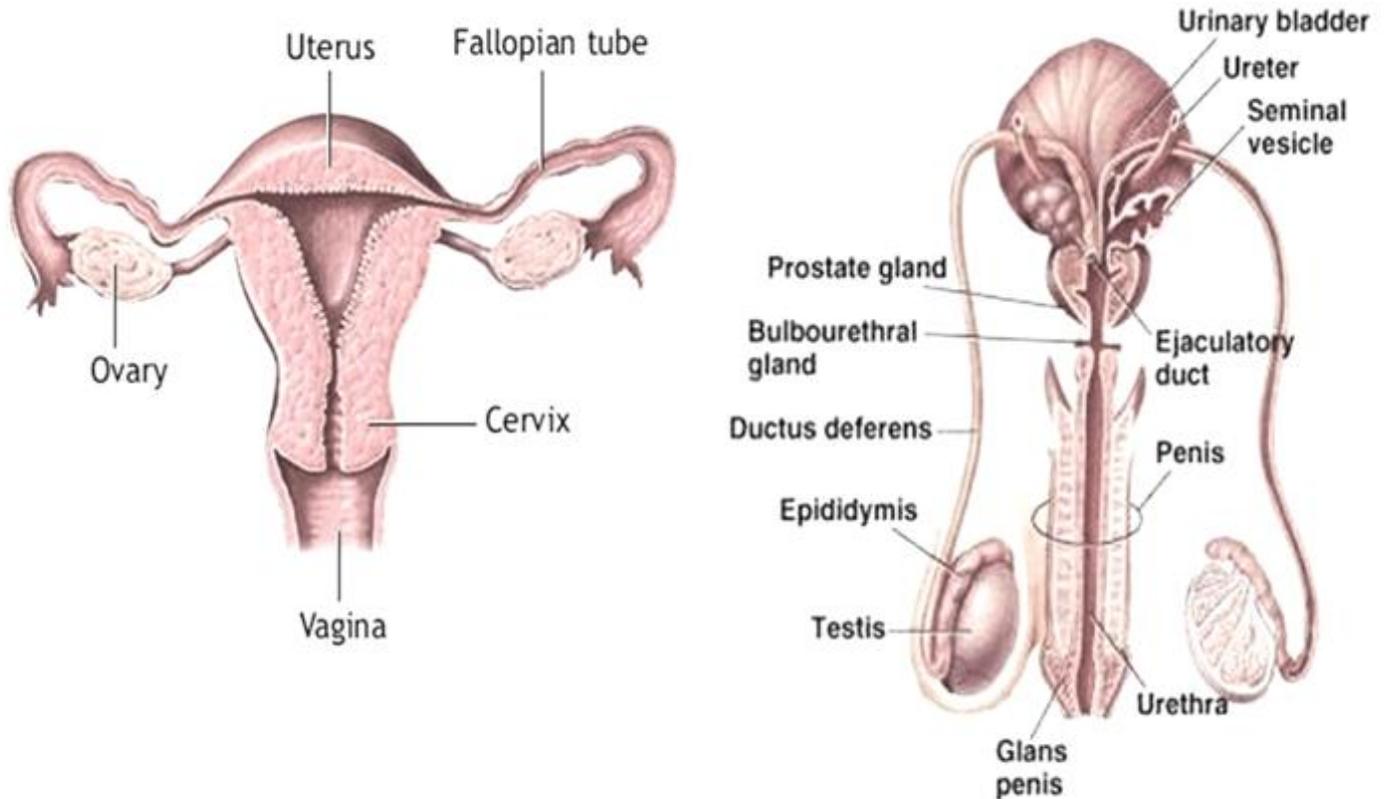


5th Lecture

Physiology of Androgens & Male Reproductive System



PHYSIOLOGY TEAM – 430

This Lecture is done by:

Faisal Al-Thuneyan

Hanan Al-Amer

Organized by: Al-Waleed Al-Johar

Physiology of androgens and male reproductive system

❖ Spermatogenesis: (Formation of sperm)

