Physiology of androgen and control of male sexual functions

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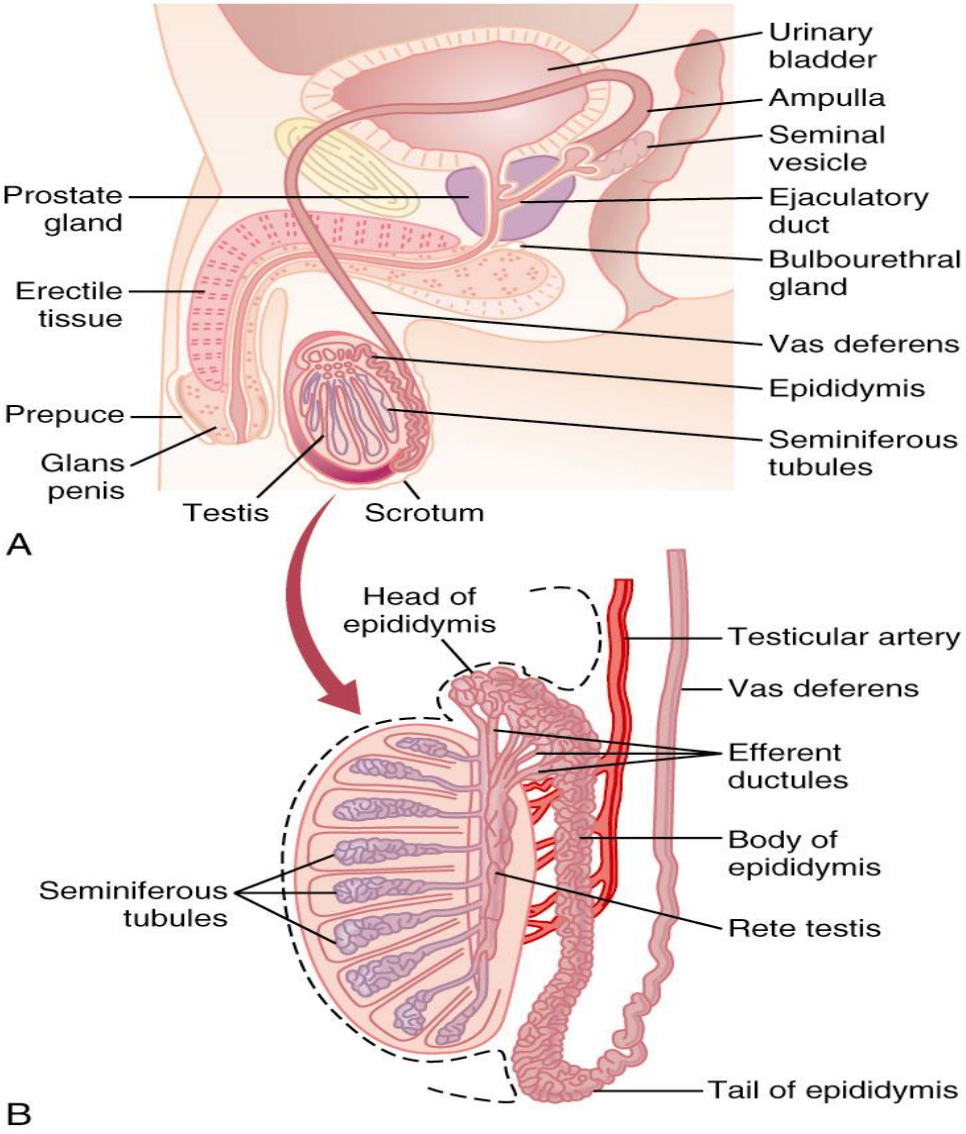
Objectives

1. Understand the functions of the male reproductive organs and glands
2. Describe the synthesis, secretion, metabolism and effects of testosterone
3. Explain how the hypothalamus and anterior pituitary gland regulate male reproductive function
4. Describe the major testicular abnormalities
5. Discuss the normal mechanism of the male sexual act

