

# Reproductive Physiology

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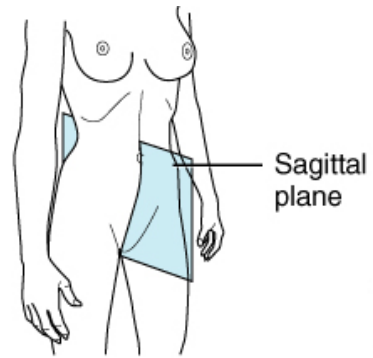
Fatima Daoud, MD. PhD

# Female Physiology Before Pregnancy and Female Hormones Female reproductive functions

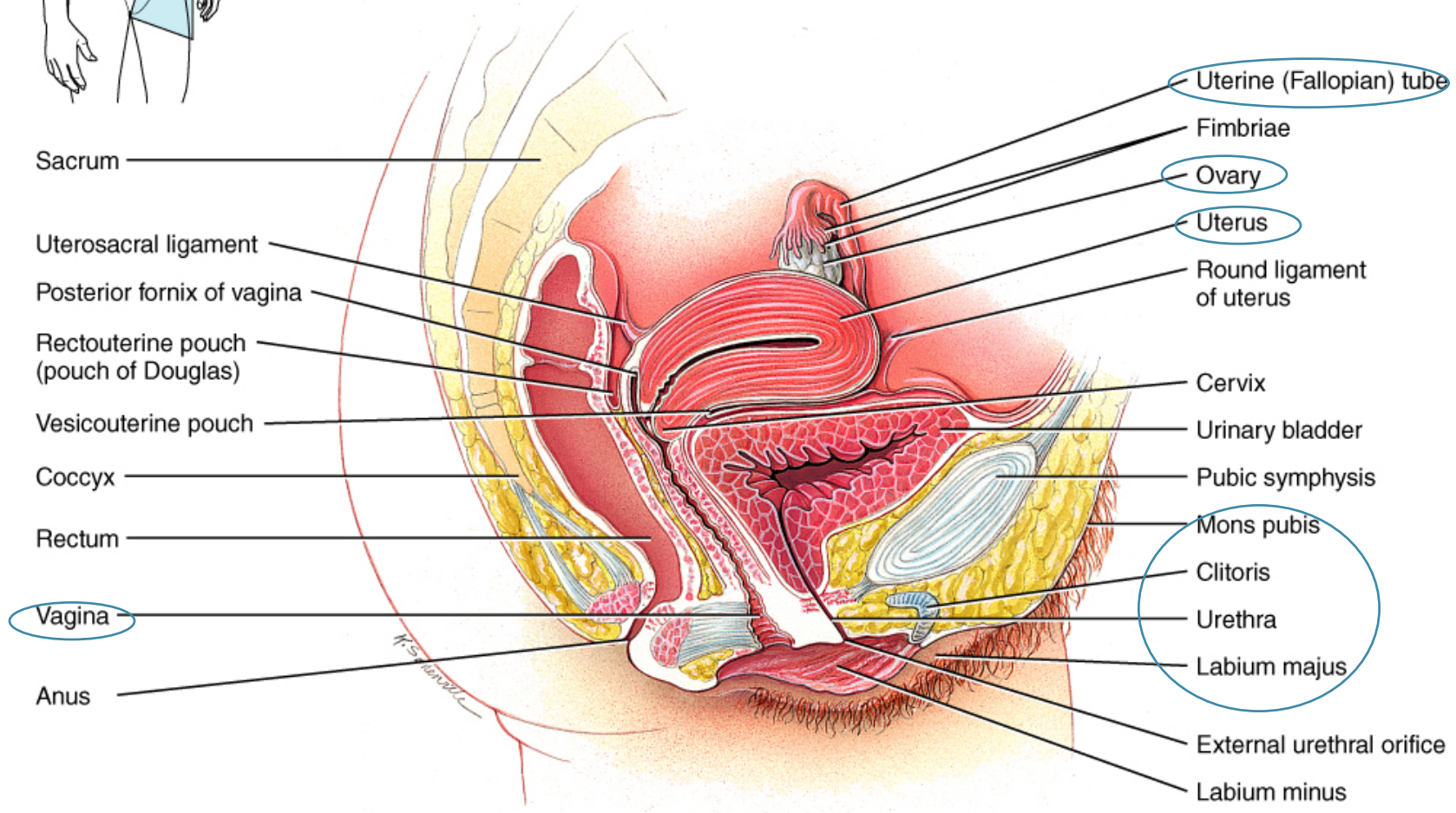
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Chapter 82

