

Physiology of Androgens & Control of Male Sexual Functions

Reproduction Block

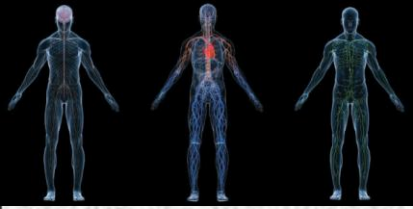
Physiology Lecture # 5

**(Physiology of Androgens & Control
of Male Sexual Functions)**

Department of Physiology

College of Medicine

King Saud University



Male Reproductive System

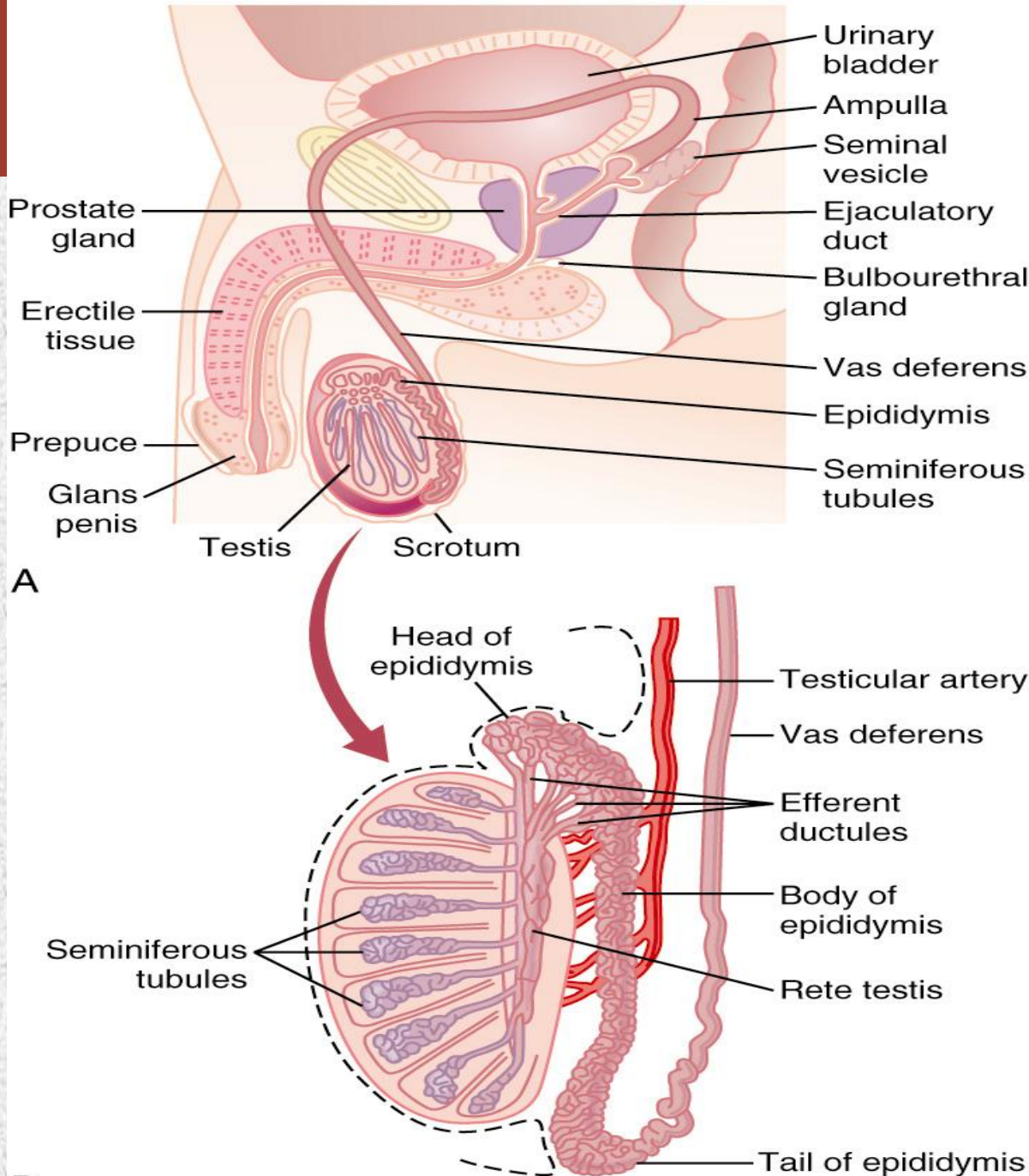
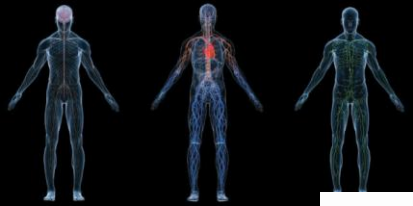
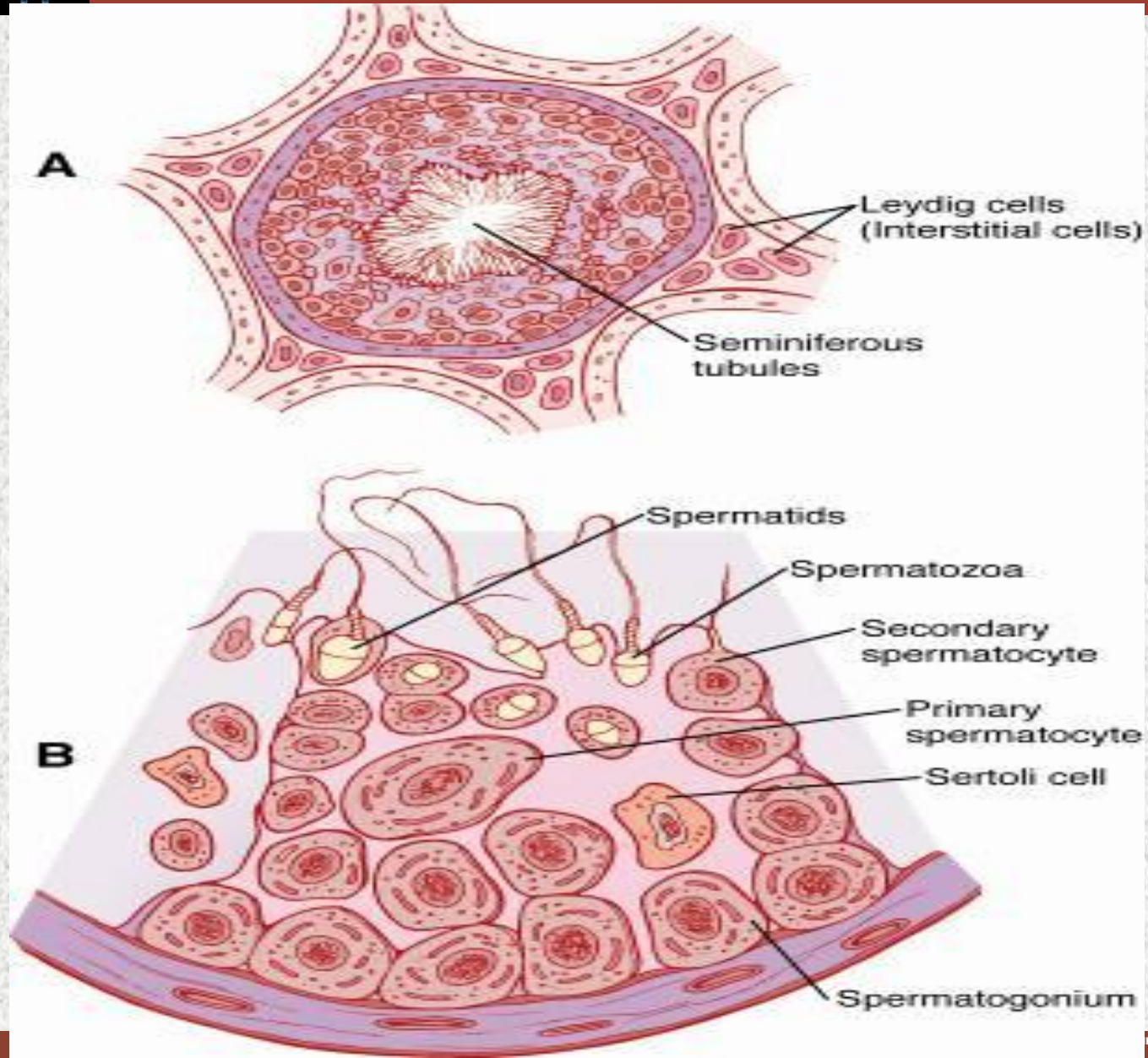


