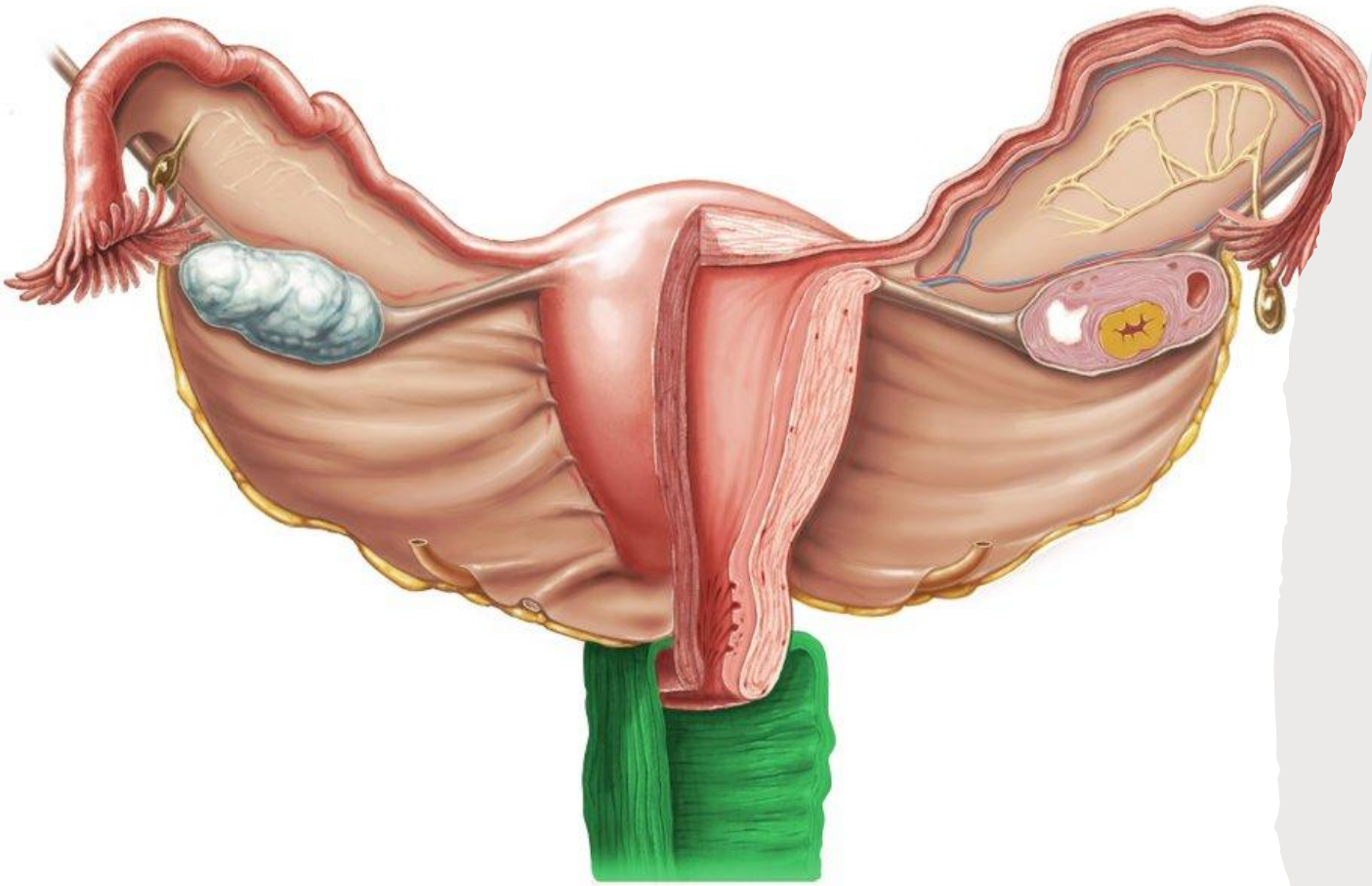
Female Reproductive System

Dr. Heba Kalbouneh
DDS, MSc, DMD/PhD
Professor of Anatomy, Histology and Embryology



Learning Objectives

By the end of this lecture, students should be able to:

- Identify the main organs of the female reproductive system and describe their functions.
- Describe the microscopic structure of the ovary at different developmental stages.
- Explain the hormonal regulation of the female reproductive system (GnRH, FSH, LH, estrogen, progesterone).
- Describe the stages of folliculogenesis (primordial, primary, secondary, and Graafian follicles) and correlate structural changes with hormonal influences.
- Describe the stages of oogenesis (oogonia, primary oocyte, secondary oocyte, ovum) and correlate meiotic events with developmental timing.

The female reproductive system consists of the **ovary, oviduct (fallopian/uterine tube), uterus and vagina.**

The ovary is where oogenesis occurs

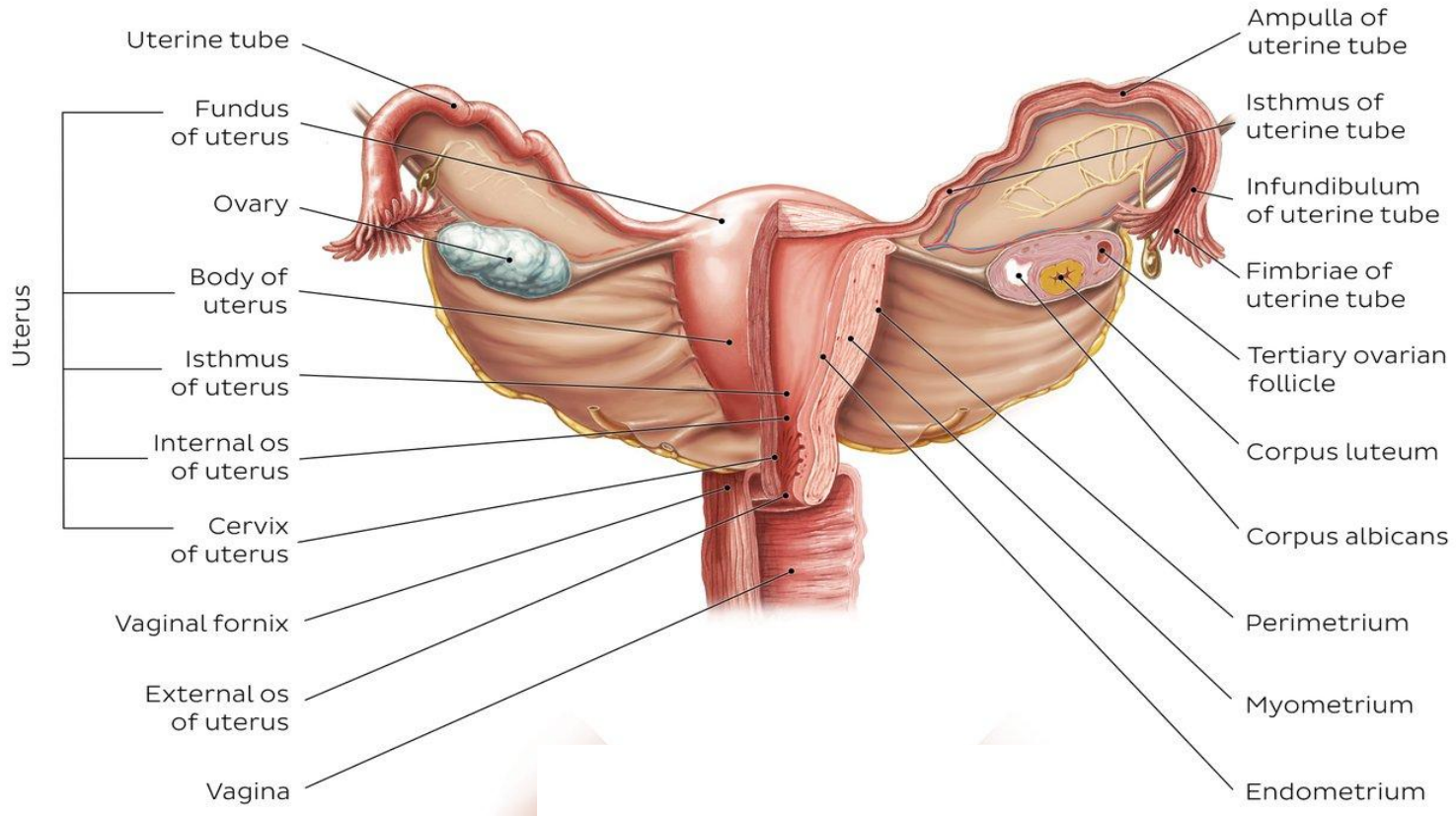
Mixed gland (Exocrine and Endocrine)

- ✓ Exocrine function: produces ova
- ✓ Endocrine function: releases estrogen and progesterone

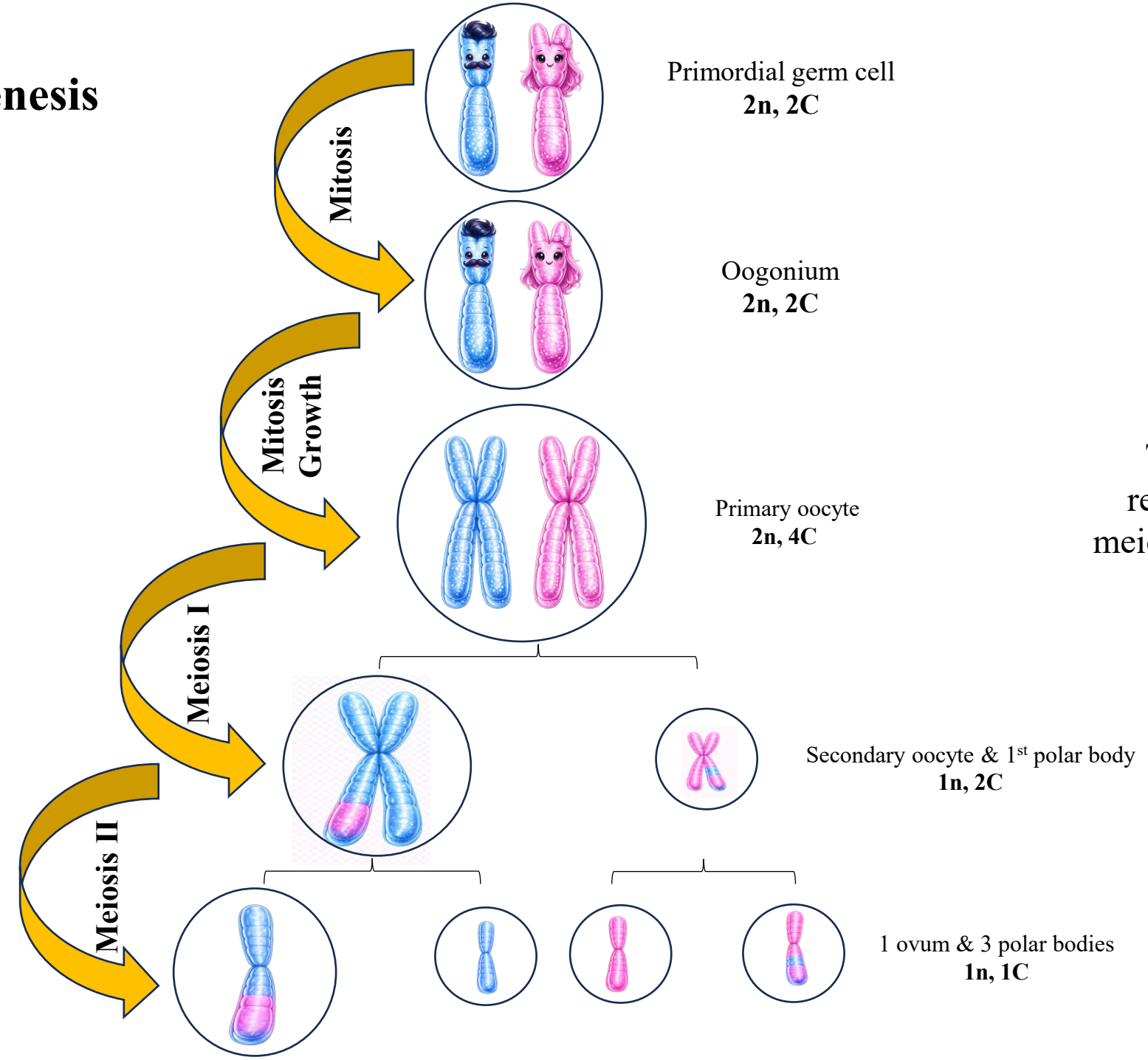
Ovaries are stimulated by gonadotrophins from the anterior pituitary (FSH & LH)

The genital tract makes up the rest of the female reproductive system:

- ✓ Fallopian tubes take the ova to the uterus.
- ✓ The uterus is a thick-walled, muscular organ whose mucosal lining (endometrium) undergoes cyclic, hormone-dependent changes and provides the site for implantation and development of the embryo and fetus until birth.
- ✓ The vagina is a muscular tube that leads to the outside.

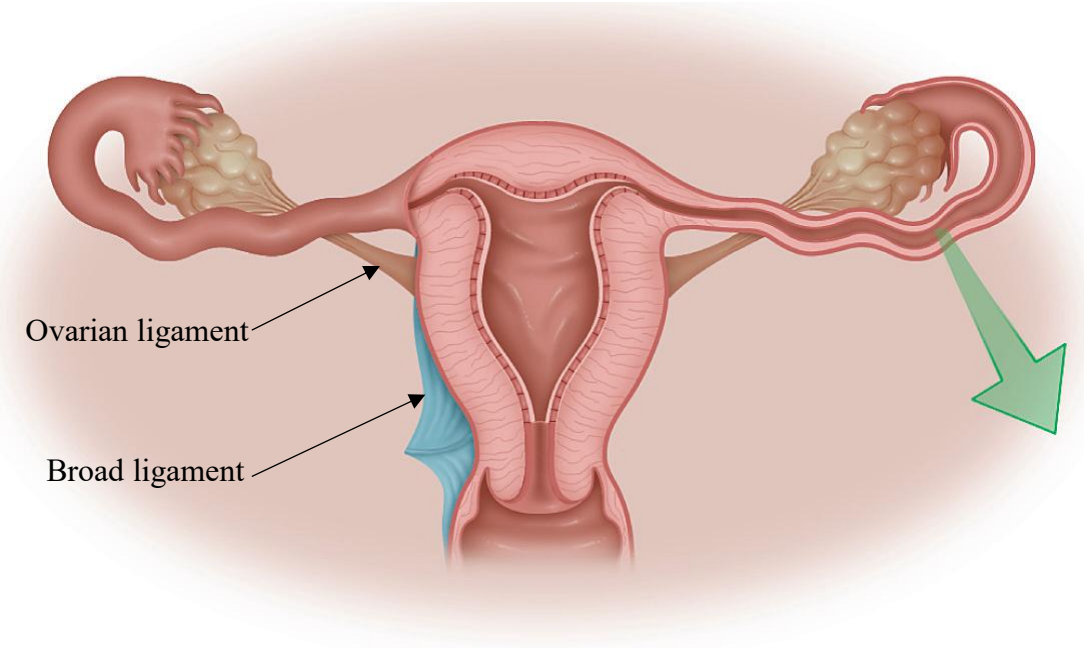


Outline of Oogenesis



Remember:
There is no DNA replication between meiosis I and meiosis II.

The ovaries



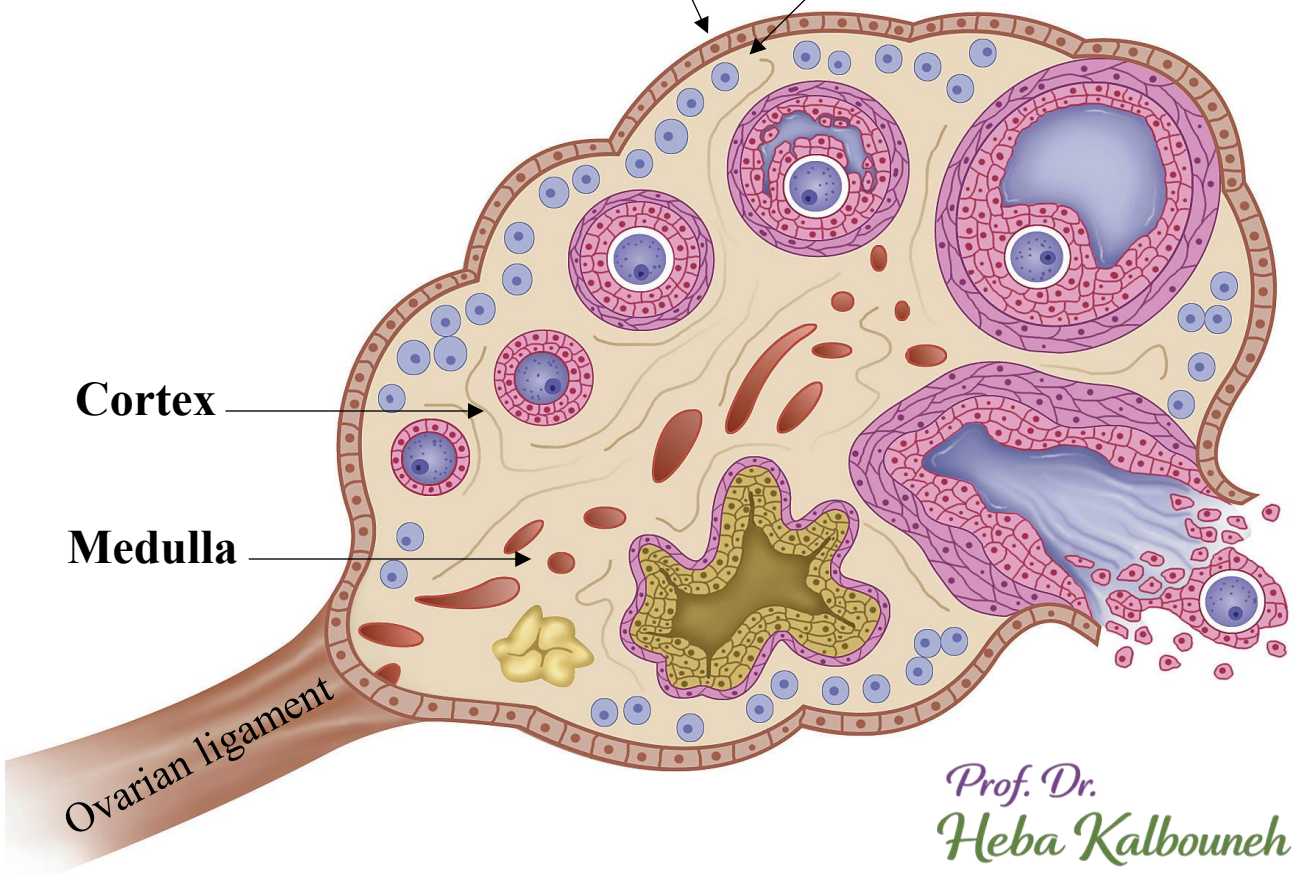
The ovaries are small almond shaped structures, covered by a connective tissue capsule **the tunica albuginea**.
(dense irregular connective tissue)
Approximately 3-cm long, 1.5-cm wide, and 1-cm thick.

