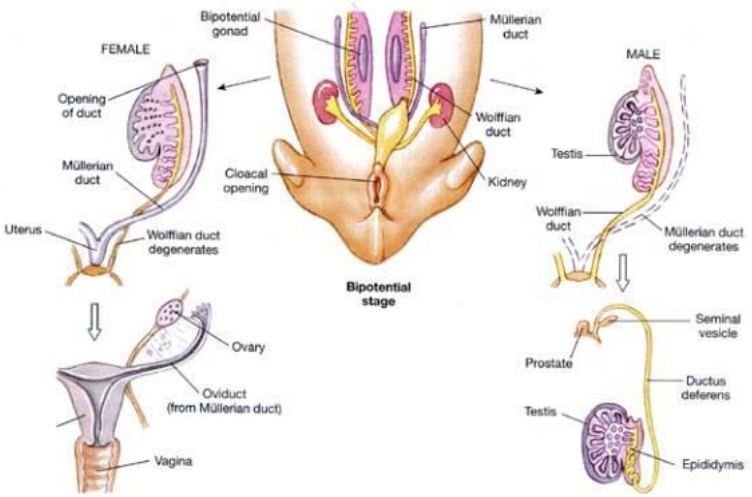
Mammalian Reproductive System

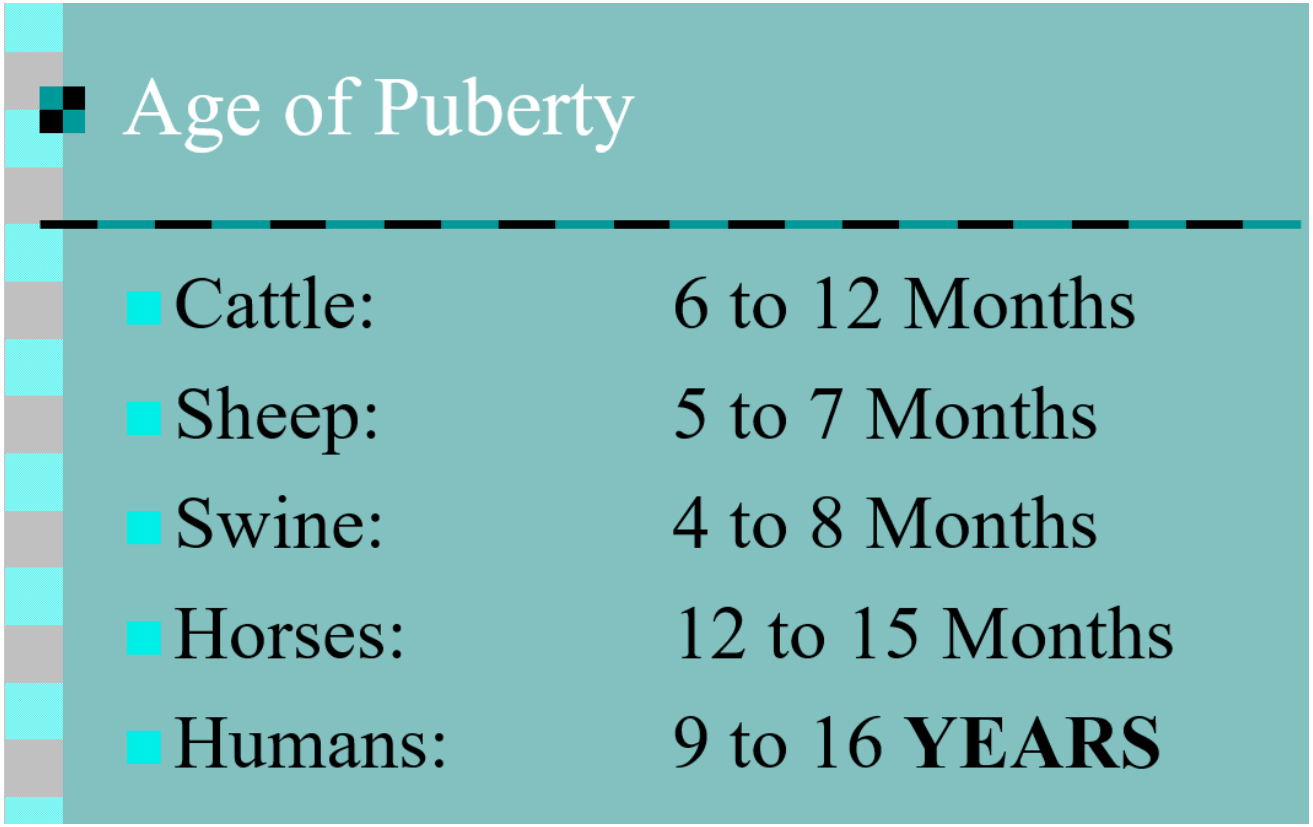
Basics of Reproduction in Mammals

- Male and female reproductive systems develop from similar embryonic tissue.
- First few weeks of development, male and female embryos are indistinguishable.
- Adult reproductive systems share some functional similarities.



Basics of Reproduction in Mammals

- All reproductive activities start after (puberty):
  Age at which reproductive organs become functional



Fertility: Male VS Female

- Male: all over his life span , Female: stop at **menopause** age! ((published papers on captive and wild mammals from more than 70 species, Shows that females in more than 80% of the species stopped reproducing before the end of their lives. The list includes horses, domestic cattle, African and Asian elephants, house mice, and, yes, chimps.))
- In Female: At birth, the normal female ovary contains about 1-2 million/oocytes (eggs). **Females are not capable of making new eggs**, and in fact, there is a continuous decline in the total number of eggs each month. By the time a girl enters puberty, only about 25% of her lifetime total egg pool remains, around 300,000. (No new oocyte cells are made during a woman's lifetime and sease the production of oocytes at the Menopause age!).
- In Male: The production of sperm is a continuous process once it has been initiated.

- Female- Reproduction process occurs within Cycles:
  - Menstrual or Estrous cycle- Repetitive cycle occurring when pregnancy does not occur.
- Gonads:
  - Within the abdominal cavity (in female)
  - Outside the abdominal cavity (in male)

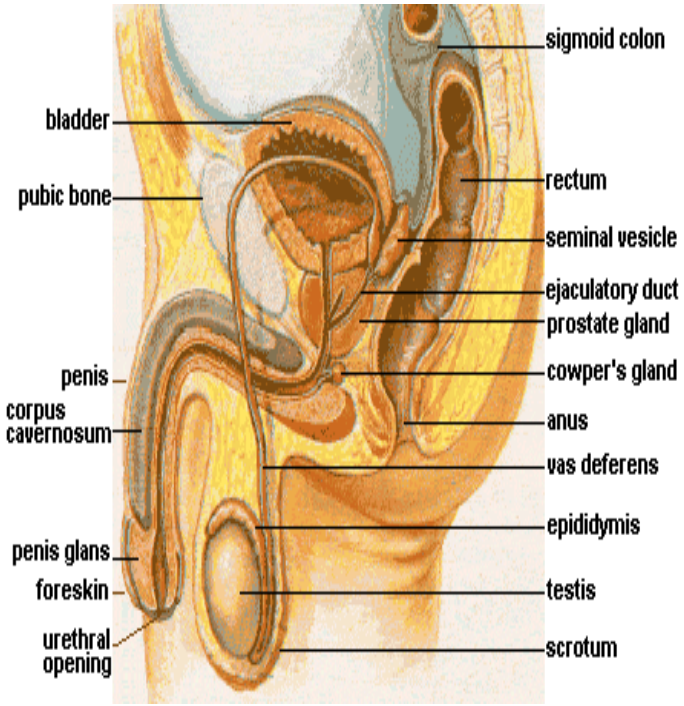
- Gonads – primary sex organs
  - Testes in males
  - Ovaries in females
- Gonads produce gametes (sex cells) and secrete hormones
  - Sperm – male gametes
  - Ova (eggs) – female gametes

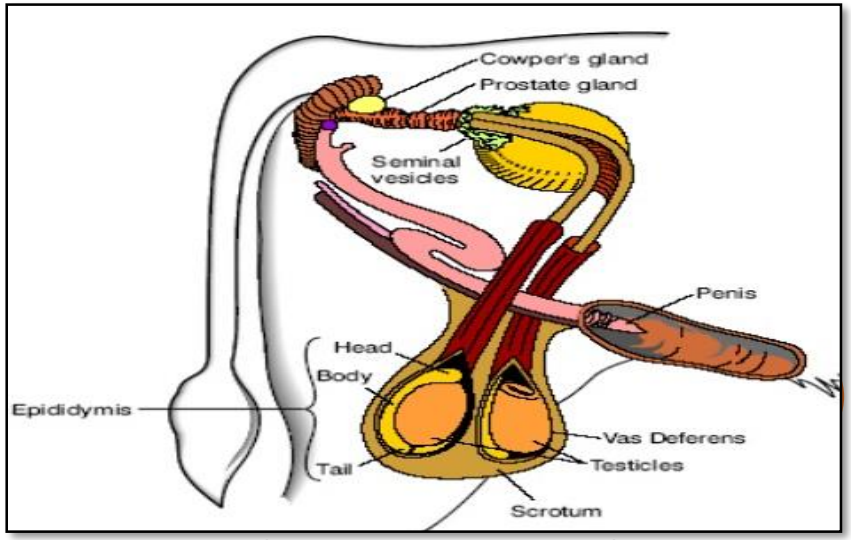
The Male Reproductive System

(Human)

