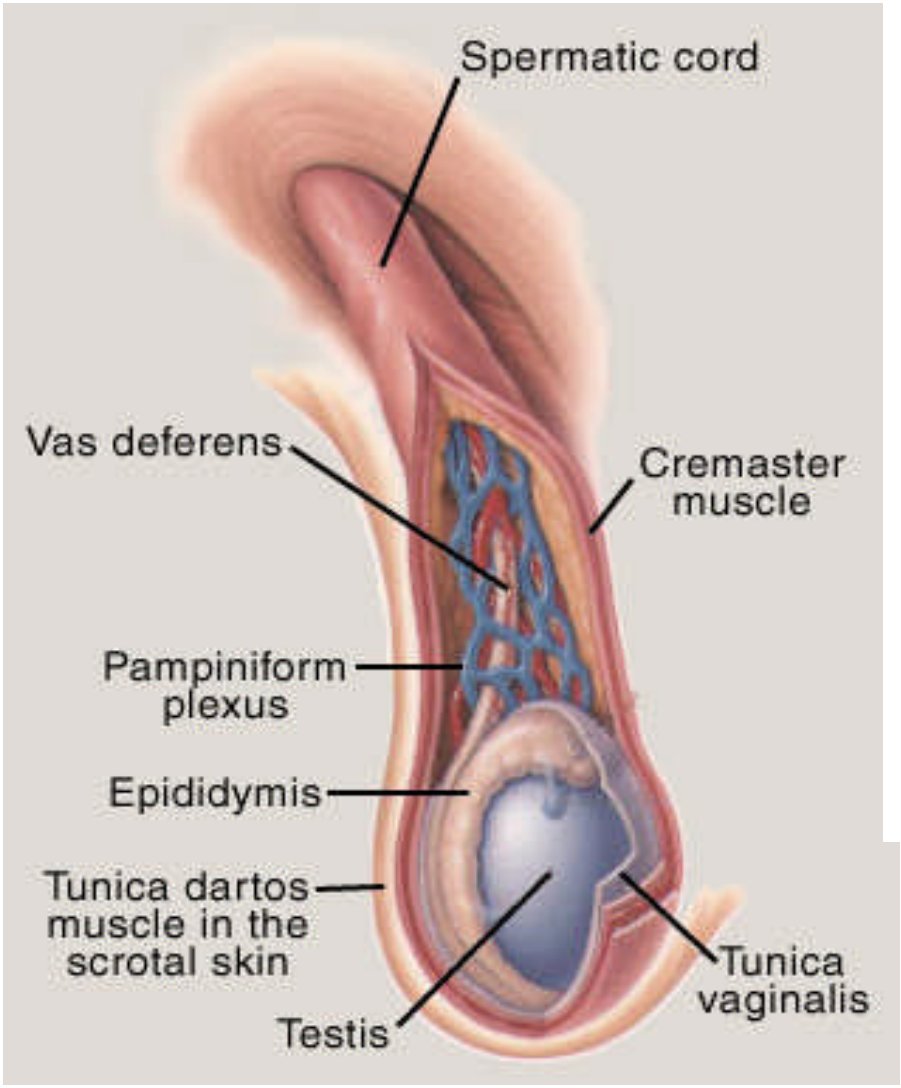
Dartos – smooth muscle that wrinkles scrotal skin. regulate the temperature of the testicles, which promotes spermatogenesis. I does this by expanding or contracting to wrinkle the scrotal skir Contraction reduces the surface area available for heat loss, th reducing heat loss and warming the testicles.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

•**Cremaster** – bands of skeletal muscle that elevate the testes, I 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 in to the testicles during sex

In human females, the cremaster muscle is smaller and is found on the round ligament.




Scrotal ligament



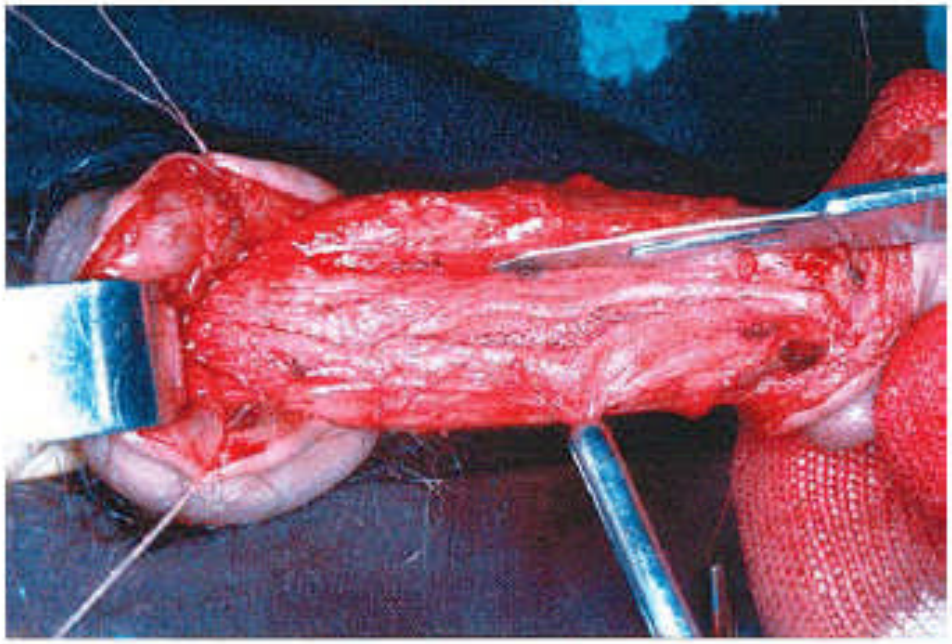
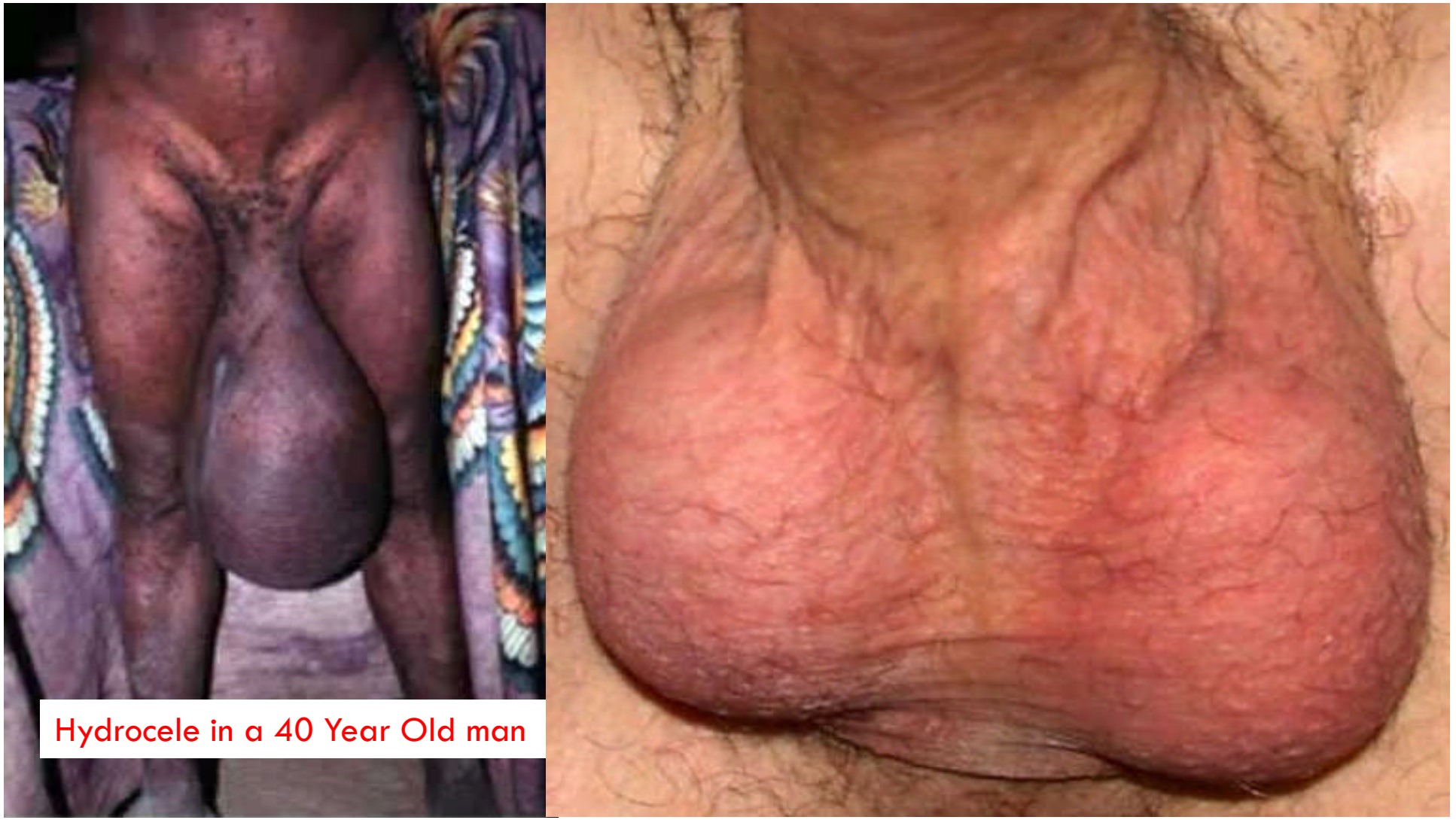
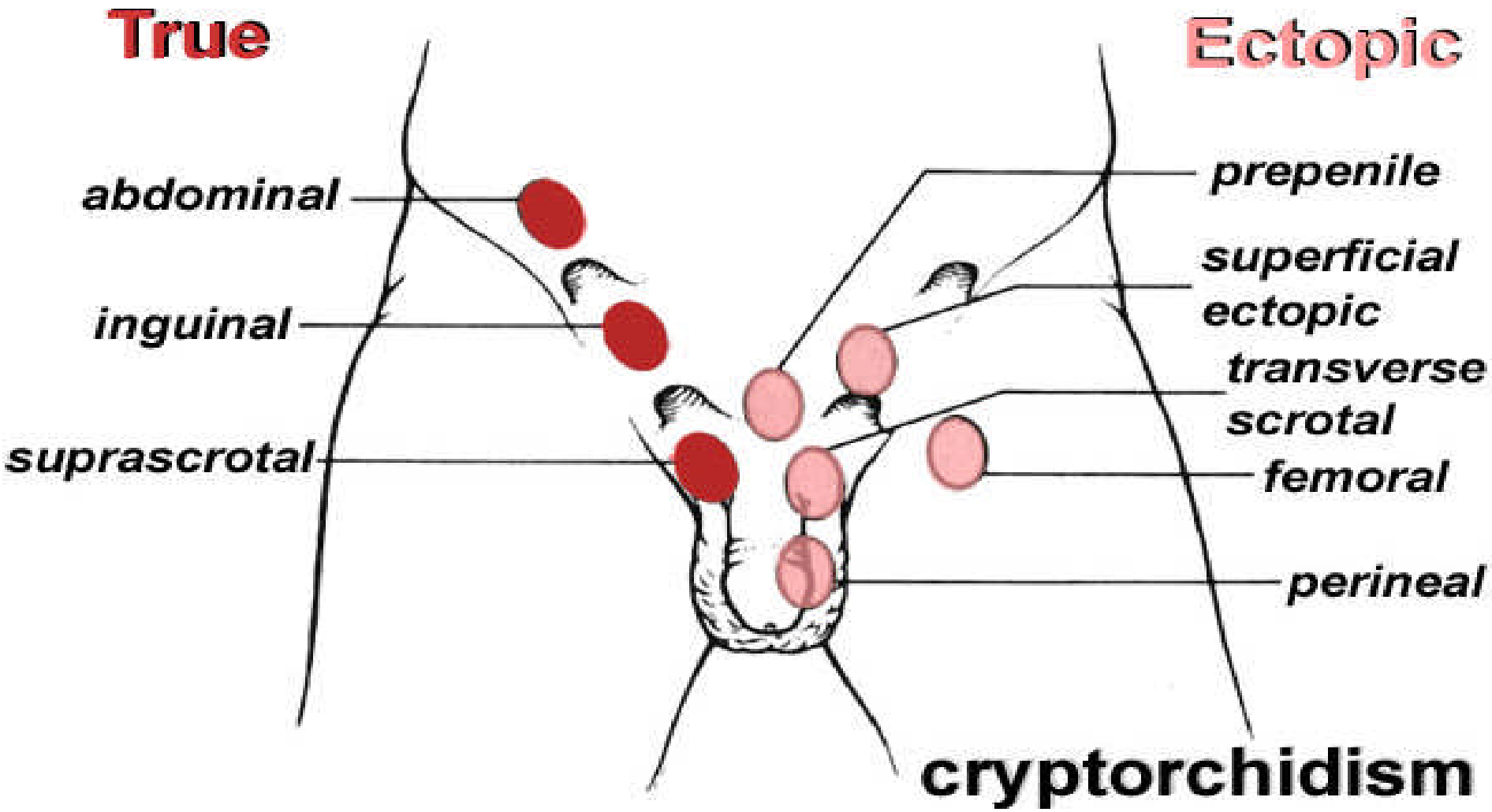


Figure 1 – Incision of the tunica albuginea on the left corpus cavernosum. A longitudinal band in the tunica (of about 0.5 cm) is prepared.



Hydrocele in a 40 Year Old man

Testes


True
Ectopic
abdominal
inguinal
suprascrotal
prepenile
superficial ectopic
transverse scrotal
femoral
perineal
cryptorchidism

MALE REPRODUCTIVE SYSTEM

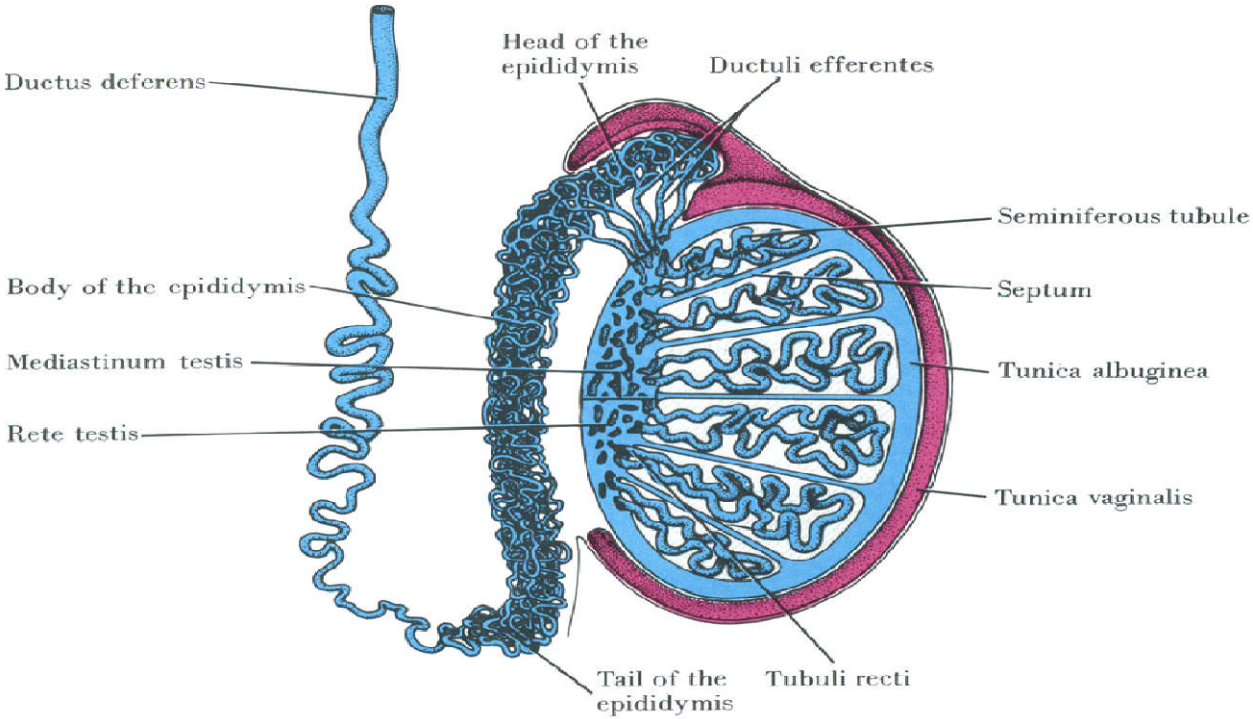
- TESTIS

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

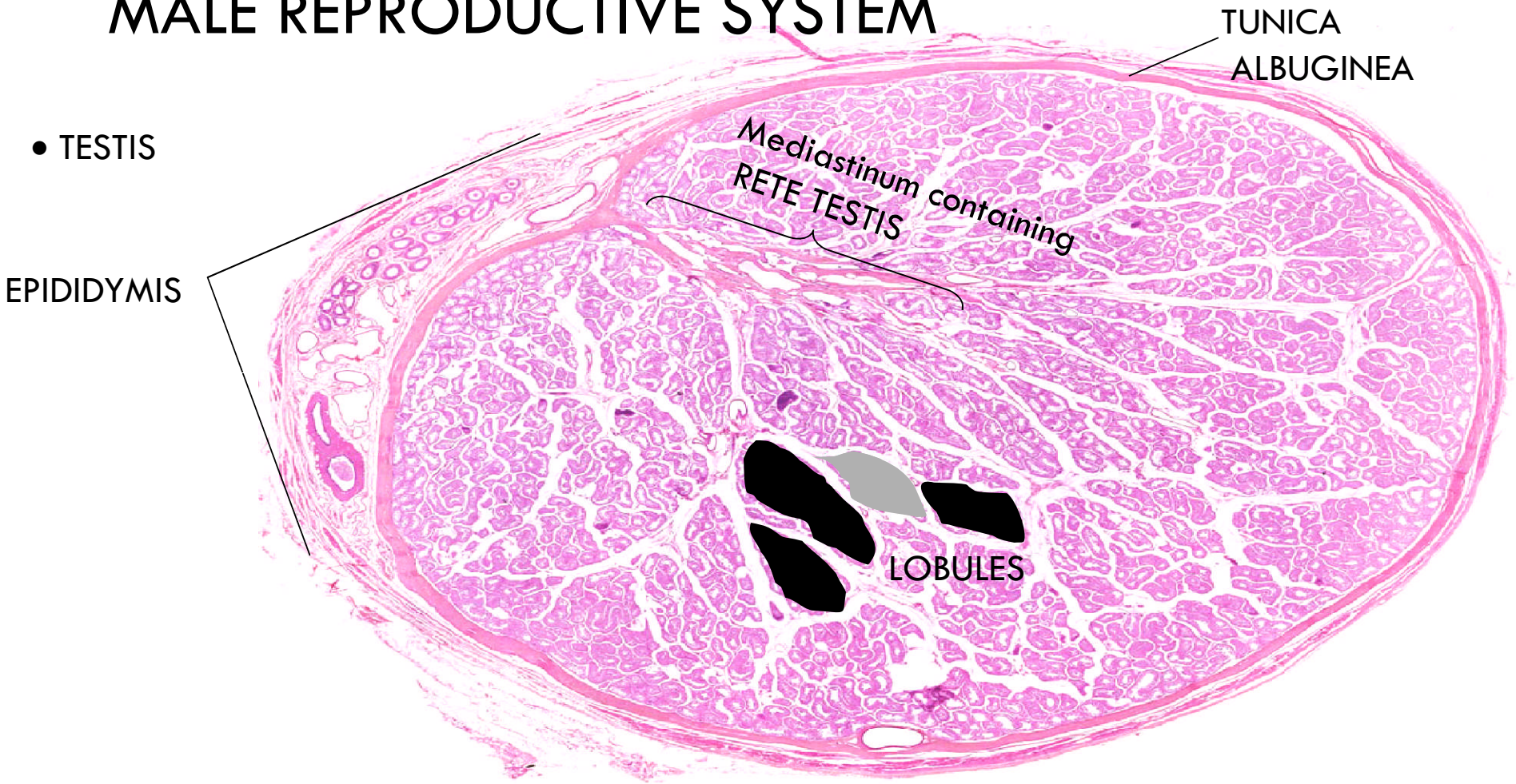
(1) SEMINIFEROUS TUBULES
- produce sperm

INTERSTITIAL TISSUE
- contains Leydig cells which produce *testosterone*

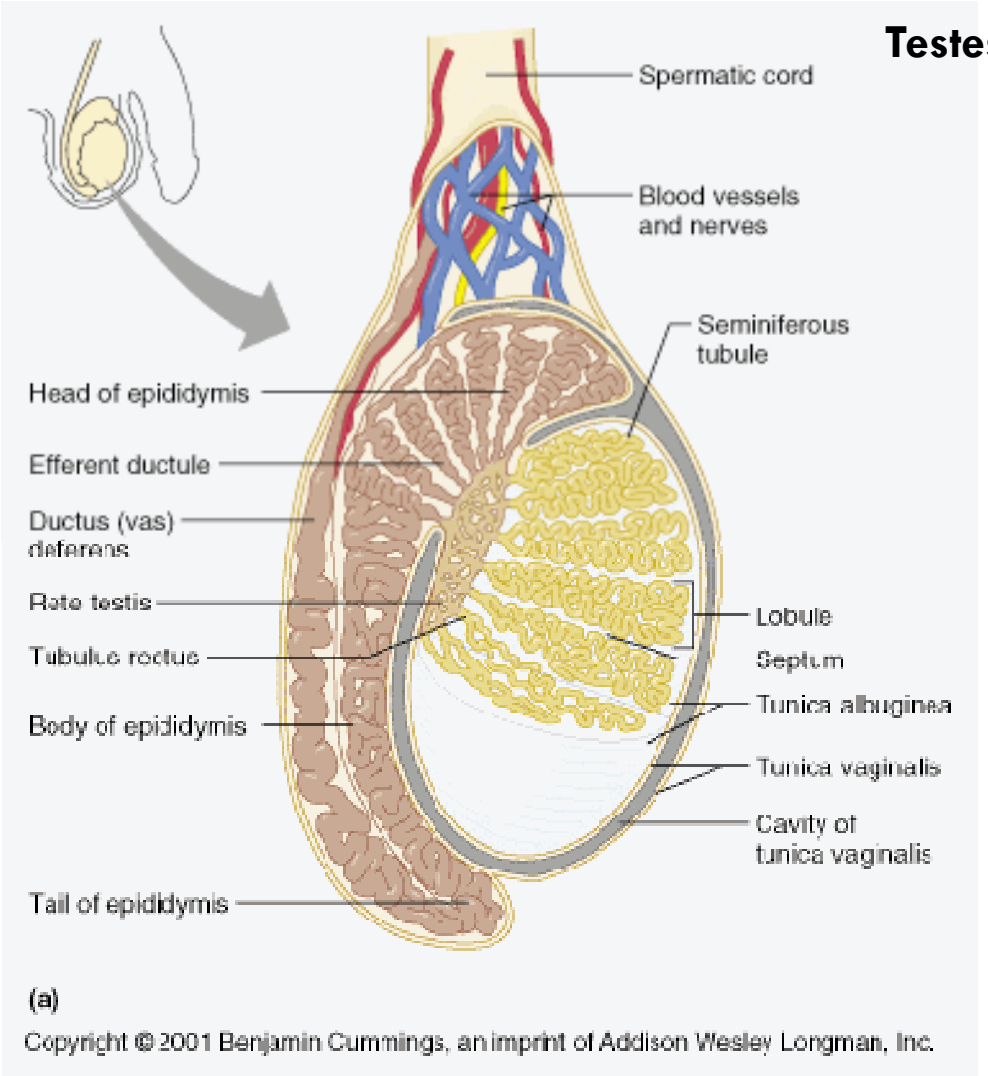
(2) RECTUS TUBULES
(3) RETE TESTIS
(4) EFFERENT DUCTULES
(5) EPIDIDYMIS



MALE REPRODUCTIVE SYSTEM



Testes (single testis)

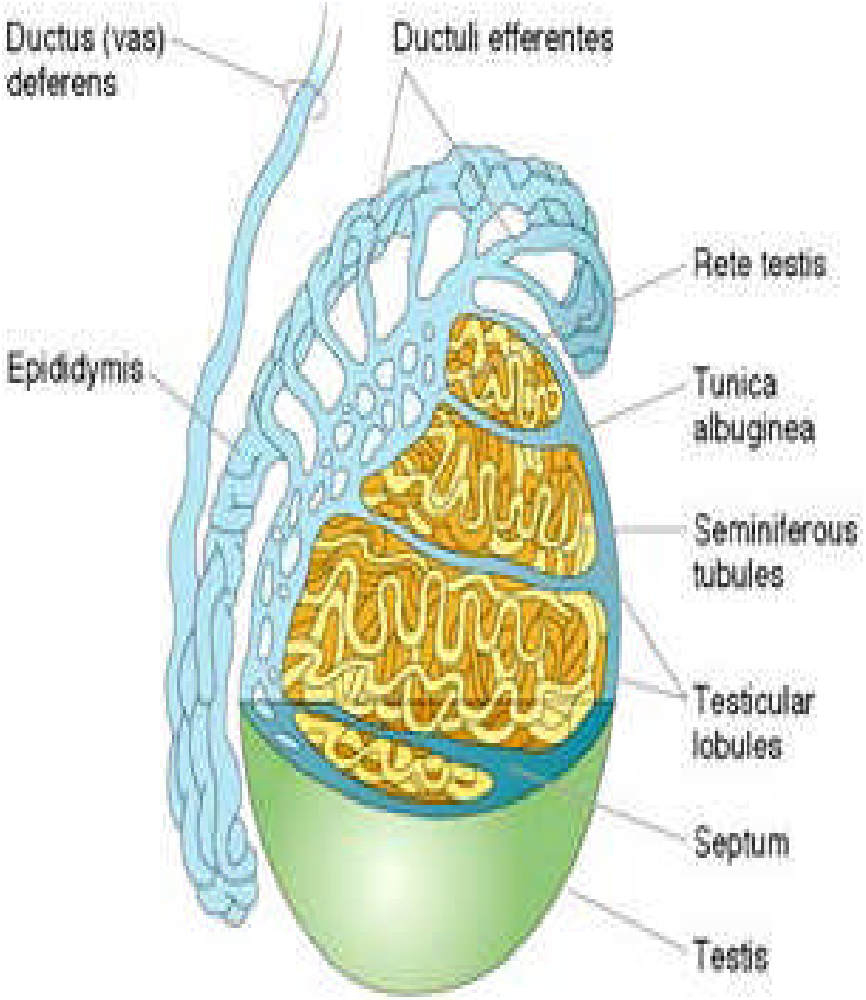


Divided into 200-300 wedge shaped lobules.

Testes and ovaries are from the same tissue

Seminiferous tubules:
Cells specialties
1). **Leydig cells**
2). **Spermatogenic cells**

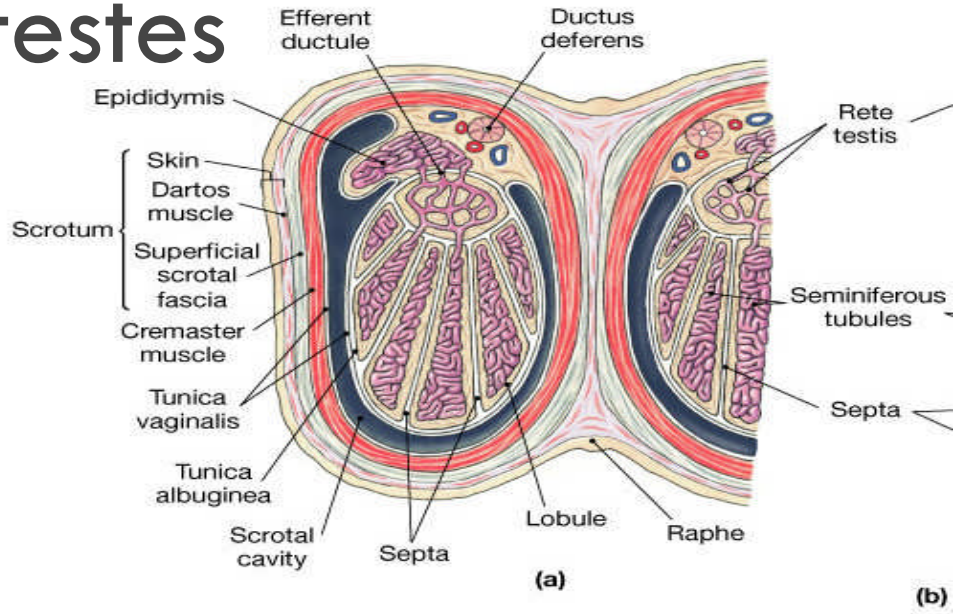
Testis



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



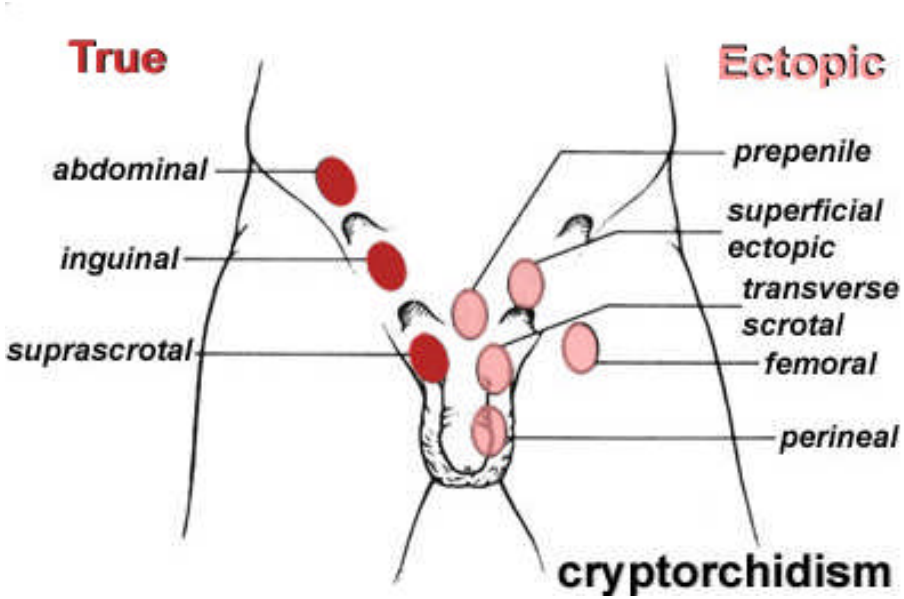
•Testes are formed in abdomen and descend into scrotum at 7th month of development

