



GENITOURINARY SYSTEM

SUBJECT : Physiology

LEC NO. : 8 + 9

DONE BY : Dania Abdullah

وَقُلْ رَبِّ زِدْنِي عِلْمًا

Reproductive and Hormonal Functions of the Male-I

Unit XIV

Chapter 81

Dr Iman Aolymat

Male Reproductive System

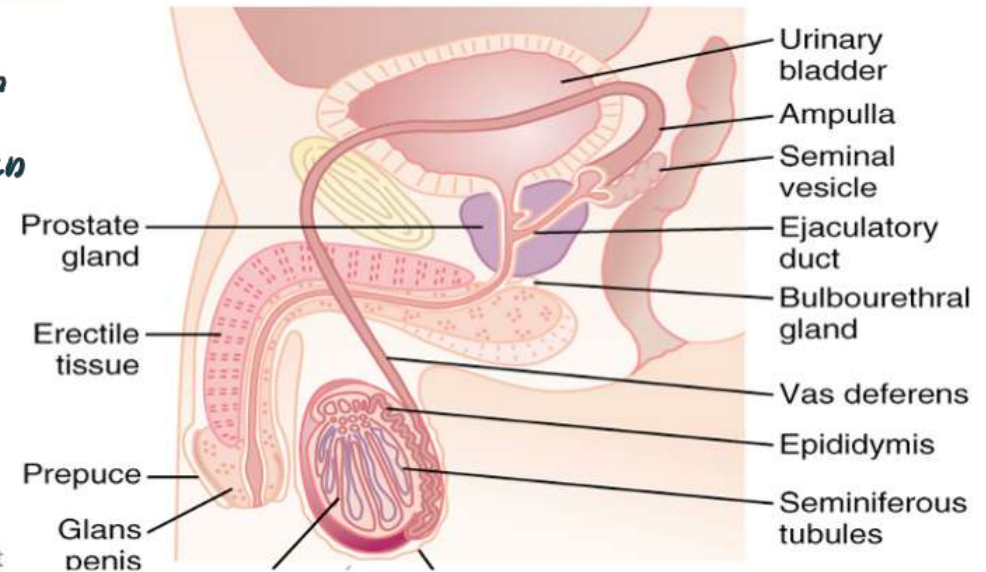
Functionally:

(1) Primary Sex Organs	(2) Accessory Sex Organs
<ul style="list-style-type: none"> ➤ Testes → Sperms Production 	<ul style="list-style-type: none"> ➤ Seminal vesicles ➤ Prostate gland ➤ Urethra ➤ Penis

→ Produce & Secrete the other components of Seminal fluid.

Excretion of urine

Ejaculation of semen



Functions of the male reproductive system

Testes	Produce sperm and male sex hormone testosterone.
Ducts	Transport, store, and assist in maturation of sperm
Accessory sex glands	Secrete most of the <u>liquid portion</u> of semen.
Penis	Contains the urethra, a <u>passageway</u> for ejaculation of semen and excretion of urine

Spermatogenesis Synthesis

- Occurs in the seminiferous tubules of the testes
- Start at Puberty / no spermatogenesis in children's Testis.
- 74 days

➤ Germ cell line, Sertoli cells & **Leydig Cells (Testosterone)**

➤ → Blood Testes Barrier

Produce

Interstitial cells.

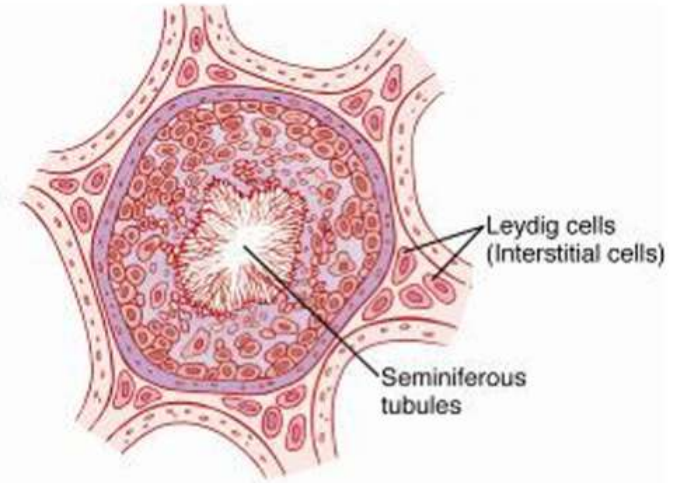
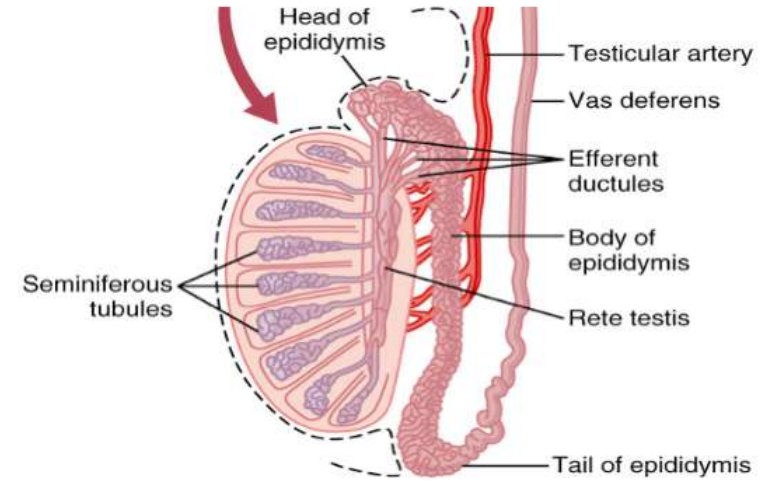
Peripheral germ cells A

maturation وال

lumen بعبر باتجاه ال

mature sperms بالأي ال

center يتكون بال



Clinically:

Infertile male Patient

والمسكلة بال Semen

الكتور سبباً هذه بعلاجات دوائيه

وعر اجهه بعد ٣ اشهر لانه

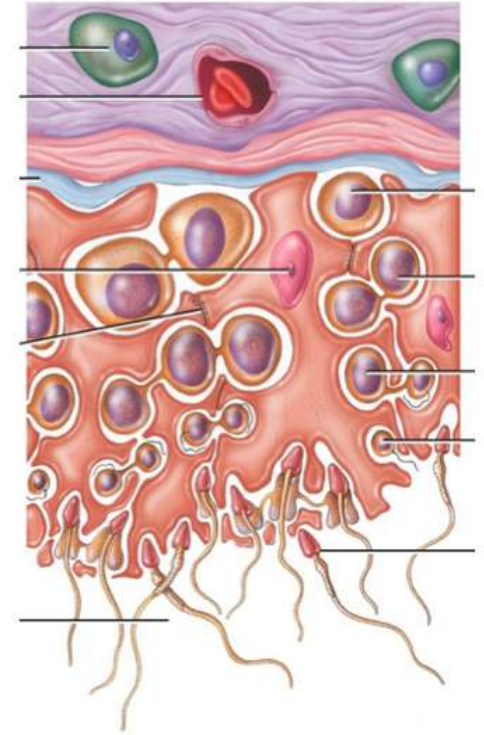
حاج يظهر نتيجته حين هيك.

Sustentacular cells

Sertoli Cells & Spermatogenesis

- Supporting and nourishing the germ cells + Phagocytosis
- Secretory function
- * ➤ Blood Testes Barrier → The germ cell line is completely invested by cytoplasm of surrounding Sertoli cells
- Releasing sperms into the lumen of seminiferous tubules (spermination) → sperm are released from their connections to sustentacular cells.

Immune system produces Abs against the sperms (Ag)



هنا في حال همار عن infection يؤدي إلى
تدبير هنا الحاضر مثل النكاف (Mumps)
بالطفولة ، ال sperms يتدخل ال circulation
وتتواجد ال Abs ← Infertility

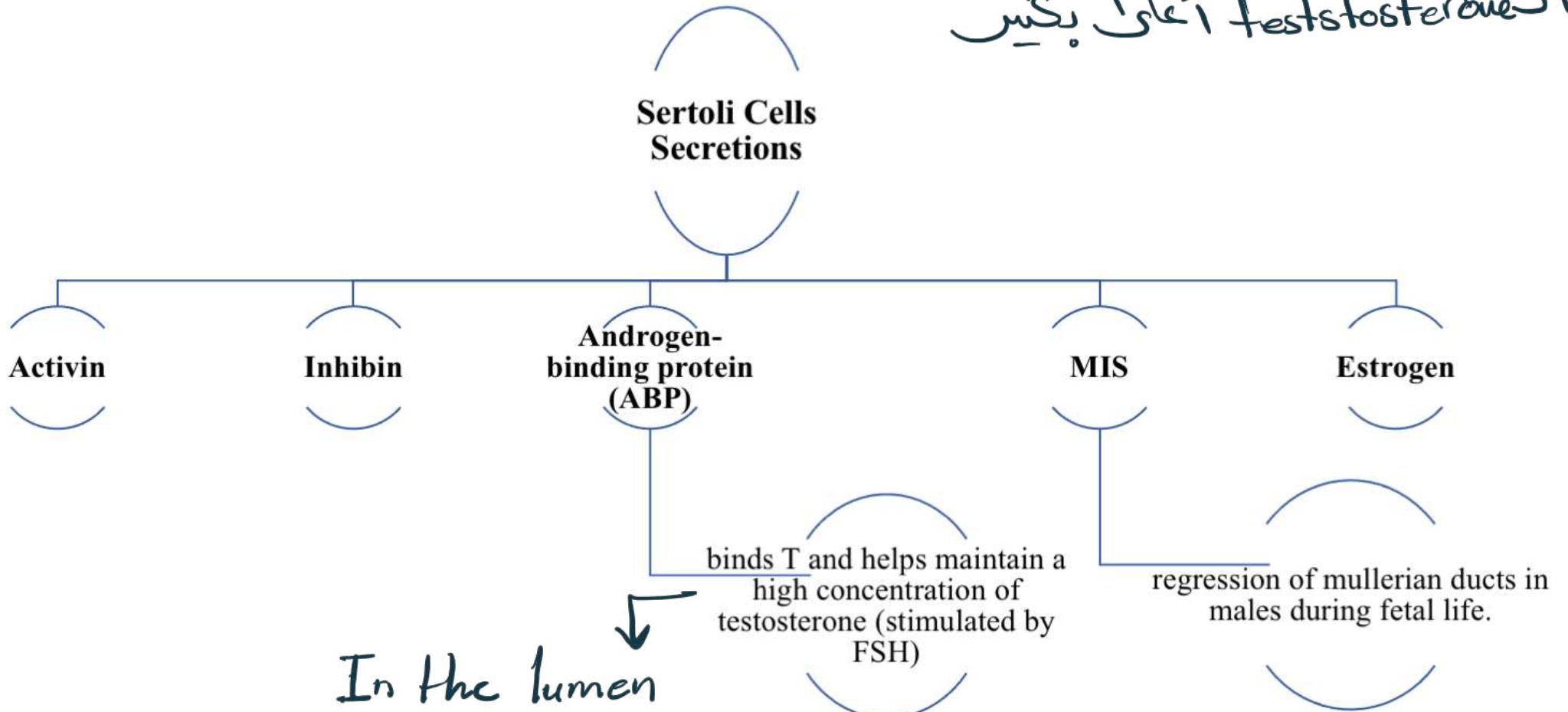
* الجسم يتطاول مع ال Sperms على انها foreign bodies
التي immune system produces Abs against the sperms (Ag).
وهذا أهمية ال Blood-testis barrier التي يمنع
وصول ال sperms ال circulation