Male reproductive system

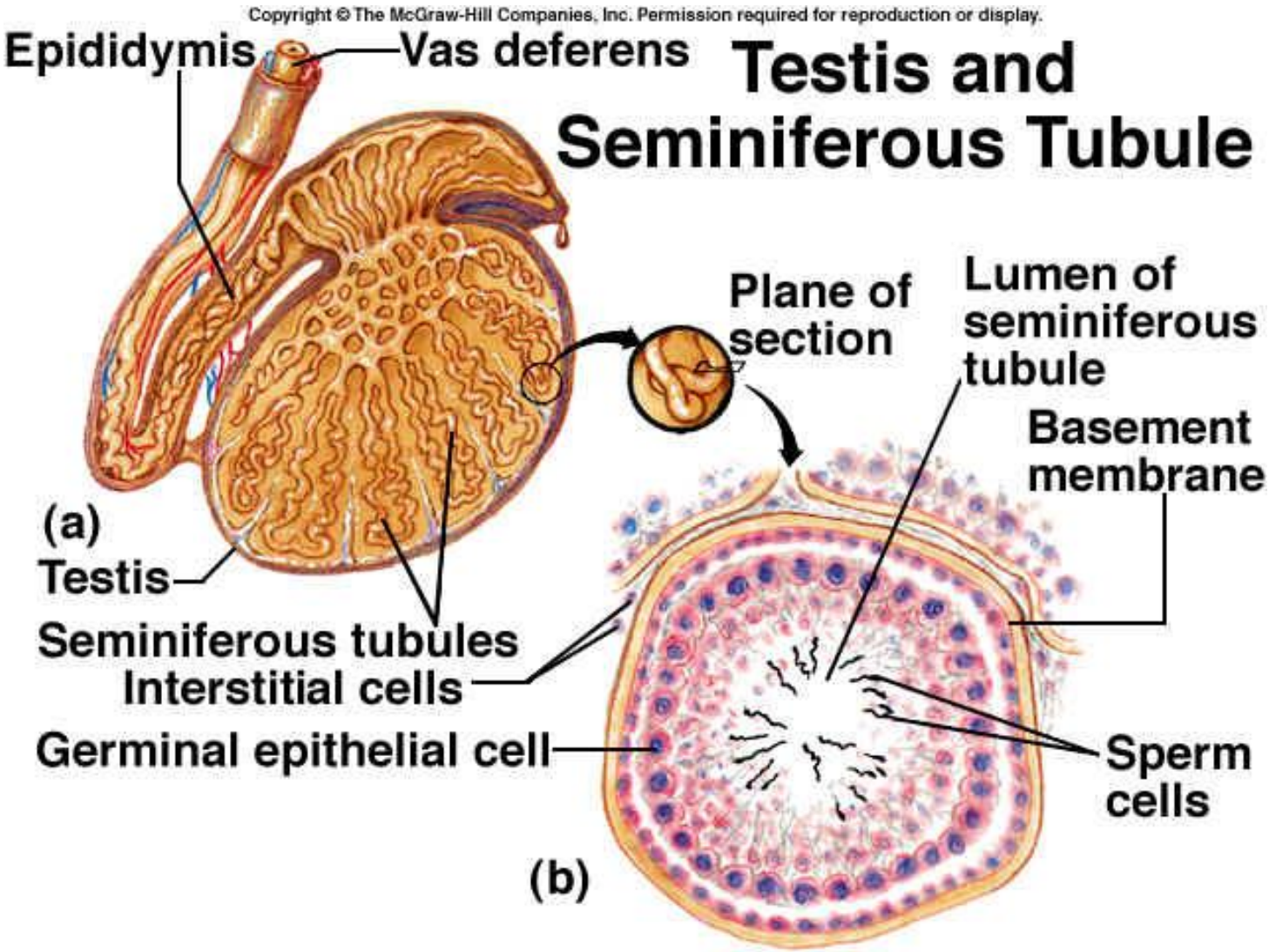


Male reproductive functions

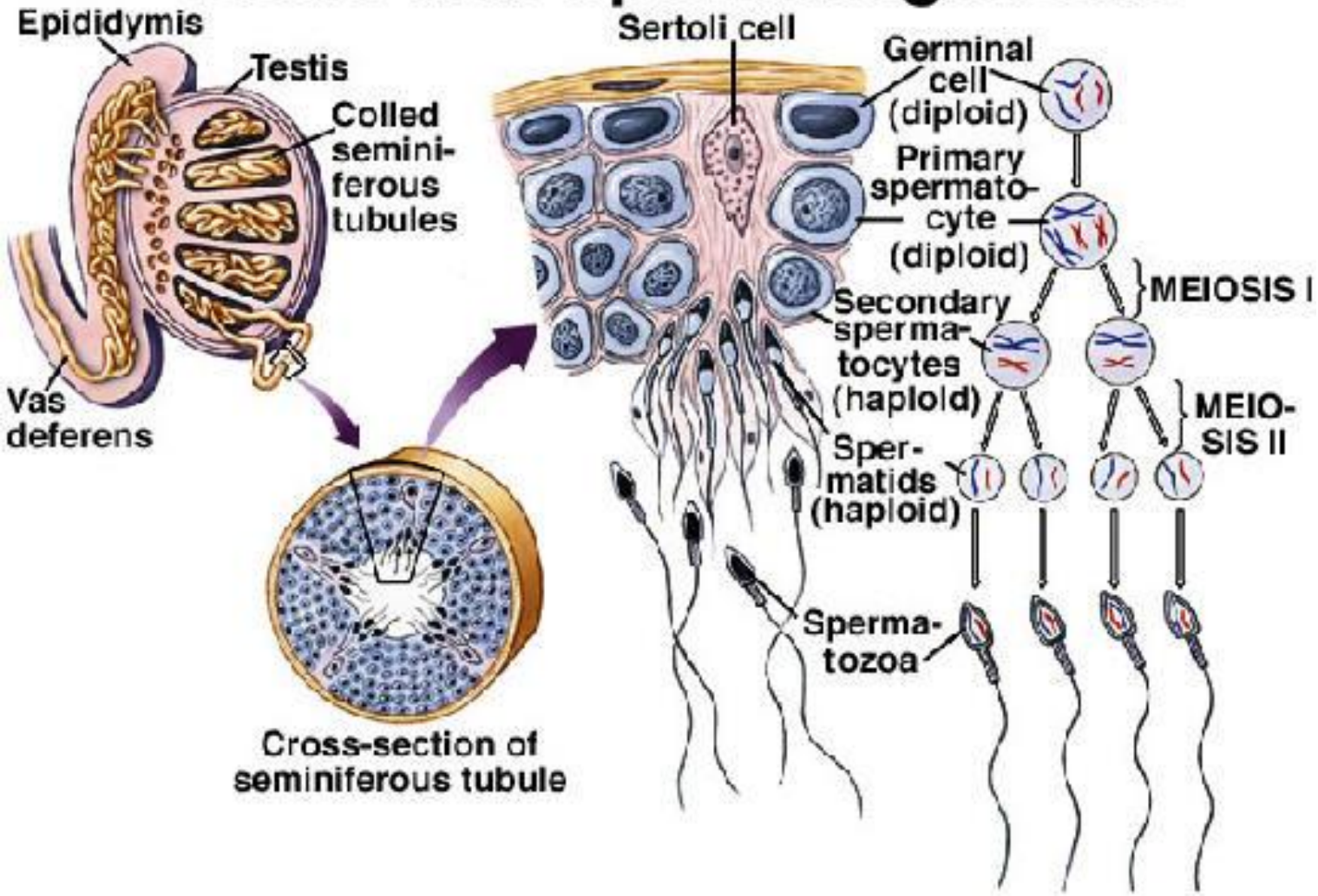
- Major functions
  - Spermatogenesis
  - Performance of male sexual act
  - Hormonal regulation of reproductive functions
- Associated effects on
  - Accessory sexual organs
  - Cellular metabolism
  - Growth

Spermatogenesis (Testes)

- Embryo:
  - Primordial germ cells migrate into the testes→ spermatogonia (seminiferous tubules)
- Puberty:
  - Spermatogonia undergoes mitotic and meiotic divisions → sperm