Tunica albuginea is covered by a **germinal epithelium !!**
Simple cuboidal or simple squamous mesothelium!!

The ovary has a **cortex**, which is where the ovarian follicles can be found, and a highly vascular **medulla**

Cortex (Outer portion)
Broad peripheral zone containing follicles in various stages of development embedded in loose connective tissue stroma

Medulla (Inner portion)
Connective tissue with many large, tortuous blood vessels, lymph vessels and nerve fibers.
Does not contain ovarian follicles.



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Ovarian follicles

An ovarian follicle consists of an oocyte surrounded by one or more layers of epithelial cells (follicular) within a basal lamina.

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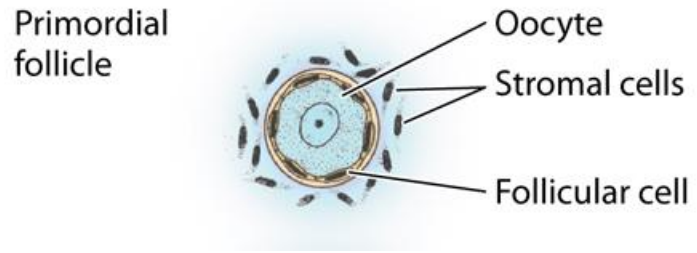
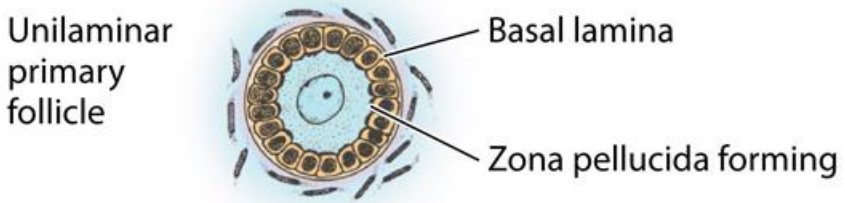
Primordial follicle:
Comprises of primary oocyte surrounded by follicular cells (simple squamous epithelium)

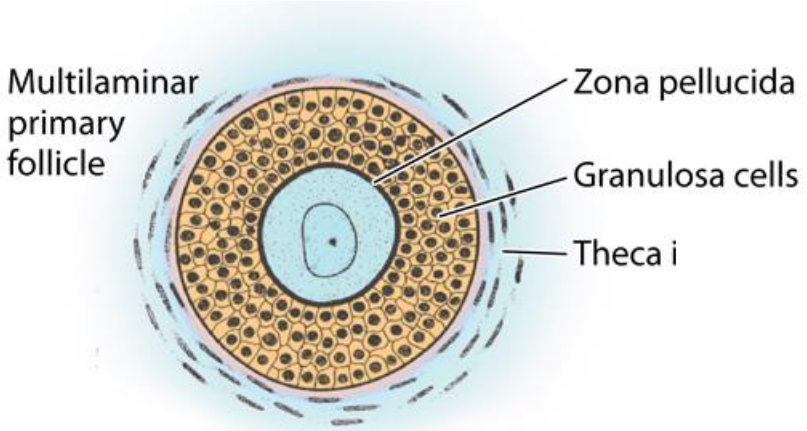


Unilaminar Primary follicle:
Comprises of primary oocyte surrounded by follicular cells (simple cuboidal epithelium)



Multilaminar Primary follicle:
Comprises of primary oocyte surrounded by zona pellucida and stratified follicular cells called the granulosa cells with an outer covering of theca.

Zona pellucida is a glycoprotein layer located between the oocyte and the granulosa cells, secreted by the oocyte



Secondary follicle:

✓ Comprises of primary oocyte surrounded by zona pellucida and granulosa cells with an outer covering of two theca layers.

The theca differentiates further as two distinct layers around the follicle:

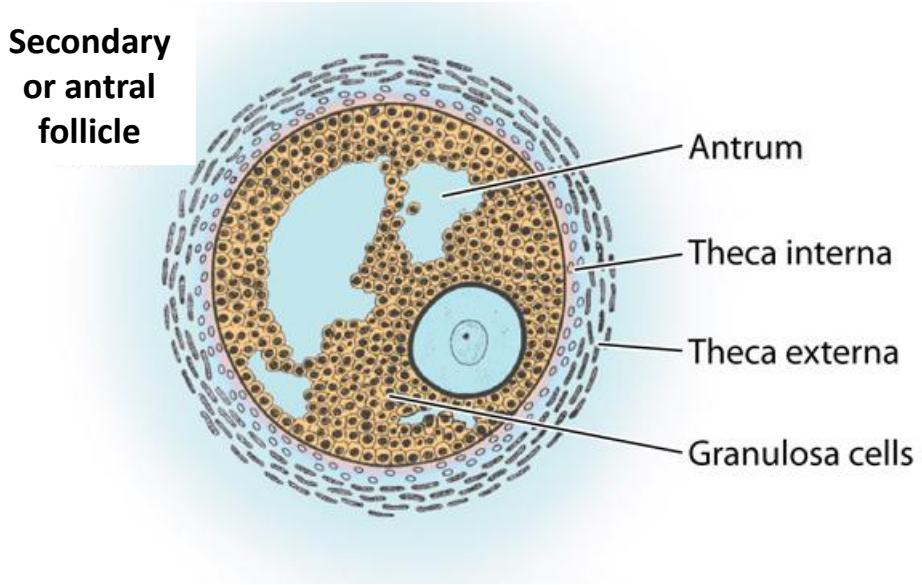
Theca interna (inner vascular layer!! *Endocrine*)

Theca externa (outer fibrous layer)

✓ Antral pockets are formed containing follicular fluid

Small spaces appear within the follicle between the granulosa layers as the cells secrete follicular fluid. This fluid accumulates, the spaces enlarge and gradually coalesce, and the granulosa cells reorganize themselves around a larger cavity called the **antrum**

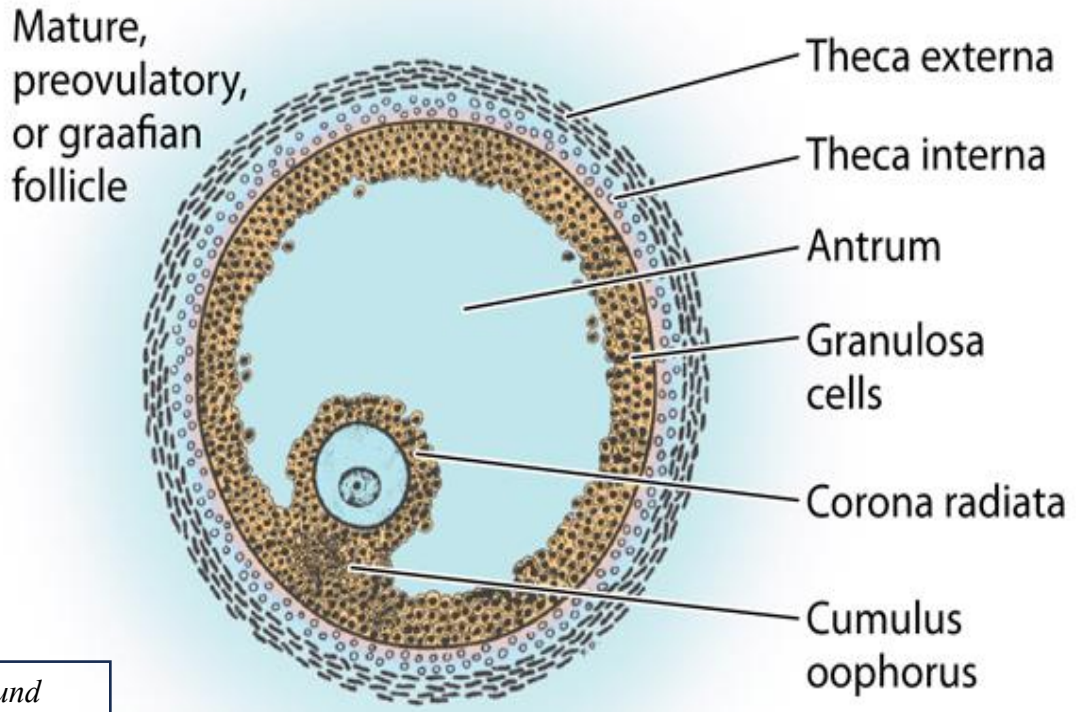
Also called Antral follicle



Medical application: A secondary follicle in the ovary can sometimes form a follicular cyst, which is a thin-walled, fluid-filled sac lined by granulosa and theca cells. These cysts are common and usually benign, but they may produce high levels of estrogen, leading to menstrual irregularities. If the cyst damages nearby blood vessels, blood can leak into it, forming a hemorrhagic cyst, which may develop quickly and cause pain.

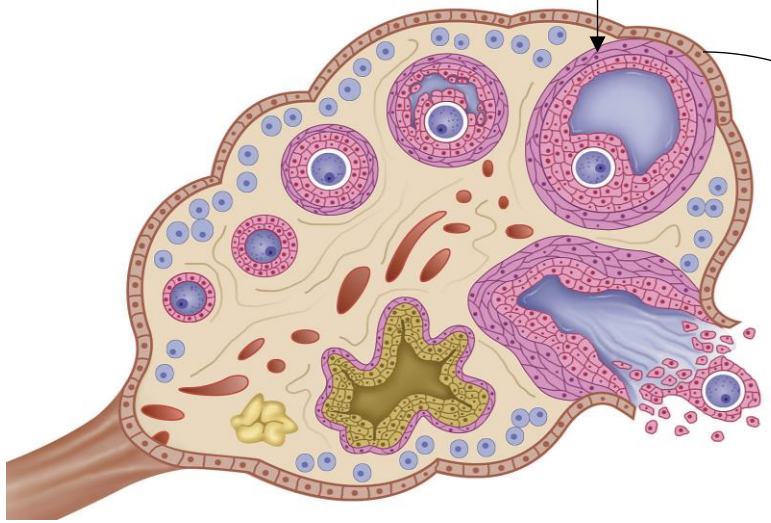
Graafian follicle:

- ✓ Also called Vesicular/ Mature/ Preovulatory/ Tertiary follicle.
- ✓ Comprises of primary oocyte surrounded by Zona pellucida, Granulosa cells with Antrum and two Theca layers.
- ✓ Antrum is filled with follicular fluid
- ✓ As the antrum develops, the granulosa cells around the oocyte form the **cumulus oophorus** → *surrounds the oocyte and forms the bridge between the oocyte and the follicle wall*
- ✓ The tightly adhering granulosa cells immediately surrounding the zona pellucida make up the **corona radiata** and accompany the oocyte when it leaves the ovary at ovulation.



Graafian follicle

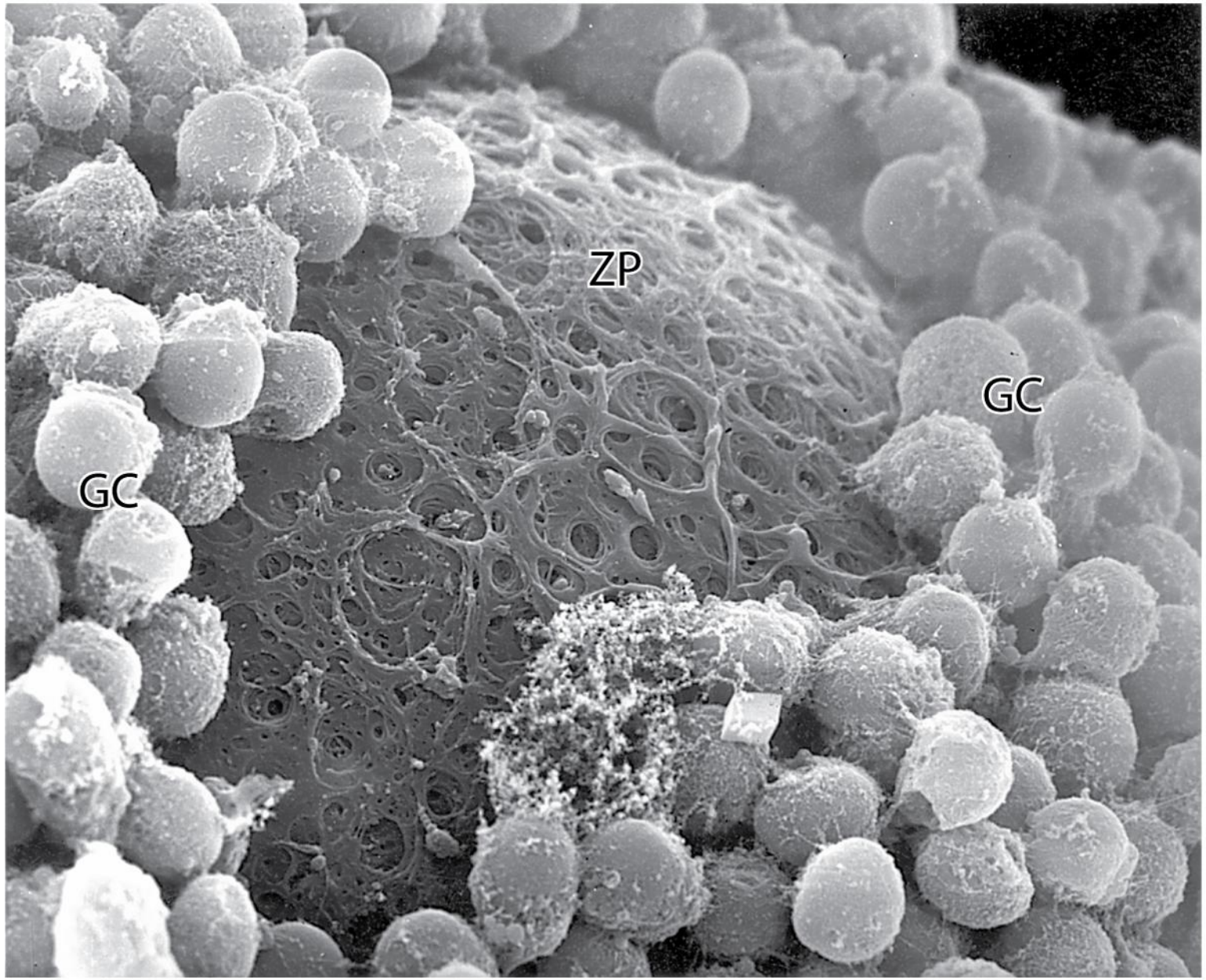
Cumulus oophorus= *Egg-bearing mound*
Cumulus = *mound / small mass*
Oophorus
Oo- = egg/ -phorus = bearing / carrying



Note: After ovulation, the corona radiata cells remain attached to the oocyte after ovulation.

- ➢ The single large antrum of a Graafian follicle rapidly accumulates more follicular fluid and expands to a diameter of 2 cm.
- ➢ A Graafian follicle forms a bulge at the ovary surface visible with ultrasound imaging (**Stigma**).

