

FISIOLOGI REPRODUKSI

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Reproduction

- Reproduction is process **to maintain continuation of species** by which
 - new individuals of a species are produced
 - genetic material is passed from generation to generation
- Cell division in a multicellular organism is necessary for growth and it involves passing of genetic material from parent cells to daughter cells
- Performed by **reproductive system**

The Reproductive System

- This system does not contribute to homeostasis
- Is not essential for survival of an individual
- But still plays an important in a person's life, e.g. the manner:
 - in which people relate as sexual beings contributes in significant ways to **psychosocial behavior**
 - how people **view themselves**
 - how people **interact with others**

....The Reproductive System

- Reproductive function also has a profound effect on society:
 - universal organization of societies into family units provide **a stable environment** that is **conducive for perpetuating** our species
 - on other hand, **population explosion** and its resultant drain on **dwindling resources** have led to worldwide concern with means by which **reproduction can be limited**

....The Reproductive System

- Reproductive capability depends on intricate **relationship** among **hypothalamus, anterior pituitary, reproductive organs, and target cells** of sex hormones
- These relationship employ many of **regulatory mechanisms** used by other body systems **for maintaining homeostasis**, such as negative-feedback control

....The Reproductive System

- The organ of male and female may be grouped by **function**
- Testes and ovaries (called **gonads**), function in **production of gametes**: sperm cells and ova
- Gonads also **secrete hormones**
- The ducts of reproductive systems transport, receive, and store gametes
- **Accessory sex glands** produce materials that support gametes
In females, the **breasts** are also considered **accessory reproductive organs**
- The externally visible portions of reproductive system are known as **external genitalia**

Secondary Sexual Characteristic

- Secondary sexual characteristic (SSC) are many external characteristics **not directly involved in reproduction**
- That **distinguish** male and female
- Development and maintenance governed by **testosterone** in males and **estrogen** in females
- **Progesterone has no influence on SSC**
- **Axillary and pubic hair growth is not SSC**

.....Secondary Sexual Characteristic

- In some species, secondary sexual characteristic are great importance in courting and mating behavior (e.g. to attract female's attention)
- In humans, attraction the opposite sex not only influenced by secondary sexual characteristic but also strongly affected by the complexities of human society and cultural behavior

Sex Determination and Differentiation

- Reproductive cells each contain a **half set of chromosomes**
- Gametogenesis is accomplished by **meiosis**
- The sex of an individual is determined by **combination of sex chromosomes**
- Sexual differentiation along male or female lines depends on the presence/ absence of **masculinizing determinant**

Parents with diploid (46 chr) somatic cells

Mother

Father

Meiotic division
of germ cells

Meiotic division
of germ cells

Haploid Ovum

Haploid Sperm

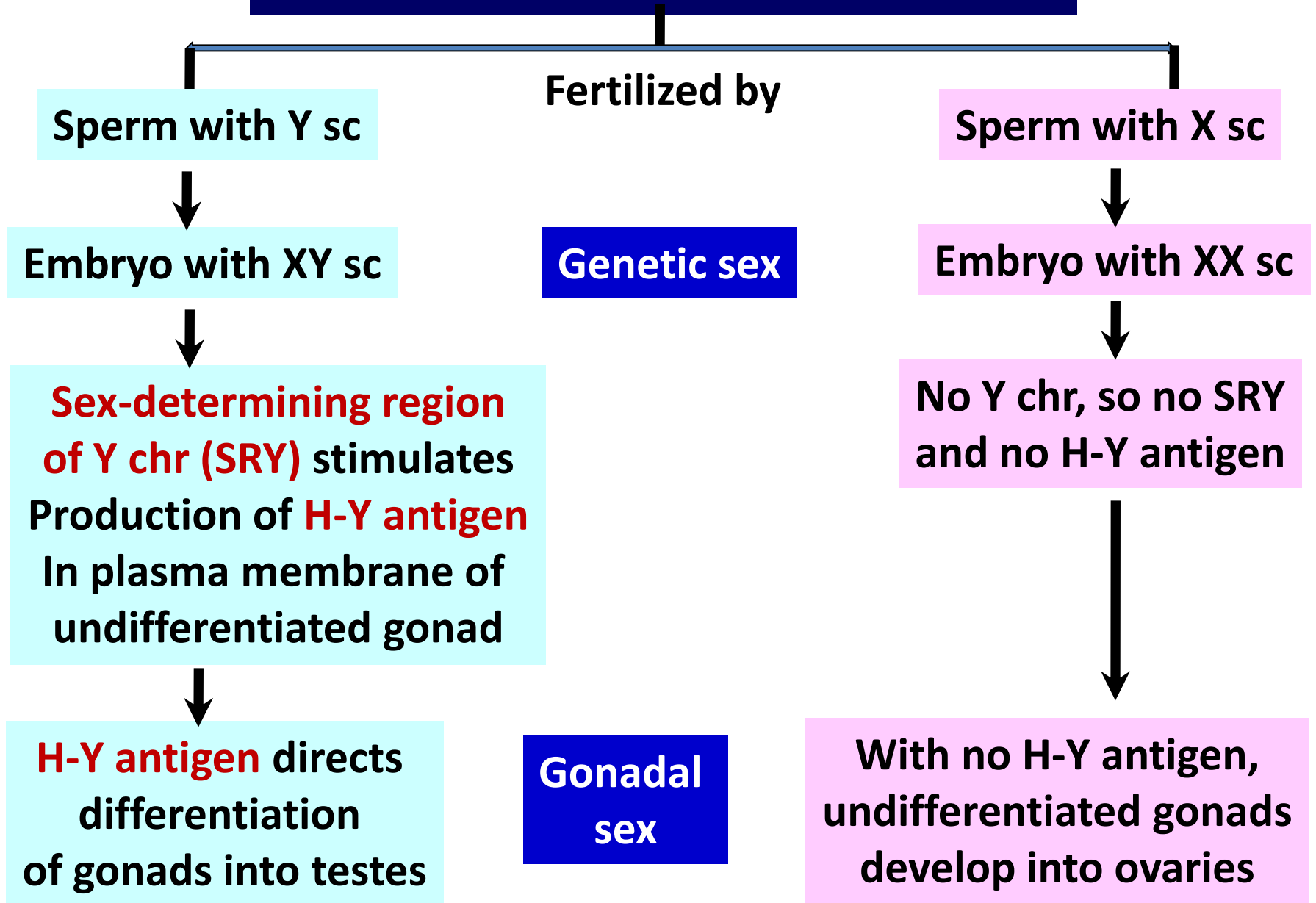
Fertilization

Diploid fertilized Ovum

Mitosis

Offspring of diploid somatic cells

Ovum with X sex chromosome



Testes secrete hormone and factor

Testosterone

Mullerian-inhibiting factor

Converted to

Dihydrotestosterone

Degeneration of Mullerian ducts

Promotes development of undifferentiated external genitalia along male lines (e.g. penis, scrotum)

Transforms Wolffian ducts into male reproductive tract (e.g. epididymis, ductus deferens, ejaculatory duct, seminal vesicle)