•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

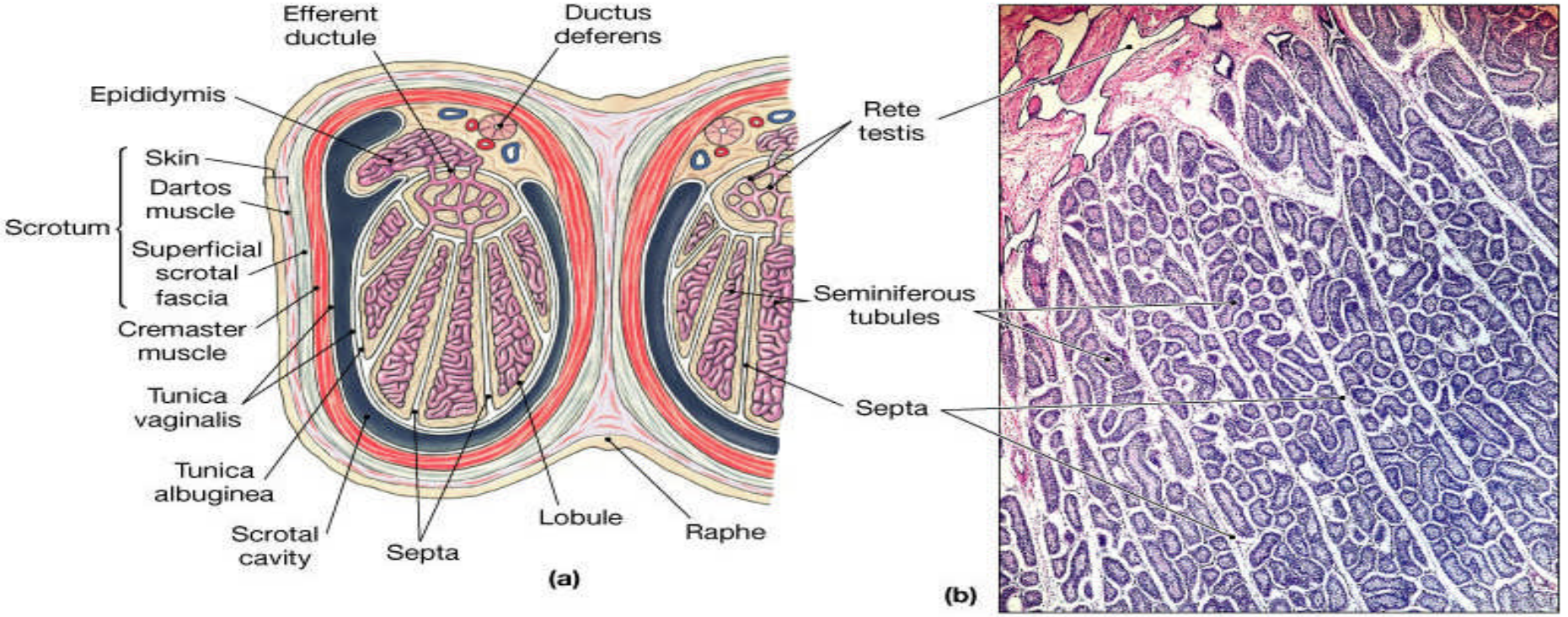
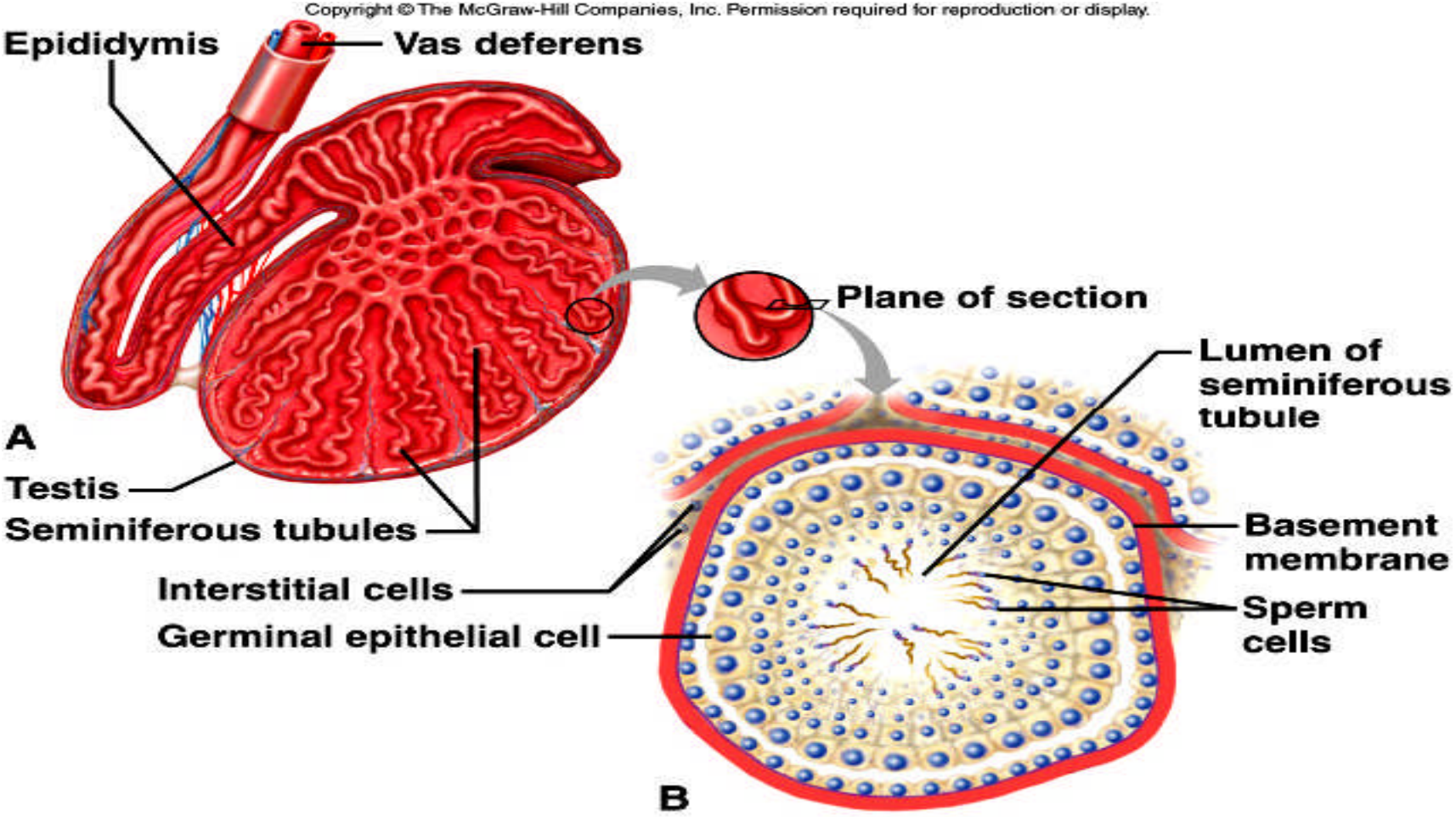
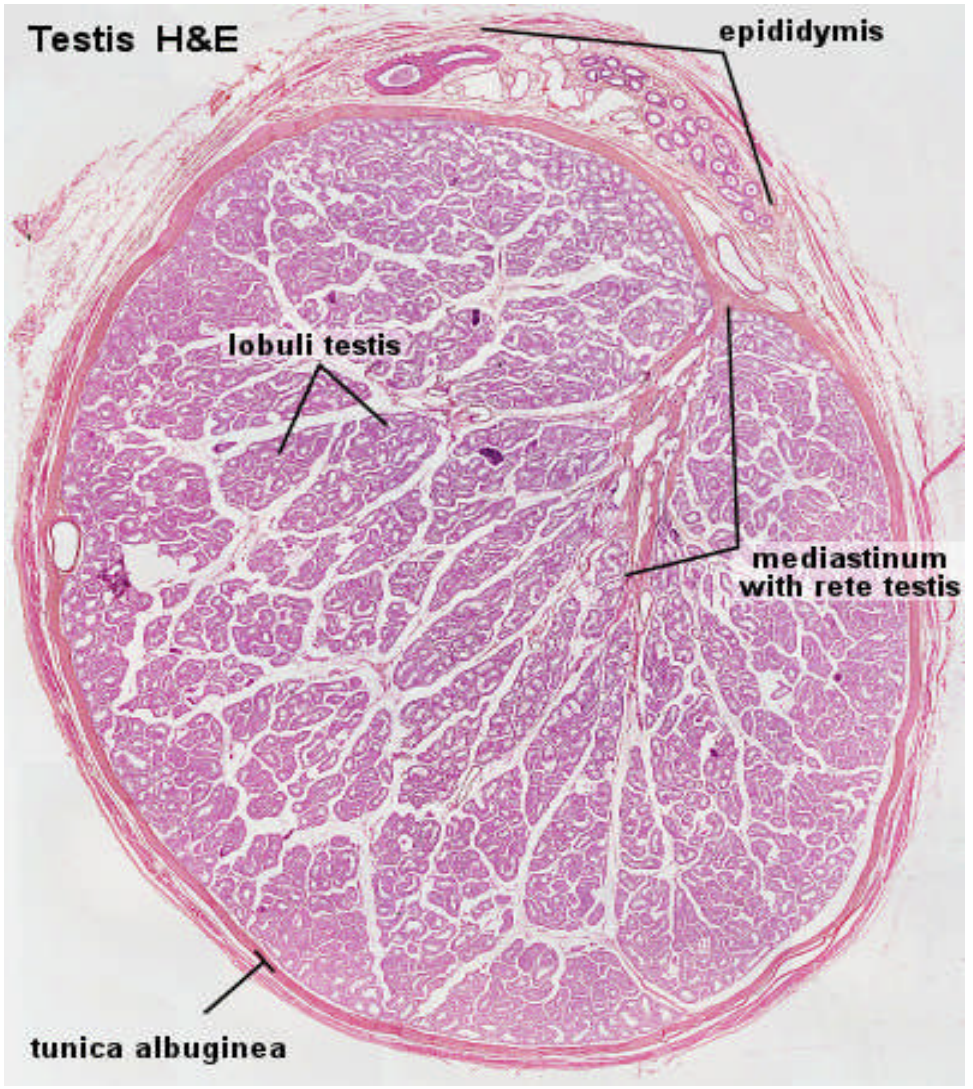
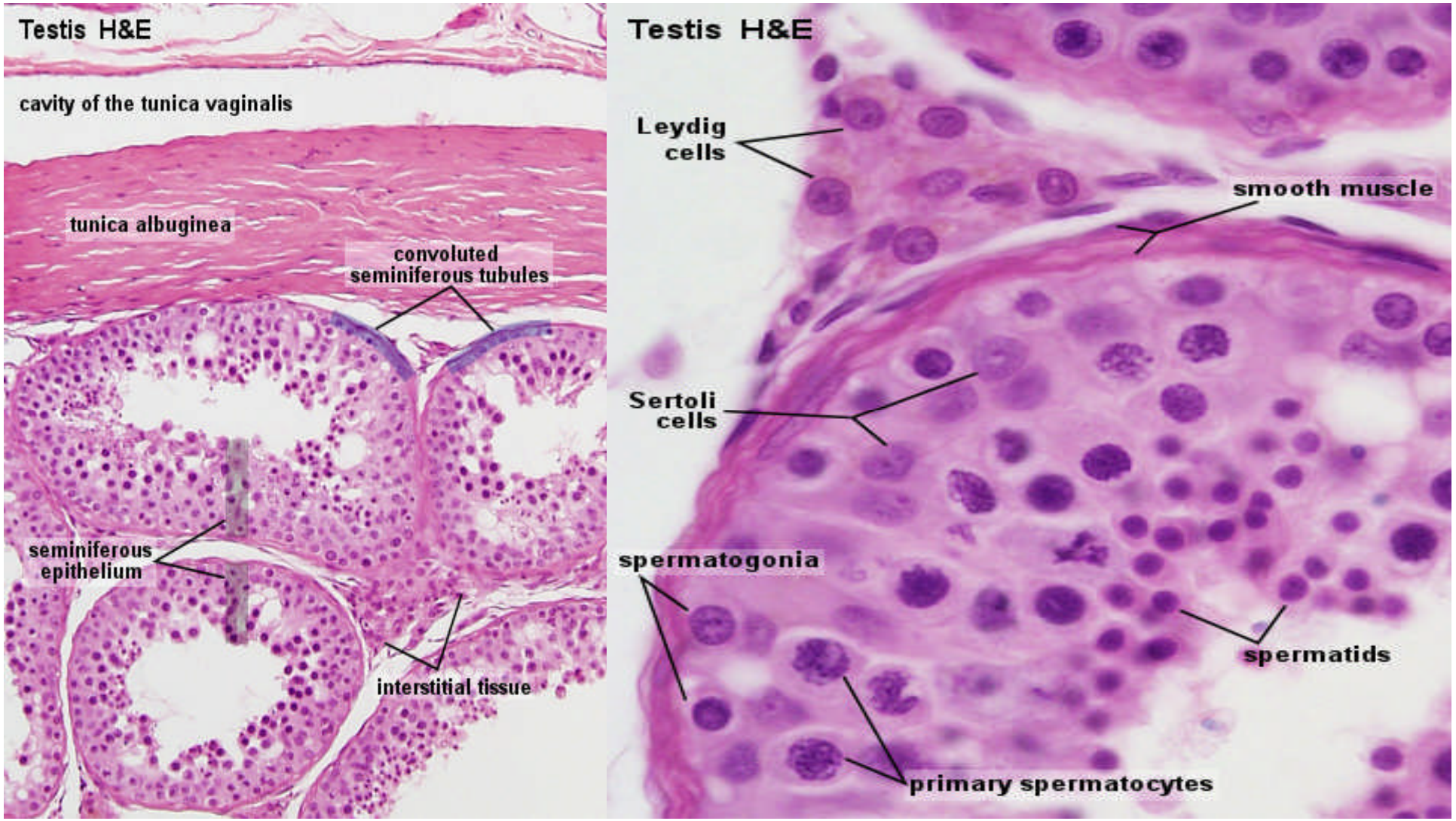
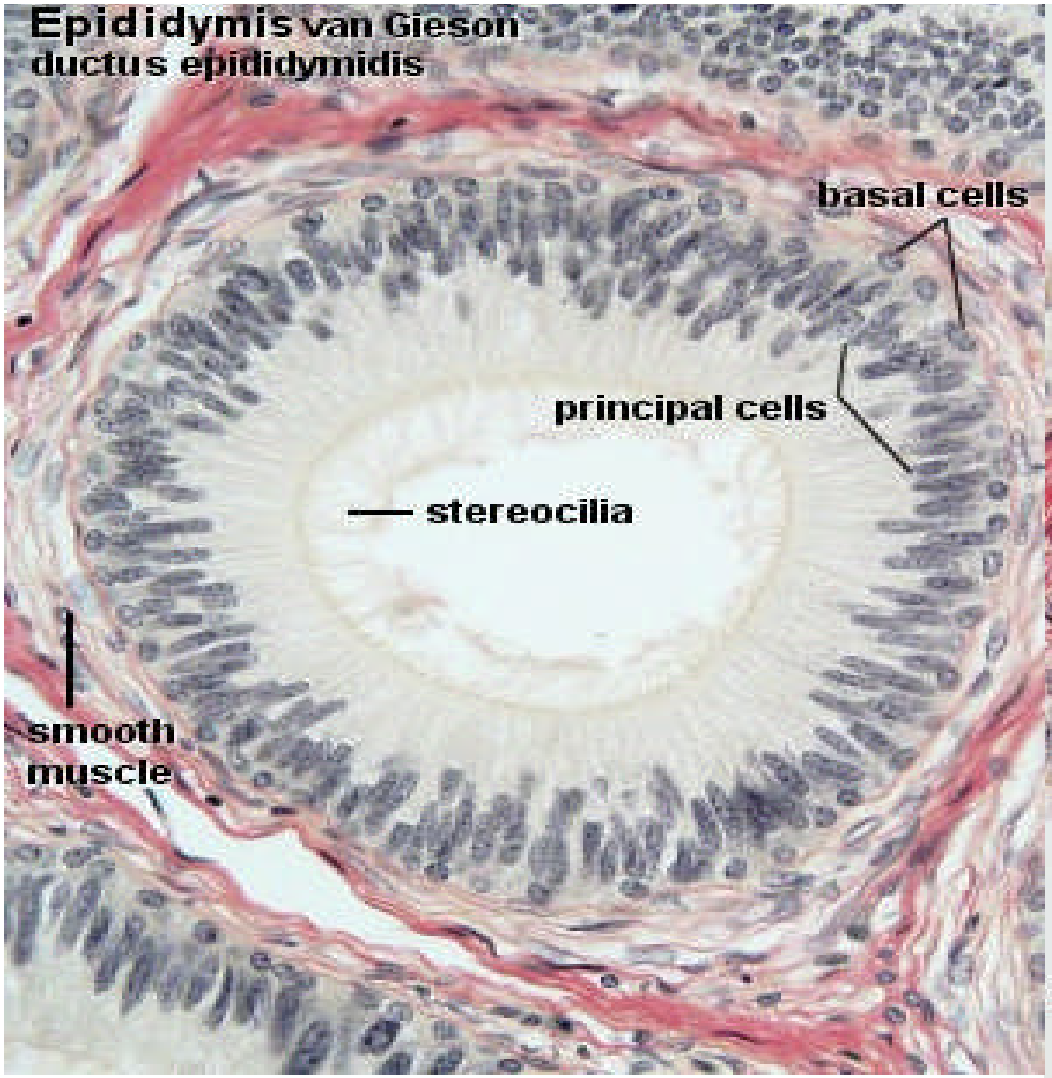


Figure 28.4

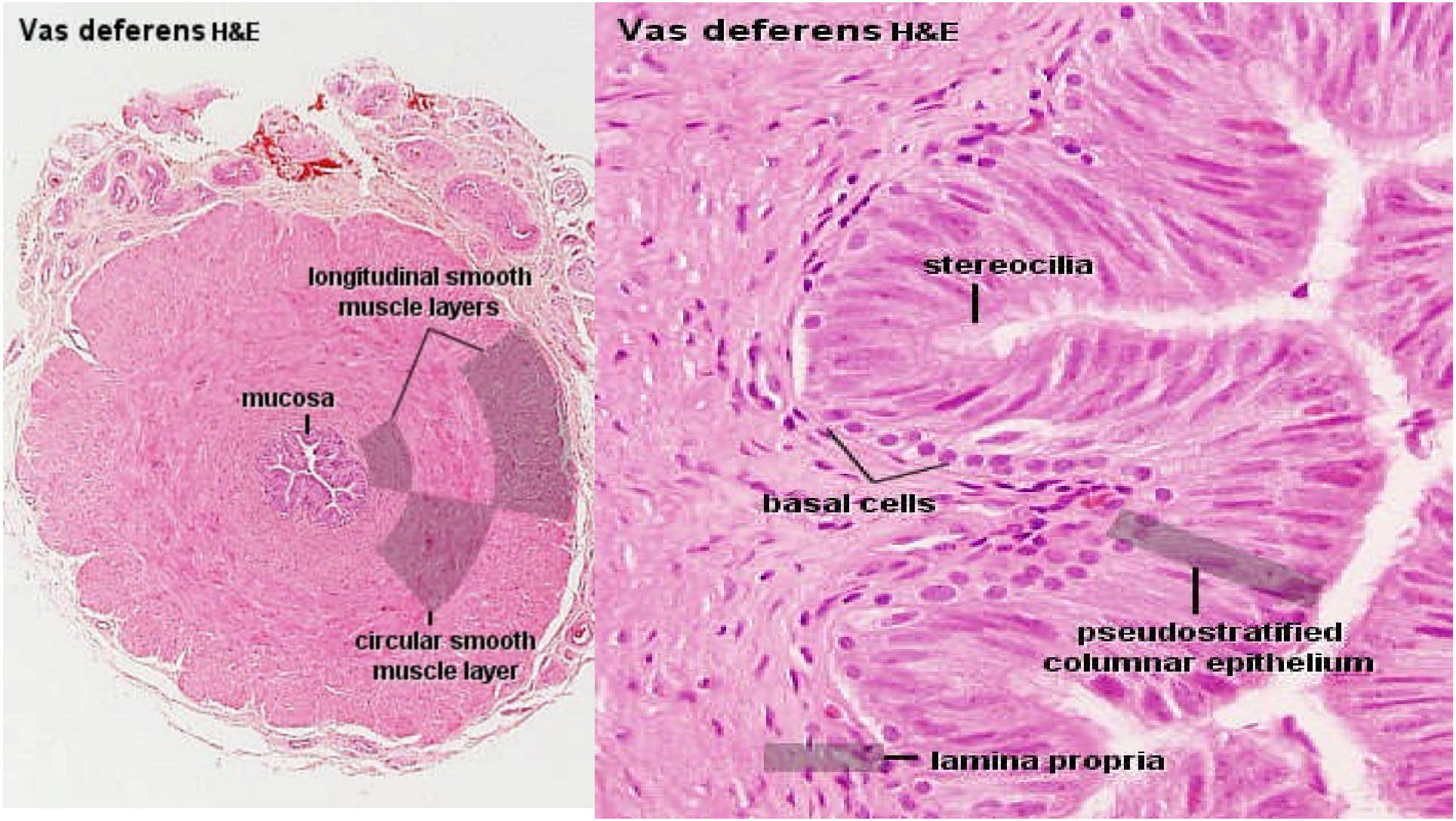


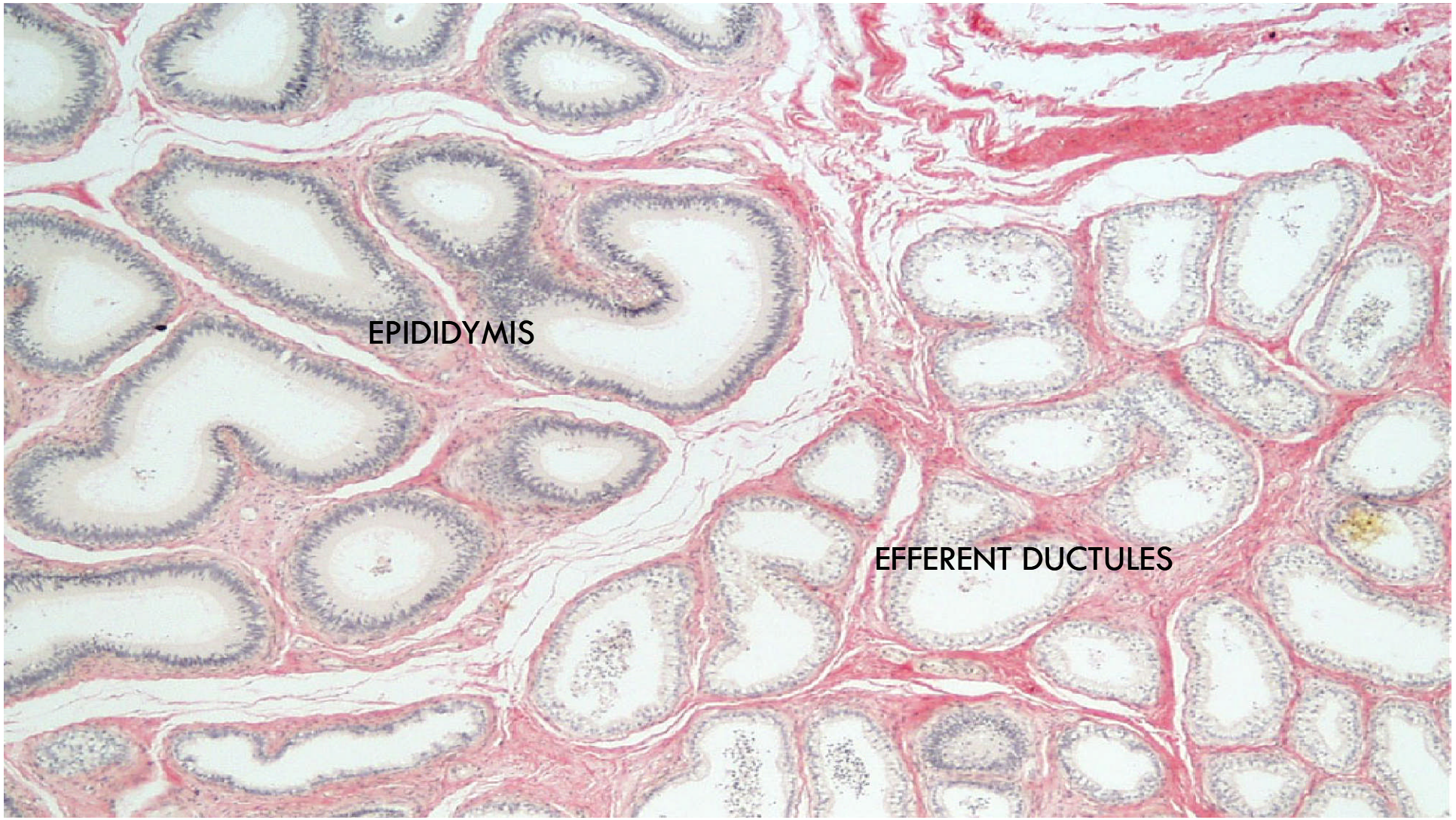

Testis H&E
epididymis
lobuli testis
mediastinum
with rete testis
tunica albuginea


Testis H&E
cavity of the tunica vaginalis
tunica albuginea
convoluted seminiferous tubules
seminiferous epithelium
interstitial tissue
Testis H&E
Leydig cells
smooth muscle
Sertoli cells
spermatogonia
spermatids
primary spermatocytes

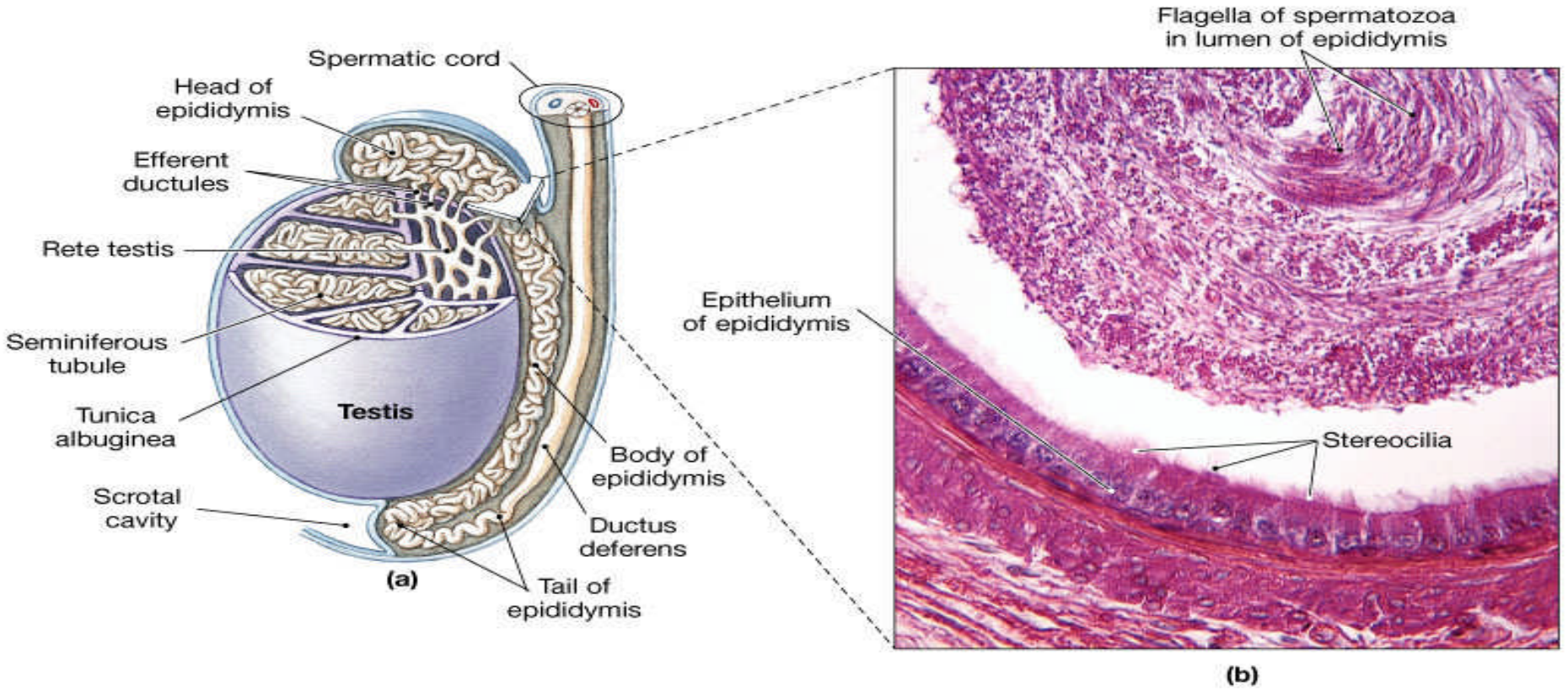

Epididymis van Gieson
ductus epididymidis
basal cells
principal cells
stereocilia
smooth muscle


Epididymis van Gieson
ductulus efferens
smooth muscle
tall ciliated cells
short absorptive cells
connective tissue


Vas deferens H&E
longitudinal smooth muscle layers
mucosa
circular smooth muscle layer
Vas deferens H&E
stereocilia
basal cells
pseudostratified columnar epithelium
lamina propria


EPIDIDYMIS
EFFERENT DUCTULES

The Epididymus



BulbourethralGlands (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

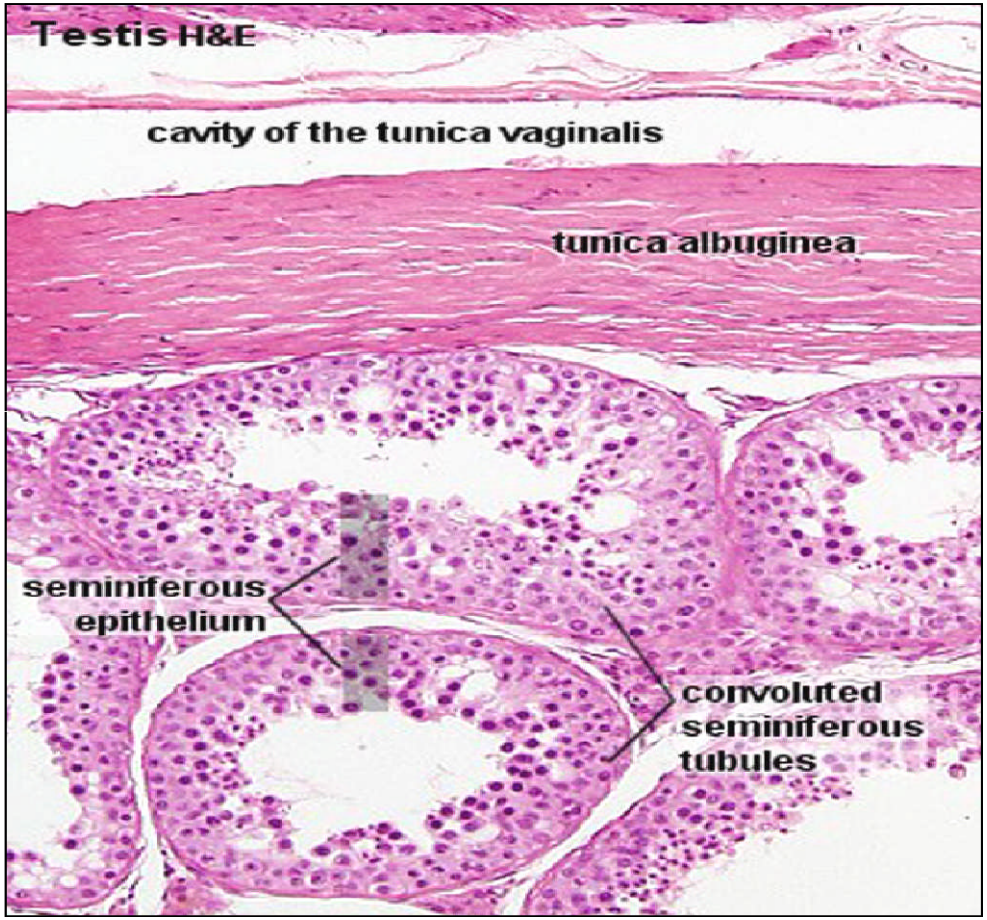
  SEMINIFEROUS TUBULES

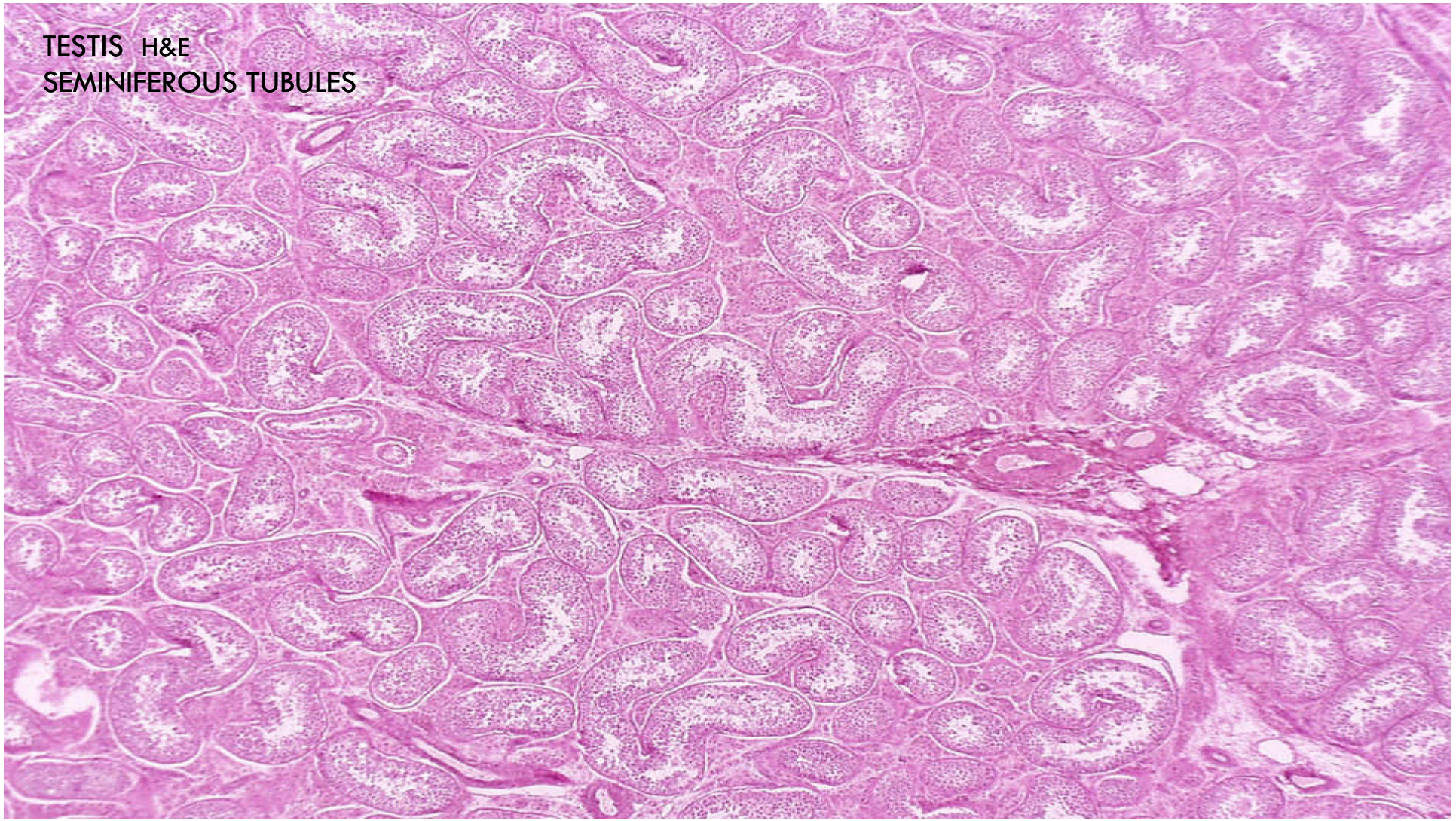
  SEMINIFEROUS EPITHELIUM

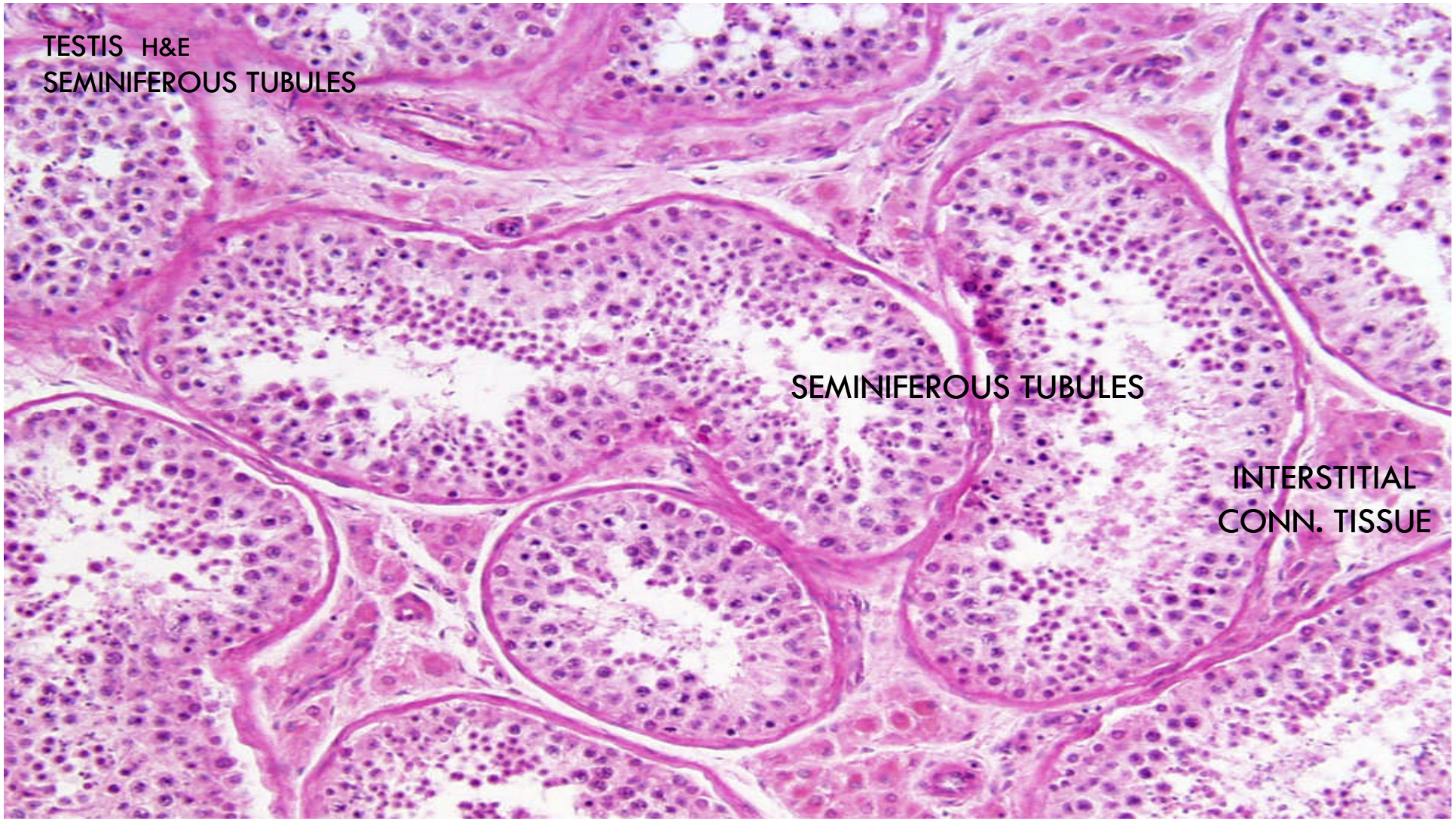
  - complex stratified epithelium containing two basic cell populations:

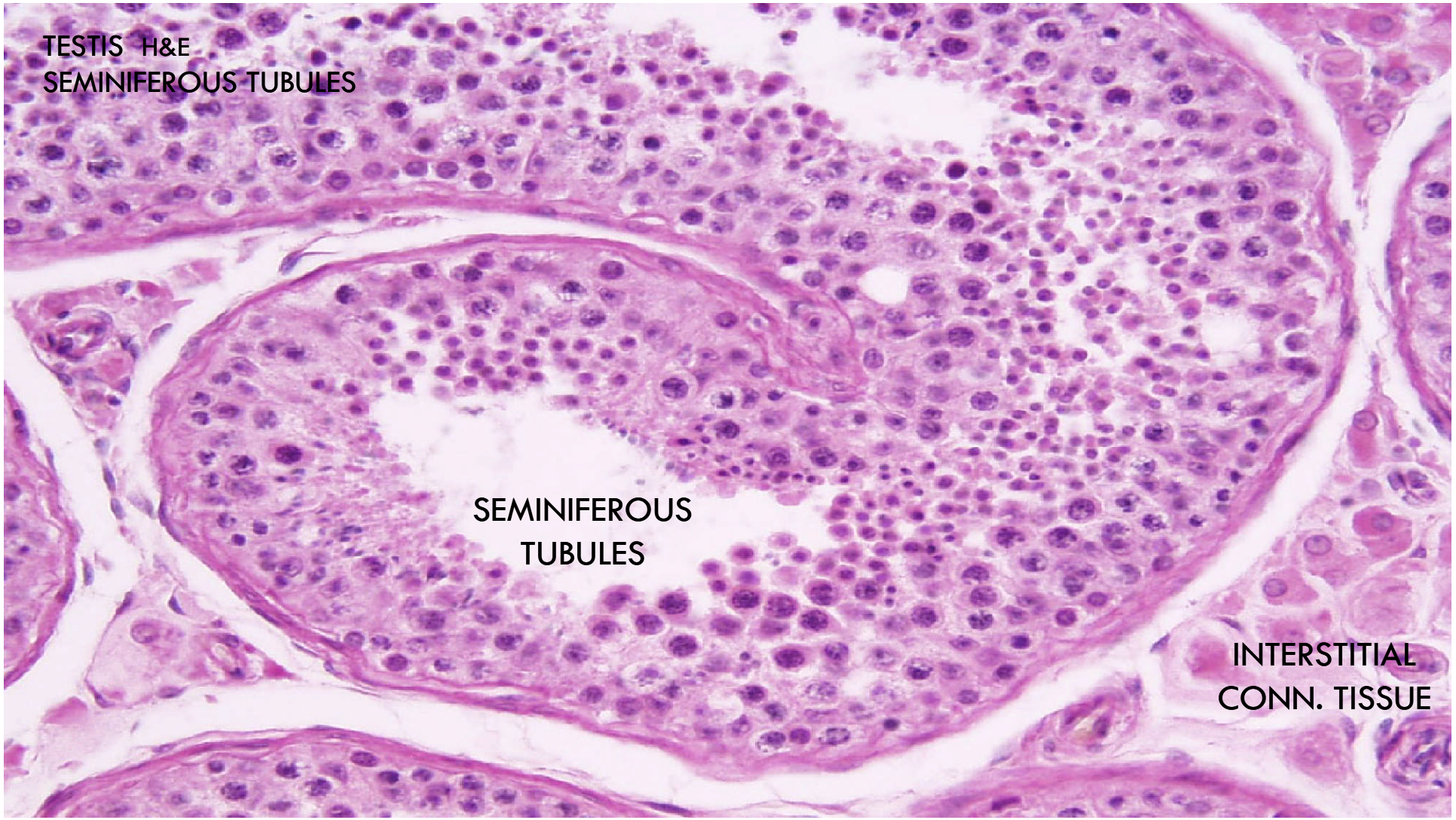
  (1) SPERMATOGENIC CELLS

  (2) SERTOLI CELLS




TESTIS H&E
SEMINIFEROUS TUBULES


TESTIS H&E
SEMINIFEROUS TUBULES
SEMINIFEROUS TUBULES
INTERSTITIAL
CONN. TISSUE


TESTIS H&E
SEMINIFEROUS TUBULES
SEMINIFEROUS
TUBULES
INTERSTITIAL
CONN. TISSUE

The Seminiferous Tubules

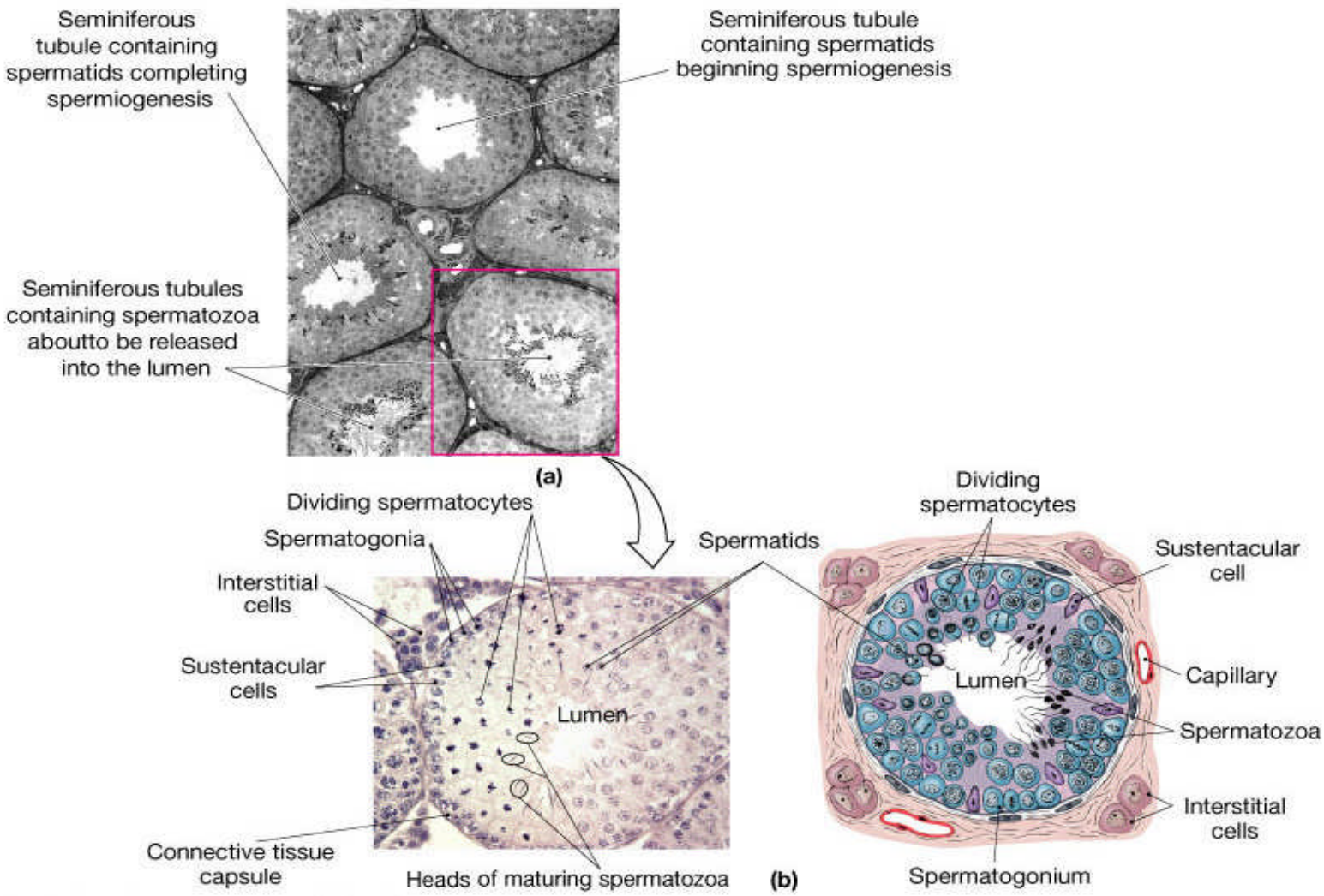


Figure 28.3d, b

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

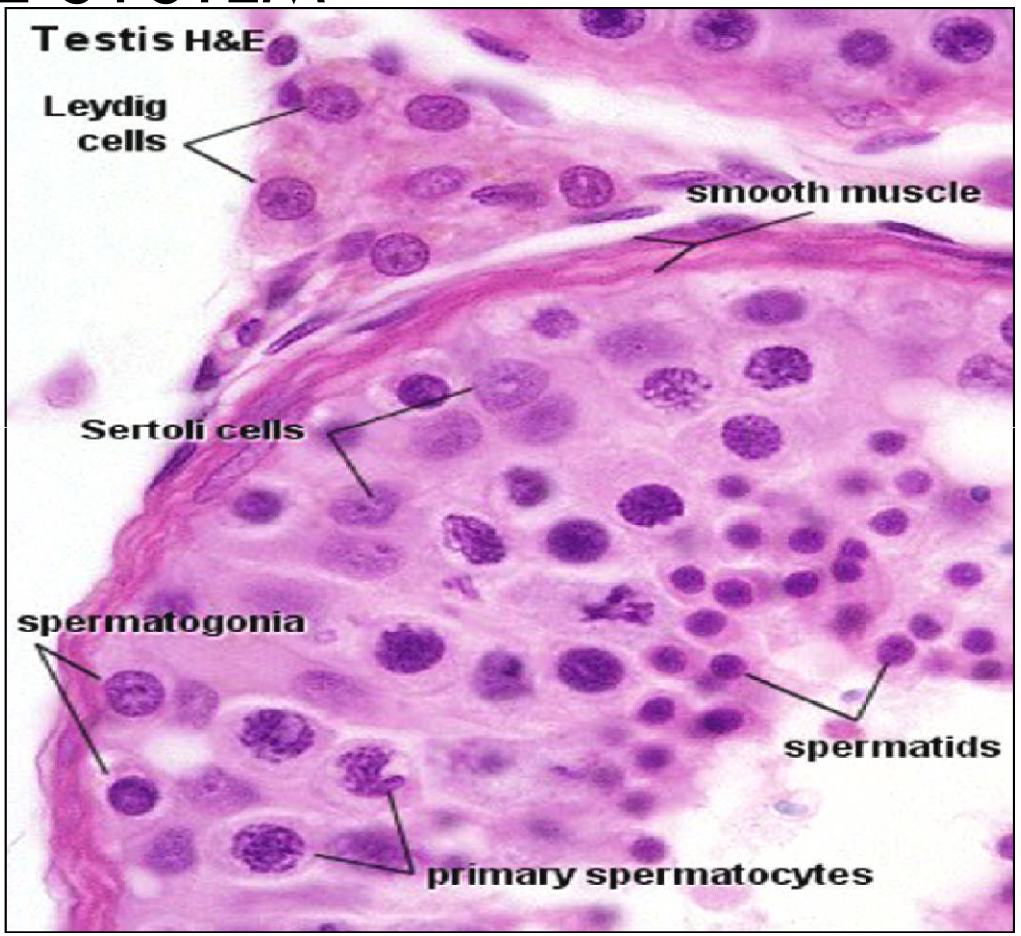
(2) SERTOLI CELLS

nonreplicating physical support cells

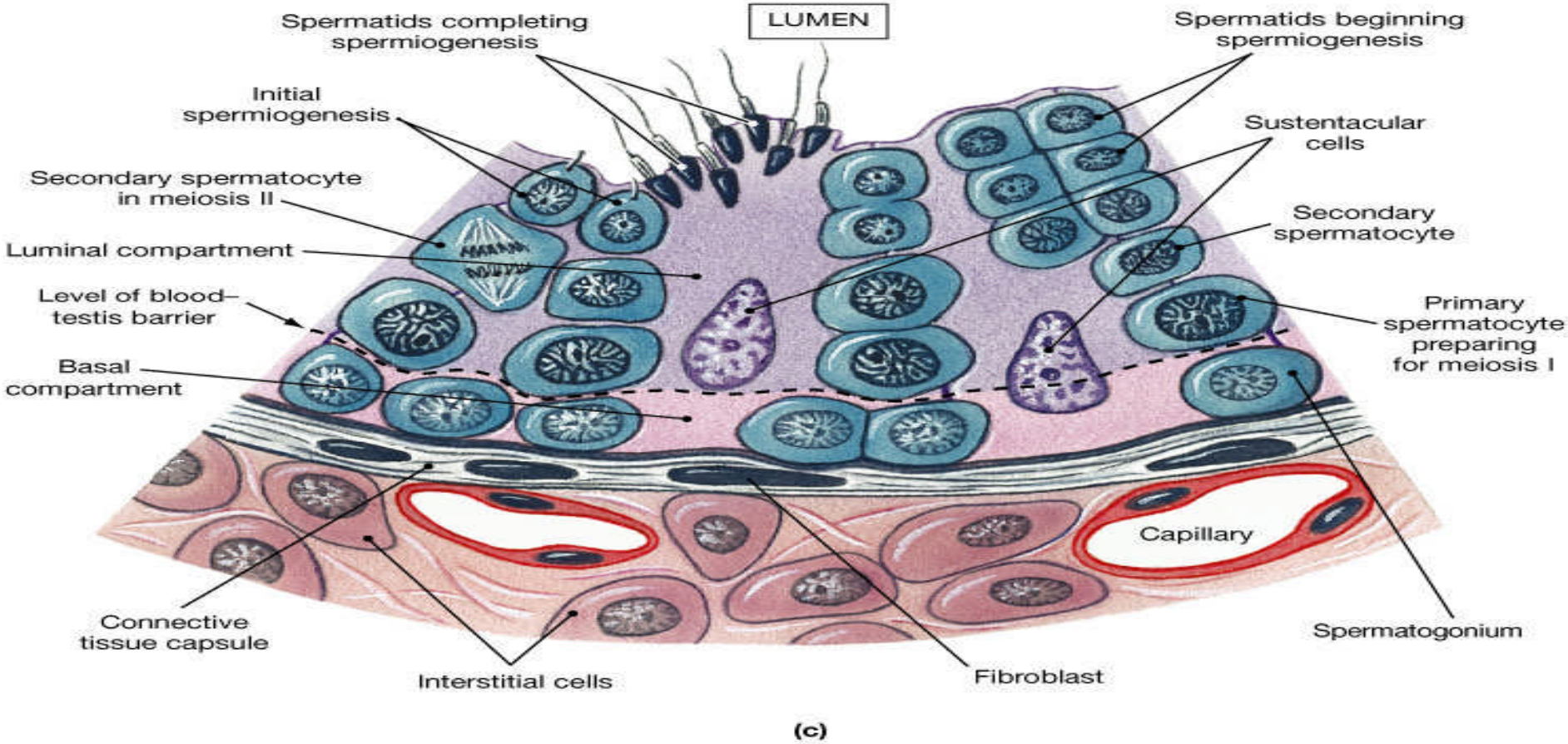
INTERSTITIAL CONNECTIVE TISSUE

(1) LEYDIG CELLS

produce and release testosterone



The Seminiferous Tubules



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.

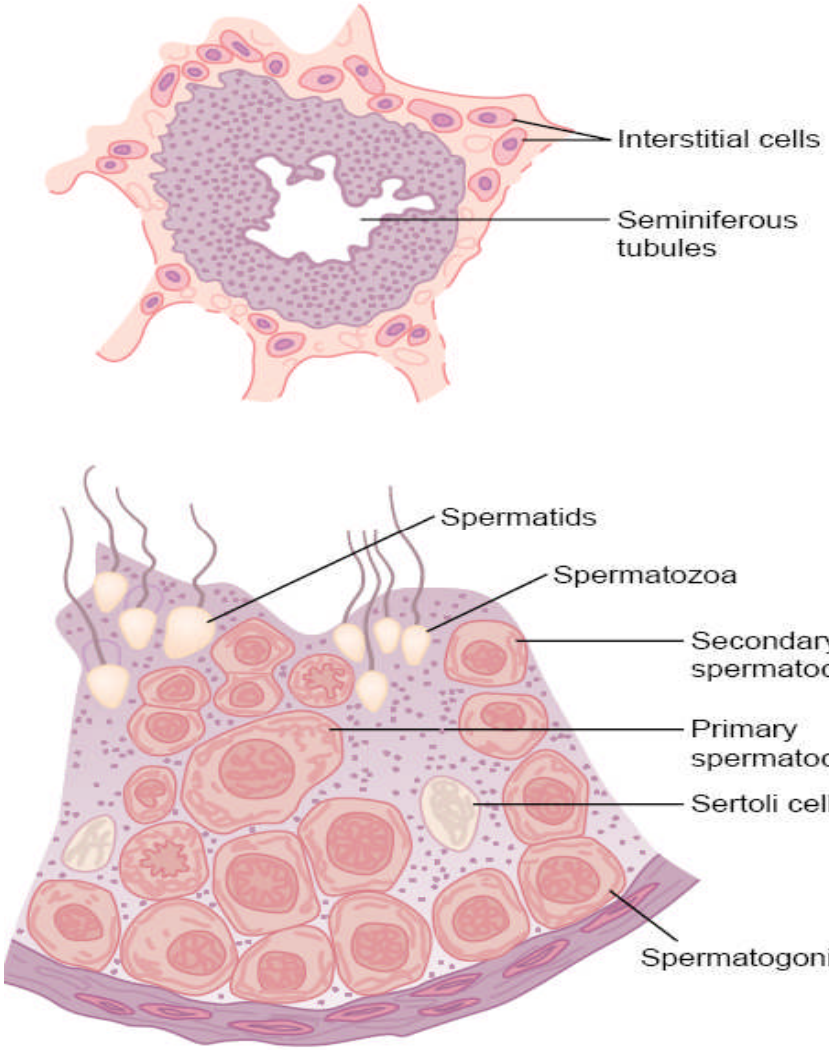
Prostaglandins are believed to aid fertilization in two ways:

(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

SPERM FORMATION

- 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 forgrowth 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 folliclestimulating 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.

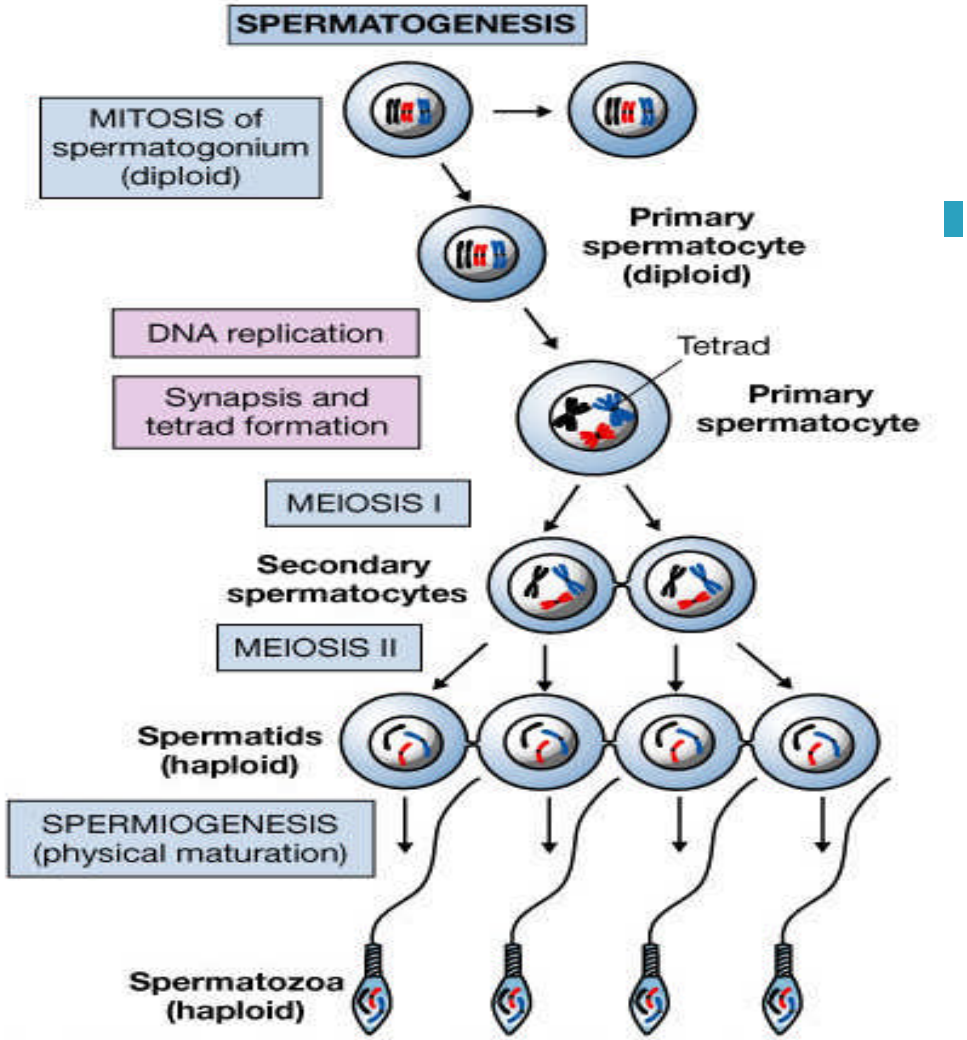
Storage of Sperm. The two testes of the human adult
form up to 120 million sperm each day.
A small quantity of these can be stored in the epididymis, but most are stored in the vas deferens.

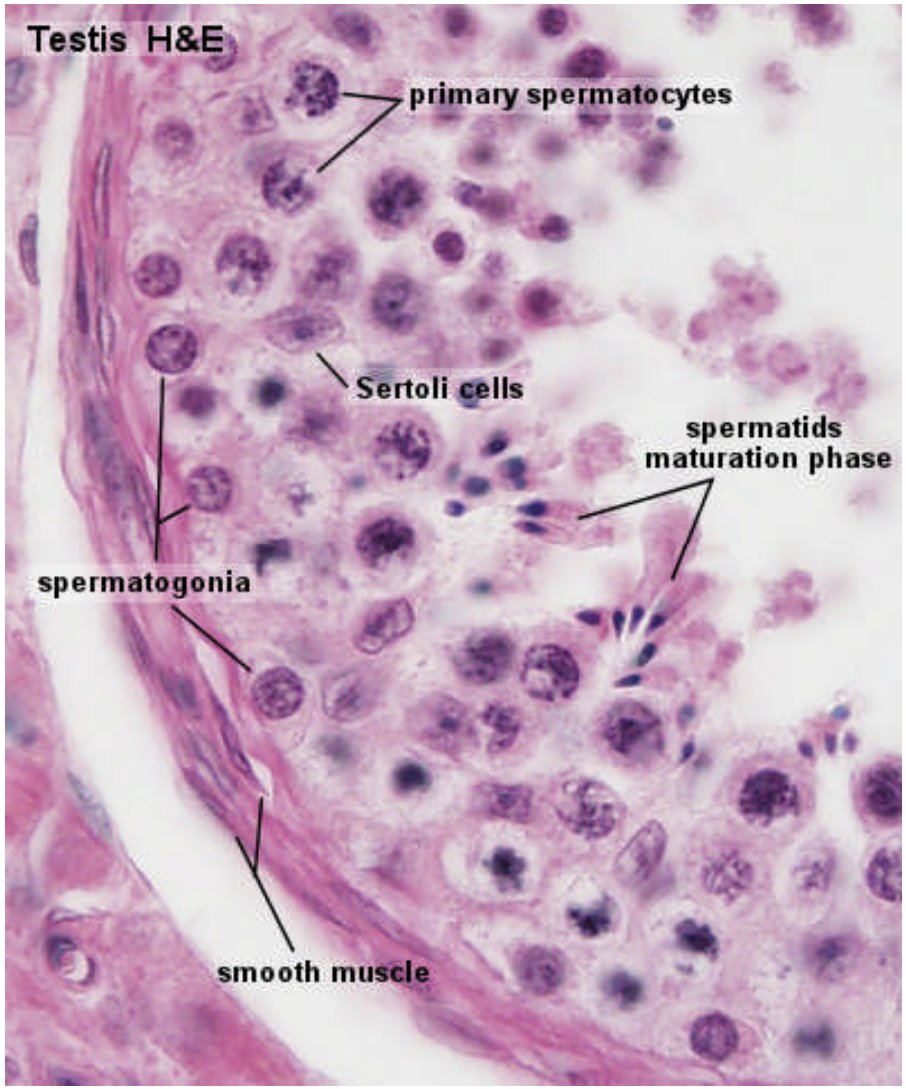
They can remain stored, maintaining their fertility, for at least a month.
During this time, they are kept in a deeply suppressed inactive state by multiple inhibitory substances in the secretions of the ducts.
Conversely, with a high level of sexual activity and ejaculations, storage may be no longer 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




Testis H&E
primary spermatocytes
Sertoli cells
spermatids
maturation phase
spermatogonia
smooth muscle

- SPERMATOGENESIS

THREE PHASES:

(1) Spermatogonial Phase (Mitosis)

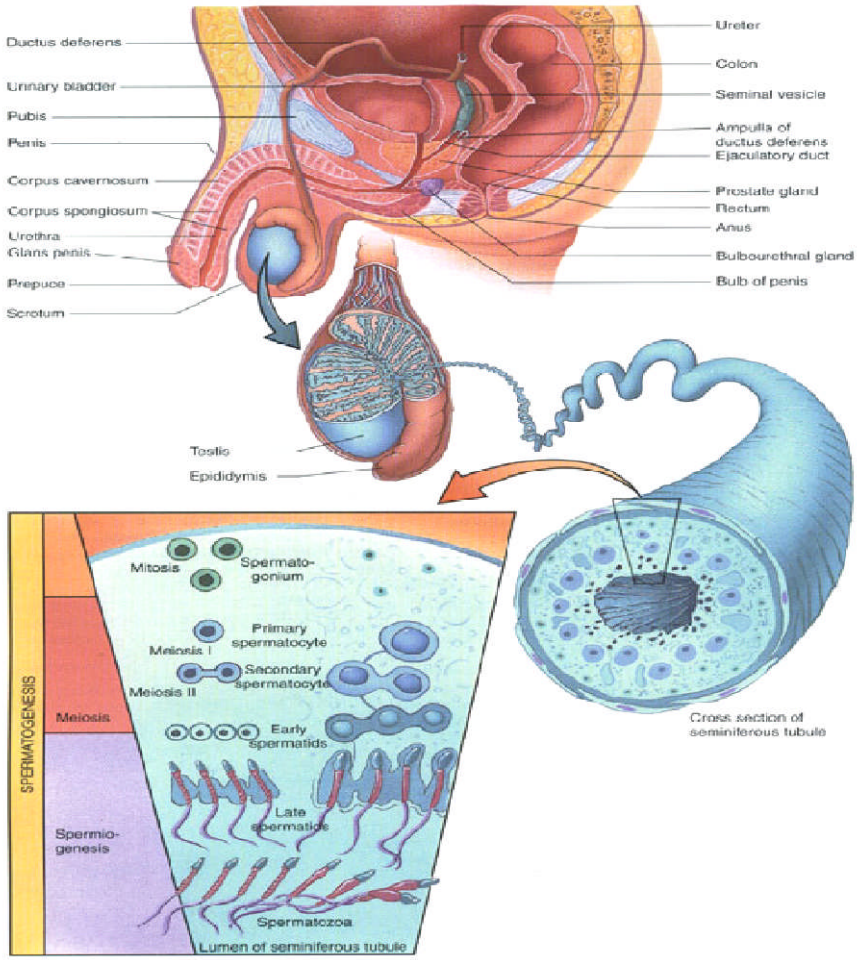
(2) Spermatocyte Phase (Meiosis)

(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)

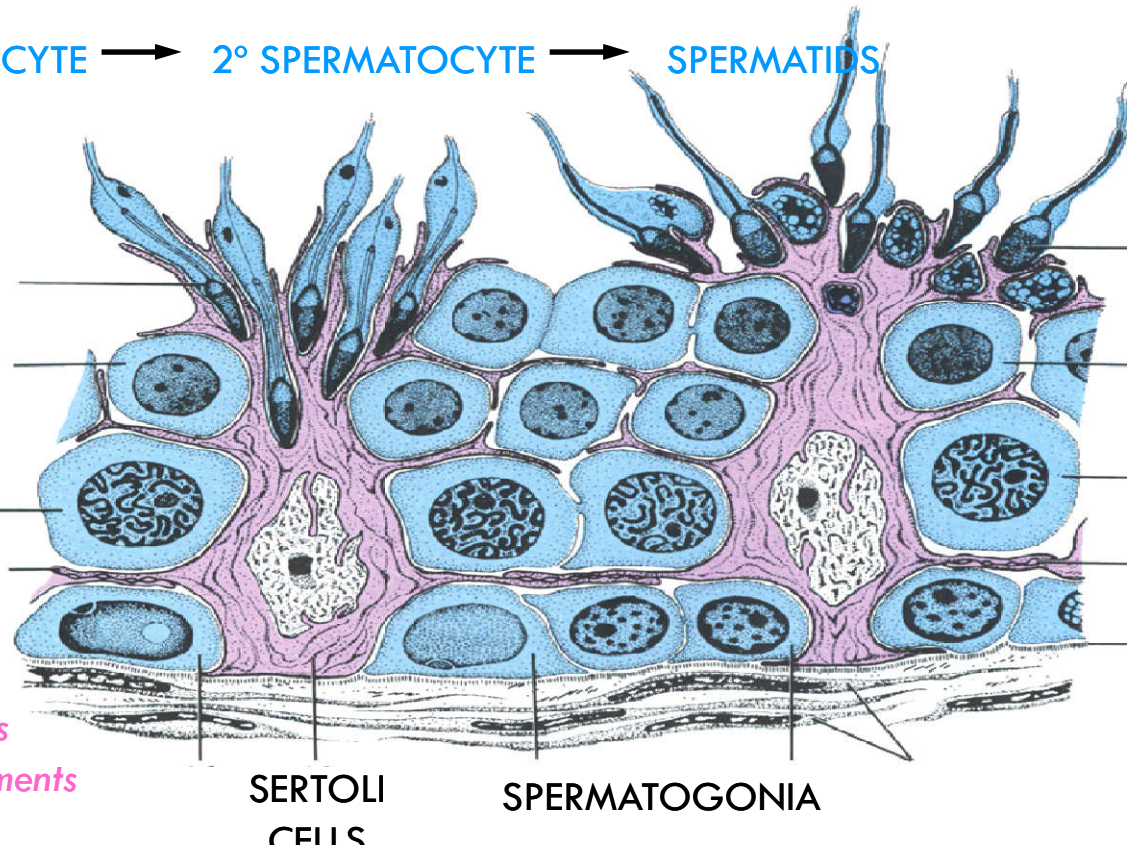
- changes in size and shape of nucleus; chromatin condenses and shedding of residual body (cytoplasm)