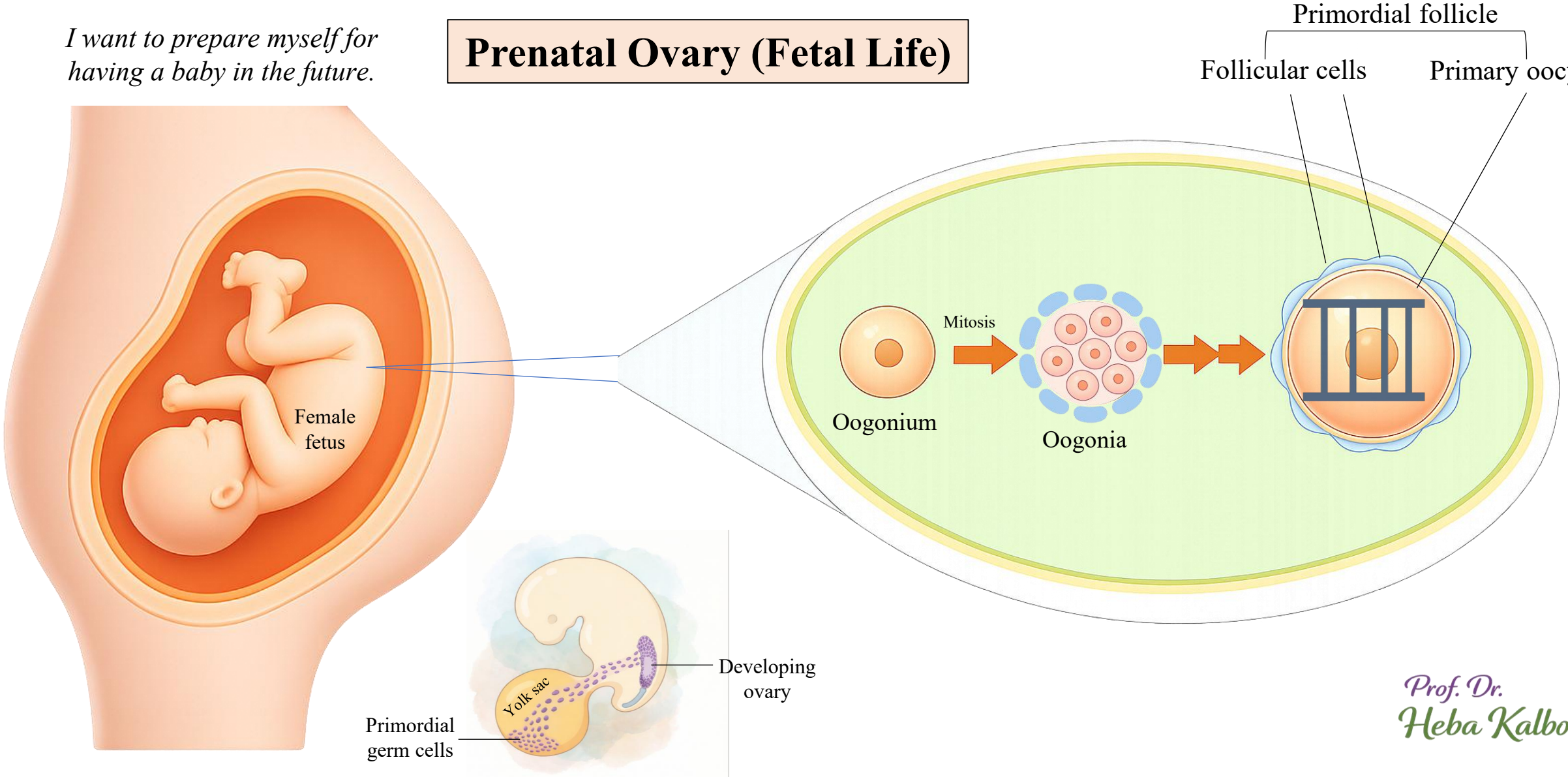
Ultrastructure of primary follicle and zona pellucida (SEM)



An SEM of a fractured primary follicle shows the oocyte surrounded by granulosa cells (**GC**). Between the very large oocyte surface and the granulosa cells is a layer of extracellular material, the zona pellucida (**ZP**), which contains four related glycoproteins that bind sperm and form an irregular meshwork.

I want to prepare myself for having a baby in the future.

Prenatal Ovary (Fetal Life)



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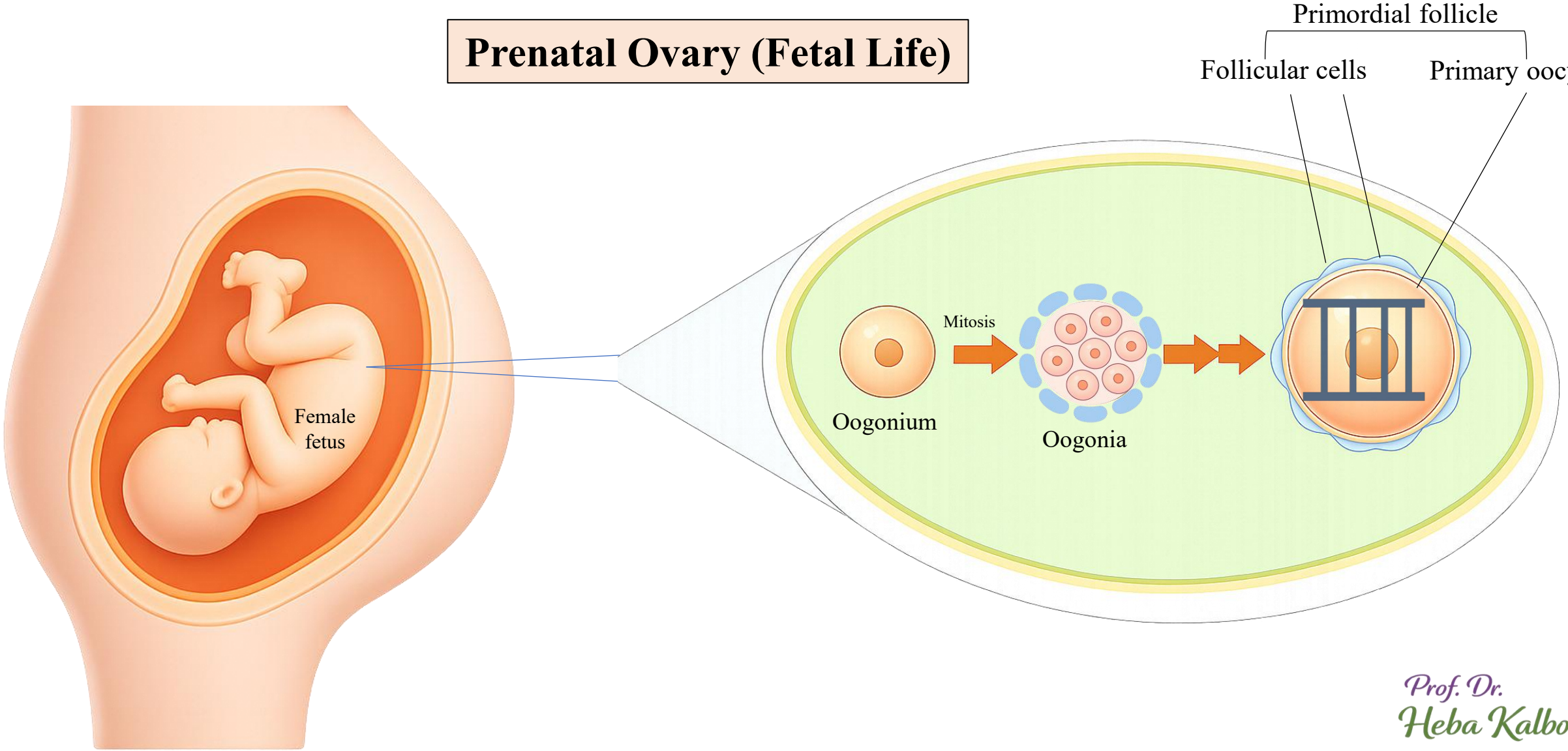
Primordial germ cells migrate from the yolk sac to the developing ovary (weeks 4-6).
Primordial germ cells → Oogonia.

- ✓ Oogonia proliferate rapidly (mitosis) (peak ≈ 6–7 million at 5 months gestation).
- ✓ Most oogonia degenerate by apoptosis; a few develop into primary oocytes
- ✓ Primary oocyte starts meiosis I and arrest in prophase I

Prenatal Ovary (Fetal Life)



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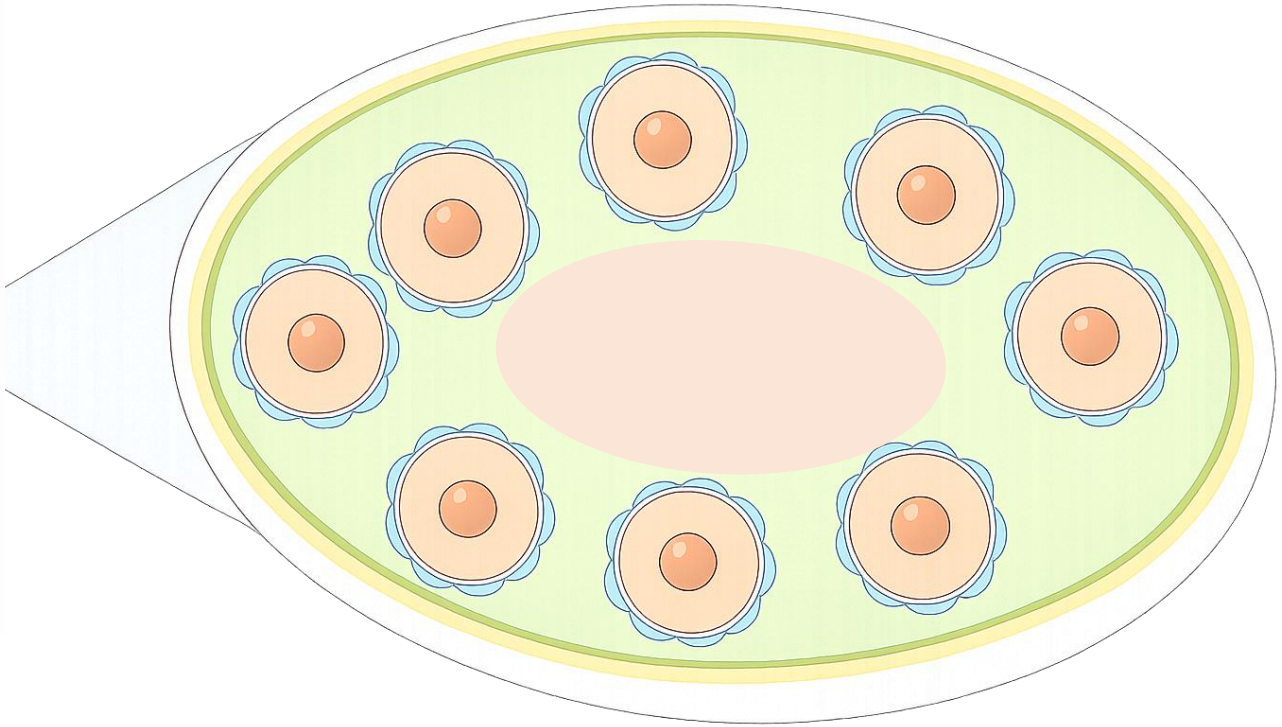
Follicle Formation: Primary oocytes become surrounded by flat follicular cells → Primordial follicles.

Numbers at Birth: ~1–2 million primary oocytes remain.

Ovary at Birth → Pre-Puberty (Childhood)



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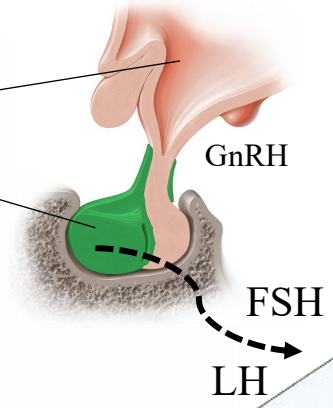
Structural Features

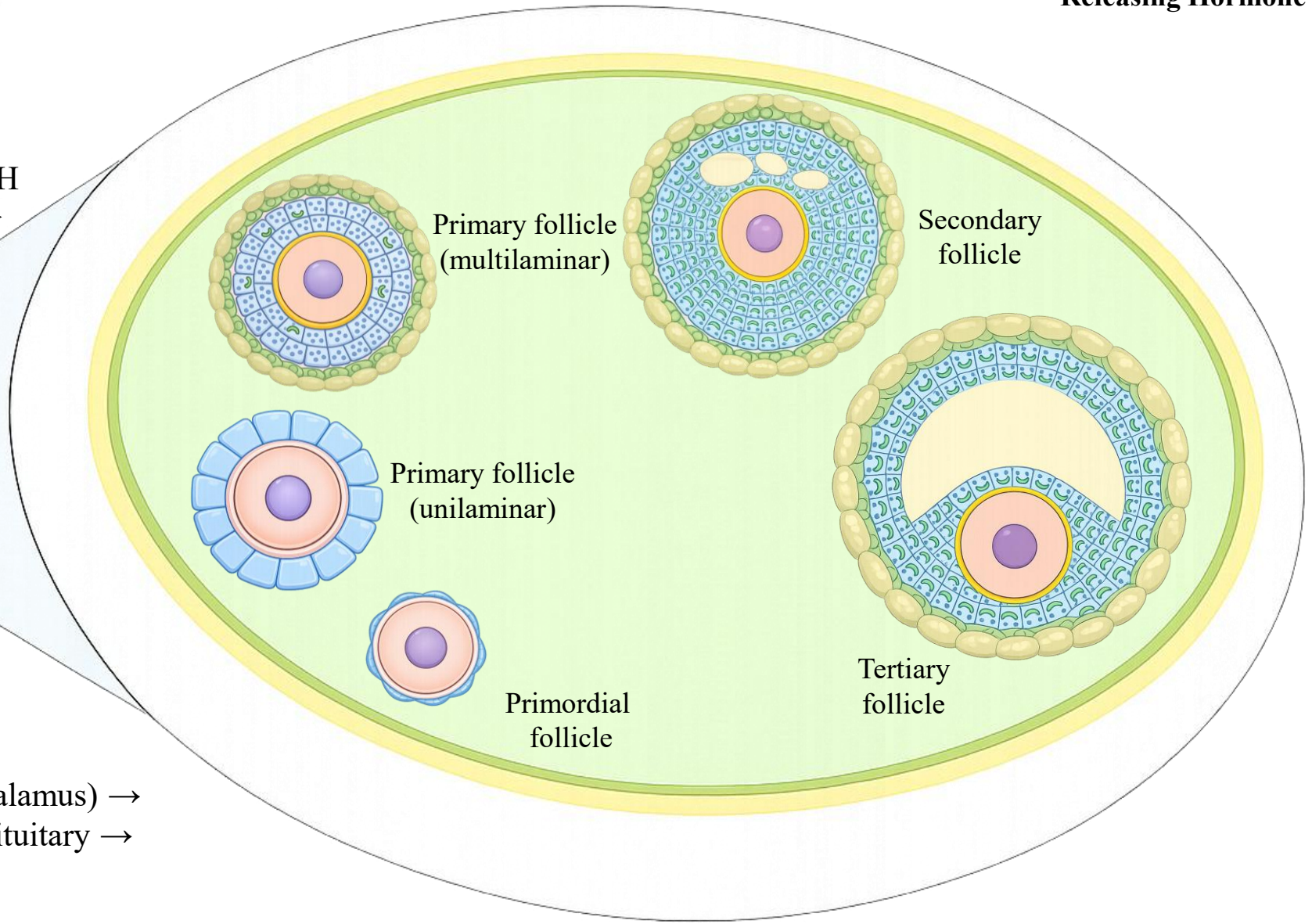
- Ovaries house primordial follicles.
- Ovaries are inactive hormonally.
- No ovulation.
- Primary oocytes remain arrested in prophase I.

Numbers

- Continuous follicular atresia.
- By puberty: ~300,000–400,000 oocytes remain.

GnRH = Gonadotropin-Releasing Hormone





GnRH (from hypothalamus) → stimulates anterior pituitary → releases: **FSH & LH**

Ovary After Puberty (Reproductive Years)

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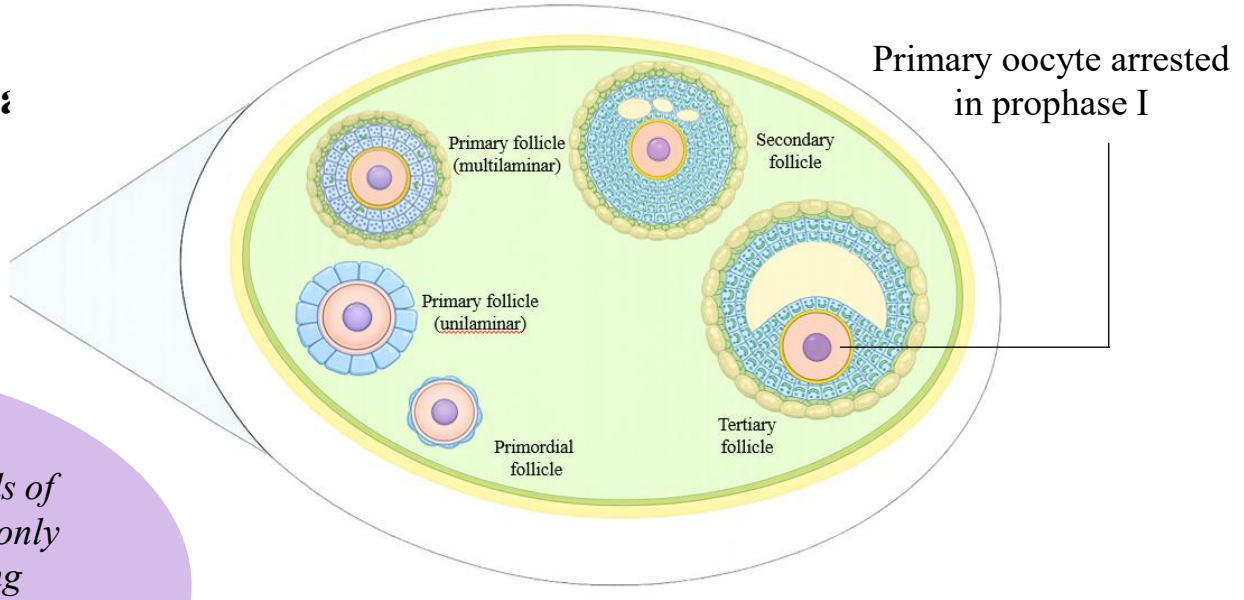
Ovary After Puberty (Reproductive Years)