Phenotype sex

Ovaries does not secrete hormone and factor

Absence of testosterone

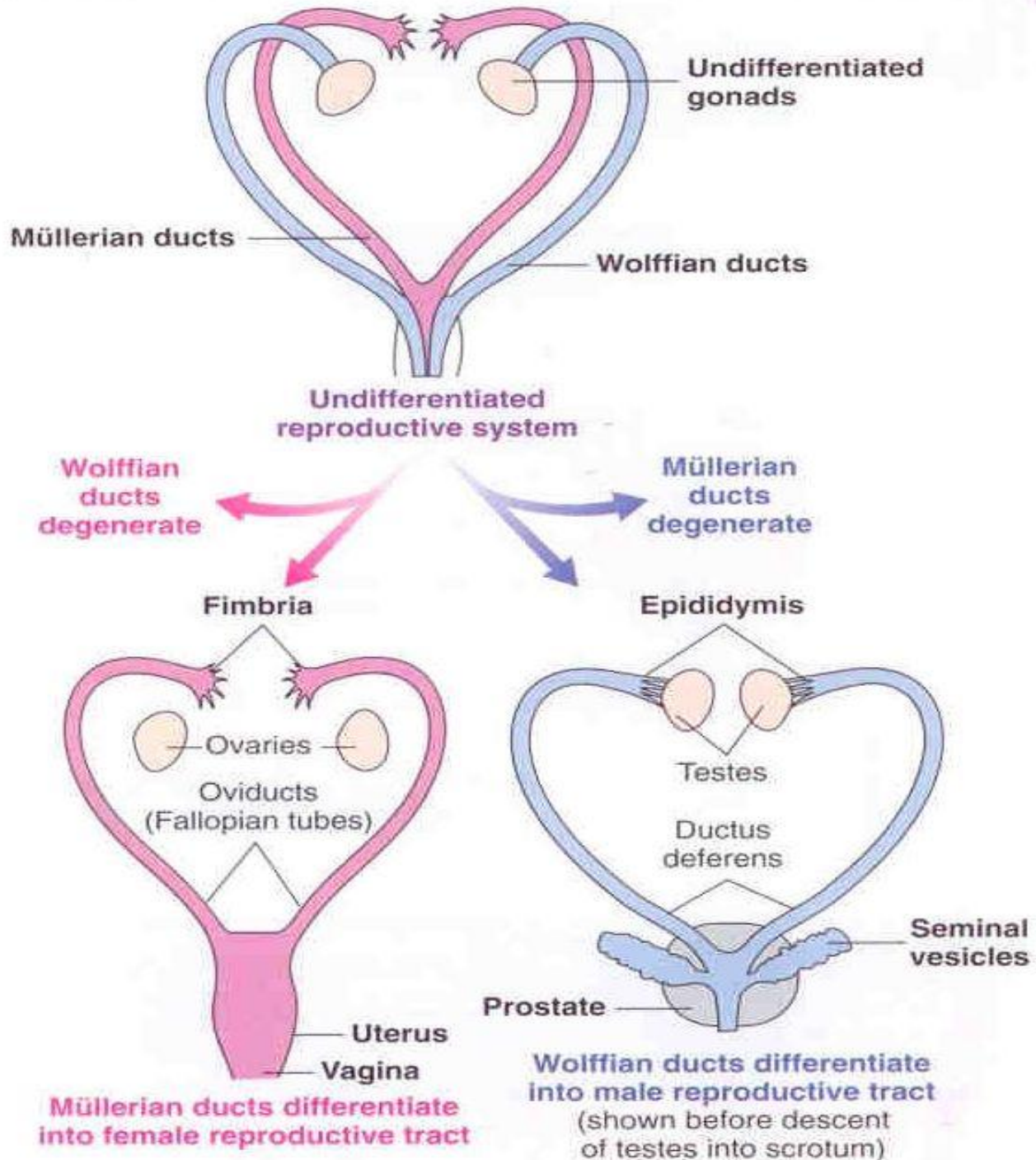
Absence of Mullerian-inhibiting factor

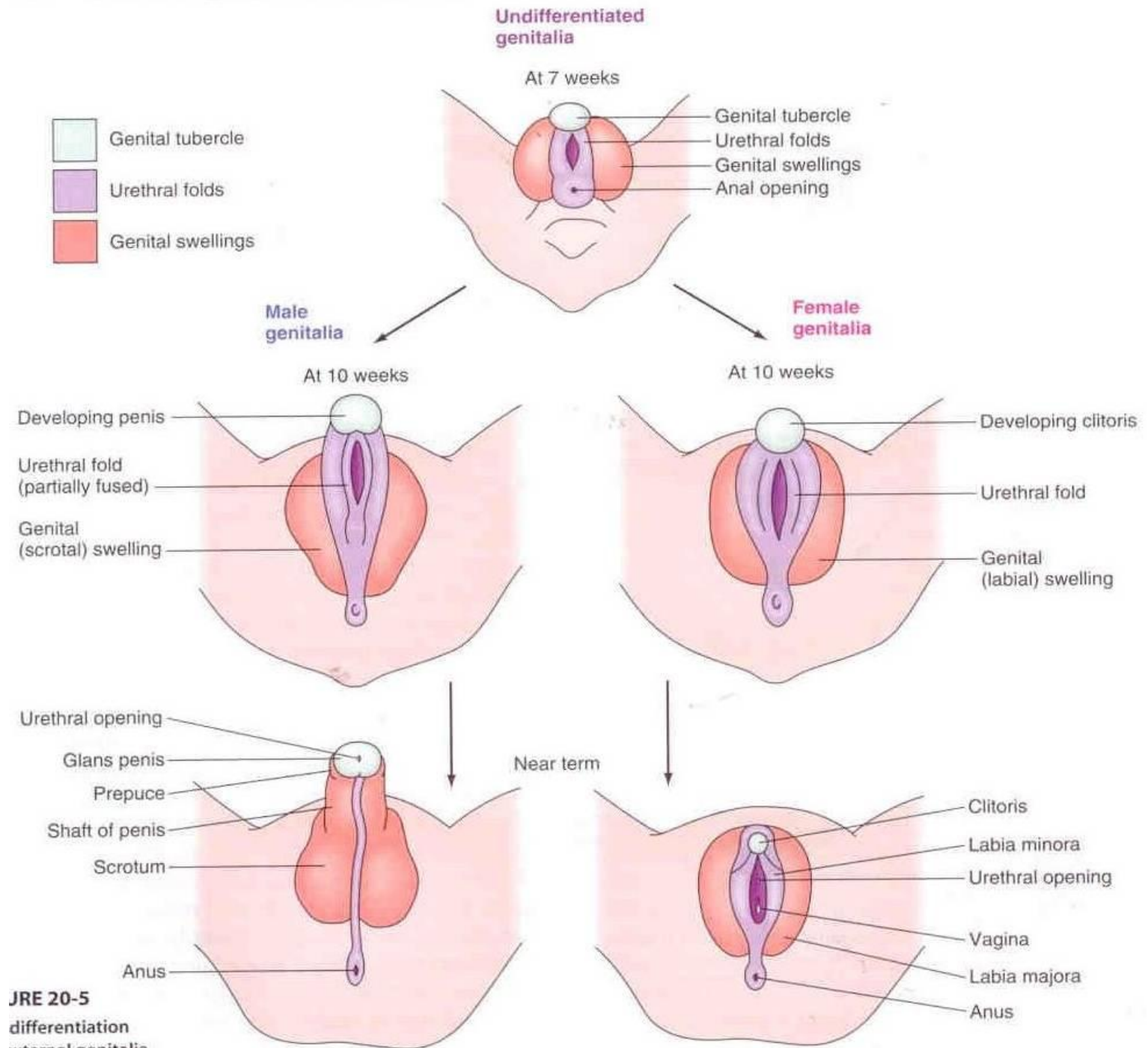
Degeneration of
Wolfian ducts

Undifferentiated external
genitalia along female lines
(e.g. clitoris, labia)

Mullerian ducts develop
Into female reproductive
tract (e.g. oviducts, uterus)

Phenotype
sex

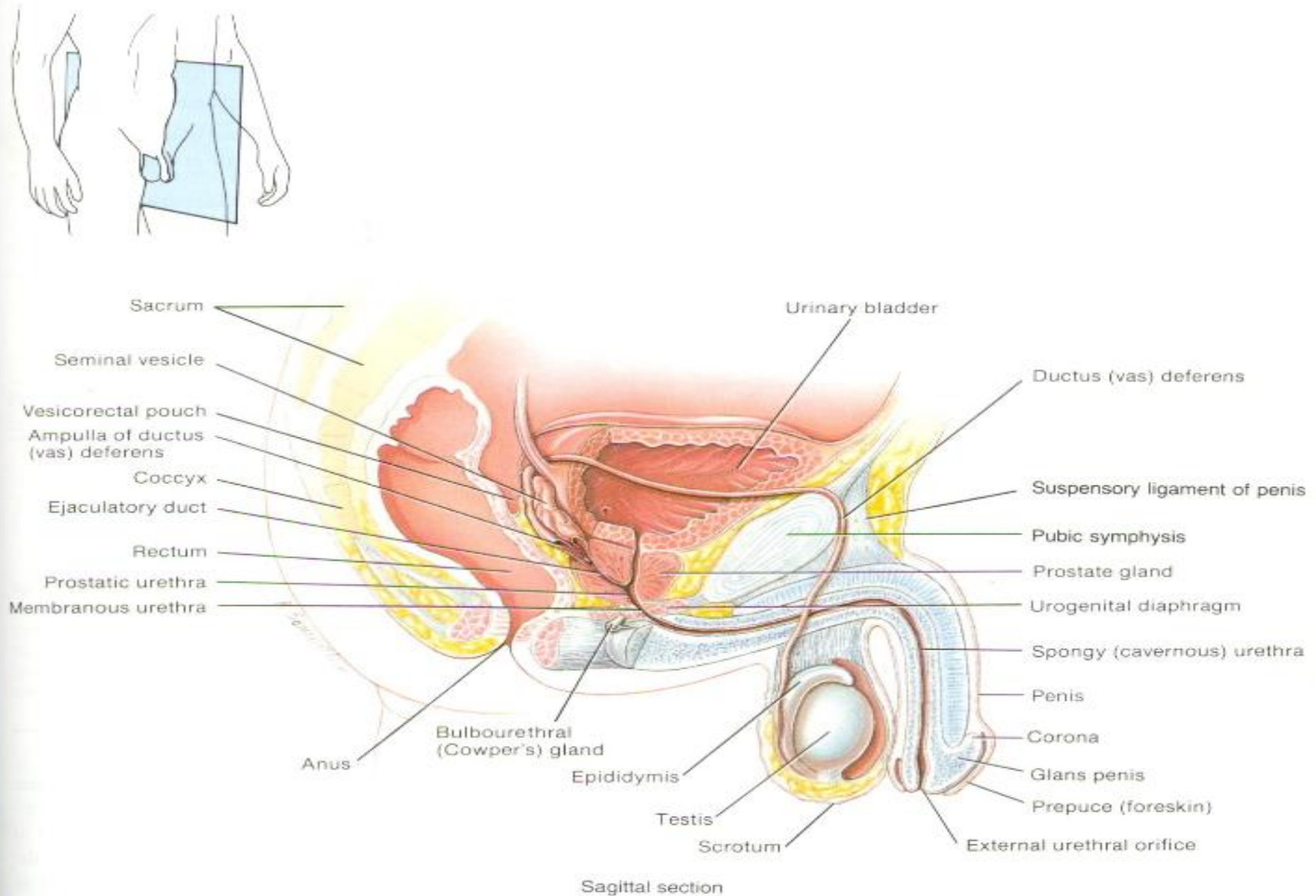




JRE 20-5
 differentiation
 external genitalia

FISIOLOGI REPRODUKSI PRIA

FIGURE 28.1 Male organs of reproduction and surrounding structures.



Question: What are the functions of the gonads? Ducts? Accessory sex glands?

Reproductive Functions of Male

The essential reproductive functions of male are:

1. Production of sperm (**spermatogenesis**) by **testes** (in skin-covered sac: **scrotum**)
2. **Delivery of sperm** to female – semen by
 - male reproductive tract: epididymis, vas deferens, ejaculatory duct
 - urethra (in **penis**)
3. **Male accessory sex glands**: providing bulk of semen: seminal vesicle, prostate, bulbourethral gland

Testes

- **Primary male reproductive organs**
- **Perform dual function:**
 - producing sperm (spermatogenesis)
 - secreting male sex hormone: testosterone
- **Scrotal location provides a cooler environment essential for spermatogenesis**
- **Position of scrotum in relation to abdominal cavity can be varied by spinal reflex mechanism that plays important role in regulating temperature**

Development of Testes

- In male embryo, testes develop from the genital ridge located at the rear of abdominal cavity
- In **last months of fetal life**, testes **begin a slow descent**, passing out of abdominal cavity through inguinal canal into scrotum which is **induced by testosterone**
- After testes descend into scrotum, the opening of abdominal wall through which inguinal canal passes **closes** snugly around sperm-carrying duct
Incomplete closure or **rupture** of this opening permits abdominal viscera to slip through resulting **inguinal hernia**

Functioning of Testis

- **During fetal life:**
 - stimulated by chorionic gonadotropin (hCG)
- **A few weeks after birth until puberty (prepubertal period / childhood):**
 - dormant
- **Productive period:**
 - stimulated by gonadotropic hormone (GnH)
 - Spermatogenesis usually continues until death
- **Male climacteric:**
 - Decrease testosterone secretion
 - Decreasing sexual function