Figure 80-1

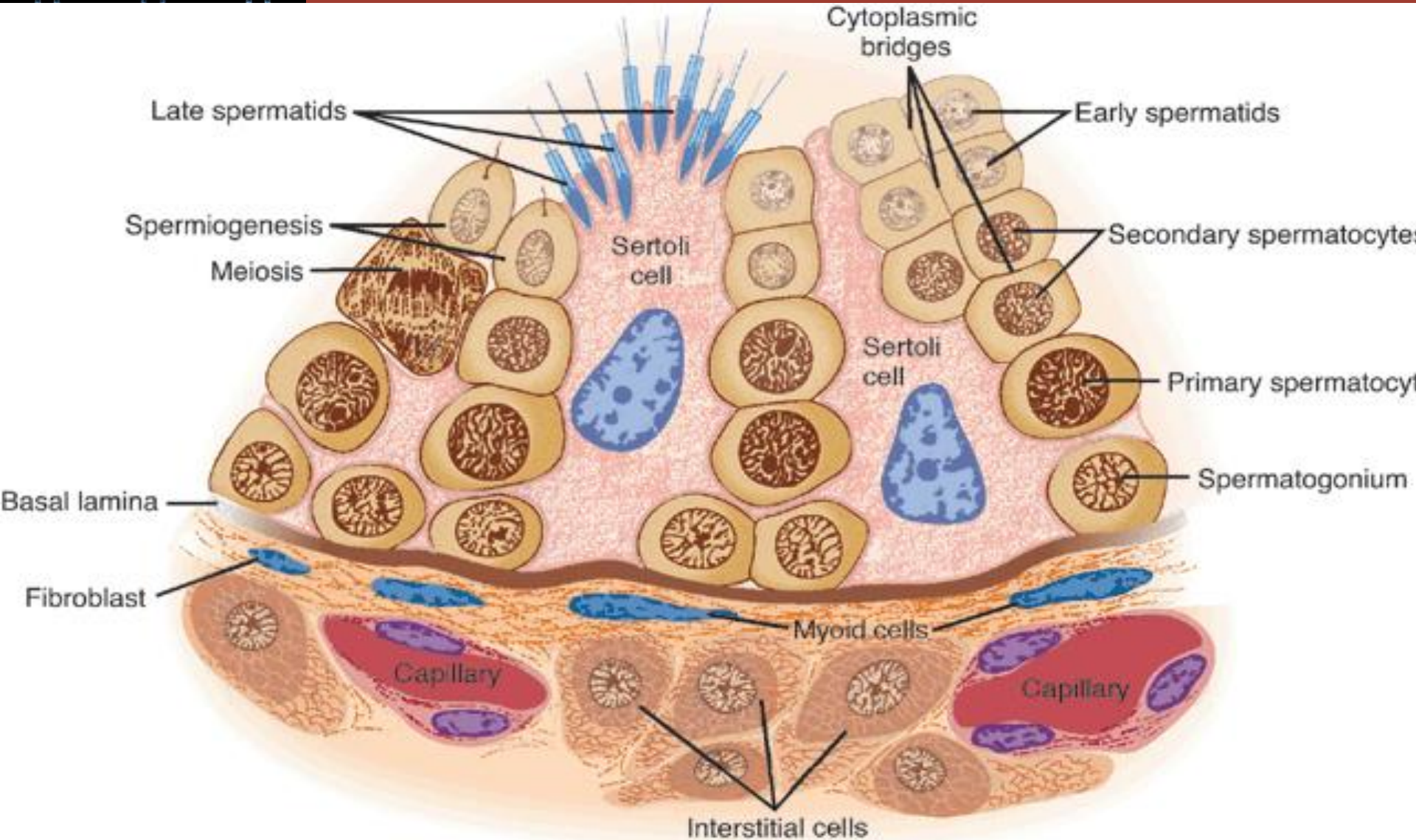


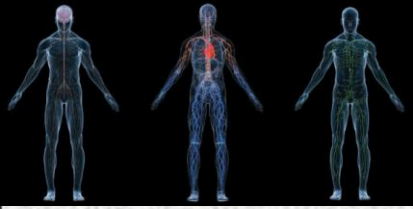
Cross Section of a seminiferous tubule





Seminiferous epithelium

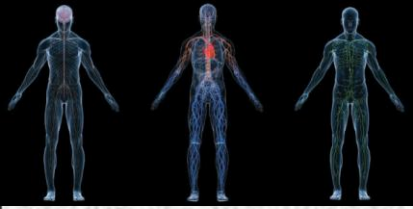




Spermatogenesis

Spermatogenesis:

- Formation of sperm, it occurs in the seminiferous tubules during active sexual life, begins at age of 13 years, continues throughout life & decreases in old age.
- After formation in the seminiferous tubules, the sperm require several days to pass through the epididymis (still non-motile).
- After the sperm have been in the epididymis for some 18 to 24 hours, they develop the capability of motility (some inhibitory proteins in the epididymal fluid prevent final motility until after ejaculation).

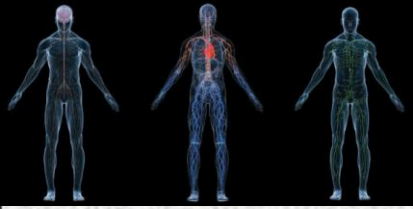


Spermatogenesis, cont.

Storage of sperm:

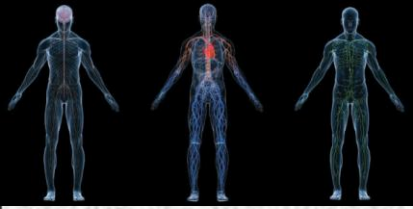
The 2 testis of adult human form up to 120 million sperm each day.

- Small quantity stored in the epididymis
- Most stored in the vas deferens, maintaining their fertility for at least a month. The sperm are kept inactive state by multiple inhibitory substances in the secretion of the ducts.



Physiology of mature sperm:

Mature sperm are motile & capable of fertilizing the ovum & their activity is enhanced in a neutral & slightly alkaline medium & depressed in mildly acidic medium. The life expectancy of ejaculated sperm in the female genital tract is only 1 to 2 days.