Triggered by activation of the **hypothalamic–pituitary–ovarian a**



Cyclical Changes

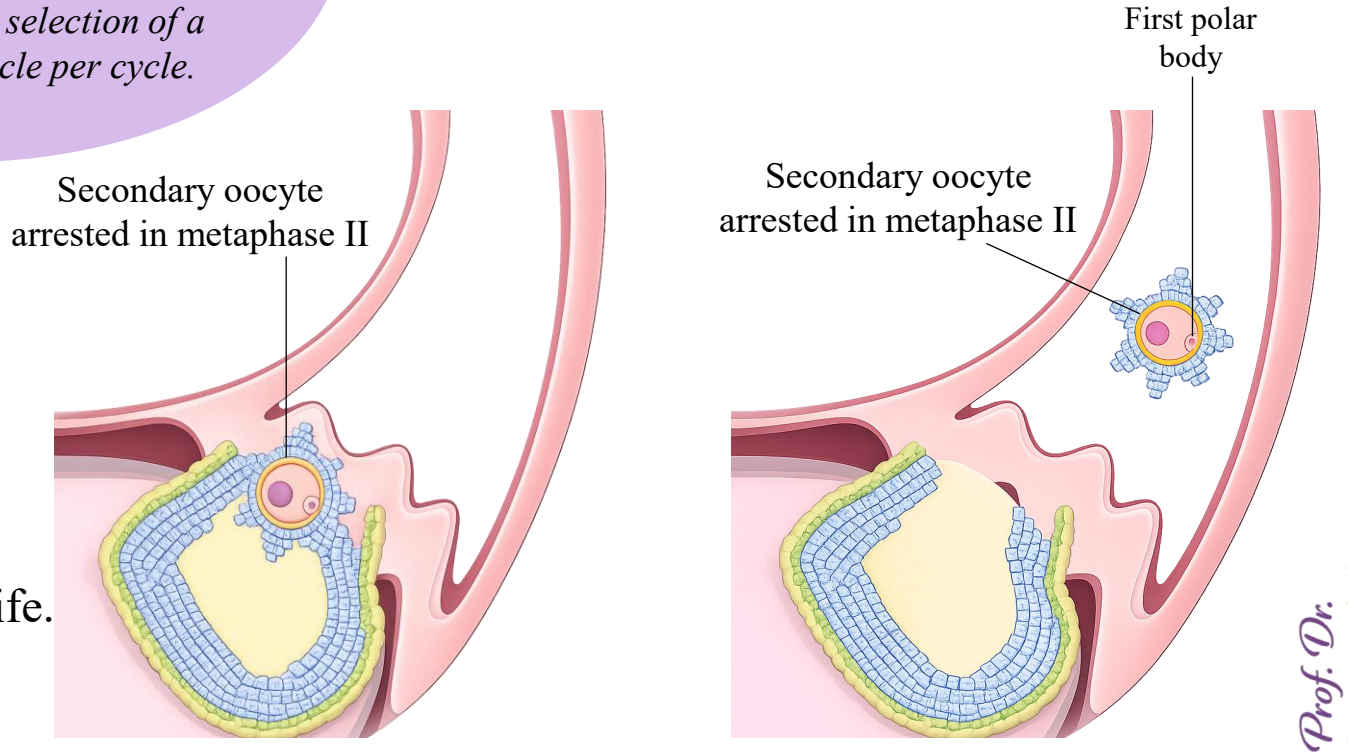
Each cycle:

1. 15-20 primordial follicles recruited.
2. Develop into:
   - Primary follicle
   - Secondary (antral) follicle
   - Tertiary (Graafian) follicle
3. One follicle ovulates.

Although hundreds of thousands of oocytes are present at puberty, only ~400–500 are ovulated during reproductive life due to continuous follicular atresia and selection of a single dominant follicle per cycle.

Ovulation

- Primary oocyte completes **meiosis I →**
  - Secondary oocyte
  - First polar body
- Secondary oocyte arrests in **metaphase II**.
- Ovulated at this stage.



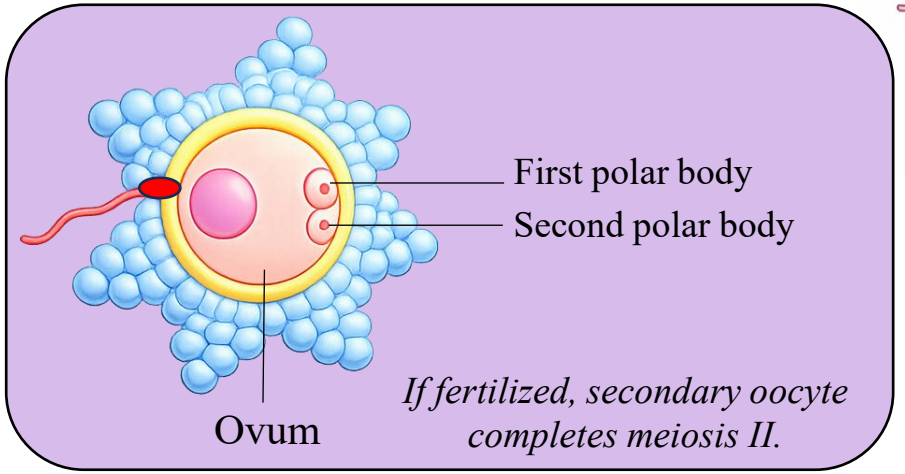
Lifetime Ovulations

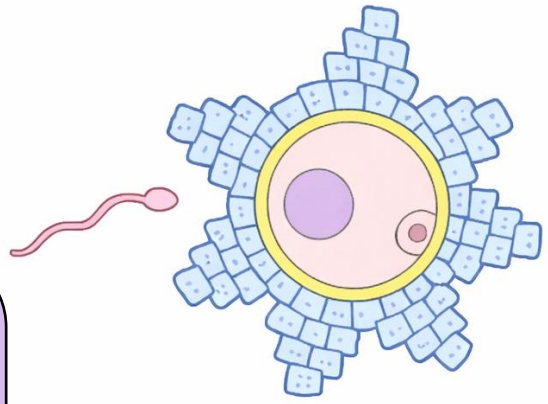
- Only ~400–500 oocytes ovulate during reproductive life.
- All others undergo atresia.

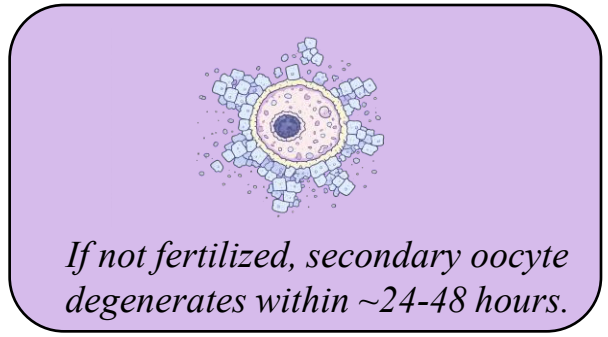
After Ovulation

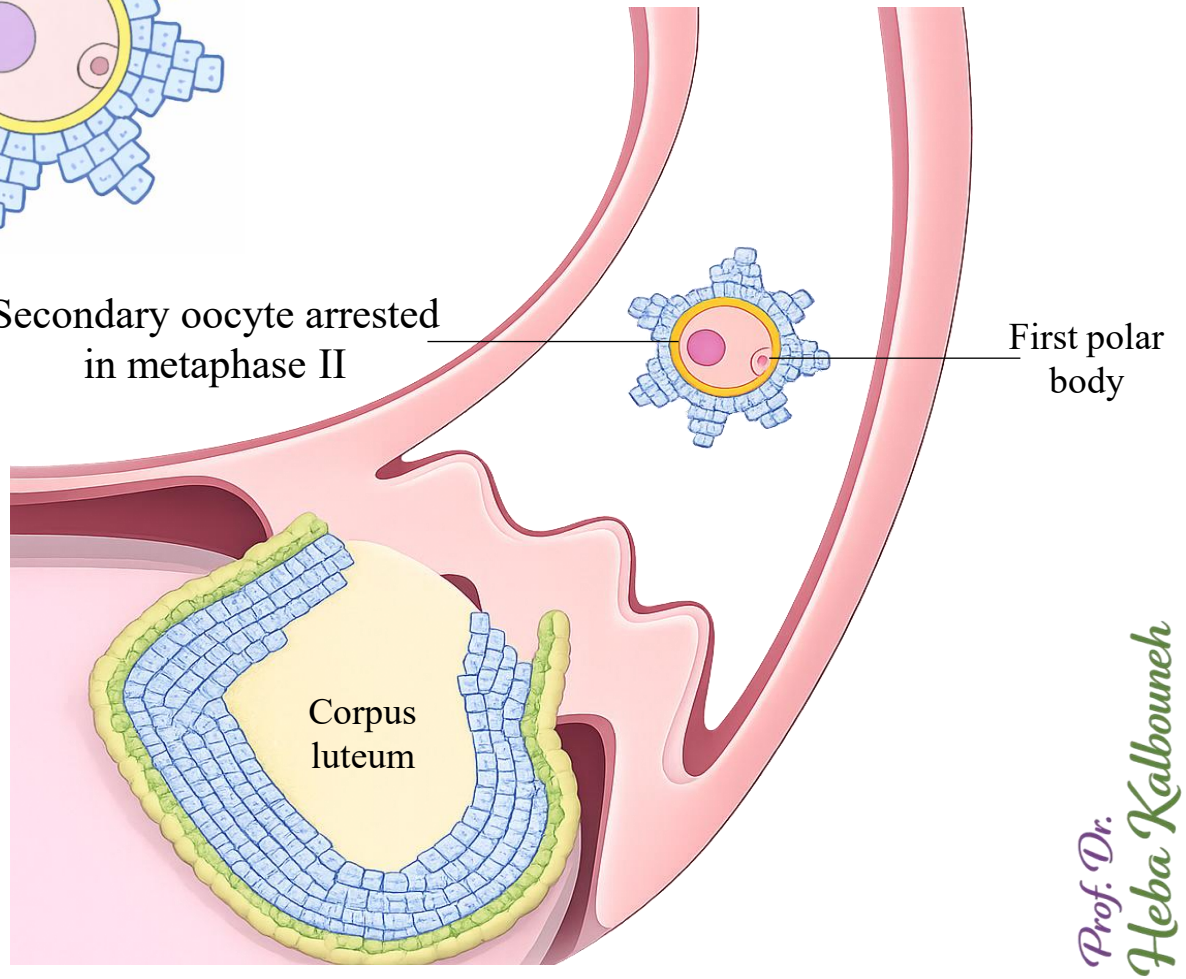
- Remaing follicle → **Corpus luteum**
  - Produces progesterone

- If fertilization occurs, the secondary oocyte completes **meiosis II** → forms:
  - Ovum
  - Second polar body









Feature	If Fertilized	If Not Fertilized
Oocyte	Completes meiosis II	Degenerates
hCG	Present	Absent
Corpus luteum	Maintained	Regresses
Progesterone	High	Falls
Endometrium	Maintained	Shed (menstruation)

After Ovulation

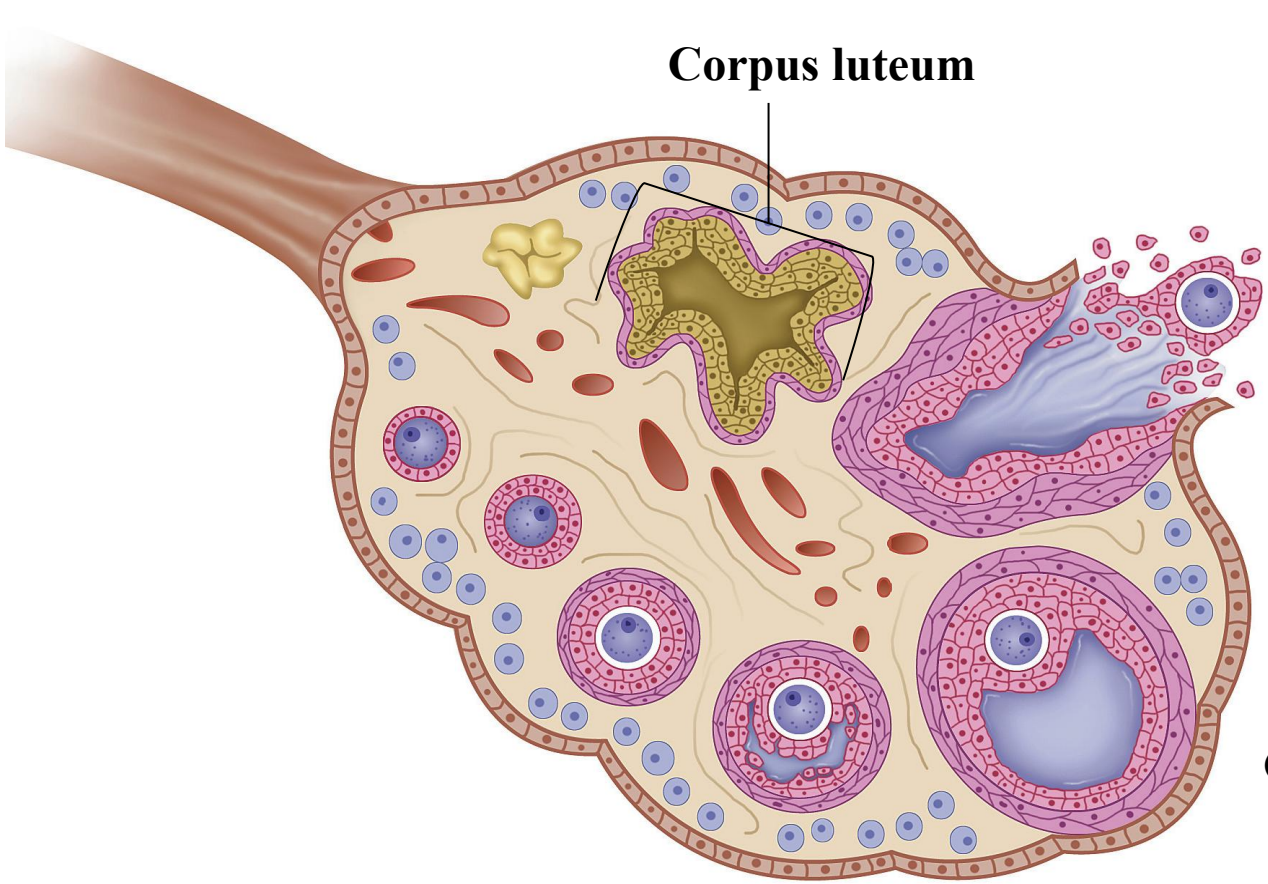
After LH surge:

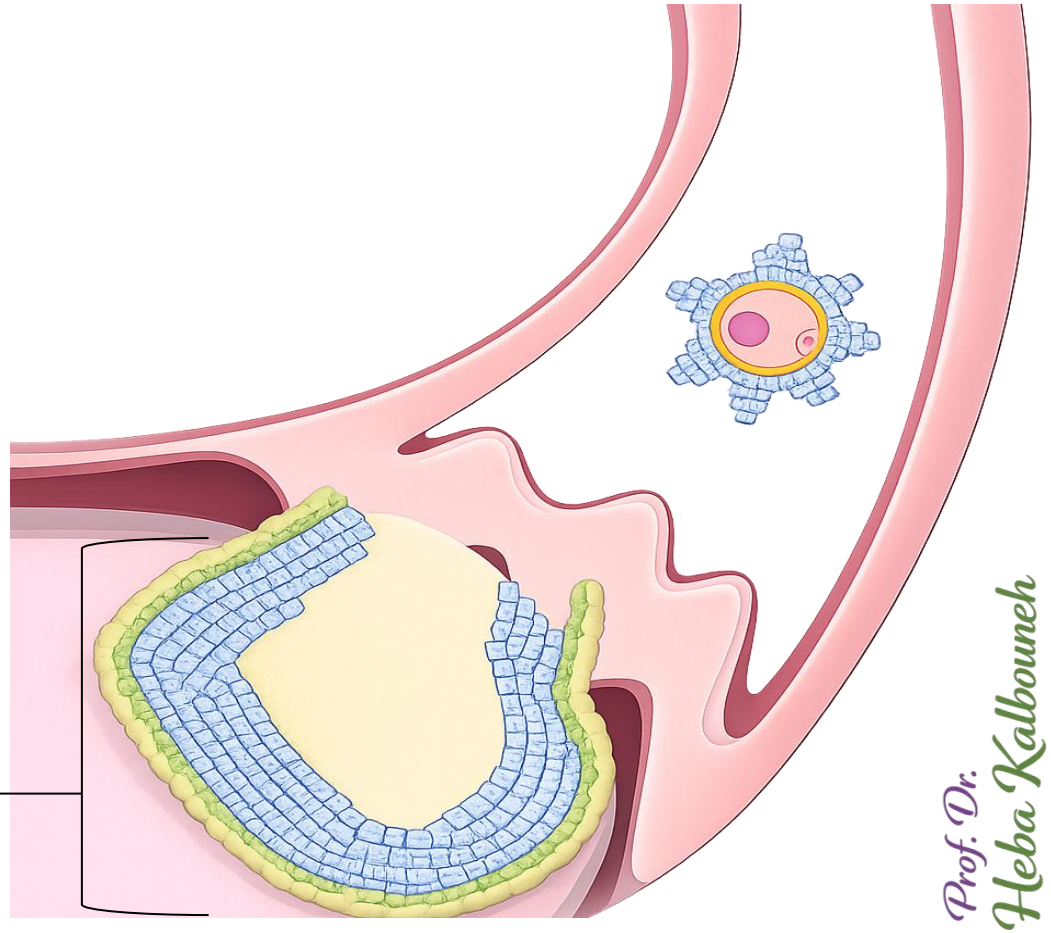
- Granulosa cells luteinize
- Theca cells luteinize

Both become part of the corpus luteum

Now:

- LH maintains corpus luteum
- Cells of corpus luteum produce:
  - **Progesterone (mainly)**
  - Estrogen (smaller amount)





After Ovulation: Two Possible Pathways

Ovulation releases a secondary oocyte (arrested in metaphase II) from the Graafian follicle, where it is captured by the uterine tube. From here, two outcomes are possible:

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If Fertilization Occurs

Events

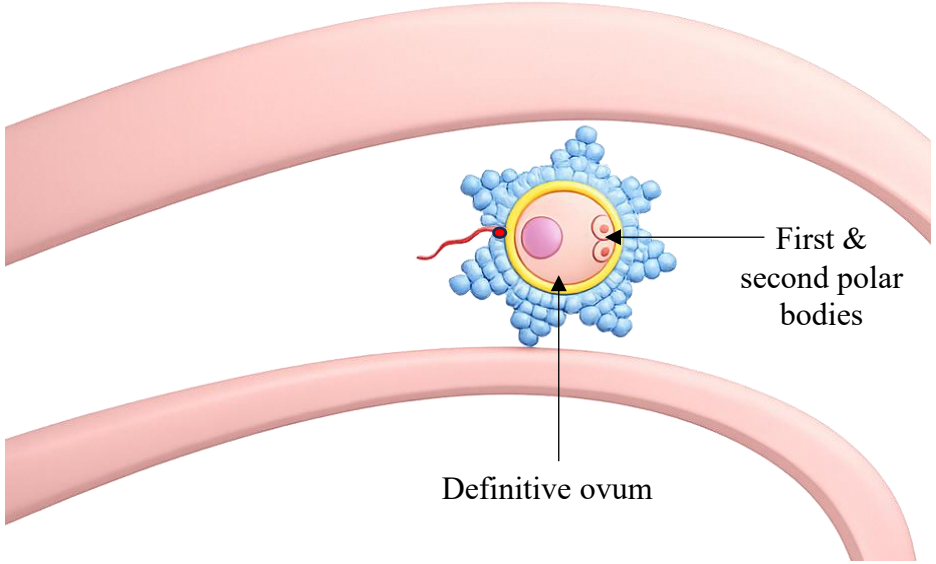
- Sperm penetrates the corona radiata and zona pellucida.
- The secondary oocyte completes meiosis II → forms: Ovum & Second polar body
- Male and female pronuclei fuse → zygote (diploid 46 chromosomes)

Fate of the Corpus Luteum

- Trophoblast cells of the developing embryo secrete hCG → maintains the corpus luteum
- Corpus luteum continues secreting: **Progesterone** & Estrogen

Functional Outcome

- Endometrium maintained
- Menstruation does NOT occur
- Corpus luteum becomes corpus luteum of pregnancy
- Placenta later takes over hormone production (~12 weeks/ ~3 months)



If Fertilization Does NOT Occur

Events

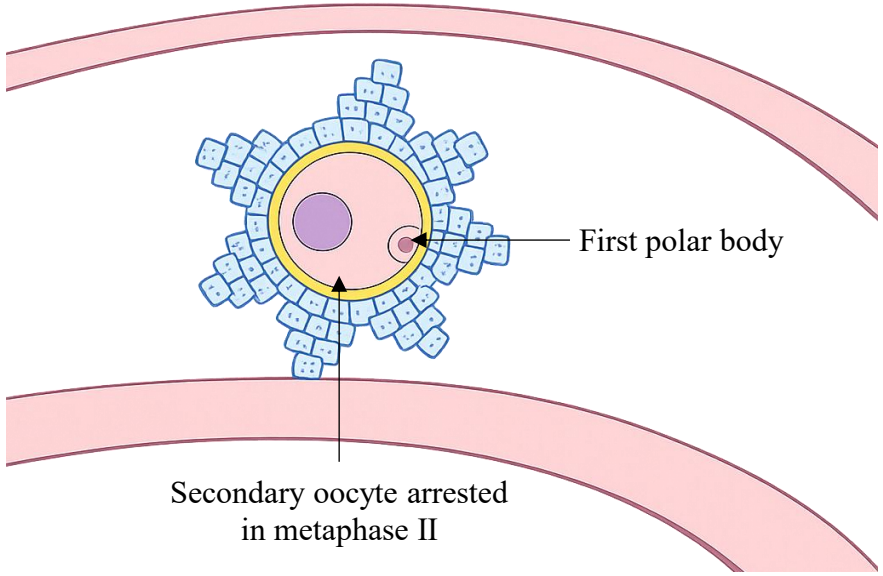
- Oocyte degenerates within ~24-48 hours.
- No hCG is produced.
- Corpus luteum survives about 10-14 days after ovulation.

Hormonal Changes

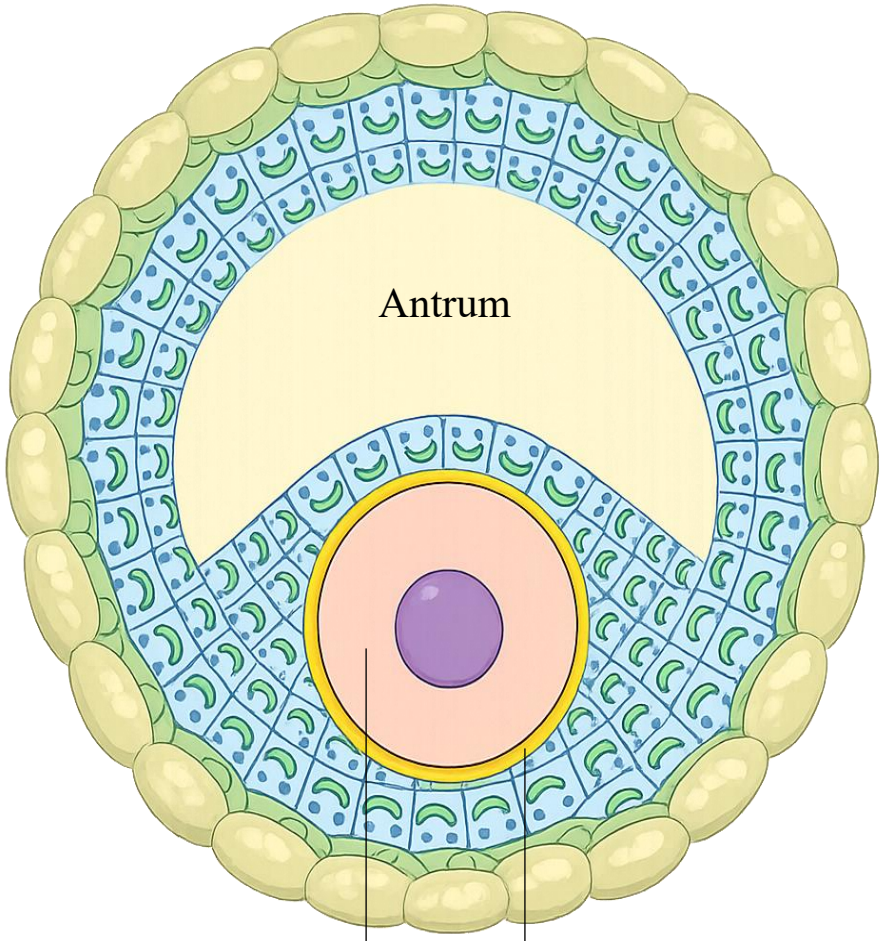
- Corpus luteum regresses → becomes corpus albicans
- Progesterone and estrogen levels drop sharply.

Functional Outcome

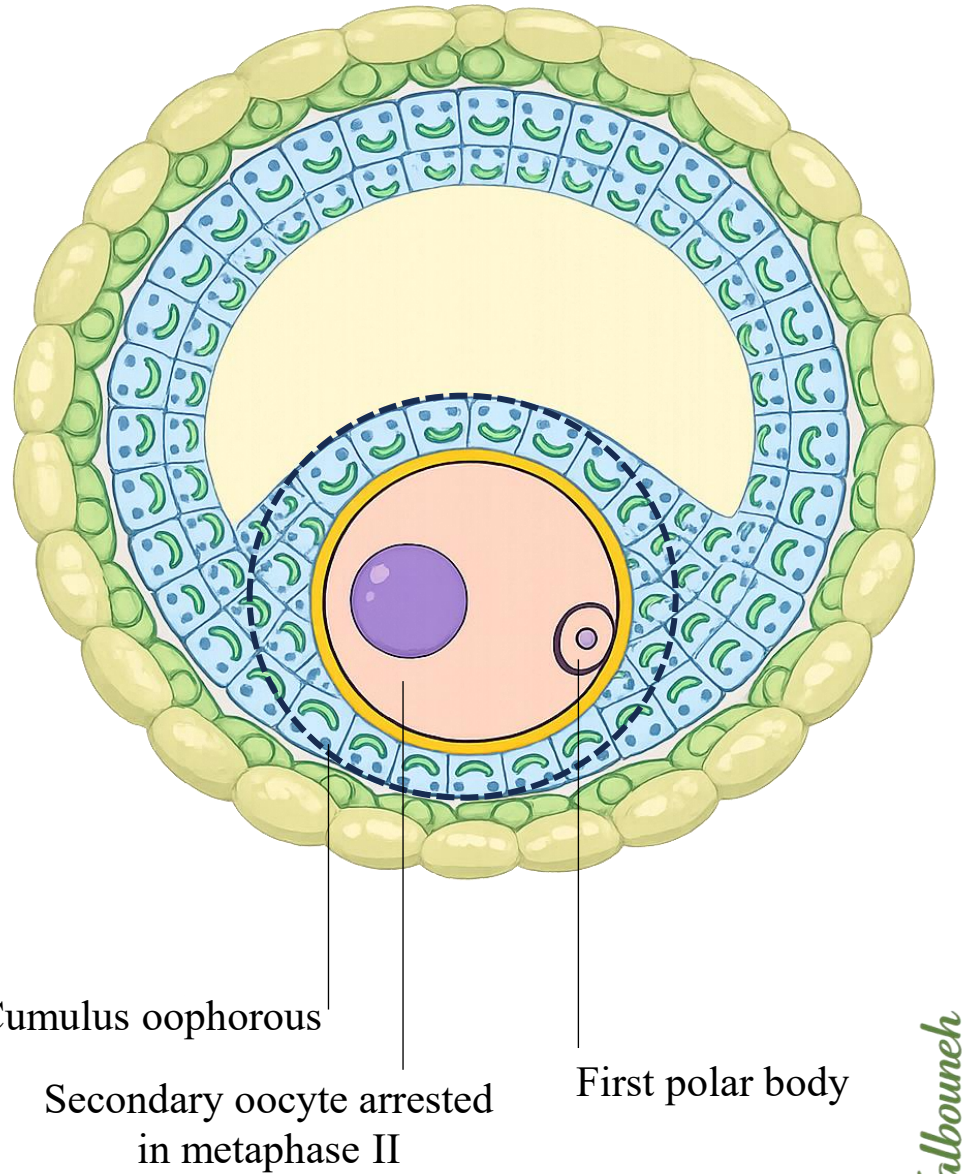
- Spiral arteries constrict
- Functional layer of endometrium sheds
- Menstruation occurs
- New cycle begins



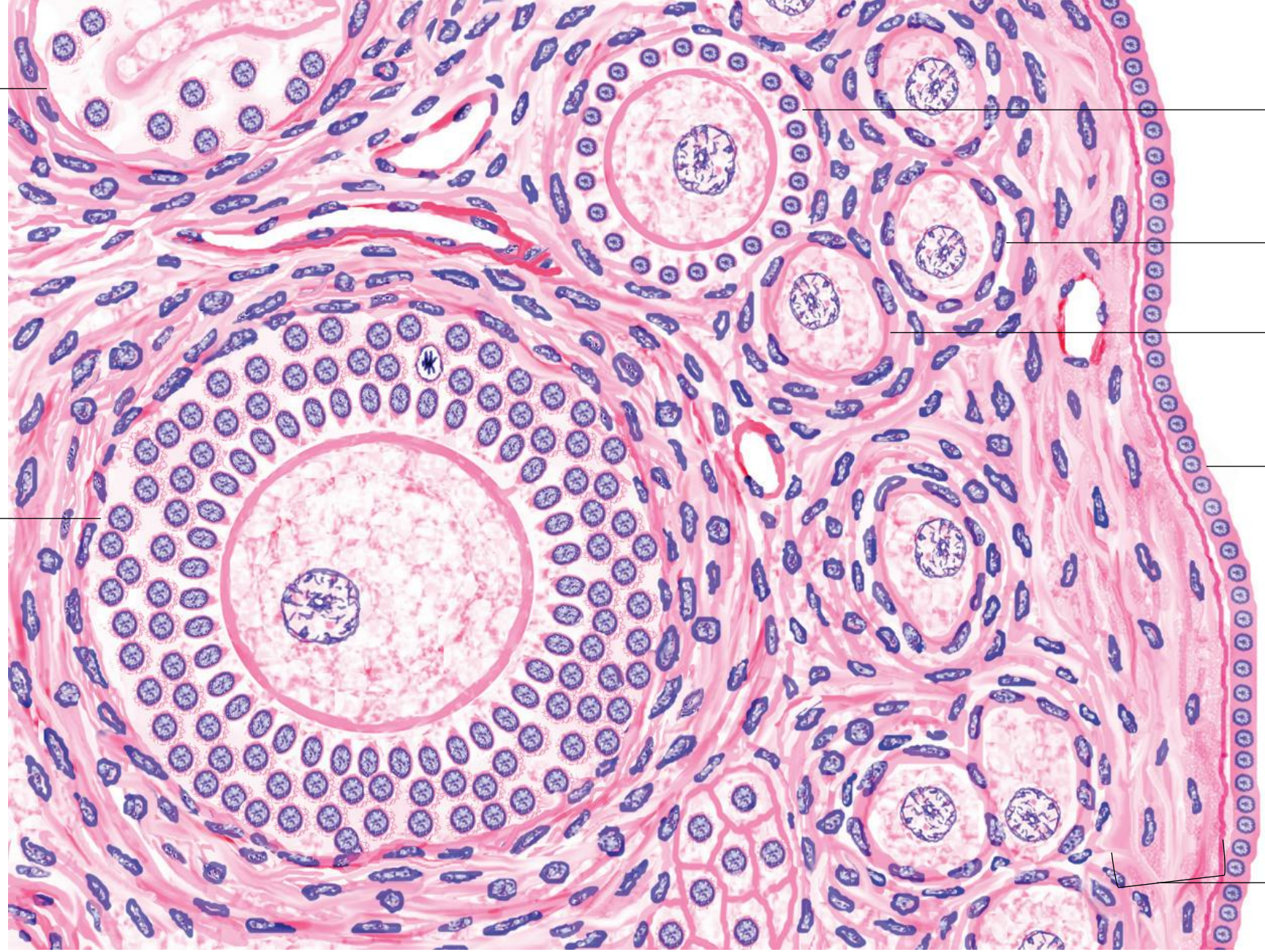
Tertiary follicle



Just before ovulation, the primary oocyte completes meiosis I to produce secondary oocyte (and a polar body). The secondary oocyte starts immediately meiosis II and arrests in metaphase II



Note:
The corona radiata is the innermost layer of cells surrounding the oocyte, forming part of the cumulus oophorus, which supports oocyte maturation and fertilization.



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LH Action → Theca Cells

Theca interna cells have **LH receptors**
When **LH binds** → Theca cells produce male hormones (**androgens)**
So:
LH → Theca → Androgens

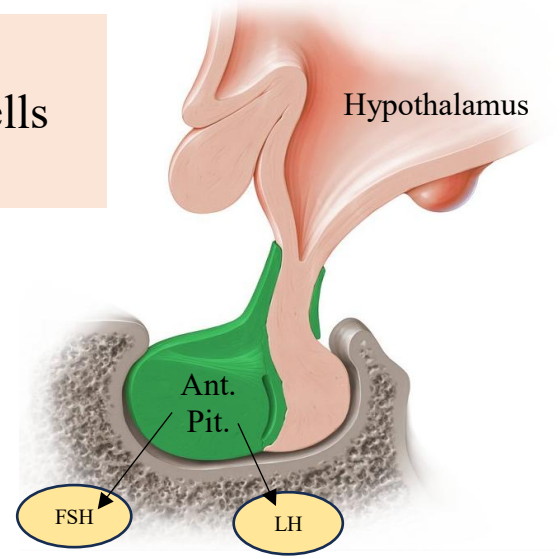
These androgens diffuse into granulosa cells.