Ductal System

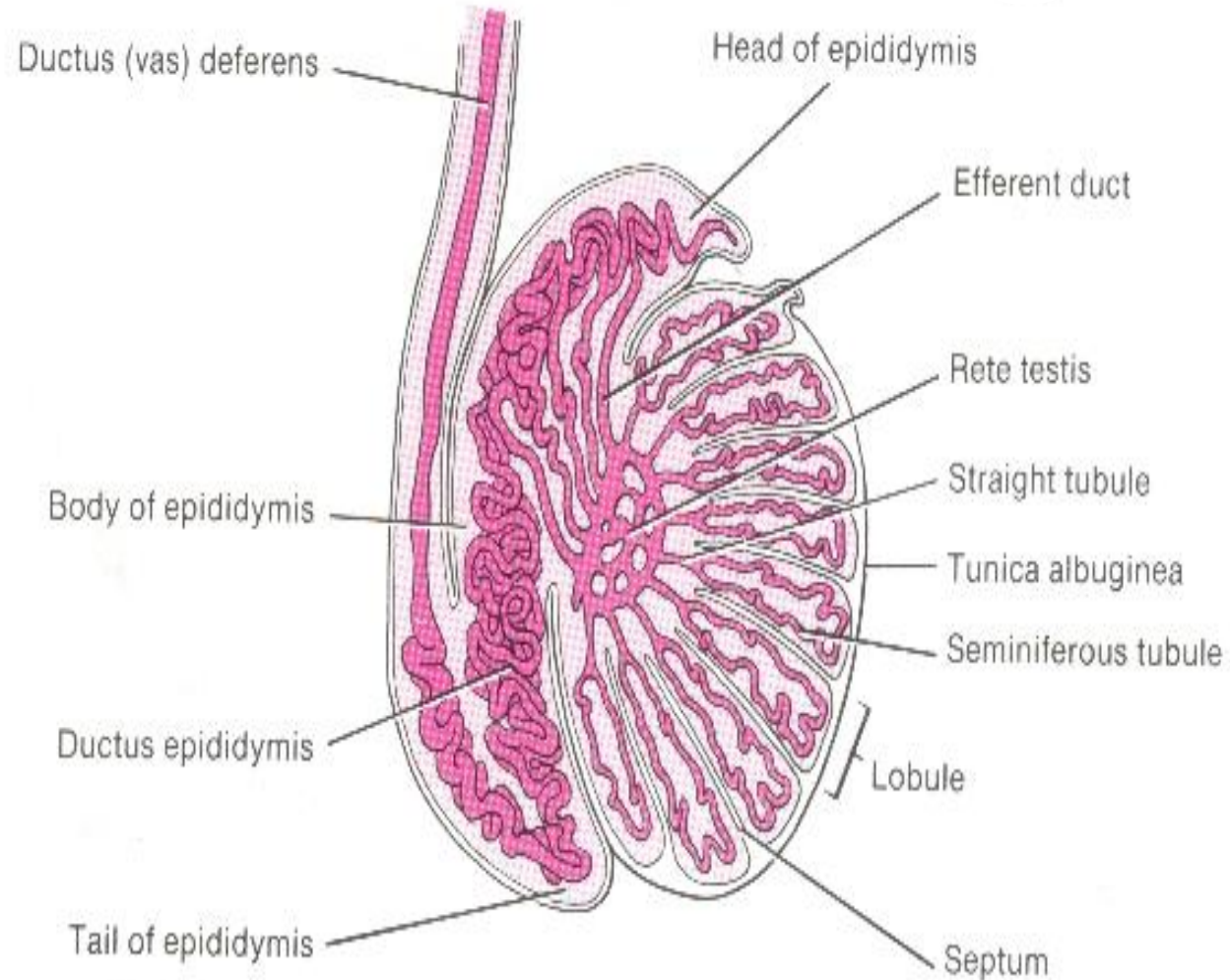
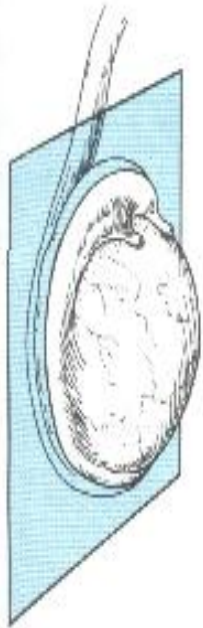
■ Ductus epididymis

- Loosely attached to the rear surface of each testes
- Sperm from seminiferous tubules are swept into epididymis as a result of pressure created by continual secretion tubular fluid by Sertoli cells

■ Ductus (vas) deferens

- Formed from converged of epididymal ducts
- Thick-walled, muscular duct
- Ductus deferens from each testes passes up out of scrotal sac and runs back through inguinal canal into abdominal cavity, where it eventually empties into urethra at neck of bladder

FIGURE 28.3 Seminiferous tubules. The stages of spermatogenesis are shown in (b) and (c).



(a) Sagittal section of a testis showing arrangement of seminiferous tubules

Figure continues

Accessory Sex Glands

■ Seminal vesicles:

- Empty secretions into the last portion of ductus deferens
- Supply fructose to nourish the ejaculated sperm
- Secrete prostaglandin for sperm motility to help transport
- Provide precursors for clotting of semen (fibrinogen)

■ Prostate gland:

- Completely surrounds urethra at bladder neck
- Secretes alkaline fluid
- Provides clotting enzymes and fibrinolysin

■ Bulbourethral glands:

- Empty secretions into urethra just before urethra enters penis

Spermatogenesis

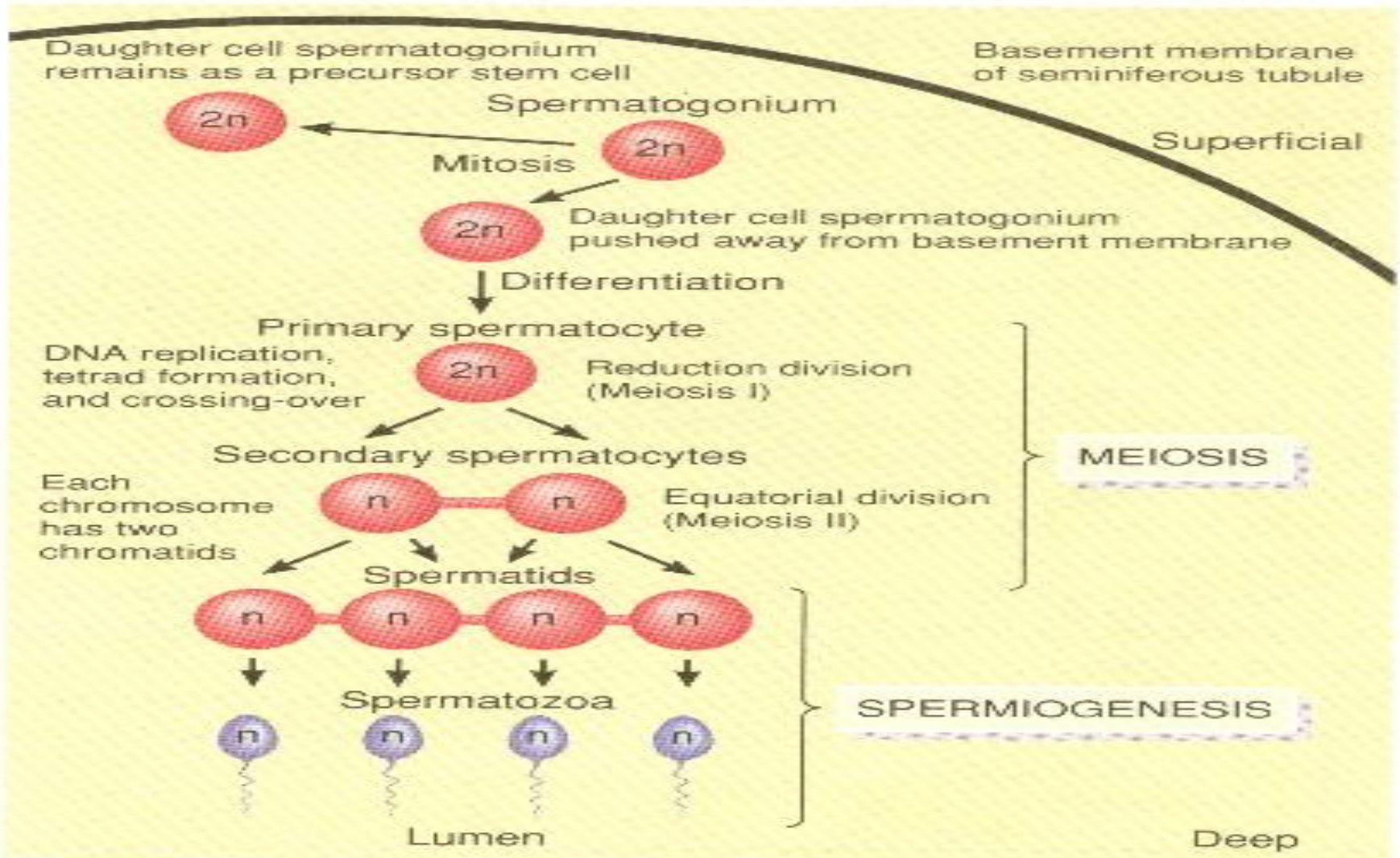
- Tubuli seminiferi
- During active sexual life
- As the result of stimulation by anterior pituitary gonadotropic hormones
- Beginning at age of ± 13 ys
- Continuing **throughout the remainder of life**

.....Spermatogenesis

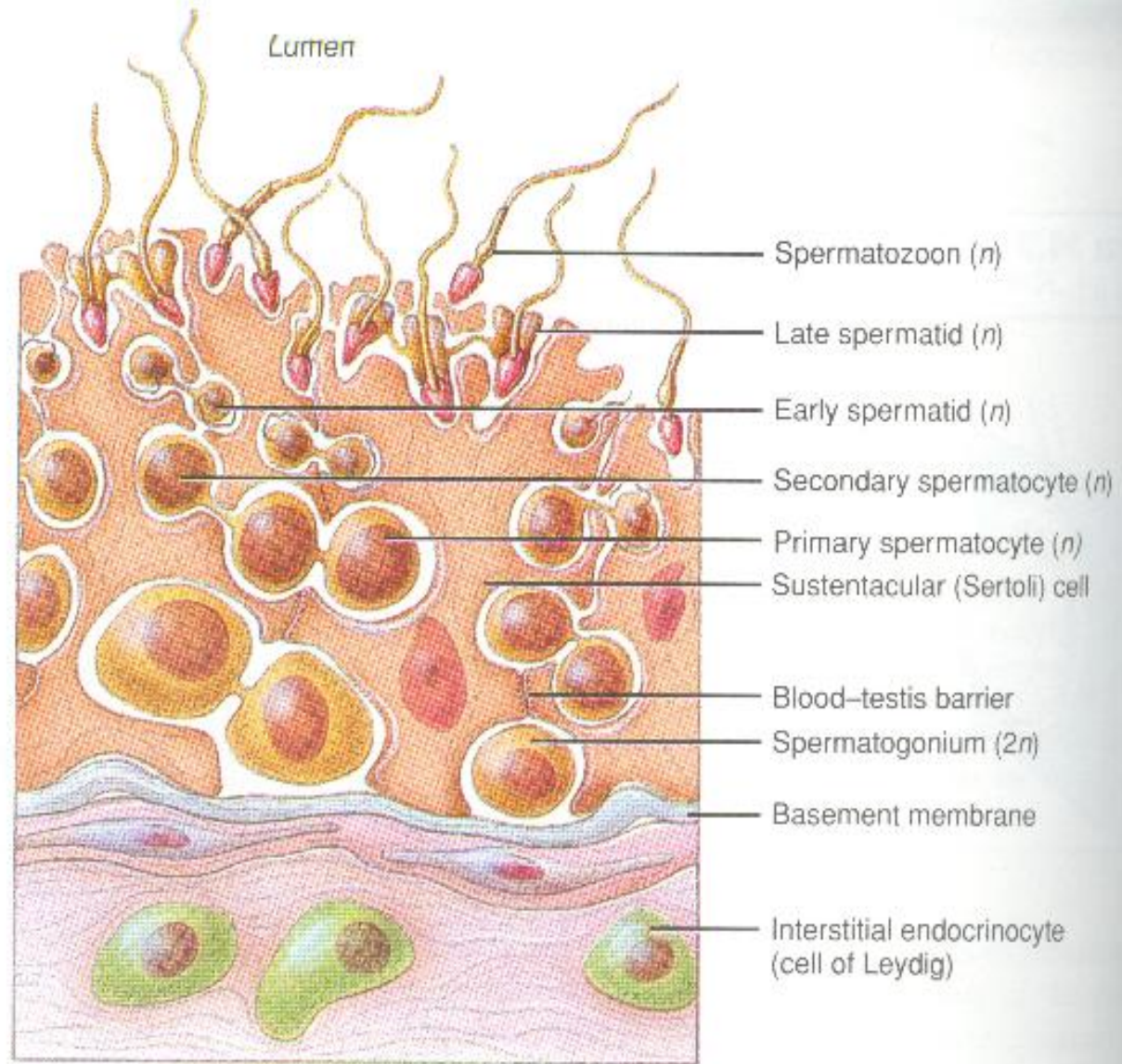
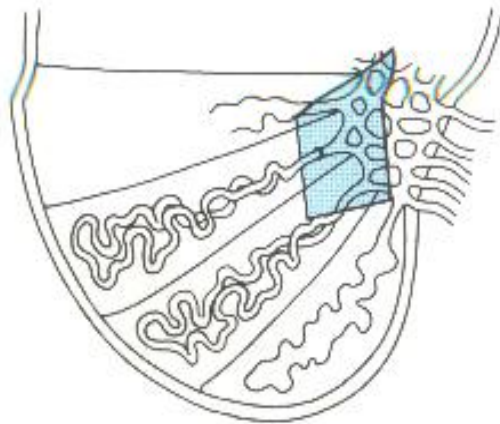
■ Steps of Spermatogenesis