* Testosterone وال Estrogen

يتواجد في جسم الذكر بنسبة

ال Testosterone اعلى بكثير

Secretory Functions of Sertoli Cells



- Each spermatogonia gives 4 sperms

Spermatogenesis

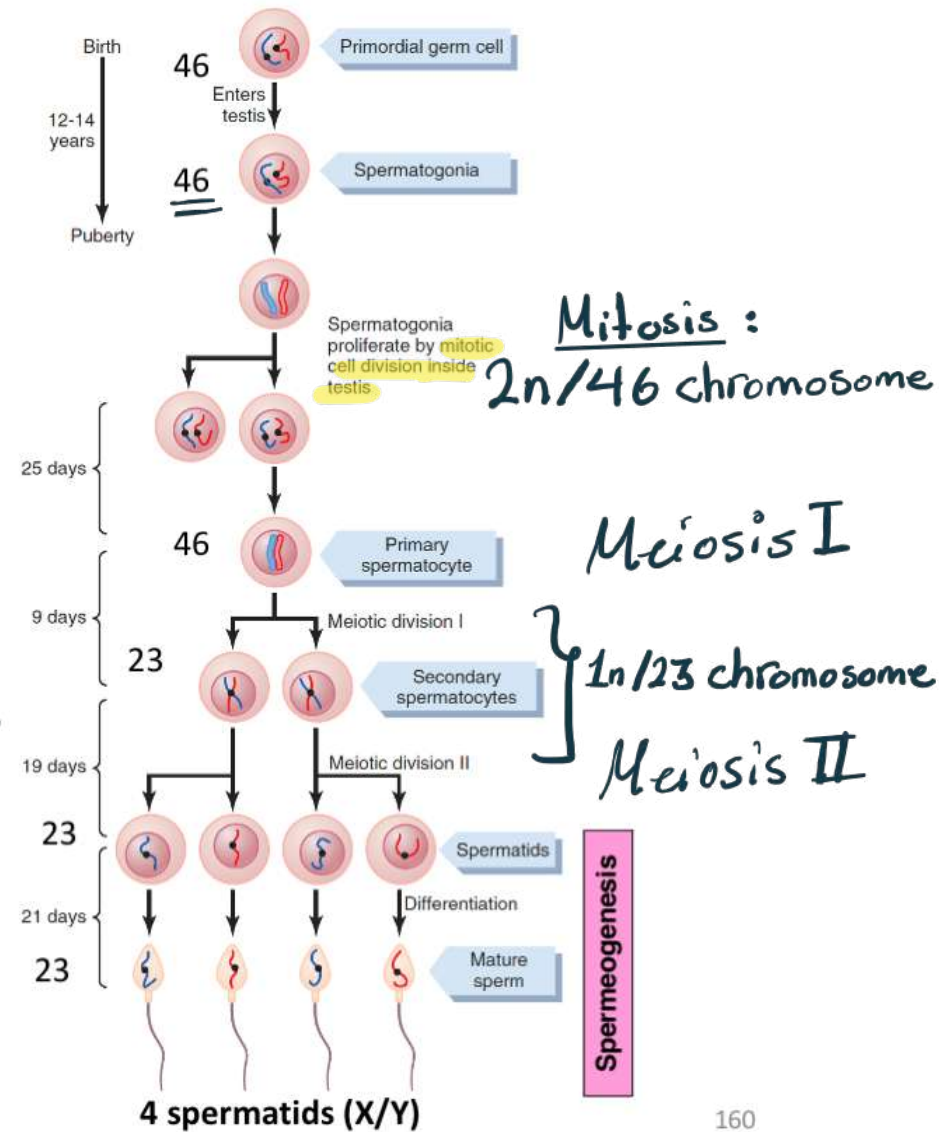
Spermeogenesis: spermatids become matured spermatozoa.

Changes during spermeogenesis:

- Condensation of nuclear material
- Formation of acrosome, mitochondrial spiral filament and tail structures
 ↳ ATP for Sperms motility
- Removal of extra volume of nonessential cytoplasm.

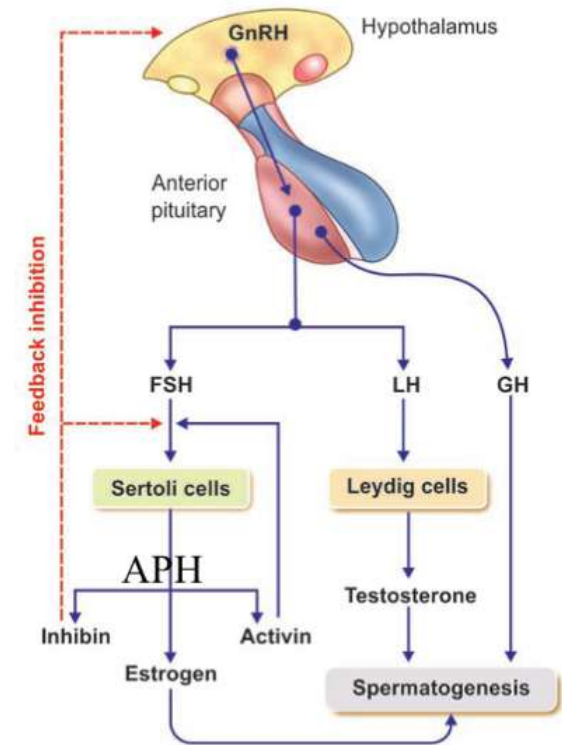
* Acrosome, the structure that covers the head of the sperm.