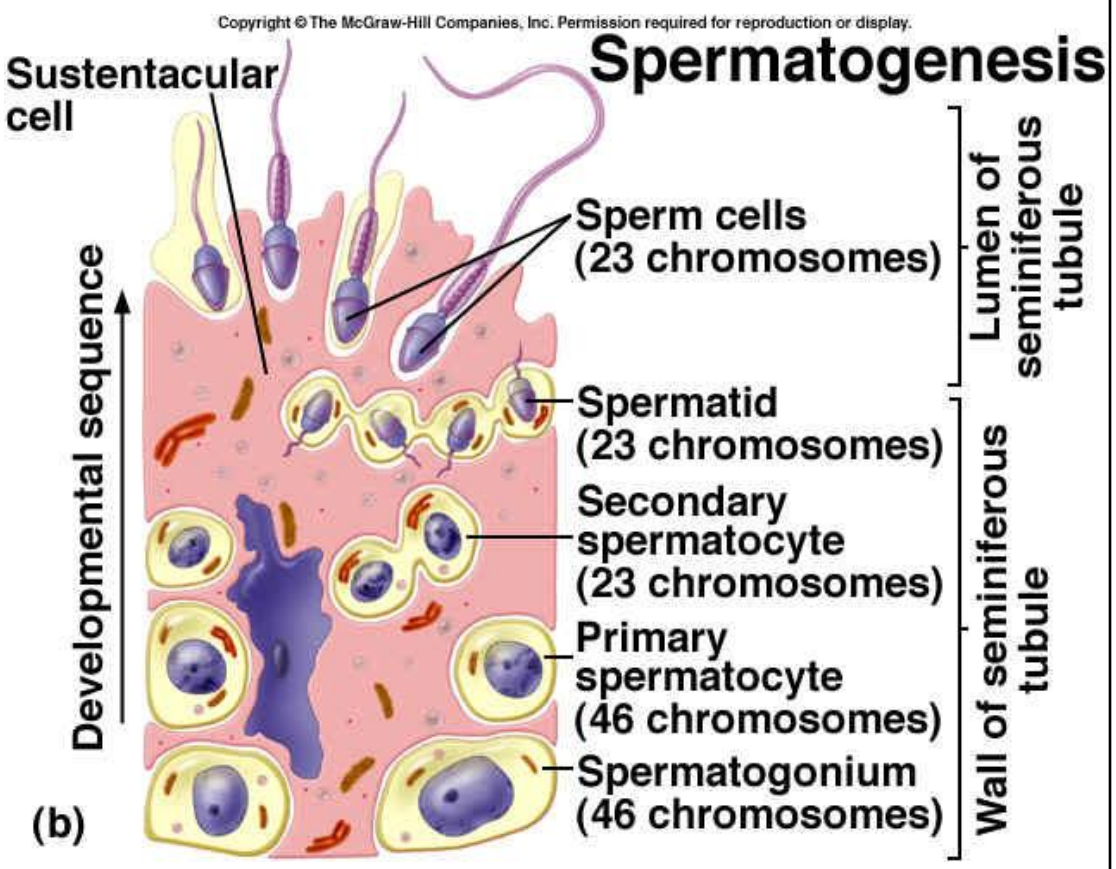


Testis and Spermatogenesis



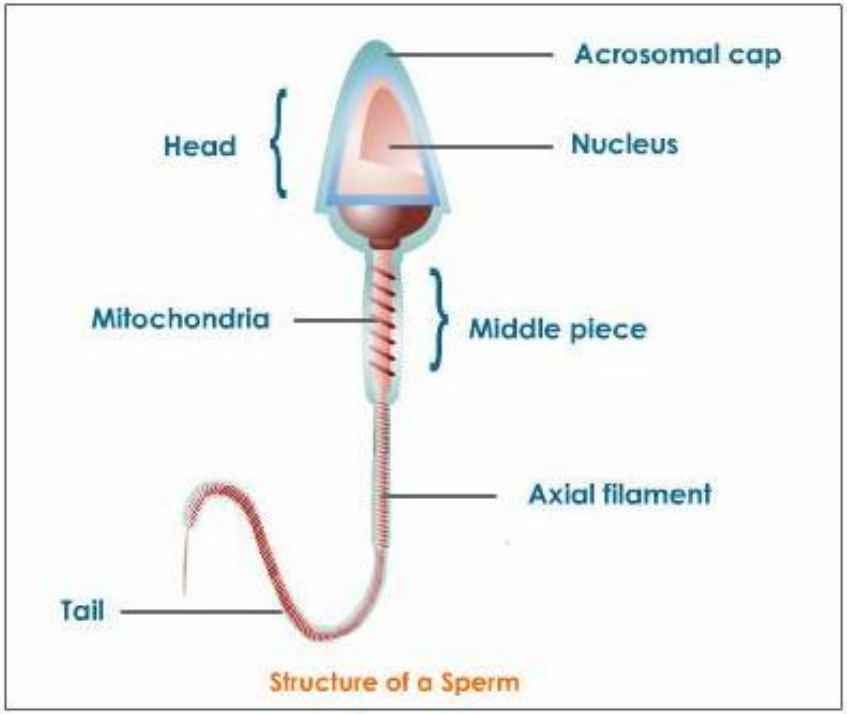
Steps

1. Spermatogonia migrate among sertoli cells → mitotic division (1^0spermatocytes)
2. 1^{st} Meiotic division (two 2^0spermatocytes)
3. 2^{nd} Meiotic division (four spermatids)
4. Mature sperm