Male reproductive system

- Gonads – testes
  - Produces sperm and secretes hormones
- System of ducts – transport and stores sperm, assists in their maturation, and conveys them to the exterior
  - Epididymis, ductus deferens, ejaculatory ducts, and urethra
- Accessory sex glands – adds secretions to semen
  - Seminal vesicles, prostate, and bulbourethral glands
- Supporting structures
  - Scrotum supports testes and penis delivers sperm into female reproductive tract

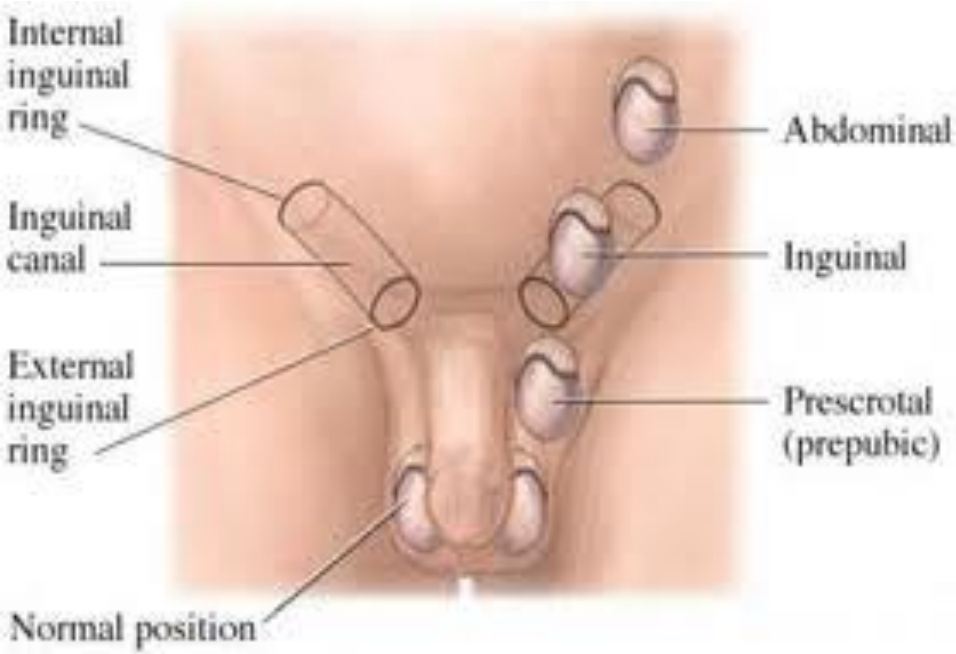




Drawing of the reproductive tract of the bull

Descent of the Testes

- Ovoid structures about 5 cm long and 3 cm wide.
- Located within the scrotal sac (scrotum)
- During fetal development they are near the kidneys and slowly move inferiorly in the abdominal cavity.
- During the 7th month they descend through the inguinal canals

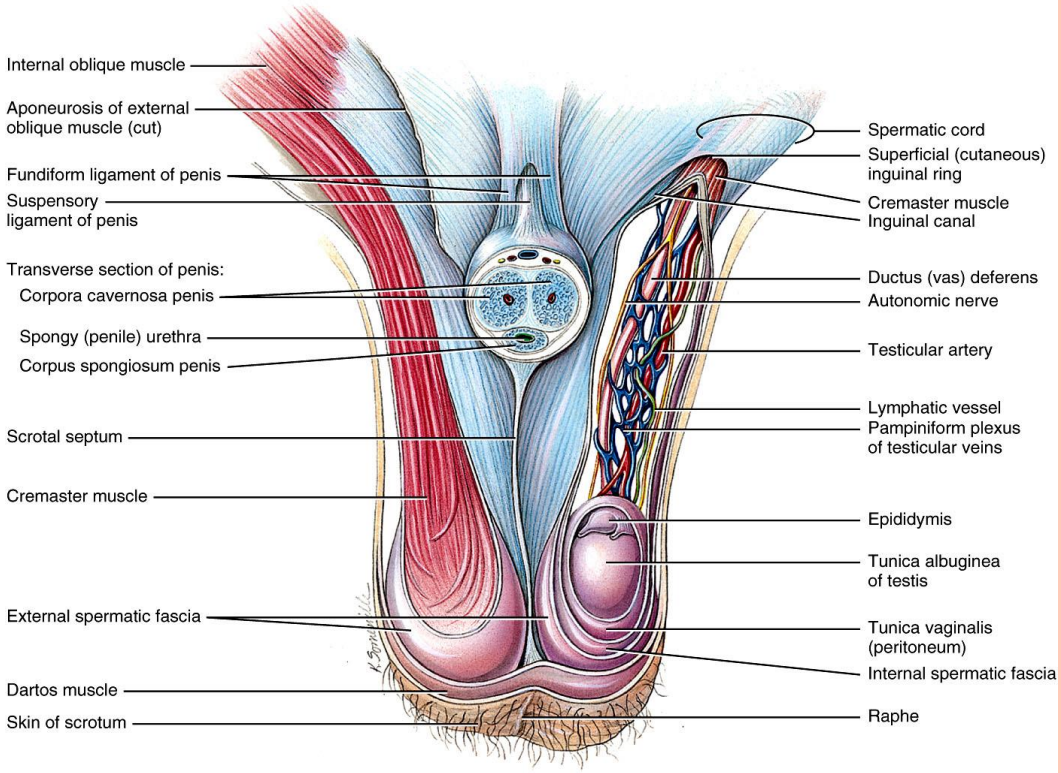


Cryptorchidism

- Failure of one or both testes to descend into the scrotum
  - Unilateral: one testis does not descend
    - testis that descends is fertile; reduced sperm concentrations
  - Bilateral- neither testes descend into scrotum
    - Results in sterility due to elevated temperature of both testes

Scrotum

- Sac of skin and superficial fascia that hangs outside the abdominopelvic cavity at the root of the penis
- Contains paired testicles separated by a midline septum
- Its external positioning keeps the testes 3°C lower than core body temperature

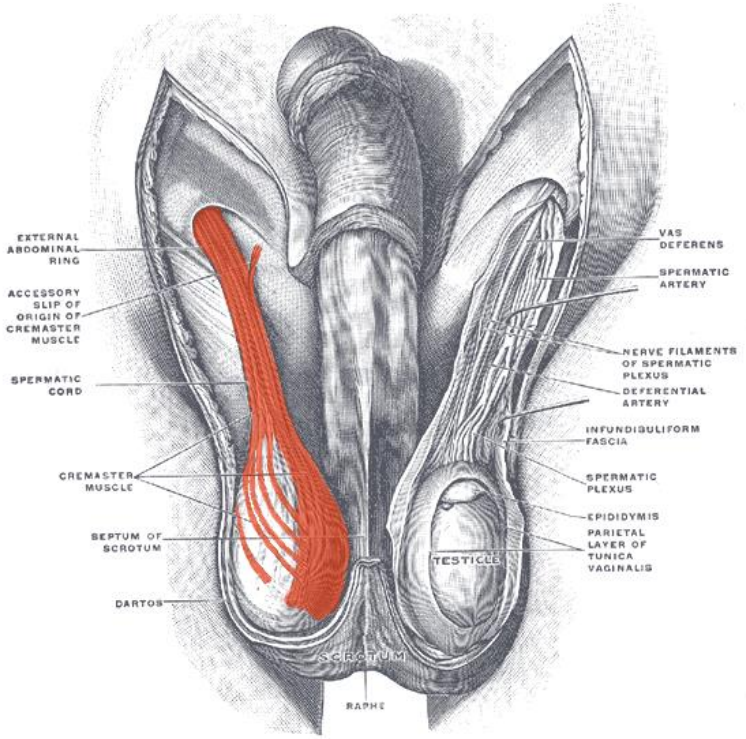


Anterior view of scrotum and testes and transverse section of penis

Figure 28.02 Tortora - PAP 12/e

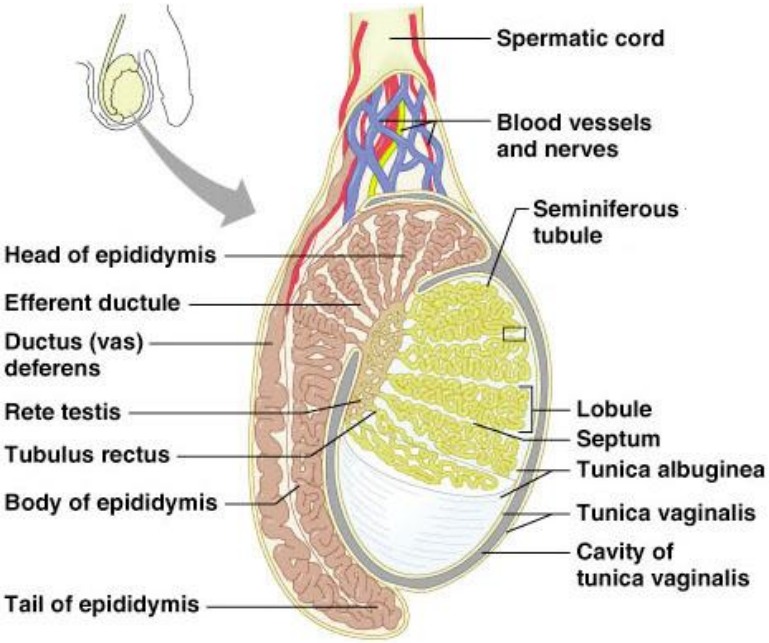
Wall of the Scrotum

- In the dermis, there is a thin layer of smooth muscle known as the **dartos muscle**. Contractions of this muscle causes wrinkling of the skin.
- The **cremaster muscle** is a thicker layer of skeletal muscle that lowers and raises the testes based on temperature.