1. **Mitosis:** spermatogonia A → spermatogonia B
2. **Enlargement:** → primary spermatocyte
3. **Meiosis:**
 - I. Primary spermatocyte → secondary spermatocyte
 - II. Secondary spermatocyte → early spermatid
4. **Physically reshaping:** spermiogenesis
Early spermatid → late spermatid → spermatozoon → 23 pairs of chromosomes

.....Spermatogenesis



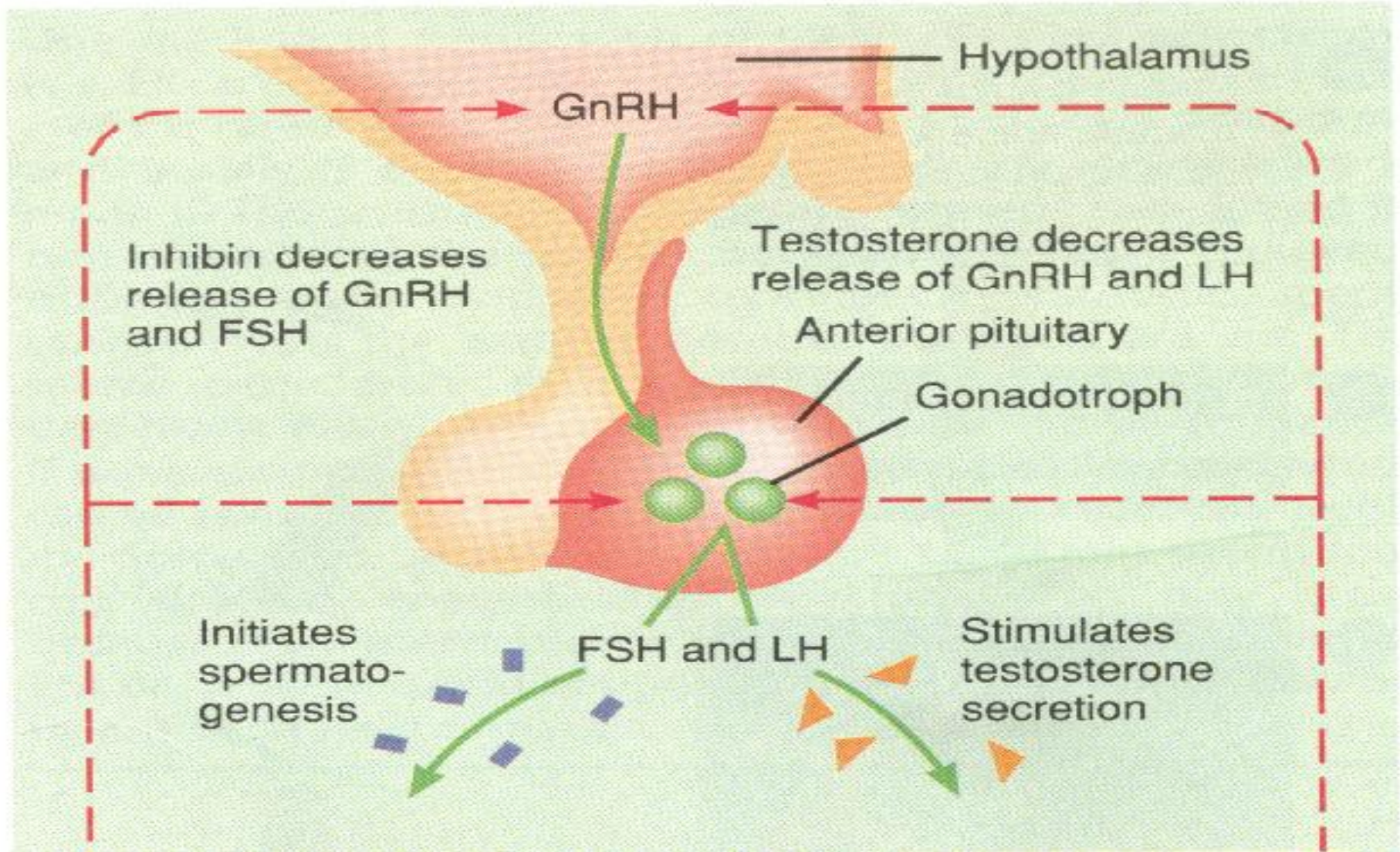
Question: Why is meiosis I also called reduction division?

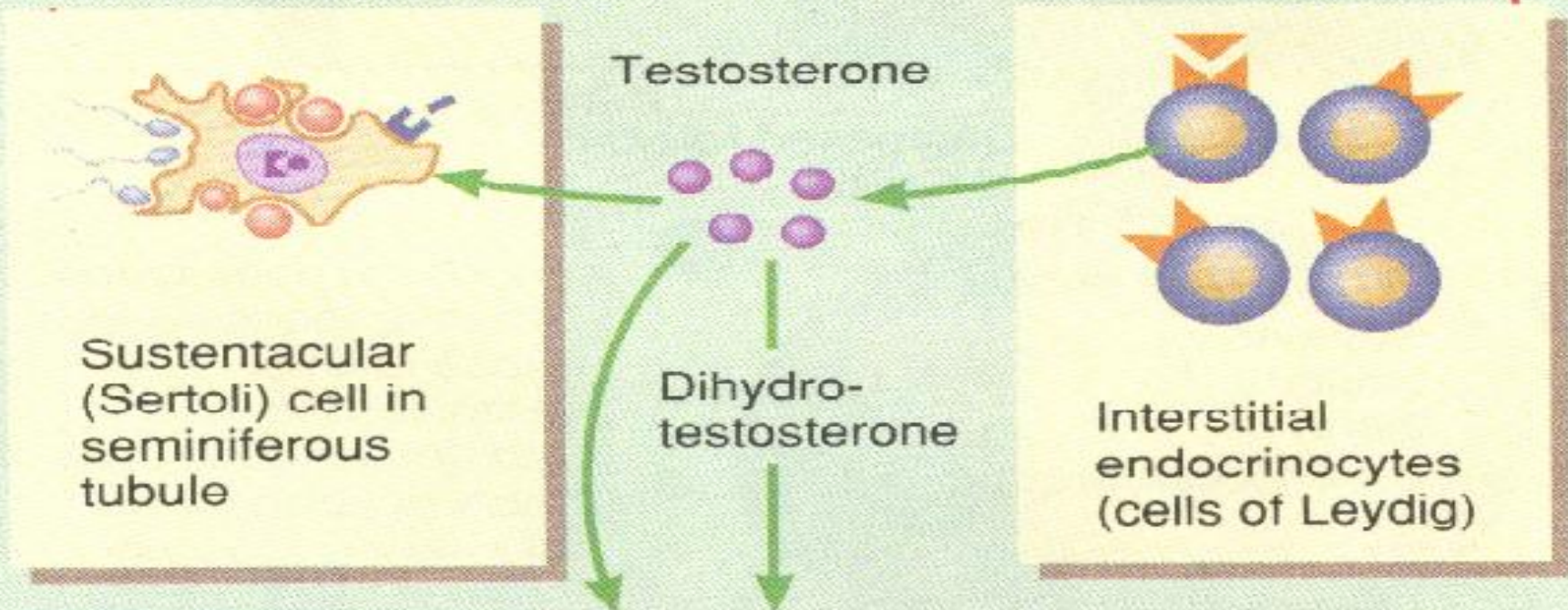


(c) Cross section of a portion of a seminiferous tubule

Question: Which spermatogenic cells are most mature and least mature in a seminiferous tubule?

Hormonal Control of Testes Function





Sustentacular (Sertoli) cell in seminiferous tubule

Testosterone


Dihydro-testosterone


Interstitial endocrinocytes (cells of Leydig)


- Male pattern of development (before birth)
- Enlargement of male sex organs and expression of male secondary sex characteristics (starting at puberty)
- Anabolism (protein synthesis)


Key:


 LH

 LH receptor

 FSH

 FSH receptor

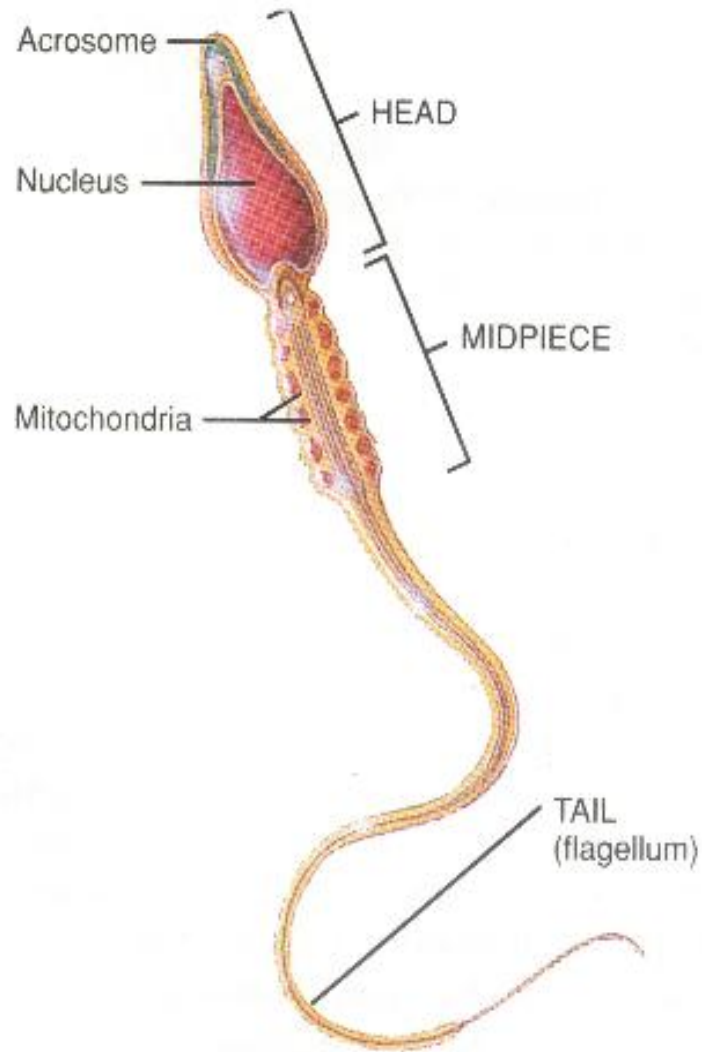
 Testosterone

 Testosterone receptor

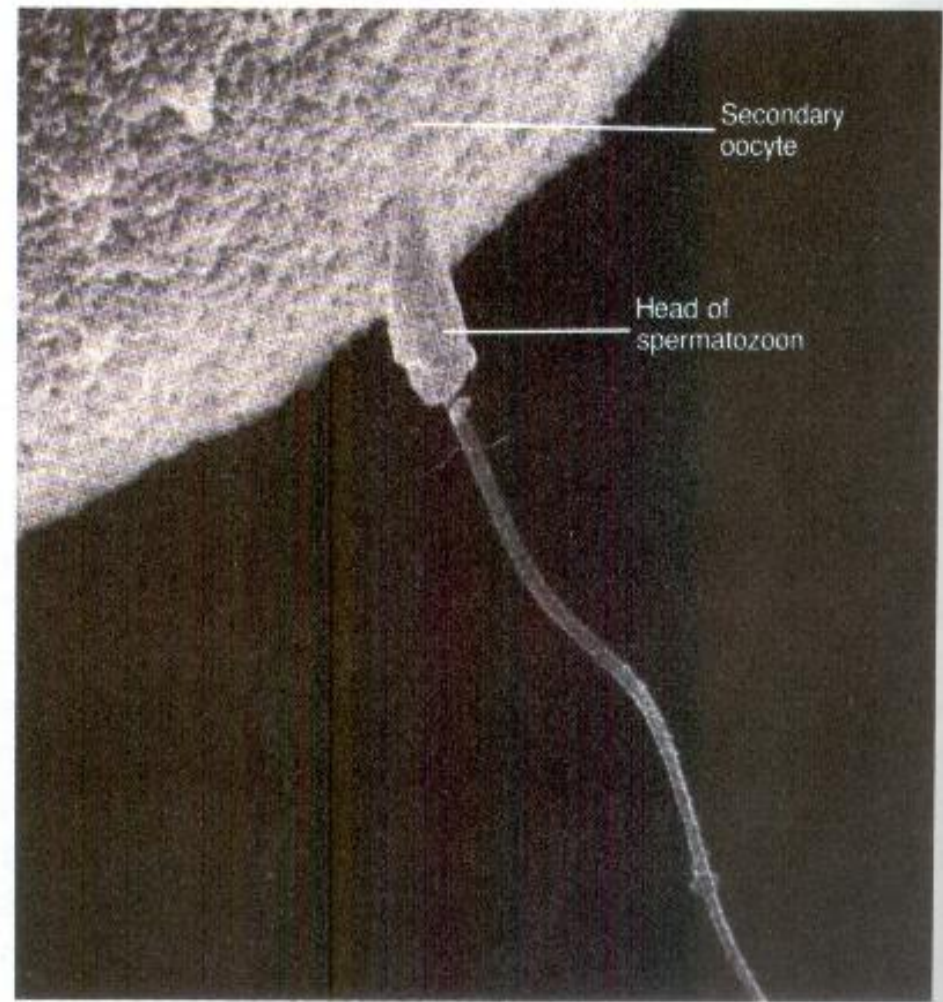
Sperms (Normal and Mature)

- Motile
- Fertile
- Movement: 1 – 4 mm/min.
- Travel in a straight line
- Activity: enhanced in neutral and slightly alkaline, depressed in mildly acidic media
- Rapid death in strong acidic media
- Temperature $\uparrow \rightarrow$ activity $\uparrow \rightarrow$ metabolism rate $\uparrow \rightarrow$ shortened life
- Live: - many weeks in genital ducts of testes
- 1 - 2 days in female genital tract

FIGURE 28.5 Spermatozoa.



(a) Parts of a spermatozoon



(b) Scanning electron micrograph of a spermatozoon in contact with a secondary oocyte (1100 x)

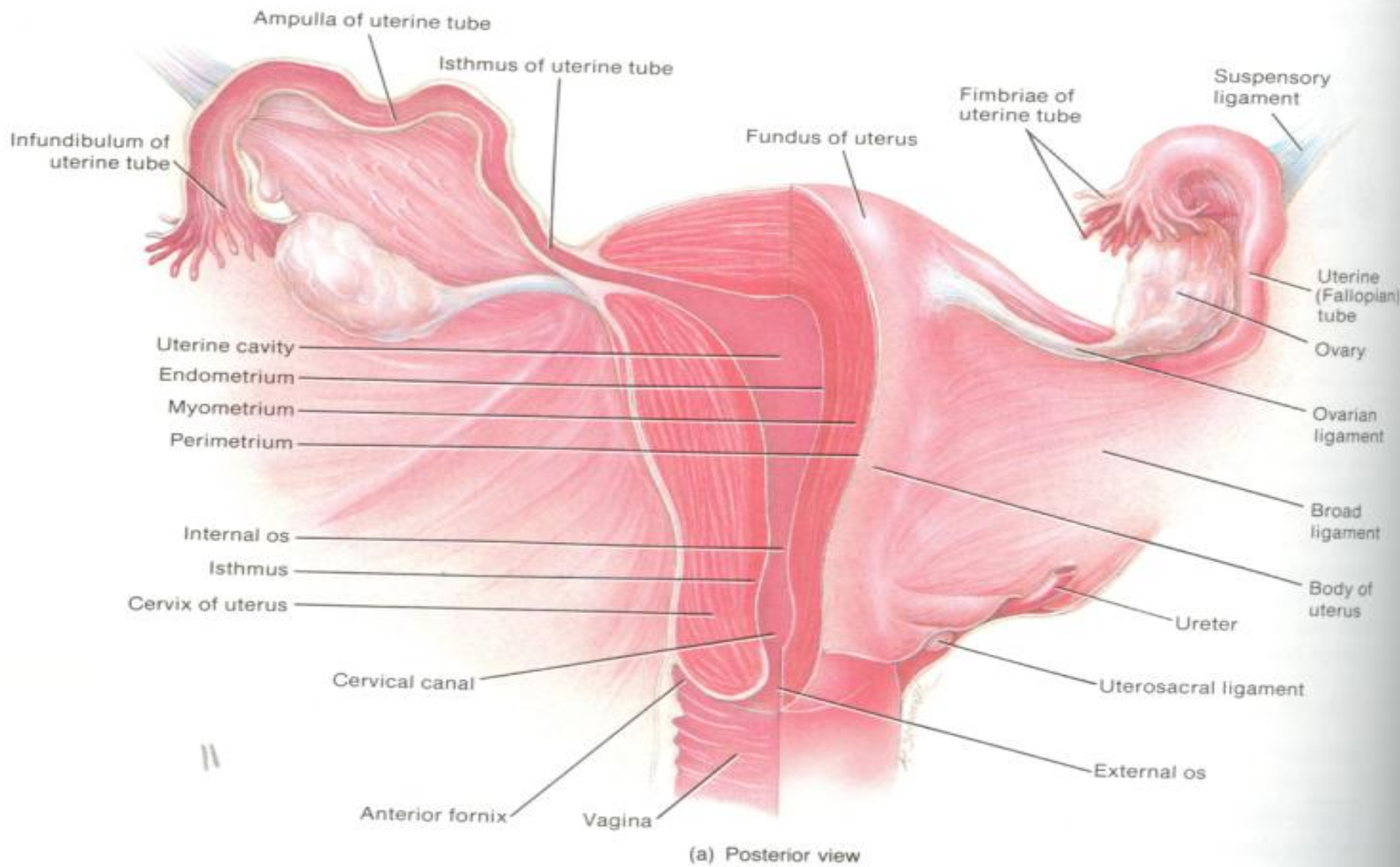
Question: What are the functions of each part of a sperm cell?

Semen

- **Fluid:** - vas deferens (10 %)
 - vesicula seminalis (60 %)
 - prostat (30 %)
 - mucous glands (bulbourethral)
- **pH: ± 7.5**
- **Mucoid and milky**
- **Weak coagulum \rightarrow dissolve in 15 – 30 minutes**
- **May be stored for years in - 100°C**

FISIOLOGI REPRODUKSI WANITA

FIGURE 28.12 Uterus and associated structures. In (a), the left side of the figure has been sectioned to show internal structures. In (b), part of the posterior wall of the uterus has been removed.



(a) Posterior view

Reproductive Functions of Female

Female's role in reproduction is more complicated:

1. Production of ova (**oogenesis**) by **ovaries**
2. Reception of sperm: **vagina-cervix**
3. Reception of sperm and ovum to a common site for union (**fertilization or conception**): **Fallopian tube**
4. Maintenance of the developing fetus until it can survive in outside world (**gestation or pregnancy**), including formation of **placenta**: **uterus**
5. Giving birth to the baby (**parturition**)
6. Nourishing the infant after birth by milk production (**lactation**): **mammae**

Ovaries

- **Primary female reproductive organs**
- **Perform dual function:**
 - producing ova (oogenesis)
 - secreting female sex hormones:
estrogen and progesterone which act together to:
 - > promote fertilization of ovum
 - > prepare female reproductive system for pregnancy
- **Homologous to testes (in structure, position, and origin)**
- **Descend to brim of pelvis during third month of development**

Development of Ovaries

- **During fetal life, the outer surface of ovary is covered by germinal epithelium**
- **Cells that give rise to ova arise from endoderm of yolk sac and migrate to ovaries during embryonic development at 5-6 weeks of gestation**
- **Primordial (primitive) germ cells migrate from endoderm of the yolk sac to ovaries during early fetal development**

Functioning of Ovaries

- **During fetal life:**
 - stimulated by chorionic gonadotropin (hCG)
- **A few weeks after birth until puberty (prepubertal period / childhood):**
 - dormant
- **Productive period:**
 - stimulated by gonadotropic hormone (GnH) and ovarian hormone
- **Menopause**

Components of Female Reproductive Tract

■ Oviducts (Fallopian tubes)

- in close association with ovaries,
- pick up ova on ovulation and serve as fertilization site

