

Date:

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لجان الدفعات



تفريغ فسيولوجي



موضوع المحاضرة: Reproductive system
part 1

رقم المحاضرة: 20

إعداد الصيدلانية: Sara Sawalmeh

(Lec-14) Reproductive System



PHYSIOLOGY

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LECTURE 14-REPRODUCTIVE SYSTEM

THE REPRODUCTIVE SYSTEMS

- The **male and female reproductive** organs **work together** to **produce offspring**. ^{النسل}
- In addition, the **female reproductive** organs contribute to sustaining the growth of embryos and fetuses. ^{استدامة}
- **Sexual reproduction** is the process by which organisms produce offspring by making germ cells called **gametes**.
- After the male gamete (sperm cell) unites with the female gamete (secondary oocyte)—an event called **fertilization**—the resulting cell contains one set of chromosomes from each parent.
- Males and females have anatomically distinct reproductive organs that are **adapted for** **producing gametes**, **facilitating fertilization**, and, **in females, sustaining the growth of the embryo and fetus**. ^{1 2 3}

* كيف يتم إنتاج offspring ← عن طريق sexual reproduction هو
* ال gamete الناتج من ال male يحد مع ال gamete الناتج من ال female ليجلج اسمها
ال Fertilization ينتج عن offspring وهذا يحتوي على ← one set of chromosomes from each parent.

(slide 1)

Sperm cell ← ^{أنثى} male gamete *

Secondary Oocyte ← ^{ذكر} Female gamete

Female reproductive organ. ^{أعضاء التناسل الأنثى} male reproductive organ. ^{أعضاء التناسل الذكر}

• ركن الألتين من الأعضاء التناسلية

THE REPRODUCTIVE SYSTEMS

❖ The male and female reproductive organs can be grouped by function.

❖ The gonads—testes in males and ovaries in females—produce gametes and secrete sex hormones.
 → function of ovaries and testes

❖ Various ducts then store and transport the gametes.
 → Secondary of sperm and oocyte

❖ Accessory sex glands produce substances that protect the gametes and facilitate their movement.

❖ Finally, supporting structures, such as the penis in males and the uterus in females, assist the delivery of gametes, and the uterus is also the site for the growth of the embryo and fetus during pregnancy.
 → in female

→ penis and uterus function → assist the delivery of gametes
only the uterus another function → the site for the growth of embryo and fetus during pregnancy.

MALE REPRODUCTIVE SYSTEM

❖ The organs of the male reproductive system include the testes, a system of ducts, accessory sex glands, and several supporting structures, including the scrotum and the penis.

* several supporting structures:

1- scrotum

2- penis

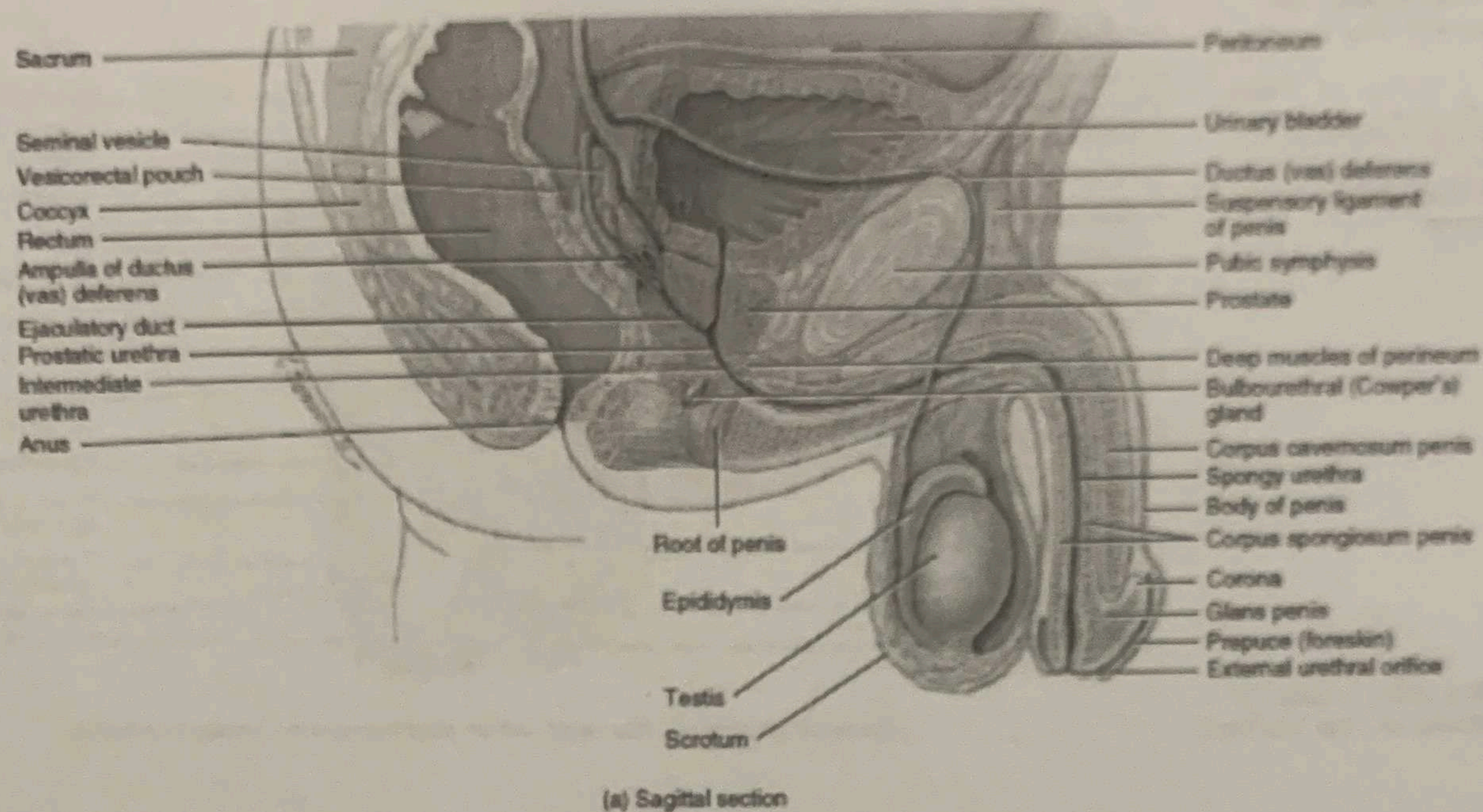
FUNCTIONS OF THE MALE REPRODUCTIVE SYSTEM

1. The testes produce sperm and the male sex hormone testosterone.
2. The ducts transport, store, and assist in maturation of sperm.
3. The accessory sex glands secrete most of the liquid portion of semen.
4. The penis contains the urethra, a passageway for ejaculation of semen and excretion of urine.

* testes → gonads / male sex hormone → testosterone

Figure 28.1 Male organs of reproduction and surrounding structures.

* Reproductive organs are adapted for producing new individuals and passing on genetic material from one generation to the next.



MALE REPRODUCTIVE SYSTEM

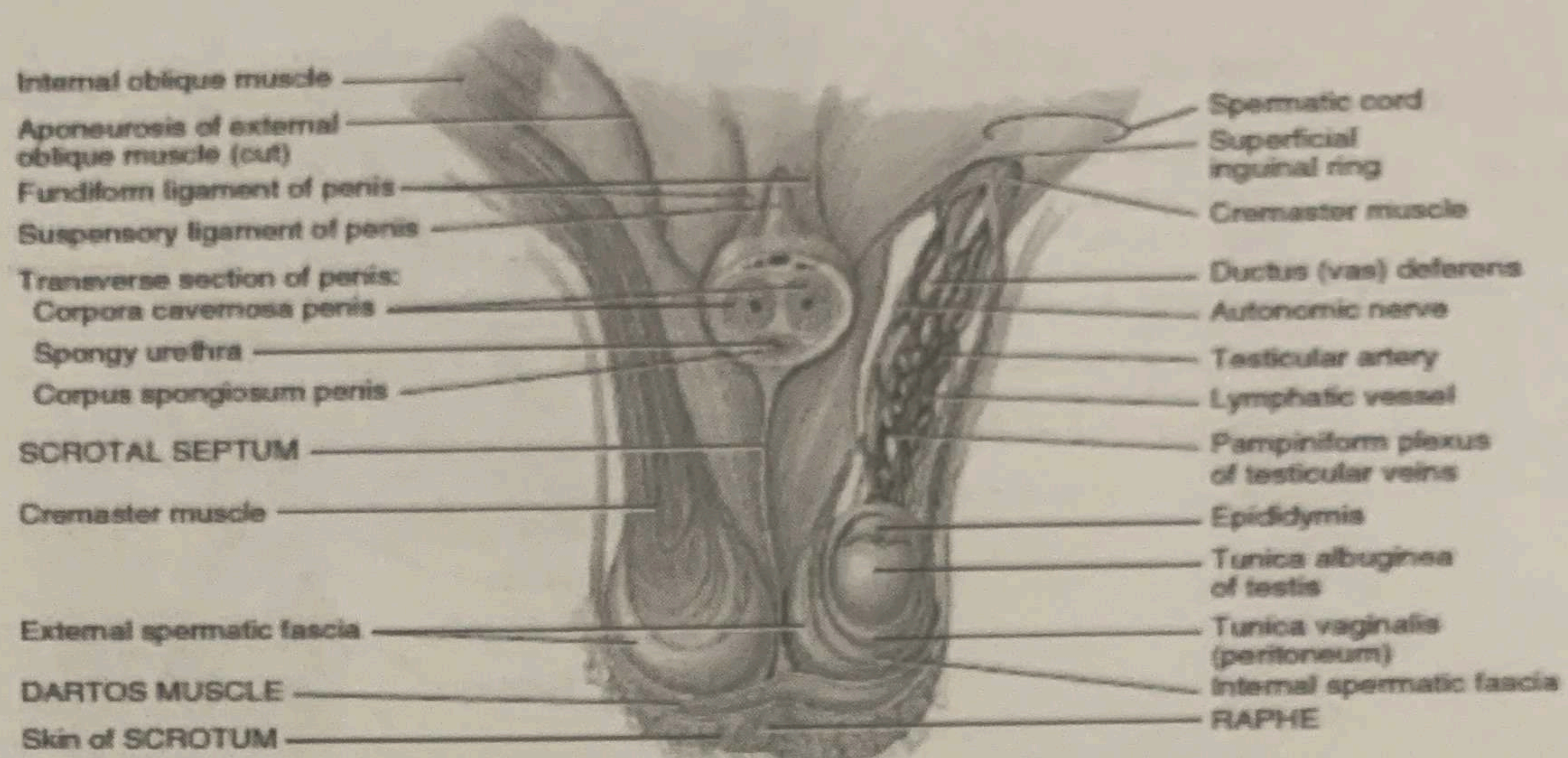
- ✓ The location of the scrotum and the contraction of its muscle fibers regulate the temperature of the testes.
- ✓ Normal sperm production requires a temperature about 2-3 Celsius below core body temperature.

* location of scrotum و contraction of muscle fibers of the scrotum
 function of scrotum
 testes temperature

MALE REPRODUCTIVE SYSTEM

Figure 28.2 The scrotum, the supporting structure for the testes.

* The scrotum consists of loose skin and an underlying subcutaneous layer and supports the testes.