# Female reproductive organs

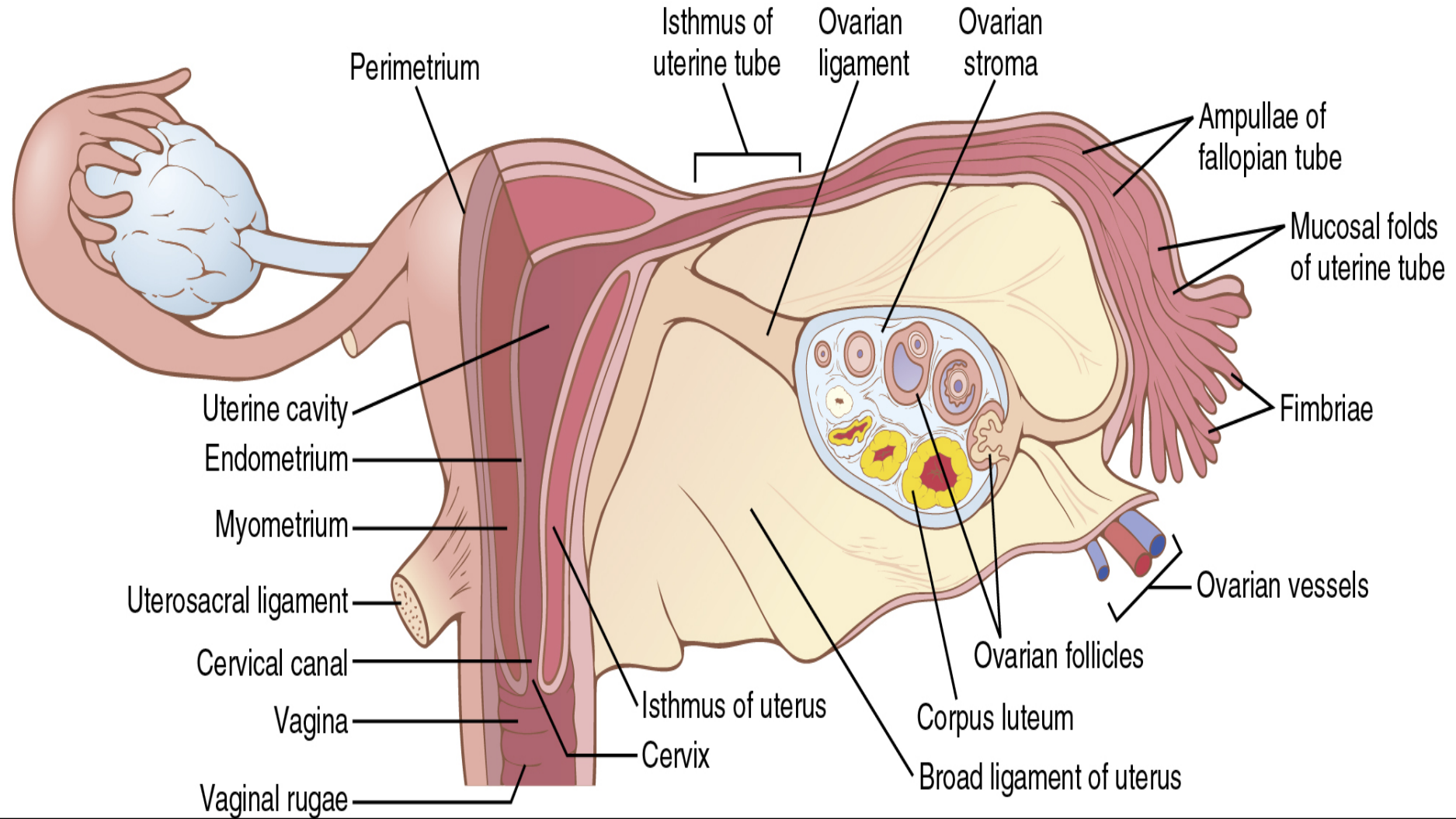


+Mammary glands



(a) Sagittal section

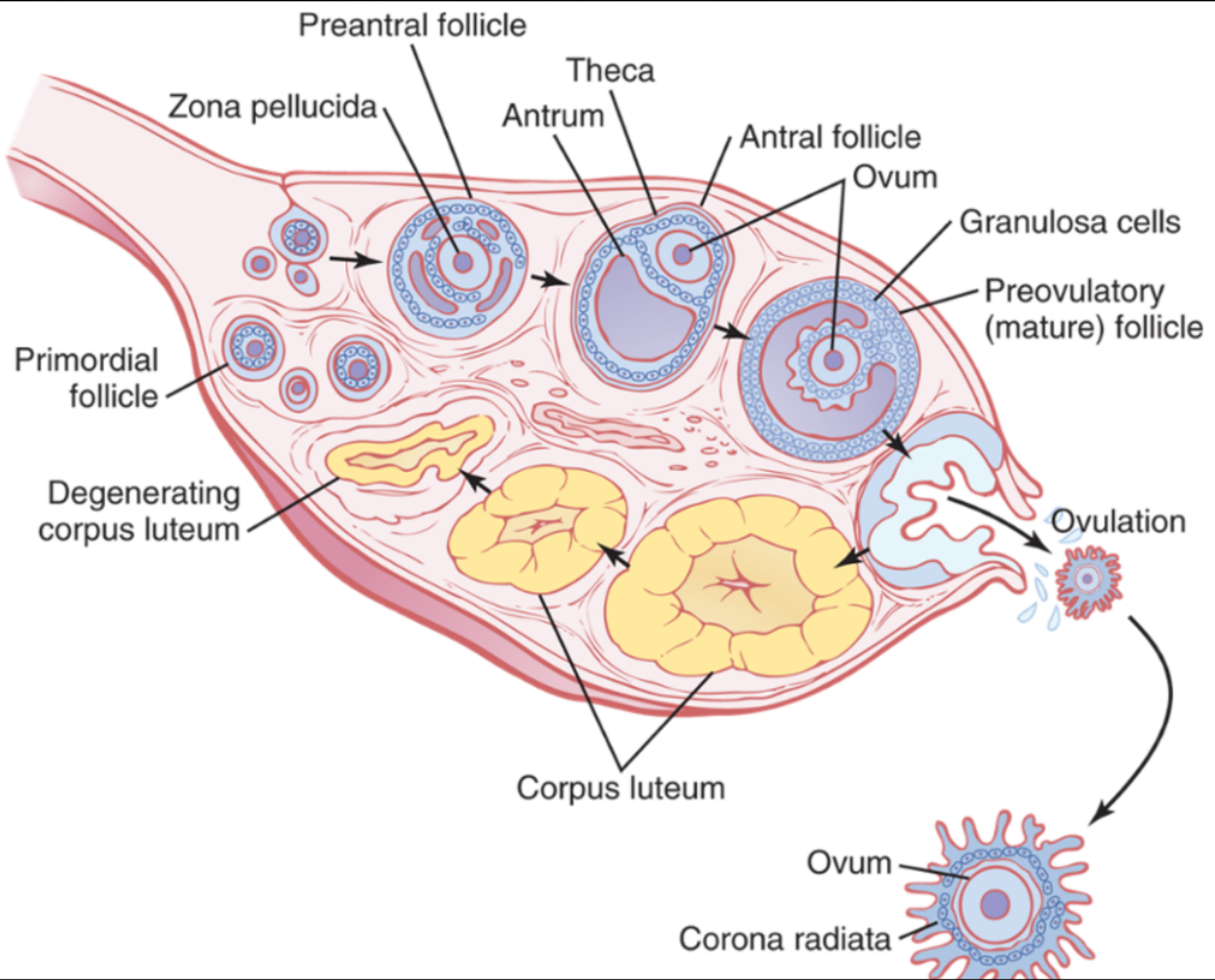
# Relationship of the uterine tubes to the ovaries, uterus, and associated structures