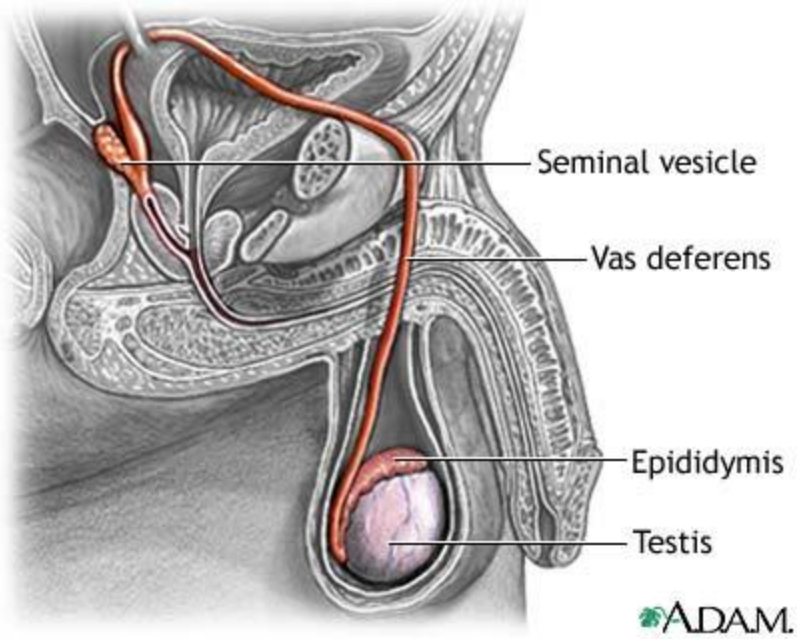
Formation of sperms

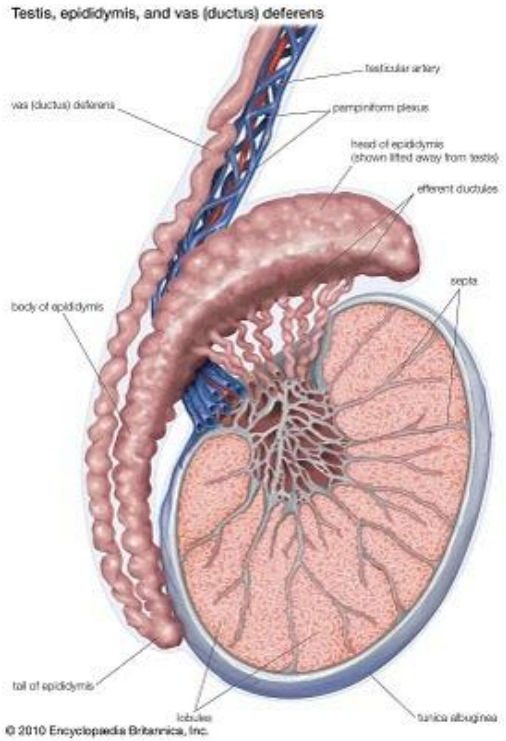
- Spermatids diffrentiate and elongate into spermatozoa
- Sperm has head (nucleus) and tail
- Acrosome (Golgi app) contain enzymes
- Tail (flagellum) provides motility



Maturation of sperms

- Occurs in epididymis (18-24 hrs) motile
- Activity↑in neutral & alkaline medium
- Active with ↑ temperature





Hormones stimulating spermatogenesis

- **LH**
  - Secreted by anterior pituitary
  - Stimulates **Leyding cells** to secret testosterone
- **Testosterone**
  - Secreted by **Leyding cells (interstitial cells)**
  - Essential for division of germinal cells
- **FSH**
  - Secreted by anterior pituitary
  - Stimulates **Sertoli cells** (spermatids→sperm)

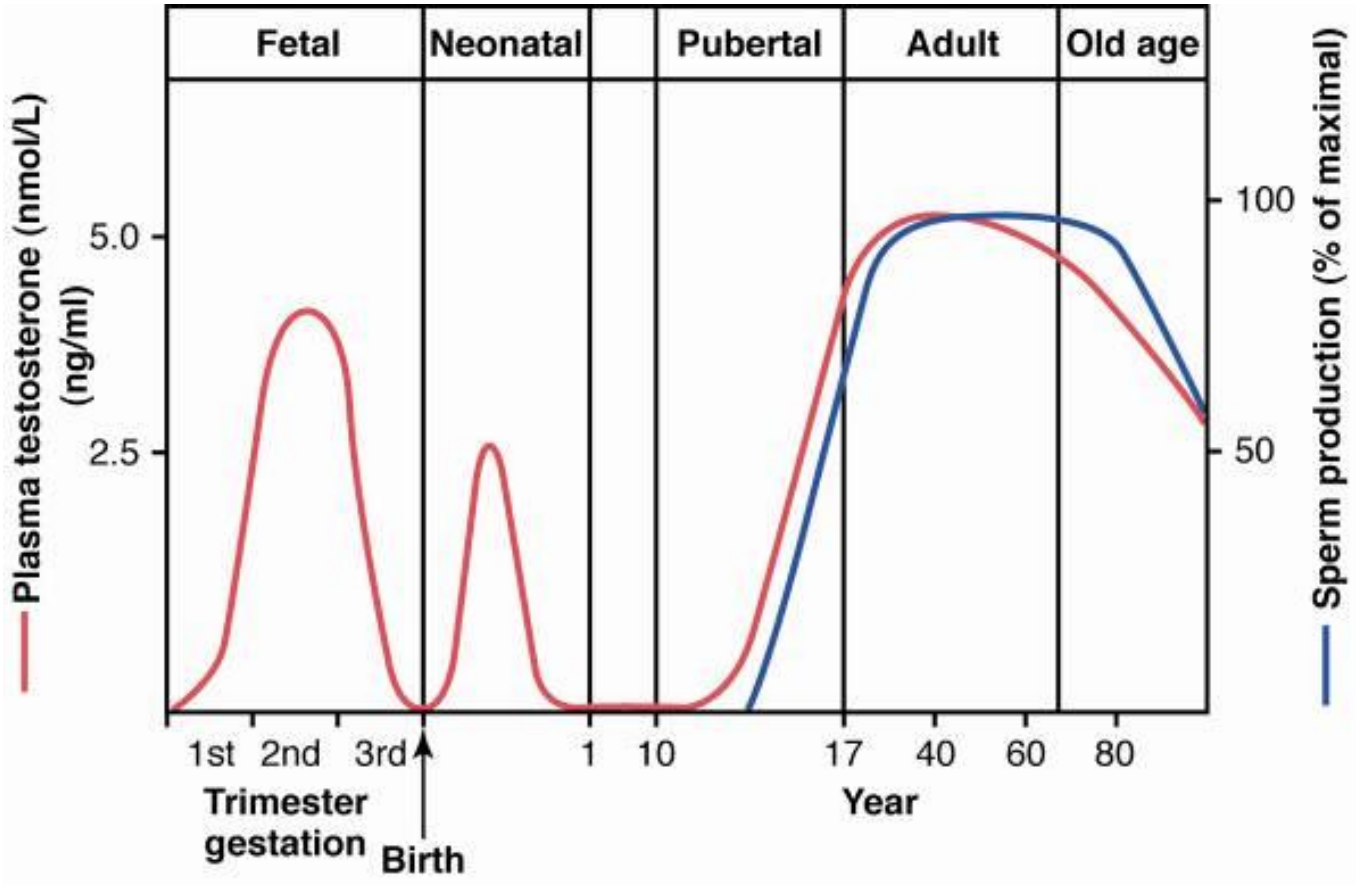
Hormones stimulating spermatogenesis

- **Estrogens** (from testosterone)
  - Secreted by **Sertoli cells** under FSH effect
  - Essential for spermiogenesis
- **GH**
  - Secreted by anterior pituitary
  - Control metabolic function of testes
  - Promotes early division of spermatogonia
  - Deficiency or absence cause infertility