MALE REPRODUCTIVE SYSTEM

- SPERMATOGENESIS

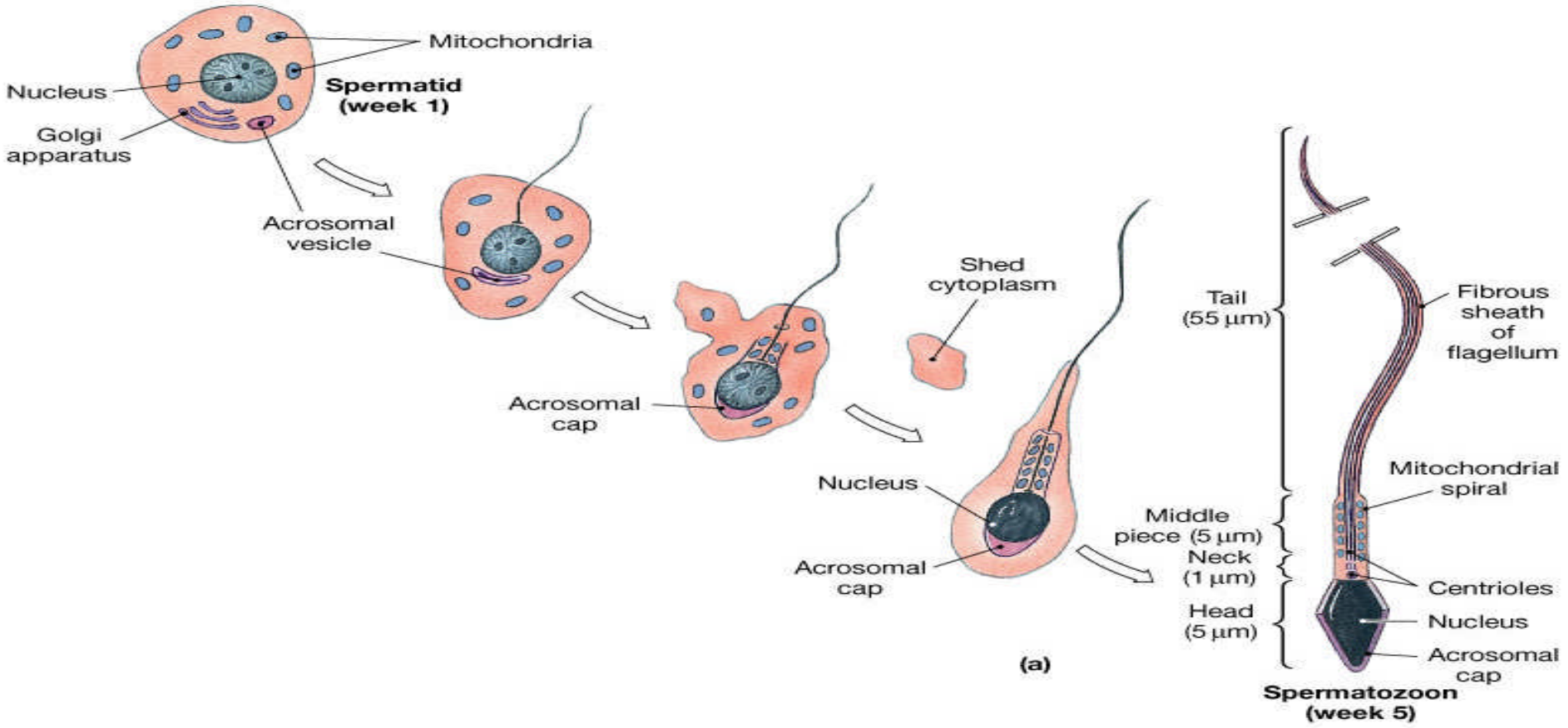
SPERMATOGONIA → 1° SPERMATOCYTE → 2° SPERMATOCYTE → SPERMATIDS



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



MALE REPRODUCTIVE SYSTEM

- SPERMATOGENESIS

THREE PHASES:

(1) Spermatogonial Phase (Mitosis)

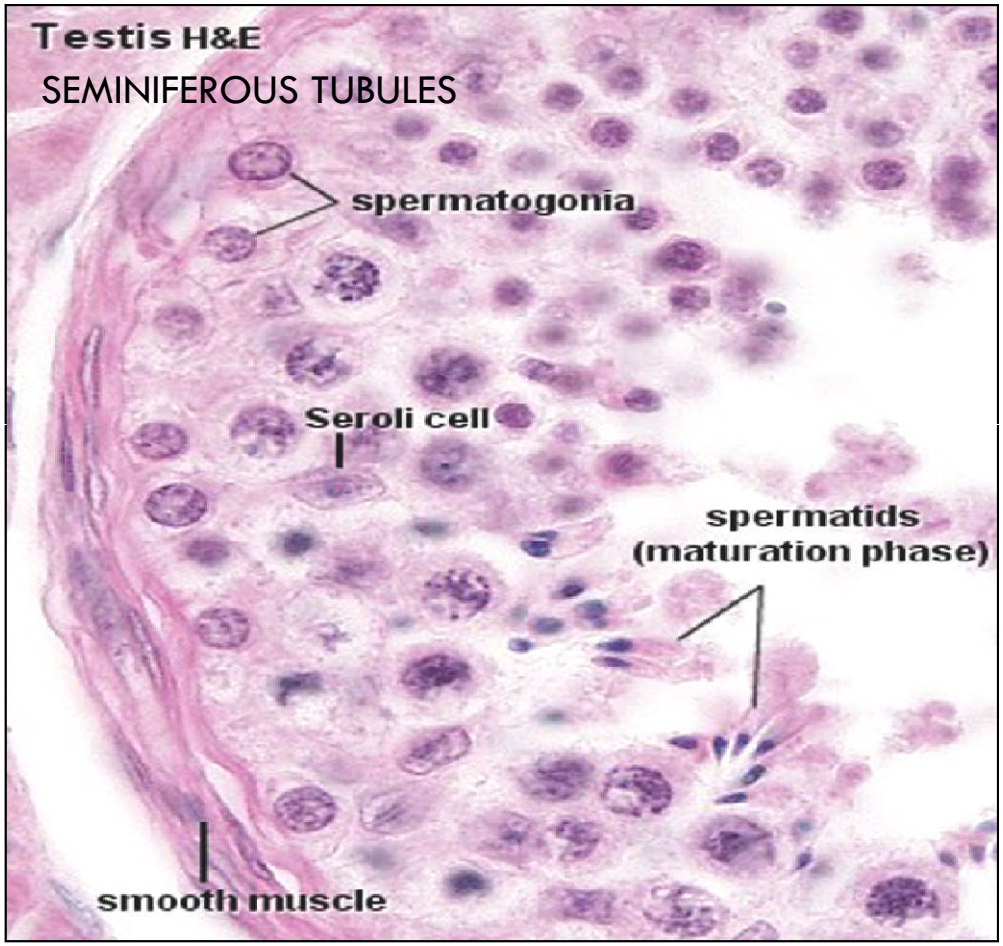
- spermatogonia proliferate by mitotic divisions to provide *stem cells* and cells which will proceed through spermatogenesis *(1° spermatocytes)*

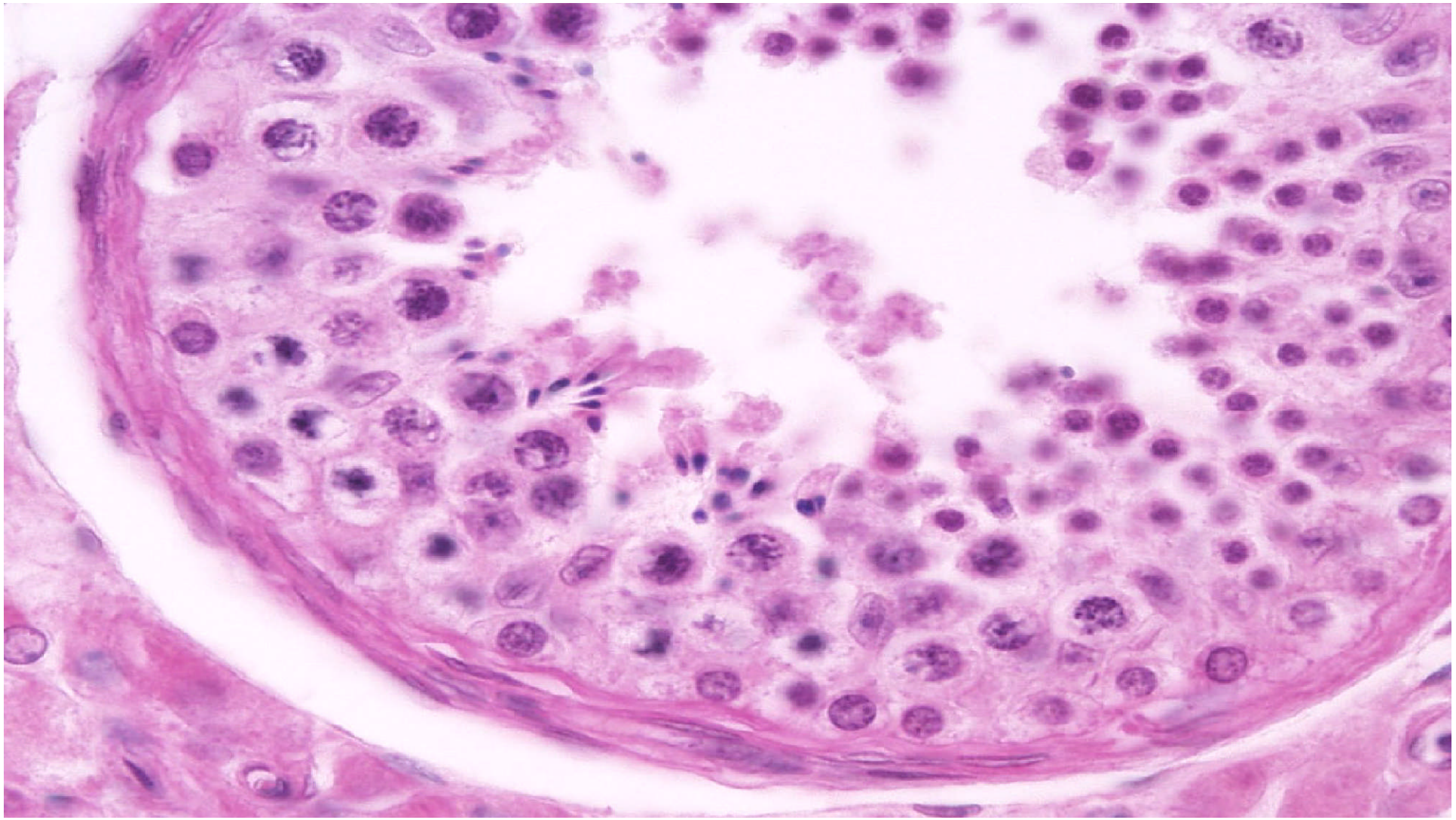
(2) Spermatocyte Phase (Meiosis)

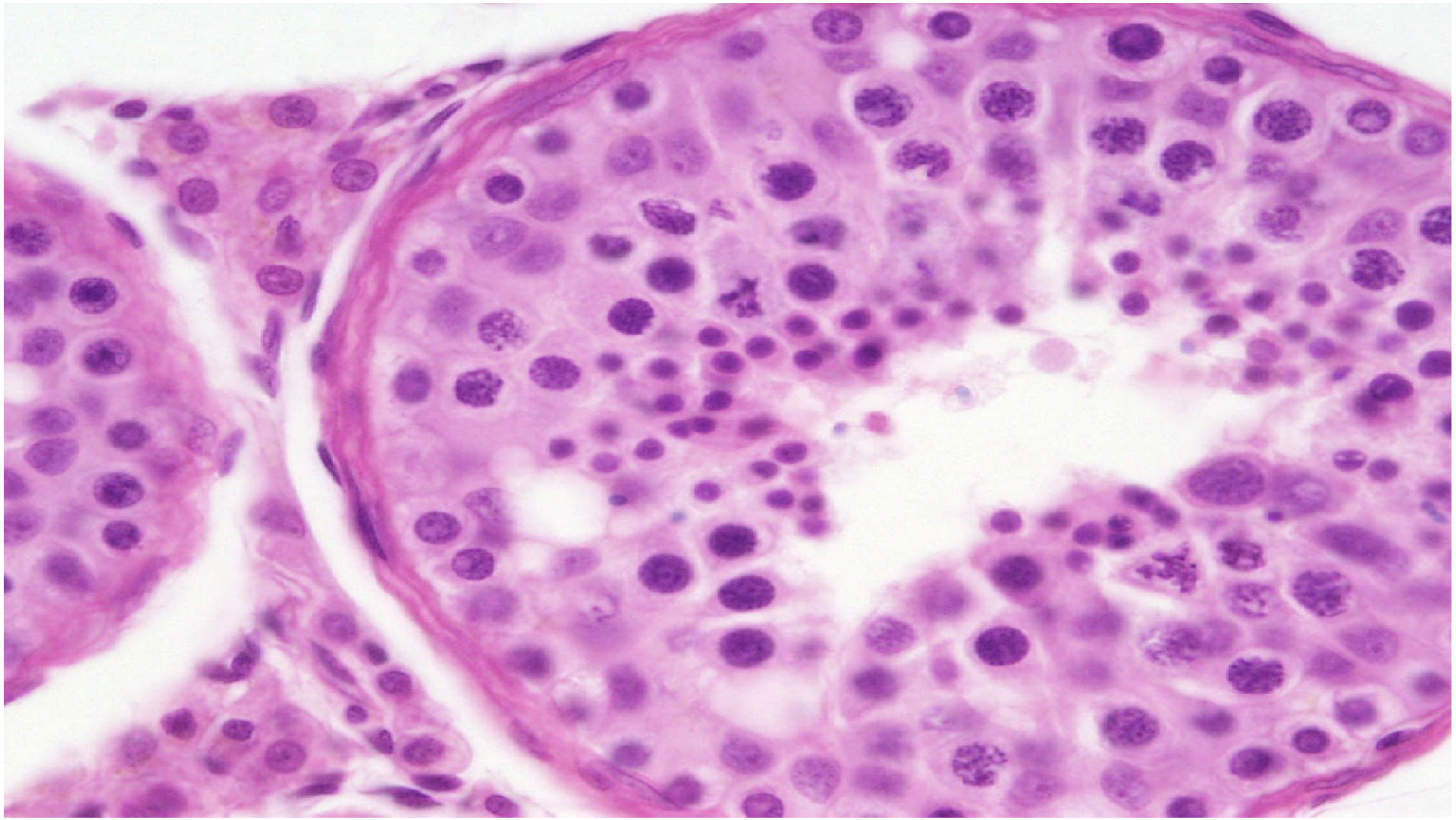
- diploid cells (2n) created in spermatogonial phase give rise to haploid cells (1n)
- Meiosis I (reduction division) & Meiosis II (equatorial division)
- 1° spermatocytes enter Meiosis I to form 2° spermatocytes which then enter Meiosis II and result in spermatids

(3) Spermatid Phase (Spermiogenesis)

- spermatid differentiation into spermatazoa







MALE REPRODUCTIVE SYSTEM

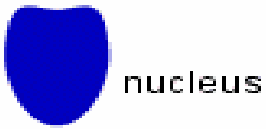
- SPERMIOGENESIS

Mature sperm 60μm long and acquire full motility in epididymis

(1) HEAD
- *nucleus and acrosome*

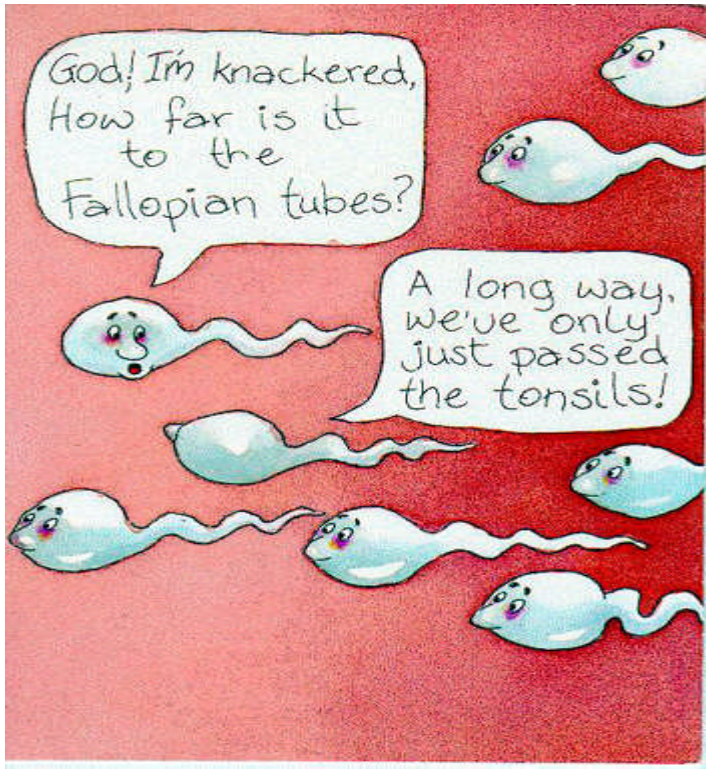
(2) NECK
- *centriole and connecting piece*

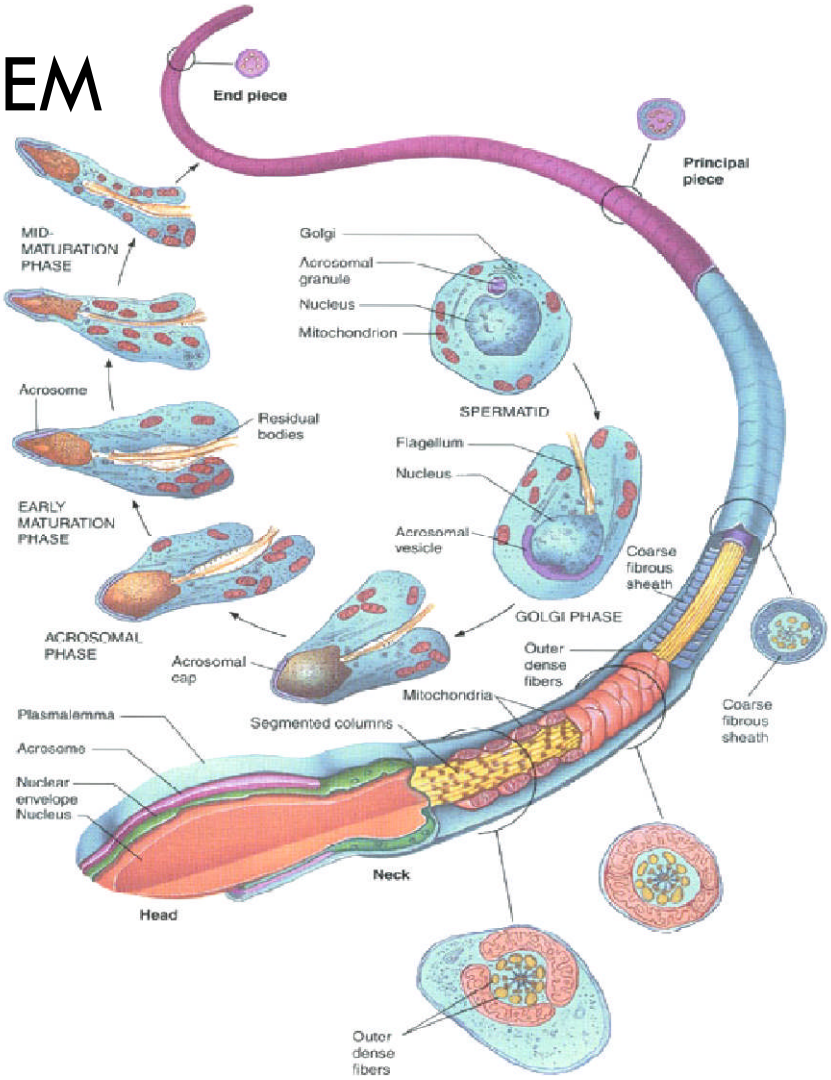
(3) TAIL
- *middle piece*
  (axoneme, outer dense fibers, mitochondial sheath)
- *principal piece*
  (axoneme, outer dense fibers, fibrous sheath)
- *end piece*
  (axoneme)



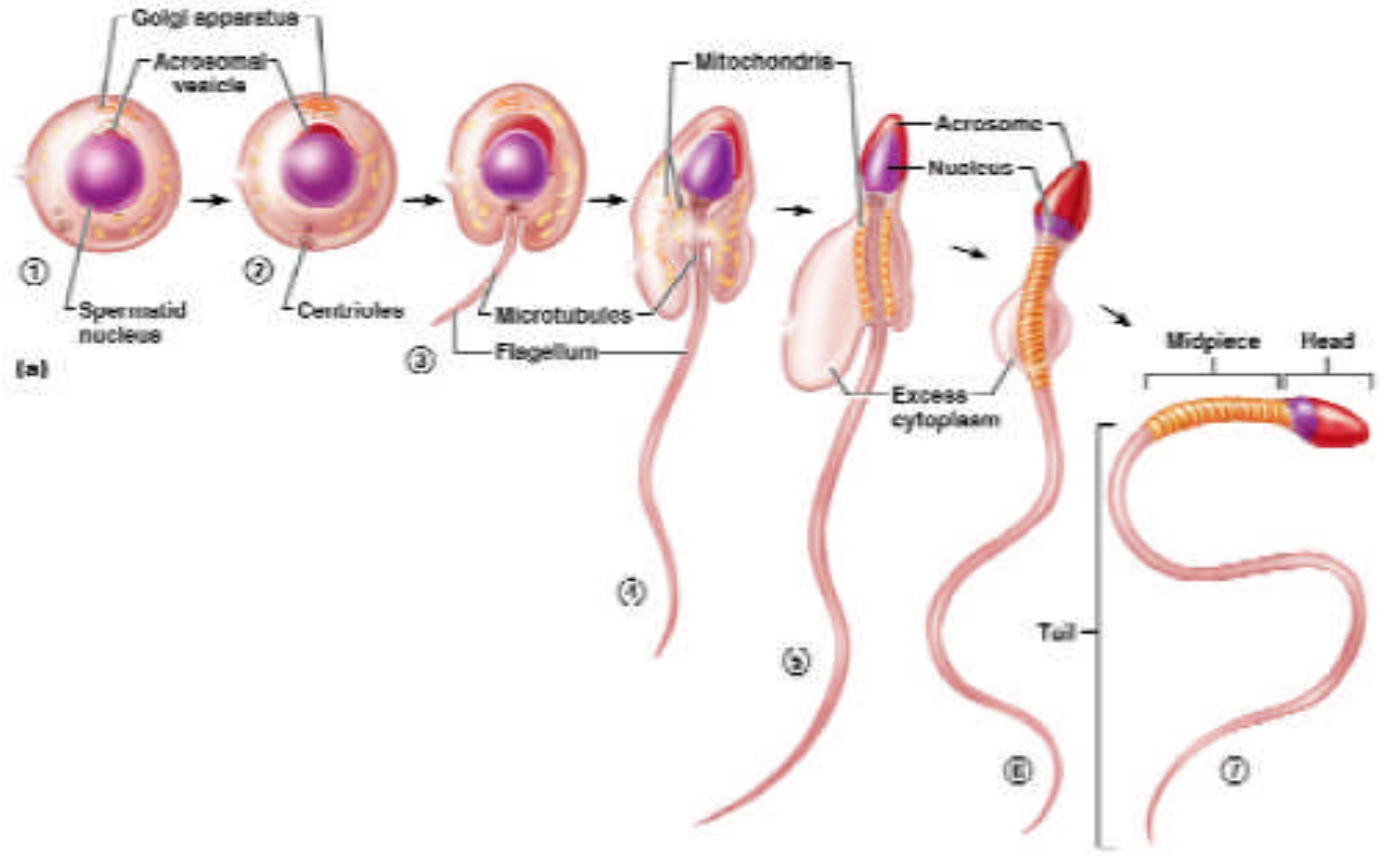
MALE REPRODUCTIVE SYSTEM

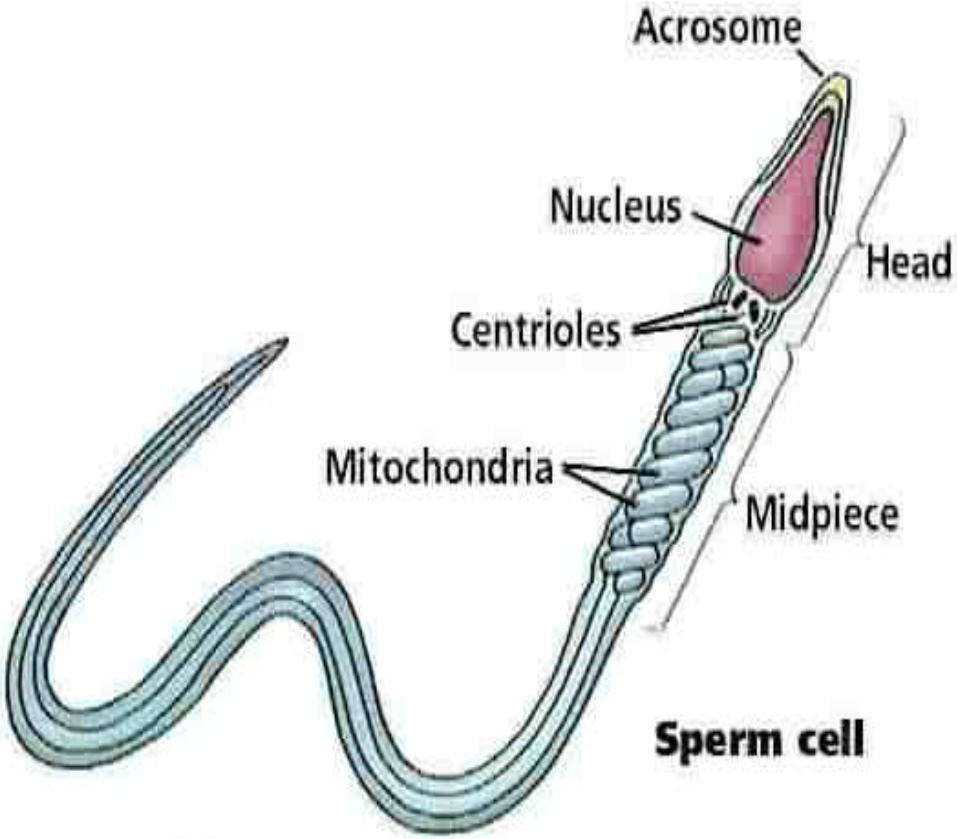
- SPERMIOGENESIS

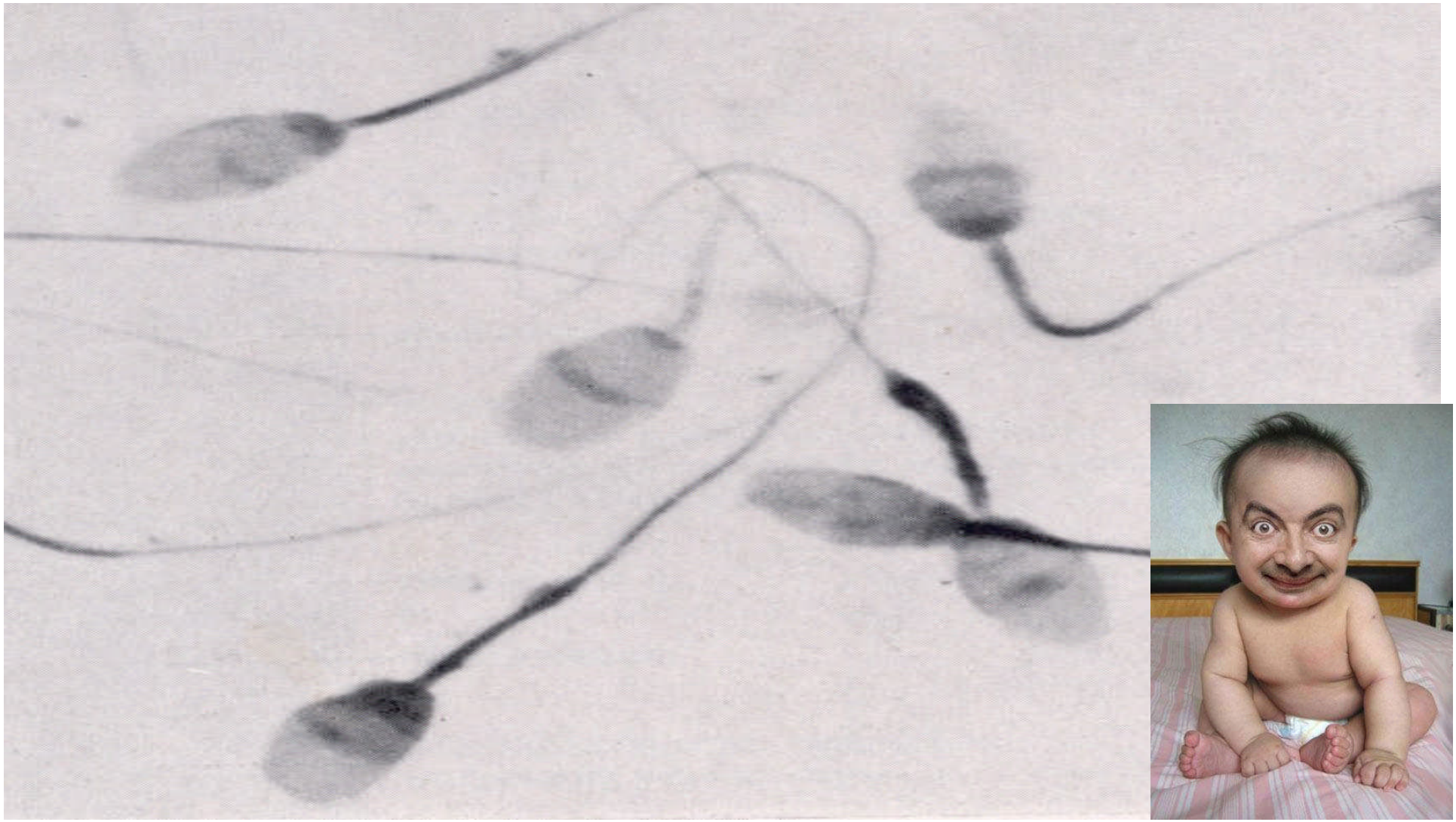




Spermiogenesis: Spermatids to Sperm




Acrosome
Nucleus
Head
Centrioles
Mitochondria
Midpiece
Sperm cell



MALE REPRODUCTIVE SYSTEM

- HORMONAL REGULATION OF MALE REPRODUCTIVE FUNCTION

HYPOTHALAMUS REGULATES ACTIVITY OF ANTERIOR PITUITARY (ADENOHYPOPHYSIS)