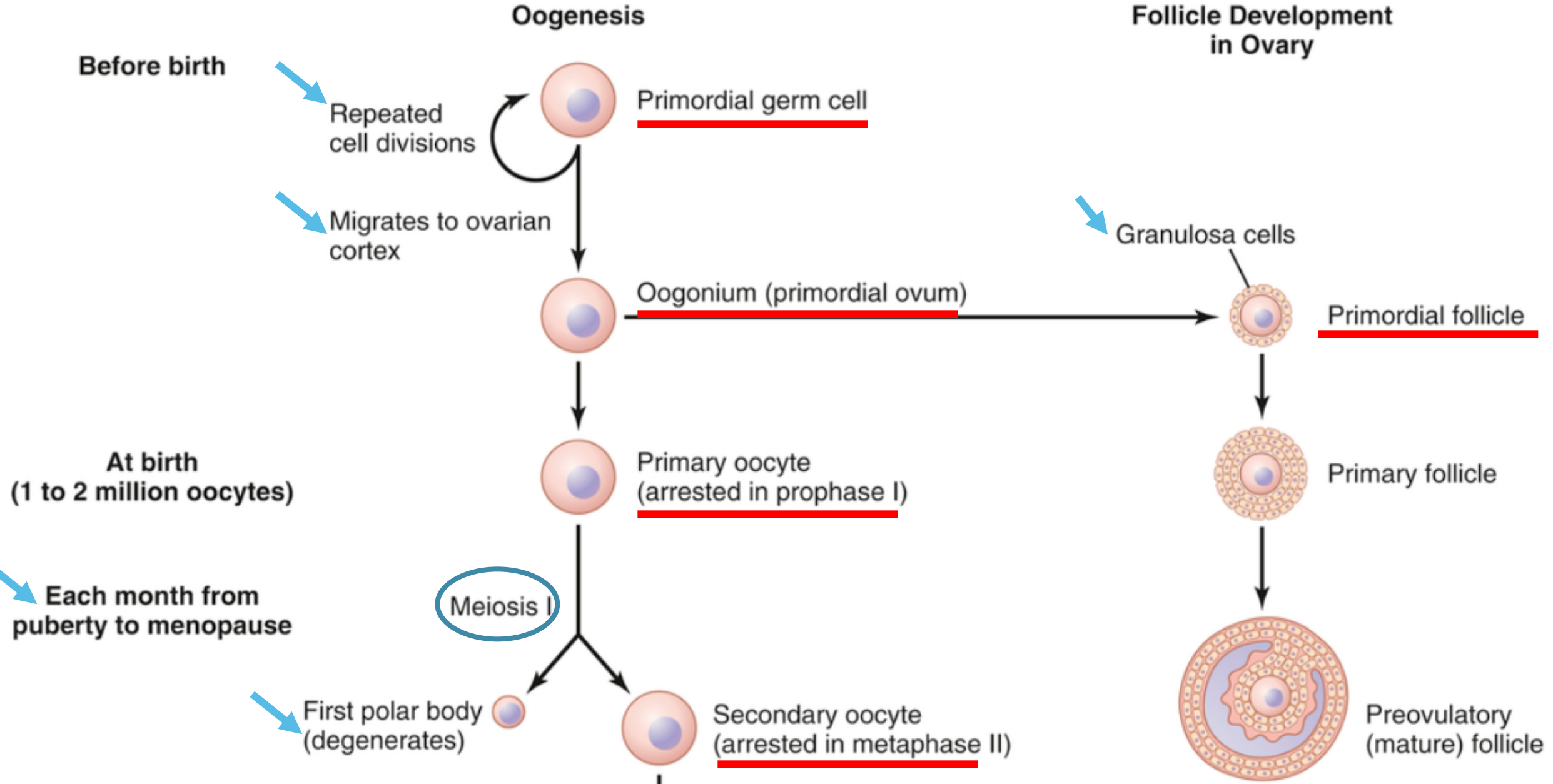


\*\* Reproduction begins with the development of ova in the ovaries. In the middle of each monthly sexual cycle, a single ovum is expelled from an ovarian follicle into the abdominal cavity near the open fimbriated ends of the two fallopian tubes. This ovum then passes through one of the fallopian tubes into the uterus; if it has been fertilized by a sperm, it implants in the uterus, where it develops into a fetus, a placenta, and fetal membranes—and eventually into a baby.

# Oogenesis

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\*\*During early embryonic development, **primordial germ cells migrate** to the outer surface of the ovary, which is covered by a germinal epithelium.

\*\*During this migration, the germ **cells divide repeatedly**.

\*\*Once these primordial germ cells reach the germinal epithelium, they migrate into the substance of the ovarian cortex and become **oogonia or primordial ova**.

\*\*Each primordial ovum then collects around it a layer of spindle cells from the **ovarian stroma** (the supporting tissue of the ovary) and causes them to take on epithelioid characteristics; these epithelioid-like cells are then called **granulosa cells**. The ovum surrounded by a single layer of granulosa cells is called a **primordial follicle**. At this stage, the ovum is still immature and is called a **primary oocyte**.

\*\*The first meiotic division of the oocyte is completed **after puberty**. Each oocyte divides into two cells, a large ovum (secondary oocyte) and a small first polar body. Each of these cells contains 23 duplicated chromosomes.

puberty to menopause

MEIOSIS I

First polar body  
(degenerates)

Secondary oocyte  
(arrested in metaphase II)

Preovulatory  
(mature) follicle

Ovulation

Ovulated  
secondary oocyte

Fertilization

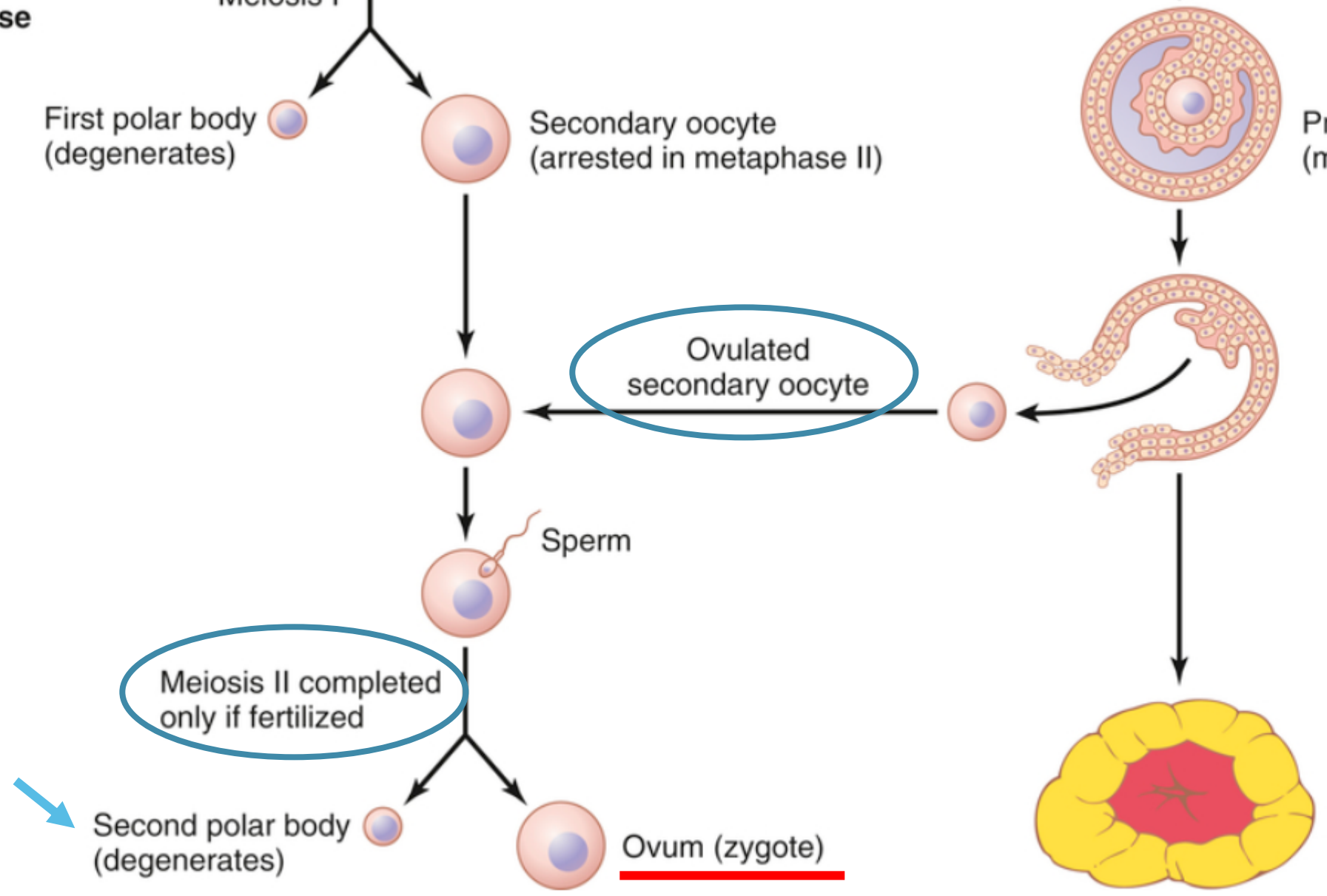
Sperm

Meiosis II completed  
only if fertilized

Second polar body  
(degenerates)

Ovum (zygote)

Corpus luteum



\*\*The ovum undergoes a second meiotic division, and after the sister chromatids separate, there is a pause in meiosis. If the ovum is fertilized, the final step in meiosis occurs and the sister chromatids in the ovum go to separate cells.

## NOTE !!

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- The oogonia in the embryonic ovary complete mitotic replication, and the first stage of meiosis starts by the **fifth month of fetal development**.
- The germ cell mitosis then ceases and **no additional oocytes are formed**.
- At birth the ovary contains about 1 to 2 million primary oocytes.

## NOTE !!

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- At puberty, only about 300,000 oocytes remain in the ovaries, and only a small percentage of these oocytes become mature.
- During all the reproductive years of adult life, between about 13 and 46 years of age on average, only 400 to 500 of the primordial follicles develop enough to expel their ova, one each month; the remainder degenerate (i.e., become atretic).
- At the end of reproductive capability (at menopause), only a few primordial follicles remain in the ovaries, and even these follicles degenerate soon thereafter.