بيحتوي على (lipid layer) يتكون فوق الإنزيمات، وطبقها تمنع خروج هادي الإنزيمات حتى وقت الـ Fertilization
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Hormonal Factors Stimulates Spermatogenesis

- GnRH → stimulates anterior pituitary gland to produce luteinizing hormone (LH) and follicle stimulating hormone (FSH)
- LH → stimulates the Leydig cells to secrete **testosterone** → growth and division of the testicular germinal cells
- FSH → stimulates Sertoli cells
- Estrogens → formed from **testosterone** by the Sertoli cells
- Growth hormone → controlling metabolic functions of the testes & promotes division of the spermatogonia
- Dwarfs → spermatogenesis is severely deficient or absent, thus causing infertility.



① Hypothalamus releases GnRH that stimulates the anterior pituitary gland [At puberty]

② The anterior pituitary gland stimulates the production of FSH & LH

③ LH stimulates Leydig cells to secrete Testosterone

④ FSH stimulates Sertoli cells to secrete its hormones.

⑤ Growth hormone is also released from the anterior pituitary gland → ⊕ Metabolism + Promotes the division of Spermatogonia.

* that's why dwarfs present with infertility
-dwarfism → ↓ GH.

- Sperms → Vagina → Uterine tube.

Structure of the Human Spermatozoon

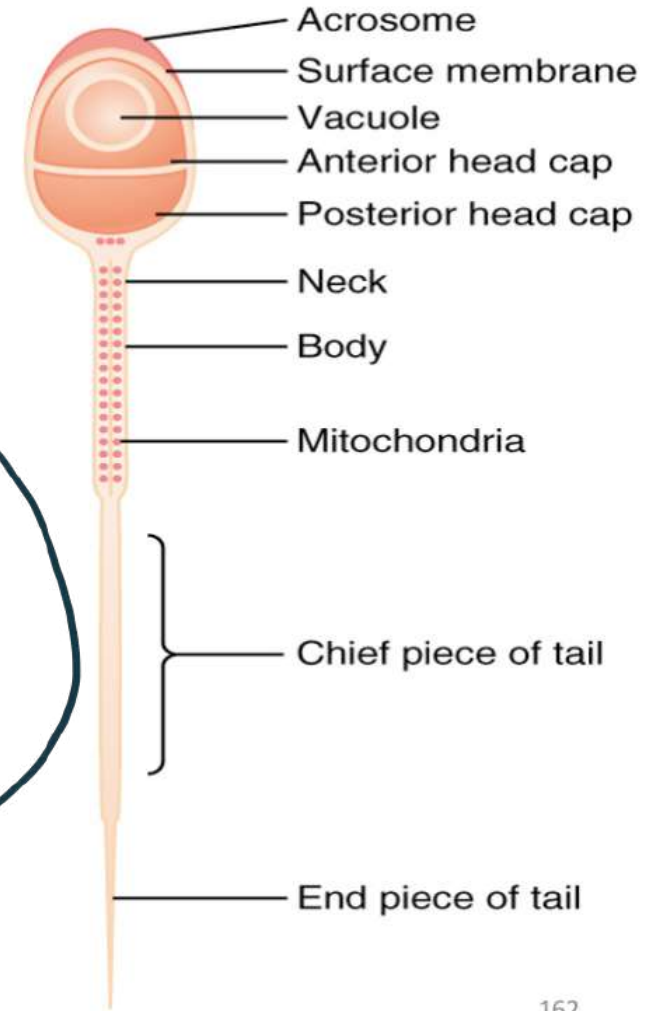
Sperm shape designed to reach and penetrate the secondary oocyte in order to achieve **fertilization** and create a zygote.

Head → contains condensed nucleus with 23 chromosomes + thin cytoplasm.

Acrosome → covers the head and contains enzymes (hyaluronidases & proteolytic enzymes) to help with penetration.

Tail = flagellum

Microtubules & Mitochondria → ATP for locomotion



* عند تلاصق ال Sperm مع ال Ovum

لطبقة ال lipid اللى بيخطف ال Proteolytic Enzymes
بيدخفن ويتحرر الاينزيمات لإكمال عملية ال Fertilization

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هادي من حكمة ربنا للمدفن
استهلاك ال Sperms للطاقة
في غير أوانها

اللي كالي حركتها محدودة وجود
inhibitory proteins in the
epididymis

* يعني ك قيلي 18-24 hrs حذتواجدها
بال epididymis طابون عندها القدرة
على الحركة نهائيا، بعد هادي المدة
يركسب قدرة محدودة على الحركة

Maturation of Sperms

- Seminiferous tubules → tubule of the epididymis
- Sperms at early portions of epididymis → **nonmotile & cannot fertilize an ovum.**
- **After 18- 24 hours** presence in epididymis → sperms develop **capability of motility**, even though **several inhibitory proteins** in the epididymal fluid still prevent final motility until after ejaculation.

The Sertoli cells and the epithelium of the epididymis → secrete a special **fluid** that is ejaculated along with the sperm.

fluid contains:

Hormones (testosterone and estrogens)

Enzymes

Nutrients

* محدودية الحركة يتسفر كالي بيس
ال Semen ejaculation

- Stored at epididymis (mainly) & vas deferens for 1 month in depressed state *due to the inhibitory Ptns*
- Frequent ejaculation → few days storage *(in case) the male is sexually-active.*
- After ejaculation → maturation of sperm → *become motile* and capable of fertilizing the ovum
• motility من ناحية ال

Maturation of Sperms

- gaining full capacity

Capacitation: A process to render the sperms **competent to fertilize** the ovum/
hypermotile.