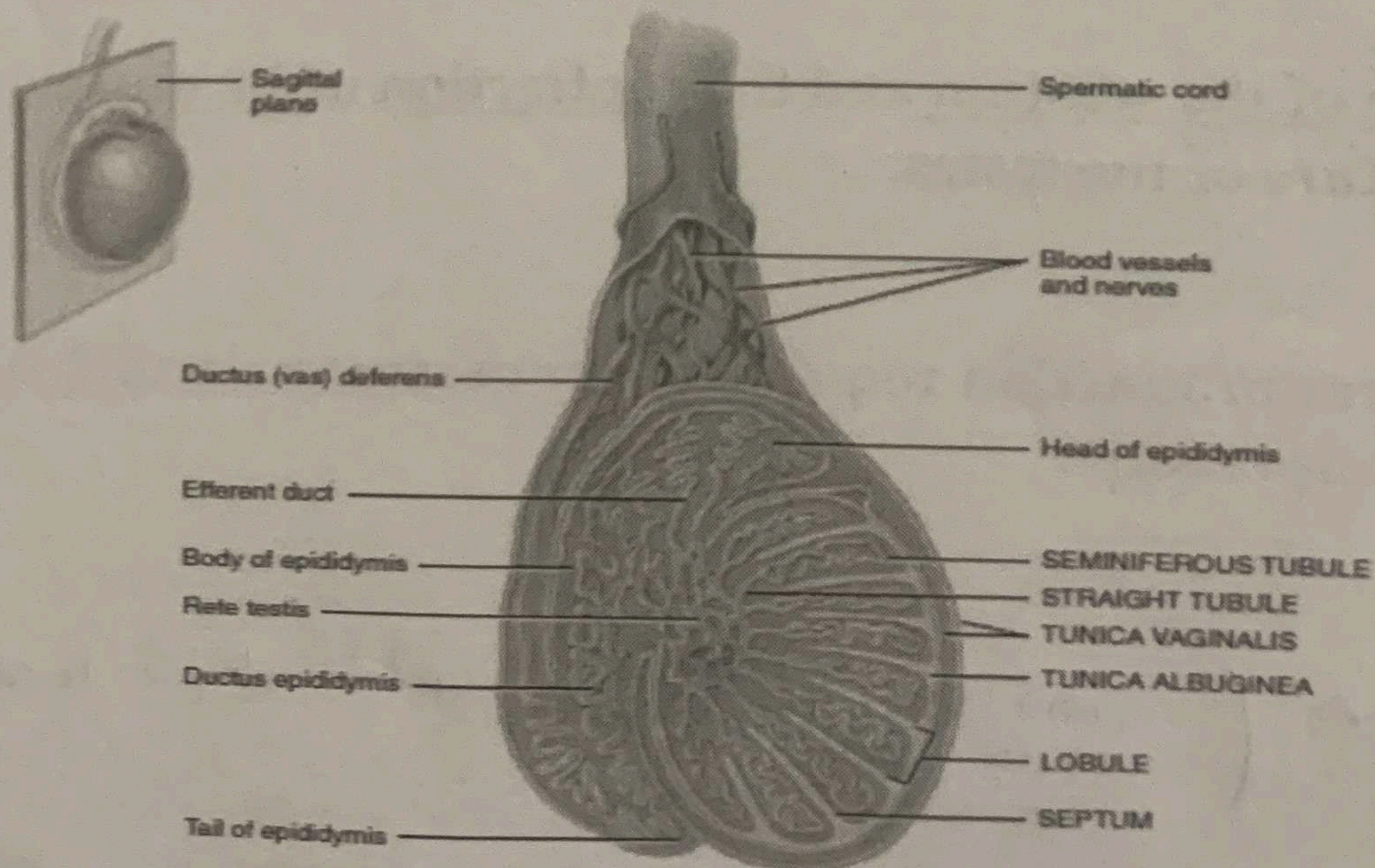
Anterior view of scrotum and testes and transverse section of penis

Which muscles help regulate the temperature of the testes?

MALE REPRODUCTIVE SYSTEM

Figure 28.3 Internal and external anatomy of a testis.

The testes are the male gonads, which produce haploid sperm.



(a) Sagittal section of testis showing seminiferous tubules

* sperm يكون haploid

haploid يكون يحتوي على نصف عدد الكروموسومات
23 ← في الإنسان (1n)

diploid يكون يحتوي على العدد الكامل من الكروموسومات
46 ← في الإنسان (2n)

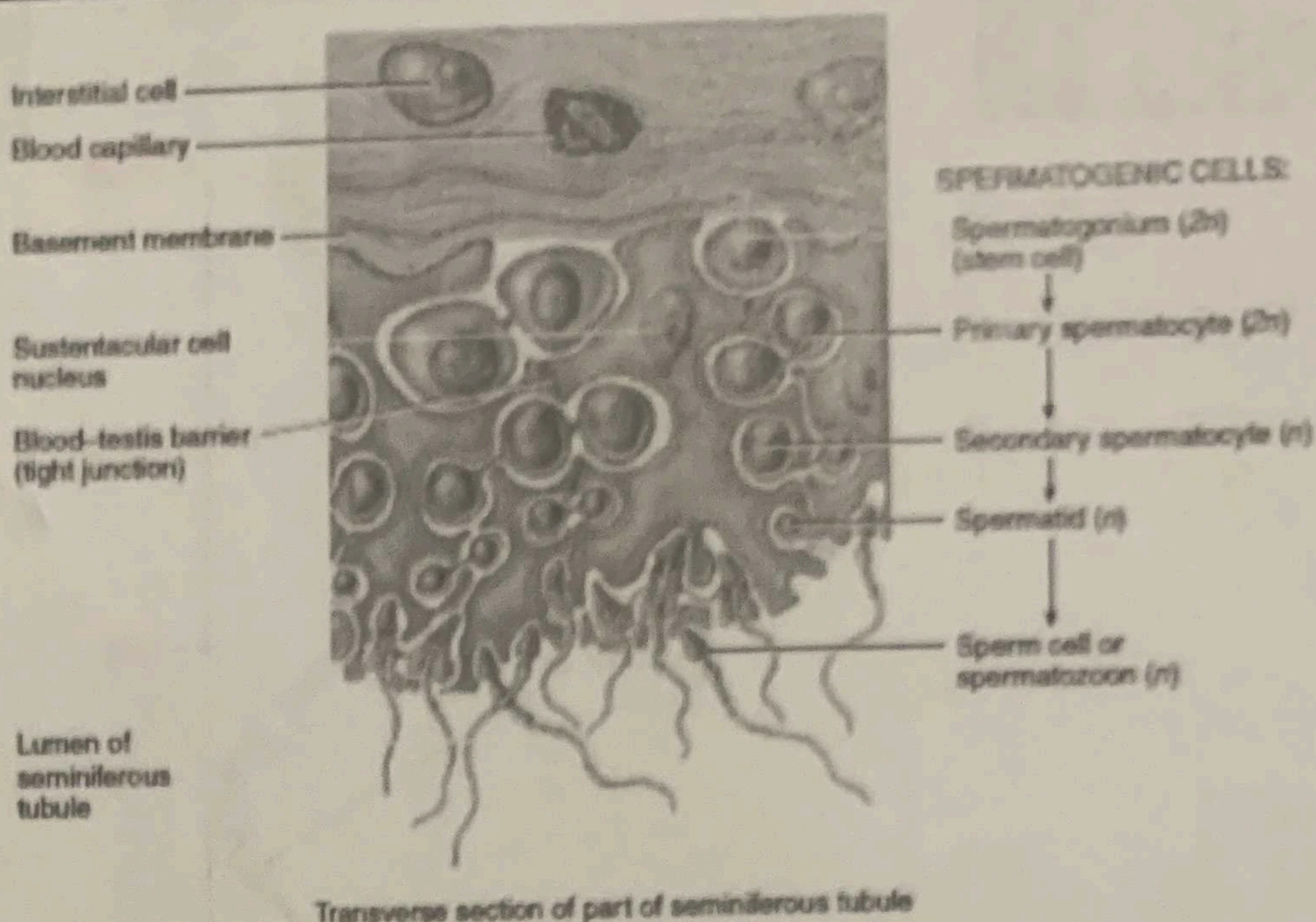
23 Female 23 male

Full set of chromosome ← بنيت cell يحتوي على

46

Figure 28.4 Microscopic anatomy of the seminiferous tubules and stages of sperm production (spermatogenesis). Arrows indicate the progression of spermatogenic cells from least mature to most mature. The (n) and ($2n$) refer to haploid and diploid numbers of chromosomes, respectively.

🔑 Spermatogenesis occurs in the seminiferous tubules of the testes.

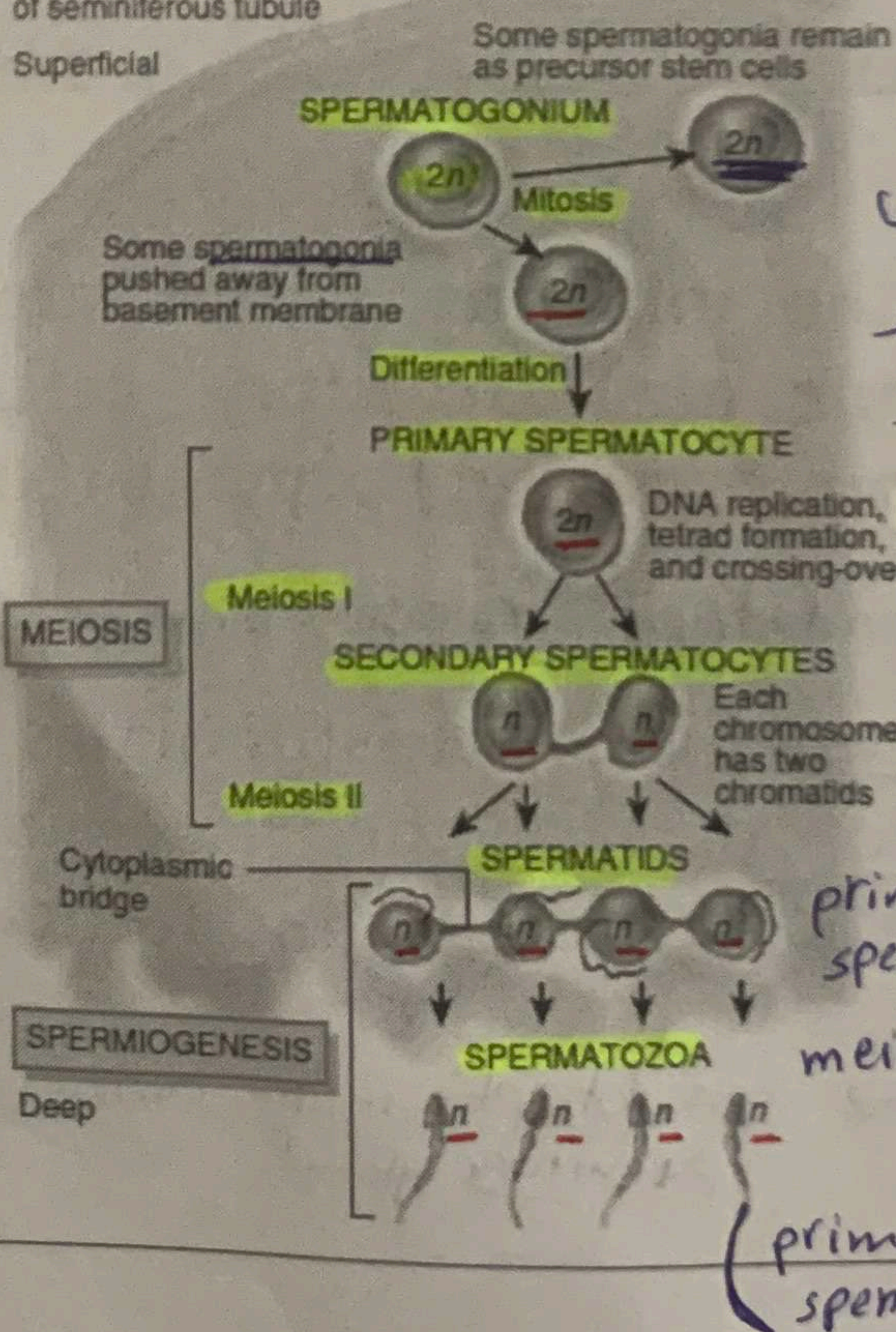


? Which cells secrete testosterone?

Figure 28.5 Events in spermatogenesis. Diploid cells ($2n$) have 46 chromosomes; haploid cells (n) have 23 chromosomes.

🔑 Spermiogenesis involves the maturation of spermatids into sperm.

Basement membrane of seminiferous tubule
Superficial



❑ **Spermatogonium:**

➤ A cell produced at an early stage in the formation of spermatozoa, formed in the wall of a seminiferous tubule and giving rise by mitosis to spermatocytes.