# Differences between oogenesis and spermatogenesis

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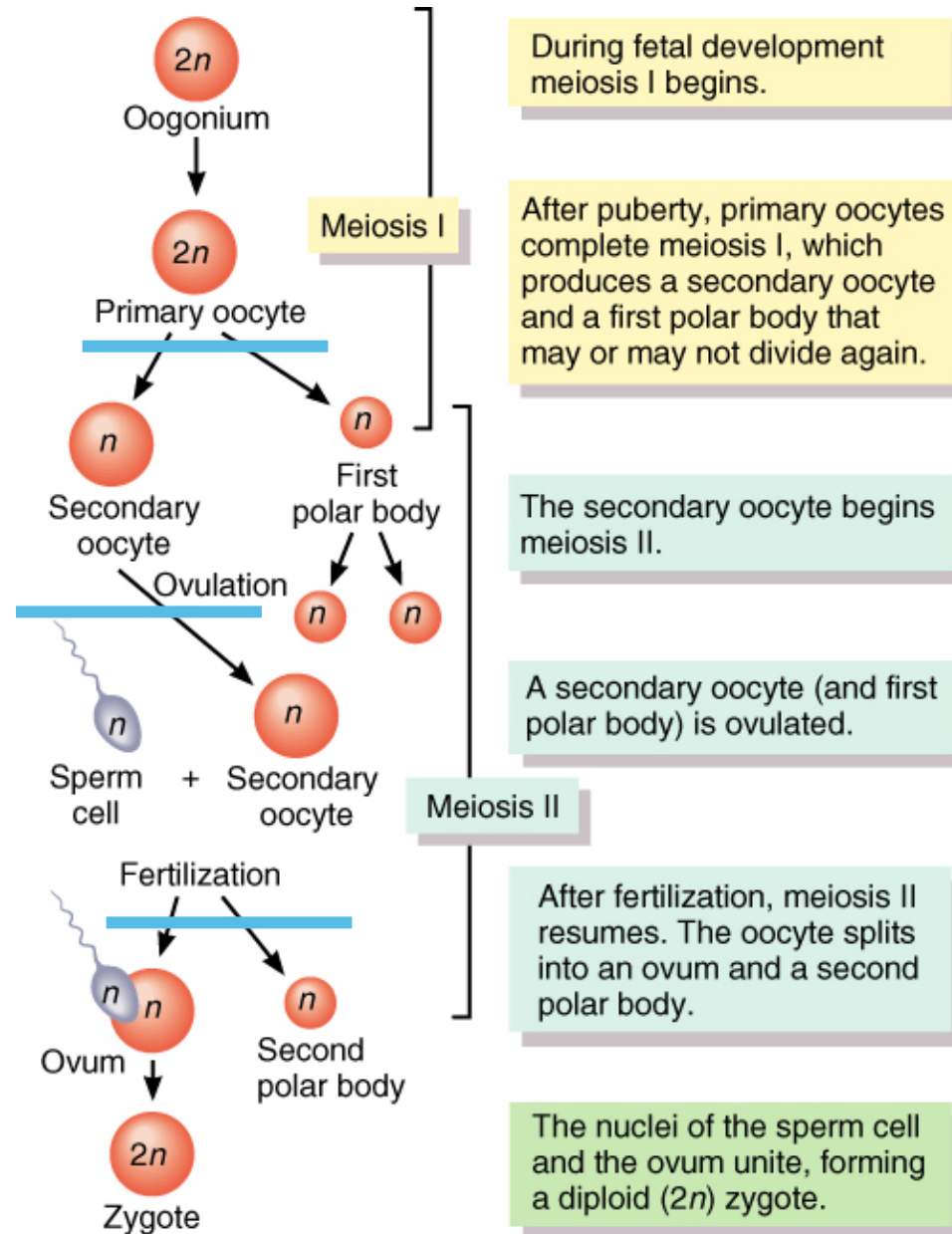
- (1) In the **female**, the **mitotic** proliferation of germ cells takes place **entirely before birth**. In the male, spermatogonia proliferate **only after puberty and then throughout life**.
- (2) The meiotic divisions of a primary oocyte in the female produce only **one mature ovum** with a **large amount of cytoplasm** and two to three polar bodies. In the male, the meiotic divisions of a primary spermatocyte produce **four mature spermatozoa** with a **minimal amount of cytoplasm**.

# Differences between oogenesis and spermatogenesis

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- (3) In the female, the second meiotic division is completed only on fertilization, and **thus no further development of the cell takes place after the completion of meiosis.**
- In the male, the products of meiosis (the spermatids) **undergo substantial further differentiation** to produce mature spermatozoa.