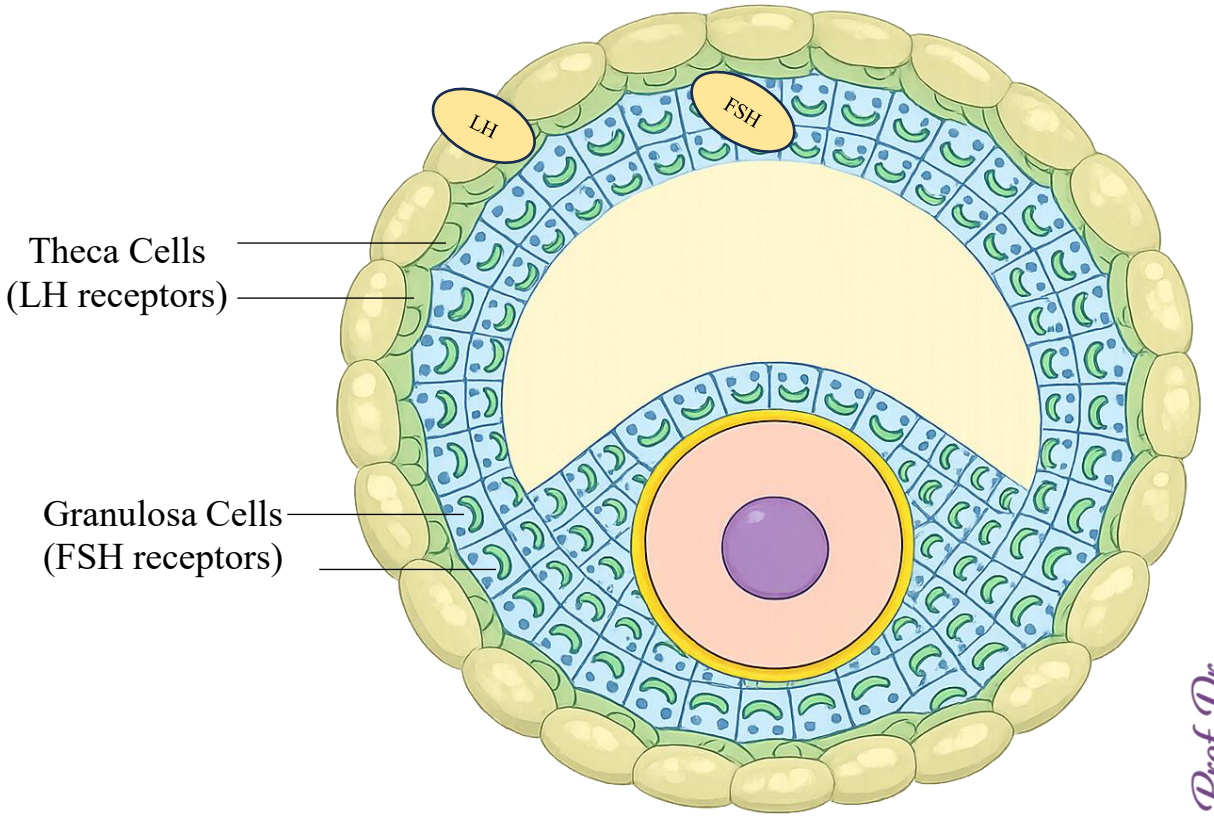
FSH Action → Granulosa Cells

Granulosa cells have **FSH receptors**
When **FSH binds** → Granulosa cells convert male hormones (**Androgens**) into female hormones (**Estrogens)**
So:
FSH → Granulosa → Estrogen production

- LH stimulates androgen production (theca)
- FSH converts androgens into estrogens (granulosa)
- Result → Increasing **estrogen levels**

Estrogen production in the ovary requires:
Two cell types → Theca cells + Granulosa cells
Two hormones → LH + FSH





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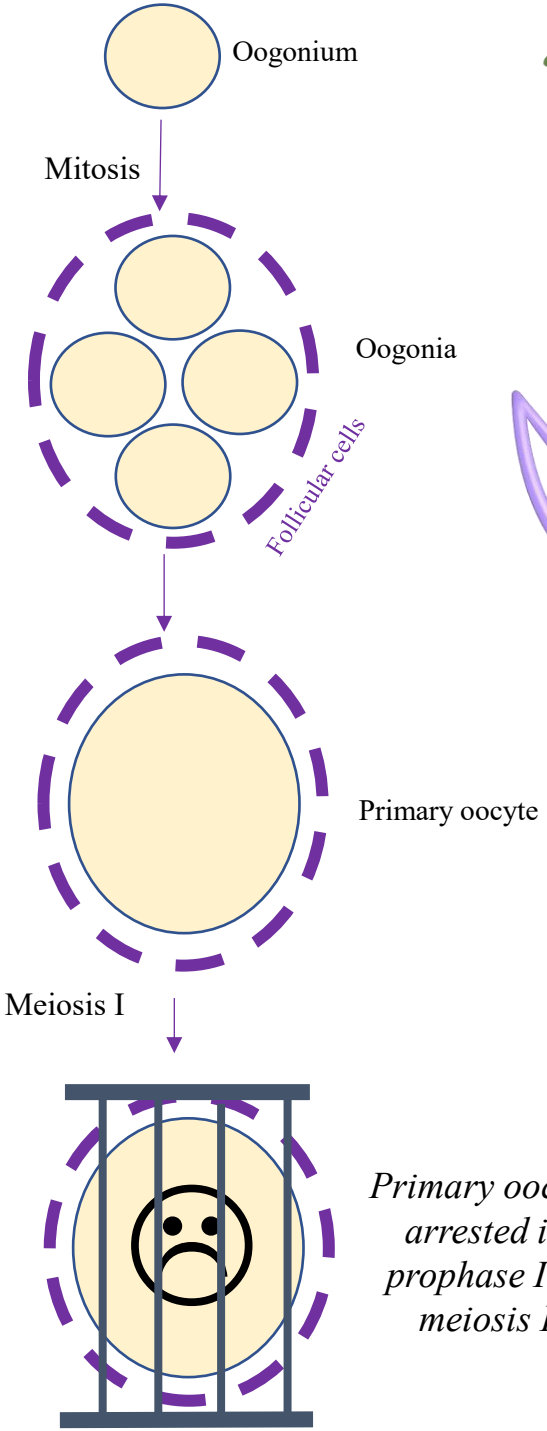
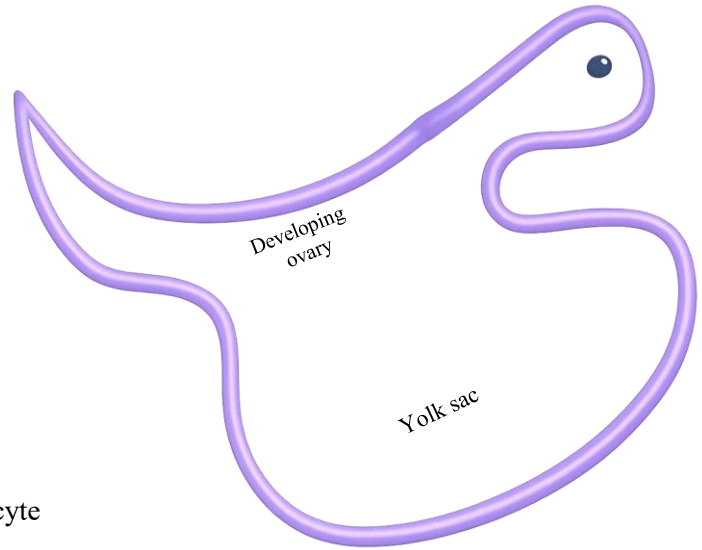
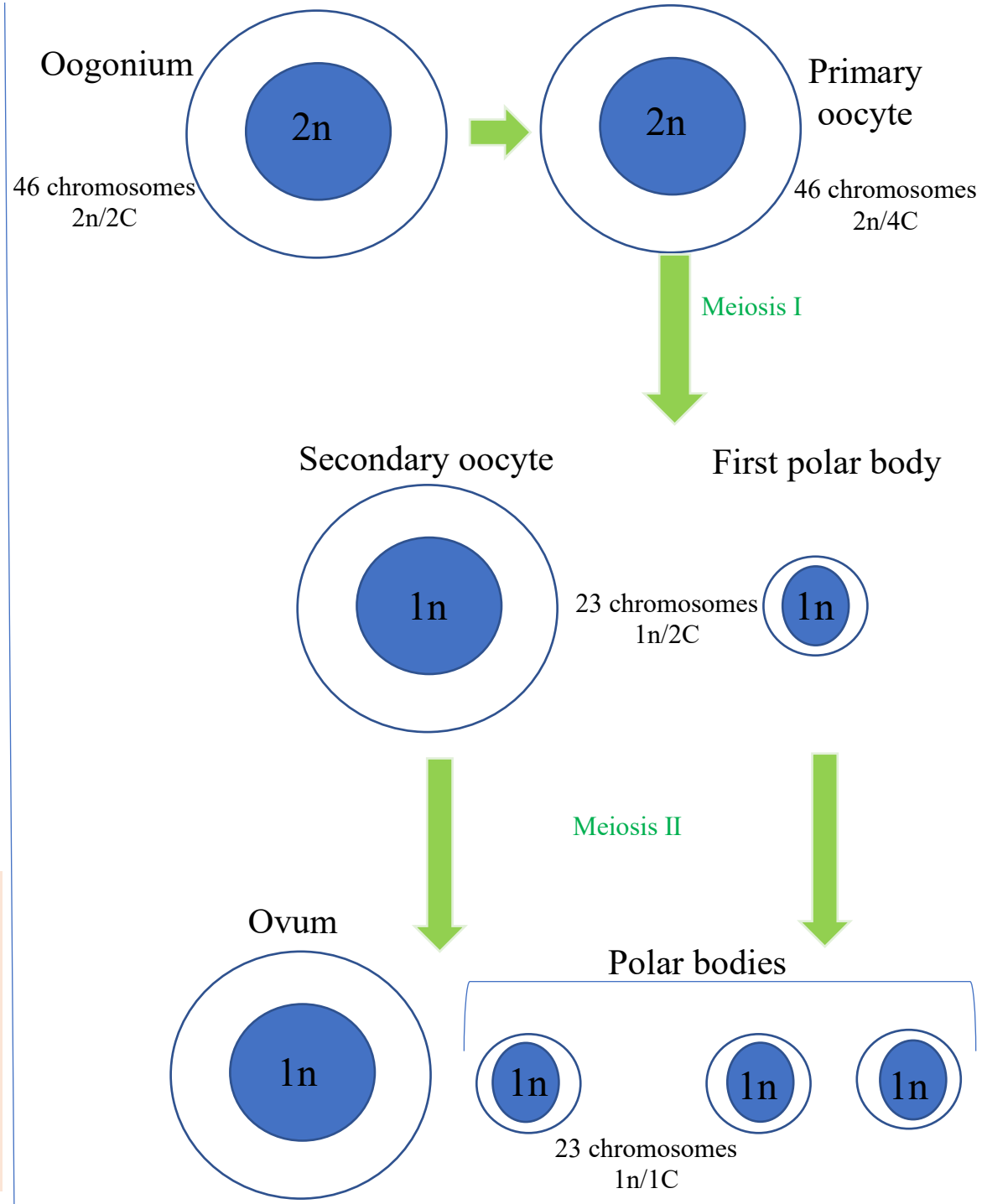


Primary oocyte arrested in prophase I of meiosis I

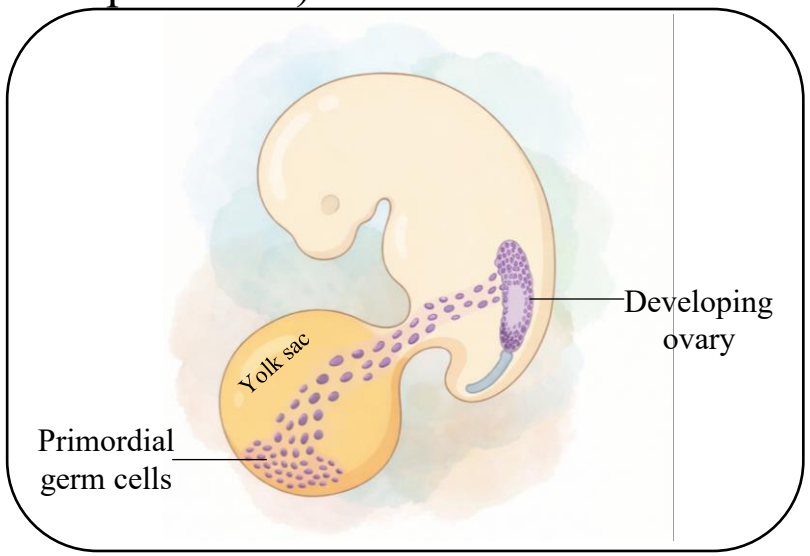


Mid-fetal life (~20 weeks/~5 months):
6–7 million oogonia
At birth (both ovaries):
1–2 million primordial follicles
At puberty (both ovaries):
300,000–400,000 primordial follicles
Ovulated during reproductive life:
~400–500 oocytes



Beginning at the end of the first month, a population of primordial germ cells migrates from the yolk sac to the developing ovaries (gonadal primordia).

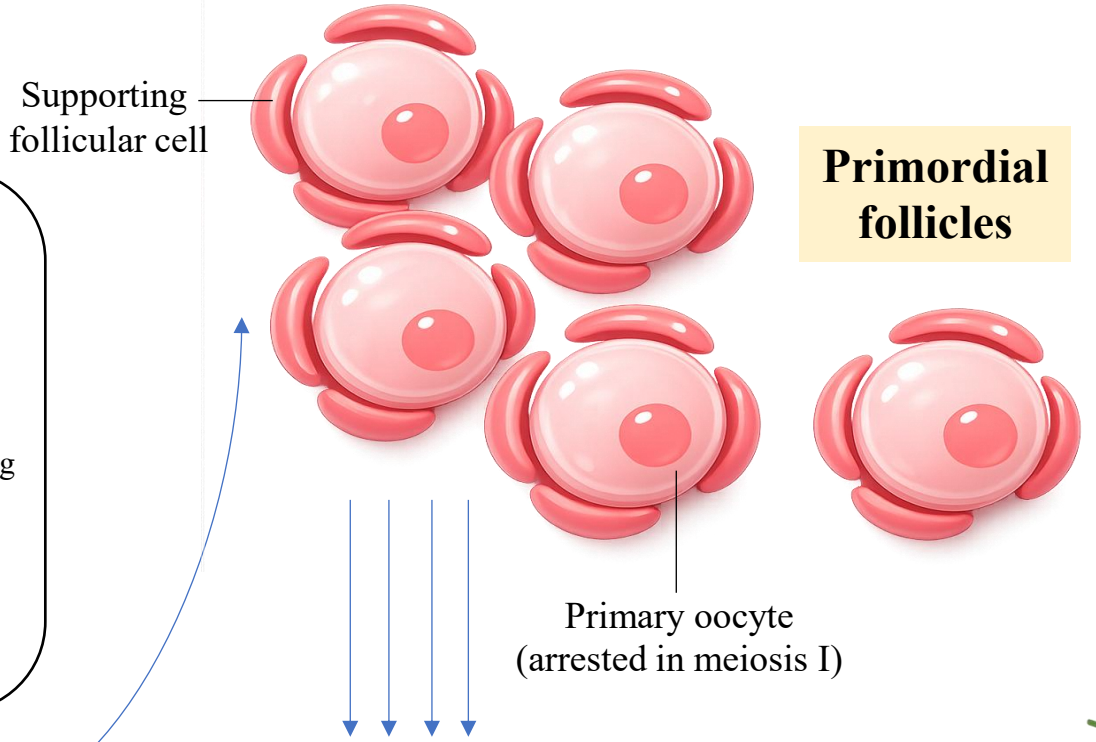
Primordia means an organ, structure, or tissue in the earliest stage of development



These germ cells undergo mitotic divisions producing a few million oogonia

This mitotic activity ceases and the oogonia enter the long prophase of a first meiotic division
(Most of these cells undergo apoptotic cell death)

These cells arrested in the prophase I of meiosis I are called **primary oocytes** and each cell is surrounded by flattened supporting cells called follicular cells to form a **primordial follicle**



At birth there are about 1-2 million primordial follicles, BUT about 300,000- 400,000 remain at puberty !!!

The others having been lost through the degenerative process called atresia

Because generally only one oocyte resuming meiosis undergoes ovulation during each menstrual cycle and the reproductive life of a woman is about 35-40 years, only about 450 oocytes are liberated from ovaries by ovulation. All others degenerate through **atresia**.

Ovary

Before birth

Oogonium

Mitosis

Oogonia

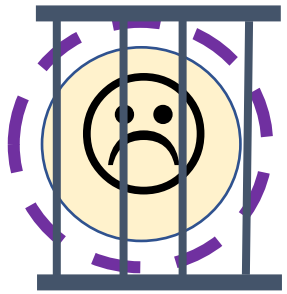
Follicular cells

Primary oocyte

Meiosis I

Primary oocyte arrested in prophase I

Childhood (from birth to puberty)

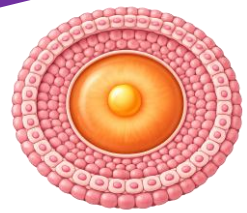


Primordial follicle

Monthly, from puberty to menopause

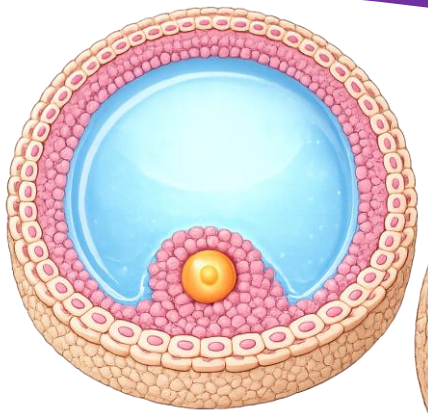
Primordial follicle

Unilaminar primary follicle

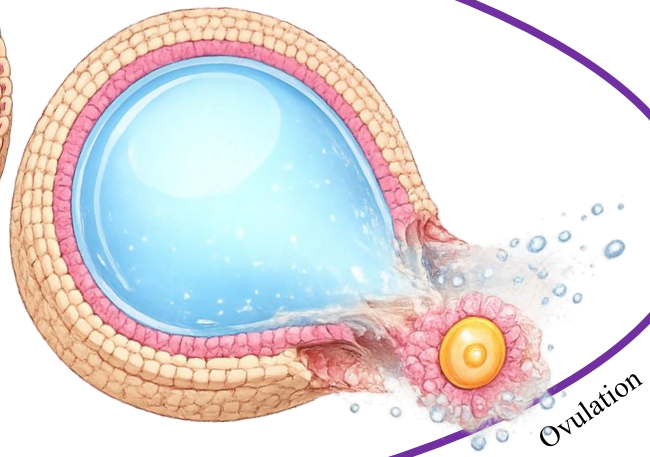


Multilaminar primary follicle

Secondary follicle



Graafian (tertiary) follicle



Ovulation

Just before ovulation, the primary oocyte completes meiosis I to produce secondary oocyte (and a polar body). The secondary oocyte starts immediately meiosis II and arrests in metaphase II