■ Uterus

thick-walled hollow: responsible for

- maintaining fetus during development
- expelling it at the end of pregnancy

■ Cervix

- lowest portion of uterus
- projects into vagina

■ Cervical canal

pathway for sperm and passageway for baby delivery

.....Components of Female Reproductive Tract

■ **Vagina**

expandable tube, connects uterus to external environment

■ **Vaginal opening**

located in perineal region between urethral and anal opening

■ **Hymen**

thin mucus membrane partially covering vaginal opening

■ **Labia minora and labia majora**

skin folds surrounding vaginal and urethral openings

■ **Clitoris**

Female external genitalia collectively: **vulva**

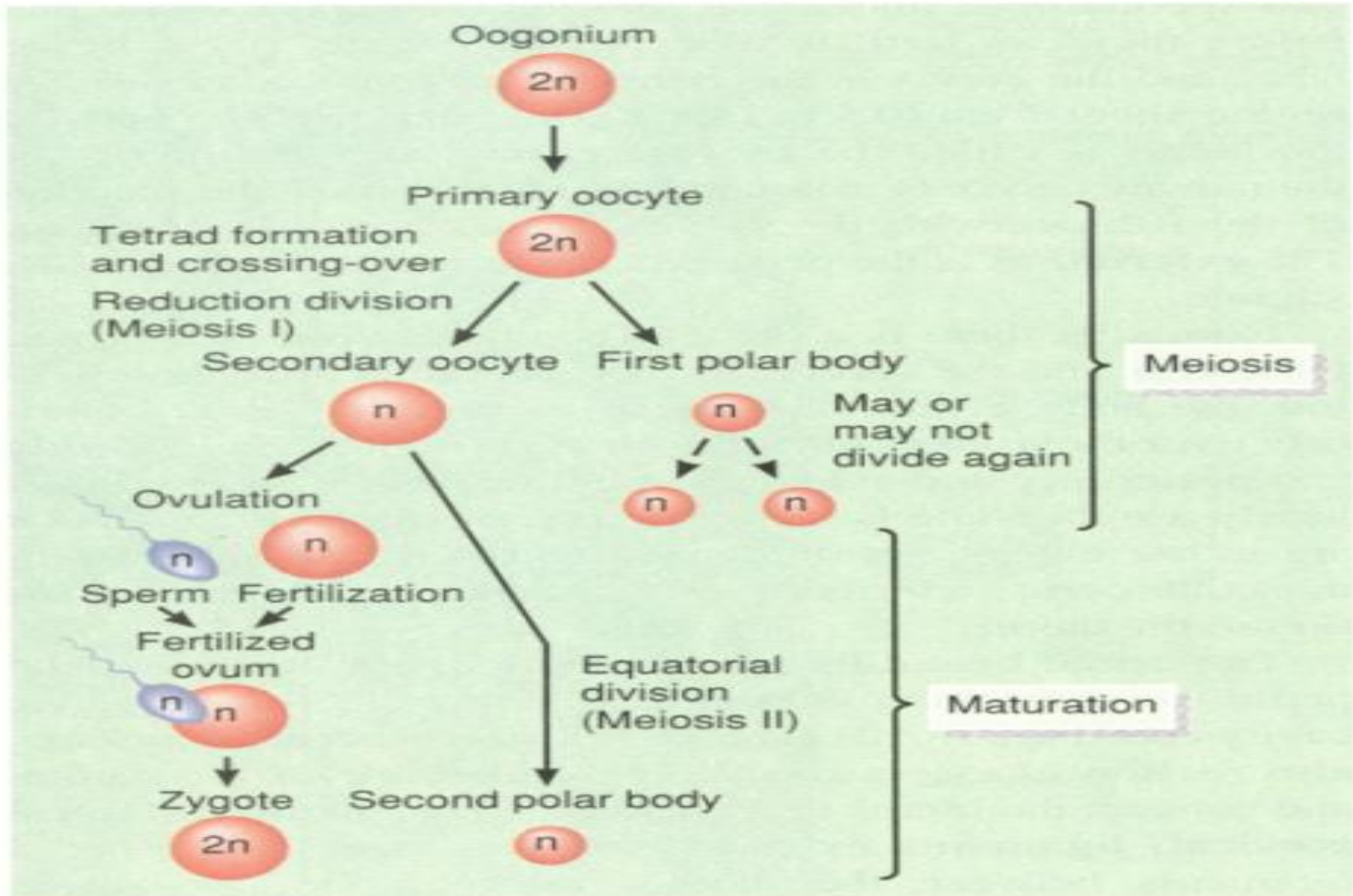
Oogenesis

- In the 3rd month of prenatal development: oogonia divided mitotically into primary oocytes (diploid/ $2n$) until 20-24 weeks → 7 million (maximum)
- 7 month after conception, fetal oogonia cease dividing
From this point on no new germ cells are generated
- Almost from the start, attrition process occurs:
 - by birth only 2 million primary oocytes remain
 - by puberty: 300.000 - 400.000
 - during active sexual life: 400 expelled ova
 - at or soon after menopause: few (if any)

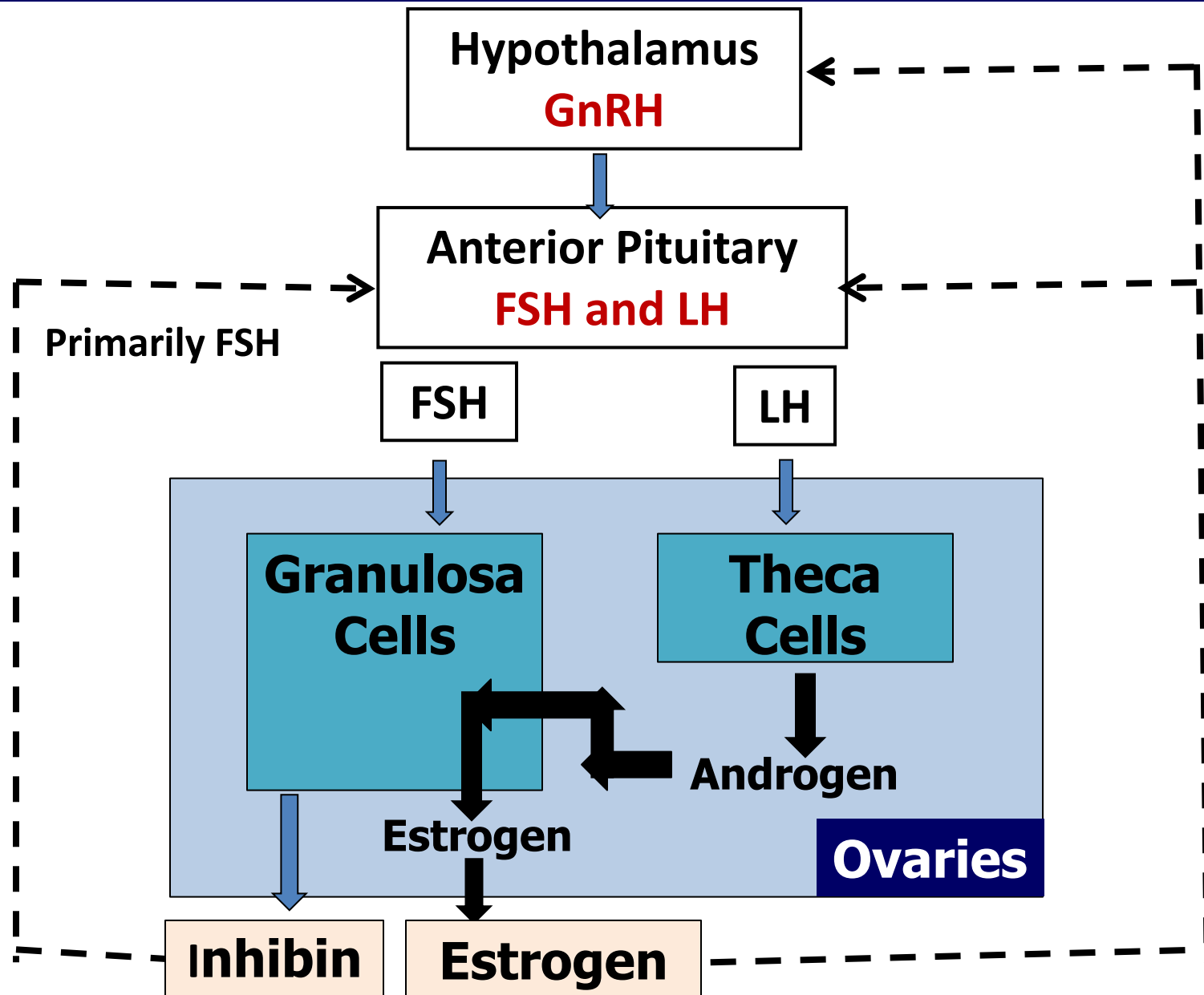
.....Oogenesis

- Primary oocytes enter reduction division (meiosis I), but do not complete the division **in the fetus**
- Cells are said to be in a state meiotic arrest, and this state continues until puberty
- Only primary oocytes destined for ovulation will ever complete the first meiotic division, for it occurs just before the egg is ovulated
- The second meiotic division occurs in a fallopian tube after ovulation, but only if the secondary oocyte is penetrated by a sperm (fertilized)
- Daughter cell receive 23 chromosomes (haploid/ n)
- Each primary oocyte can produce only one ovum