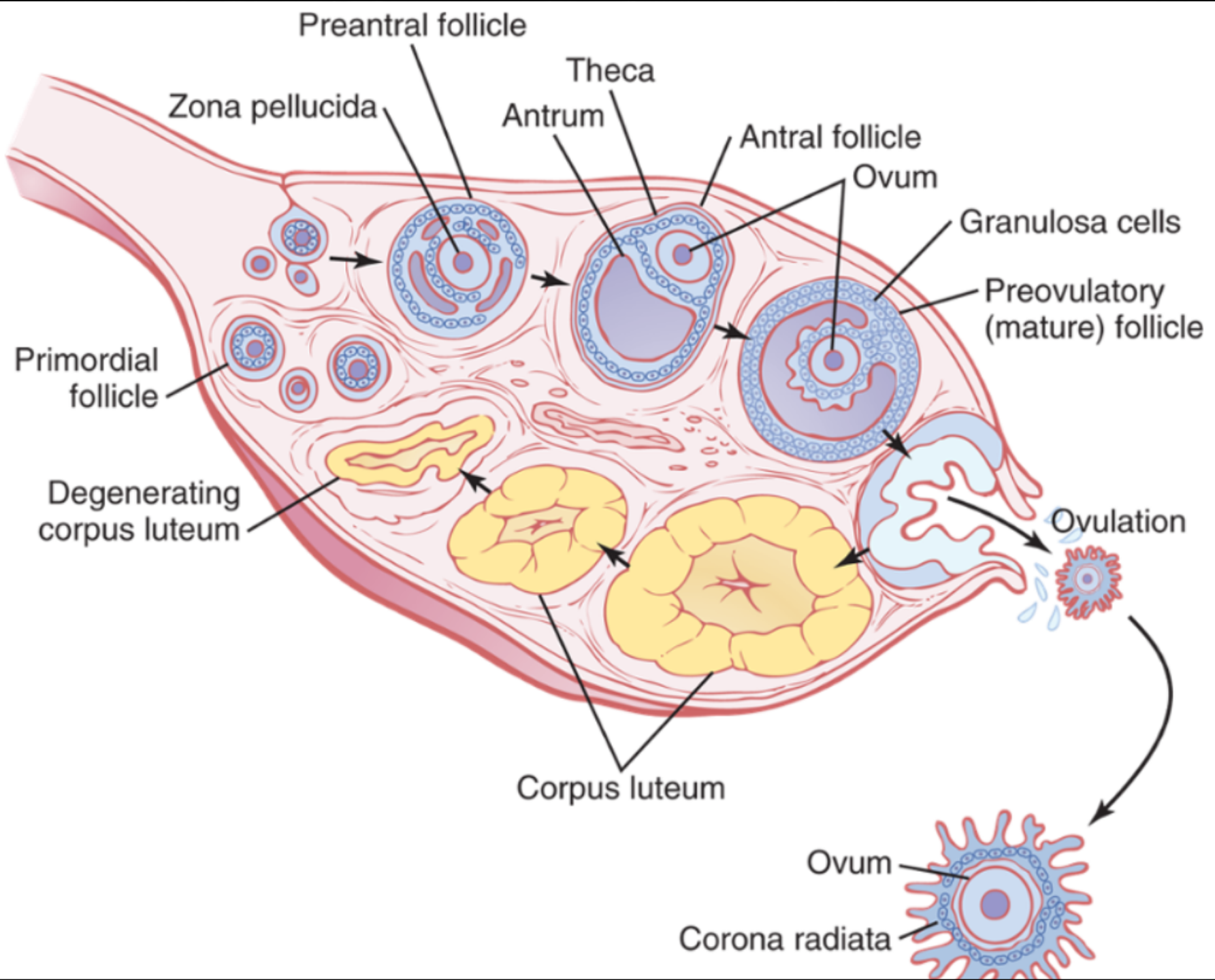
# Oogenesis





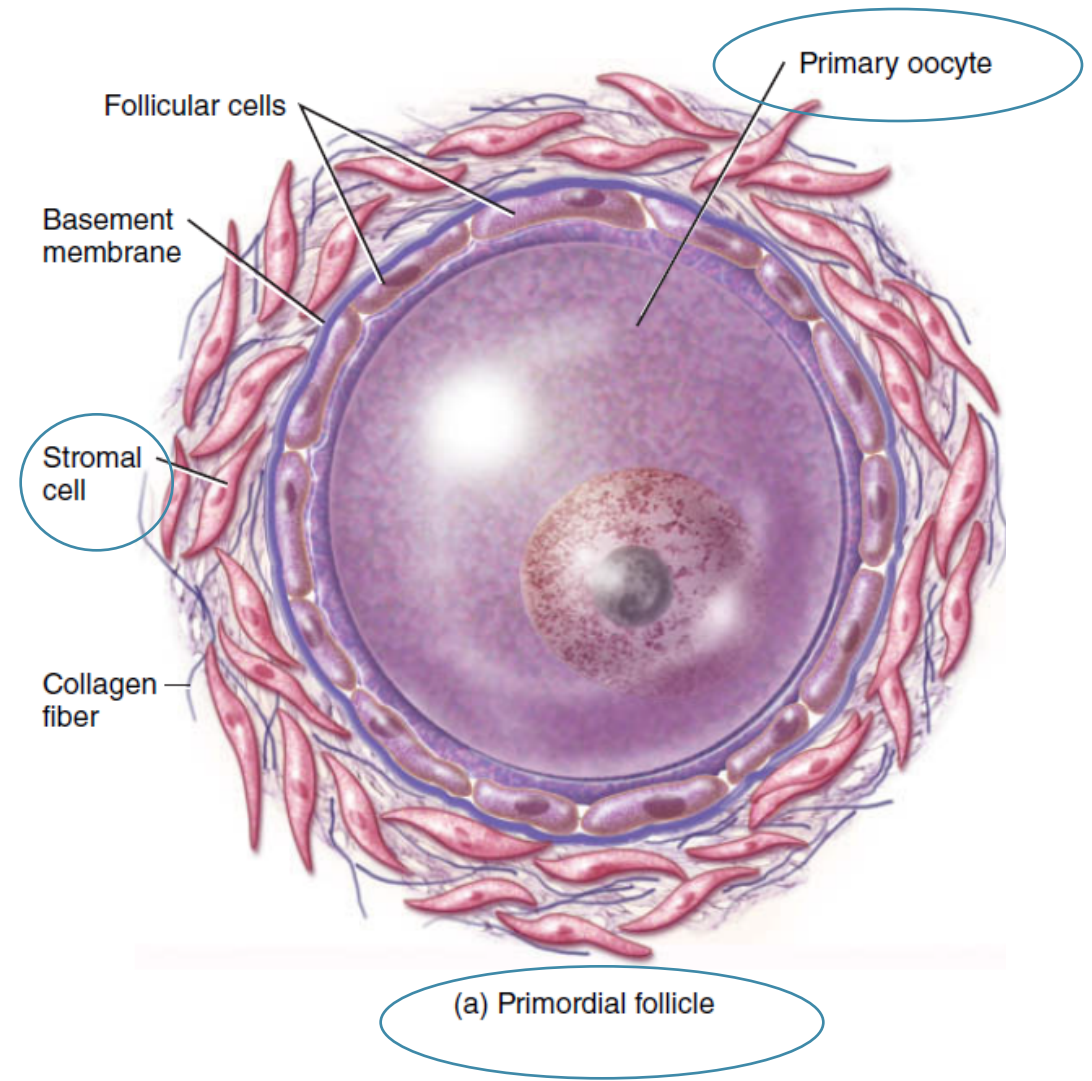
# Follicular Developments

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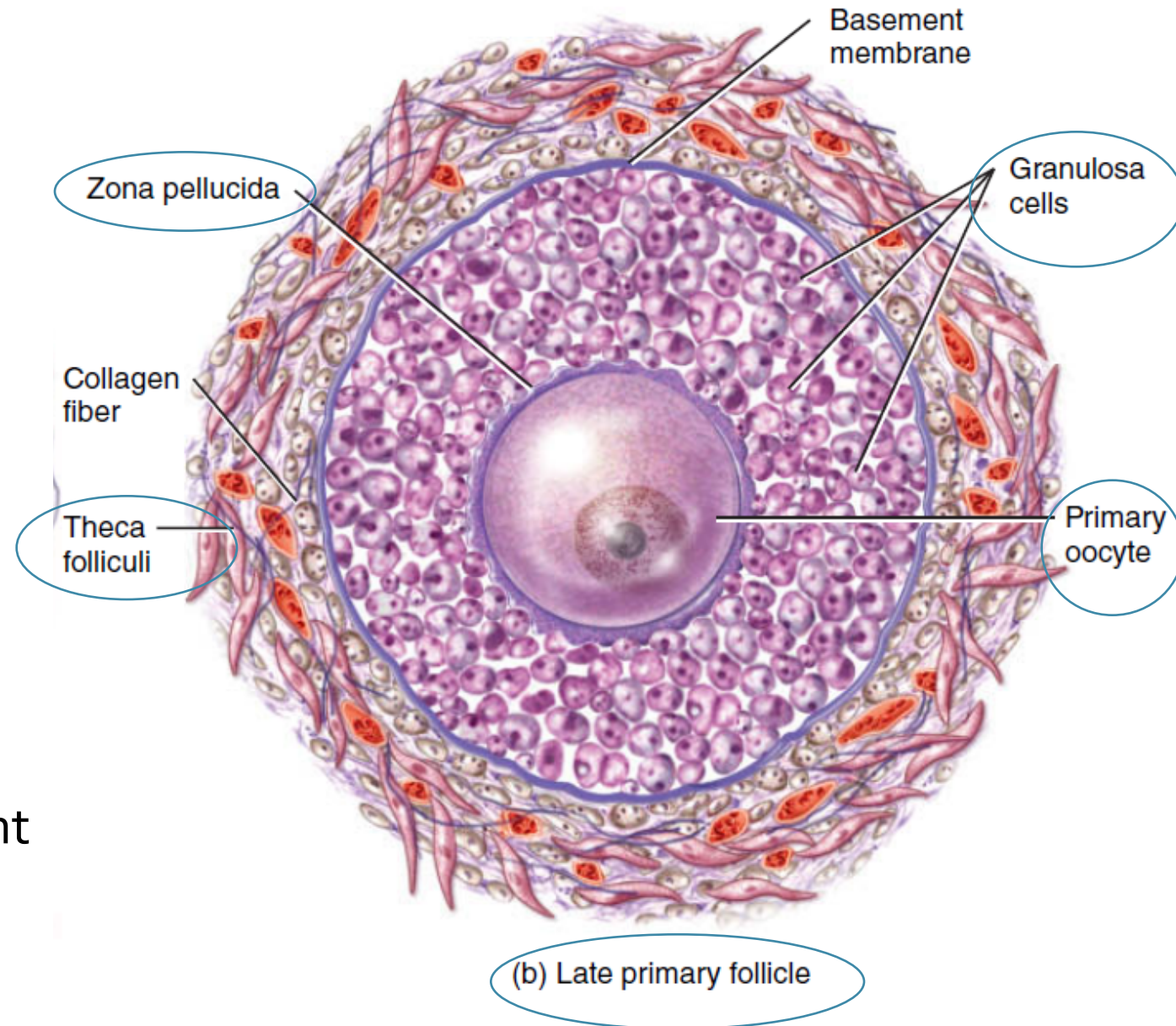
# Primordial follicle

- When a **female child is born**, each ovum is surrounded by a single layer of granulosa cells; the ovum, with this granulosa cell sheath, is called a **primordial follicle**.
- **Throughout childhood**, the granulosa cells are believed to provide **nourishment** for the ovum and to secrete an ***oocyte maturation-inhibiting factor*** that keeps the ovum suspended in its primordial state in the prophase stage of meiotic division.