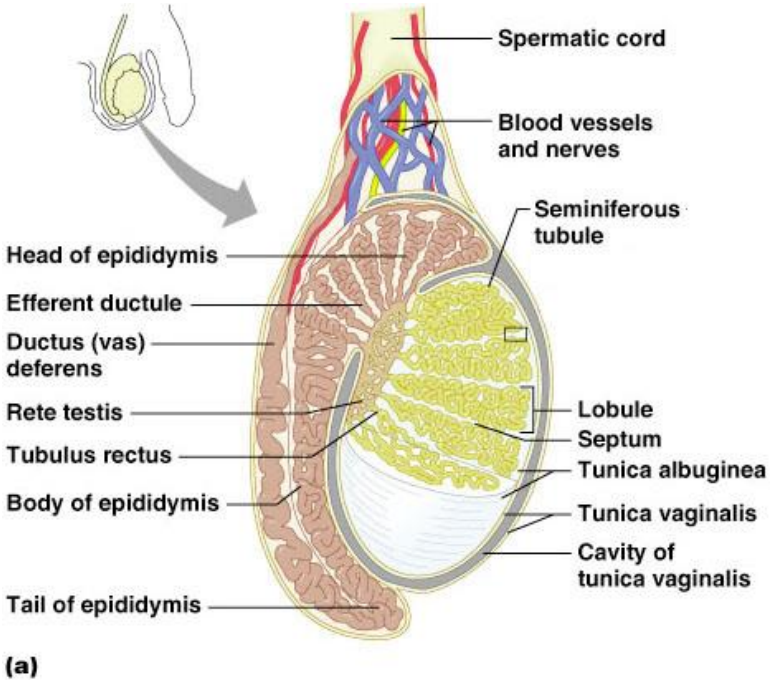


Inside the Scrotum

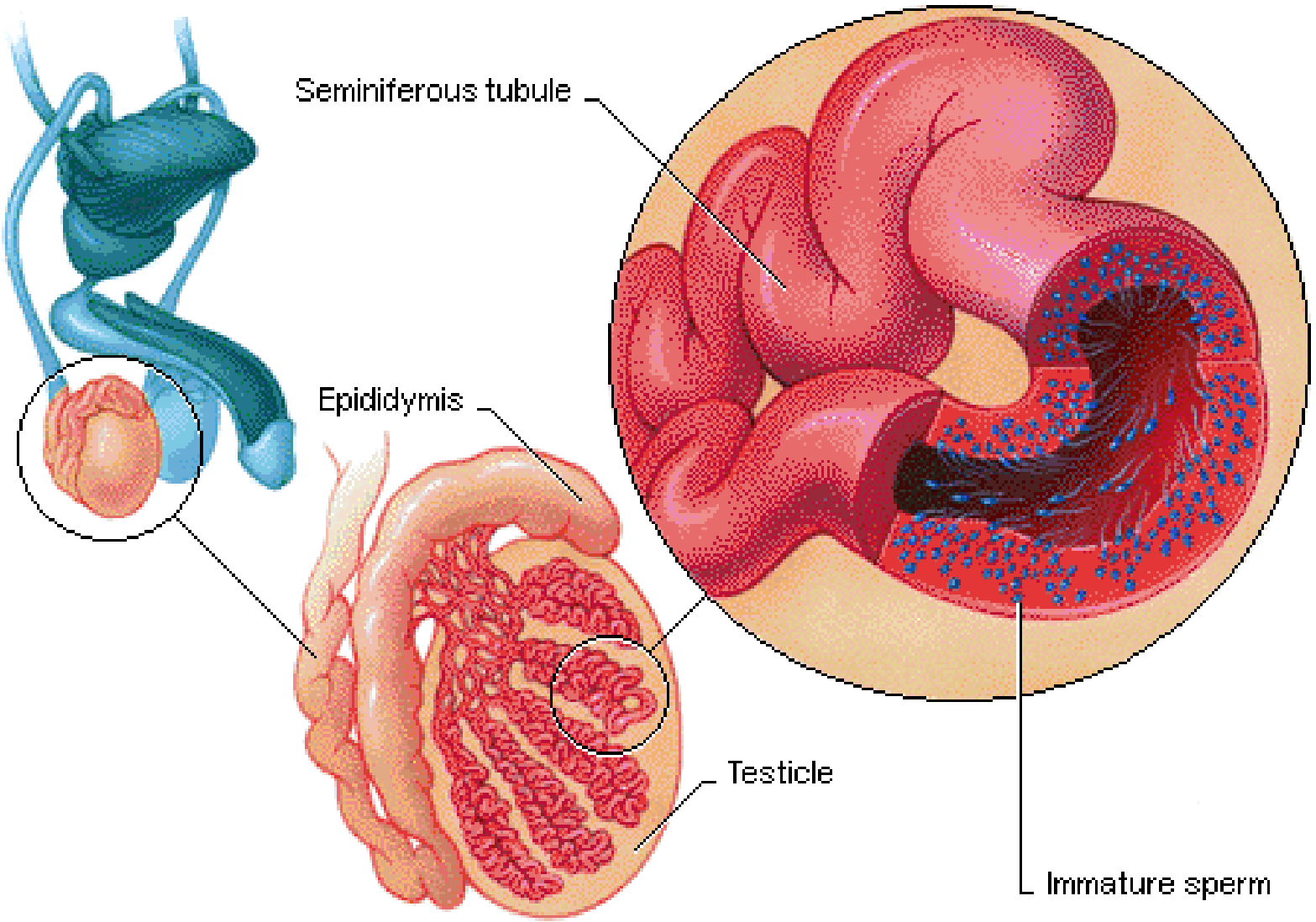
- Each testes is enclosed by the **tunica vaginalis**, a continuation of the peritoneum that lines the abdominopelvic cavity.
- A fibrous capsule covers each testis called the **tunica albuginea.**



Testicle



- The tunica albuginea gives rise to septa (partitions) that divide the testis into lobules (about 250) in human
- Each lobule contains 3 or 4 highly coiled **seminiferous tubules**
- These converge to become **rete testis** which transport sperm to the **epididymis**

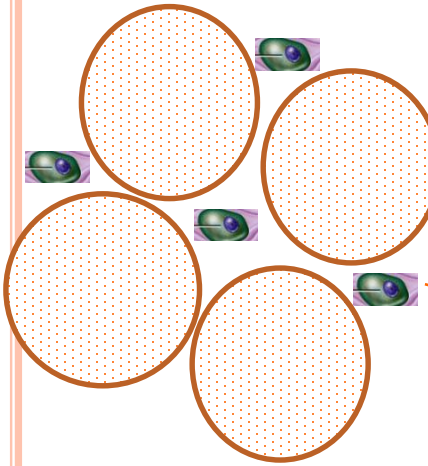

Seminiferous tubule
Epididymis
Testicle
Immature sperm

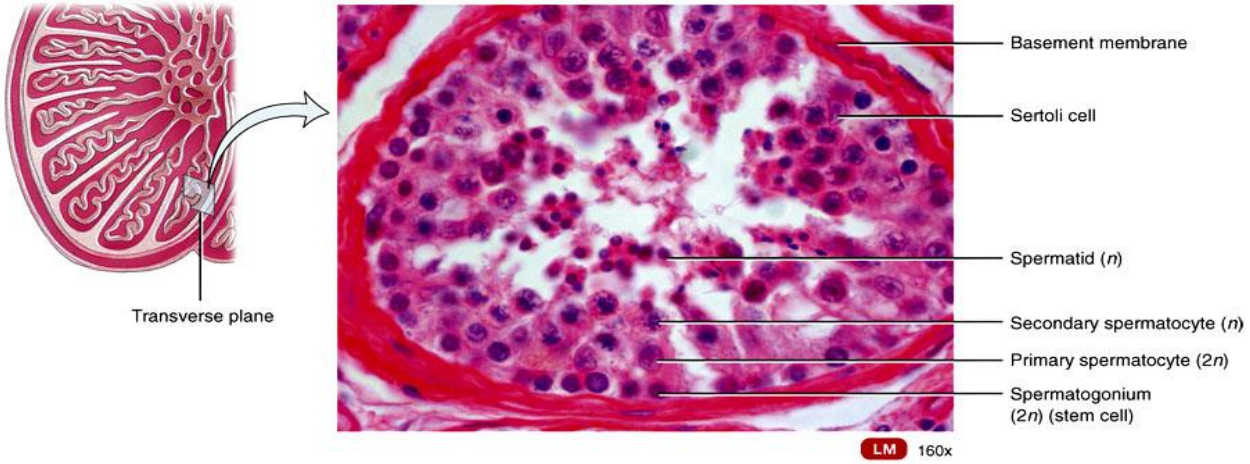
Seminferous tubule cells

- Spermatogenic cells – sperm-forming cells
  - Spermatagonia (stem cell) develop from primordial germ cells that arise in yolk sac and enter testes in 5th week of development
  - Primary spermatocytes → secondary spermatocytes → spermatids → sperm cells → lumen
- Sertoli cells or sustenacular cells– support cells
  - Tight junction form blood-testis barrier – prevents immune response against sperm cell surface antigens
  - Nourish spermatocytes, spermatids and sperm, phagocytize excess spermatid cytoplasm, control movements of spermatogenic cells, release sperm into lumen, produce fluid for sperm transport, secrete inhibin, regulate effects of testosterone and follicle-stimulating hormone (FSH)