* أول الخلية يتم انتاجها في testes هو الـ spermatogonium

شرح الصورة
* sperm cell لا يتم انتاجها مباشرة اول شيء بجير عن الـ mitosis والـ

mitosis بجير الـ spermatogonium

بعد ان هاتي الـ spermatocyte بجير الـ differentiation

تبعطينا الـ primary spermatocyte

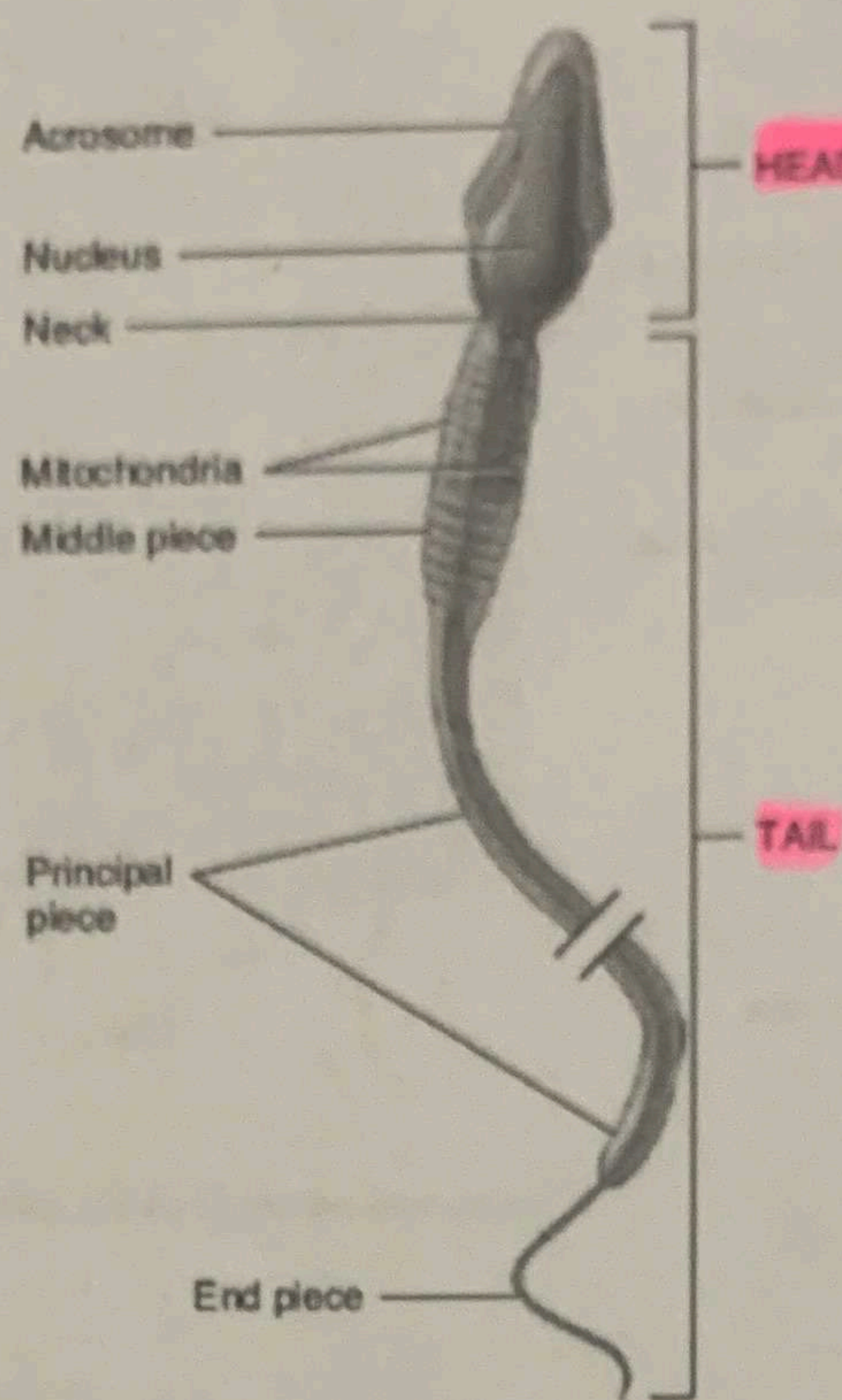
والتي بجير الـ meiosis I و meiosis II

وينتج من الـ (primary spermatocyte)

في الـ meiosis I الـ secondary spermatocyte
في الـ meiosis II يتم انتاج الـ spermatids وبالنهاية يتم انتاج sperm cell

Figure 28.6 Parts of a sperm cell.

About 300 million sperm mature each day.



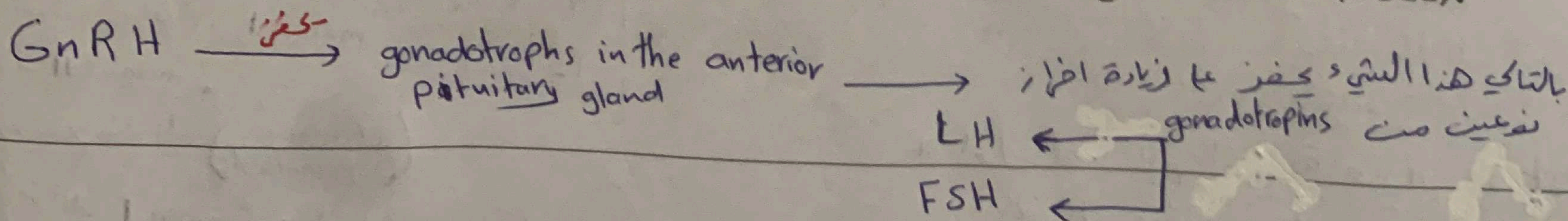
sperm consists of

HORMONAL CONTROL OF TESTICULAR FUNCTION

* Although the initiating factors are **unknown**, **at puberty** certain **hypothalamic neurosecretory cells** increase their secretion of **gonadotropin-releasing hormone (GnRH)**.

→ gonadotropin - releasing hormone

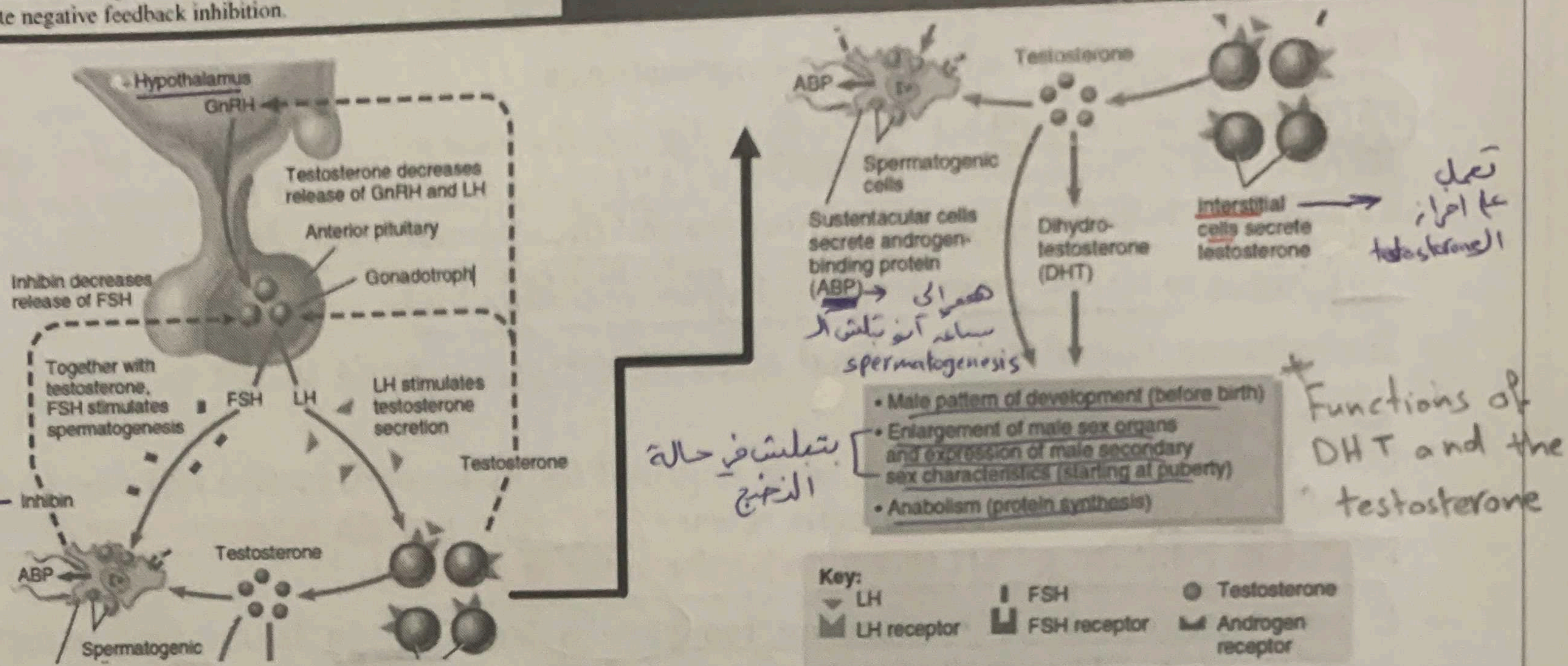
❖ **This** hormone in turn stimulates gonadotrophs in the anterior pituitary to increase their secretion of the two gonadotropins, luteinizing hormone (LH) and follicles-stimulating hormone (FSH).



* الفرق بين LH و FSH

Figure 28.7 Hormonal control of spermatogenesis and actions of testosterone and dihydrotestosterone (DHT). In response to stimulation by FSH and testosterone, sustentacular cells secrete androgen-binding protein (ABP). Dashed red lines indicate negative feedback inhibition.

Release of FSH is stimulated by GnRH and inhibited by inhibin. Release of LH is stimulated by GnRH and inhibited by testosterone. → why → as a feedback regulation.



HORMONAL CONTROL OF TESTICULAR FUNCTION

- ❖ LH stimulates **interstitial cells**, which are located between seminiferous tubules, to secrete the hormone testosterone.
 - testosterone ← **This steroid hormone** is synthesized from cholesterol in the testes and is the principal androgen.
 - testosterone ← **It is lipid-soluble** and **readily diffuses out of interstitial cells into the interstitial fluid** and then into blood.
 - testosterone or the steroid hormone. ❖ **Via negative feedback**, testosterone suppresses secretion of LH by anterior pituitary gonadotrophs and suppresses secretion of GnRH by hypothalamic neurosecretory cells.
 - ❖ In some target cells, such as those in the external genitals and prostate, the enzyme 5 alpha-reductase converts testosterone to another androgen called dihydrotestosterone (DHT).

* testosterone
 via negative feedback.
 
 inhibit secretion of LH by anterior pituitary gland.
 inhibit secretion of GnRH by hypothalamic neurosecretory cells.

* hypothalamus في مرحلة النموذج تعمل مع افراز كمية كبيرة من GnRH

- GnRH يحفز الـ (Anterior pituitary) مع انفا تنسج اكثر FSH و اكثر LH.

- LH يعمل تحفيزا لـ testosterone فعند ارتفاع الـ (LH) يرتفع من الـ level of testosterone

- FSH يتم تثبيطه أو تقليله من هرمون يسمى الـ (inhibin)

- testosterone إلى ثم انتاجه من LH و FSH يساهم بعملية الـ spermatogenesis

HORMONAL CONTROL OF TESTICULAR FUNCTION

- FSH acts indirectly to stimulate spermatogenesis.
- FSH and testosterone act synergistically on the sustentacular cells to stimulate secretion of androgen-binding protein (ABP) into the lumen of the seminiferous tubules and into the interstitial fluid around the spermatogenic cells.
- ABP binds to testosterone, keeping ^{testosterone} its concentration high.
- Testosterone stimulates the final steps of spermatogenesis in the seminiferous tubules.
- Once the degree of spermatogenesis required for male reproductive functions has been achieved, sustentacular cells release inhibin, a protein hormone named for its role in inhibiting FSH secretion by the anterior pituitary.
- If spermatogenesis is proceeding too slowly, less inhibin is released, which permits more FSH secretion and an increased rate of spermatogenesis.

بالتالي

HORMONAL CONTROL OF TESTICULAR FUNCTION

[Testosterone and dihydrotestosterone] both bind to the same androgen receptors, which are found within the nuclei of target cells.

this receptor

Function

The hormone-receptor complex regulates gene expression, turning some genes on and others off.

Because of these changes, the androgens produce several effects:

→ Hormones that contribute to growth and reproduction in men.

THE ANDROGENS PRODUCE SEVERAL EFFECTS:

1. Prenatal development:

- Before birth, testosterone stimulates the male pattern of development of reproductive system ducts and the descent of the testes.

تسلسل على
مرحلة الجنين

- Testosterone also is converted in the brain to estrogens (feminizing hormones), which may play a role in the development of certain regions of the brain in males.

THE ANDROGENS PRODUCE SEVERAL EFFECTS:

2. Development of male sexual characteristics:

- At puberty, testosterone and dihydrotestosterone bring about development and enlargement of the male sex organs.

3. Development of sexual function:

- Androgens contribute to male sexual behavior and spermatogenesis and to sex drive (libido) in both males and females.