....Oogenesis



Hormonal Control of Ovarian Function



Female Monthly Rhythm

■ **Cycle: 28 days (20 – 45 days)**

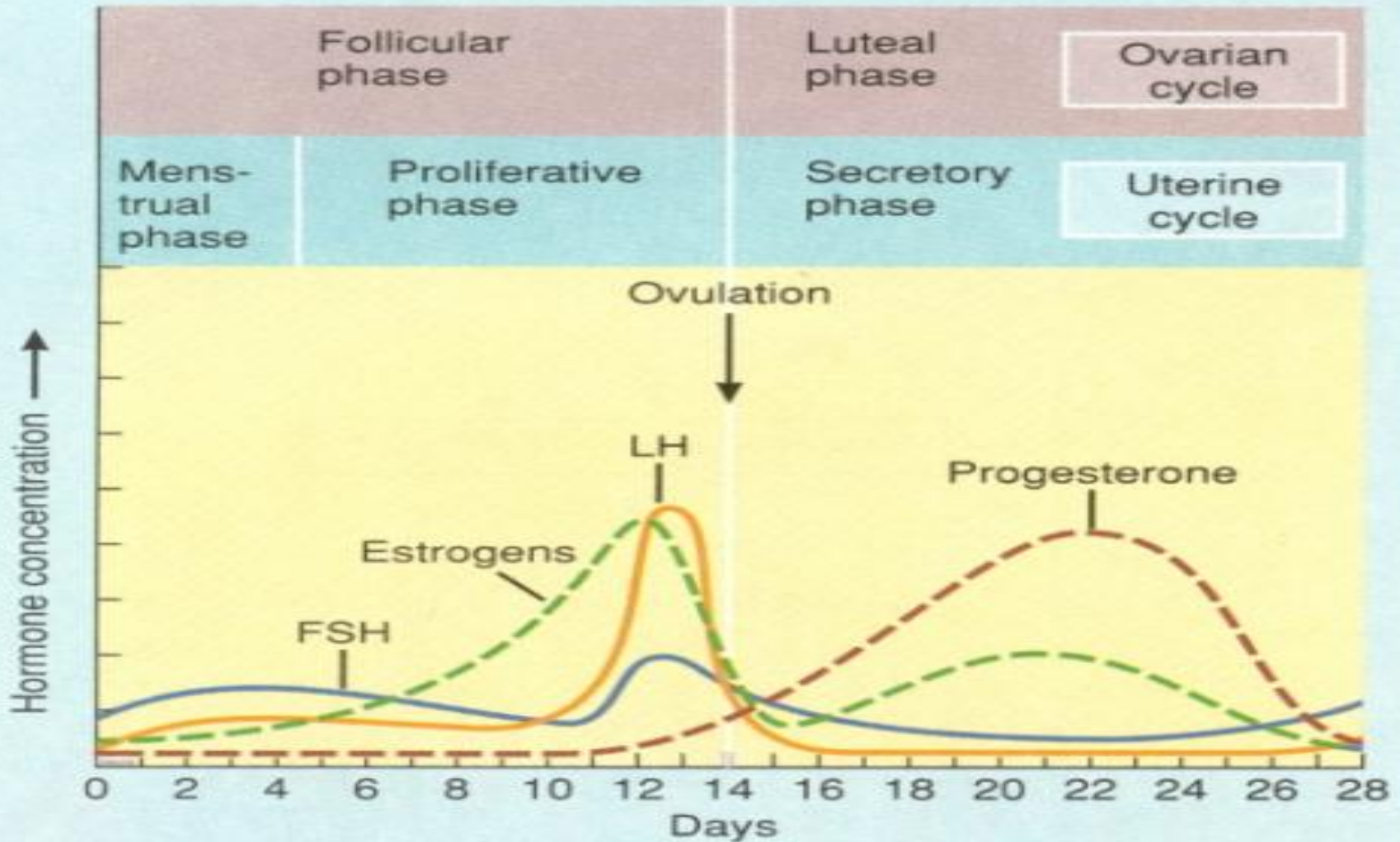
■ **Ovarian cycle**

1. The follicular phase: - ovarian follicle growth
- ovulation
2. The luteal phase: development of corpus luteum

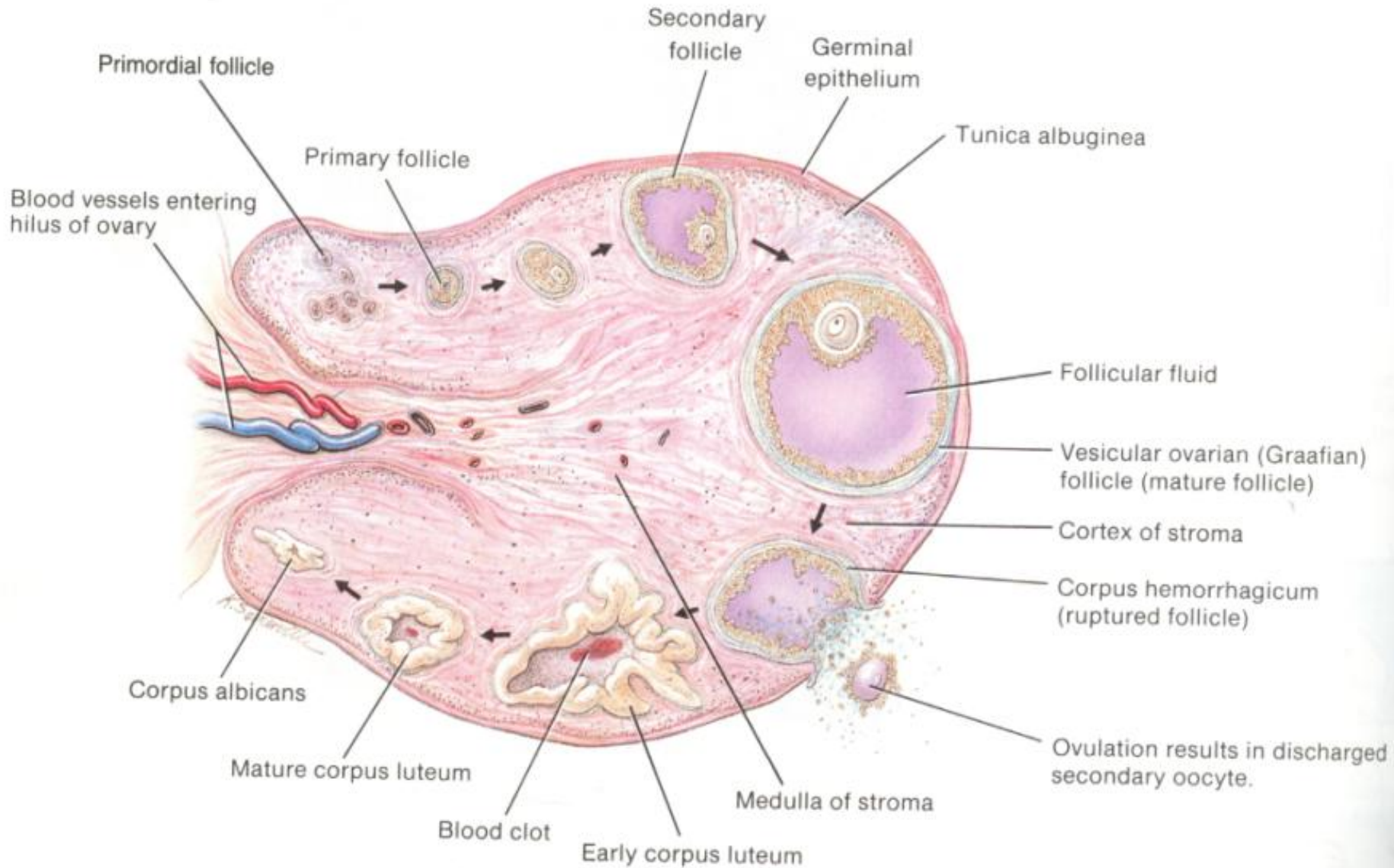
■ **Endometrial cycle (Uterine cycle)**

1. Proliferative phase: - estrogen phase
- before ovulation
2. Secretory phase: - progestational phase
- after ovulation
3. Menstruation