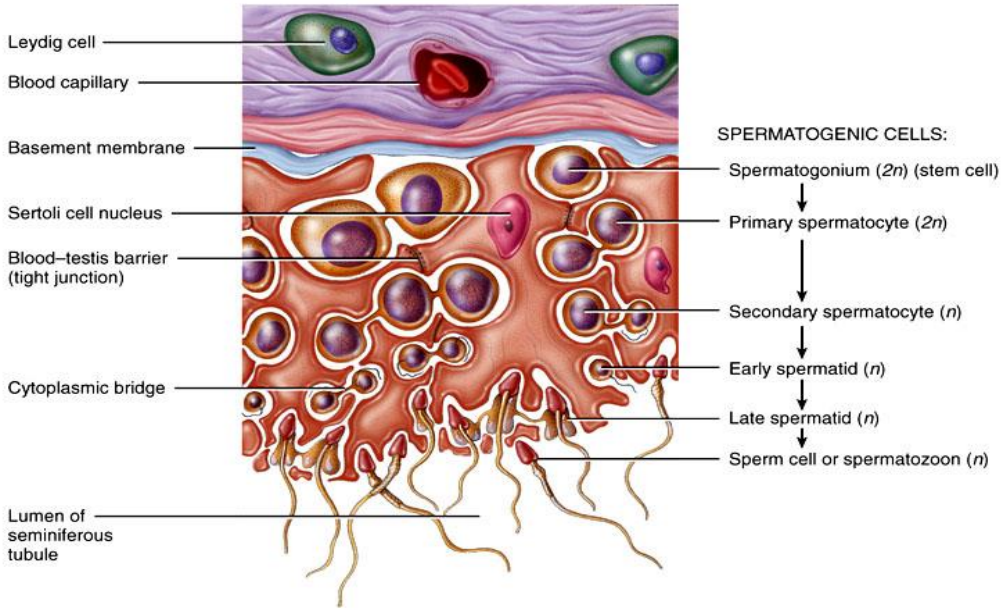
- Leydig (interstitial) cells found in spaces between seminiferous tubules
  - **Secrete testosterone**

Seminiferous tubules and stages of sperm production





(a) Transverse section of several seminiferous tubules

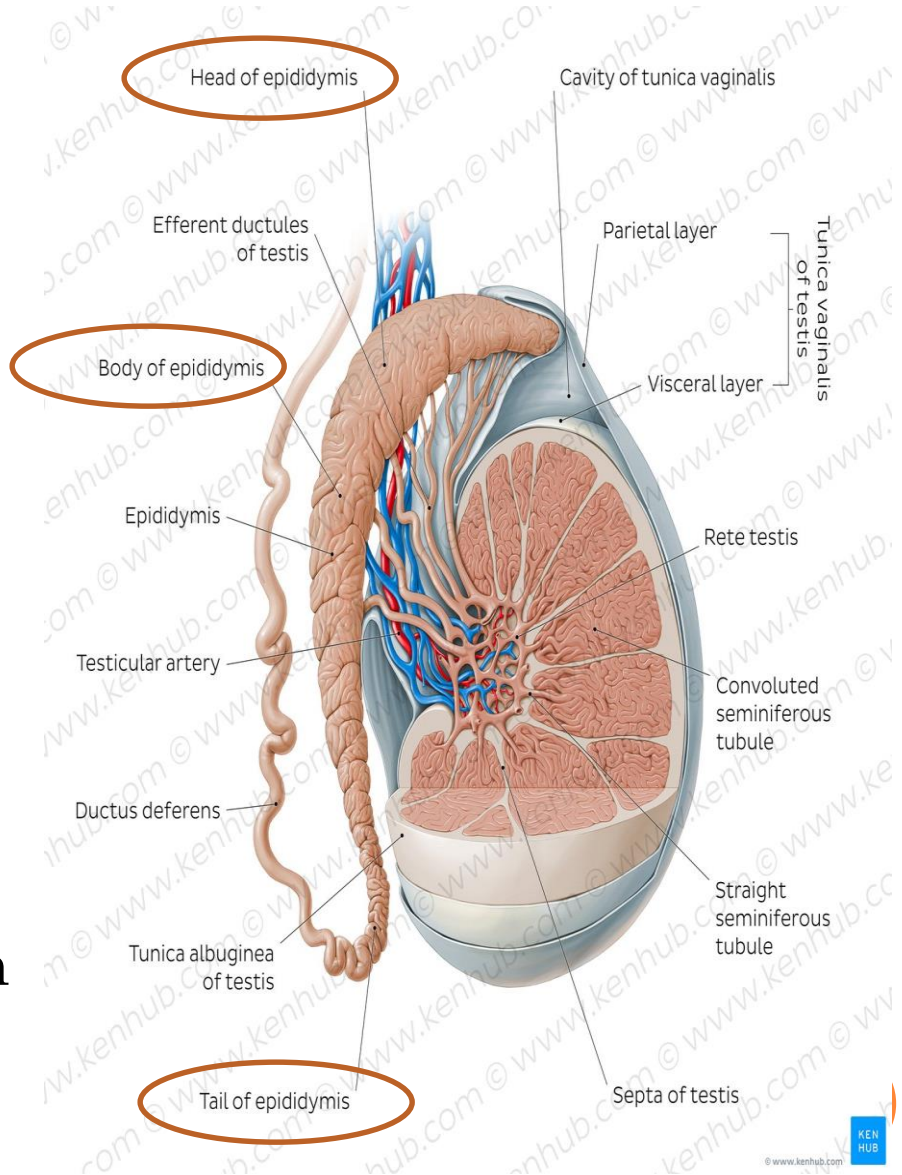


(b) Transverse section of a portion of a seminiferous tubule

Figure 28.04 Tortora - PAP 12/e

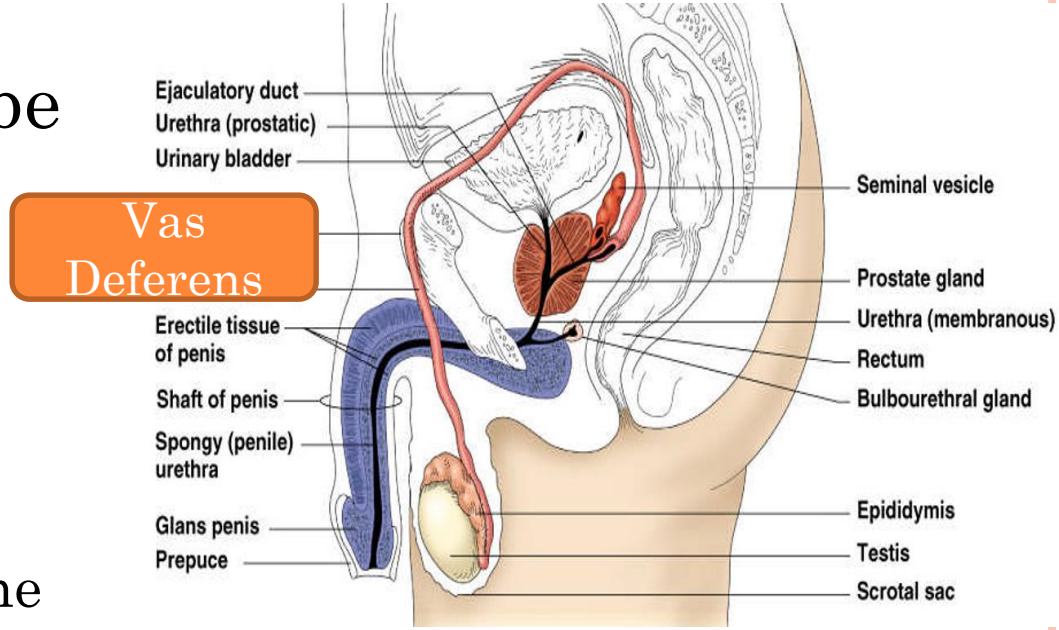
Epididymis

- Epididymis: long coiled tube (6-7 meters) that is a path for sperm
  - Sperm entering the caput epididymis are incomplete—they lack the ability to swim forward (motility) and to fertilize an egg.
  - Functions to mature and store sperm cells (at least 20 days)
  - Fluid secretion to nourish sperm