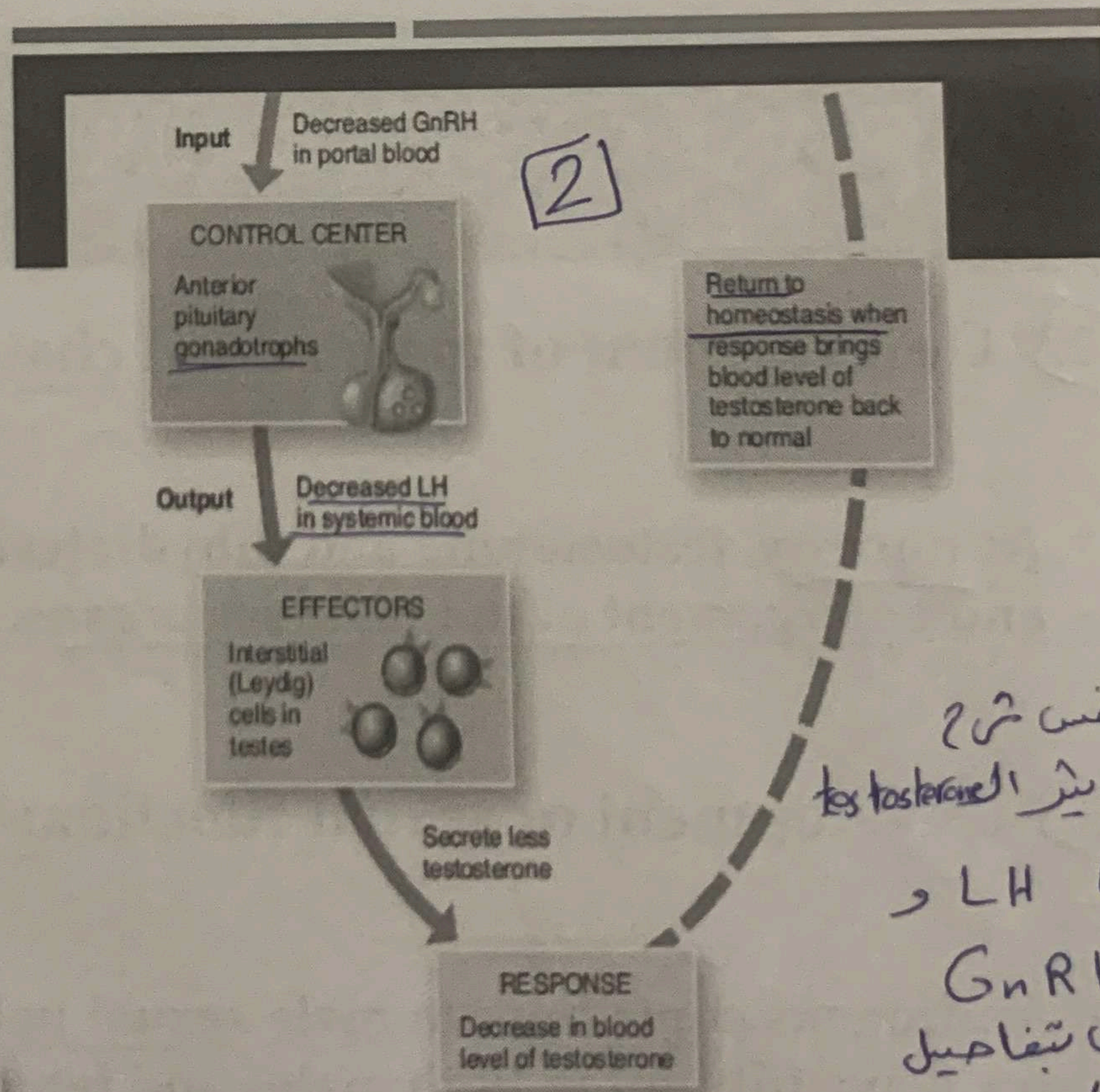
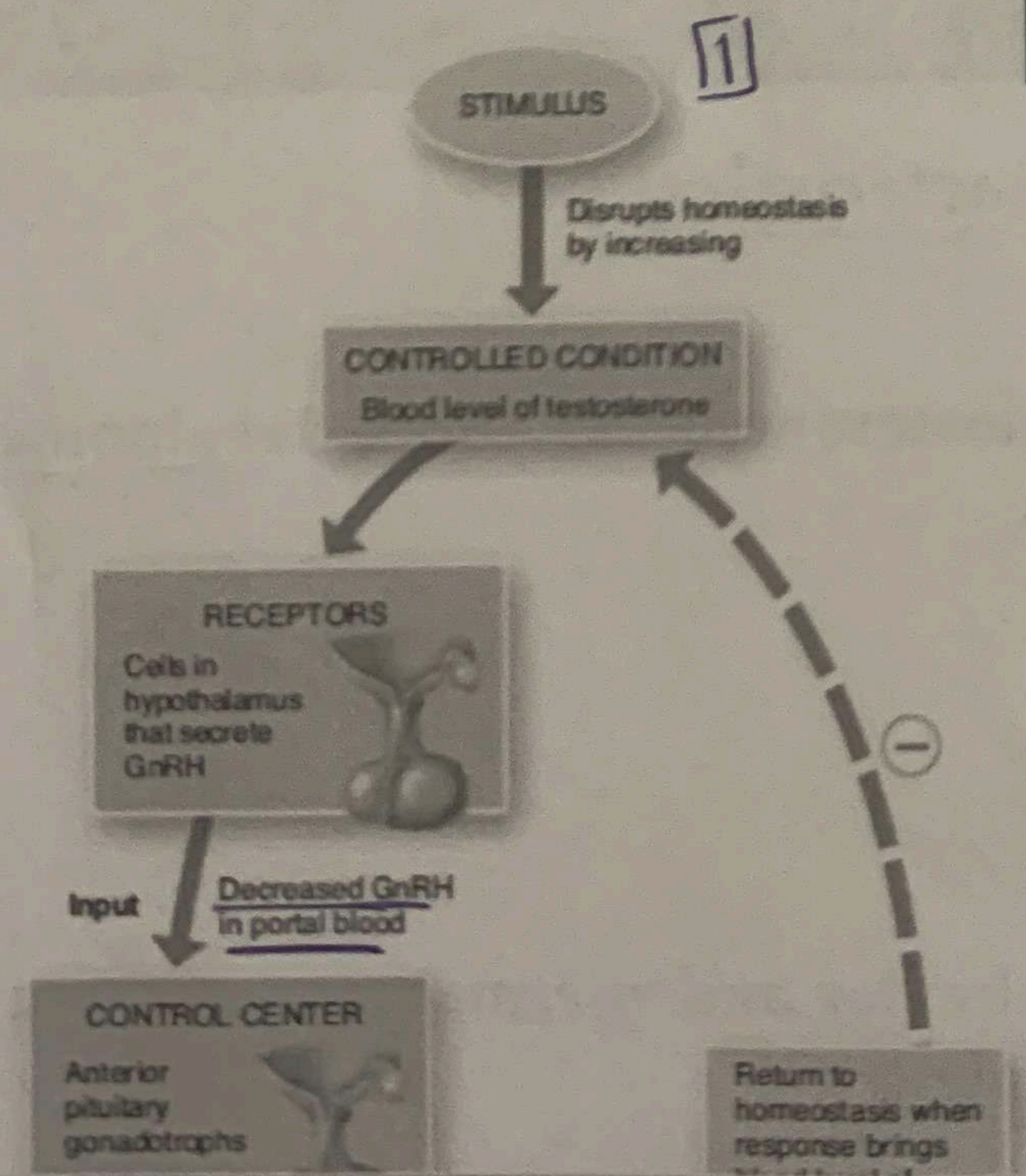
THE ANDROGENS PRODUCE SEVERAL EFFECTS:

4. Stimulation of anabolism:

- Androgens are anabolic hormones; that is, they stimulate protein synthesis. This effect is obvious in the heavier muscle and bone mass of most men as compared to women. → more clear.

Figure 28.8 Negative feedback control of blood level of testosterone.

Key: Gonadotrophs of the anterior pituitary produce luteinizing hormone (LH).



* نفس شرح
تأثير testosterone
على LH و
GnRH
بمن تغاير
الكم.

FUNCTIONS OF ACCESSORY SEX GLAND SECRETIONS

FUNCTIONS OF ACCESSORY SEX GLAND SECRETIONS

- Seminal vesicles
↓
alkaline viscous fluid
↓
neutralization acid in the female reproductive tract
↓
1- sperm motility and viability
2- semen coagulate after ejaculation.

1. The seminal vesicles secrete an alkaline, viscous fluid that helps neutralize acid in the female reproductive tract, provides fructose for ATP production by sperm, contributes to sperm motility and viability, and helps semen coagulate after ejaculation.

2. The prostate secretes a milky, slightly acidic fluid that contains

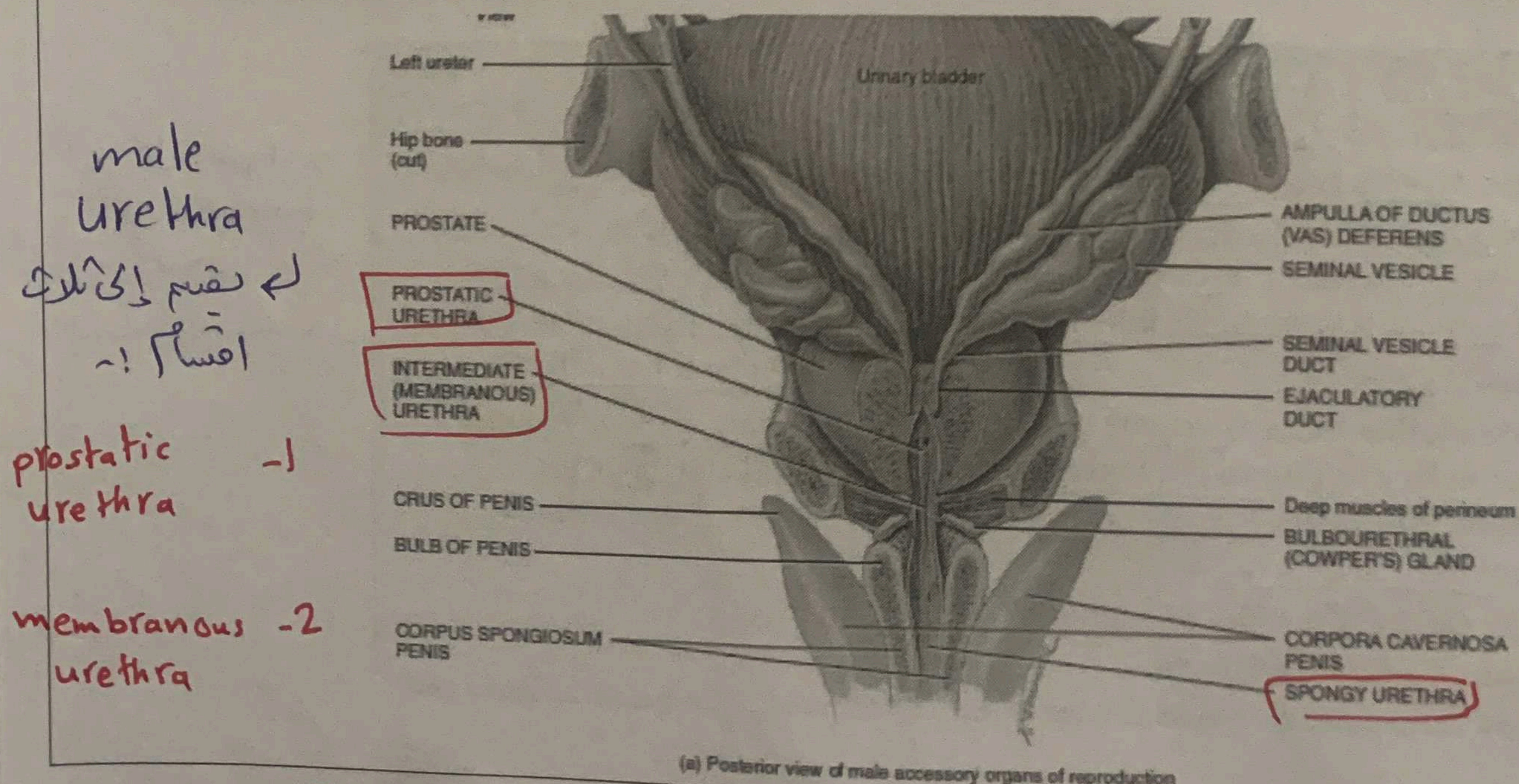
enzymes that break down clotting proteins from the seminal vesicles.