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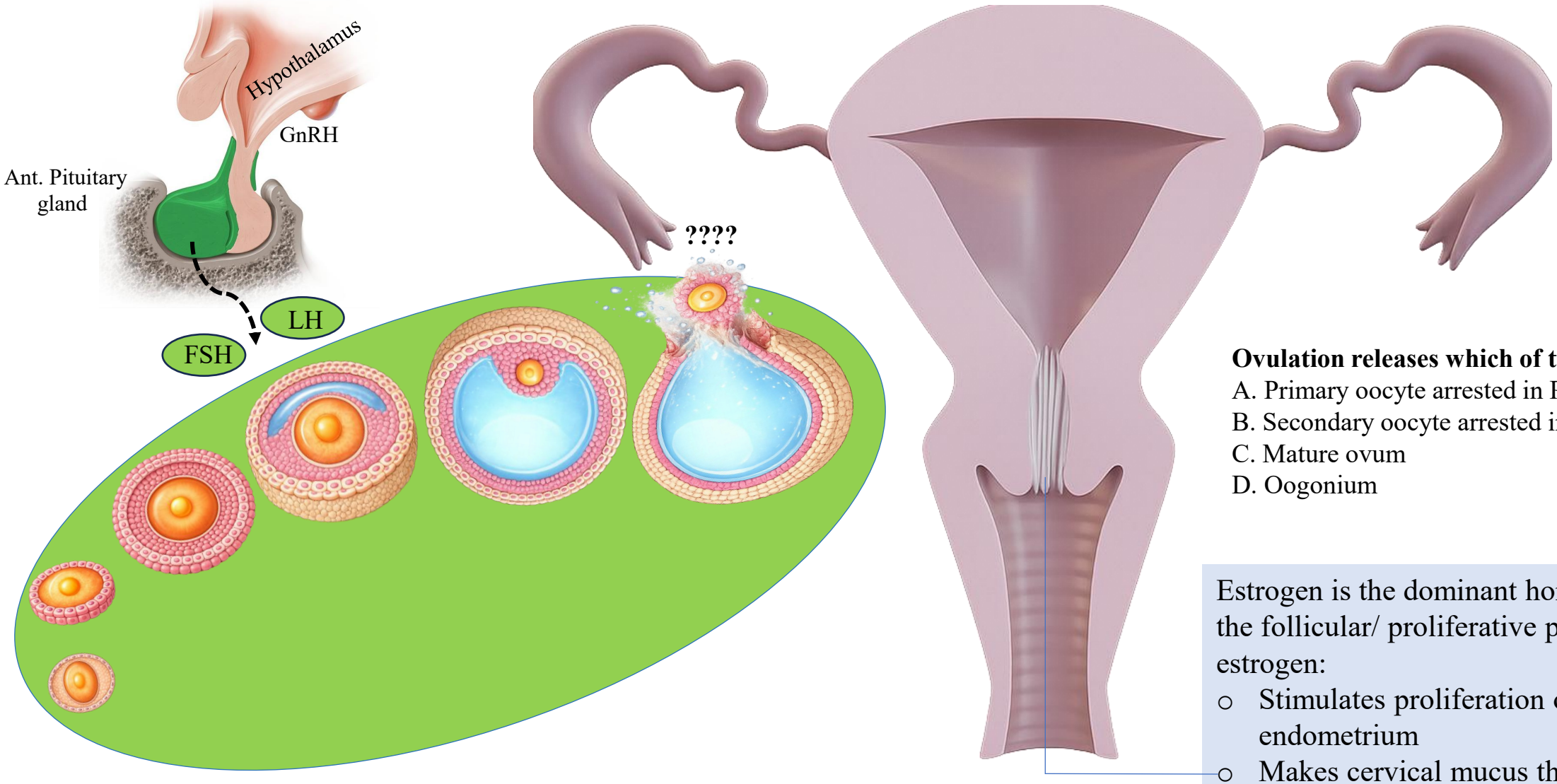

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Ovulation releases which of the following?

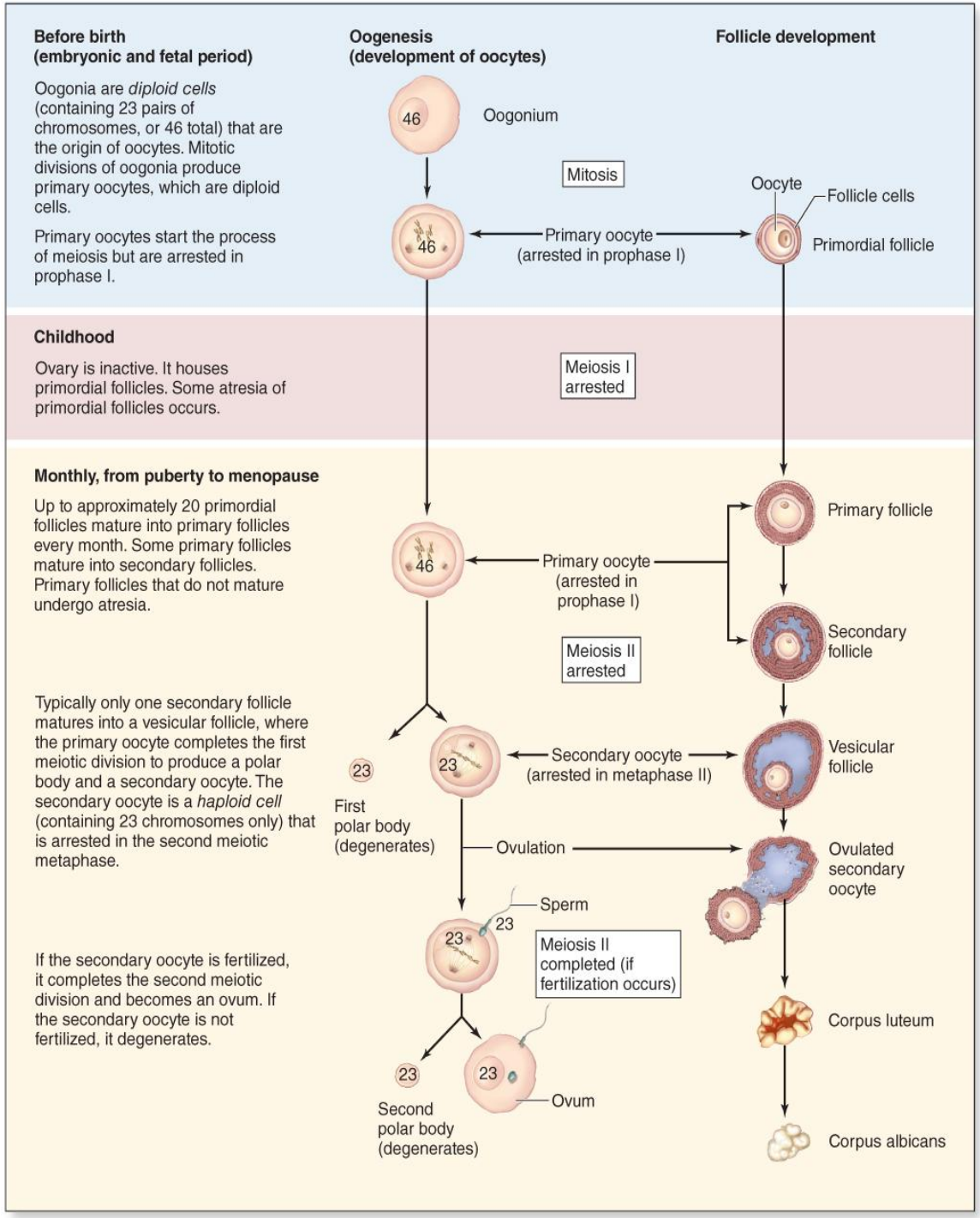
A. Primary oocyte arrested in Prophase I
B. Secondary oocyte arrested in Metaphase II
C. Mature ovum
D. Oogonium

Estrogen is the dominant hormone during the follicular/ proliferative phase. This estrogen:

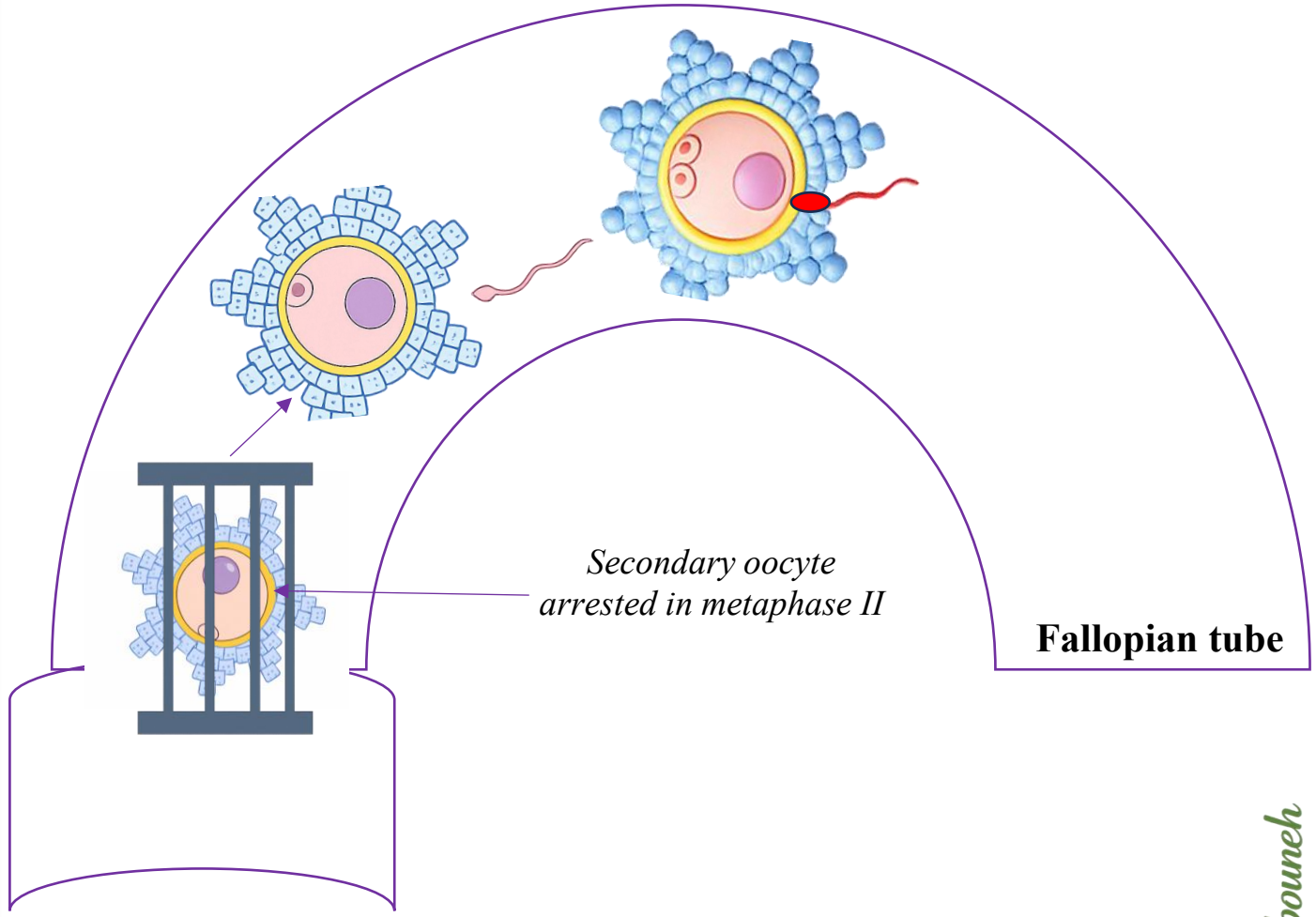
- Stimulates proliferation of the endometrium
- Makes cervical mucus thin and watery (facilitates sperm passage)
- Stimulates LH surge at high sustained levels
- Prepares the uterus for possible progesterone action after ovulation

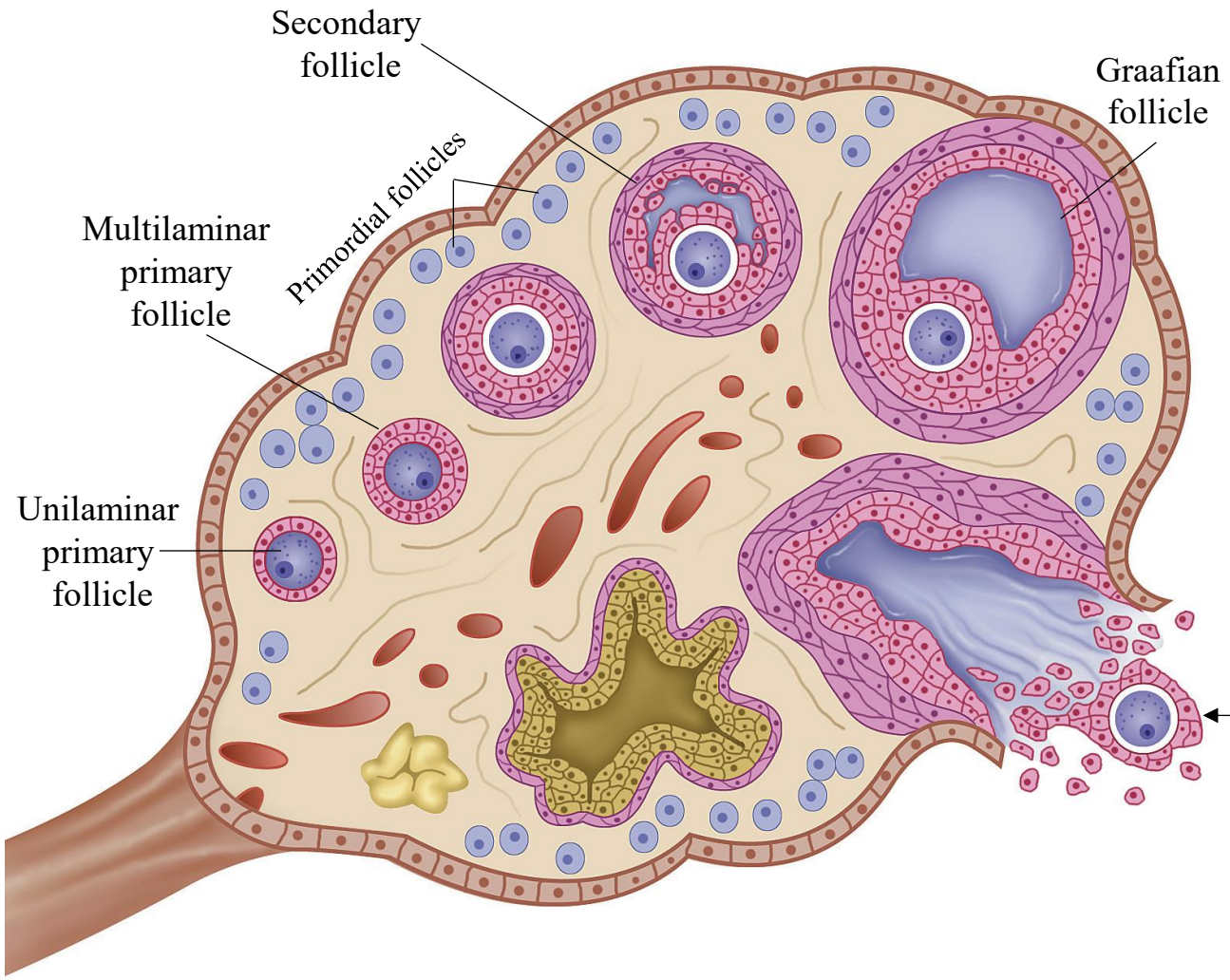
Menses

1 — 5 **Follicular/ Proliferative/ Estrogenic** — 14 **Luteal / Secretory/ Progestational** — 28



If the secondary oocyte is fertilized, it completes meiosis II and becomes an ovum





Beginning in puberty with the release of FSH/LH from the pituitary, about 15-20 primordial follicles each month begin a process of follicular growth (folliculogenesis)

In Follicular Growth & Development

Notice the changing size and morphology of follicular (granulosa) cells at each stage, as well as the arrangement of the surrounding thecal cells.

During a typical menstrual cycle, one follicle becomes dominant and develops farther than the others.

The dominant follicle usually reaches the most developed stage of follicular growth and undergoes **ovulation**, while the other primary and secondary follicles undergo **atresia!!!**.

Although their oocytes are never directly used, the large growing follicles each month produce much estrogen before becoming atretic.

This estrogen stimulates preparation of the reproductive tract to transport and sustain the embryo if the oocyte from the dominant follicle is fertilized.

Follicular Atresia

Most ovarian follicles undergo the degenerative process called atresia.

Atresia = degeneration of ovarian follicles

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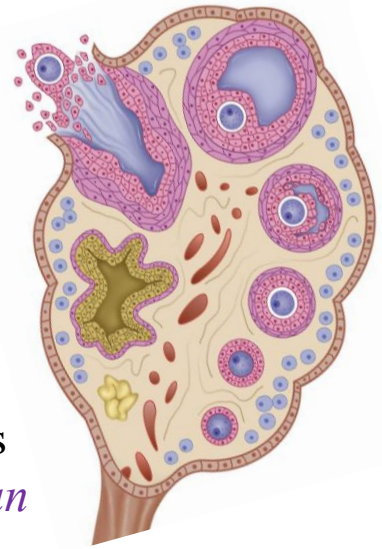
Ovulation

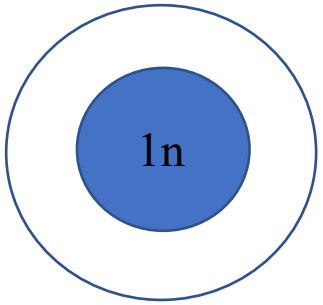
Ovulation is the hormone-stimulated process by which the oocyte is released from the ovary. Ovulation normally occurs midway through the menstrual cycle, that is, around the 14th day of a typical 28-day cycle.