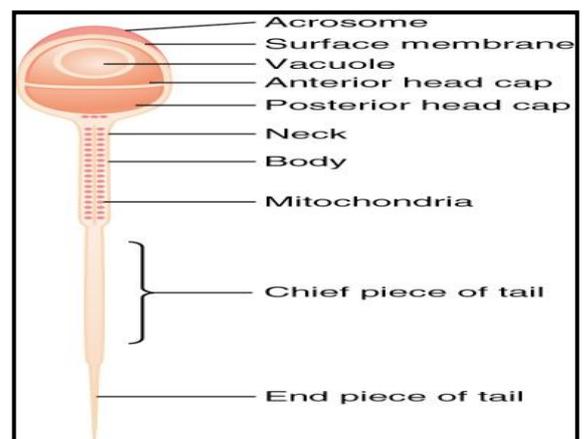
- It occurs in the **seminiferous tubules** during active sexual life.
- Begins at age of **13 years**, continues throughout life and **decreases in old age**.
- After formation in the seminiferous tubules, the sperm require several days to pass through the epididymis (**still non-motile**).
- After the sperms have been in the **epididymis** for some **18 to 24 hours**, they develop the capability of motility (some **inhibitory proteins** in the epididymis fluid **prevent final motility until after ejaculation**).
- The two testis of adult human form up to 120 million sperms each day.
- Storage of sperm:
 - Most **stored in the vas deferens**, maintaining their fertility for at least a month. The sperms are kept **inactive** state by multiple inhibitory substances in the secretion of the ducts.
 - **Small quantity** stored in the **epididymis**.

❖ Physiology of mature sperm:

- **Mature sperms** are **motile** and capable of **fertilizing the ovum**.
- Their activity is **enhanced** in a neutral and slightly **alkaline medium** and **depressed** in a mildly **acidic medium**.
- The life expectancy of ejaculated sperms in the female tract is **only 1 to 2 days**.

❖ Morphology of sperm:

- The sperm consist of **head, neck, body and tail**.
- **Acrosome**: a cap-like structure at the top of sperm head contains **Hyaluronidase** and **proteolytic enzymes** that function in **penetration of the ovum**.
- **Mitochondria**: arranged around the **body**.
- **Tail (flagellum)**: outgrowth of **centriole**, **two microtubules** in center, and **nine** around the outside.



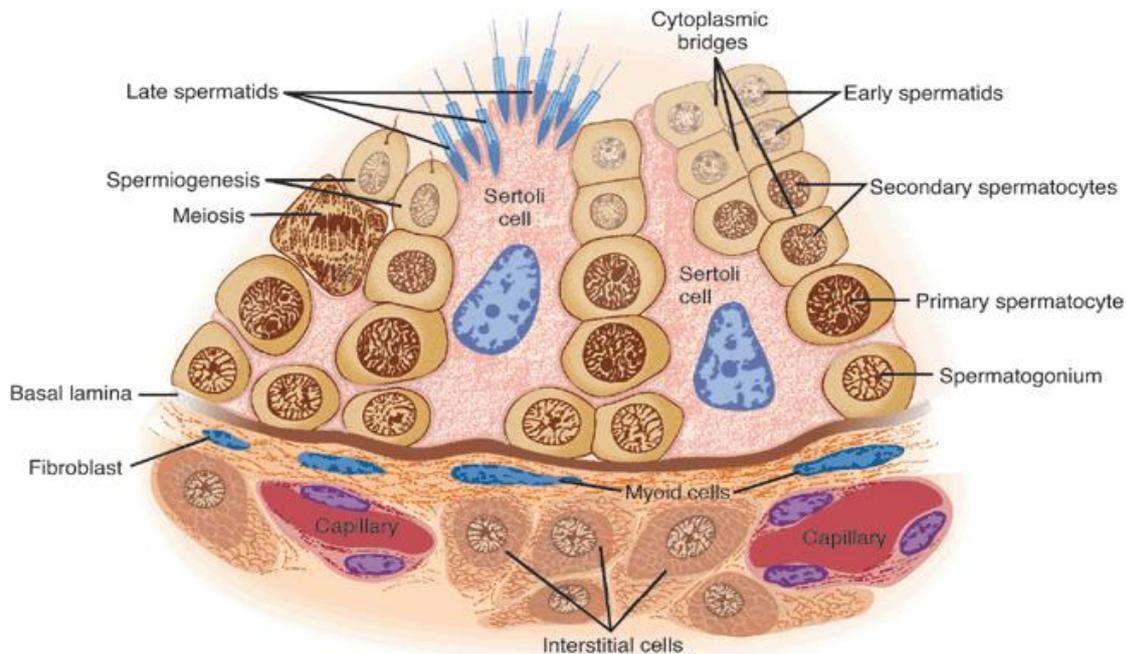
Spermatozoon: The mature sperm cell

❖ Hormonal Control Of Spermatogenesis:

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

❖ 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 mucoïd material containing fructose, citric acid, nutrient substances, large amount of prostaglandins and 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 and fallopian tubes to move the ejaculated sperm toward ovaries.

❖ Function of the prostate gland:

- Secretes milky fluid contains Ca^{2+} ion, citrate ion, phosphate ion, a clotting enzyme and profibrinolysin.
- The alkaline prostatic fluid is important for successful fertilization of the ovum.
- Functions of alkaline prostate fluid:
 - Neutralizing the slightly acidic fluid of vas deferens (due to the presence of citric acid and metabolic products of the sperm which inhibits sperm fertility).
 - Neutralizing the acidity of other seminal fluid during ejaculation (and thus enhances motility and fertility of sperm).