3. The bulbourethral glands secrete an alkaline fluid that neutralizes the acidic environment of the urethra and mucus that lubricates the lining of the urethra and the tip of the penis during sexual intercourse.

- bulbourethral gland
↓
alkaline fluid
↓
neutralization the acidic environment of urethra.
↓
mucus
↓
lubricates the lining of the urethra and the tip of the penis during sexual intercourse.

Figure 28.9 Locations of several accessory reproductive organs in males. The prostate, urethra, and penis have been sectioned to show internal details.

The male urethra has three subdivisions: the prostatic, membranous, and spongy (penile) urethra.



male urethra
← بقسمين رئيسيين
-1- prostatic urethra

-2- membranous urethra

-3- spongy urethra

(a) Posterior view of male accessory organs of reproduction

FEMALE REPRODUCTIVE SYSTEM

- The organs of the female reproductive system include the ovaries (female gonads); the uterine (fallopian) tubes, or oviducts; the uterus; the vagina; and external organs, which are collectively called the vulva, or pudendum.

مثل

FEMALE REPRODUCTIVE SYSTEM

FUNCTIONS OF THE FEMALE REPRODUCTIVE SYSTEM

1. The ovaries produce secondary oocytes and hormones, including progesterone and estrogens (female sex hormones), inhibin, and relaxin.
2. The uterine tubes transport a secondary oocyte to the uterus and normally are the sites where fertilization occurs.
3. The uterus is the site of implantation of a fertilized ovum,
4. The vagina receives the penis during sexual intercourse and is a passageway for childbirth.
5. The mammary glands synthesize, secrete, and eject milk for nourishment of the newborn.

* female sex hormones

- ↳ - progesterone
- estrogens

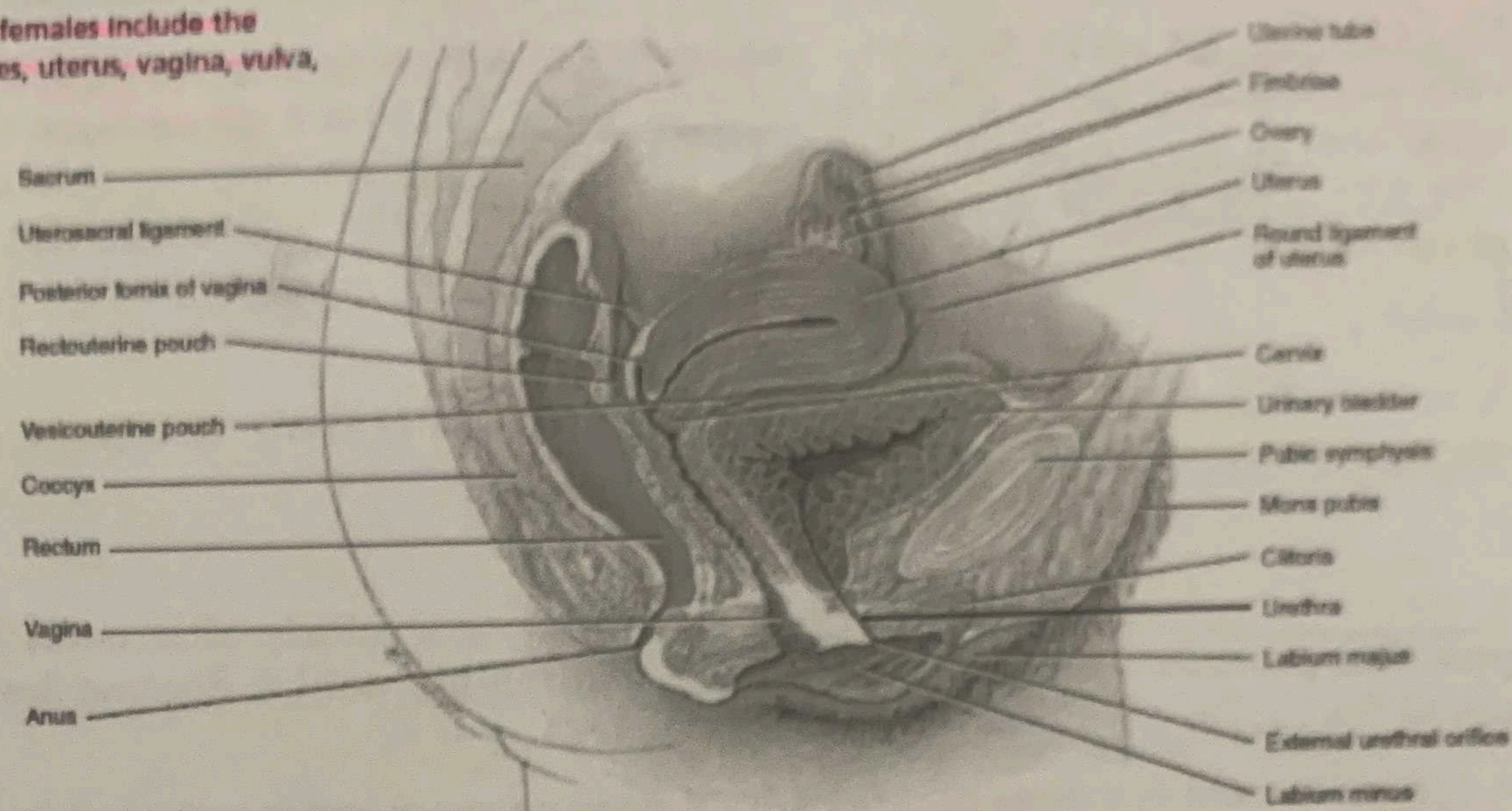
* the uterine (fallopian tubes)

- ↳ the site where fertilization occurs.

* كل organ
Function
تجو

Figure 28.11 Female organs of reproduction and surrounding structures.

The organs of reproduction in females include the ovaries, uterine (fallopian) tubes, uterus, vagina, vulva, and mammary glands.

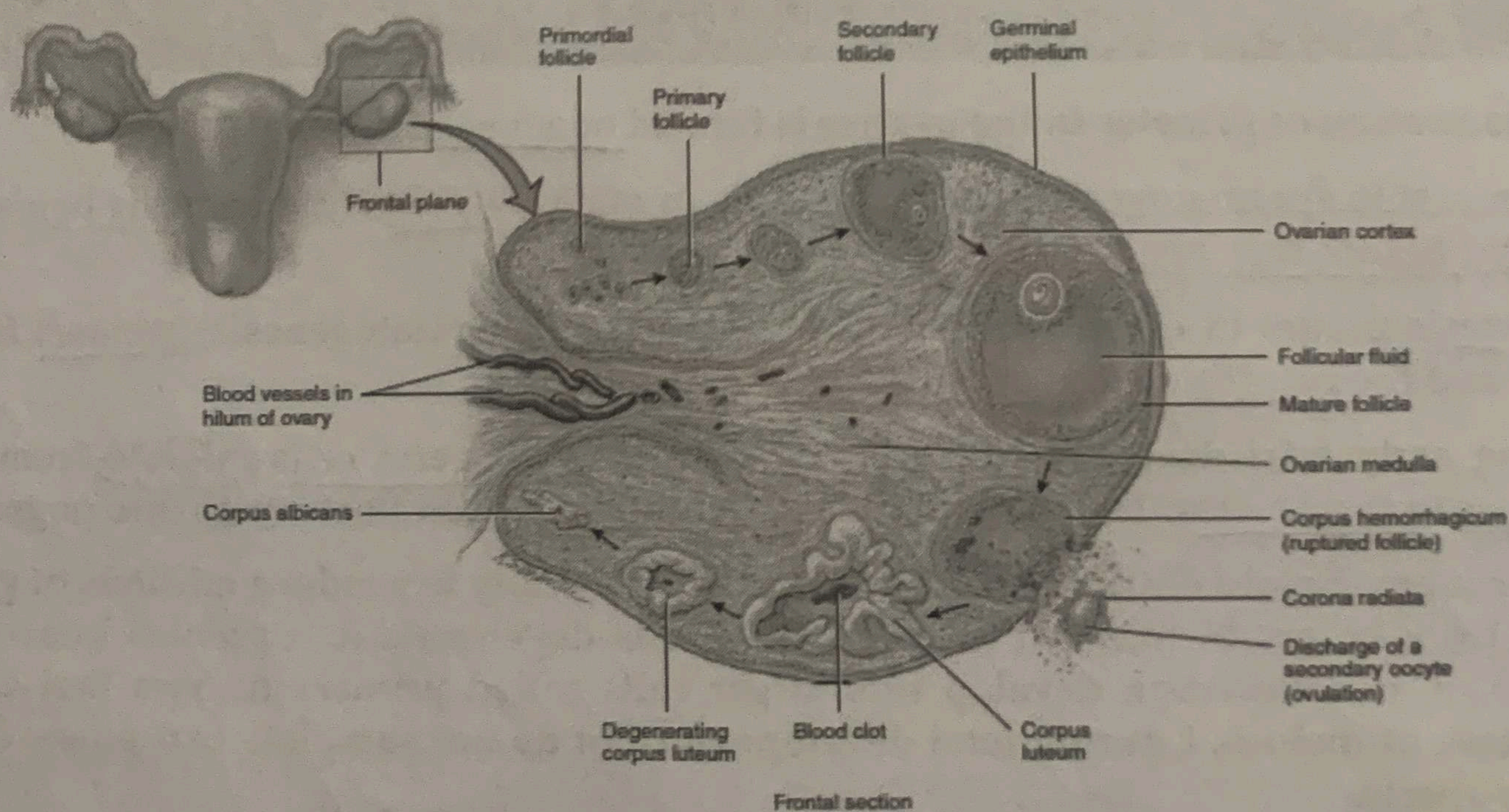


(a) Sagittal section

FIGURE 28.11 CONTINUES

Figure 28.13 Histology of the ovary. The arrows indicate the sequence of developmental stages that occur as part of the maturation of an ovum during the ovarian cycle.

The ovaries are the female gonads; they produce haploid oocytes.



THE FEMALE REPRODUCTIVE CYCLE

- Ovarian follicles are in the cortex and consist of oocytes in various stages of development, plus the cells surrounding them. When the surrounding cells form a single layer, they are called follicular cells; later in development, when they form several layers, they are referred to as granulosa cells. The surrounding cells nourish the developing oocyte and begin to secrete estrogens as the follicle grows larger.

Function:-

وحيث لمرحلة النضج

- A mature follicle is a large, fluid-filled follicle that is ready to rupture and expel its secondary oocyte, a process known as ovulation.

- A corpus luteum contains the remnants of a mature follicle after ovulation. The corpus luteum produces progesterone, estrogens, relaxin, and inhibin until it degenerates into fibrous scar tissue called the corpus albicans.

- A corpus luteum is a mass of cells that forms in an ovary and is responsible for the production of the hormone progesterone during early pregnancy.

الهرمونات التي يفرزها

later on. corpus luteum يحترق عليه degeneration ويحول إلى Fibrous scar tissue corpus albicans

THE FEMALE REPRODUCTIVE CYCLE

- The formation of gametes in the ovaries is termed oogenesis.

عملية تكوين البويضات في المبايض

- In contrast to spermatogenesis, which begins in males at puberty, oogenesis begins in females before they are even born.

الفرد
بنت
عملية
تكوين

- Oogenesis occurs in essentially the same manner as spermatogenesis; meiosis takes place and the resulting germ cells undergo maturation.

المبايض
من
male
female

- During early fetal development, primordial (primitive) germ cells migrate from the yolk sac to the ovaries. There, germ cells differentiate within the ovaries into oogonia.

- Oogonia are diploid (2n) stem cells that divide mitotically to produce millions of germ cells. Even before birth, most of these germ cells degenerate in a process known as atresia. A few, however, develop into larger cells called primary oocytes that enter prophase of meiosis I during fetal development but do not complete that phase until after puberty.

* During early fetal development

primordial (primitive)
germ cell

migrate



from yolk sac to the ovaries



the germ cell differentiate
ovaries داخل البويضات

تتحول لـ

oogonia
(diploid $2n$)

mitosis
تنتج



millions of
germ cells

بمجرد انشاء degeneration في عملية موتها
atresia

later on بعض من هاتي germ cells بحيرتها develop لـ larger cells
بنتسها primary oocytes ← هاتي ال primary oocytes تدخل ال prophase

لا during fetal dev. meiosis I لكن ما يتكمل هاتي ال phase

until after puberty
(يعني لا تنتهي إلا بعد البلوغ)

THE FEMALE REPRODUCTIVE CYCLE

- During ^{early fetal development} this arrested stage of development, each primary oocyte is surrounded by a single layer of flat follicular cells, and the entire structure is called a primordial follicle.
- At birth, approximately 200,000 to 2,000,000 primary oocytes remain in each ovary. Of these, about 40,000 are still present at puberty, and around 400 will mature and ovulate during a woman's reproductive lifetime. The remainder of the primary oocytes undergo atresia.
- Each month after puberty ^{كثرة البويضات} until menopause, gonadotropins (FSH and LH) secreted by the anterior pituitary further stimulate the development of several primordial follicles, although only one will typically reach the maturity needed for ovulation.
- A few primordial follicles start to grow, developing into primary follicles.
- Each primary follicle consists of a primary oocyte that is surrounded in a later stage of development by several layers of cuboidal and low-columnar cells called granulosa cells.