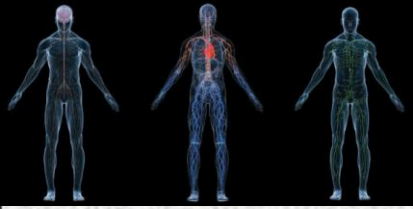
Morphology of sperm

head, neck, body, tail

Acrosome: cap at top of sperm head, contains hyaluronidase and proteolytic enzymes, important in penetration into ovum

Mitochondria -- arranged around body

Tail – flagellum -- outgrowth of centriole -- two microtubules in center, nine around the outside



Structure of the Human Spermatozoon

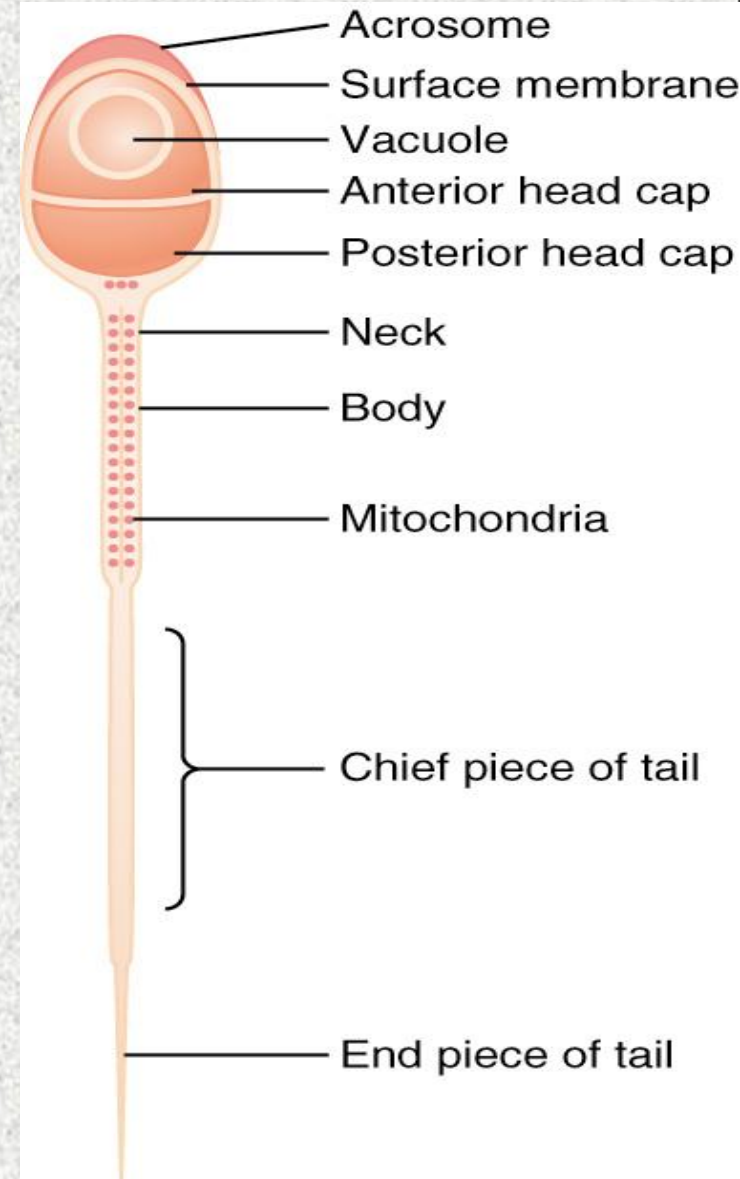
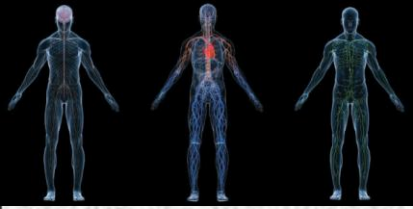


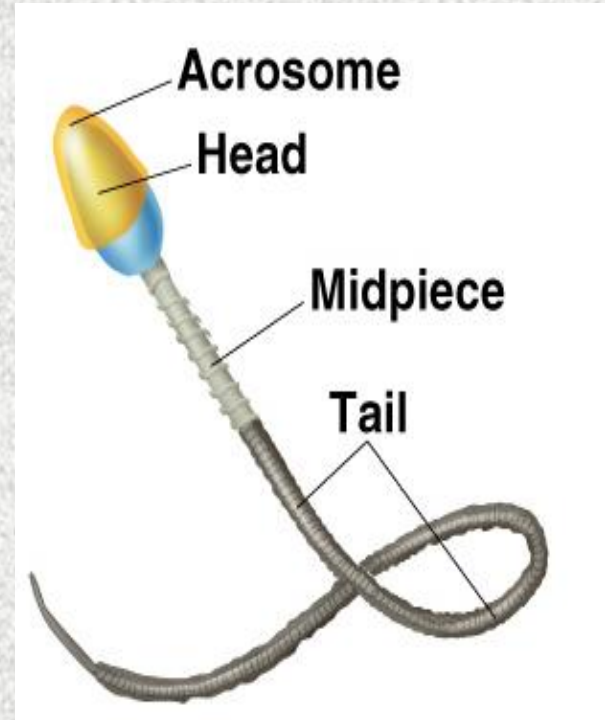
Figure 80-4

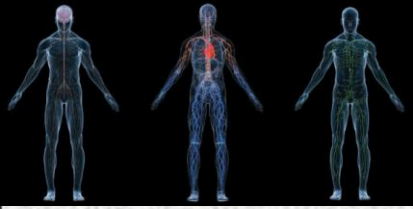


Hormonal Control of Spermatogenesis

- Formation of primary spermatocytes begin during embryonic development.
 - Spermatogenesis arrested until puberty.
- LH & Testosterone.
- Paracrine regulators:
 - GH & IGF-1.
 - Inhibin.
 - Transforming growth factor.
 - Estrogen
- FSH necessary in the later stages of spermatid maturation.