- Occurs when sperm is expelled coming in contact with **the fluids of the female genital tract** *it becomes hypermotile.*
- Normally requires from 1 to 10 hours.

Changes leading Capacitation of Spermatozoa

- * ➤ various inhibitory factors that suppress sperm activity → washed by uterine and fallopian tube fluids
- * ➤ Loss of ^{lipid layer} cholesterol vesicles (tough & prevent enzymatic release) at acrosome of sperm
- * ➤ Increase permeability of flagella to *Ca ions cause increase in motility*
- * ➤ Ca ions enhances the release of enzymes by the acrosome enhancing the penetration of ovum

Seminal Vesicles

➤ Secretes 60% of total semen.

➤ **Functions of seminal fluid-**

➤ Nutrition to sperms → **Fructose** ***

➤ Other substances: citric acid, PG

➤ Secretes fibrinogen.

➤ Fertilization

gen → inactive form of fibrin.

Prostaglandin → enhances fertilization of ovum by:

1. Increasing the receptive capacity of cervical mucosa for sperms

2. Initiating peristaltic movement of uterus and fallopian tubes → increasing rate of semen transport (oxytocin is also responsible for this process).

** oxytocin is released due to the excitation during sexual intercourse*

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** الضيق عادةً يسمح الأزواج*

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زيادة ال ← frequency of sexual

at initiation of labor ← semen, PG and PGE₂ ← intercourse عند اقتراب موعد الولادة

* Semen favors alkaline media.

Prostate Gland

- Secretes 30% of total semen.

Functions of prostatic fluid-Ca, citrate, phosphate → Maintenance of sperm motility

$pH < 6$ → **NON-MOTILE SPERM** → acidic media (6)

Vas deference & female genital tract are acidic.

Prostatic fluid provides optimum pH for the motility of sperms.

Clotting of semen

* Clotting enzymes present in prostatic fluid → convert fibrinogen (from seminal vesicles) into fibrin → **coagulum** → holding the sperms in uterine cervix.

Lysis of coagulum ↪ *entraps spermatozoa*

The coagulum is dissolved by **fibrinolysin** of prostatic fluid (15-30 min after ejaculation), so that the sperms **become motile**.

* *more than 30 mins*

Prostate-specific antigen (PSA) → hydrolyse sperm motility inhibitors.

→ *indication of infertility*

- PAS → *سرقة حالات ال Tumors*

و ال *infections* فلا *تعتبر كبر* Specific

it inhibits the inhibitory proteins.

Bulbourethral (Cowper's) glands

Secrete an alkaline fluid during sexual arousal that neutralizes acids from urine and mucus for lubrication

Semen:

Milky fluid from seminal vesicles, prostate, vas deference and mucus glands, such as bulbourethral gland

Fructose, vit B, C, E, electrolytes & proteins

pH = 7.5 final alkaline

Each ejaculation contains approximately 2-6 ml,
35-200 sperm, avg 120 m/ml, Avg 400 million/ejaculation

Reach fallopian tube 30-60 min

* الرجال الذي يتسجلوا تسجل يتعرضوا
فيه لدرجات حرارة عالية أكثر عرضة
للضعف.

Factors affecting sperm activity

Factors affecting activity of sperm:

1-pH

Neutral and slightly alkaline medium → increase activity

Mildly acidic medium → depressed

Strong acidic medium → death

2- Temperature → activity increases with increasing T

Optimum 2°C below the internal temperature.

On cold days → scrotal reflexes → pulling the testes close to the body

Warm days → scrotum descend

Excessive temperature → degeneration of cells of seminiferous tubules

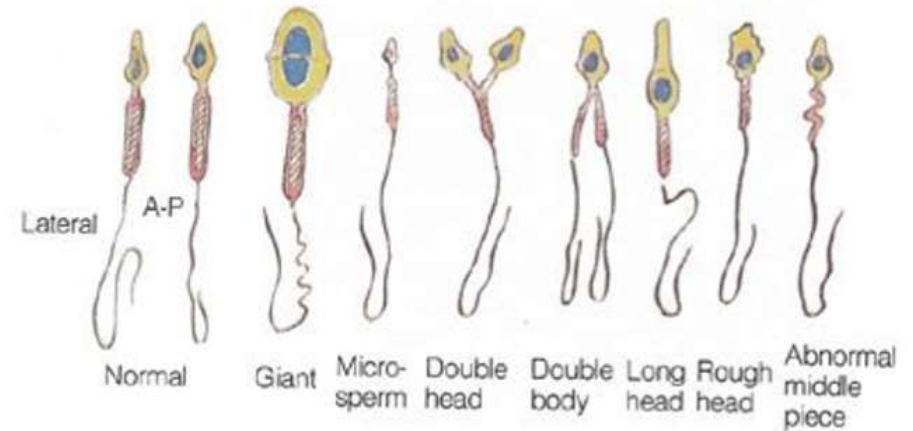
- (scrotal reflexes)
Protective mechanism.

3-Rate of metabolism → Proportional

the life expectancy of ejaculated sperm in the female genital tract is only 1 to 2 days.

Qualities of semen required for fertility

	Minimum required
Volume	2 mL
Sperm count	20 million/mL
Number of sperms /ejaculation	40 million
Alive sperms	75%
Motile sperms	50%
normal shape and structure	30%



* حتی عند ذل Fertile males

بکوتا عند ذل - abnormal shaped - sperms

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پس با سبب ذل 70% .

Male sexual response *not necessarily somatic, it could be*

1-Sensation: somatic

Genitalia & perineum → pudendal nerve → S2-S4

[visual, smell, Imagination ...]