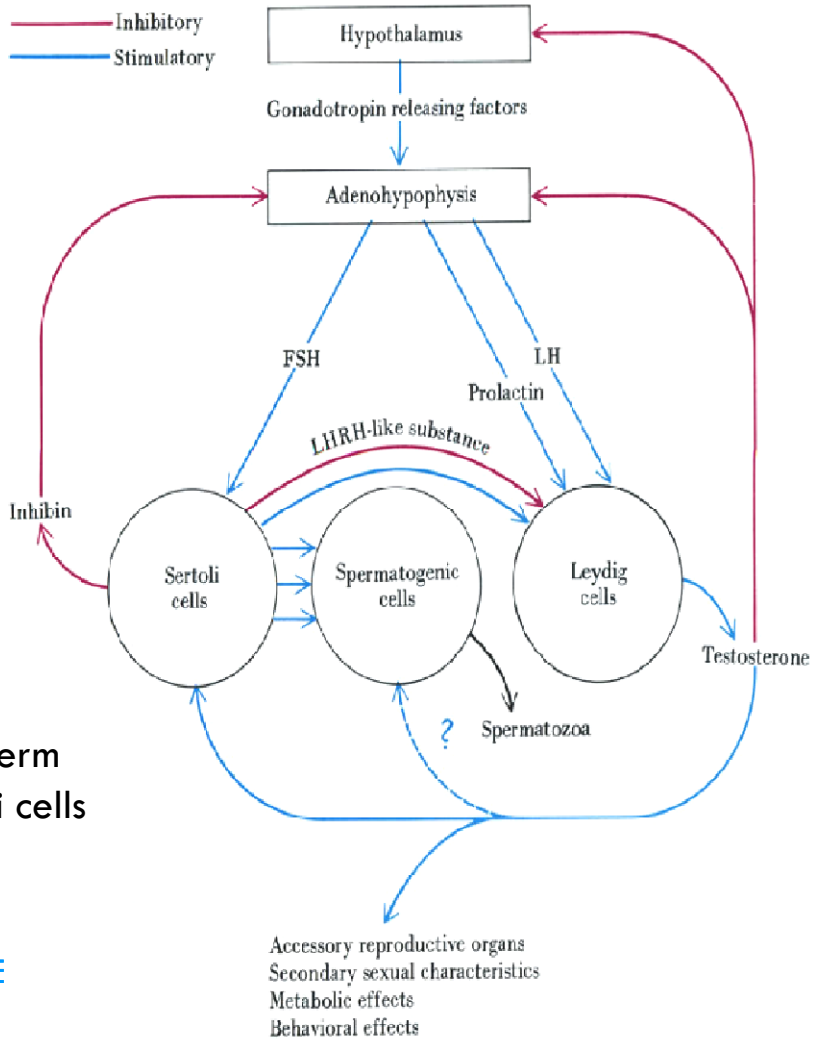
↓

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

<u>Luteinizing Hormone</u> (LH): stimulates testosterone production by Leydig cells

<u>Follicle Stimulating Hormone</u> (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



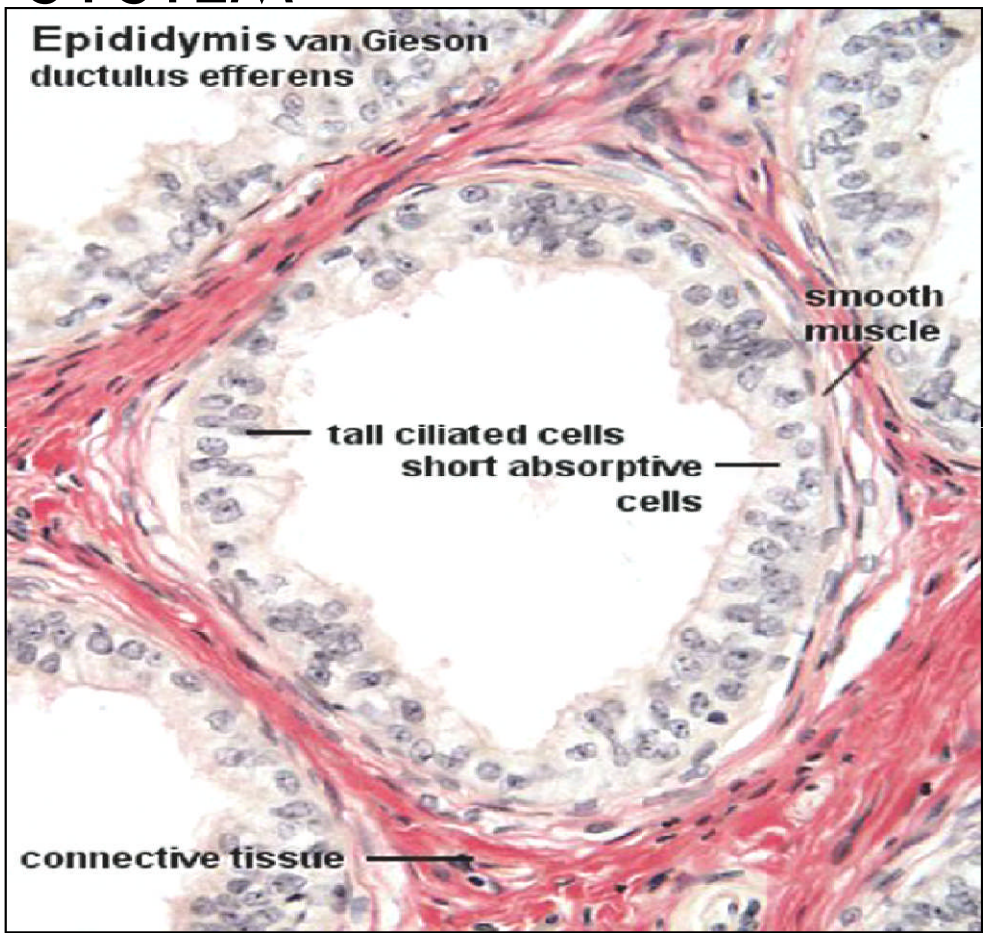
MALE REPRODUCTIVE SYSTEM

- EFFERENT DUCTULES

CONNECT RETE TESTIS 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

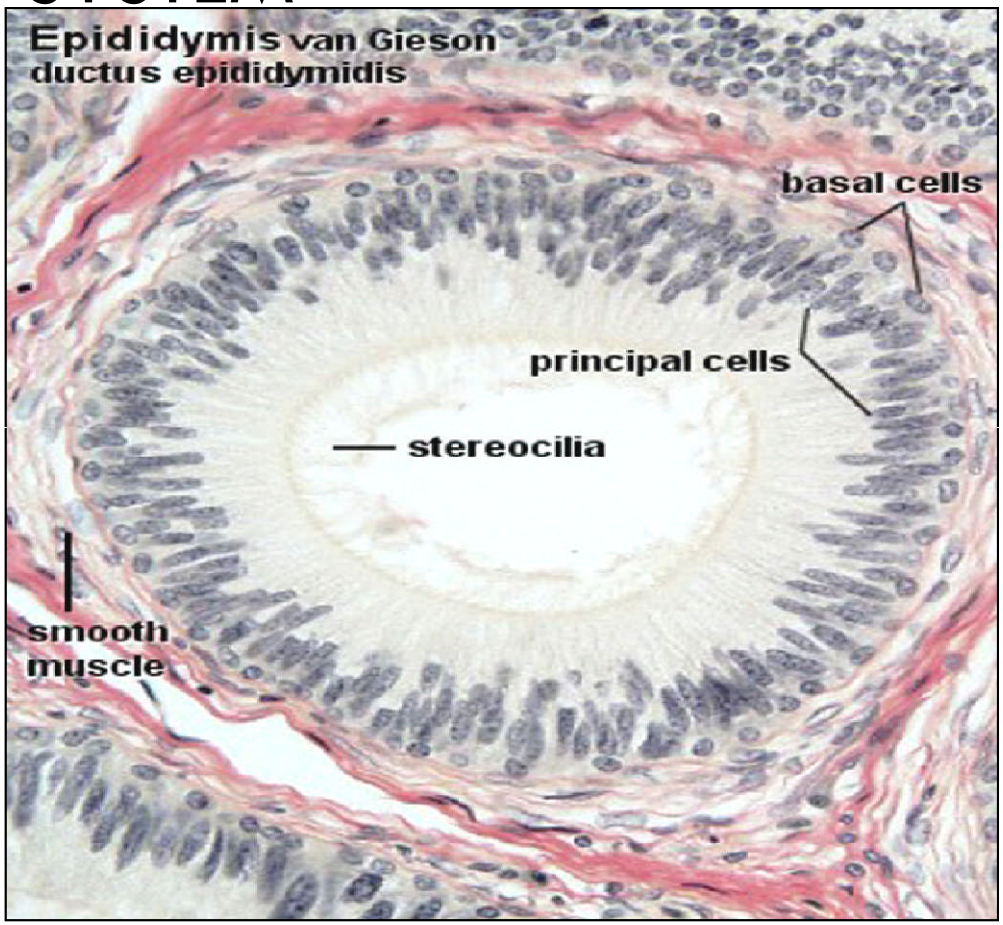
- EPIDIDYMIS

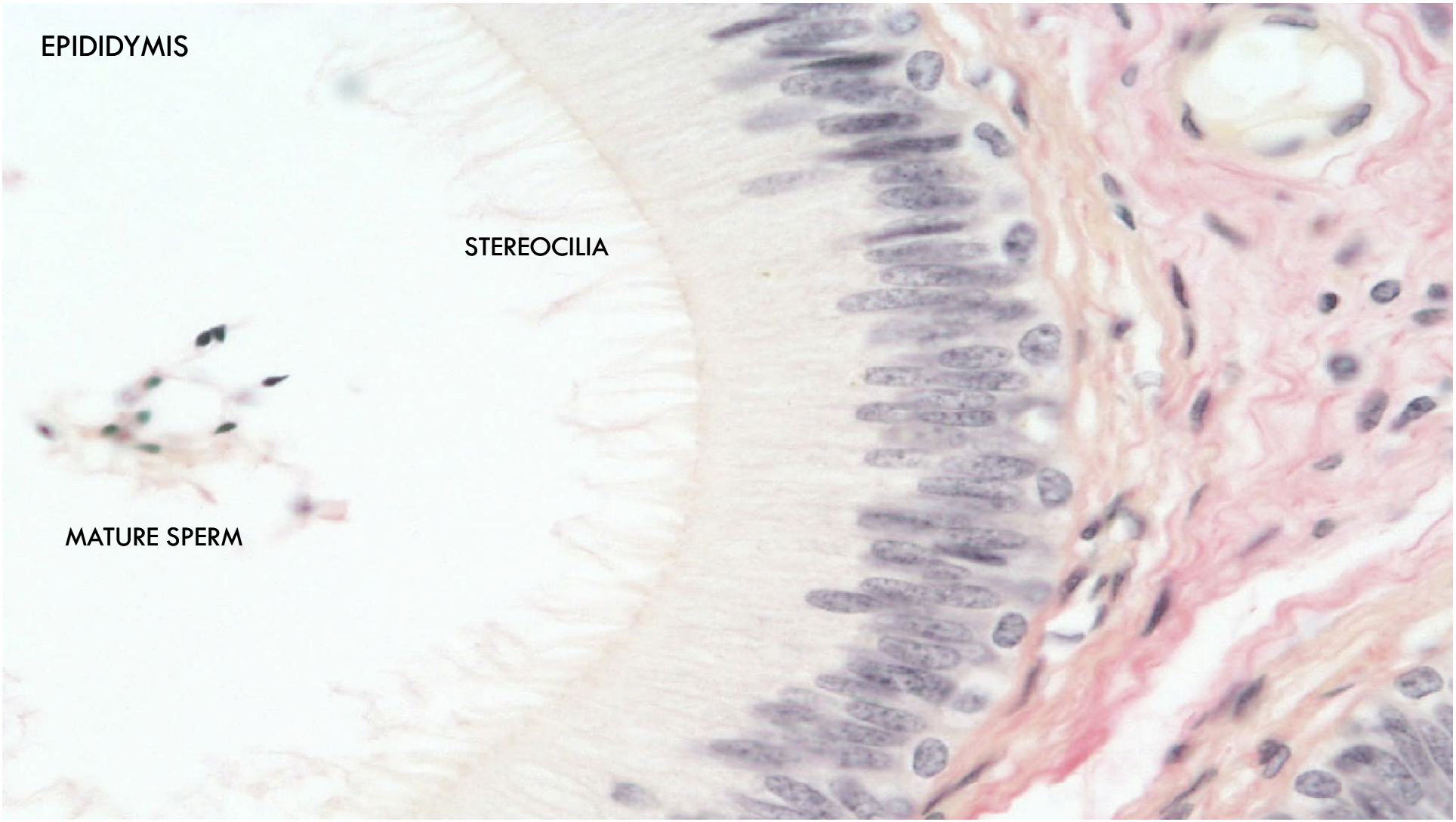
RECEIVES EFFERENT DUCTULES

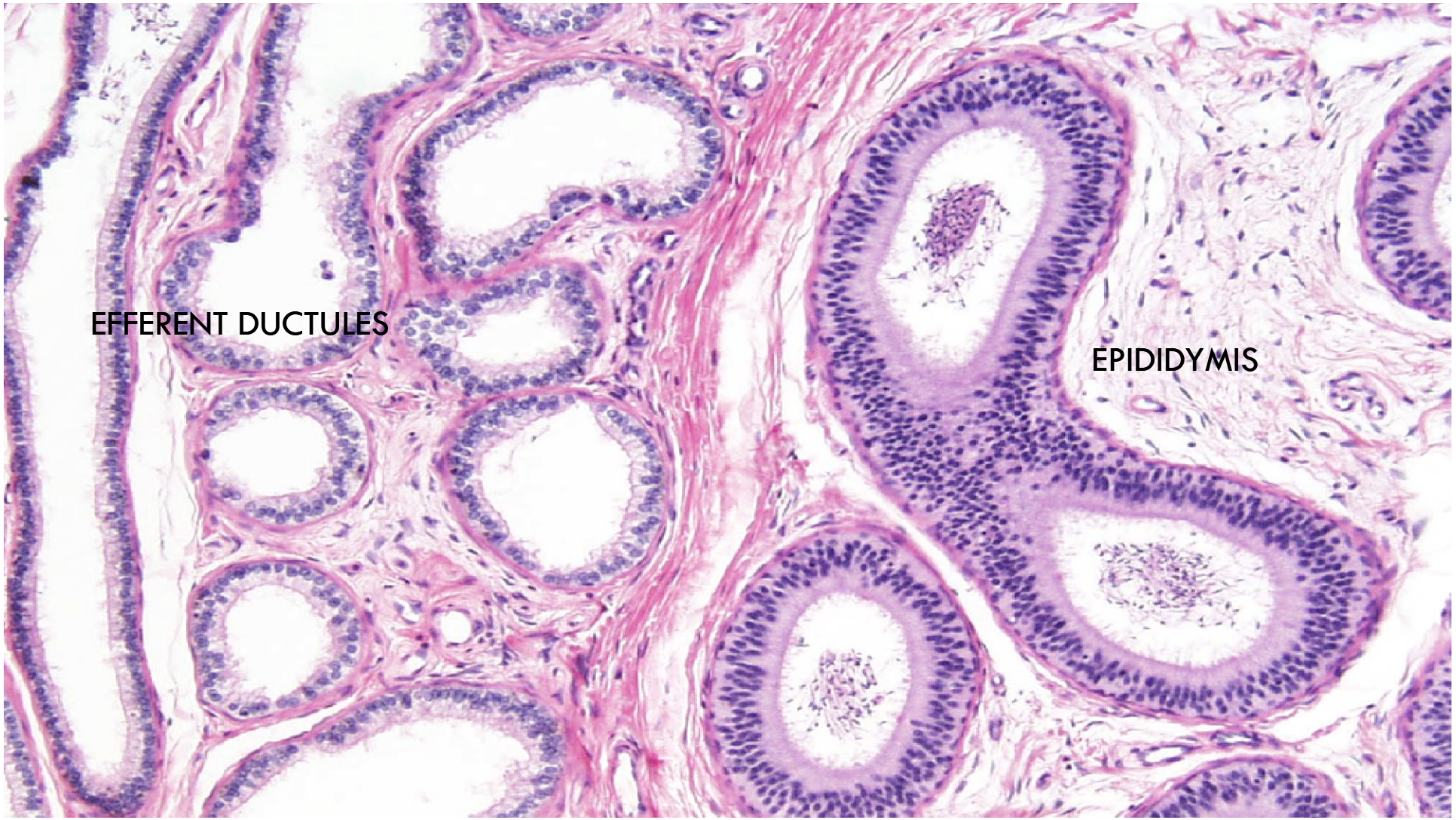
DIVIDED INTO HEAD, BODY, AND TAIL

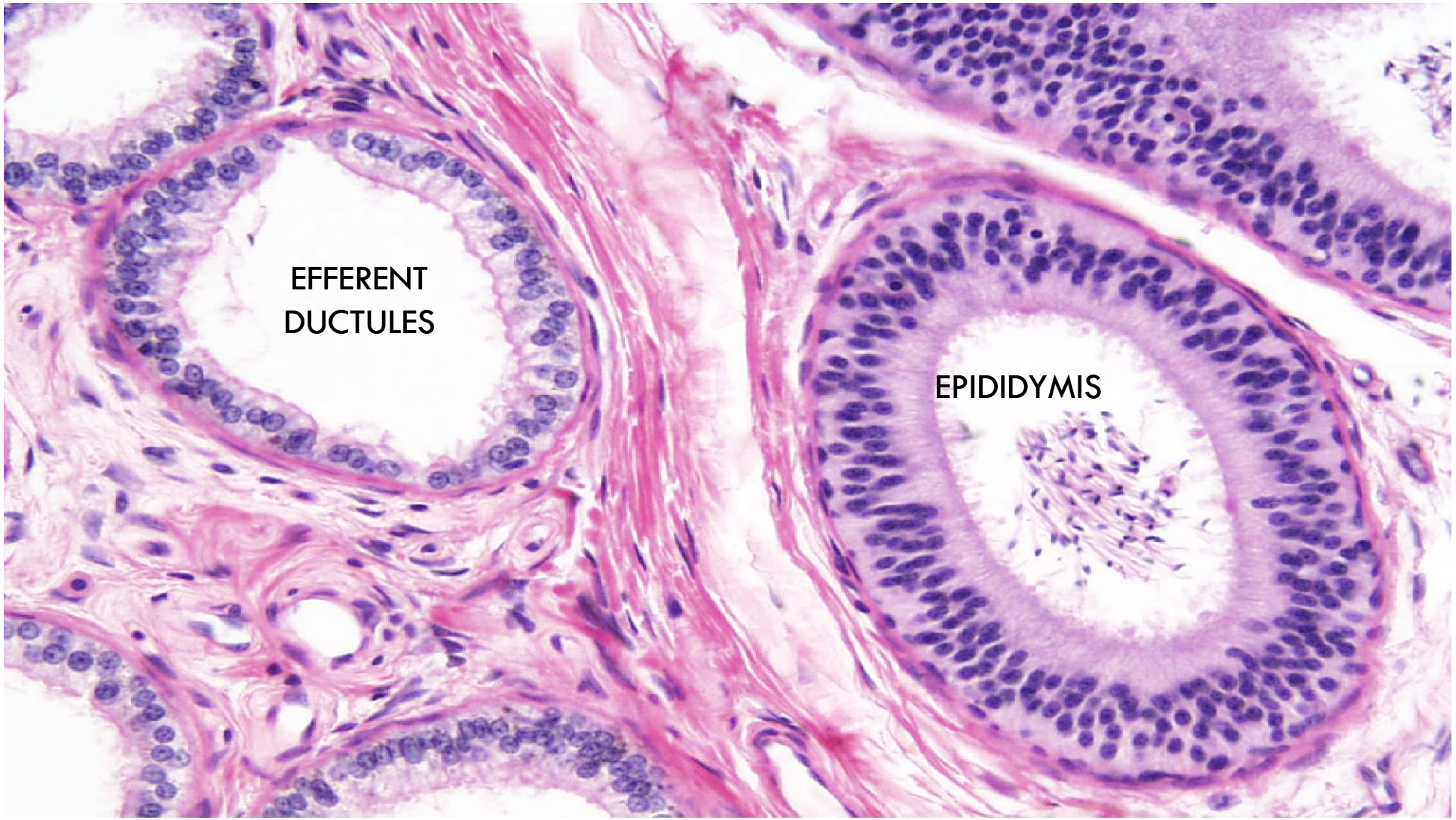
PSEUDOSTRATIFIED EPITHELIUM CONSISTING OF PRINCIPAL AND BASAL CELLS

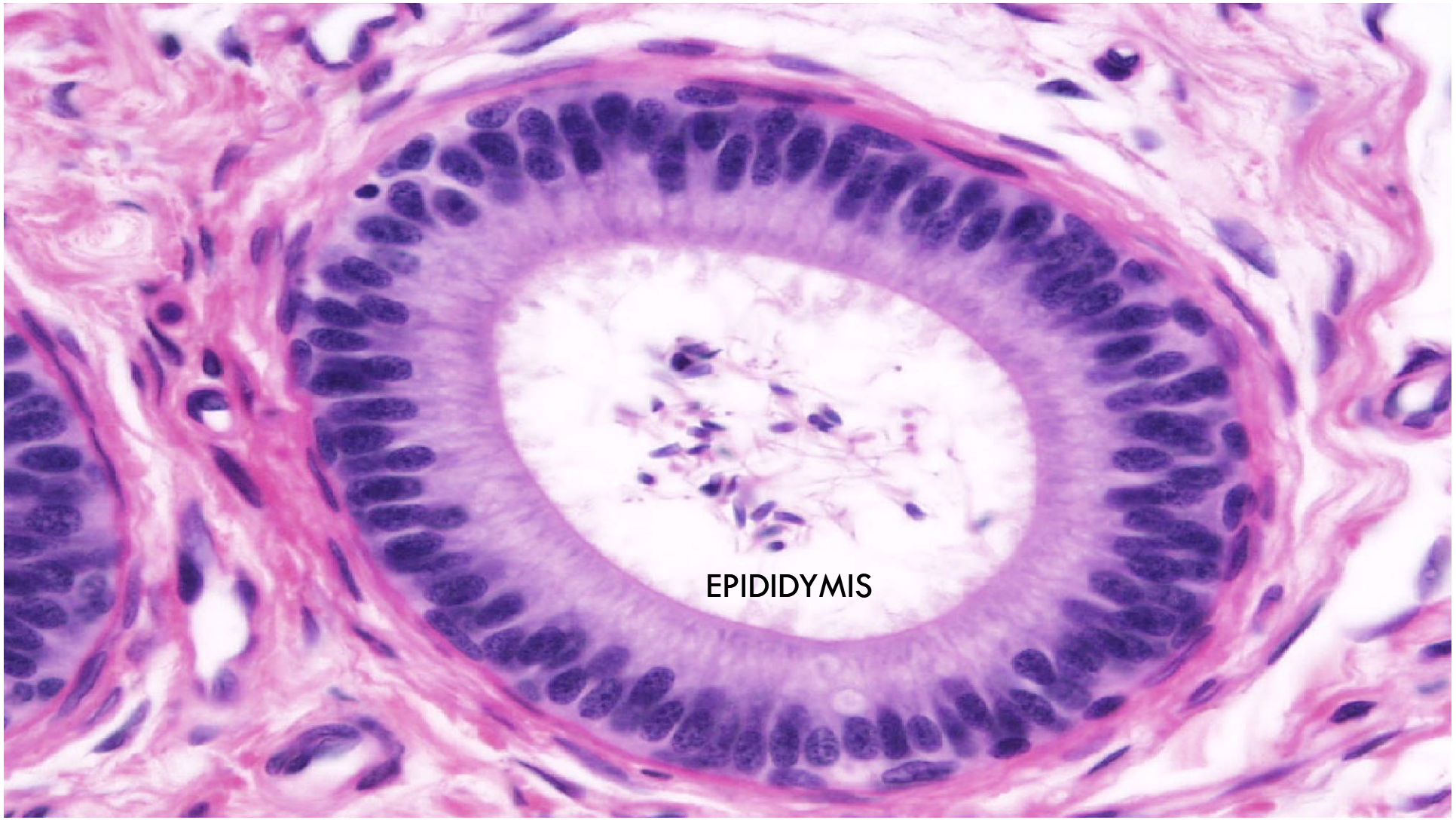
SMOOTH MUSCLE IN HEAD AND TAIL CONTRACT SPONTANEOUSLY; SMOOTH MUSCLE IN TAIL REQUIRES SYMPATHETIC INNERVATION FOR CONTRACTION




EPIDIDYMIS
STEREOCILIA
MATURE SPERM


EFFERENT DUCTULES
EPIDIDYMIS


EFFERENT
DUCTULES
EPIDIDYMIS


EPIDIDYMIS

MALE REPRODUCTIVE SYSTEM

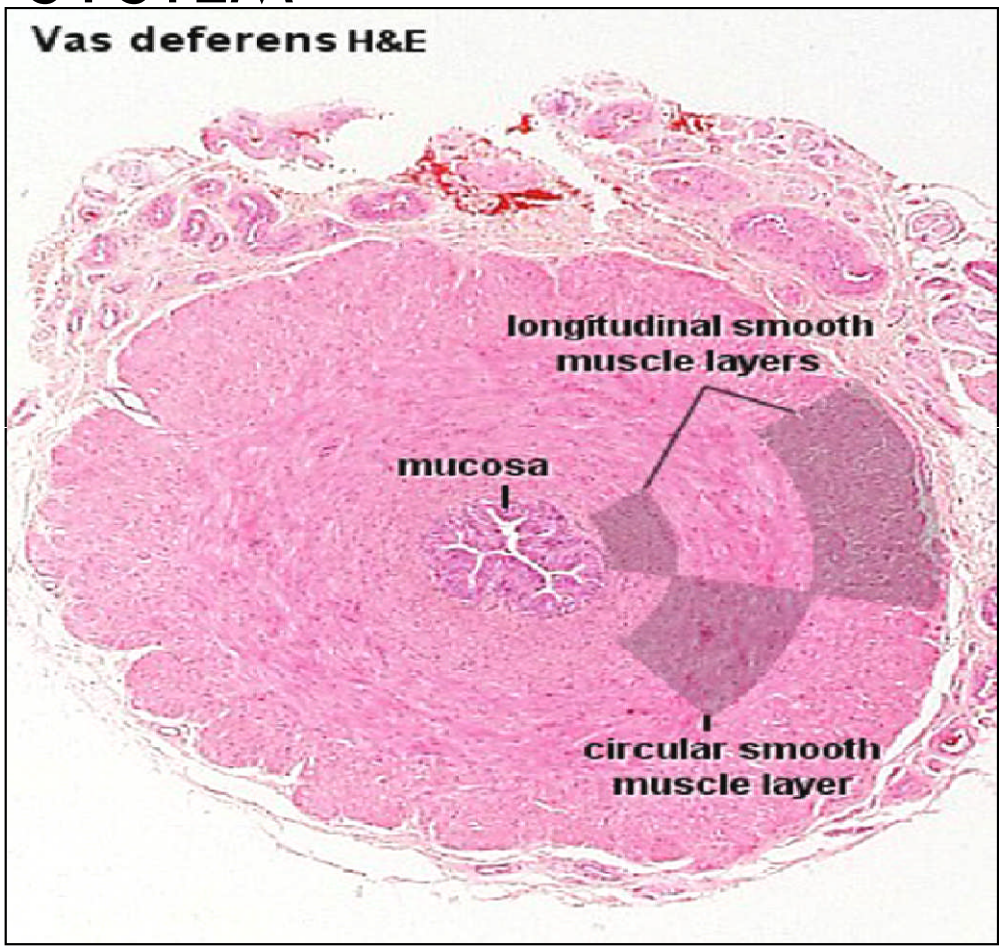
- VAS DEFERENS

  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

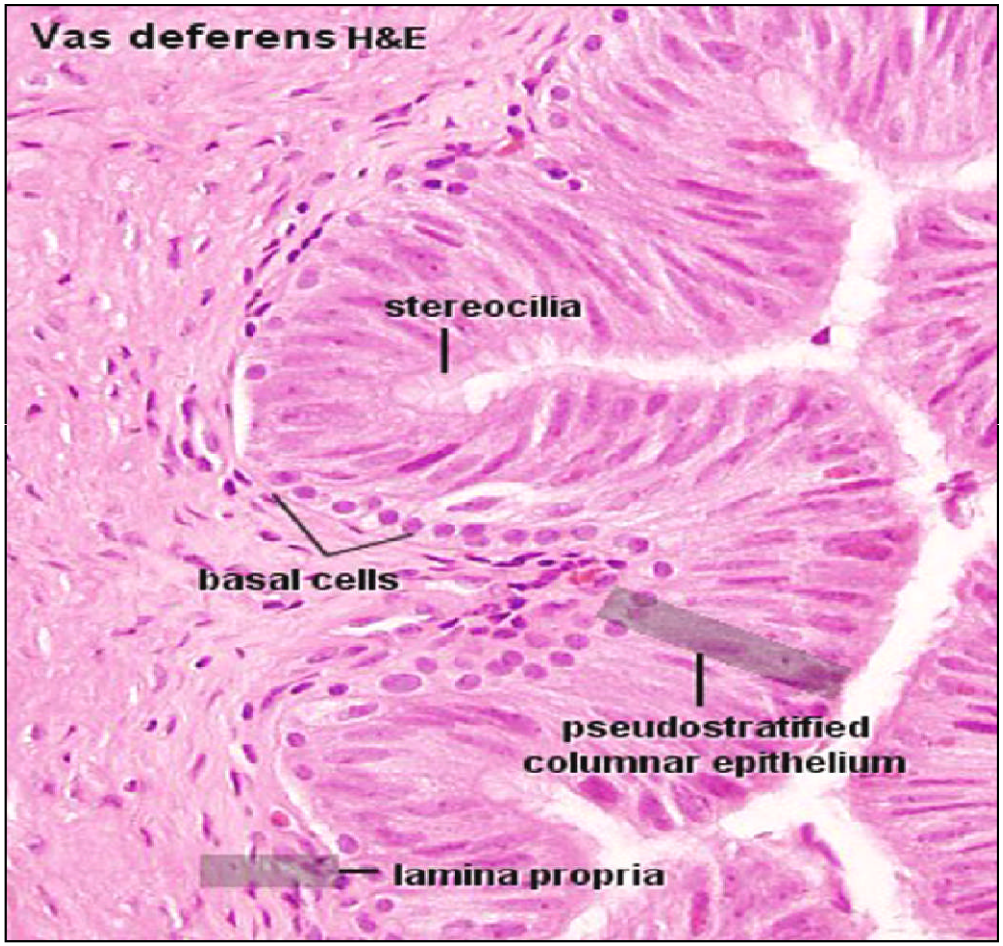
Ductus Deferens and Ejaculatory Duct

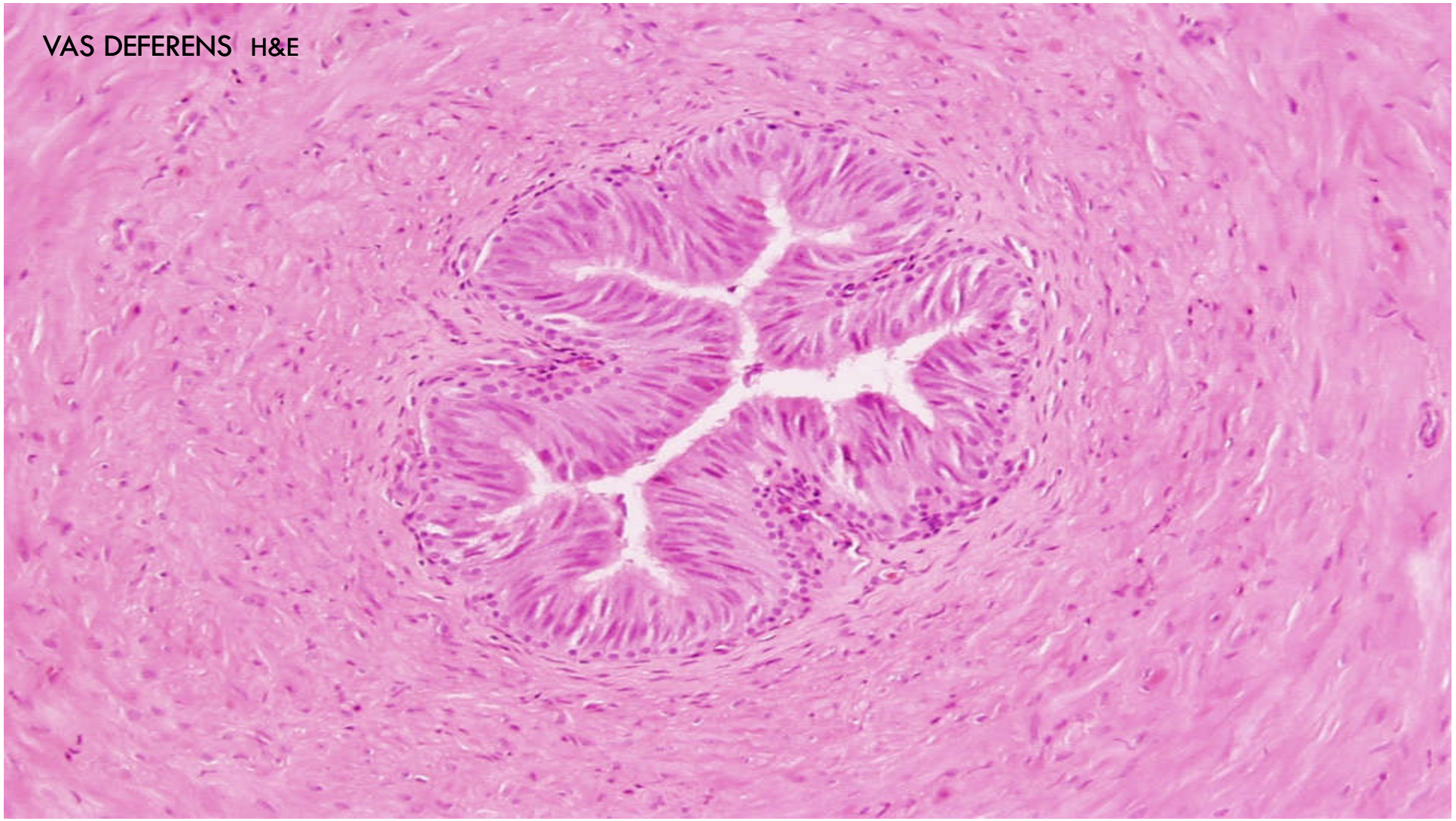
Runs from the epididymis through the inguinal canal into the pelvic cavity