# Primary follicle

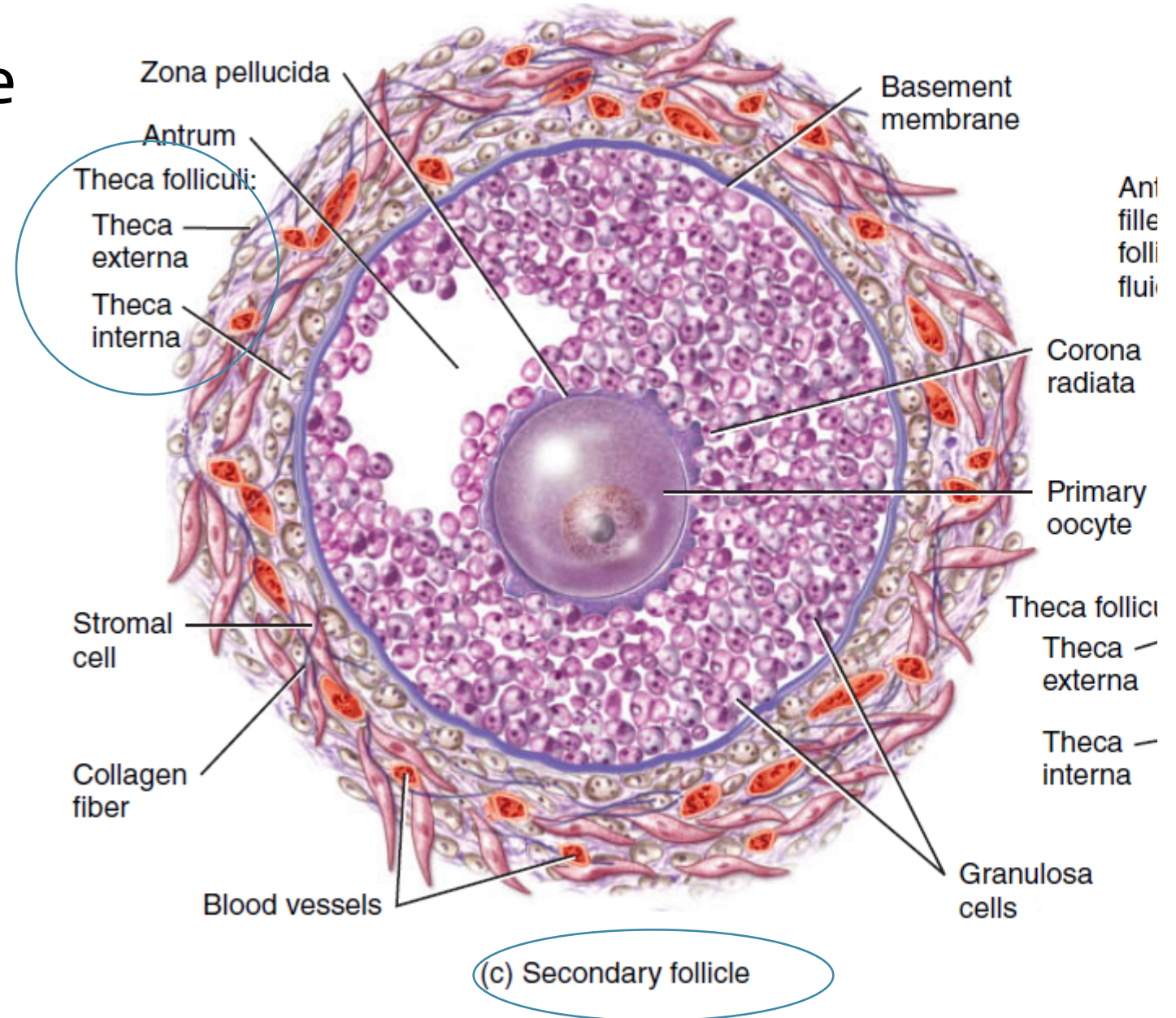
- Then, after puberty, when FSH and LH are secreted in significant quantities, the ovaries (together with some of the follicles within them) begin to grow.
- Consists of a primary oocyte that is surrounded by **several layers** of cuboidal and low columnar **granulosa cells**.
- **zona pellucida**, a clear glycoprotein layer
- Stromal cells surrounding the basement membrane begin to form.



# Secondary follicle

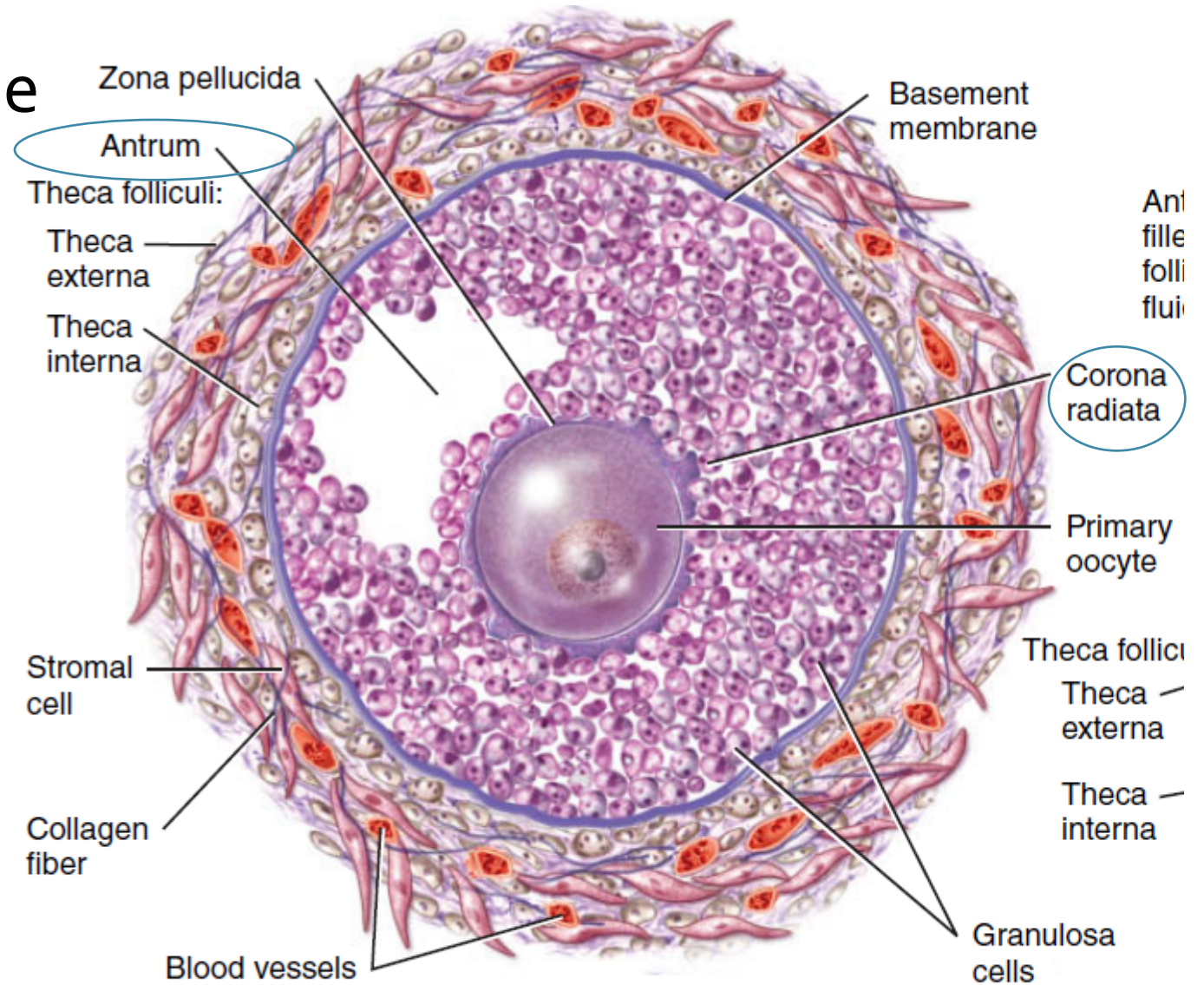
The theca differentiates into two layers:

- 1) Theca interna, epithelioid characteristics, secrete additional steroid sex hormones.
- 2) Theca externa, develops into a highly vascular connective tissue capsule.