Vas Deferens

- Vas Deferens – muscular slender tube from epididymis to urethra (45 cm)
  - Moves sperm to the urethra at ejaculation
  - **Vasectomy** – cutting of the ductus deferens at the level of the testes to prevent transportation of sperm. (for male sterilization or permanent contraception)

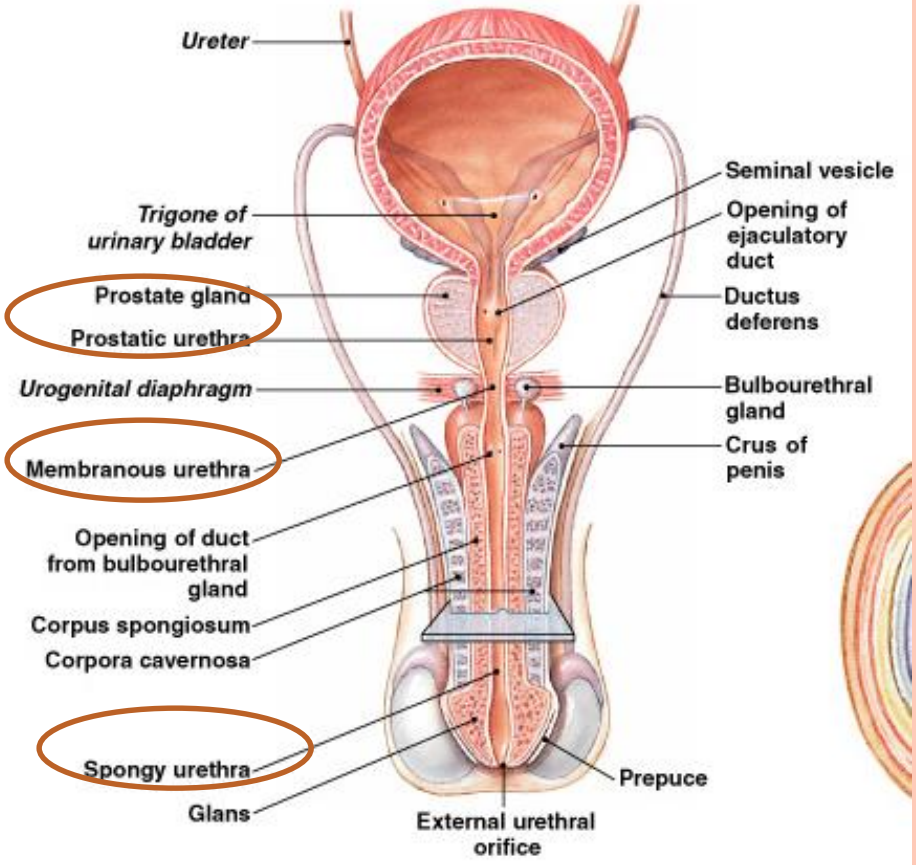


URETHRA

Urethra - long tube from bladder to penis

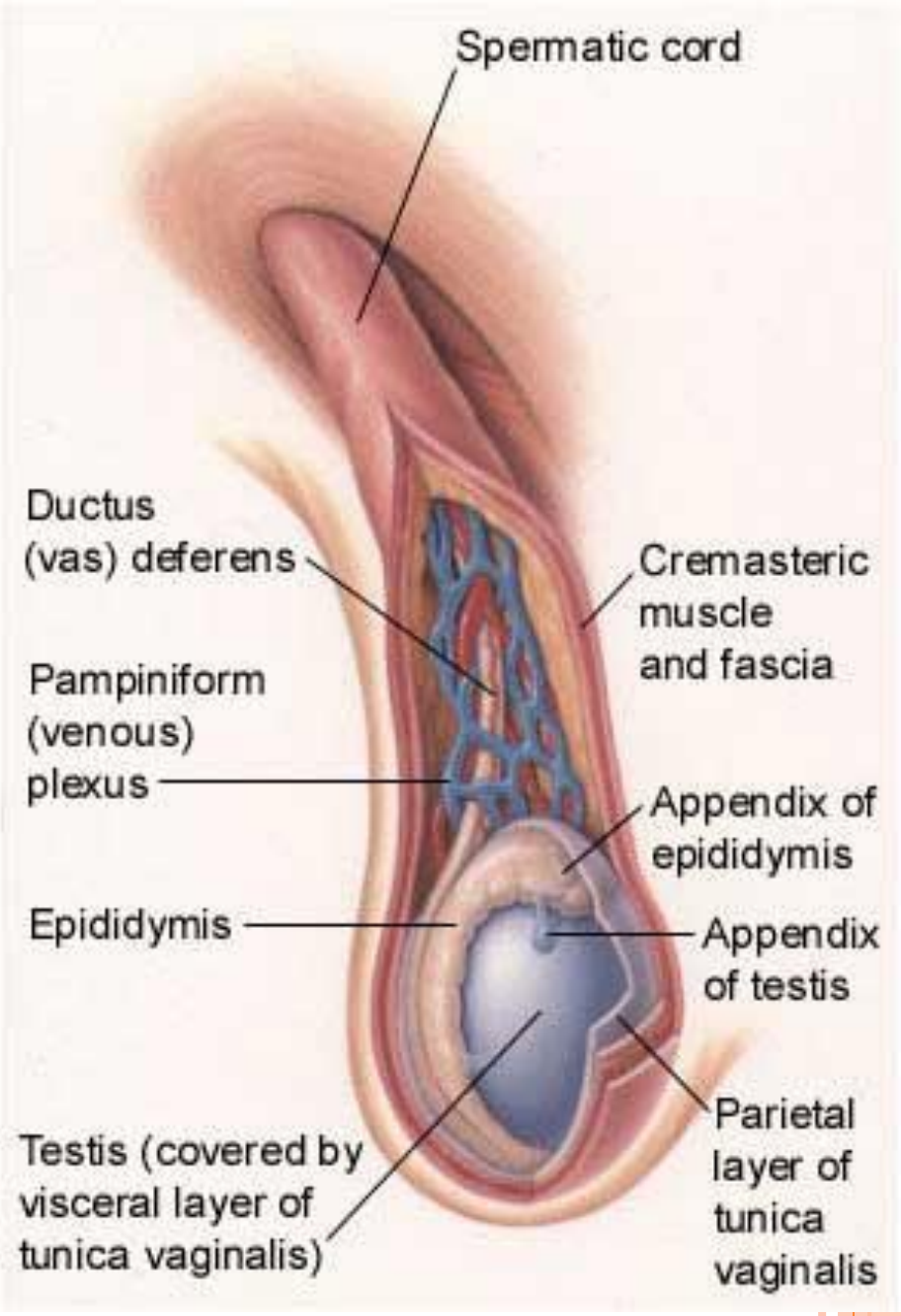
(Passageway for urine and sperm out of the body)

- Regions of the urethra
  - Prostatic urethra –surrounded by prostate
  - Membranous urethra – from prostatic urethra to penis
  - Spongy (penile) urethra – runs the length of the penis



Spermatic Cord

- Contains the structures running from the testicles to the pelvic cavity.
  - Passes through the inguinal canal
- Contents:
  - Vas Deferens
  - Nerves
  - Blood Vessels