* primary oocyte is surrounded by a single layer of flat follicular cells.

* but if the primordial follicles start to grow into primary follicles

several layers of cuboidal and low columnar cells called granulosa cells. ← primary oocyte

للنضار (primary) oocyte
أي موجودة داخل follicle

THE FEMALE REPRODUCTIVE CYCLE

- The outermost granulosa cells rest on a basement membrane. As the primary follicle grows, it forms a clear glycoprotein layer called the zona pellucida between the primary oocyte and the granulosa cells.

- In addition, ^{تبط}stromal cells surrounding the basement membrane begin to form an organized layer called the theca folliculi.

→ Function of stromal cells

* primary follicle grows

- 1 Form clear glycoprotein layer called zona pellucida.
- 2 Form the theca folliculi →

← هاء الطبقة من نوال (primary) follicle
تكونها الstromal cell

THE FEMALE REPRODUCTIVE CYCLE

- With continuing maturation: → to the primary follicle
- ❖ A primary follicle develops into a secondary follicle.
- ❖ In a secondary follicle, the theca differentiates into two layers.
- ❖ These layers are the theca interna, a highly vascularized internal layer of cuboidal secretory cells that secrete estrogens, and the theca externa, an outer layer of stromal cells and collagen fibers.
- ❖ In addition, the granulosa cells begin to secrete follicular fluid, which builds up in a cavity called the antrum in the center of the secondary follicle.
- ❖ The innermost layer of granulosa cells becomes firmly attached to the zona pellucida and is now called the corona radiata.
→ innermost layer of granulosa attached to the zona pellucida

THE FEMALE REPRODUCTIVE CYCLE

- The secondary follicle eventually becomes larger, turning into a mature follicle. secondary oocyte
- While in this follicle, and just before ovulation, the diploid primary oocyte completes meiosis I, producing two haploid (n) cells of unequal size — each with 23 chromosomes.
- The smaller cell produced by meiosis I, called the first polar body, is essentially a packet of discarded nuclear material. The larger cell, known as the secondary oocyte, receives most of the cytoplasm. Once a secondary oocyte is formed, it begins meiosis II but then stops in metaphase.
- The mature follicle soon ruptures and releases its secondary oocyte, a process known as ovulation.

THE FEMALE REPRODUCTIVE CYCLE

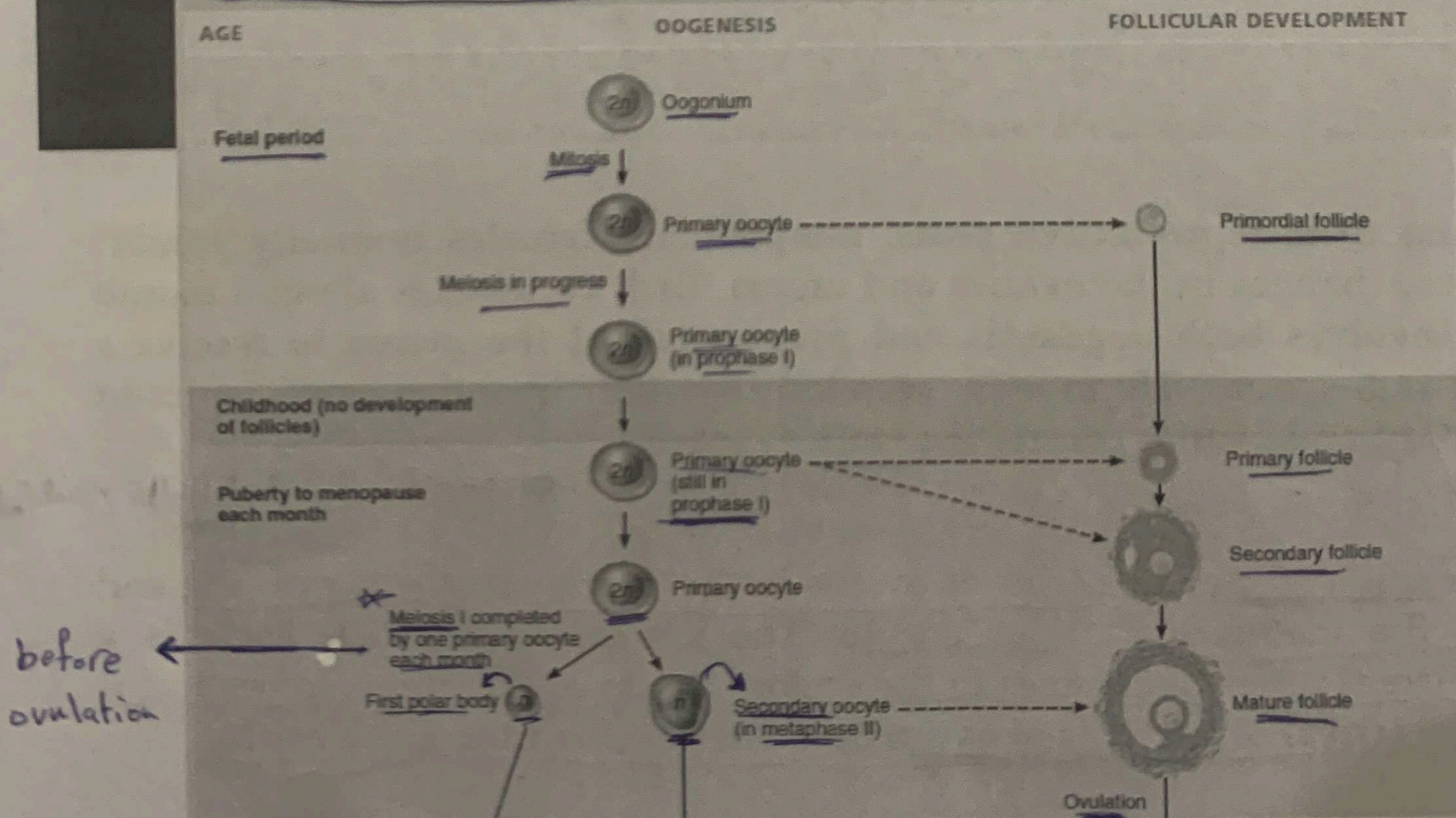
- At ovulation, the secondary oocyte is **expelled** into the **pelvic cavity** together with the **first polar body** and **corona radiata**. → corona radiata and First polar body J go secondary oocyte * pelvic cavity ينقلو لـ
- The secondary oocyte **splits** into two **haploid** cells, again of **unequal** size.
- The **larger** cell is **the ovum**, or **r mature egg**.
- The **smaller** one is **the second polar body**.
- The **nuclei** of the **sperm cell** and the **ovum** then **unite**, forming a **diploid zygote**.
- If the **first polar body** undergoes **another division** to **produce two polar bodies**, then the **primary oocyte** ultimately gives rise to **three haploid polar bodies**, which all degenerate, and a **single haploid ovum**. Thus, **one primary oocyte gives rise to a single gamete (an ovum)**. By contrast, recall that in males one **primary spermatocyte produces four gametes (sperm)**. → الفرق بين ال female and male في نواتج عملية تكوين البويضات

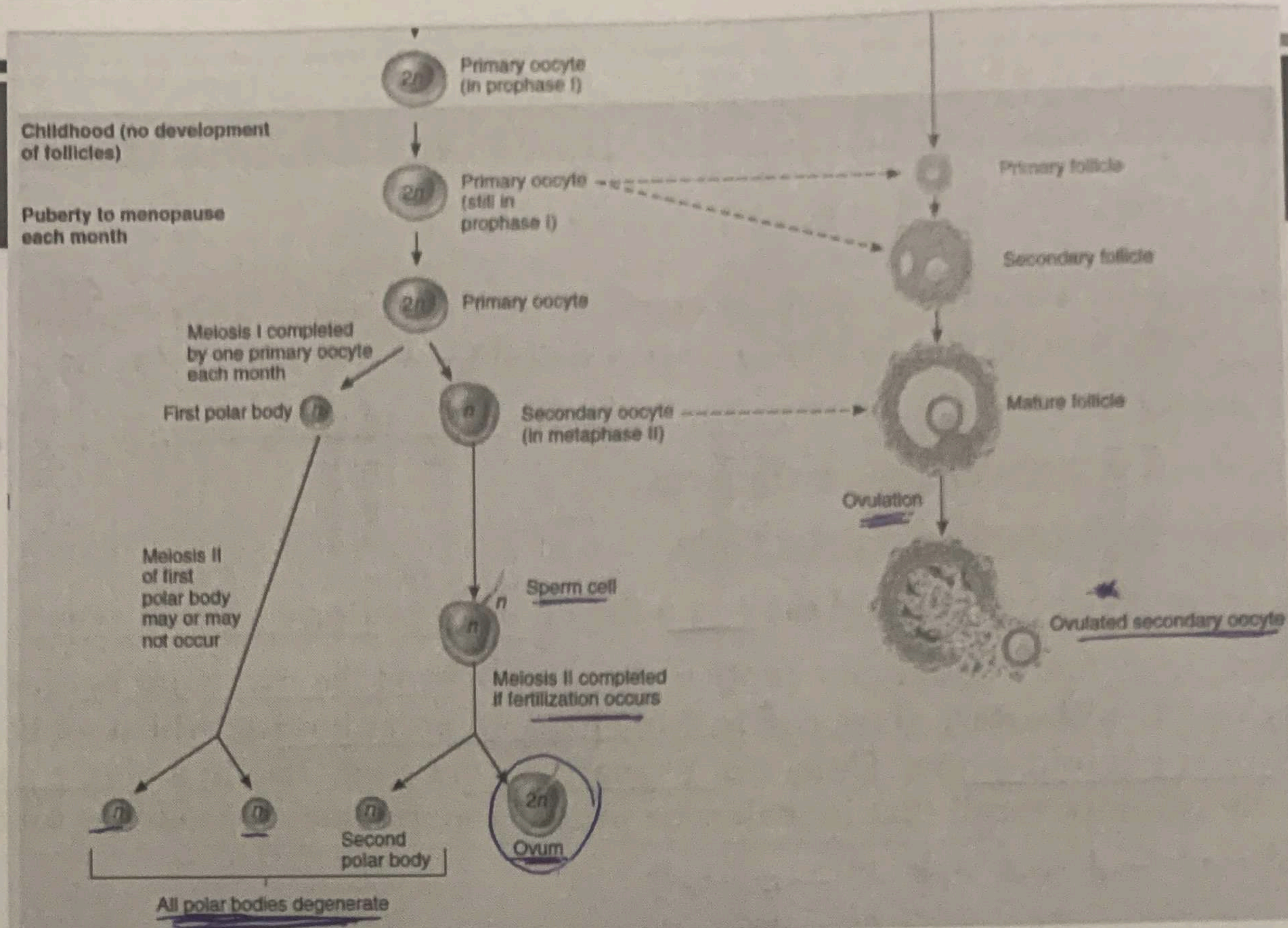
* nuclei sperm cell + nuclei ovum = diploid zygote

TABLE 28.1

Summary of Oogenesis and Follicular Development

تغيير شكل ال cycle





THE FEMALE REPRODUCTIVE CYCLE

- During their reproductive years, nonpregnant females normally exhibit cyclical changes in the ovaries and uterus. Each cycle takes about a month and involves both oogenesis and preparation of the uterus to receive a fertilized ovum. Hormones secreted by the hypothalamus, anterior pituitary, and ovaries control the main events.

1- oogenesis 2- fertilization
ovum

- The ovarian cycle is a series of events in the ovaries that occur during and after the maturation of an oocyte. The uterine (menstrual) cycle is a concurrent series of changes in the endometrium of the uterus to prepare it for the arrival of a fertilized ovum that will develop there until birth.