→ Erection.
→ Micturition.
→ defecation.

2-Erection:

Controlled by **parasympathetic** nervous system

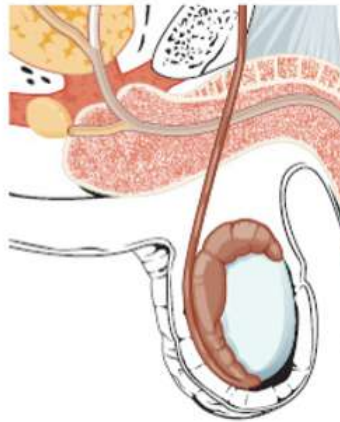
S2-S4 → Pelvic splanchnic nerve → pre-ortic & prostatic plexuses → penis

(deep penile arterioles) → **NO** → vasodilation of penile arterioles &

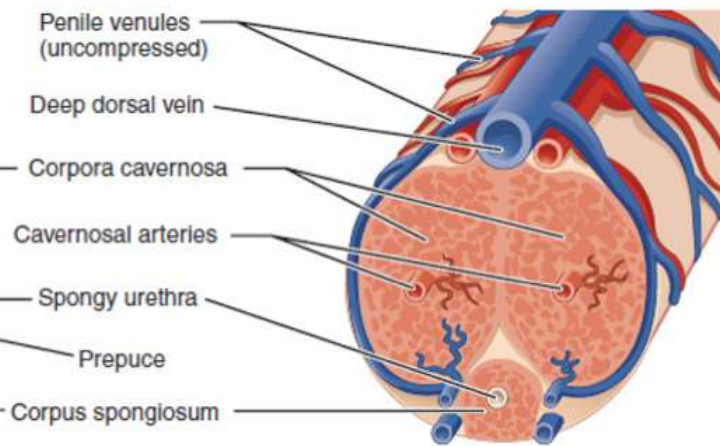
engorgement of erectile tissue & compression of veins causing reduction

in venous return → *Penis is erected.*

Flaccid: Lateral view

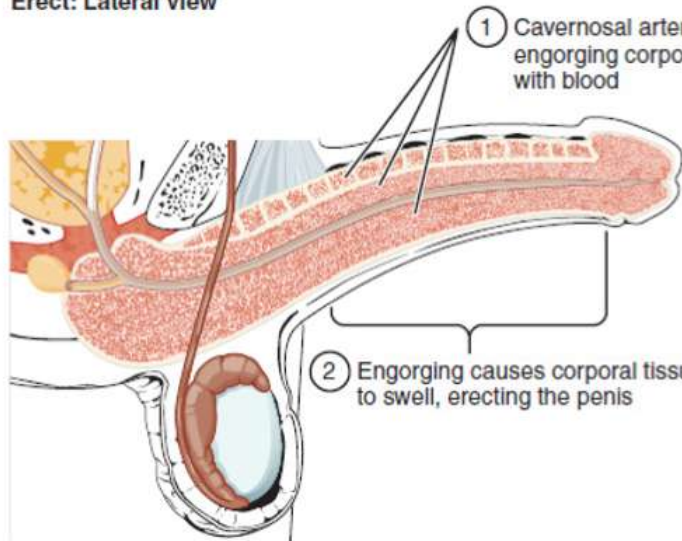


Flaccid: Transverse view



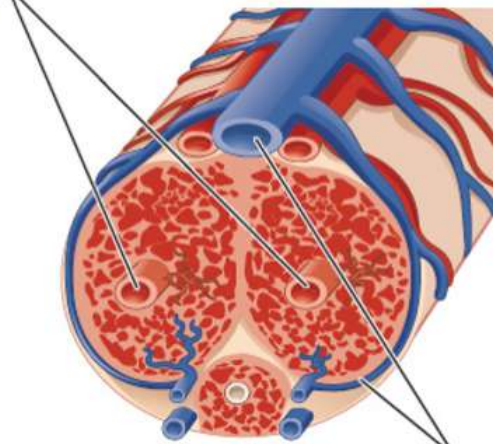
- Penile venules (uncompressed)
- Deep dorsal vein
- Corpora cavernosa
- Cavernosal arteries
- Spongy urethra
- Prepuce
- Corpus spongiosum