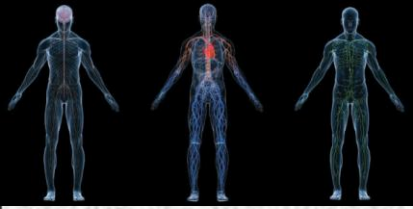
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Functions of Sertoli cells:

- 1) Tight junctions between Sertoli cells form blood-testes barrier which maintains critical composition of tubular fluid for sperm maturation & prevents autoimmune destruction of sperm.
- 2) Secrete fluid for carrying sperm into the epididymis.
- 3) Provide nutrients for maturing sperm.
- 4) Secrete ABP (androgen-binding protein) that functions to maintain high levels of androgens in the tubular fluid.
- 5) Contain aromatase which converts androgens to estrogens.
- 6) Secrete MIS & inhibin.
- 7) Phagocytosis of residual bodies

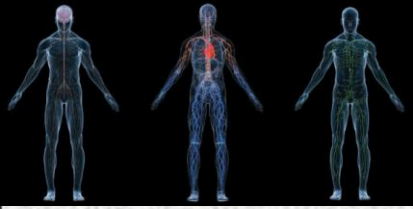


Function of the seminal vesicles:

- secrete mucoid material containing fructose, citric acid & nutrient substances & large quantities of prostaglandins & fibrinogen.

The prostaglandins aid fertilization:

- 1- by reacting with the female cervical mucus making it more receptive to sperm movement.
- 2- by causing backward reverse peristaltic contractions of the uterus & fallopian tubes to move the ejaculated sperm toward the ovaries.

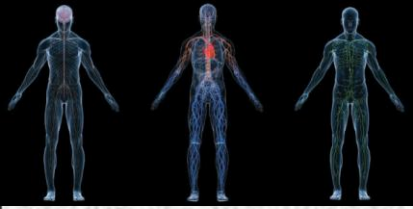


Function of the prostate gland:

- The prostate gland secretes thin milky fluid contains Ca^{2+} ion, citrate ion, phosphate ion, a clotting enzyme & profibrinolysin. The alkaline prostatic fluid is important for successful fertilization of the ovum.

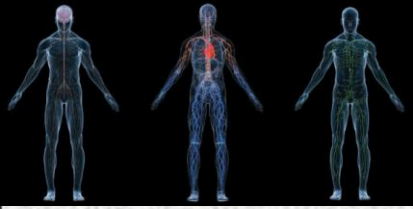
Functions of alkaline prostate fluid :

1. successful fertilization of the ovum by neutralizing the slightly acidic fluid of the vas deferens (due to the presence of citric acid and metabolic products of the sperm which inhibits sperm fertility).
3. helps to neutralize the acidity of other seminal fluids during ejaculation & thus enhances motility & fertility of sperm



Semen:

- Ejaculated semen during sexual act is composed of fluid & sperm;
fluid from the vas deferens ($\simeq 10\%$),
+fluid from the prostate gland ($\simeq 30\%$),
+fluid from the seminal vesicles ($\simeq 60\%$),
+ small amounts from the mucous glands the bulbourethral glands.
- The average pH is about 7.5, the alkaline prostatic fluid helps to neutralize the mild acidity of other portions of the semen & gives the semen a milky appearance.
- Fluid from the seminal vesicles & mucous glands gives the semen its mucoid consistency.



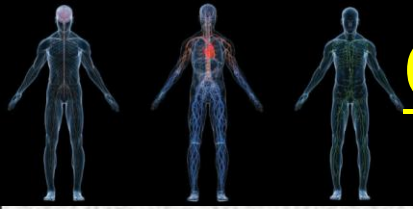
Semen:

Effect of sperm count on fertility:

- The quantity of ejaculated semen during coitus about 3-5 ml, each milliliter contains about 120 million sperm (normal male count vary between 35 million to 200 million sperm). Sperm count below 20 million leads to infertility.

Effect of sperm morphology and motility on fertility:

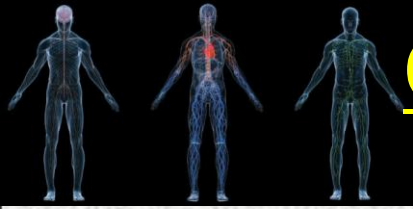
- Sometimes sperm count is normal but still infertile when about one half of the sperm having abnormal shape.
- Sometimes the shape of the sperm is normal but they either relatively non-motile or entirely non-motile which causes infertility.