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




VAS DEFERENS H&E

MALE REPRODUCTIVE SYSTEM

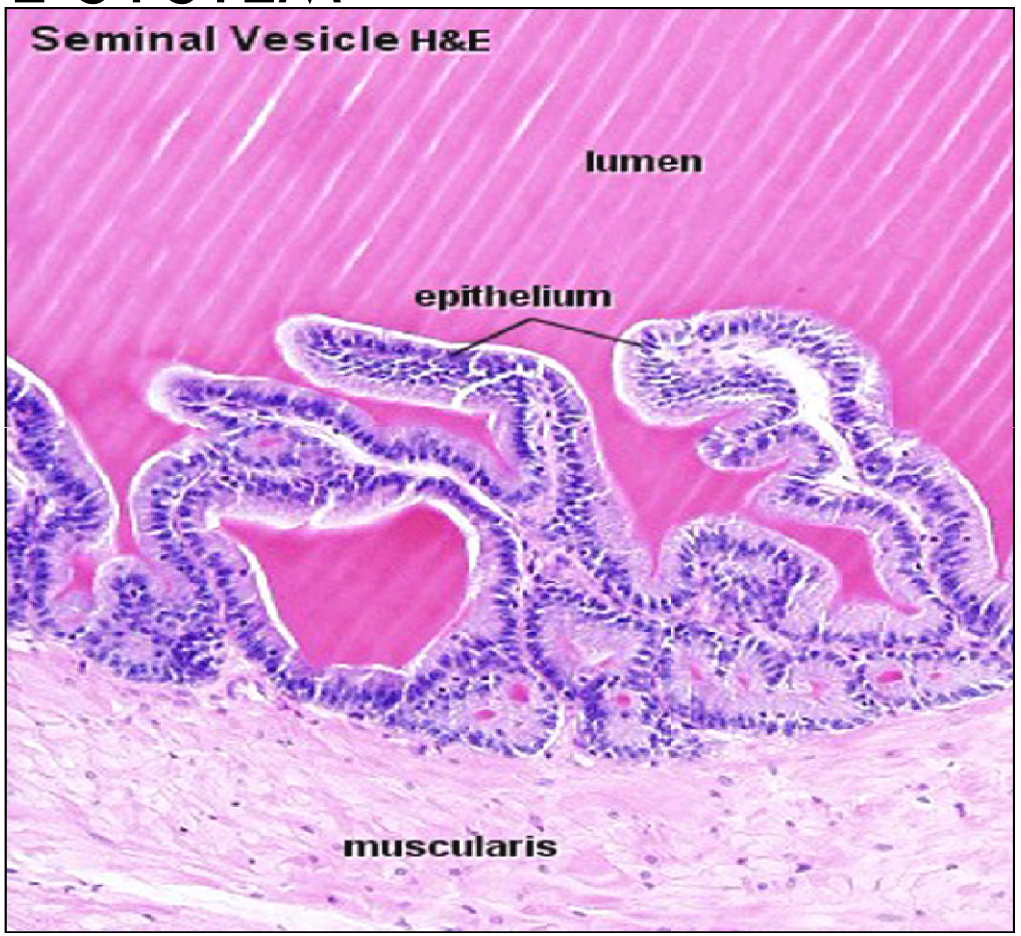
- **SEMINAL VESICLES**

MUCOSA HIGHLY FOLDED

EPITHELIUM PSEUDOSTRATIFIED

SECRETIONS ARE HIGH IN FRUCTOSE AND BASIC

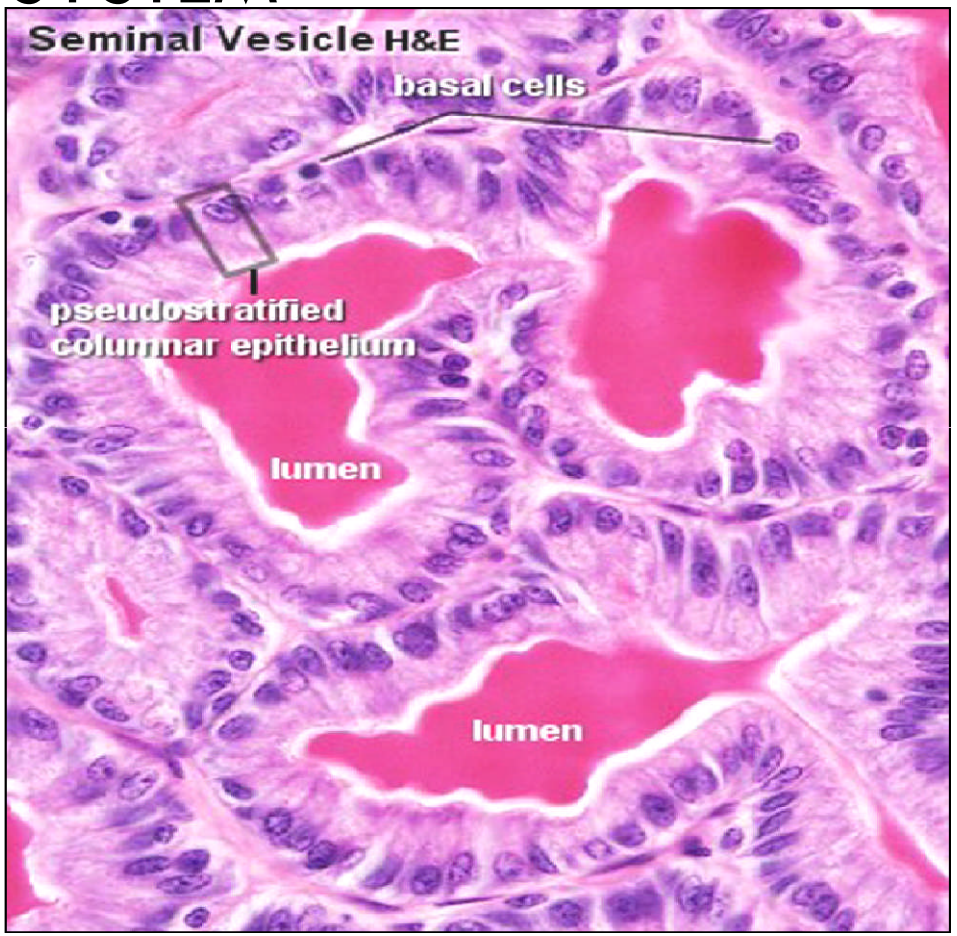
REGULAR SMOOTH MUSCLE CONTRACTS DURING EJACULATION



MALE REPRODUCTIVE SYSTEM

- SEMINAL VESICLES

  EPITHELIUM PSEUDOSTRATIFIED



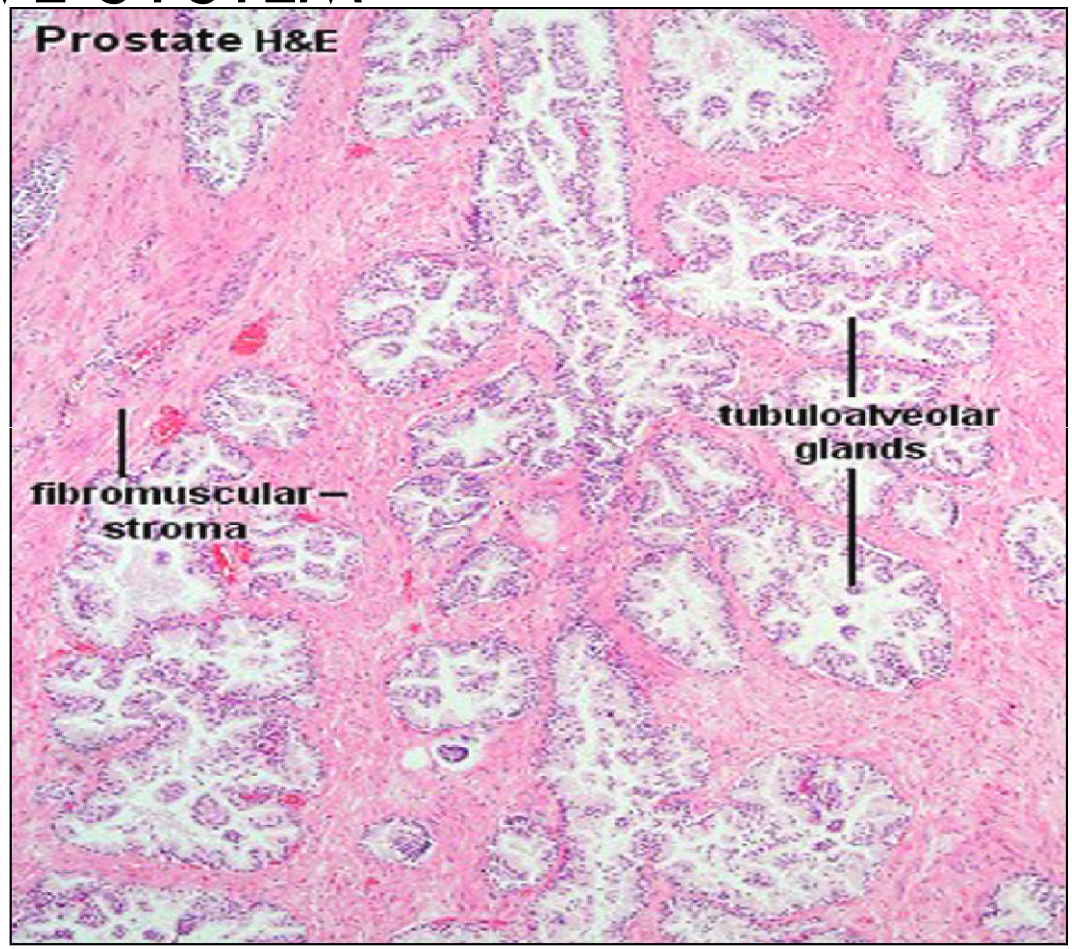
MALE REPRODUCTIVE SYSTEM

- PROSTATE

  SIMPLE OR PSEUDOSTRATIFIED COLUMNAR EPITHELIUM

  30-50 TUBULOALVEOLAR GLANDS WHICH EMPTY INTO URETHRA

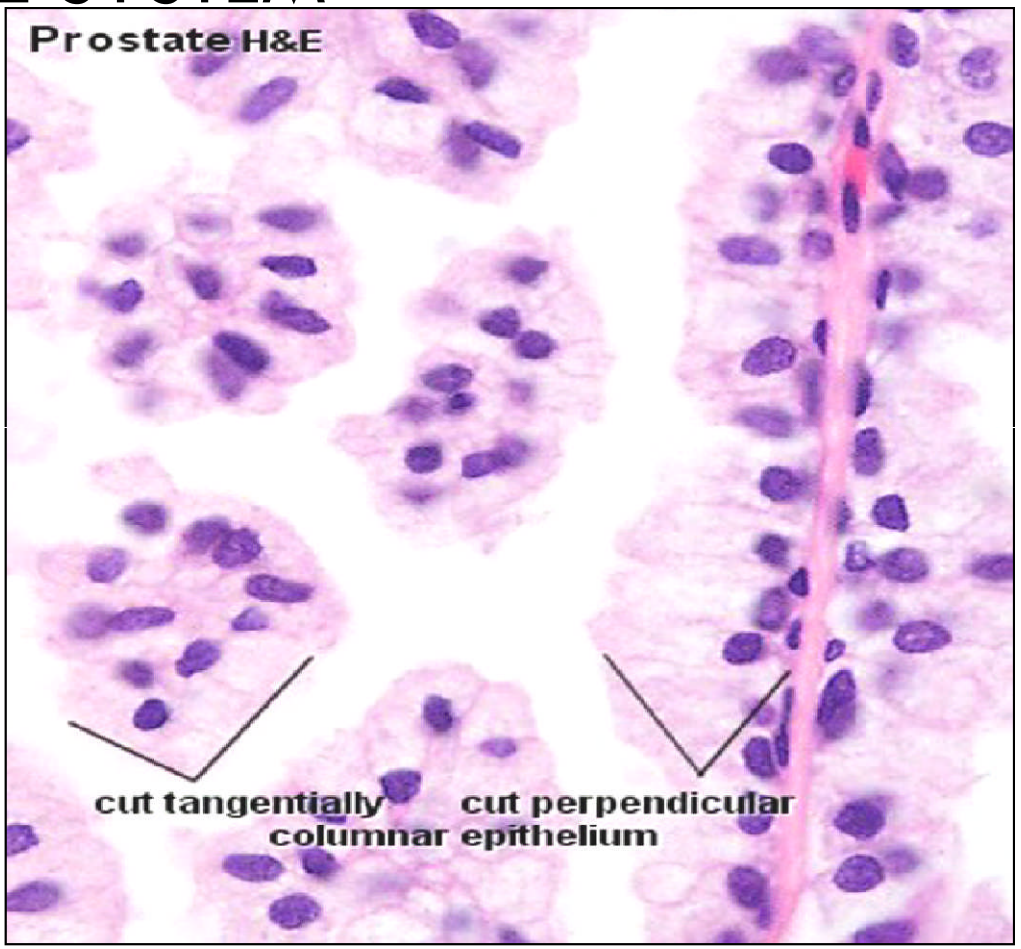
  PROSTATIC SECRETIONS RICH IN CITRIC ACID, ACID PHOSPHATASE, AND PROTEOLYTIC ENZYMES



MALE REPRODUCTIVE SYSTEM

- PROSTATE

SIMPLE OR PSEUDOSTRATIFIED COLUMNAR EPITHELIUM

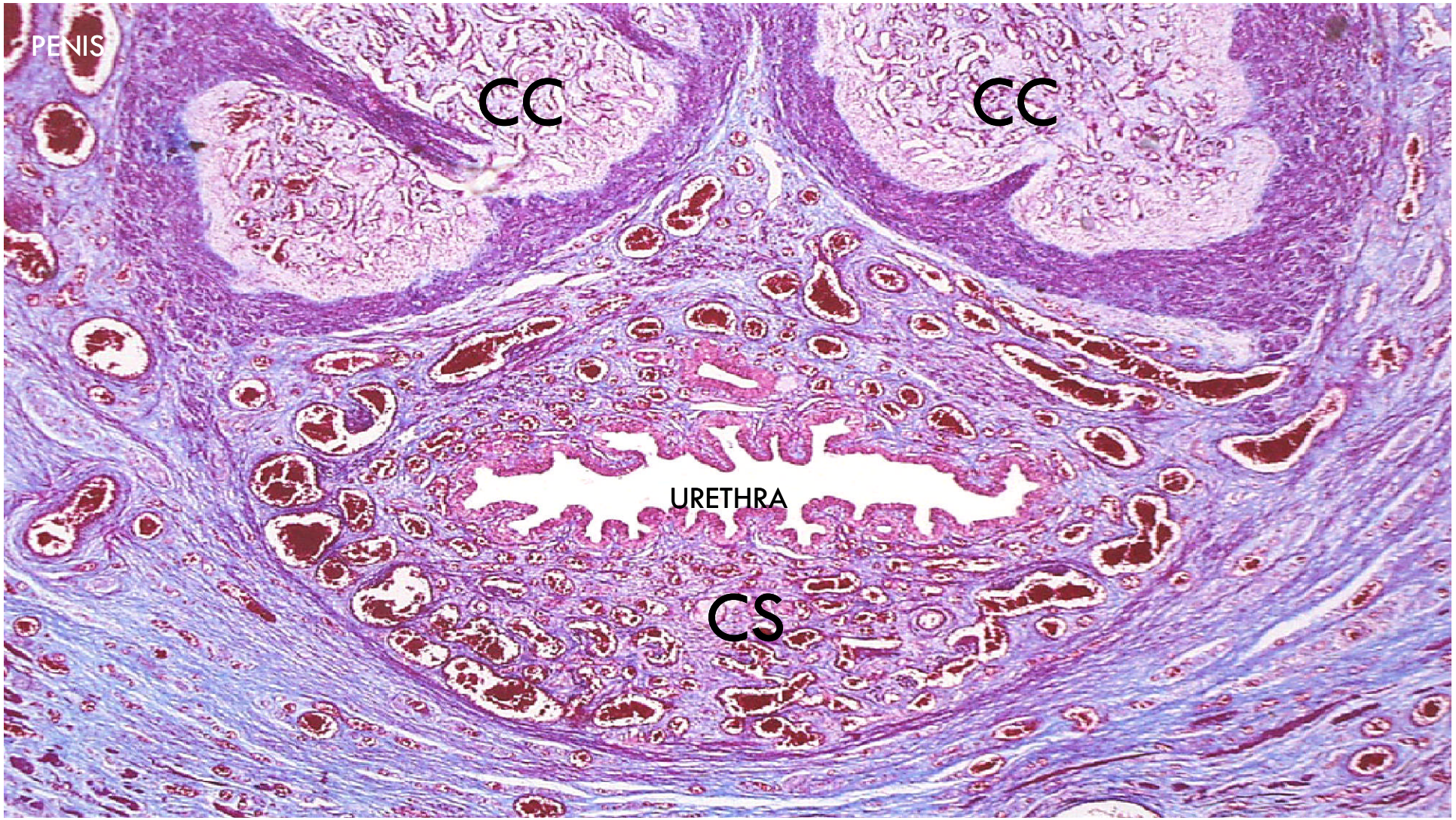


MALE REPRODUCTIVE SYSTEM

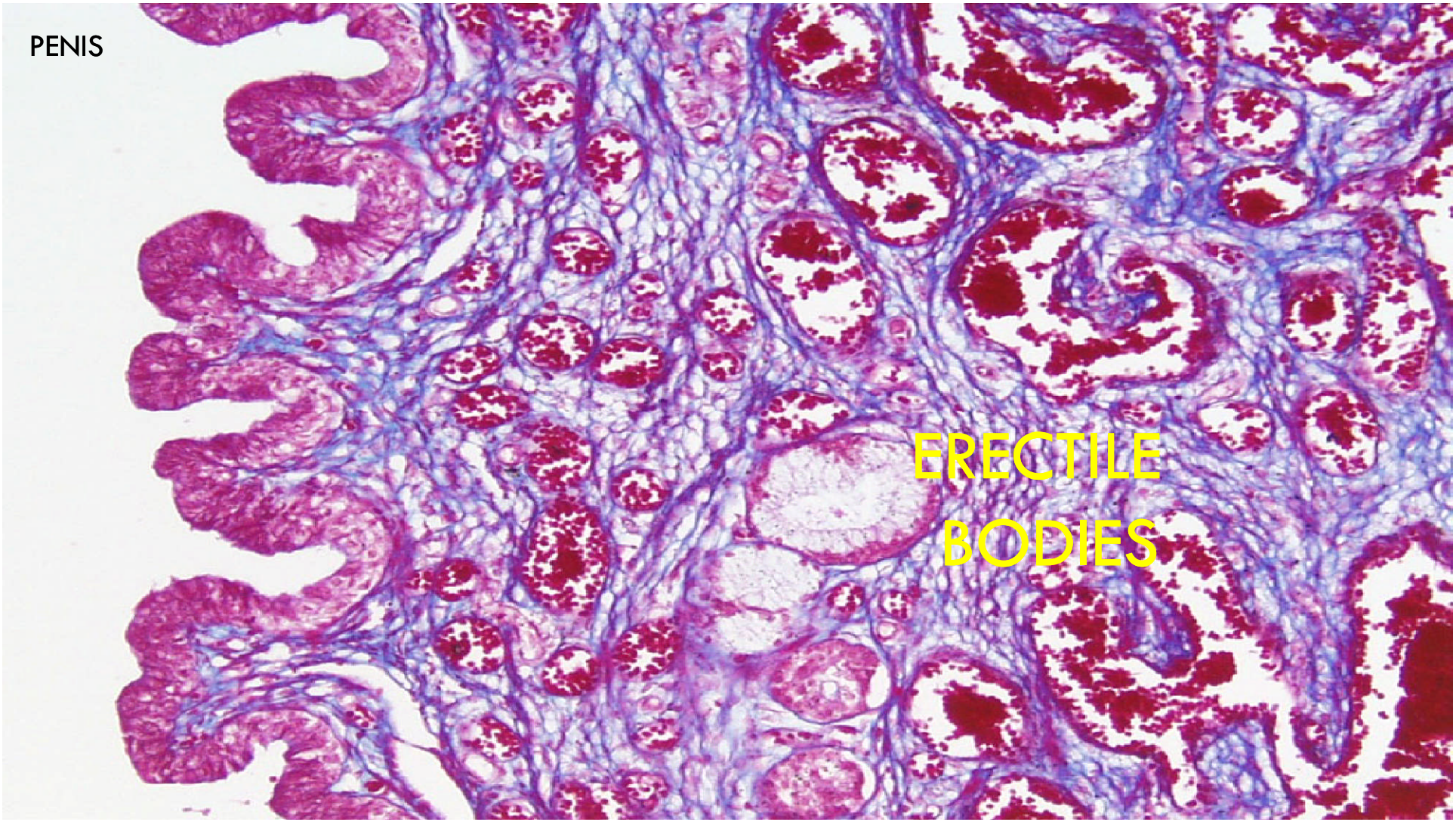
- PROSTATE

PROSTATIC CONCRETIONS

- precipitation of secretory product

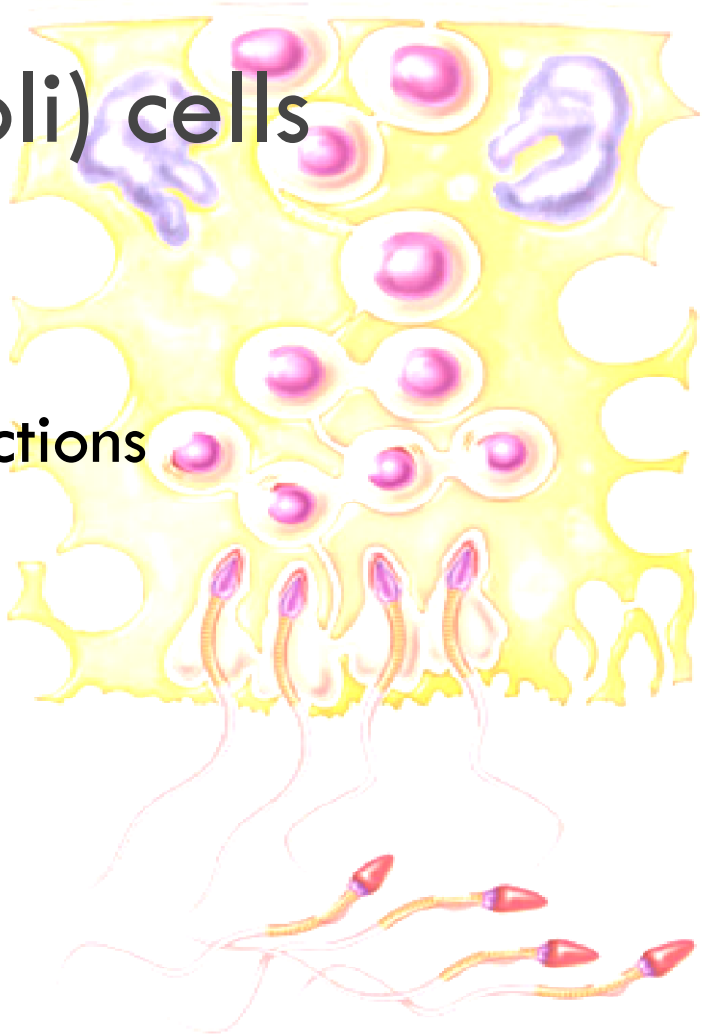

PENIS
CC
CC
URETHRA
CS

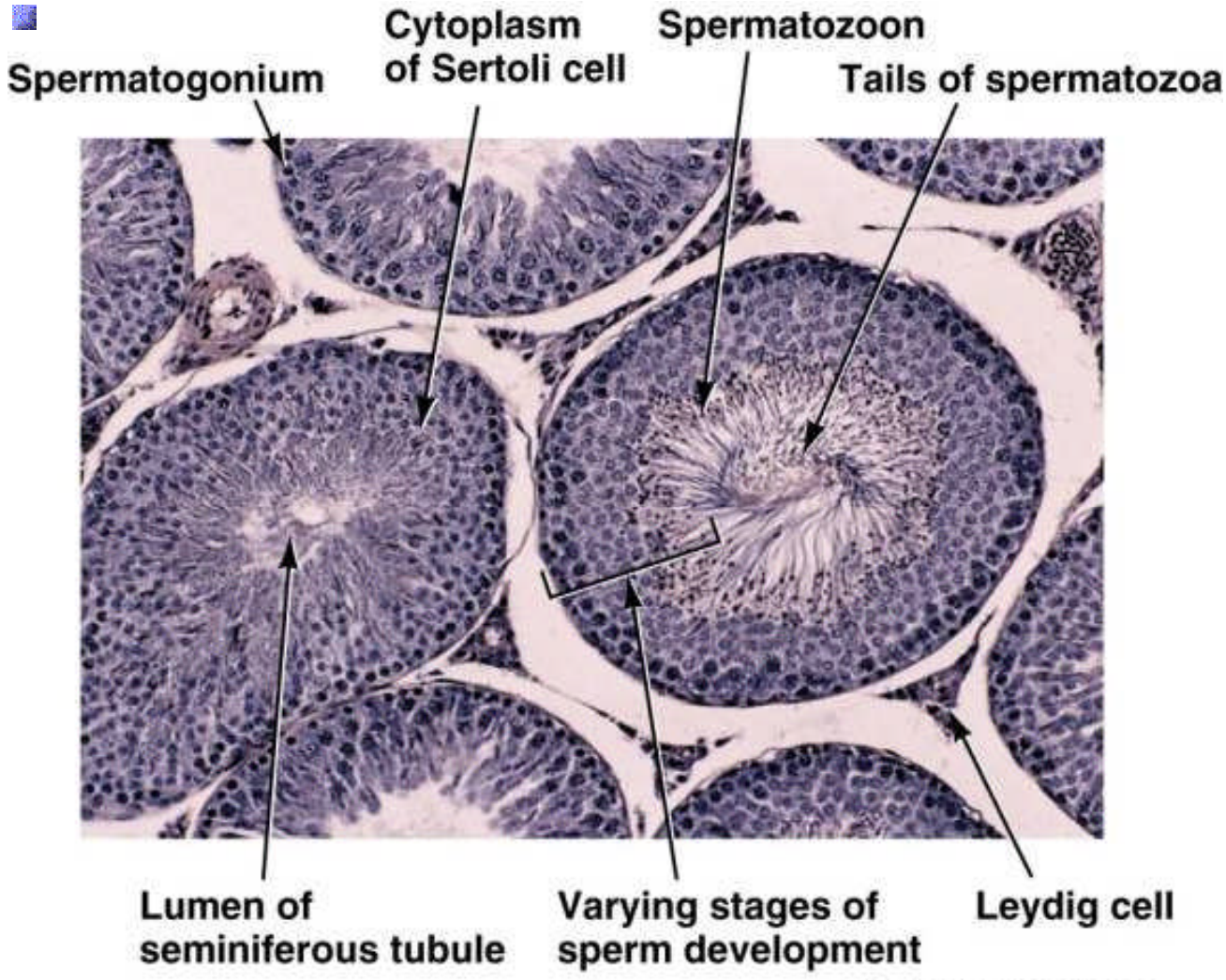
PENIS



Sustentacular (Sertoli) cells

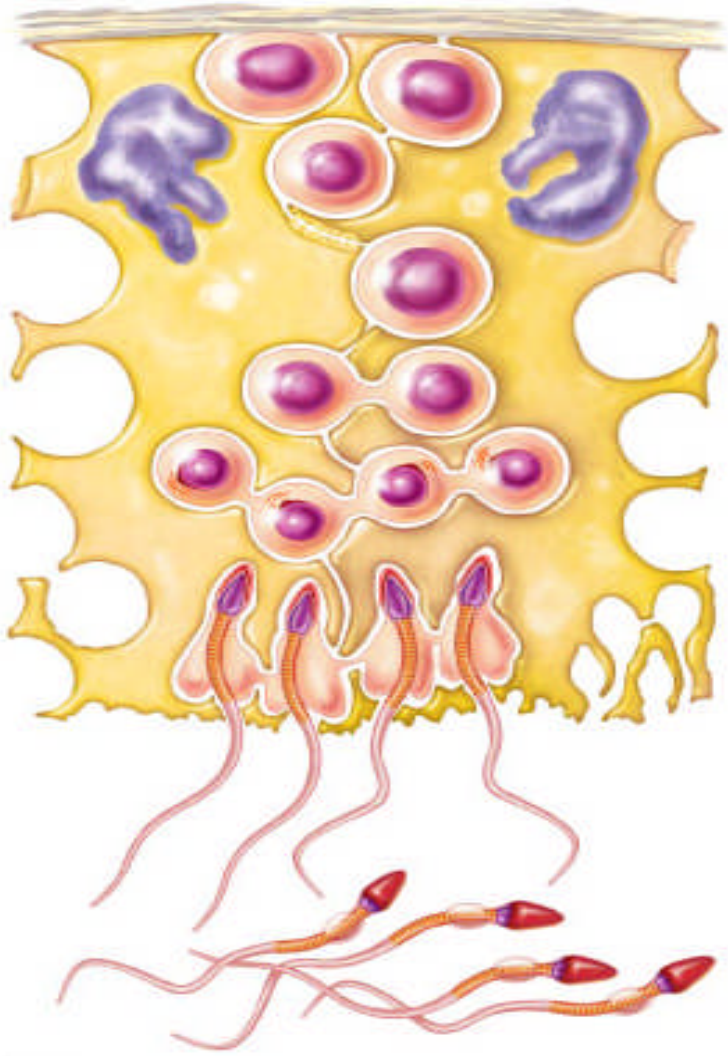
- Nurse cells
- Extend from basal lamina to lumen
- Connected to each other by tight junctions
- Nourish spermatogenic cells
- Transport spermatogenic cells
- Phagocytize excess cytoplasm
- Secretions regulate spermatogenesis





Sustentacular cells

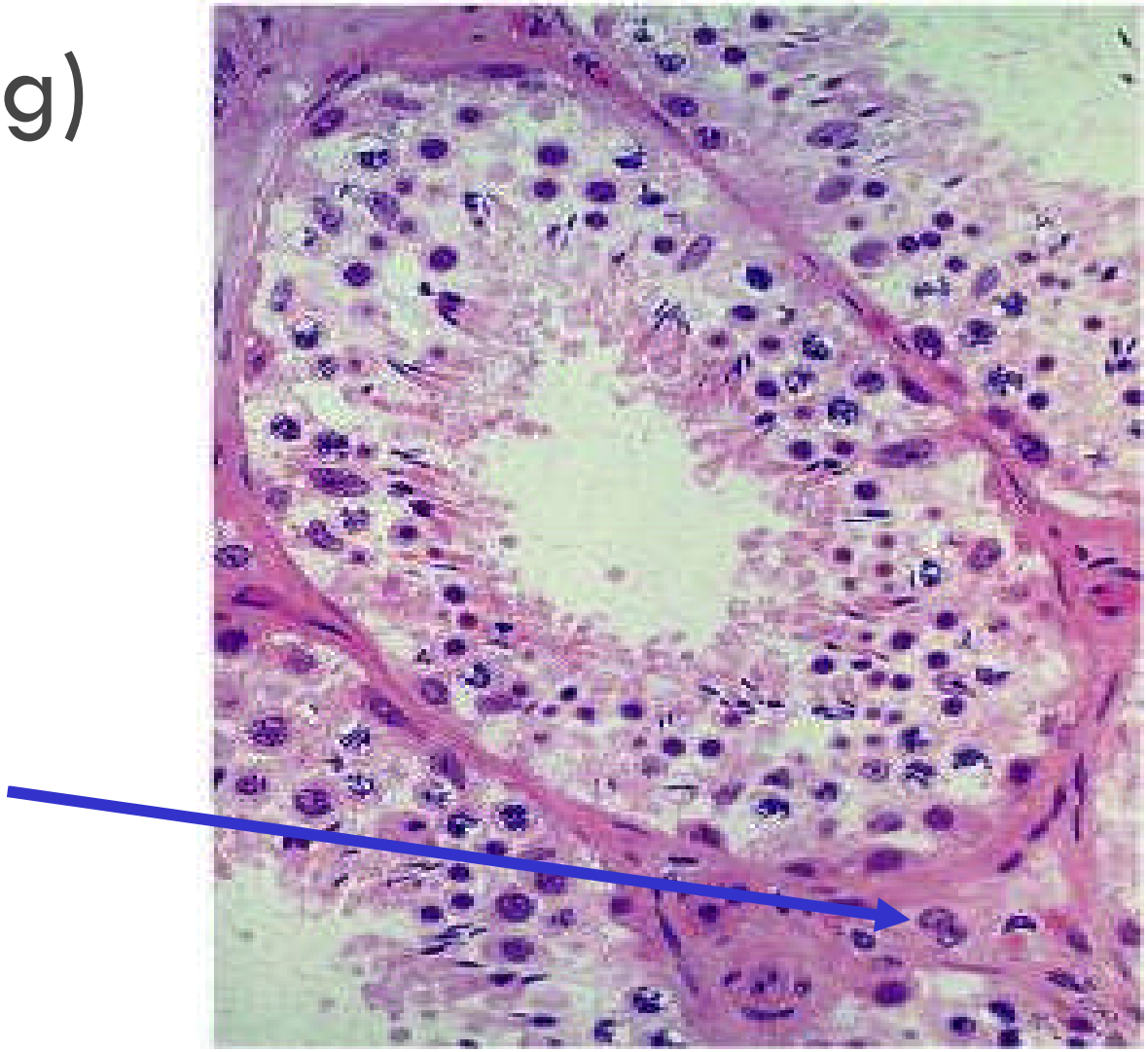
2 Sertoli cells with associated spermatogenesis cells.