Erect: Lateral view



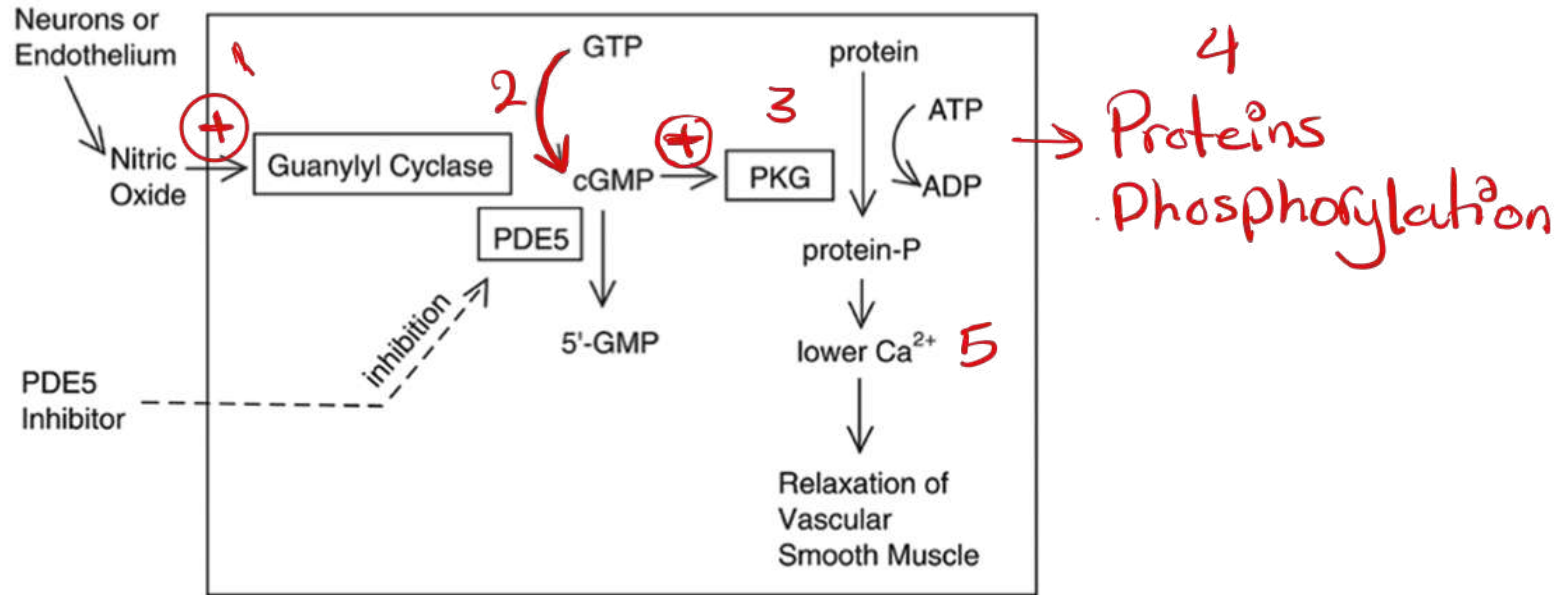
- 1 Cavernosal arteries dilate, engorging corporal tissue with blood
- 2 Engorging causes corporal tissue to swell, erecting the penis

Erect: Transverse view



- 3 Engorged corporal tissue compresses penile veins and venules, maintaining erection

Regulation of Smooth Muscle
Relaxation and Effect of PDE5 inhibitors



-- NO → protein kinase G (PKG) → dec Ca⁺⁺ → relaxation } inhibition of the inhibitor

Erectile dysfunction: phosphodiesterase-5 inhibitors: sildenafil citrate, vardeafil, tadalafil

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* phosphodiesterase - 5 → cleaves & degrades cGMP → 5'-GMP
→ ⊖ the Pathway

Male sexual response

3-Emission:

movement of ejaculate into proximal part of urethra

under sympathetic control (T10-L2, Lumbar & sacral splanchnic nerve) →

sequential peristaltic contraction of smooth muscle of vas deferens

closing of internal urethral sphincter to avoid retrograde ejaculation.

Semen → bladder

→ Semen & Urine get mixed.

* male orgasm → during ejaculation in all males.

Male sexual response

4-Ejaculation:

Spinal reflex → triggered by entry of semen into urethra → causes motor nerve impulses by **pudendal nerve (S2-S4)** to activate perineal muscles → forcibly expel semen from urethra

* Orgasm: culmination of sexual excitation

↪ Vasculature

Detumescence: (flaccidity) NE from **sympathetics**, endothelin = contraction of smooth muscle and inc venous outflow

* NE & Endothelin → vasoconstriction

Sympathetic Stimulation نتيجة { → Penis Blood flow ↓
→ Erection ↓

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Testosterone and other male sex hormones

- Androgens → masculinizing effects → مظاهر الذكورة
- Androgen secretion sites
 - 1- Testes → Interstitial **cells of Leydig** in the testes → secrete androgens (testosterone, DHT & androstenedione)
 - 2- Adrenals (<5% of total androgens in male)
- Testosterone is **the most abundant** male testicular androgen
- DHT is the active form of T

Testosterone and other male sex hormones

- T is secreted in:

- 1- Newborn male infant (Only for the first few months of life)
- 2- Adult male after puberty

- ✱ Germinal epithelium of the testes is more sensitive for radiation or excessive heat than Leydig cells ^{heat resistant} → impaired spermatogenesis but normal testosterone production.

لا يعني اجاب فريضه يستغل بناجم فهم
وكان infertile ← نسبة هورمون

ال Testosterone بالمستويات

الطبيعية.

The different stages of male sexual function as reflected by average plasma testosterone concentrations (red line) and sperm production (blue line) at different ages.