Capacitation of the spermatozoa:

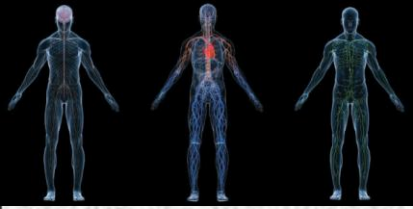
Making it possible for them to penetrate the ovum:

- Sperm in the epididymis is kept inactive by multiple inhibitory factors secreted by the genital duct epithelia & they are activated in female genital tract, for the final processes of fertilization. These activation changes are called capacitation of the spermatozoa (require 1 to 10 hrs).
- Uterine & fallopian fluids wash away the inhibitory factors which suppress the sperm activity in the male genital ducts.



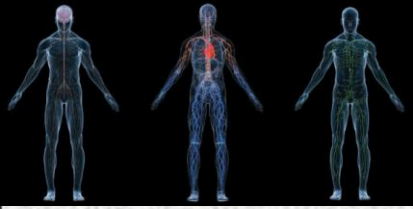
Capacitation of the spermatozoa:, cont.

- While the spermatozoa remain in the fluid of the genital ducts, they are exposed to many floating vesicles from the seminiferous tubules containing large amount of cholesterol. This cholesterol is added to the cellular membrane covering the acrosome making it harder & prevents the release of its enzyme. Gradually, the sperm loses its cholesterol vesicles & this makes the membrane of the sperm's head to become weaker.
- The sperm membrane becomes more permeable to Ca^{2+} ions which increase their movements & help to release the proteolytic enzymes from the acrosome and thus aid in penetrating the ovum.



Acrosome enzymes, the “Acrosome Reaction” and penetration of the ovum:

The acrosome of the sperm stores large quantities of hyaluronidase and proteolytic enzymes. Hyaluronidase depolarizes hyaluronic acid polymers in the intracellular cement that hold the ovarian granulosa cells together. Also the proteolytic enzymes digest the proteins that adhere to ovum.



Male sexual act

Erection: controlled by parasympathetic nervous system

Incr. Parasympathetic and dec. sympathetic activity to penile arterioles = vasodilation of the arterioles and erection

Parasympathetic postganglionic fibers release Ach

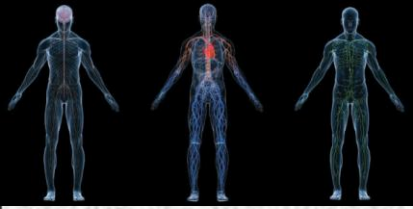
- muscarinic receptors on endothelium --produce NO → arteriolar dilatation

- veins are compressed causing reduction in venous return

- pressure in corpus cavernosum higher than blood pressure

- NO → PKG → dec Ca^{++} → relaxation

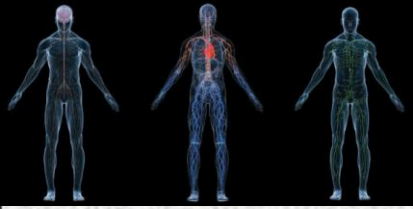
(Protein Kinase G)



Male sexual act, cont.

Lubrication: a parasympathetic function

Emission: movement of ejaculate into proximal part of urethra **under sympathetic control** -- causes sequential peristaltic contraction of smooth muscle of vas deferens -- closing of bladder sphincter

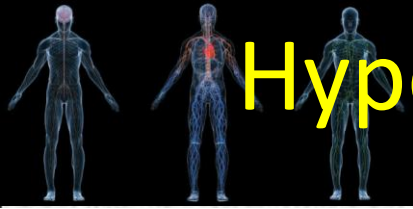


Male sexual act, cont.