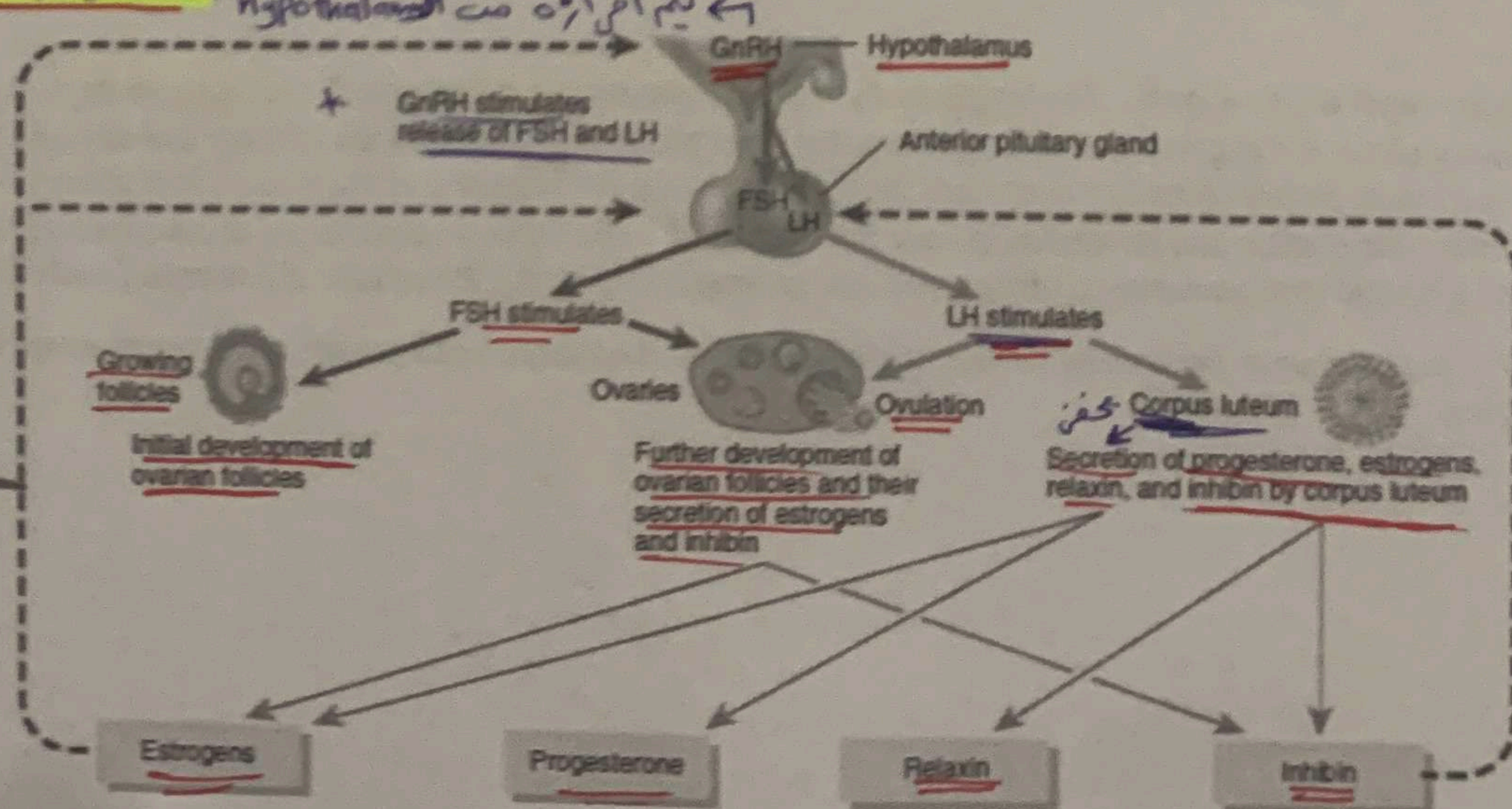
THE FEMALE REPRODUCTIVE CYCLE

- The general term female reproductive cycle ^{يشمل} encompasses the ovarian and uterine cycles, ² the hormonal changes that regulate them, and the related cyclical changes in the breasts and cervix.

HORMONAL REGULATION OF THE FEMALE REPRODUCTIVE CYCLE

Figure 28.23 Secretion and physiological effects of estrogens, progesterone, relaxin, and inhibin in the female reproductive cycle. Dashed red lines indicate negative feedback inhibition.

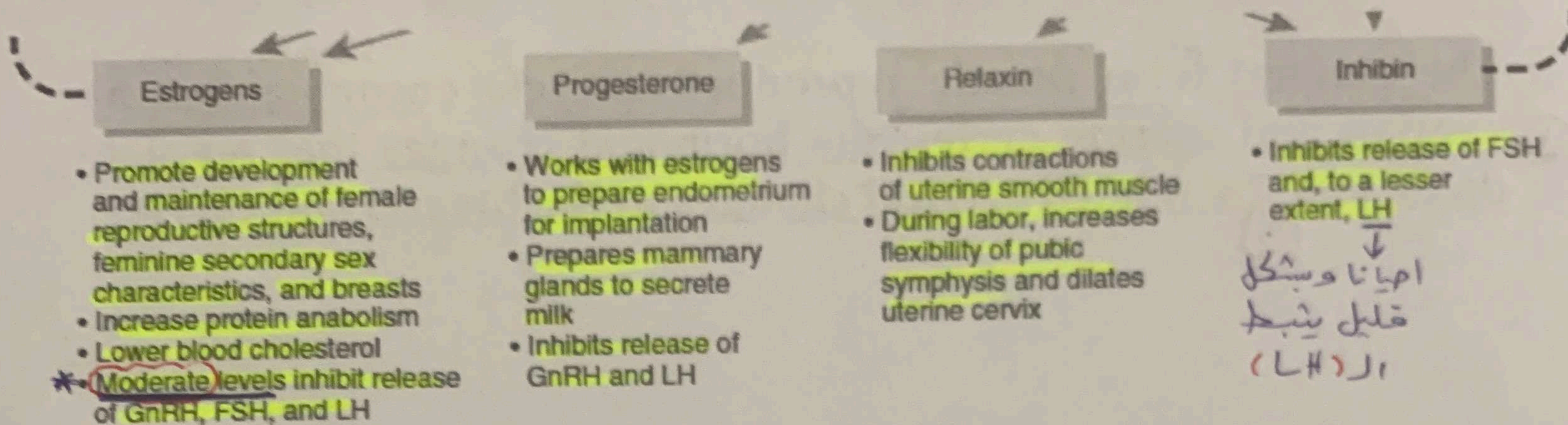
The uterine and ovarian cycles are controlled by gonadotropin-releasing hormone (GnRH) and ovarian hormones (estrogens and progesterone).



* FSH و LH
وال Function
تبعهم.

* FSH و LH
بما هموا بال
Ovulation
أنهم يملكون

* Further development
of ovarian follicles
and their secretion
of estrogens and
inhibin.

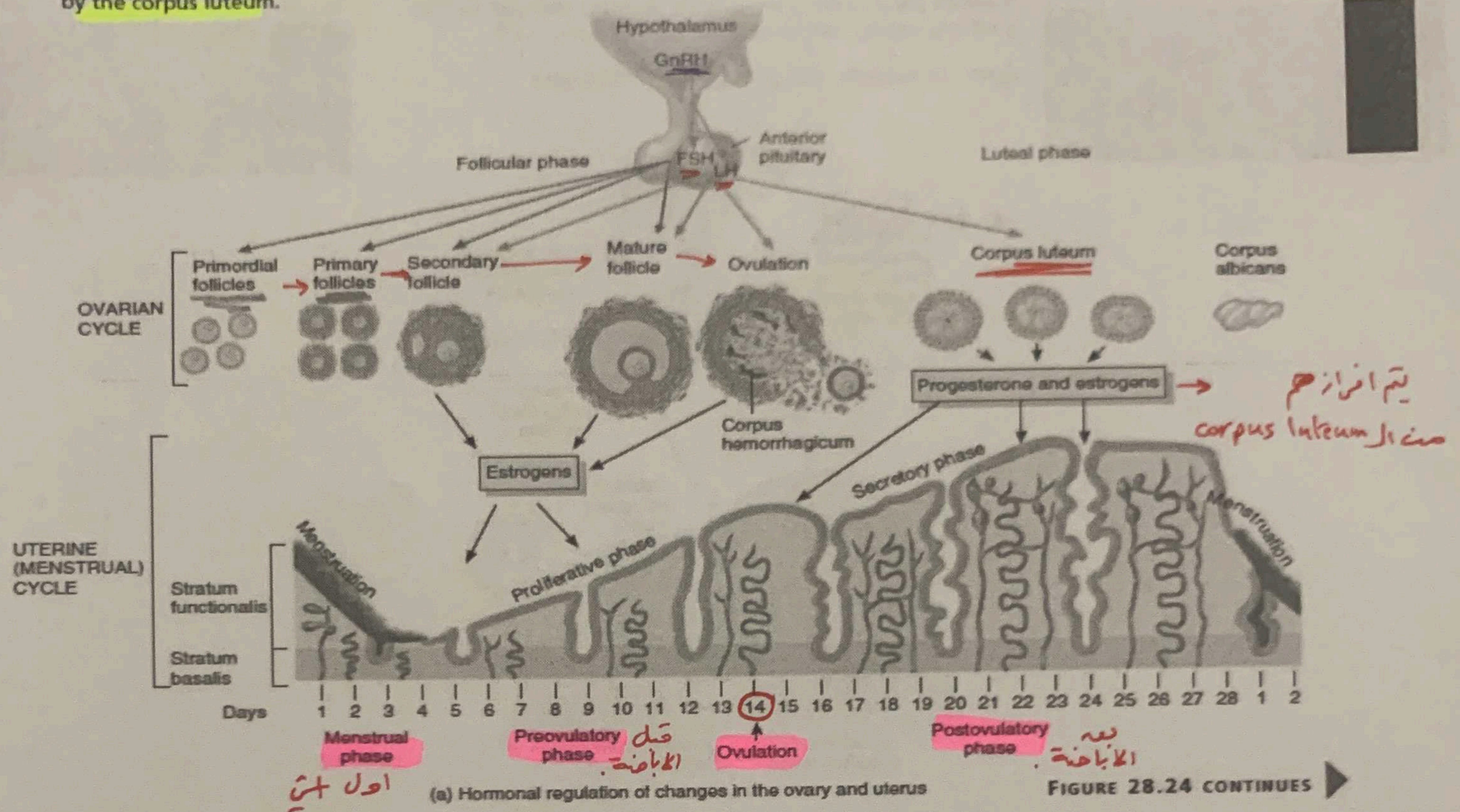


Functions ↑

Figure 28.24 The female reproductive cycle. The length of the female reproductive cycle typically is 24 to 36 days; the preovulatory phase is more variable in length than the other phases. (a) Events in the ovarian and uterine cycles and the release of anterior pituitary hormones are correlated with the sequence of the cycle's four phases. In the cycle shown, fertilization and implantation have not occurred. (b) Relative concentrations of anterior pituitary hormones (FSH and LH) and ovarian hormones (estrogens and progesterone) during the phases of a normal female reproductive cycle.

Estrogens are the primary ovarian hormones before ovulation; after ovulation, both progesterone and estrogens are secreted by the corpus luteum.

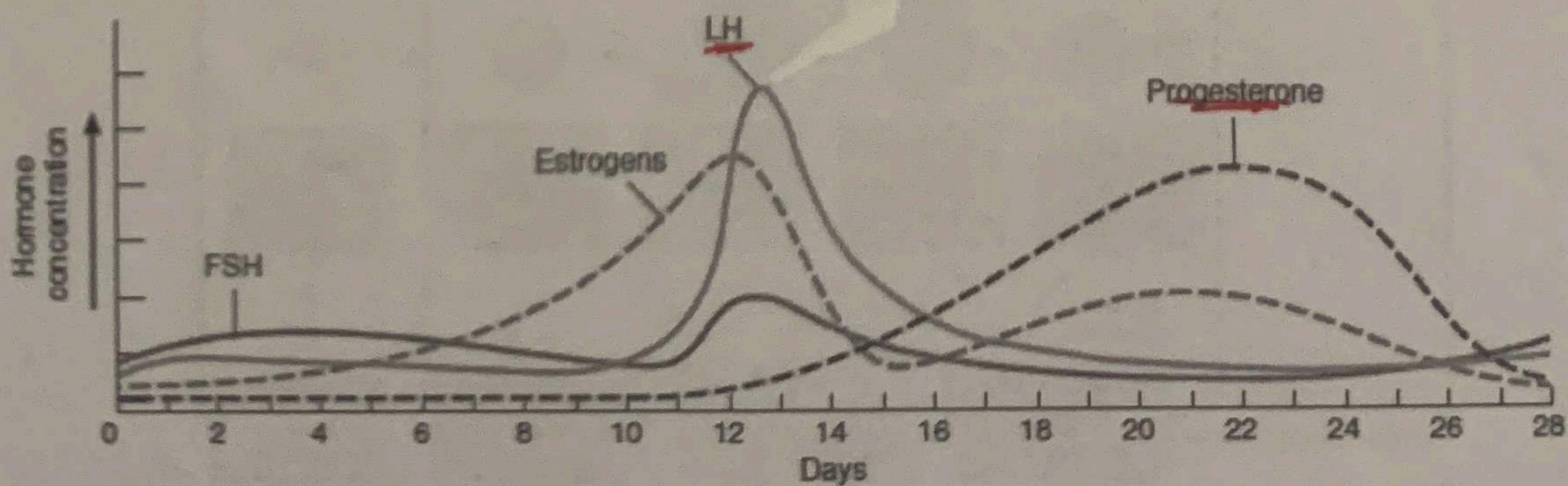
Estrogens are the primary ovarian hormones before ovulation; after ovulation, both progesterone and estrogens are secreted by the corpus luteum.