24.4c

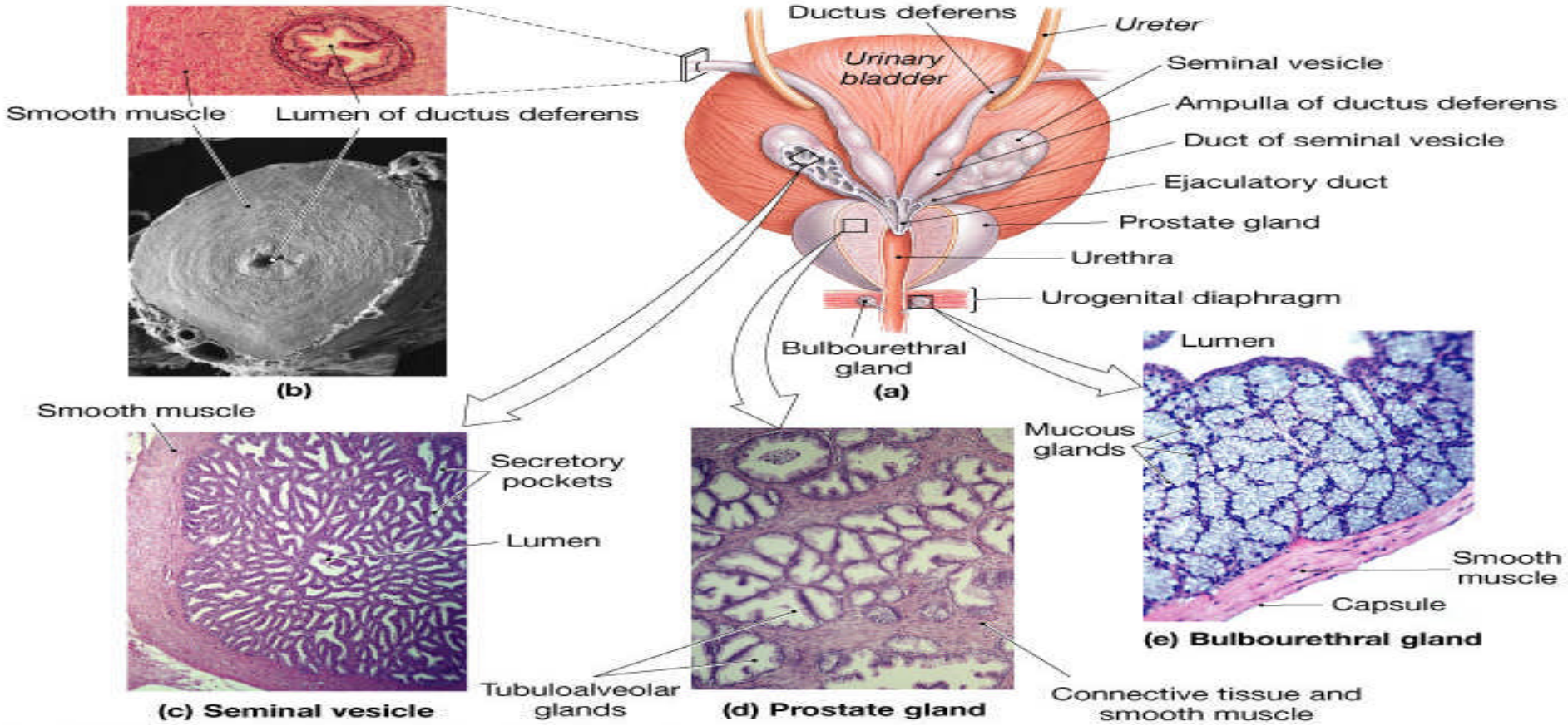
Interstitial (Leydig) cells

- 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 **prostrate 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

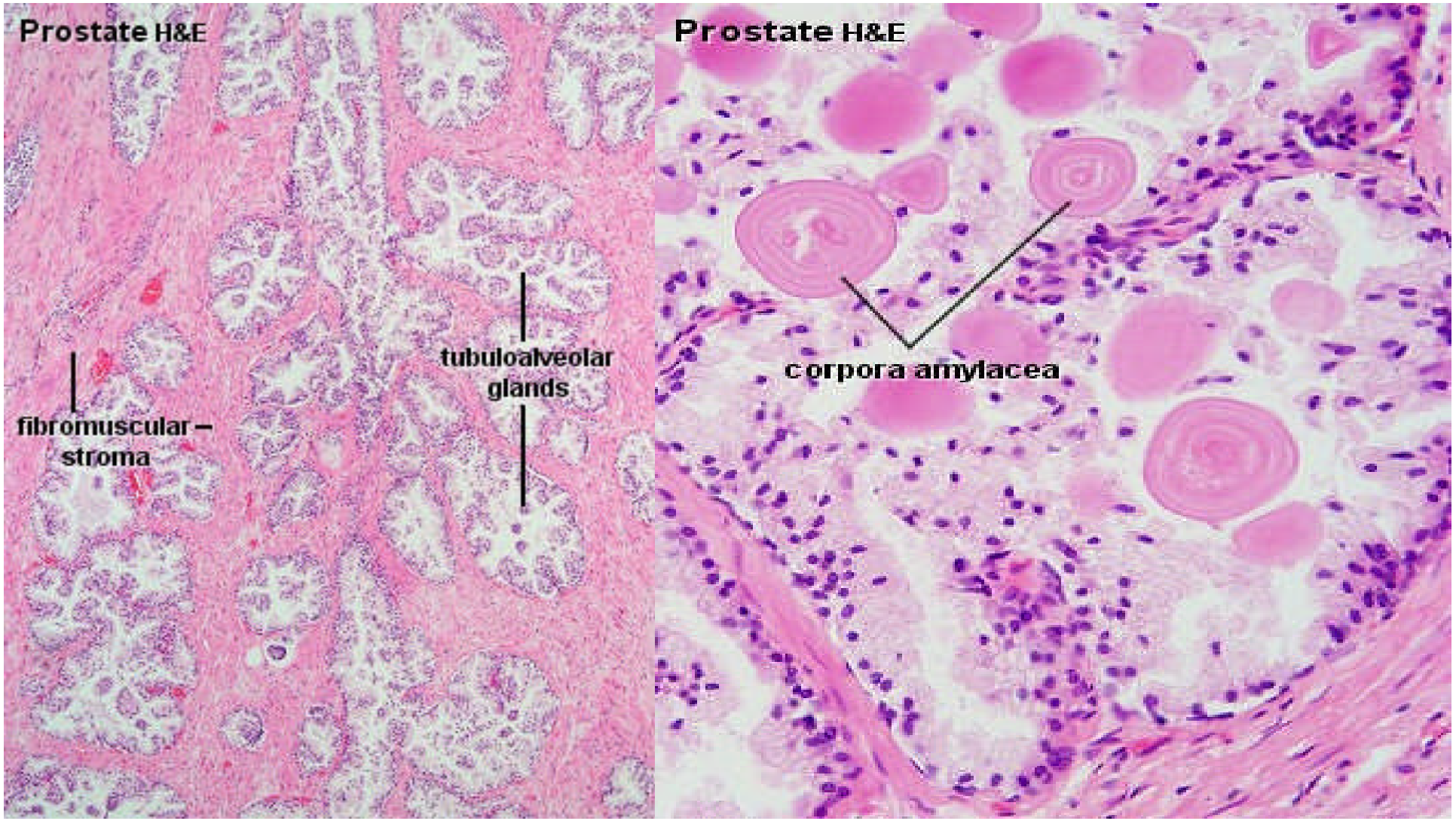
The prostate gland secretes a thin, milky fluid that contains calcium, citrate ion, phosphate ion, a clotting enzyme, and a profibrinolysin.

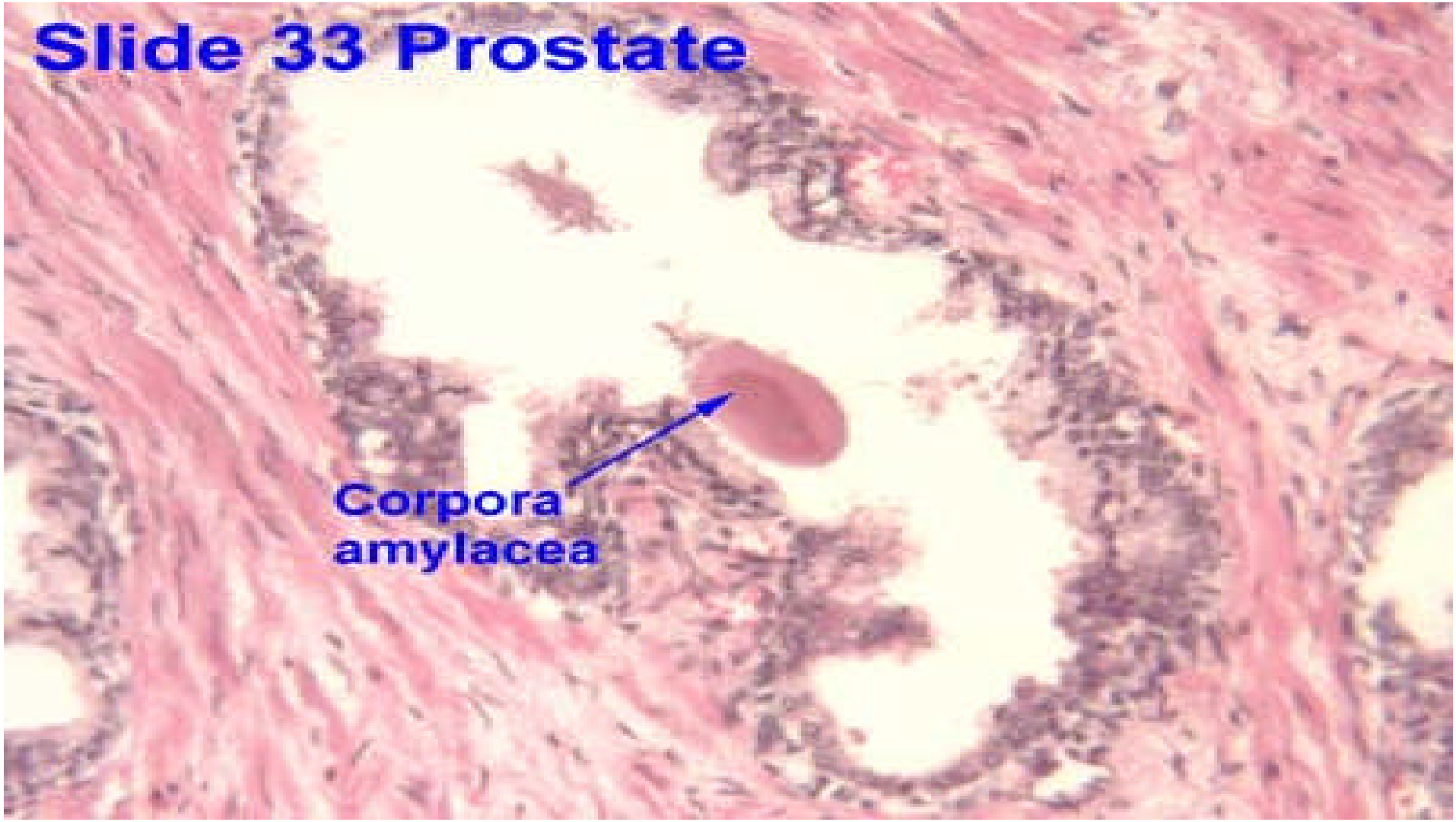
During emission, the capsule of the prostate gland contracts simultaneously with the contractions of the vas deferens so that the thin, milky fluid of the prostate gland adds further tothe bulk of the semen.

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.


Prostate H&E
tubuloalveolar glands
fibromuscular – stroma
Prostate H&E
corpora amylacea


Slide 33 Prostate
Corpora amylacea

Corpora amylacea

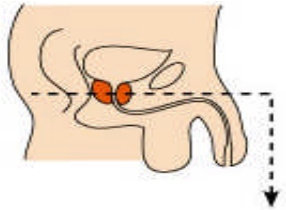
Are small hyaline masses of unknown significance found in the prostate gland, neuroglia, and pulmonary alveoli.

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

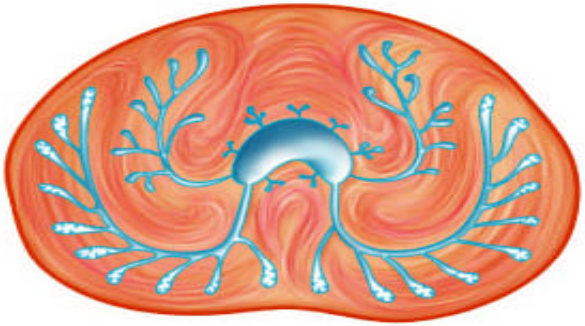
While their significance is unknown, they can be used to identify these organs microscopically

Prostate Gland

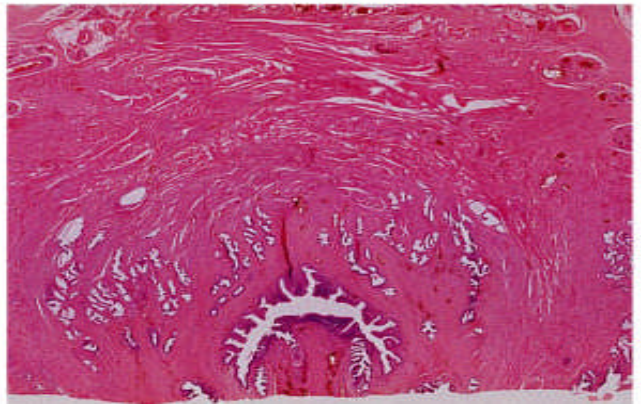
- Prostate gland
  - Surrounds prostatic urethra
  - 30% of semen
  - Supports sperm



(a)



(b)



24.9

The prostate gland is shaped like an inverted cone and lies just below the neck of the urinary bladder.

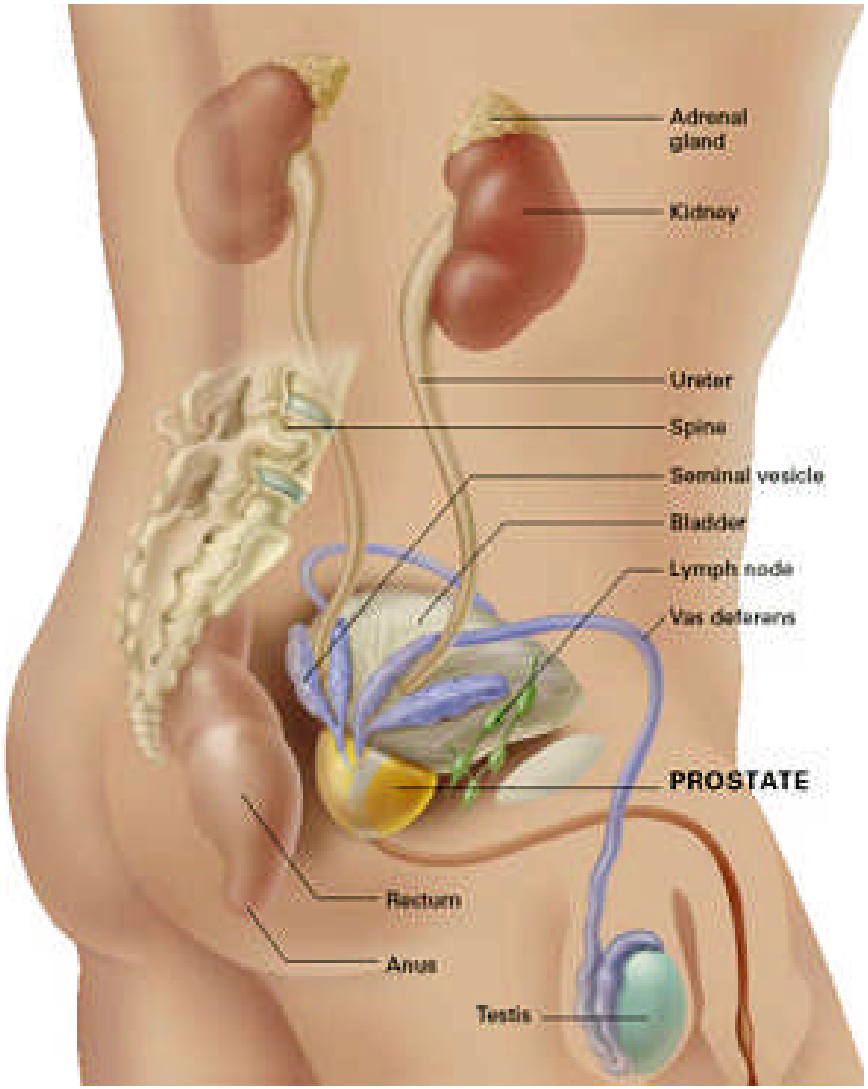
It is about 5 cm (3 inches) long and 3-4cm wide.

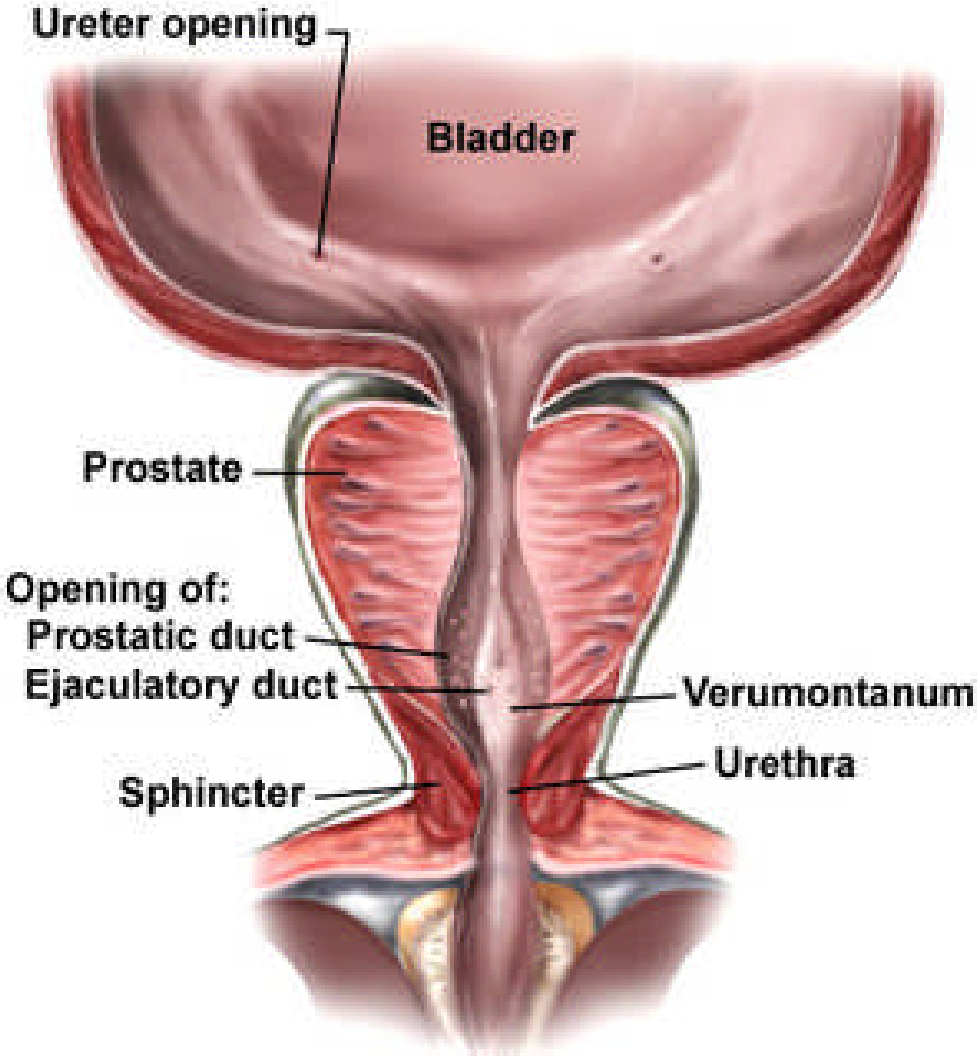
The urethra, which runs from the bladder through the middle of the prostate gland and through the penis, carries urine from the bladder.
The smooth muscle of the urethra is the internal urinary sphincter.

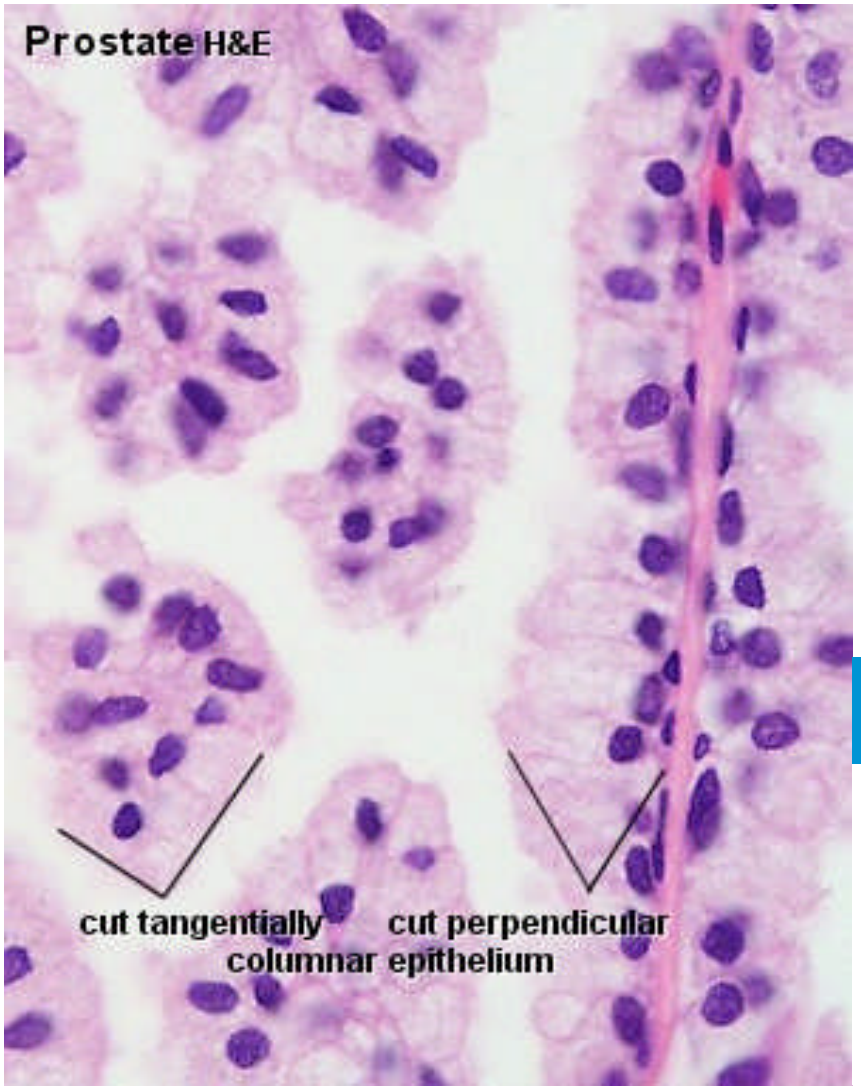
Just below the prostate gland is a muscular diaphragm that acts as the external urinary sphincter.

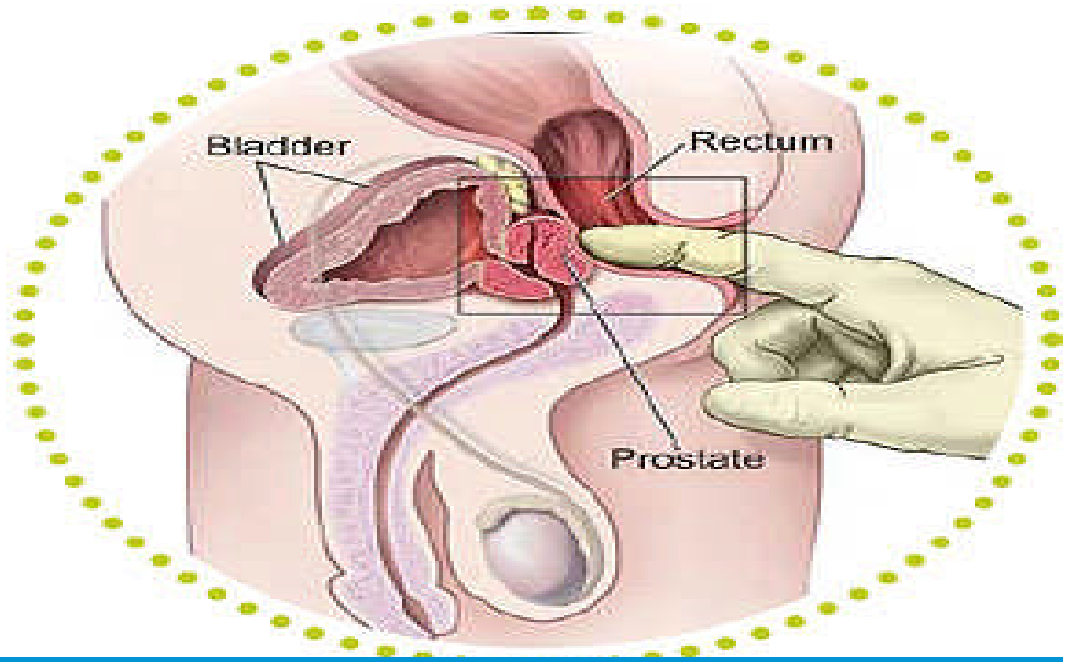
This sphincter, which encircles the urethra, is under both reflex and voluntary control

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


Adrenal gland
Kidney
Ureter
Spine
Seminal vesicle
Bladder
Lymph node
Vas deferens
PROSTATE
Rectum
Anus
Testis

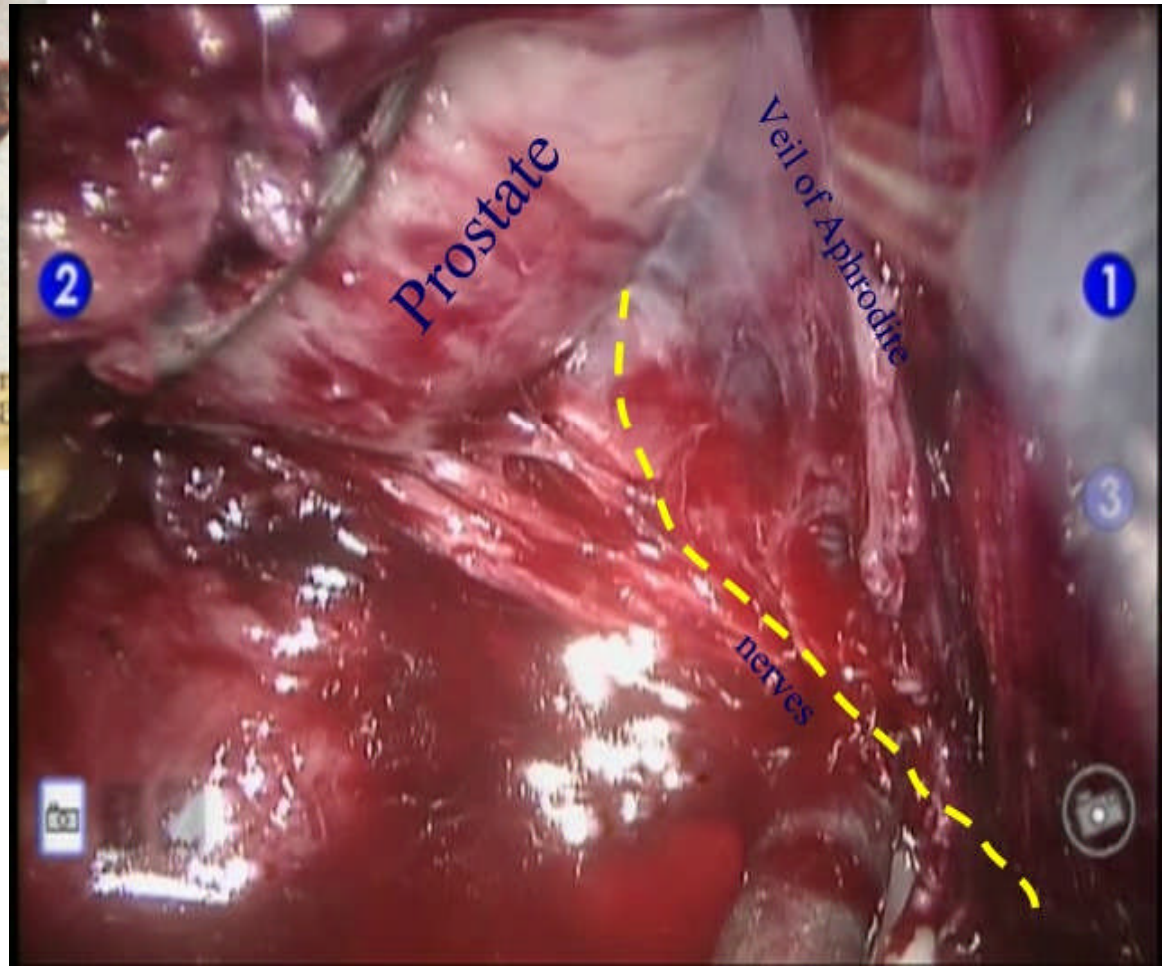

Ureter opening
Bladder
Prostate
Opening of:
Prostatic duct
Ejaculatory duct
Verumontanum
Urethra
Sphincter

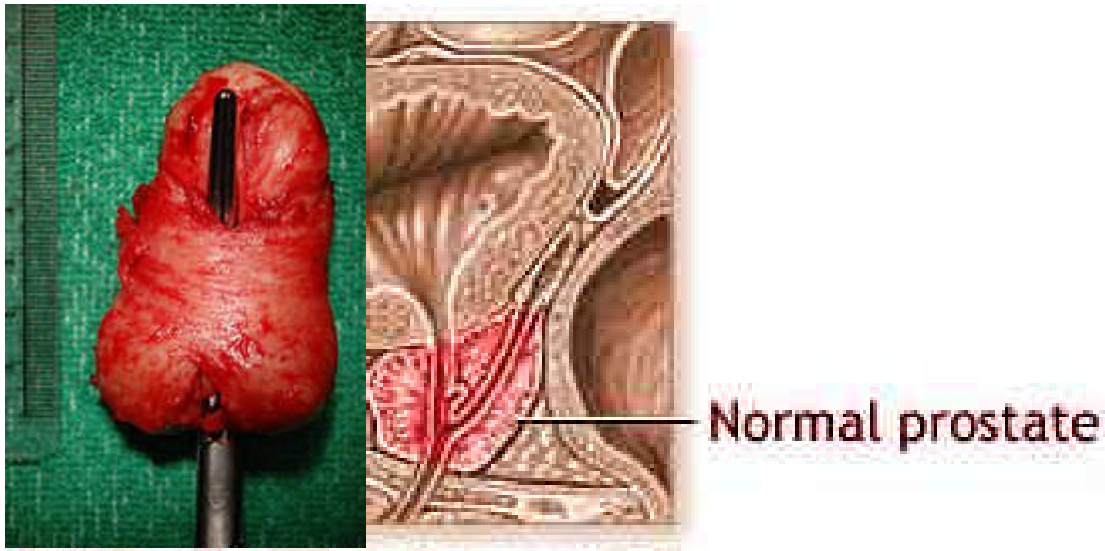


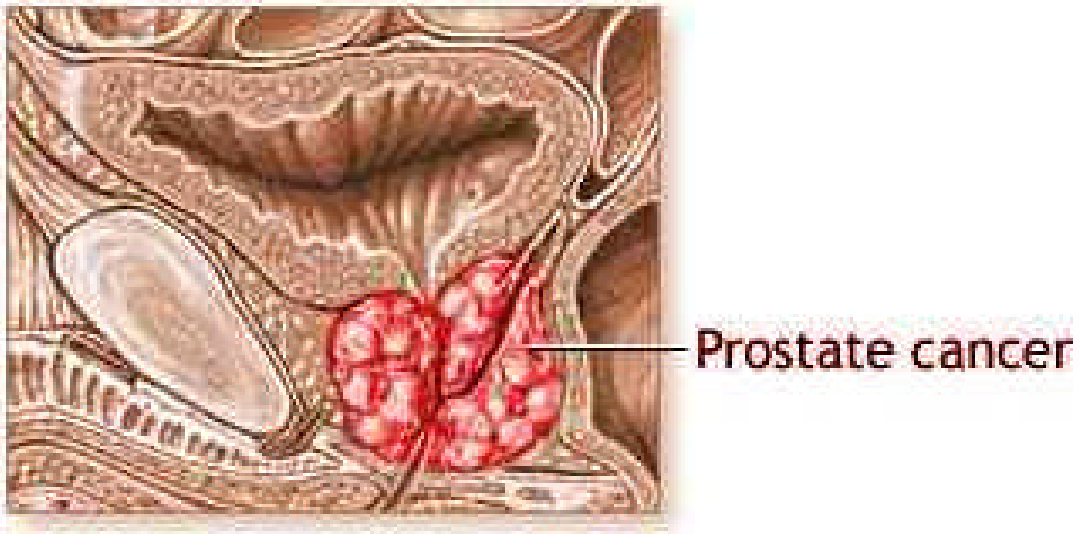


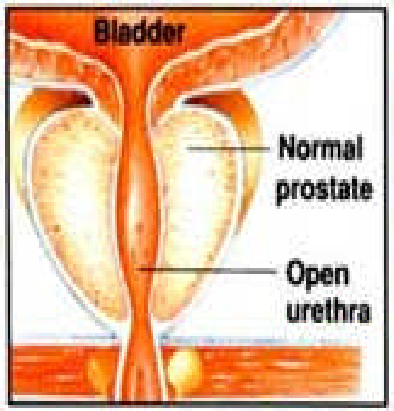
PS Level ng/mL	Condition
<4	Normal
4 to 10	Borderline
>10	Abnormally High

BPH

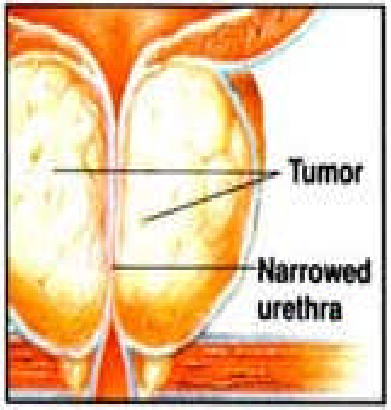




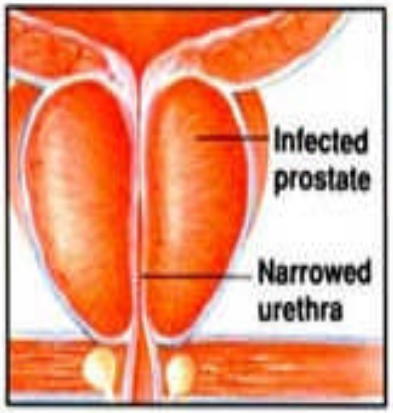




Normal prostate doesn't interfere with the urethra or urination.