Androgens secretion & function

- Androgens
  - **Testosterone** (primary testicular hormone)
  - Dihydrotestosteone
  - Androstenedione
- Secreted by **Leyding cells** (interstitial cells) which is numerous in newborn male and adult after puberty
- Synthesized from cholesterol
- Metabolism
  - 97% bound to either: albumin or sex hormone binding globulin
  - Conjugated in the liver
  - Excreted in the bile (gut) or in urine (kidney)

Average plasma testosterone concentration and sperm production at different ages



Functions of testosterone

- During fetal life:
  - Released at 7th week (placental hCG)
  - Stimulate development of male genital organs
  - Formation of prostate & seminal vesicles
  - Stimulate the descent of testes during last 2-3 month of intrauterine life
- During childhood:
  - No testosterone

Functions of testosterone

- During adulthood
  - Enlargement of penis, scrotum and testes
  - Secondary sexual characteristics
    - Growth of pubic hair
    - Upward hair growth along the linea alba
    - Facial hair
    - Hair on the chest
    - baldness

Functions of testosterone

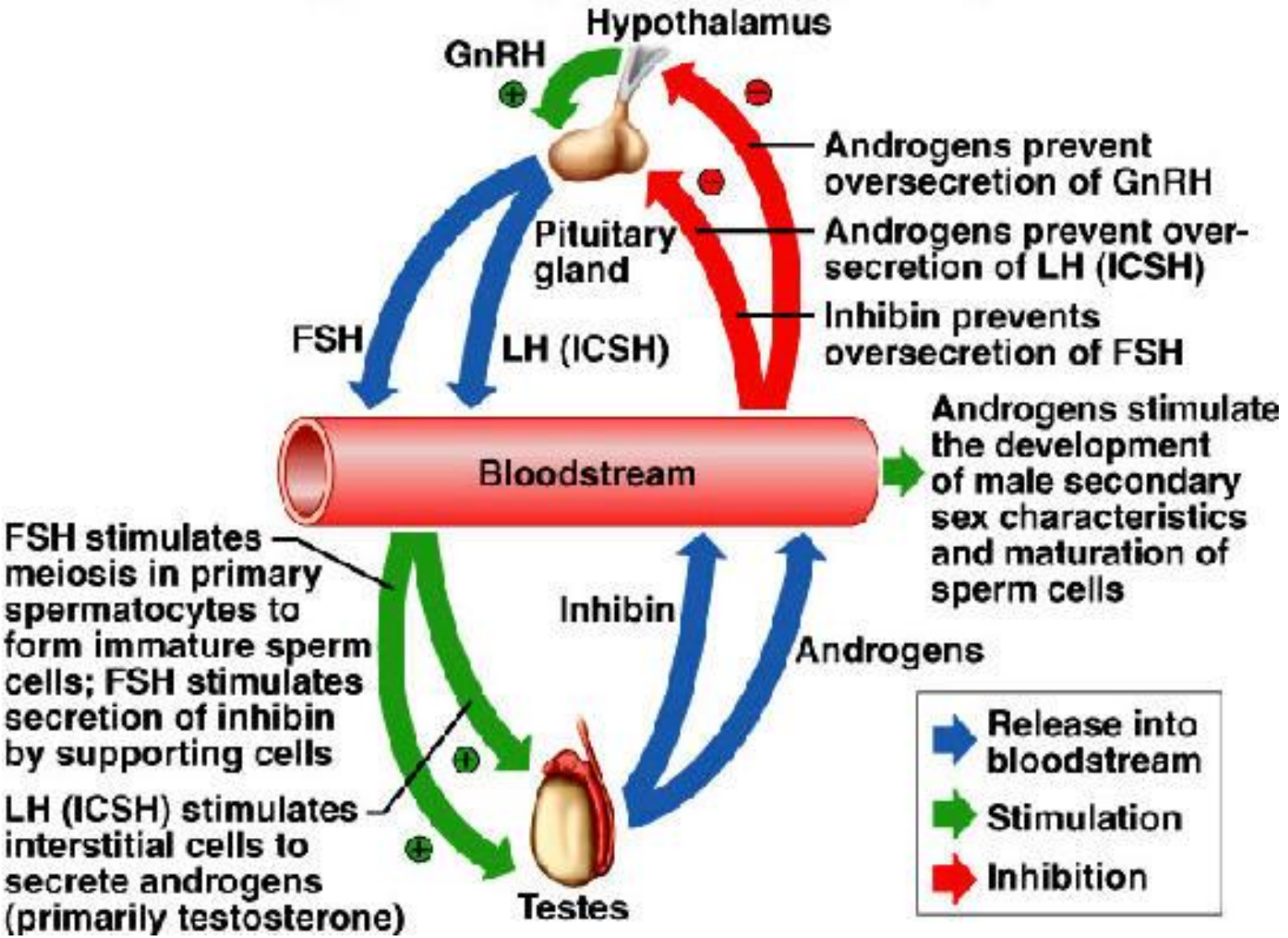
- Secondary sexual characteristics
  - Masculine voice (thickening of vocal cords)
  - Increases rate of secretion of sebaceous glands (acne)
  - Increases protein formation and muscle mass
  - Increases bone thickness
- Other associated effects
  - Increases thickness of skin
  - Increases BMR
  - Increases RBC production
  - Increases renal absorption of sodium (↑ECV)

Functions of reproductive glands

- Seminal vesicles
  - Secrets mucoid material containing fructose, citric acid, prostaglndins and fibrinogen
  - Fructose for nutrition of sperms
  - Prostaglndins help fertilization by
    - Chang cervical mucus to be receptive to sperm movement
    - Stimulate contraction of uterus and fallopian tubes that facilitate travel of sperms

Functions of reproductive glands

- Prostate gland
  - Secrets thin milky alkaline fluid
  - Important for sperm motility & fertilization
  - Neutralizes the acidity of other seminal fluids
  - Neutralizes the acidity vaginal secretion