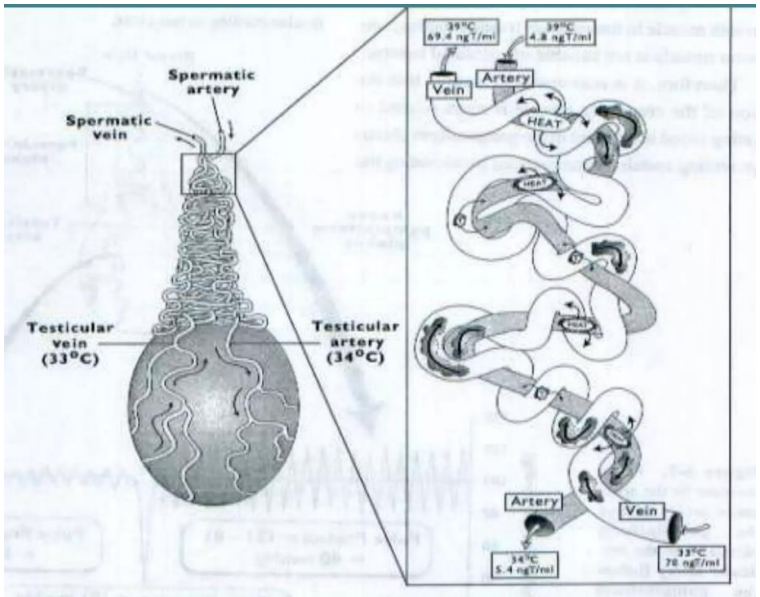


Counter-current heat-exchange system

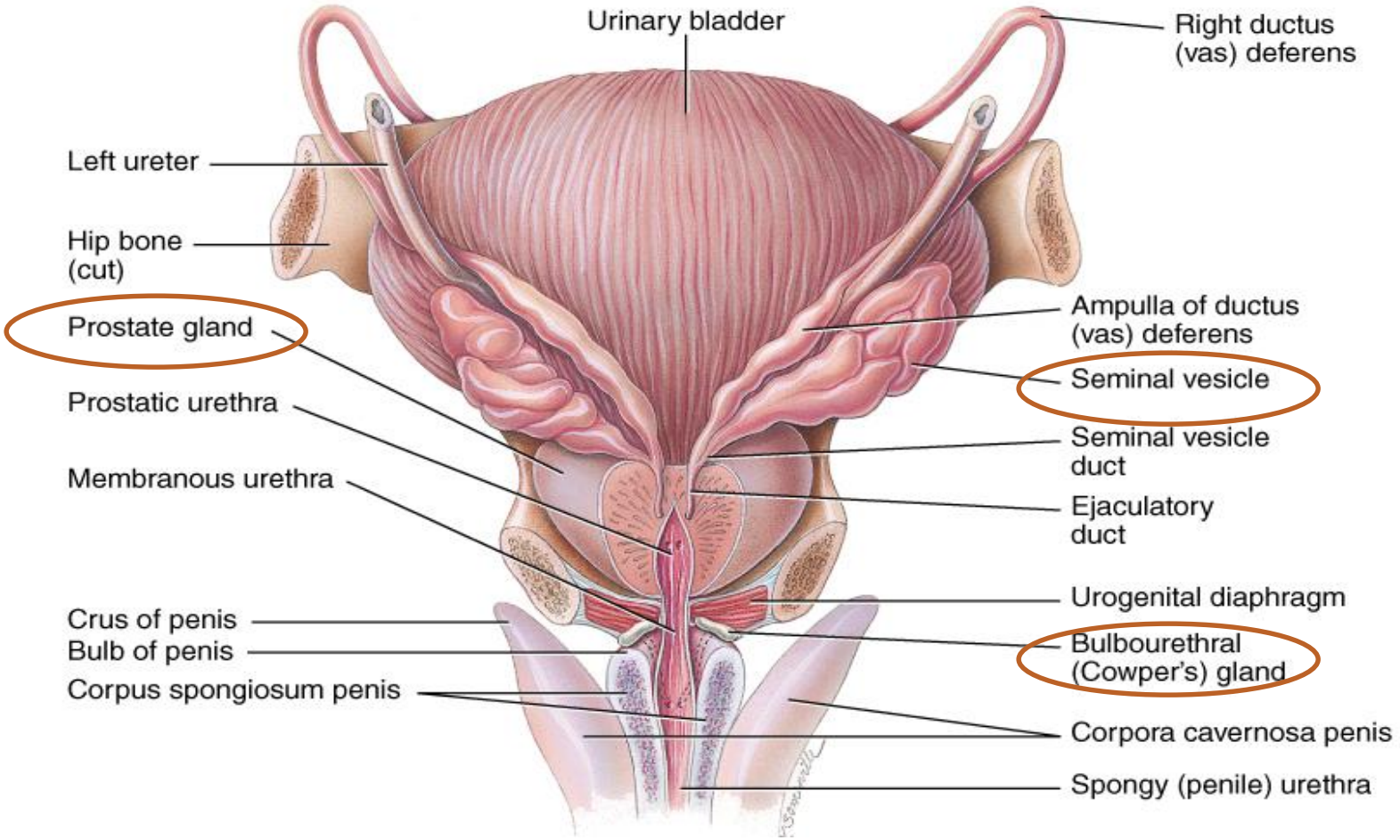
Counter - current system

- The pampiniform plexus is a vascular structure consisting of an intimately tangled artery and vein and this structure is important for proper temperature control of the testis and it is wrapped around the spermatic cord
- Testicular artery that takes blood to the testes from abdominal aorta descents from the pampiniform plexus of veins the return blood from testes.
- Heat exchange b/w the artery and the veins via this arrangement also help in scrotal temperature

- **Because of the counter current the testes receives cooler blood compared to other part of the body**
- **Blood returning from the testis has lost heat to the environment and this it is cooler than artery blood.**
- **When the artery blood enters the pampiniform tissue it loses its heat to the cooler blood and cooled blood travel around the testis and veins**
- **This mechanism is effective only it loses its heat by the radiation, convection and evaporation to the environment**



Accessory Glands:



Accessory Glands:

1- Seminal Vesicles

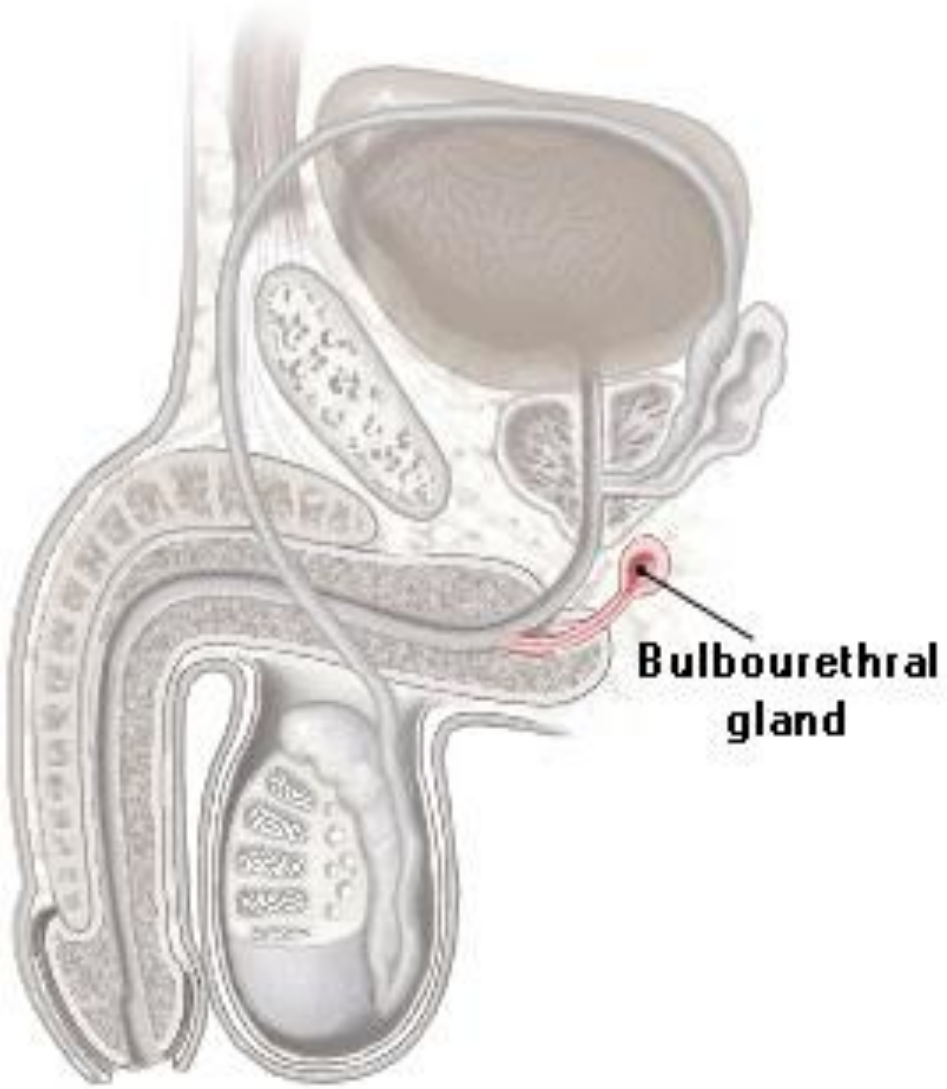
- Lie on the posterior wall of the bladder and **secrete 60% of the volume of semen**
  - Seminal fluid:
    - Fructose: provides energy for the sperm.
    - Fibrinogen: helps turn semen into a bolus that can be readily propelled into the vagina.
    - Prostaglandins: decrease cervical mucus viscosity and stimulate reverse peristalsis of the uterus.
- Join the ductus deferens to form the ejaculatory duct

2- Prostate Gland

- Gland that encircles part of the urethra inferior to the bladder
- About 25% of semen volume (Secretes a milky fluid)
- Plays a role in the activation of sperm
- Enters the prostatic urethra during ejaculation
- Prostatic secretions include:
  - Citrate: is a food source (TCA cycle)
  - Proteolytic enzymes: acts to "decoagulate" the semen that was coagulated by seminal vesicle secretions, which helps the sperm begin their journey once inside the vagina

3- Bulbourethral Glands (Cowper's Glands)

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



Accessory Glands:

Seminal Fluid Components, Function and Location

Mucus	Lubricant	Bulbourethral glands
Water	Provides liquid medium	All accessory glands
Buffers	Neutralize acidic environment of the vagina	Prostate, bulbo-urethral glands
Nutrients	Nourish sperm	
Fructose		Seminal vesicles
Citric acid		Prostate
Vitamin C		Seminal vesicles
Carnitine		Epididymis
Enzymes	Clot semen in vagina, then liquefy the clot	Seminal vesicles and prostate
Zinc	Unknown; possible association with fertility	Unknown
Prostaglandins	Smooth muscle contraction; may aid sperm transport	Seminal vesicles

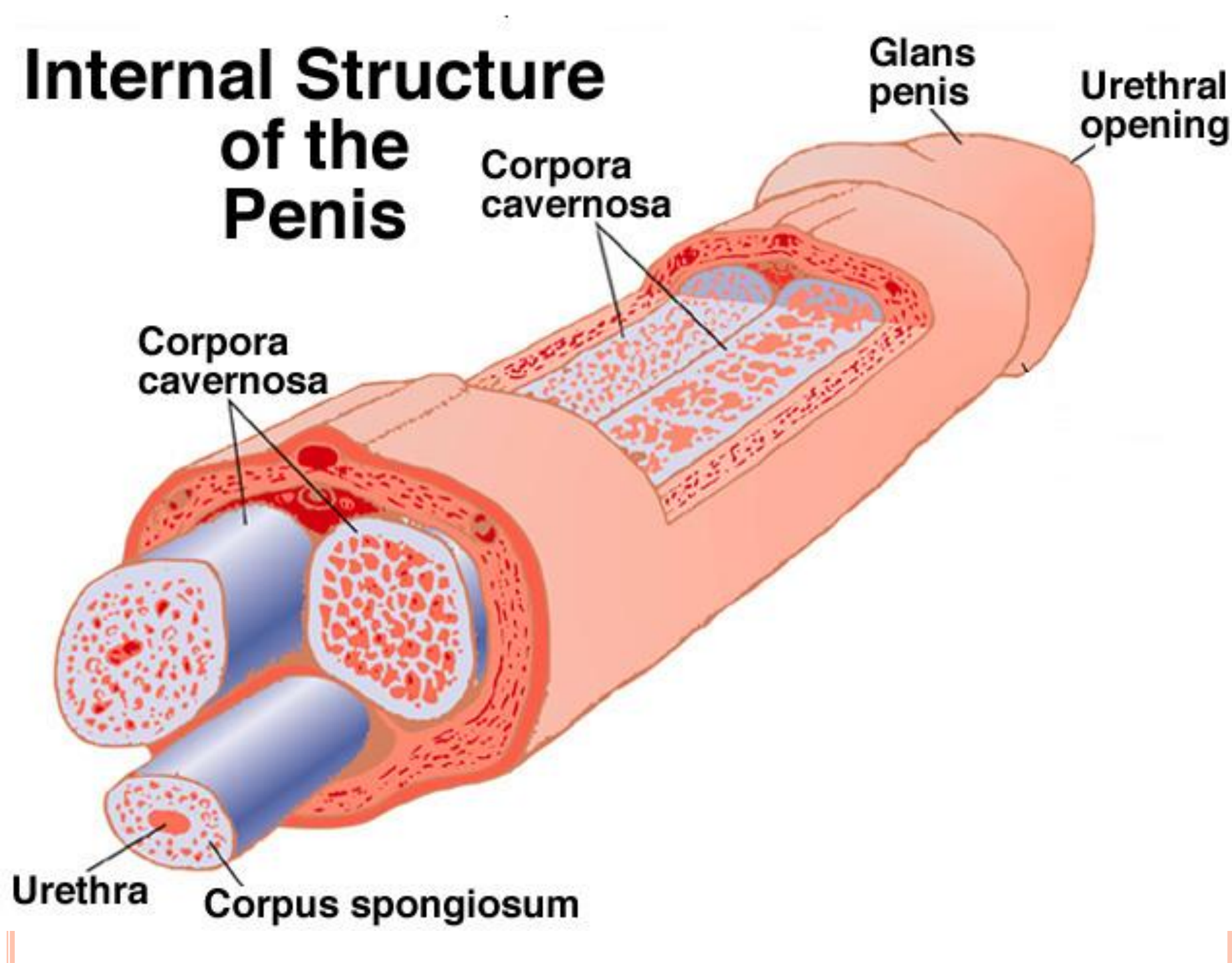
The Penis

- Nerves, blood vessels, fibrous tissue, and three parallel cylinders of spongy tissue.
- There is no bone and little muscular tissue (although there are muscles at the base of the penis)
- Terms:
  - Root, shaft, glans, cavernous bodies, spongy body, foreskin (defined on next slide)

The Penis

- **Penis**: consists of internal root, external shaft, & glans.
- **Root**: the portion of the penis that extends internally into the pelvic cavity.
- **Shaft**: the length of the penis between the glans and the body.
- **Glans**: the head of the penis; has many nerve endings.
- **Cavernous bodies**: the structures in the shaft of the penis that engorge with blood during sexual arousal.
- **Spongy body**: a cylinder that forms a bulb at the base of the penis, extends up into the penile shaft, and forms the penile glans. Also engorge with blood during arousal.
- **Foreskin**: a covering of skin over the penile glans (Circumcision).

Internal Structure of the Penis



Internal structure of the penis: top view

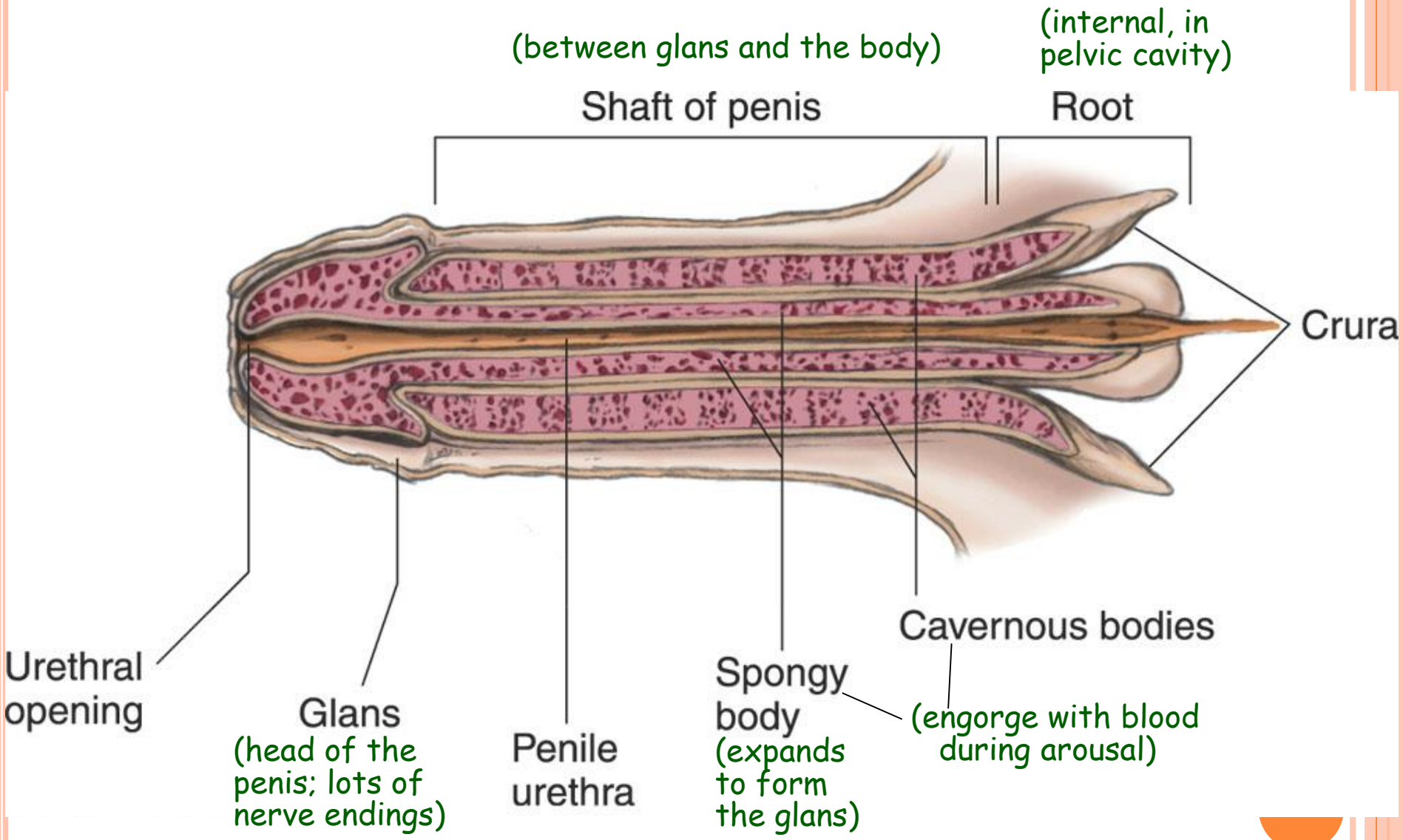


Fig 5.1a Interior structure of the penis: (a) view from above.