## Secondary follicle/Antral stage

- The granulosa cells begin to secrete follicular fluid, which builds up in a cavity called the **antrum**. (**high concentration of estrogen**)
- The innermost layer of granulosa cells becomes firmly attached to the zona pellucida and is now called the **corona radiata**.



(c) Secondary follicle

# vesicular follicle

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- The early growth of the primary follicle up to the antral stage is stimulated mainly **by FSH alone**.
- Greatly **accelerated growth** then occurs, leading to still larger follicles called vesicular follicles and this due to :
  1. **Estrogen** is secreted into the follicle and causes the **granulosa cells** to form increasing numbers of **FSH receptors**, which causes a **positive feedback effect** because it makes the granulosa cells even more sensitive to FSH.

## vesicular follicles

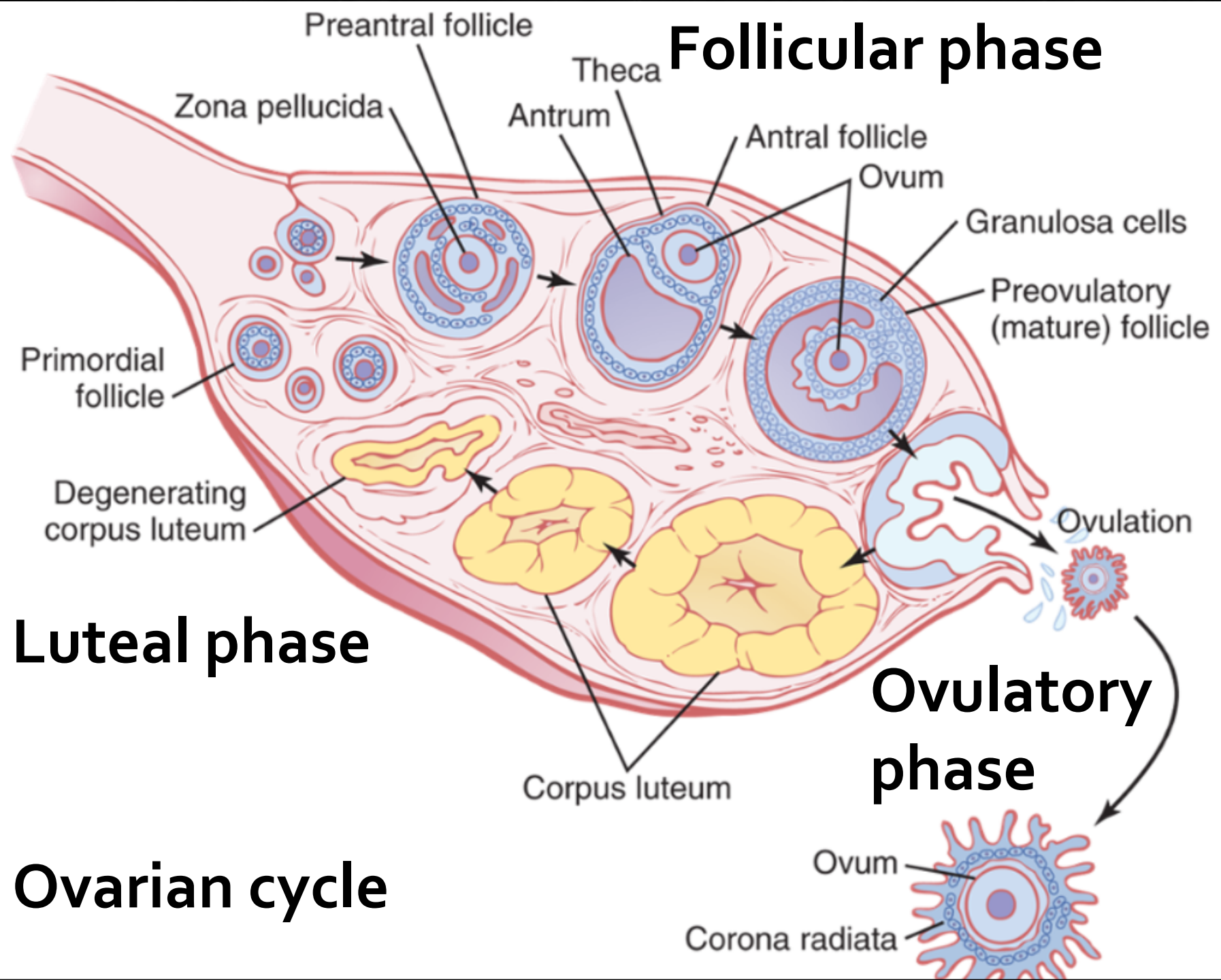
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- 2. The pituitary **FSH and the estrogens** combine to promote **LH receptors** on the original granulosa cells, thus allowing LH stimulation to occur in addition to FSH stimulation and creating an **even more rapid increase in follicular secretion**.
- 3. The increasing **estrogens** from the follicle plus the **increasing LH** from the anterior pituitary gland act together to cause proliferation of the follicular **thecal cells** and increase their secretion.



# Only One Follicle Fully Matures Each Month, and the Remainder Undergo Atresia.

- Before ovulation occurs, one of the follicles begins to outgrow all the others; the remaining 5 to 11 developing follicles involute (a process called *atresia*)
- The large amounts of estrogen from the most rapidly growing follicle → the hypothalamus to depress further enhancement of FSH secretion → in this way blocking further growth of the less well developed follicles.
- → The largest follicle continues to grow because of its intrinsic positive feedback effects, while all the other follicles stop growing and actually involute.
- This process of atresia is important because it normally allows only one of the follicles to grow large enough each month to ovulate.
- **Note: \*\* About every 28 days, gonadotropic hormones from the anterior pituitary gland cause 8 to 12 new follicles to begin to grow in the ovaries.**
- **\*\* One of these follicles finally becomes "mature" and ovulates on the 14th day of the cycle.**