Hypothalamic pituitary testicular axis and feedback regulation

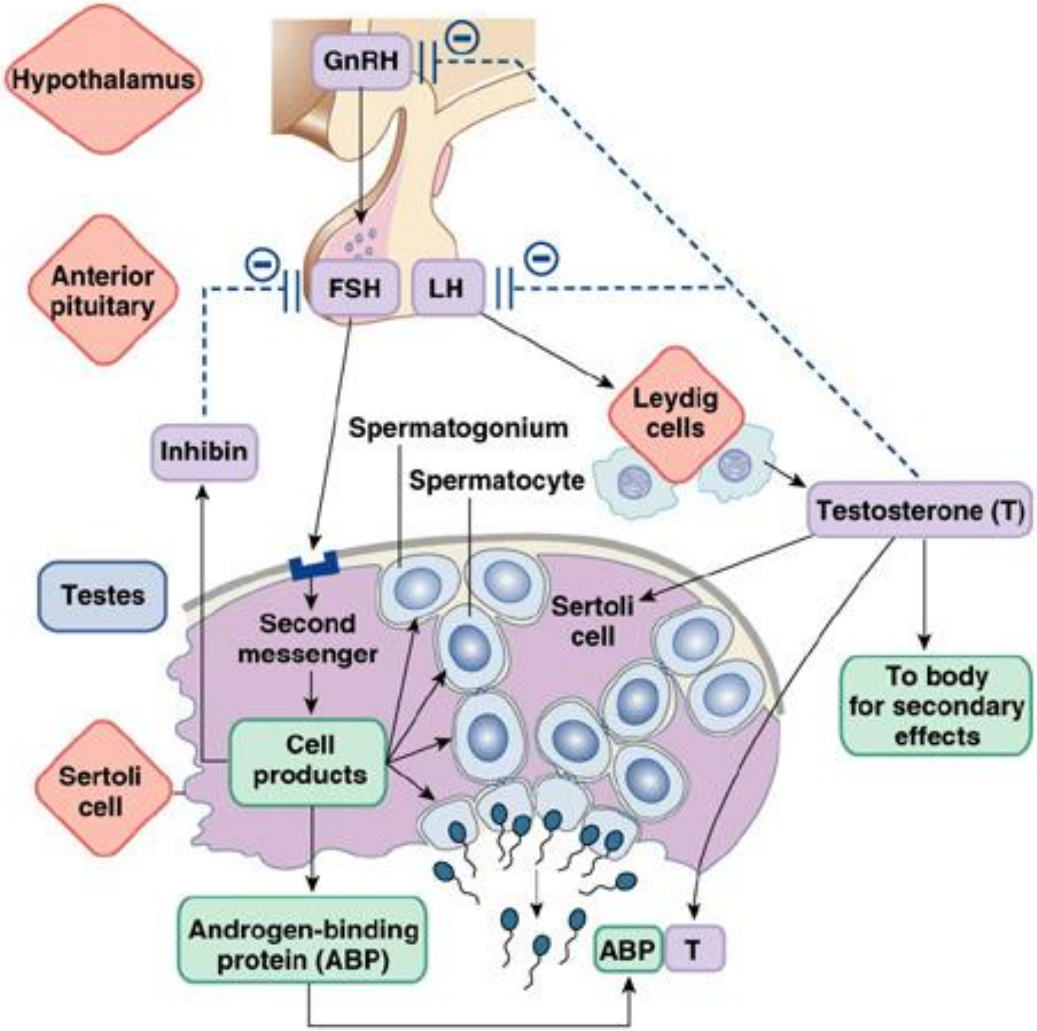


Fig. 26-11

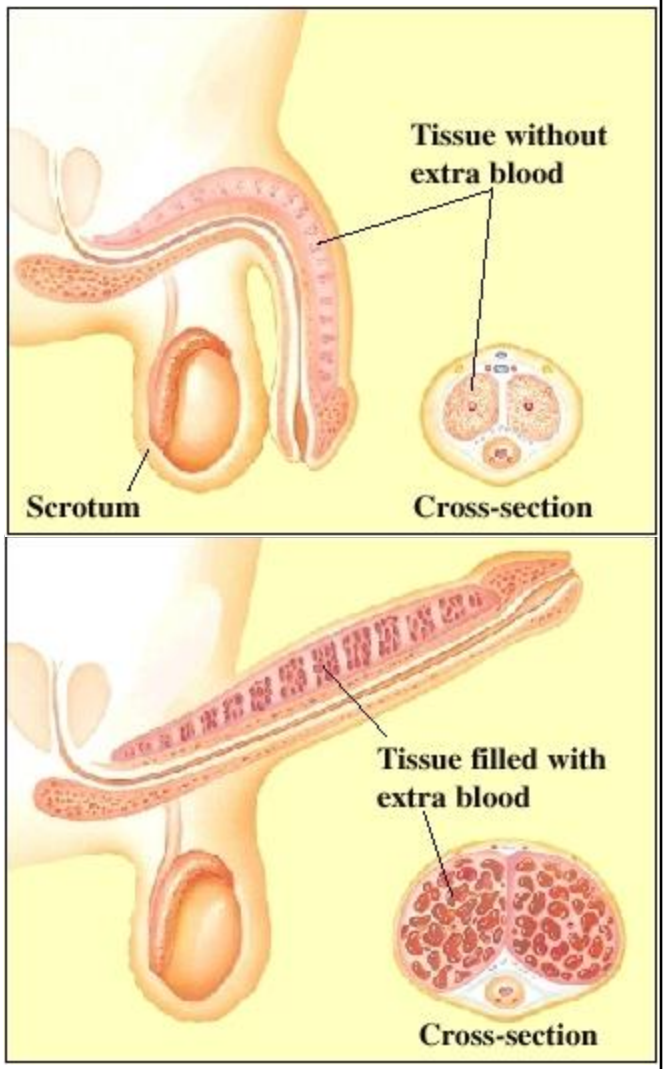
Male sexual act

- Inherent reflex mechanism (sacral & lumbar spinal cord)
- Initiation is either
  - Psychic stimulation (brain)