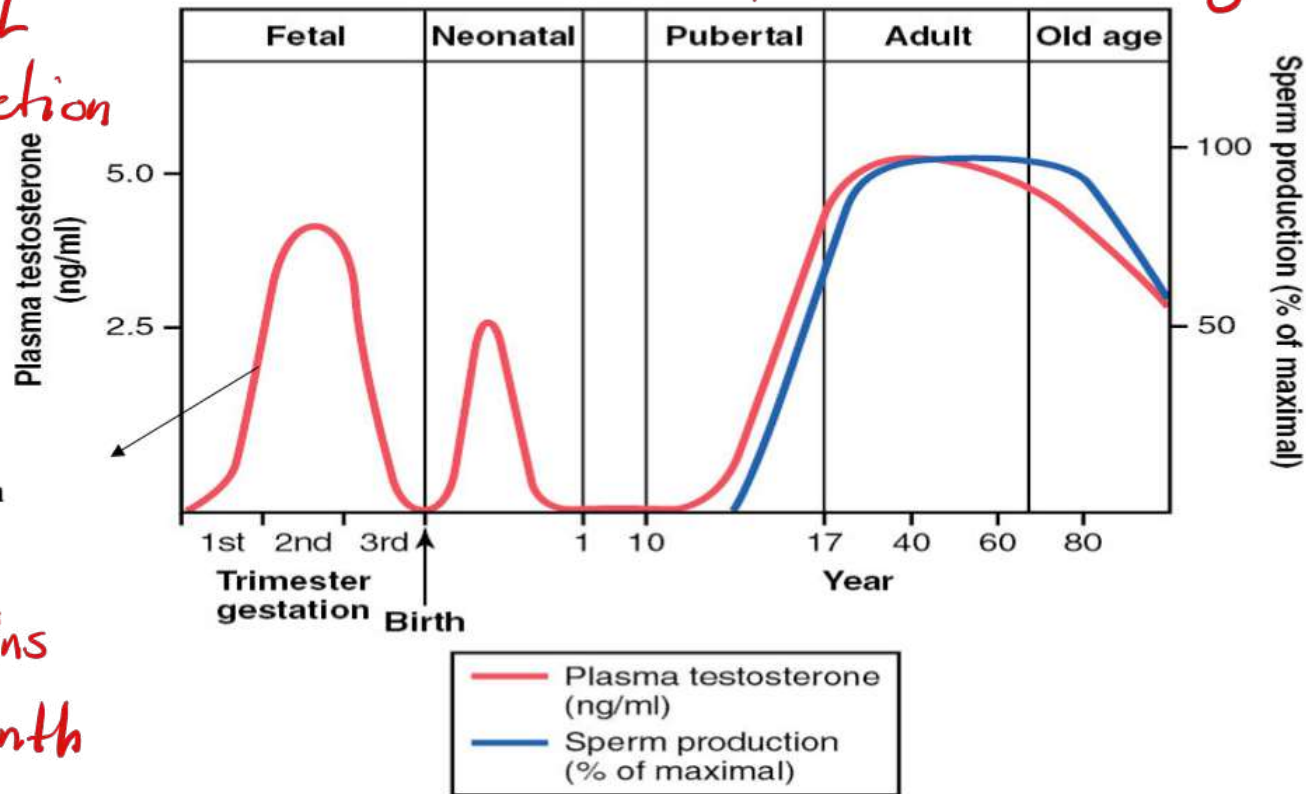
→ stimulated by GnRH.

Fetal & Neonatal testosterone secretion is stimulated by hCG

chorionic gonadotropin from the placenta

it's effect remains til the first month after delivery.

then Testosterone secretion stops until Puberty.



(Modified from Griffin JF, Wilson JD: The testis. In: Bondy PK, Rosenberg LE [eds]: Metabolic Control and Disease. 8th ed. Philadelphia: WB Saunders, 1980.)

Male Reproductive Hormones

Placental **chorionic gonadotropins (hCG)** → fetal and neonatal testosterone secretion

* Gonadotropins → Puberty & adulthood - No secretion during childhood

- Gonadotropin releasing hormone (GnRH) → LH & FSH.
- LH stimulates cells in the testes to produce testosterone → spermatogenesis.
- FSH stimulates spermatogenesis. *Sertoli cells.*

Functions of Testosterone During Fetal Development

- Stimulated by hCG

- 7th week of embryonic life → Testosterone secreted first by the genital ridges
- Later by the fetal testes

* Before the development of Testes.

• Functions:

1- Development of the male body characteristics:

Formation of penis, scrotum, prostate gland, seminal vesicles, & male genital ducts

* at the same time suppressing the formation of female genital organs

NO TESTESTERONE → NO MALE GENITALIA

2- Descends testis to scrotum

during intrauterine life are in the abdomen.

→ testes

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* Testosterone يمكن تصنيعه
ملاحة
males with
undescended testes
→ surgical more common.

Functions of testosterone-Puberty

- Pubertal growth of penis, scrotum, and testes to 8X
- Development of secondary sexual characteristics of the male & spermeiogenesis

→ In female the Testosterone Secreted by the adrenal glands is responsible for body hair distribution

Functions of testosterone

Secondary male sexual characteristics	
Body hair distribution	Pubis, face, chest, back, linea alba, etc <u>T</u> → Secreted in Testes/Males Male Pattern Baldness → T ↓ growth of hair on the top of the head (androgen & genetic factors)
Voice	Masculine voice → hypertrophy of laryngeal mucosa and larynx
Skin	↑ Skin thickens ↑ sebaceous glands secretion and oil production → acne * لعين أثناء مرحلة البلوغ الذكور معززين أكثر حب الشباب
Protein & muscle development	↑ muscle mass & ↑ protein * Makes bone density > Female's
Bone - than females ←	Increases Bone Matrix → protein anabolic function & Ca retention * Earlier closure of epiphyses * Strong & long pelvis & narrow pelvic outlet → funnel-like shape
Others	↑ metabolic rate, RBC number, Na reabsorption. RBCs, Hb >

Testosterone in aging:

decrease slowly after age 40
decreased bone formation, muscle mass,
decreased growth of facial hair, appetite,
decreased libido

LH not changed; FSH increased with aging in men

أعراض نقص ال T أقل سُدةً عن
نقص ال Estrogen عند ال Females
اللي يمكن يؤدي ل Osteoporosis

* على الرغم من ذلك مستوى
هرمون ال T مع التقدم بالهرس
إلا إنه الذكور يتسمر عندهم
عملية ال spermatogenesis كعمر كبير.

Dihydrotestosterone (DHT) function

- **Fetal** development of penis, penile urethra, scrotum, prostate
- **Pubertal** growth of scrotum, prostate, pubic hair, sebaceous glands

 **Prostatic secretion**

Testosterone and other male sex hormones

Estrogen

- Small amounts formed by **Sertoli cells**.

①

Testosterone → estradiol

- important role in spermiogenesis (Spermatide → Sperm)

②

Much larger amounts (80%) of estrogens are formed from T and androstenediol in other tissues of the body, especially the **liver**.

only 5%

①

80%

②

* فقط ال Estrogen بالذكور هو هرمون ال T