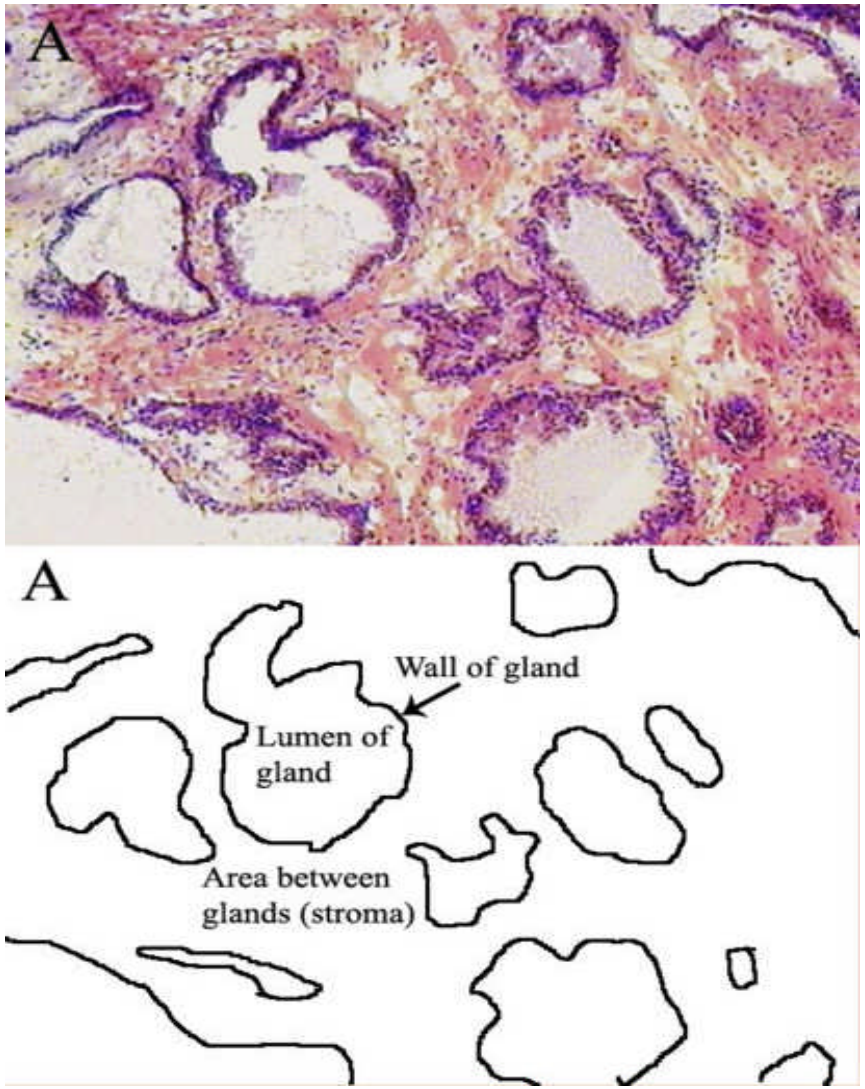


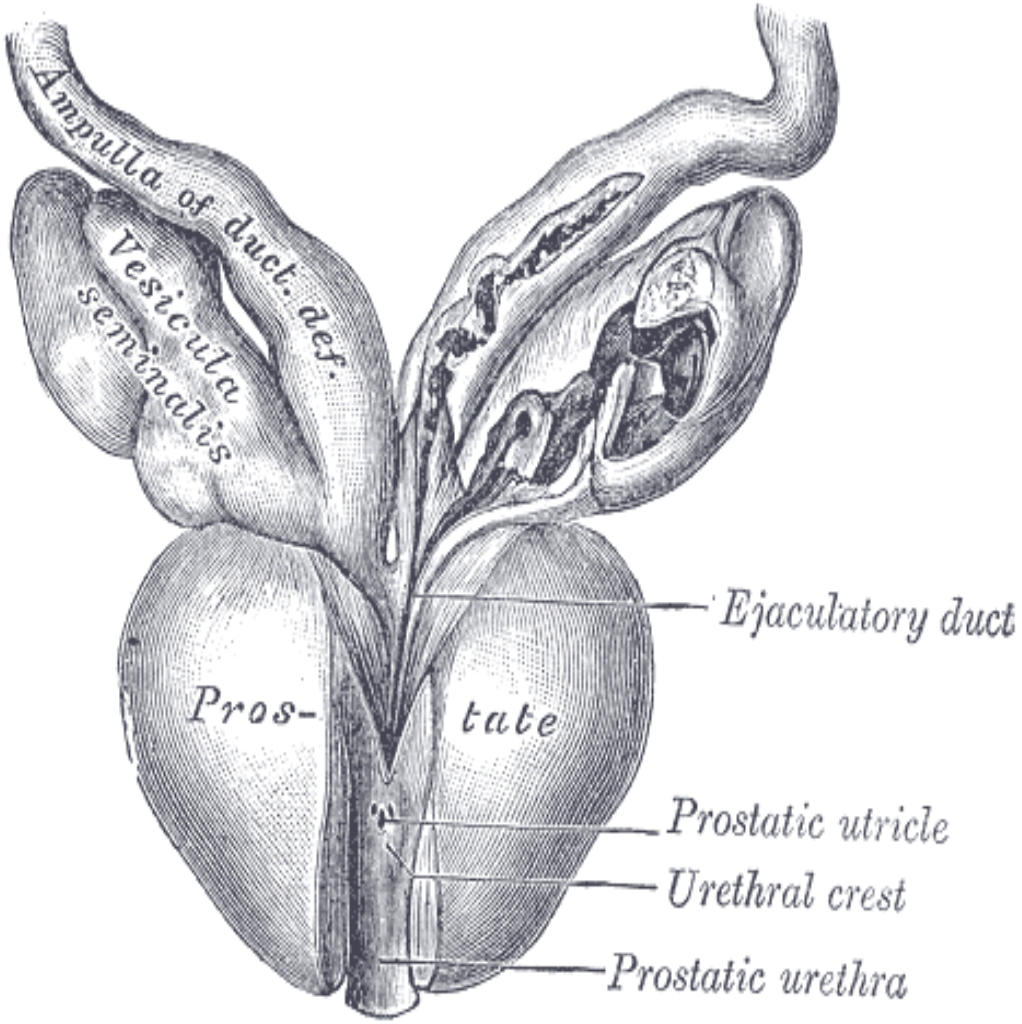
Benign tumors may squeeze and narrow the urethra.



Infected prostate may cause pain with urination.

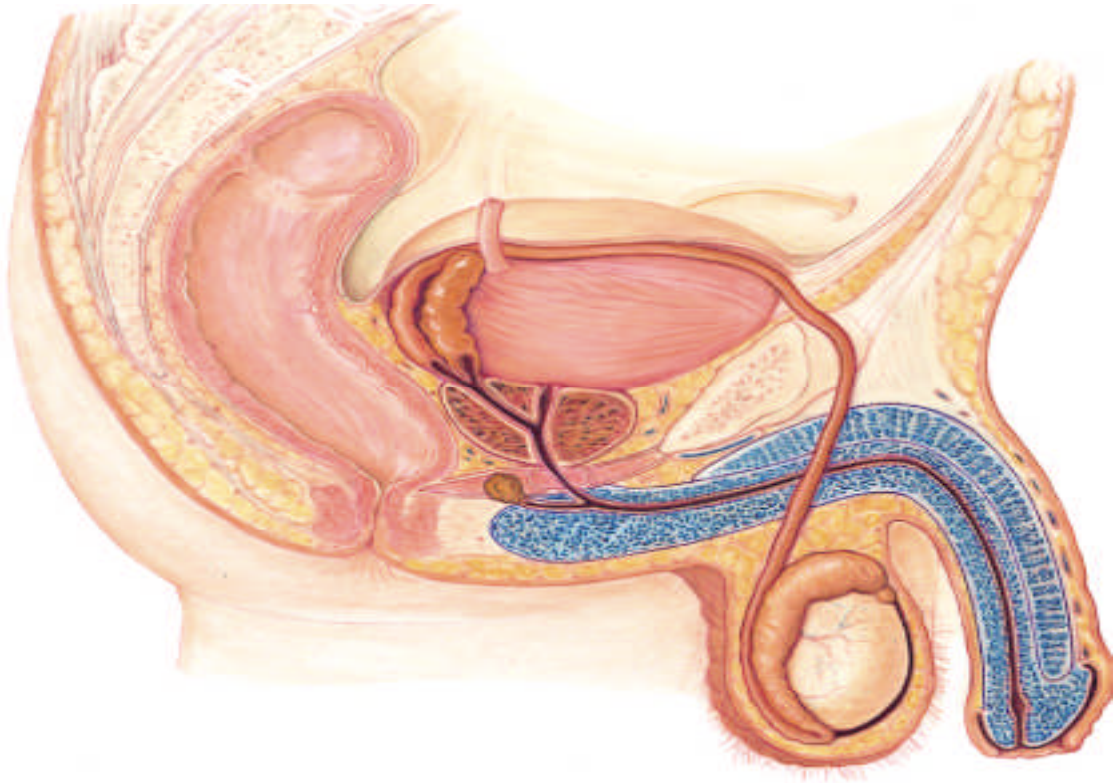
Malignant tumors in early stages don't cause symptoms.


A
A
Wall of gland
Lumen of gland
Area between glands (stroma)


Ampulla of duct. def.
Vesicula seminalis
Ejaculatory duct
Pros-
tate
Prostatic utricle
Urethral crest
Prostatic urethra

Ducts

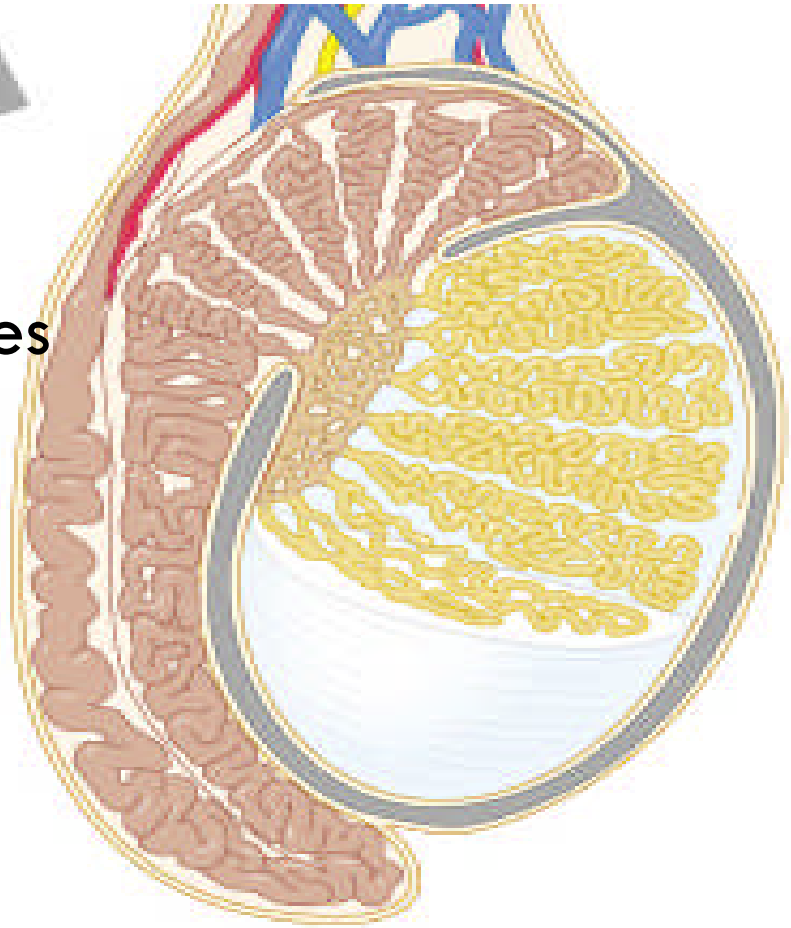
- Epididymis
- Ductus deferens
- Ejaculatory duct
- (urethra)



24.1

Epididymis

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

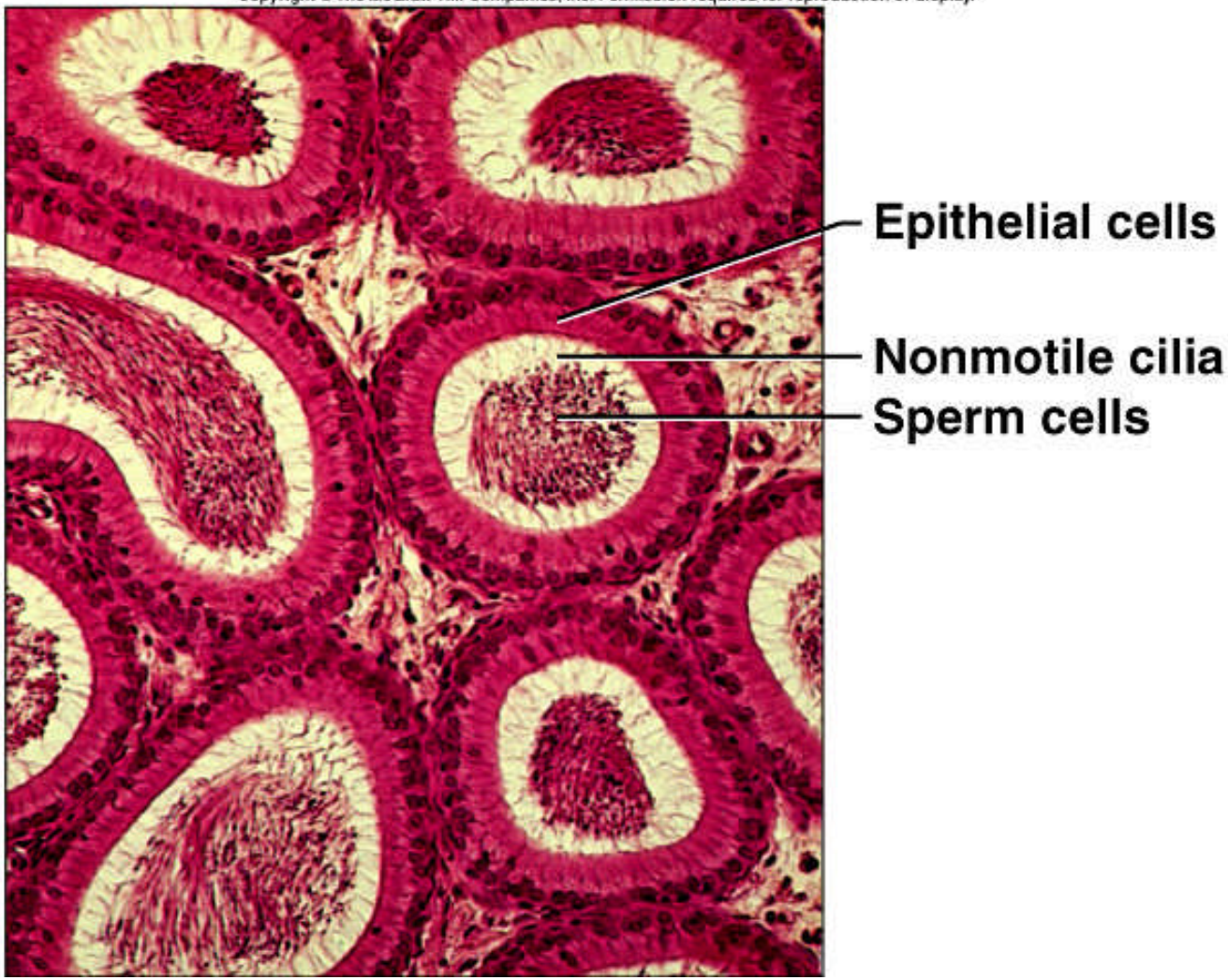


24.3a

Epididymis

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

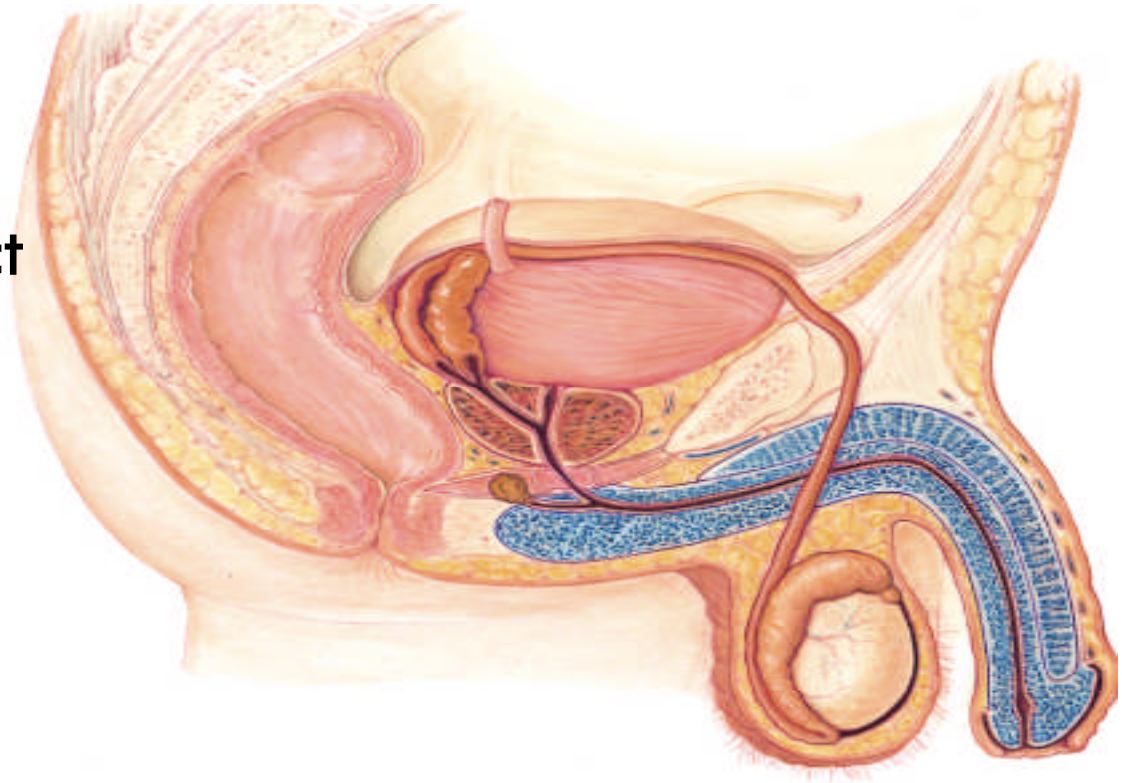
24.6a



Epididymis:

Ductus (vas) deferens

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



24.1

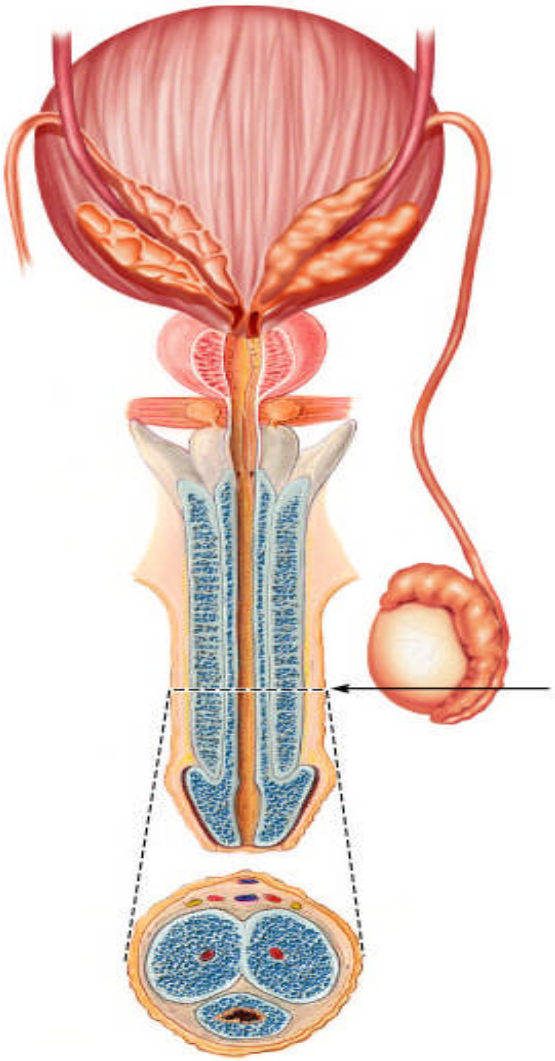
Ductus deferens

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

24.6b

Urethra

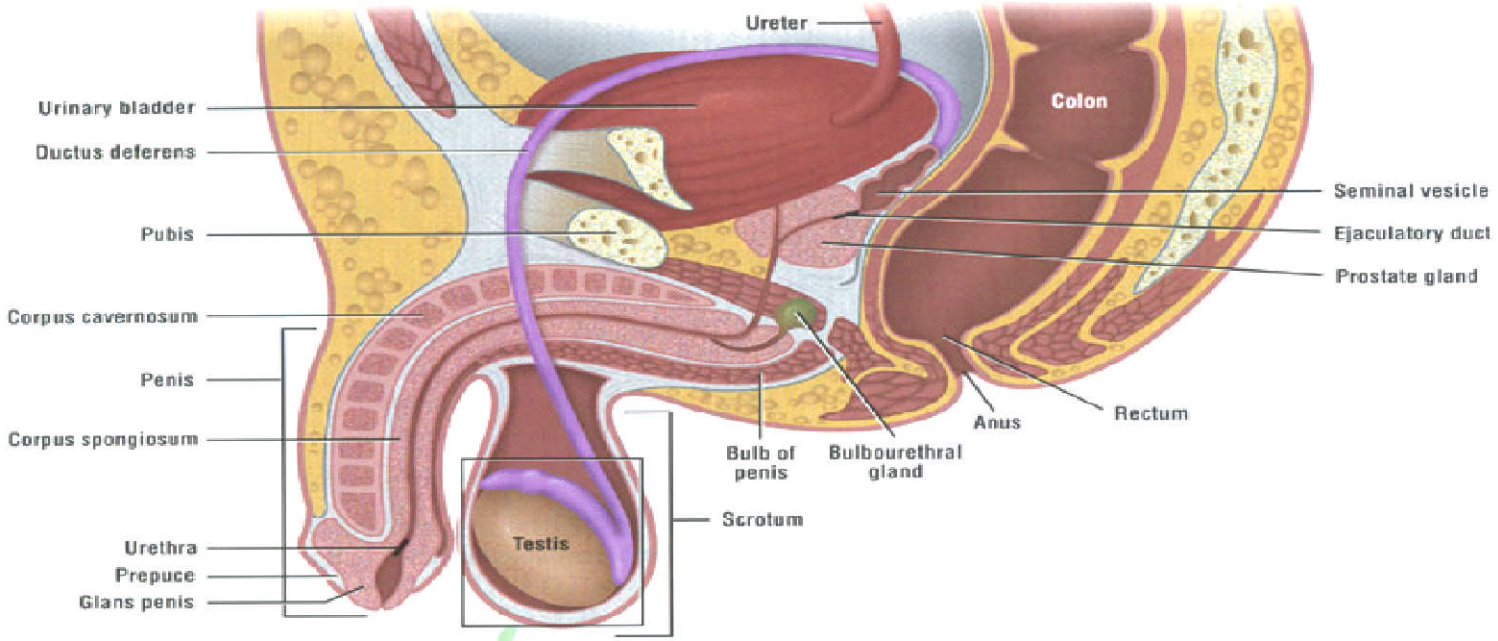
- Shared with urinary system
- Prostatic urethra
- Membranous urethra
- Spongy (penile) urethra



MALE REPRODUCTIVE SYSTEM

- URETHRA

  PROSTATIC, MEMBRANOUS, SPONGY (PENILE)



Urethra

Conveys both urine and semen (at different times)

Consists of three regions

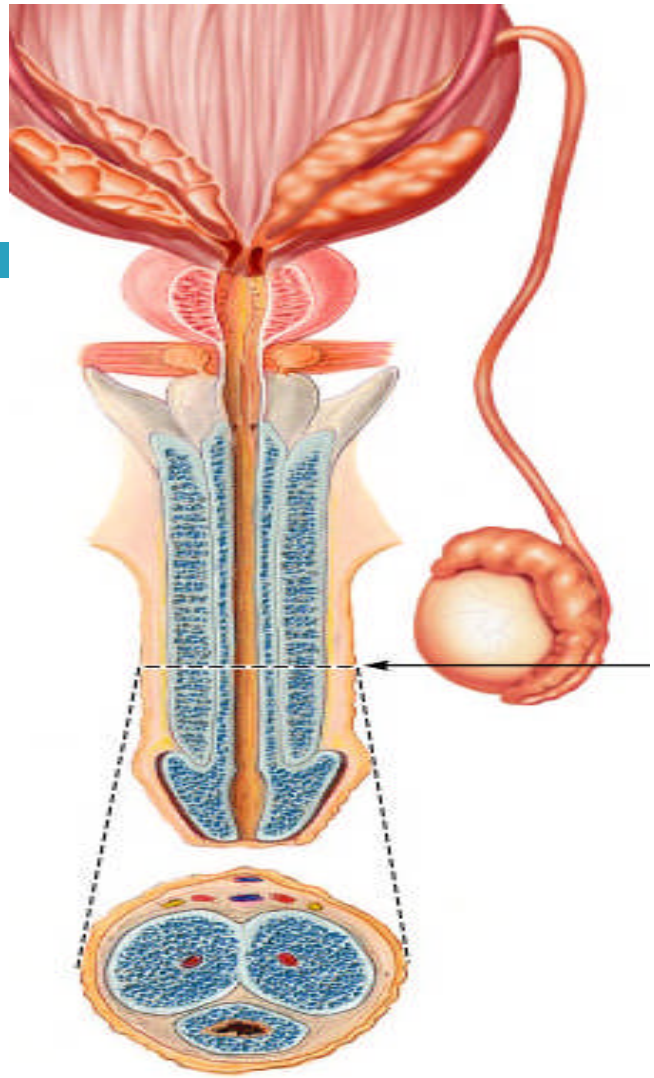
Prostatic – portion surrounded by the prostate

Membranous – lies in the urogenital diaphragm

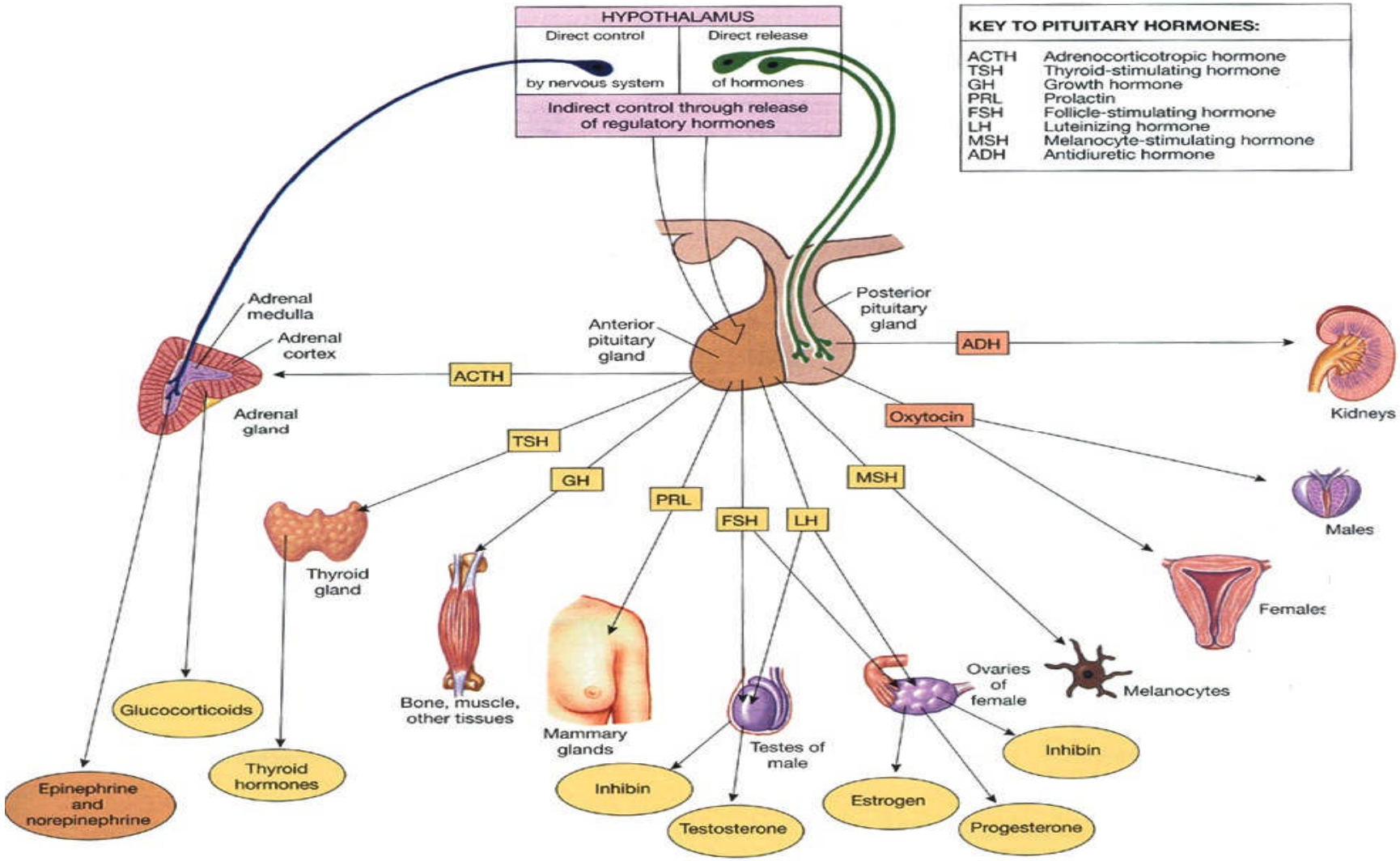
Spongy, or penile – runs through the penis and opens to the outside at the external urethral orifice

Ejaculation

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



24.8


HYPOTHALAMUS
Direct control
by nervous system
Direct release
of hormones
Indirect control through release of regulatory hormones
KEY TO PITUITARY HORMONES:
ACTH Adrenocorticotropic hormone
TSH Thyroid-stimulating hormone
GH Growth hormone
PRL Prolactin
FSH Follicle-stimulating hormone
LH Luteinizing hormone
MSH Melanocyte-stimulating hormone
ADH Antidiuretic hormone
Adrenal medulla
Adrenal cortex
Adrenal gland
Anterior pituitary gland
Posterior pituitary gland
ACTH
ADH
Kidneys
Oxytocin
TSH
GH
PRL
FSH
LH
MSH
Males
Females
Thyroid gland
Bone, muscle, other tissues
Mammary glands
Ovaries of female
Melanocytes
Testes of male
Glucocorticoids
Thyroid hormones
Epinephrine and norepinephrine
Inhibin
Testosterone
Estrogen
Progesterone
Inhibin

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 gonadotropinreleasing 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 ofTestosterone 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 abou stimulatory effects in certain neurons
- Testosterone targets all accessory organs and its deficiency causes these organs to atrophy

Male Secondary Sex Characteristics

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