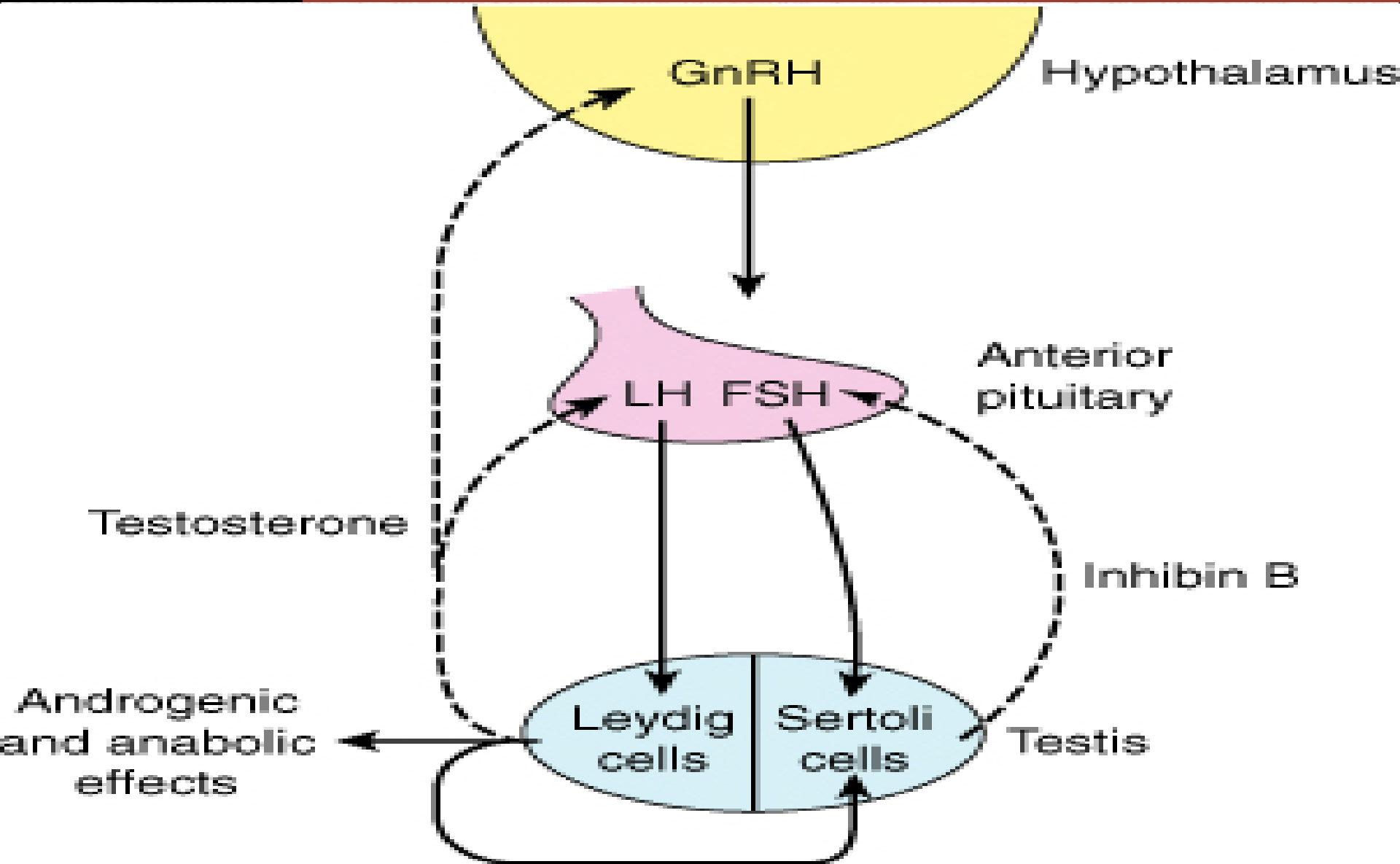
Ejaculation: spinal reflex -- **under sympathetic control** triggered by entry of semen into urethra causes nerve impulses to activate perineal muscles
-- forcibly expel semen from urethra

Orgasm: culmination of sexual excitation

Resolution: Detumescence, termination within 1-2 minutes



Hypothalamic-Pituitary-Testicular Axis





Different Stages of Male Sexual Function: Plasma Testosterone and Sperm Production

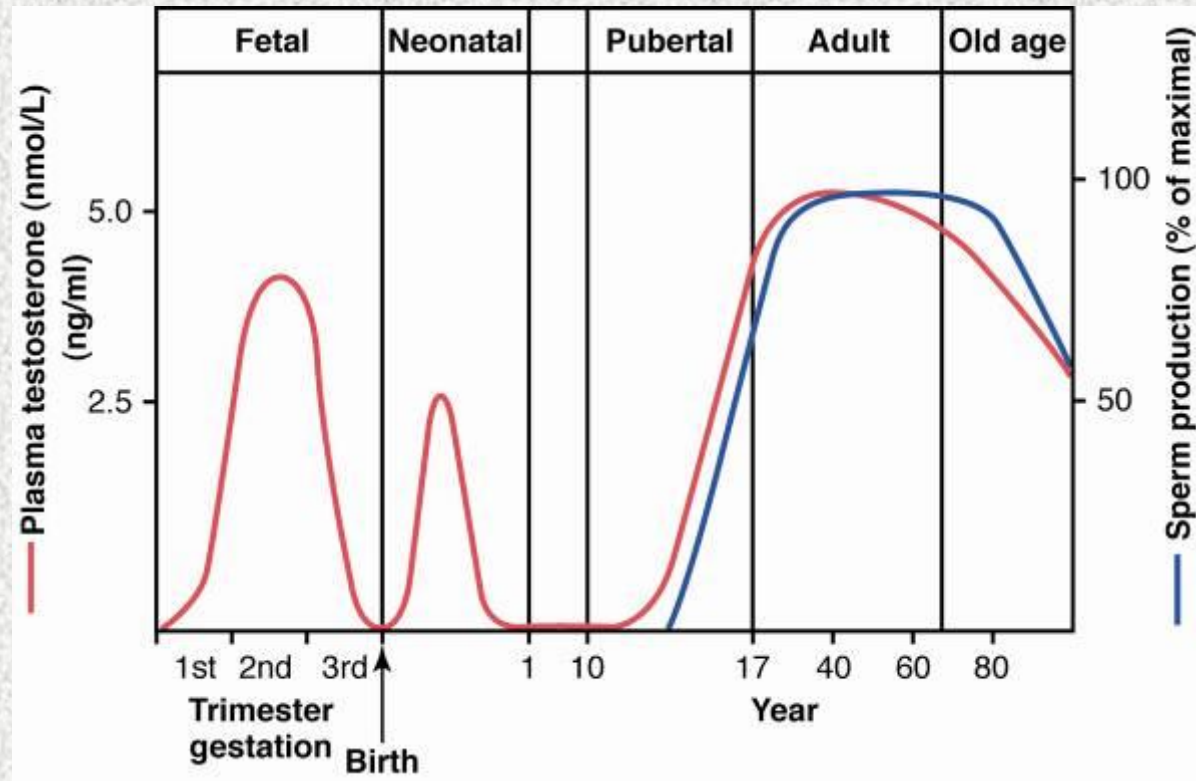
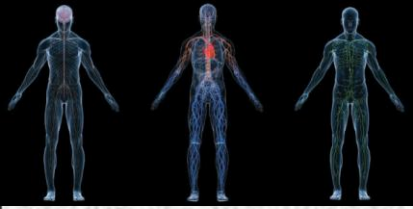