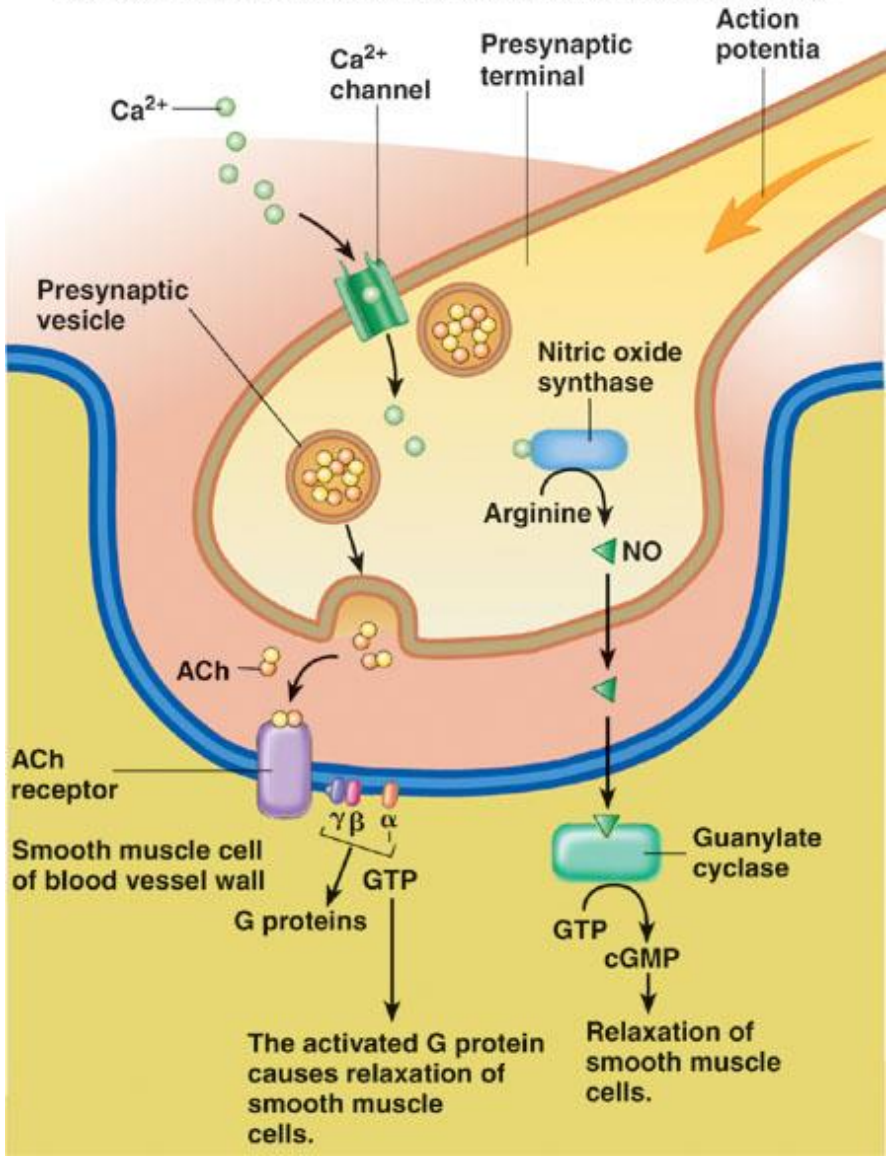
Male sexual function: Erection

- Brain sends message that causes relaxation of the arteries that supply blood to the cavernous and spongy bodies in the penis.
- Veins that drain blood away from cavernous and spongy bodies can't keep up with blood inflow, producing an erection.
- Erection is maintained by pressure of spongy and cavernous bodies against the skin, partially closing off the veins.
- Involves both psychological and physiological factors

Mechanism Of Erection:

- An **erection** is a physiological phenomenon in which the penis becomes firmer, engorged and enlarged.
- erection is triggered by
  - the parasympathetic division of the autonomic nervous system (ANS),
  - causing nitric oxide (a vasodilator) levels to rise in the trabecular arteries and smooth muscle of the penis.
  - The arteries dilate causing the penis to fill with blood; simultaneously the ischiocavernosus and bulbospongiosus muscles compress the veins of the corpora cavernosa
  - restricting the egress and circulation of this blood. Erection subsides when parasympathetic activity reduces to baseline.

Neural Control of Erection



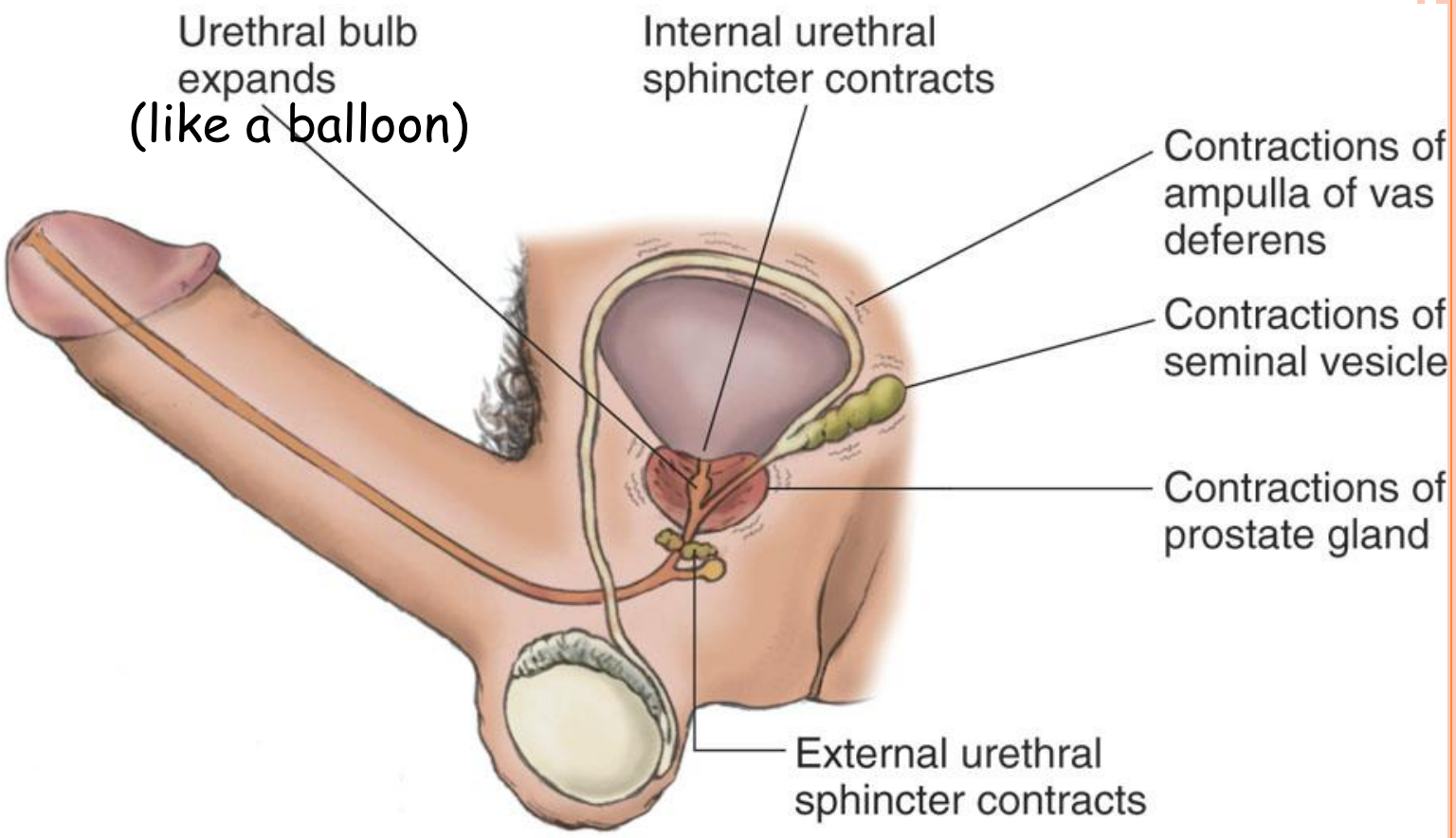
Ejaculation

- **Ejaculation**: the process by which semen is expelled through the penis outside the body.
- Ejaculation is a separate process from orgasm, and the two may not always occur simultaneously.
  - It is possible for men to experience multiple orgasms w/o ejaculation.
- 2 phases (see next slides for details):

1) Emission phase: semen collects in the urethral bulb
   - This stage is usually sensed by the man as the "point of no return"
2) Expulsion phase: semen is expelled

Emission phase of ejaculation (phase 1)

- Contractions in the prostate, seminal vesicles, and vas deferens force secretions into urethral bulb.
- Both the internal and external urethral sphincters close, trapping semen in the urethral bulb



Expulsion phase of ejaculation (phase 2)

- Collected semen is expelled out of the body by rhythmic contractions of muscles surrounding the urethral bulb and also on the urethra.
- External urethral sphincter relaxes to allow semen out; internal urethral sphincter stays contracted to prevent the escape of urine.