❖ Semen:

● Effect of sperm count on fertility:

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

● Effect of sperm morphology on fertility:

- Sometimes sperm count is normal but still infertile when about one half of the sperm having abnormal shape.

● Effect of sperm motility on fertility:

- 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 "The mature sperm":

Capacitation: the process in which the spermatozoon, after it reaches the ampulla of the fallopian tube, undergoes a series of changes that lead to its ability to fertilize an ovum.

- 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.
- The cholesterol is added to the cellular membrane covering the acrosome making it harder and prevents the release of its enzyme.
- Gradually, the sperm loses its cholesterol vesicles → the membrane of the sperm head becomes weaker and more permeable to Ca²⁺ ions.
- Ca²⁺ ions increase their movement and help to release the proteolytic enzymes from the acrosome and thus aid in penetration the ovum.

❖ The "Acrosome reaction" and penetration of the ovum:

- The Acrosome of the sperm stores large quantities of:
 1. **Hyaluronidase:** depolarizes hyaluronic acid polymers in the intracellular cement that hold the ovarian granulosa cells together.
 2. **The proteolytic enzymes:** digest the proteins that adhere to ovum.

❖ Male sexual act:

- **Erection:** controlled by parasympathetic nervous system.
 - ↑ Parasympathetic and ↓ Sympathetic 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 "Protein Kinase G" → ↓ Ca²⁺ → Relaxation

- **Lubrication:** a parasympathetic function.
- **Emission "discharge":** movement of ejaculate into proximal part of urethra under sympathetic control causes sequential peristaltic contraction of smooth muscle of vas deferens, and closing of bladder sphincter.
- **Ejaculation:** spinal reflex under sympathetic control triggered by entry of semen into the urethra causes nerve impulses to activate perineal muscle → forcibly expel semen from urethra.
- **Orgasm:** culmination of sexual excitation.
- **Resolution:** Detumescence, termination within 1-2 minutes

Erection: Parasympathetic control.
Ejaculation: Sympathetic control

❖ **Functions of testosterone:**

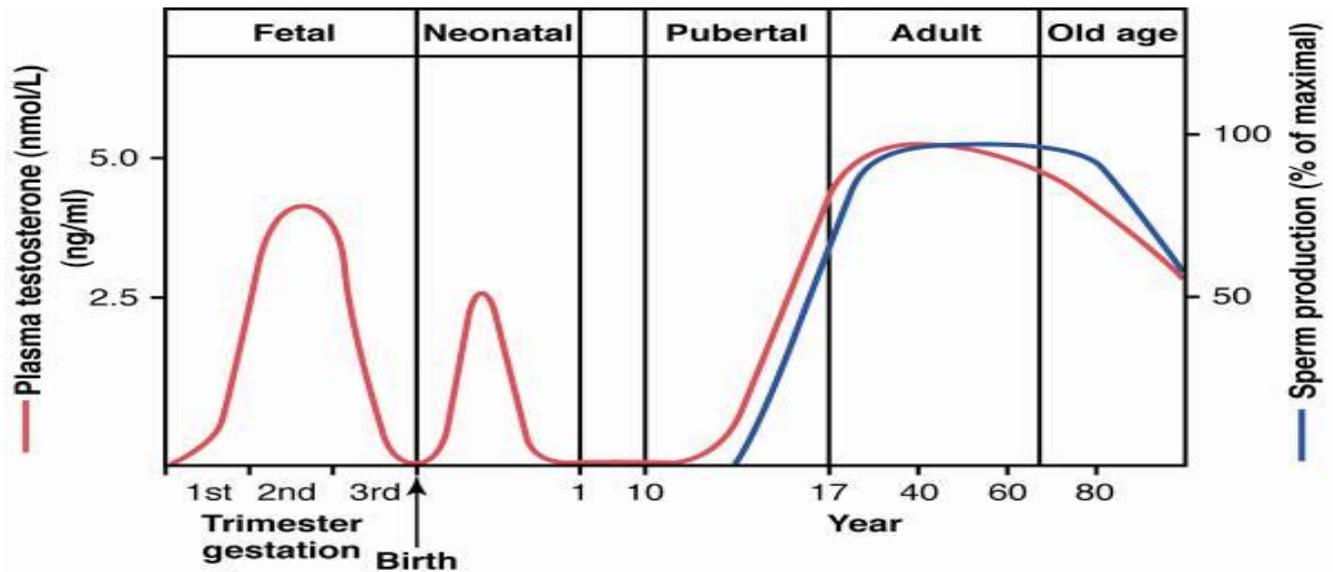
- Body hair distribution (pubis, face, chest, back, etc)
 - **Voice:** hypertrophy of laryngeal mucosa and larynx → low, deep voice.
 - **Skin:** thickens skin and increase ruggedness of subcutaneous tissue, sebaceous glands and oil production.
 - Muscle development.
 - **Bone growth and calcium retention:** thought to inhibit production of osteoclast.
 - **Red blood cells:** causes increase in erythropoietin → stimulates RBCs production.
 - Stimulates Sodium and water retention PT of kidney.
 - Development of behavioral aspects characteristic for the "male brain"
 - Development of ♂ "male" secondary sex characteristics (male sex drive and libido)
 - ↑ Protein formation and ↓ Ca²⁺ deposition.
 - It has growth promoting effect; however ↑ testosterone levels lead to decrease in final height because testosterone causes premature closure of epiphyseal plates.
 - Testosterone → male pelvis (load-bearing with narrow outlet)
 - ↑ Metabolic Rate by 15% due to its protein anabolism.
 - Maintains spermatogenesis (with FSH)
 - **Fetal development:** present at 2nd month of embryonic life presence or absence of testosterone determines development of genital characteristics.
 - + Testosterone → male external genitalia.
 - - Testosterone → female external genitalia.
 - It causes descent of testes into scrotum during last 2-3 months of pregnancy.
 - ✓ **Cryptorchidism:** failure of testicular descent.
 - Fetal development of epididymis, vas deferens, and seminal vesicles.
 - Pubertal growth of penis, seminal vesicles, musculature, skeleton, larynx and spermatogenesis.
- ❖ **5α-reductase:** is an enzyme that converts testosterone to dihydrotestosterone (DHT).