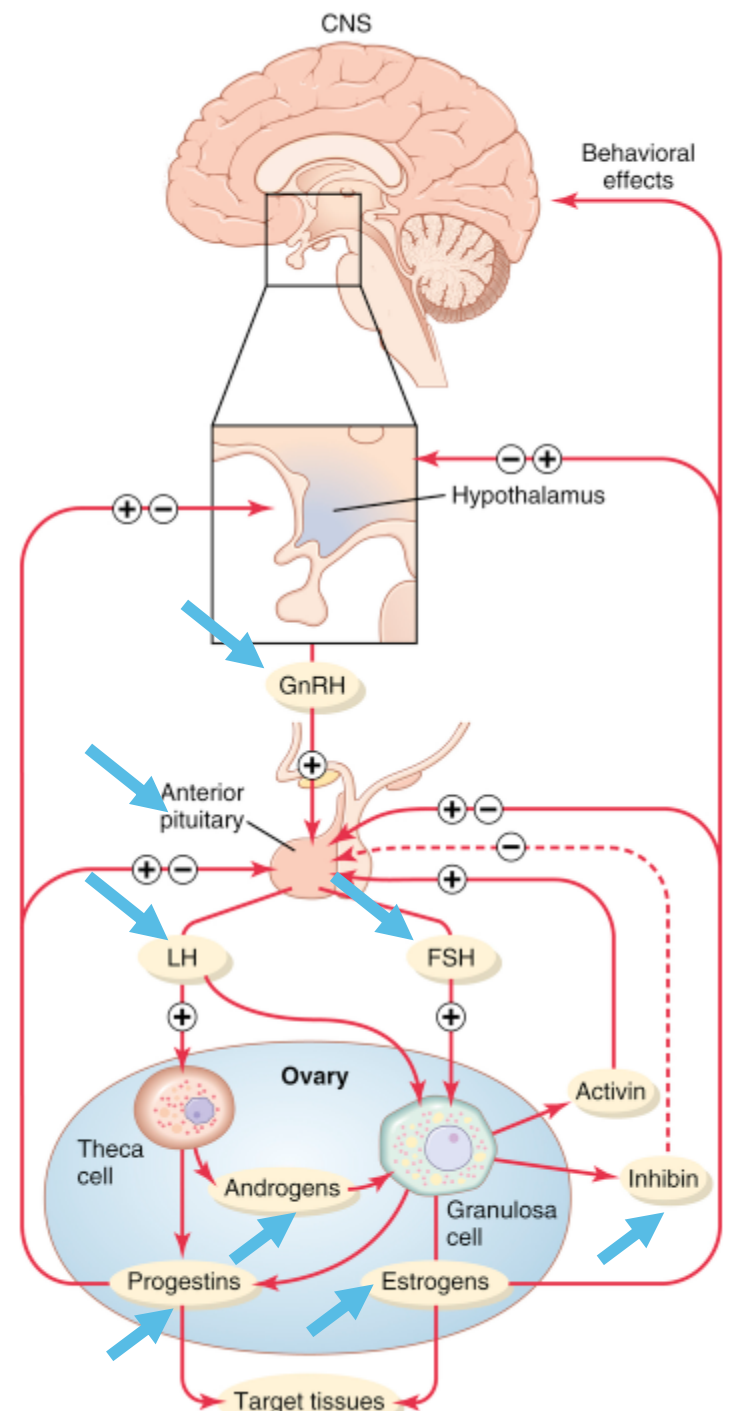
# Female Hormonal System

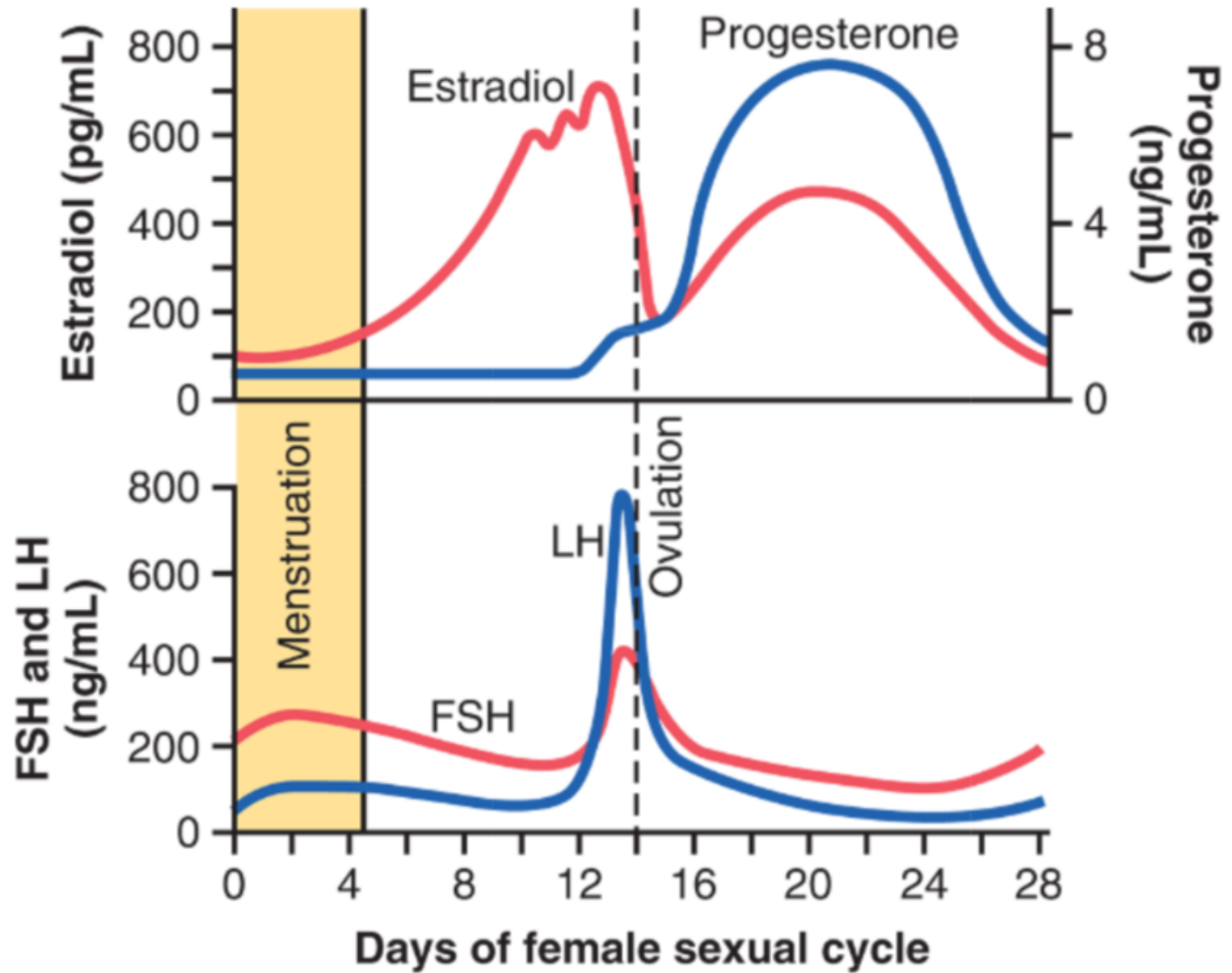
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# Gonadotropic Hormones and Their Effects on the Ovaries

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- The ovarian changes that occur during the sexual cycle depend completely on the gonadotropic hormones FSH and LH.
- In the absence of these hormones, the ovaries remain inactive, which is the case throughout childhood, when almost no pituitary gonadotropic hormones are secreted.
- At age 9 to 12 years, the pituitary begins to secrete progressively more FSH and LH, which leads to onset of normal monthly sexual cycles beginning between the ages of 11 and 15 years.
- This period of change is called *puberty*, and the time of the first menstrual cycle is called *menarche*.





\*\*These various hormones are secreted at drastically differing rates during different parts of the female monthly sexual cycle.

\*\* The amount of GnRH released from the hypothalamus increases and decreases much less drastically during the monthly sexual cycle. It is secreted in short pulses averaging once every 90 minutes.

\*\* During the first few days of each monthly female sexual cycle, the concentrations of FSH and LH secreted by the anterior pituitary gland increase slightly to moderately, with the increase in FSH slightly greater than that of LH and preceding it by a few days.

\*\* FSH, cause accelerated growth of 6 to 12 primary follicles each month.

**Note:**  
 The early growth of the primary follicle up to the antral stage is stimulated mainly by FSH alone.