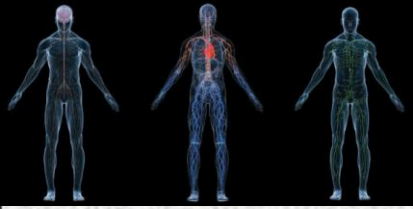
Figure 80-9



Functions of testosterone

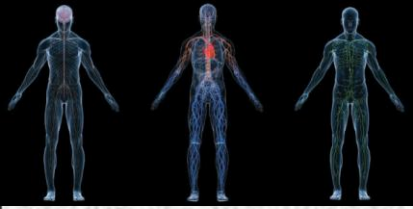
adult primary and secondary characteristics:

- 1) body hair distribution
(pubis, face, chest, back, etc)
- 2) voice: hypertrophy of laryngeal mucosa and larynx
male = low, deep voice
- 3) skin: thickens skin and
increases ruggedness of subcutaneous tissues,
sebaceous glands and oil production
- 4) muscle development



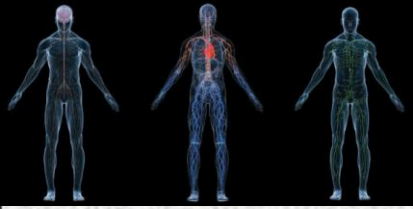
Functions of testosterone

- 5) bone growth and calcium retention: thought to inhibit production of osteoclasts
- 6) red blood cells -- causes increases in erythropoietin -- stimulates RBC production
- 7) Stimulates sodium and water reabsorption in PT of kidney (some effect on distal?)



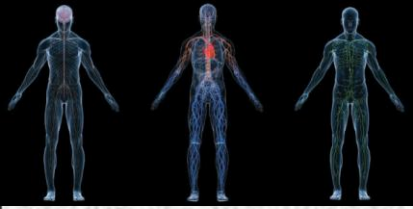
Functions of testosterone

- Development of behavioral aspects characteristic for the “male brain”.
- Development of ♂ 2^o sex characteristics (male sex drive & libido)
- ↑ protein formation & ↑ Ca⁺² deposition



Functions of testosterone

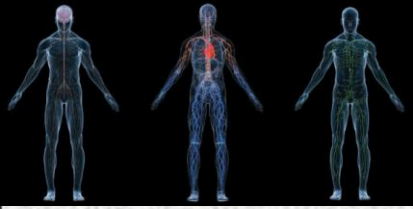
- It has growth promoting effects, however \uparrow testosterone levels lead to a decrease in final height because testosterone causes premature closure of epiphyseal plates.
- Testosterone \rightarrow male pelvis (load-bearing with narrow outlet).
- \uparrow MR by 15% due to its protein anabolism.
- Maintains spermatogenesis (with FSH)



Functions of testosterone

- **fetal development**: present at 2nd month of embryonic life
presence or absence of testosterone determines development of genital organs and characteristics
 - + testosterone = male external genitalia
 - testosterone = female external genitalia
- causes **descent of testes** into scrotum during last 2-3 mos of pregnancy

Failure of testicular descent = cryptorchidism

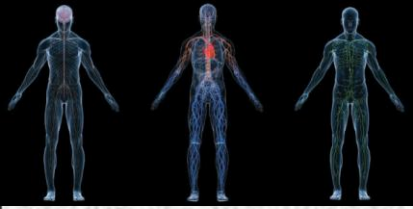


Functions of testosterone

- Fetal development of epididymis, vas deferens, seminal vesicles
- Pubertal growth of penis, seminal vesicles, musculature, skeleton, larynx, spermatogenesis

5 α -reductase

- Testosterone $\rightarrow \rightarrow \rightarrow \rightarrow$ dihydrotestosterone (DHT)



Functions of DHT

- Fetal development of penis, penile urethra, scrotum, prostate
- Pubertal growth of scrotum, prostate, sexual hair, sebaceous glands
- Prostatic secretion
- Development of ♂ 2 sex characteristics:
(facial hair, acne, temporal recession of hair line, baldness, enlargement of prostate & ♂ sex organ)