❖ **Functions of Dihydrotestosterone (DHT)**

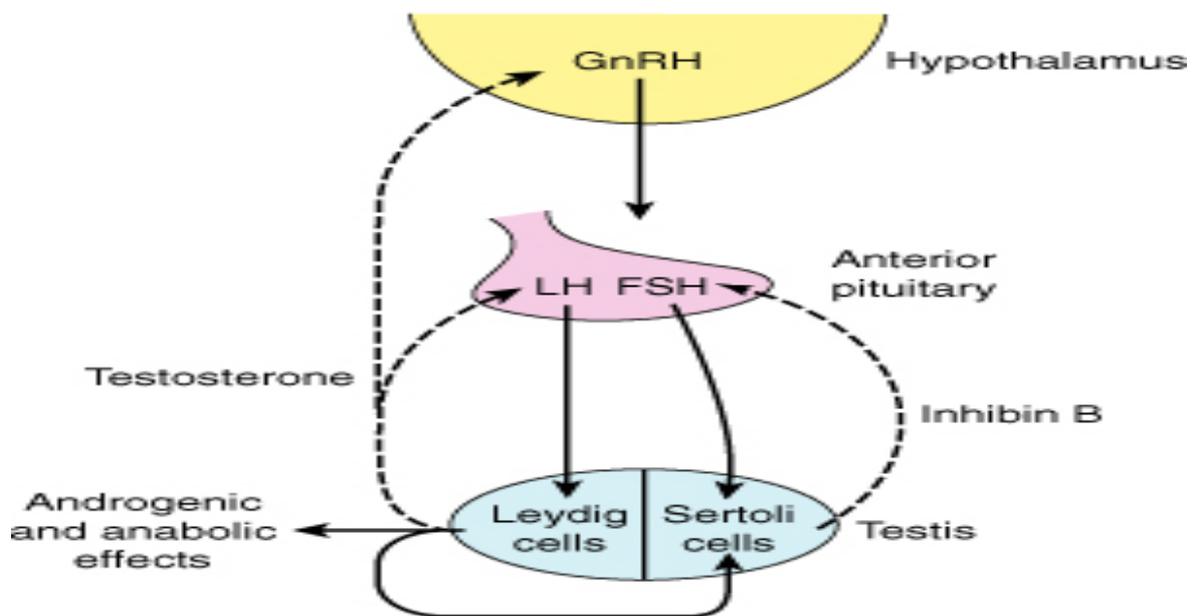
- Fetal **development** penis, penile, urethra, scrotum, and prostate.
- Pubertal **growth** of scrotum, sexual hair, and sebaceous glands.
- Prostatic **secretion**.
- **Development** of ♂ "male" sex characteristics (facial hair, acne, temporal recession of hair line, baldness, enlargement of prostate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

Dihydrotestosterone: Fetal development of penis

Testosterone: Pubertal growth "enlargement" of penis



Different Stages of Male Sexual Function:
Plasma Testosterone and Sperm Production
(Notice that spermatogenesis starts at puberty)



Hypothalamic-Pituitary-Testicular Axis