* إذا كانت طول ال cycle 28 يكون
ال ovulation بيوم 14

* estrogens ← يتم إفرازه قبل ال ovulation
* progesterone ← يتم إفرازه بعد ال ovulation

28.24 CONTINUED



(b) Changes in concentration of anterior pituitary and ovarian hormones

* LH يرتفع أكثر من مرة قبل ال ovulation
* progesterone يرتفع أكثر من مرة في نهاية menstrual cycle

Figure 28.25 High levels of estrogens exert a positive feedback effect (green arrows) on the hypothalamus and anterior pituitary, thereby increasing secretion of GnRH and LH.

At midcycle, a surge of LH triggers ovulation.

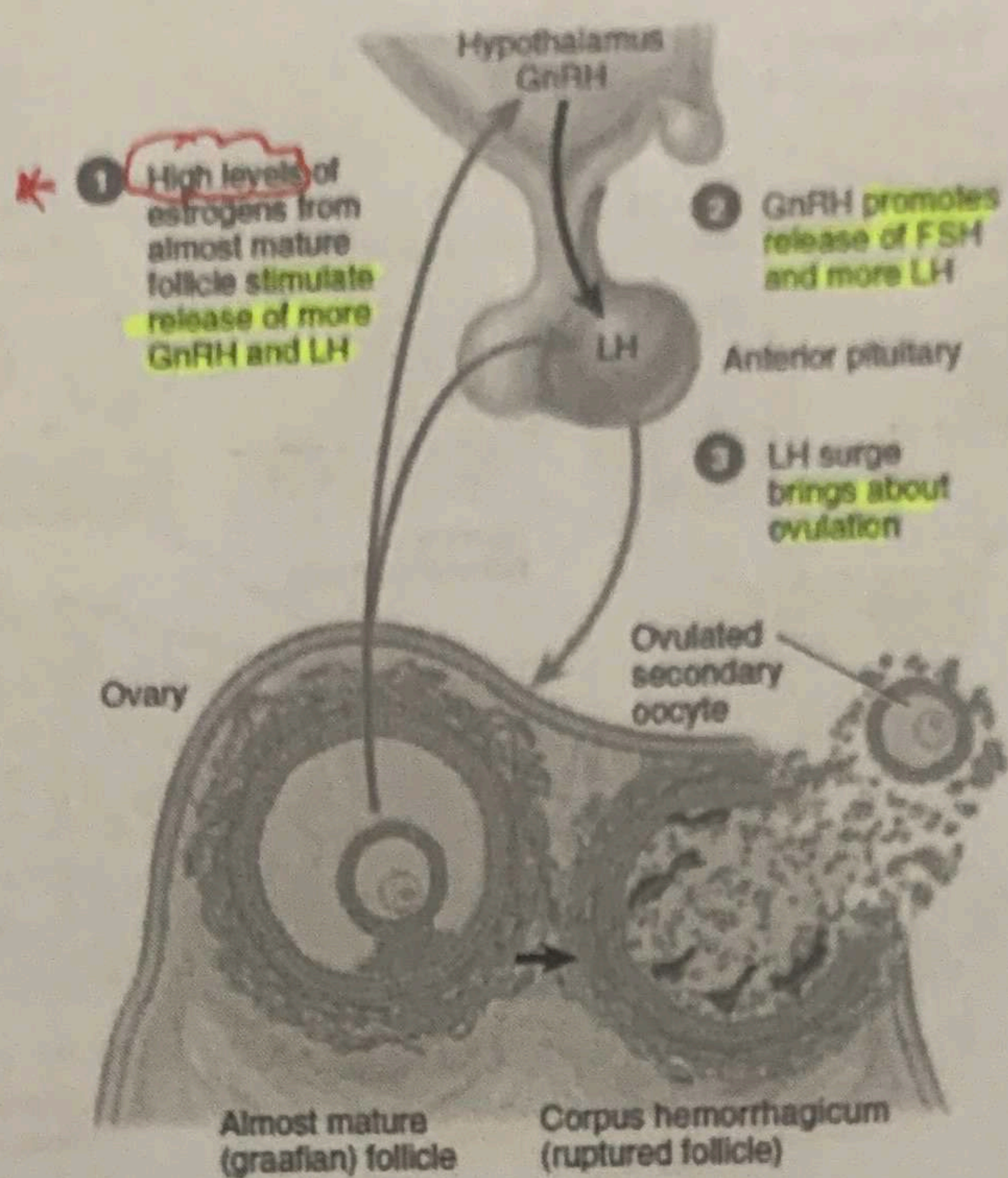
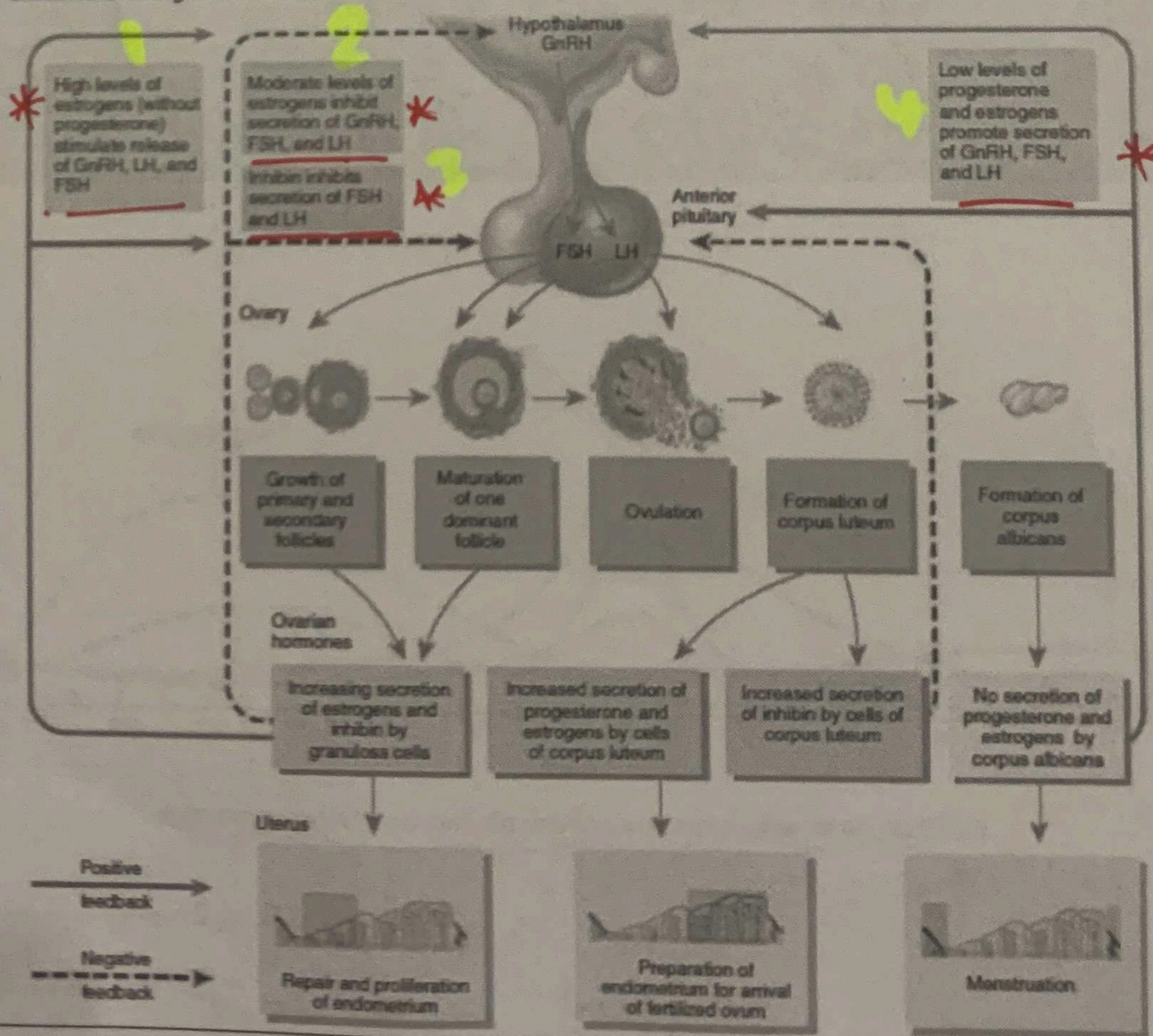
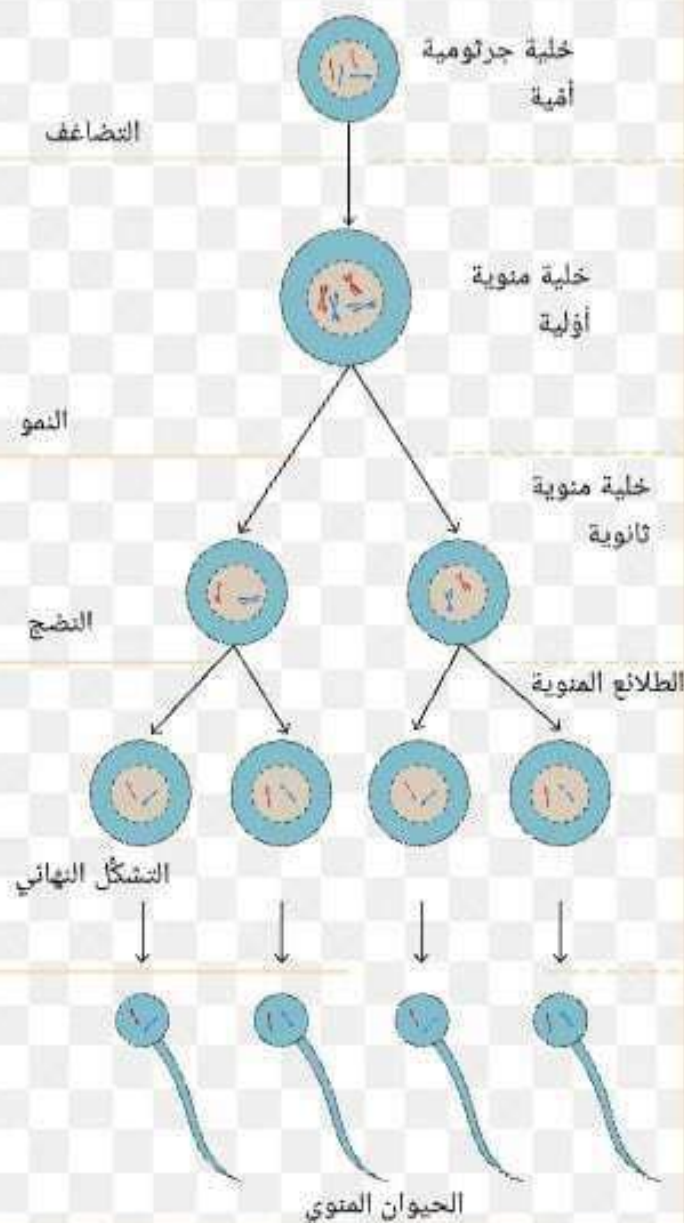


Figure 28.26 Summary of hormonal interactions in the ovarian and uterine cycles.

Hormones from the anterior pituitary regulate ovarian function, and hormones from the ovaries regulate the changes in the endometrial lining of the uterus.



تكوين الحيوان المنوي



تكوين البويضة