    Or
  - Sexual stimulation (sex organs)
  - Usually combination of both

Male sexual act

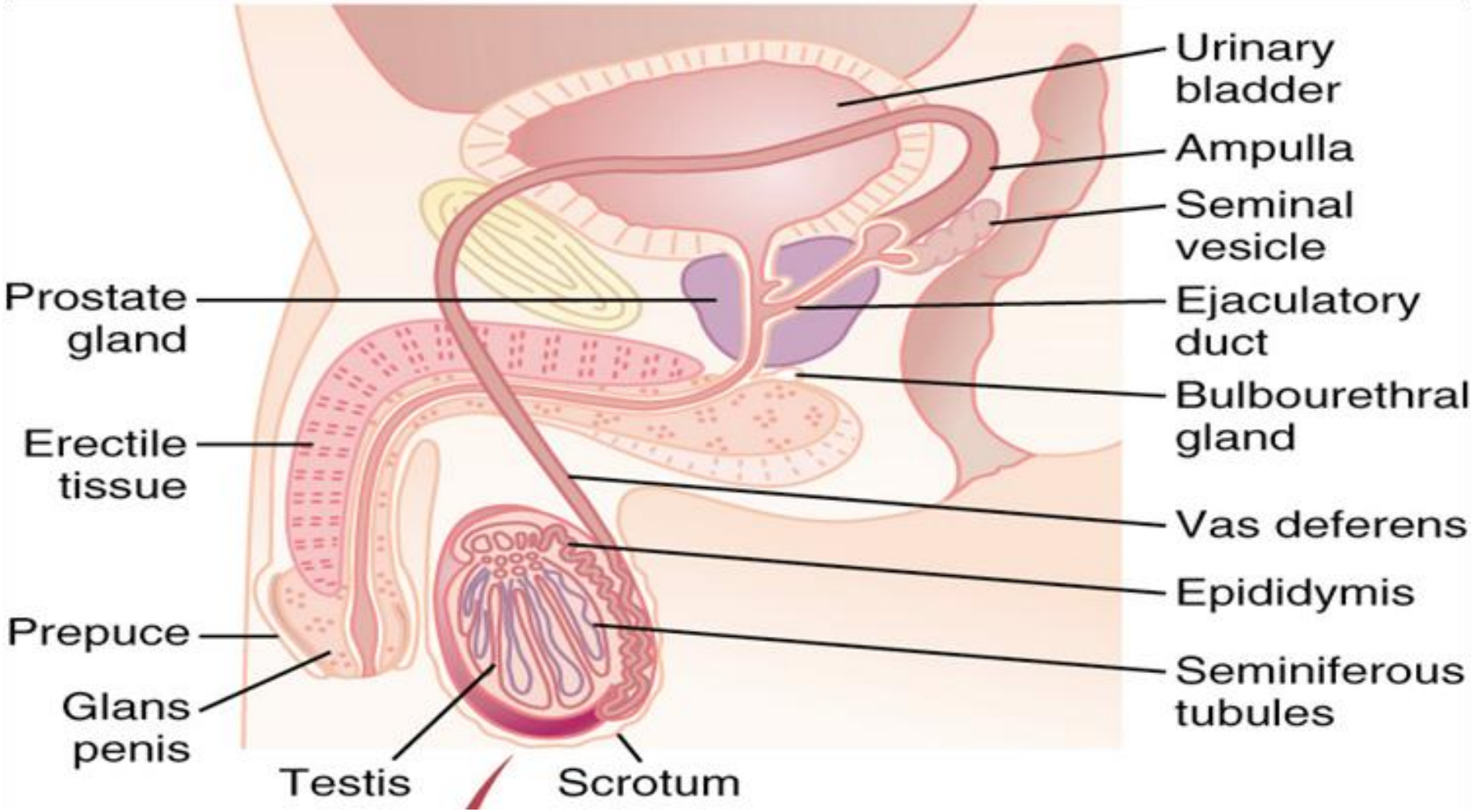
- Stages
  - Penile erection
    - Parasympathetic impulses (sacral)
    - Release of NO
    - Relaxation of penile arteries, relaxation of vascular smooth muscles in corpora cavernosa & corpus spongiosum
    - Arterial blood flows rapidly
    - High pressure→ ballooning



Male sexual act

- Lubrication (parasympathetic)
  - Urethral & bulburethral glands secret mucus
- Emission (sympathetic T-12 to L-2)
  - Contraction of vas deferens and ampulla:
    - expulsion of sperm into internal urethera
  - Contraction muscular coat of prostate gland
    - expulsion of prostatic fluid
  - Contraction of seminal vesicles
    - expulsion of seminal fluid