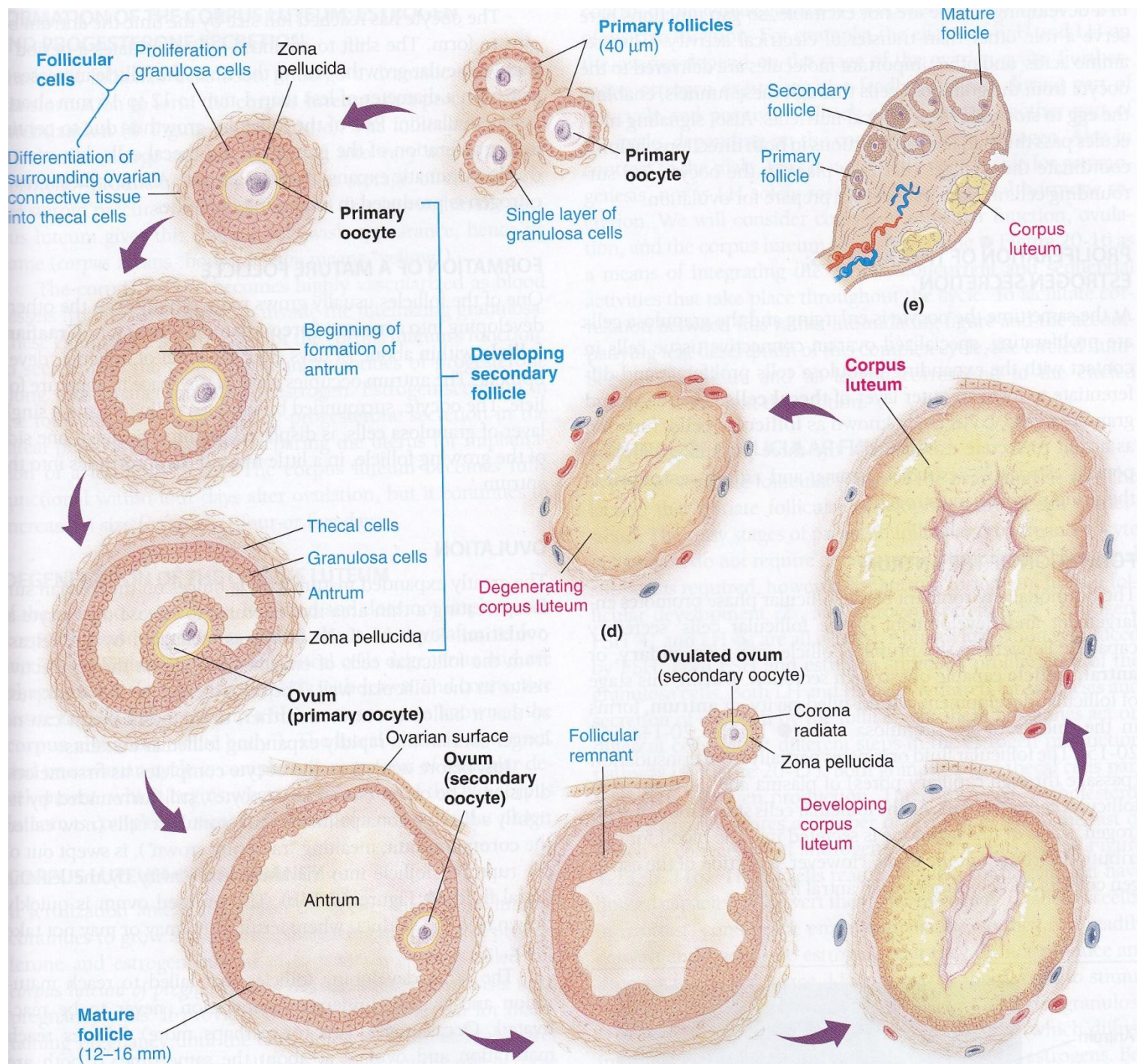
....Female Monthly Rhythm



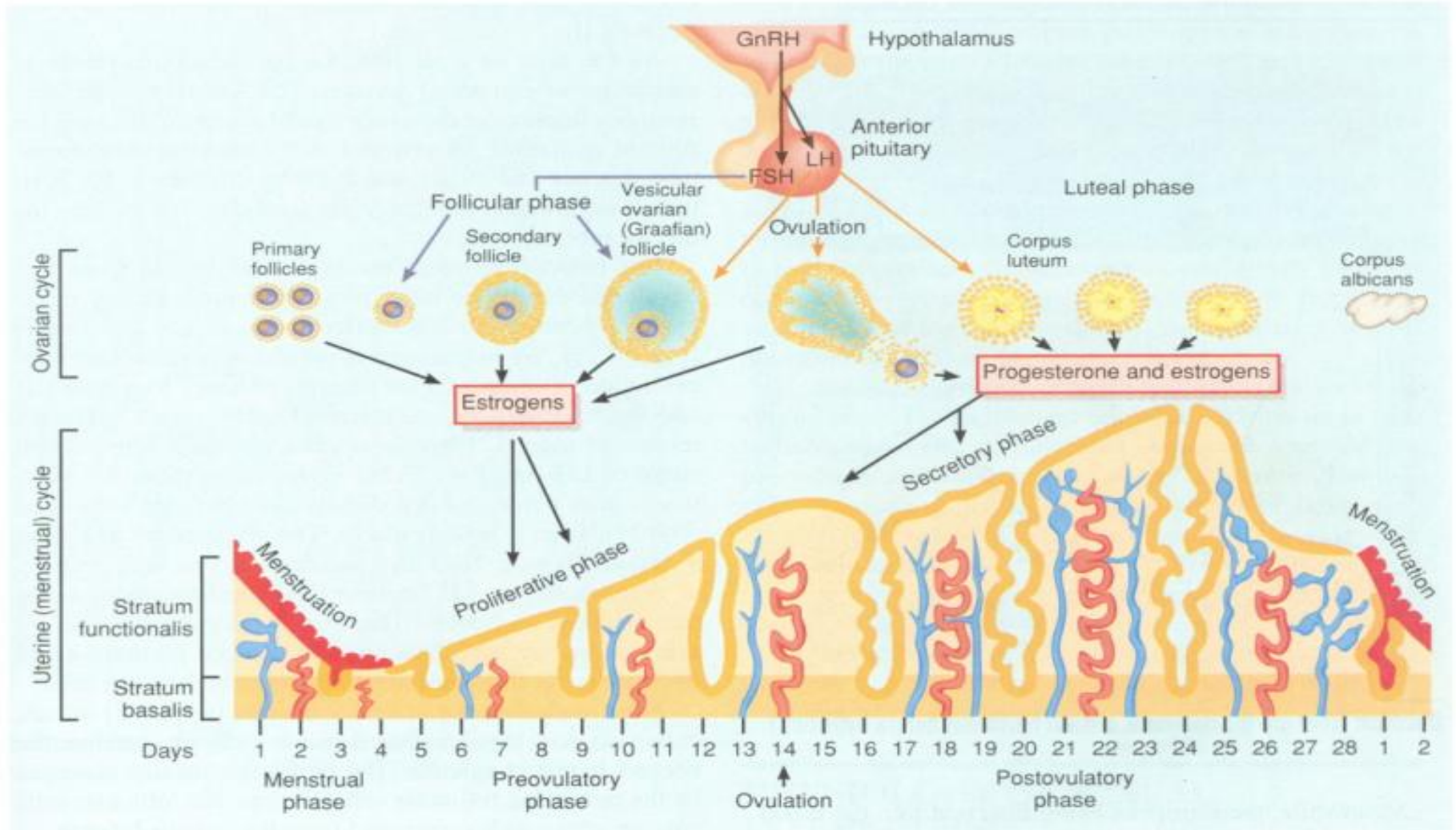
Ovarian Cycle



(a) Sectional view

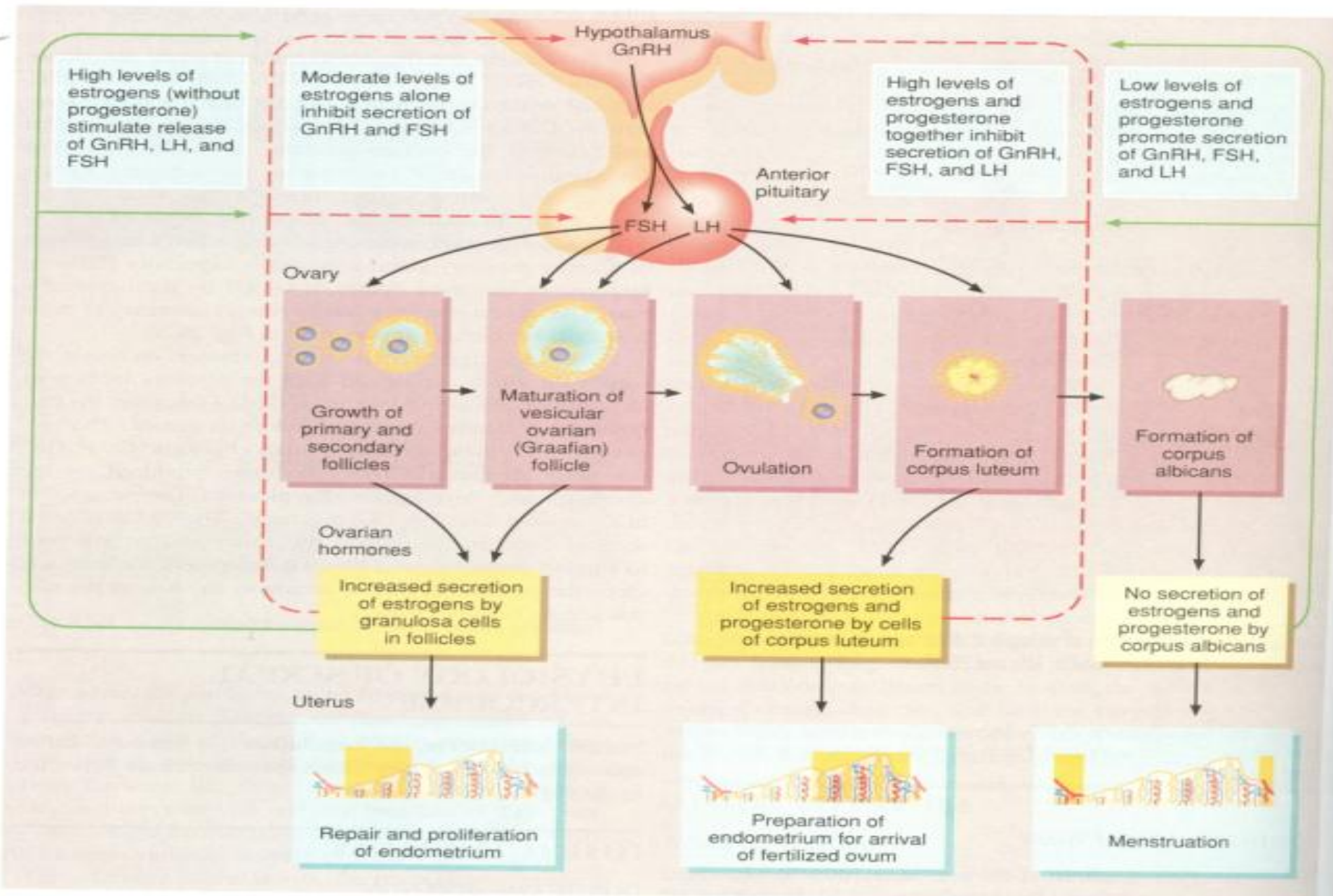


Endometrial Cycle



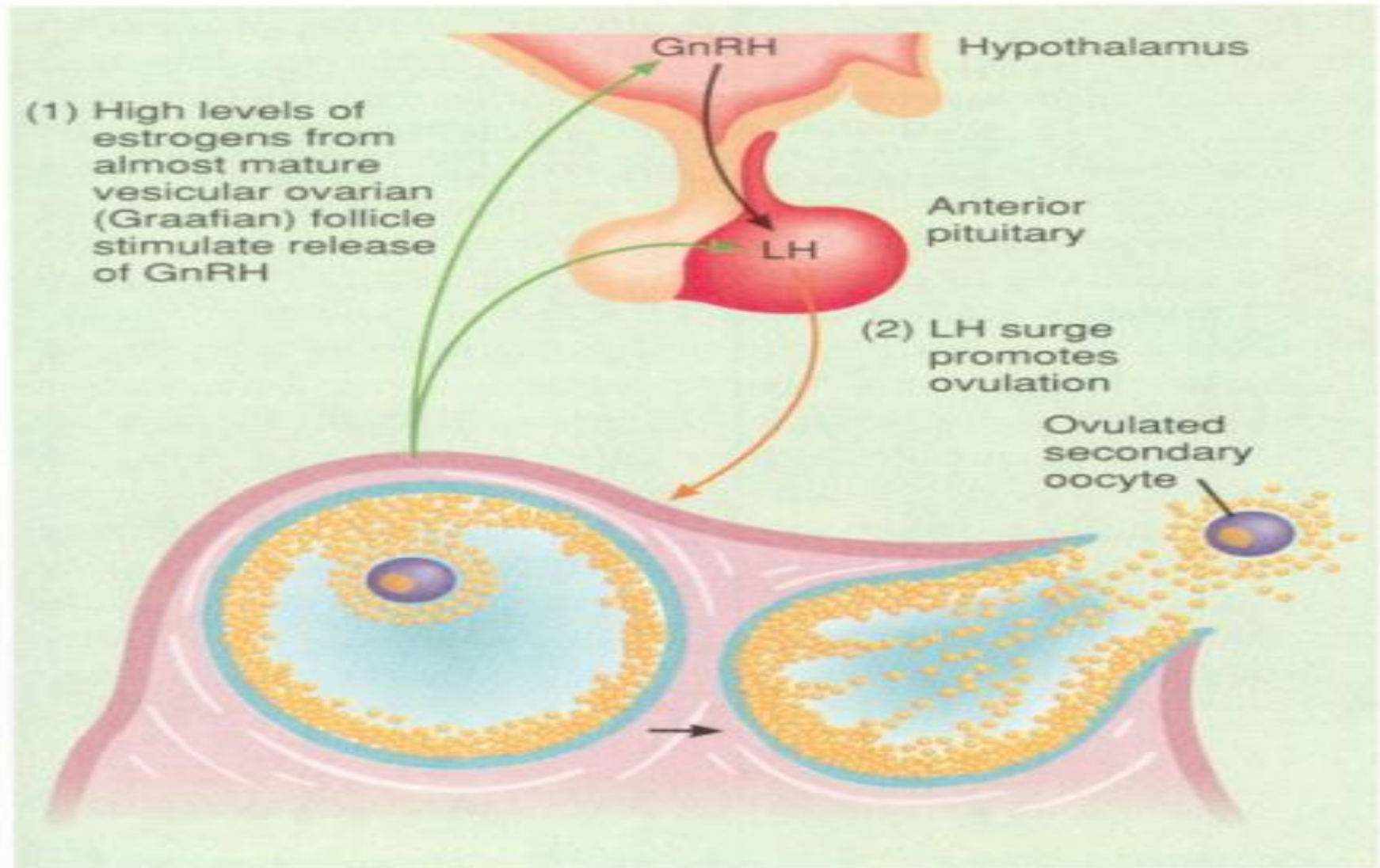
Question: Which hormones stimulate proliferation of the endometrium? Ovulation? Growth of the corpus luteum? The surge of LH at midcycle?

FIGURE 28.26 Summary of hormonal interactions of the uterine and ovarian cycles.



Question: When declining levels of estrogens and progesterone stimulate secretion of GnRH, is this a positive or negative feedback effect? Why?

FIGURE 28.25 Positive feedback effect of *high* levels of estrogens on secretion of GnRH and LH.



Question: What is the effect of rising but still moderate levels of estrogens on secretion of GnRH, LH, and FSH?

Thank You