Emission

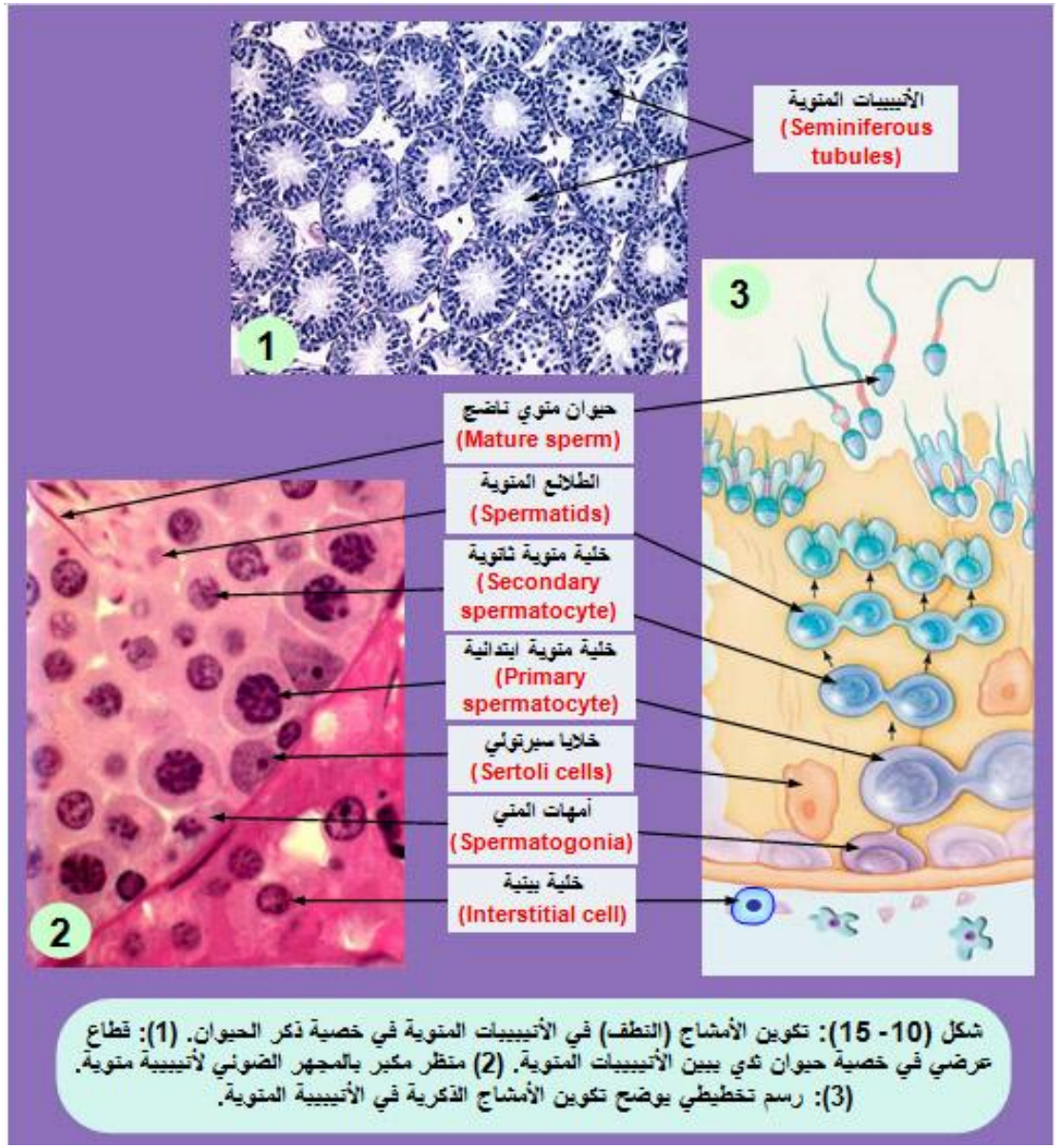

Urinary bladder
Ampulla
Seminal vesicle
Ejaculatory duct
Bulbourethral gland
Vas deferens
Epididymis
Seminiferous tubules
Prostate gland
Erectile tissue
Prepuce
Glans penis
Testis
Scrotum

Male sexual act

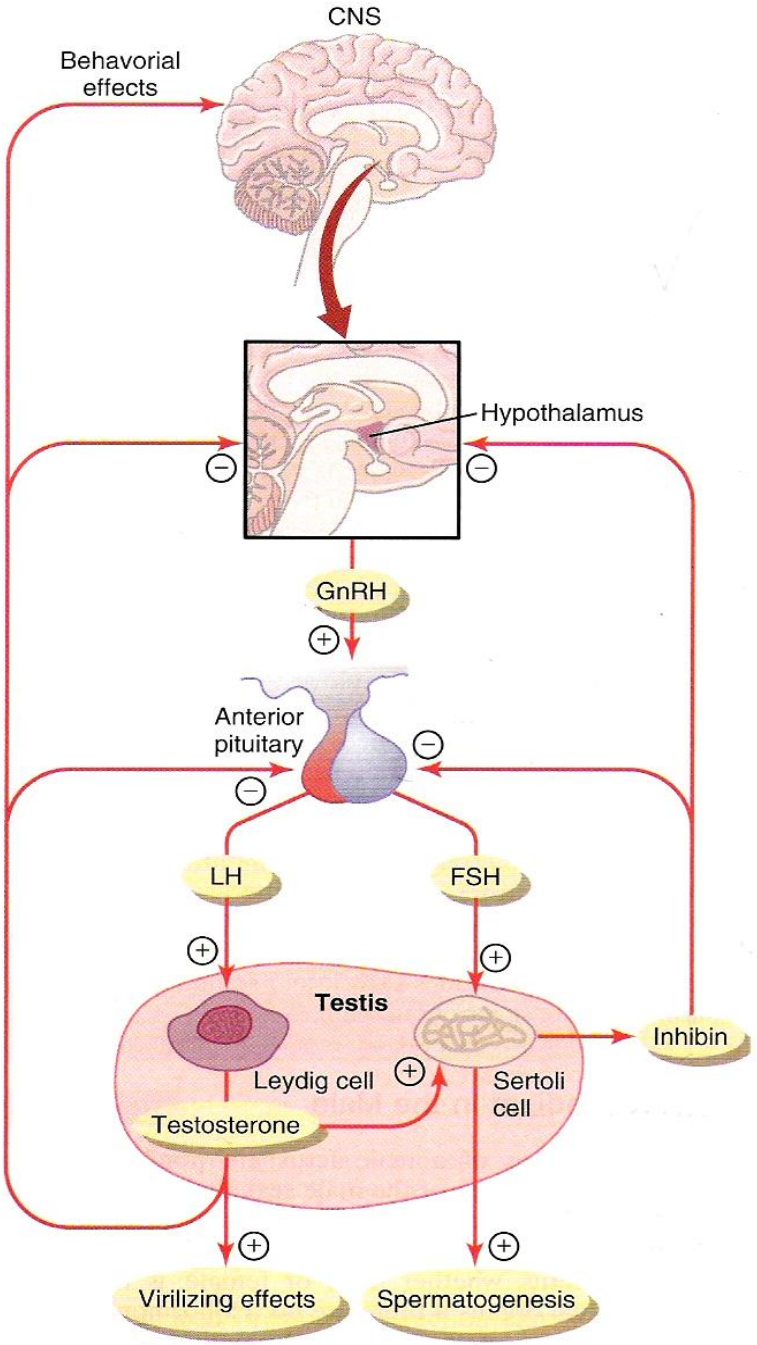
- Ejaculation
  - Filling of internal urethra with semen
  - Sensory signals (pudendal n) to sacral region (spinal cord)
  - Rhythmical contraction of internal genital organs
  - Contraction of ischio & bulbocavernousus muscle
  - Rhythmical wavelike ↑ in pressure
  - Ejaculation of semen to the exterior

Testicular abnormalities

- **Hypogonadism**
  - Nonfunctional testes in fetal life → female organs
  - Loss of testes before puberty → infantile sex organs
  - Castration after puberty → regress of some secondary sexual characteristics
  - Genetic inability of hypothalamus to secret GnRH
- **Testicular tumors**
  - Leyding cell tumors (↑testosterone)
  - Teratomas
- **Cryptorchidism**
  - affect in 10% of newborn
  - Failure of the testes to descend in the scrotum



شكل (10- 15): تكوين الأمشاج (النطف) في الأنيبيبات المنوية في خصية ذكر الحيوان. (1): قطاع عرضي في خصية حيوان ثدي يبين الأنيبيبات المنوية. (2) منظر مكبر بالمجهر الضوئي لأنيبيبة منوية. (3): رسم تخطيطي يوضح تكوين الأمشاج الذكرية في الأنيبيبة المنوية.


CNS
Behavorial effects
Hypothalamus
GnRH
Anterior pituitary
LH
FSH
Testis
Leydig cell
Testosterone
Sertoli cell
Inhibin
Virilizing effects
Spermatogenesis