Just before ovulation, the primary oocyte completes the first meiotic division. *Remember: Meiosis 1 began and arrested in prophase during fetal life*

The chromosomes are equally divided between the two daughter cells

Secondary oocyte
retains almost all of the cytoplasm



First polar body
a very small nonviable cell containing a nucleus and a minimal amount of cytoplasm

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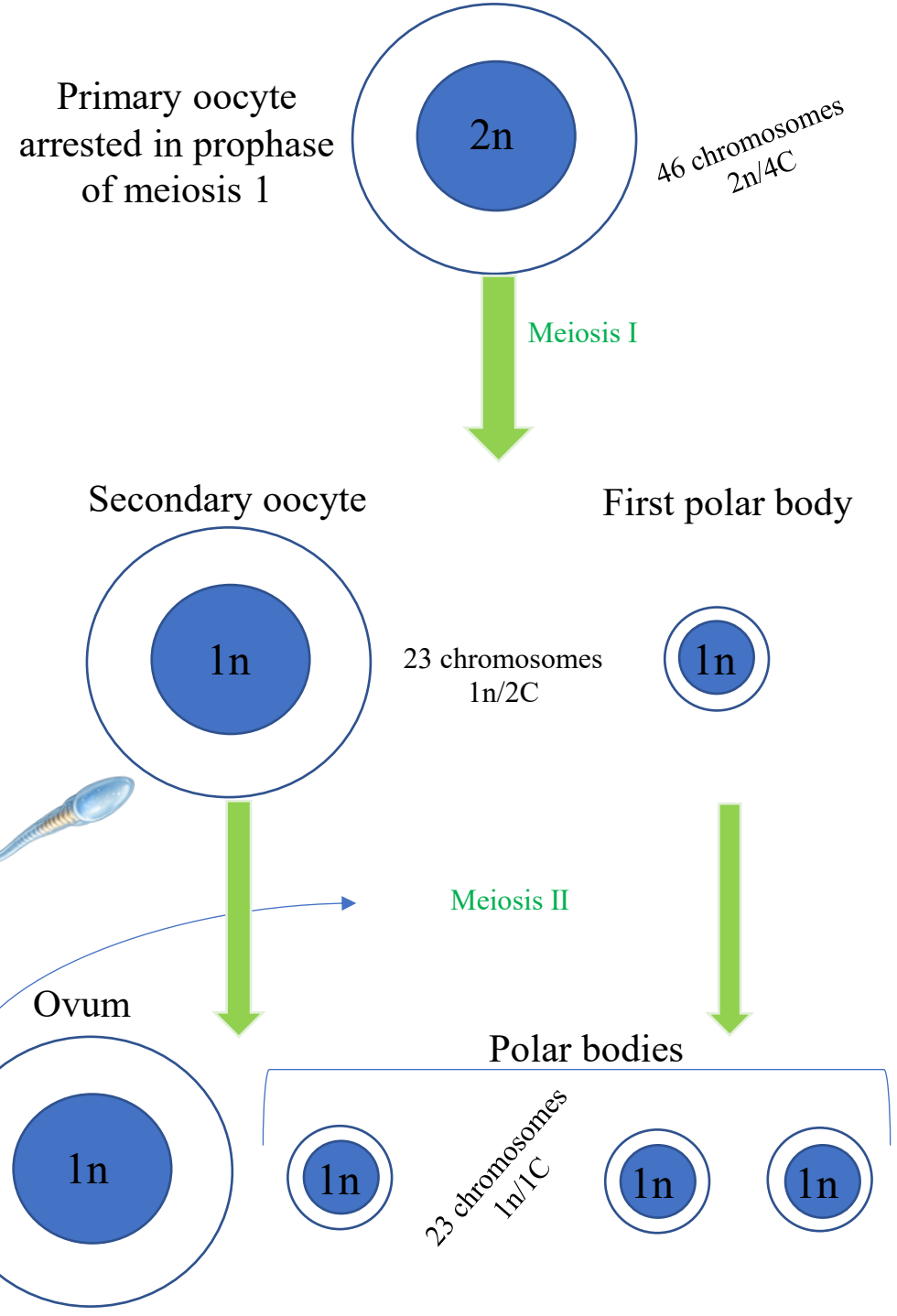
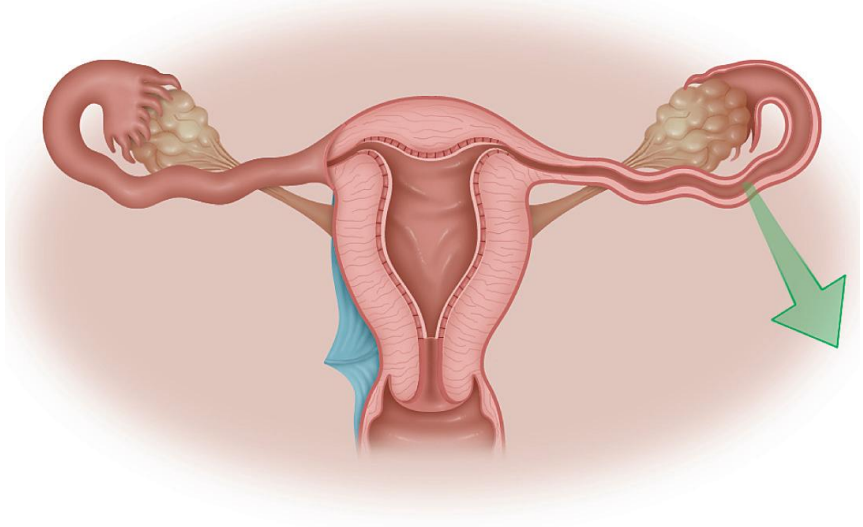
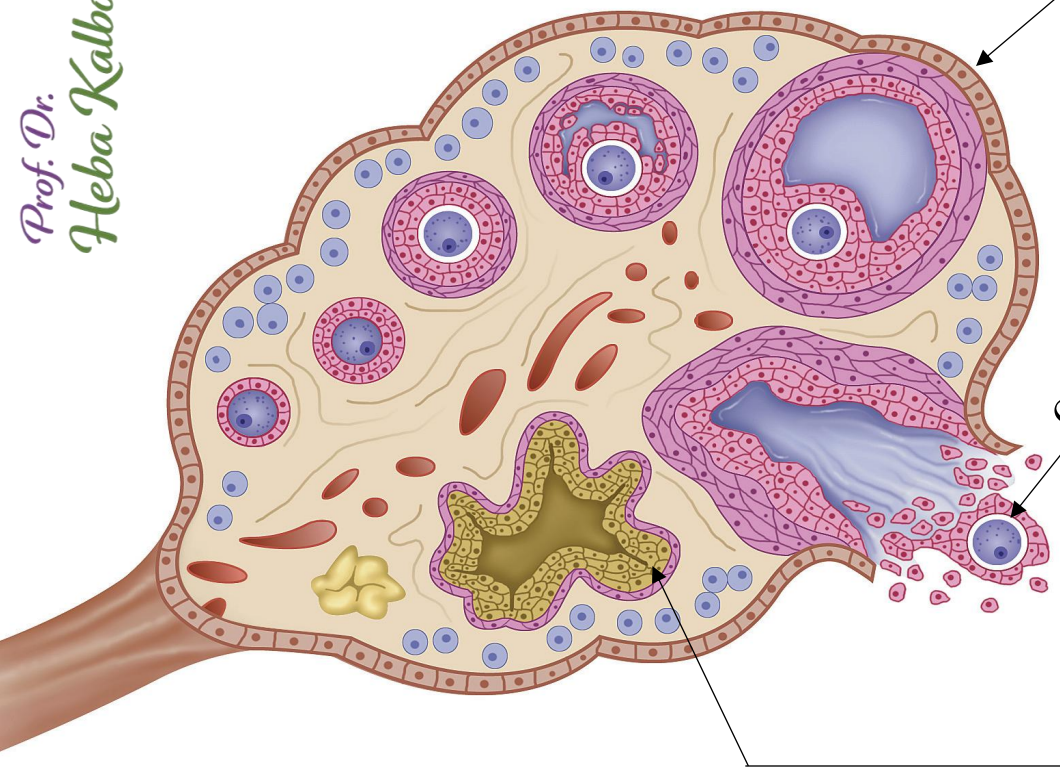
The secondary oocyte begins the second meiotic division but arrests at *metaphase II* and never completes meiosis unless fertilization occurs







- ✓ The increasing pressure within the follicle and weakening of the wall lead to rupture of the ovarian surface at the stigma.

Note: In the hours before ovulation, the mature dominant follicle bulging against the tunica albuginea develops a whitish or translucent ischemic area, **the stigma**

- ✓ The secondary oocyte and its surrounding corona radiata, along with follicular fluid, are expelled by the local smooth muscle contractions.

- ✓ The ovulated secondary oocyte is drawn into the opening of the uterine tube where fertilization may occur.

If not fertilized within about 24 -48 hours, the secondary oocyte begins to degenerate.

- ✓ Cells of the ovulated follicle that remain in the ovary redifferentiate under the influence of LH and give rise to **the corpus luteum الجسم الأصفر**

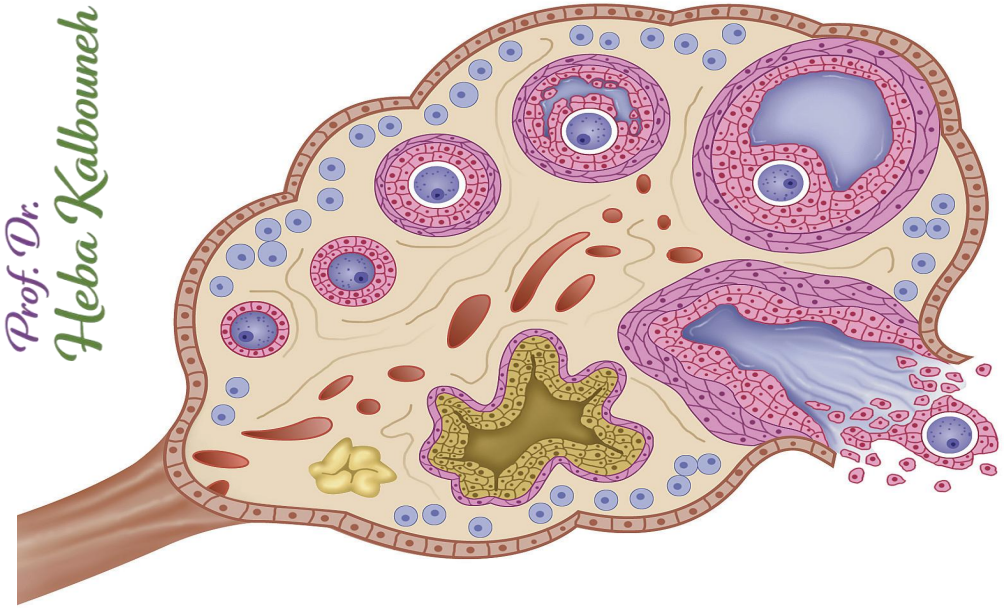
Role of LH in Ovulation

The LH surge induces final oocyte maturation, follicular rupture, and luteinization.

↓ ↓ ↓

LH is the key trigger of ovulation.

Its surge in the middle of the cycle initiates the final steps that release the oocyte from the dominant follicle.



Clinical Correlations

- ✓ LH surge detection → basis of ovulation predictor kits
- ✓ No LH surge → anovulation
- ✓ Excess LH (e.g., PCOS) → disrupted follicular maturation
- ✓ Combined OCPs prevent LH surge → prevent ovulation

What LH Does Inside the Follicle?

A. Resumption of Meiosis

LH stimulates:

- Completion of meiosis I and formation of a secondary oocyte
- Entry into metaphase II (where it arrests again until fertilization)

B. Follicular Wall Changes

LH induces:

- Increased prostaglandins
- Increased proteolytic enzymes (collagenase, plasmin)
- Increased vascular permeability

These changes:

- Weaken the follicular wall
- Increase intrafollicular pressure
- Lead to rupture at the stigma

C. Luteinization

After ovulation:

LH transforms granulosa and theca cells into:

- Granulosa lutein cells
- Theca lutein cells

↓ ↓ ↓

These form the corpus luteum

Progesterone production begins

Corpus Luteum (L., yellowish body)

- ✓ After ovulation, the granulosa cells and theca interna of the ovulated follicle reorganize to form a temporary endocrine gland, the corpus luteum in the ovarian cortex.
- ✓ The granulosa is now invaded by capillaries (Corpus luteum becomes well vascularized!!)
- ✓ Cells of both the granulosa and theca interna change histologically and functionally under the influence of LH, becoming specialized for more extensive production of progesterone in addition to estrogen.

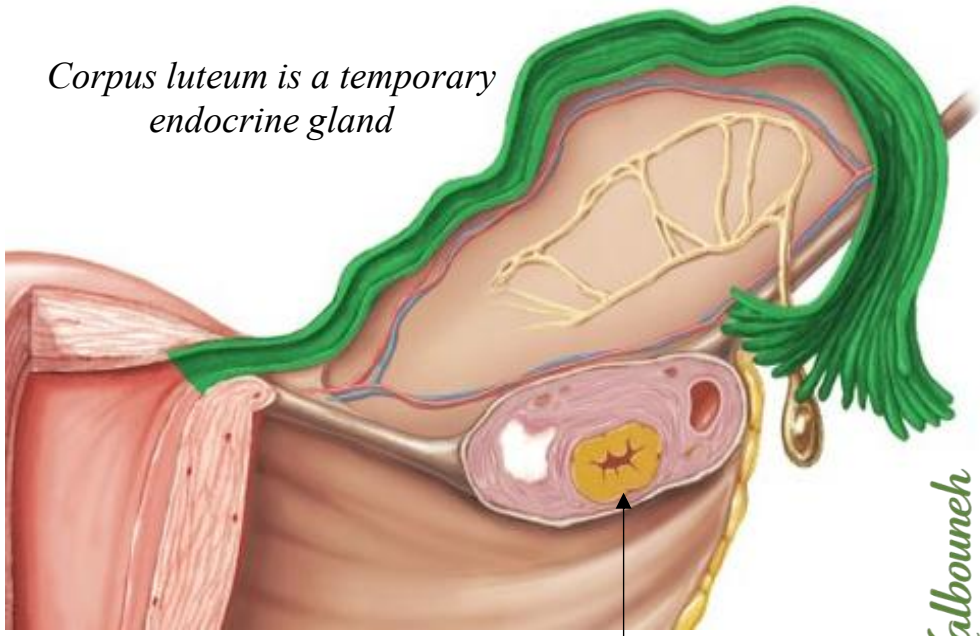
Note: A new corpus luteum develops with each menstrual cycle

After ovulation:
Granulosa cells → **granulosa lutein cells**
Theca interna cells → **theca lutein cells**

Progesterone becomes the dominant product
This progesterone:

1. Converts endometrium to secretory phase
2. Prepares uterus for implantation
3. Raises basal body temperature

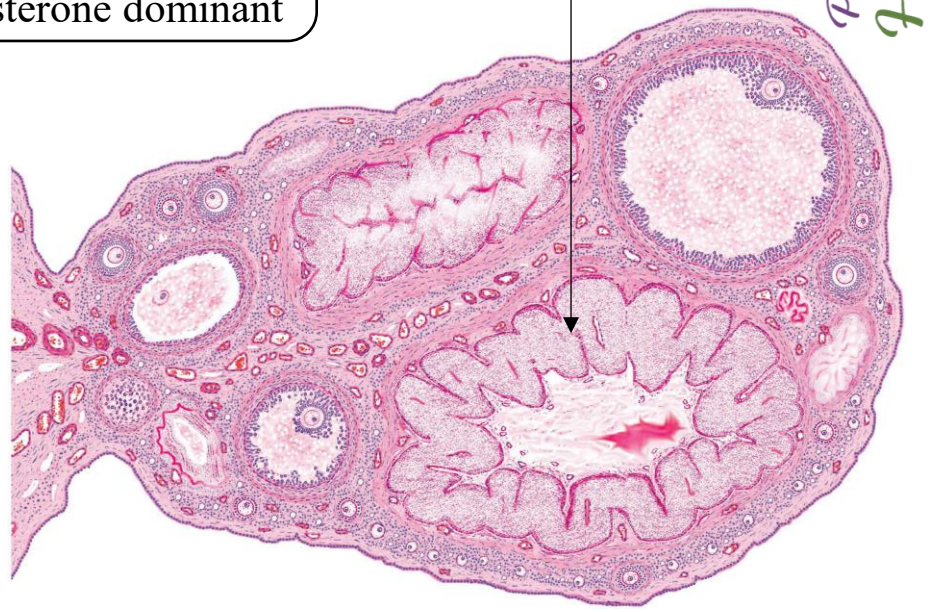
Corpus luteum is a temporary endocrine gland



Corpus Luteum

Note the hormonal shift

- ✓ **Follicular phase** → Estrogen dominant
- ✓ **Luteal phase** → Progesterone dominant



Why is the corpus luteum yellow?
Lutein cells

- Accumulate lipids (cholesterol for steroid synthesis)
- Take up carotenoids from the blood

Carotenoids + lipid-rich cytoplasm 👉 yellow appearance

The fate of the corpus luteum depends on whether fertilization and implantation occur.

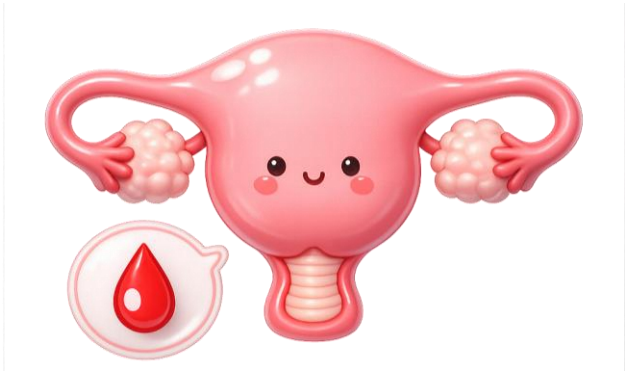
In the absence of pregnancy…… (absence of hCG):

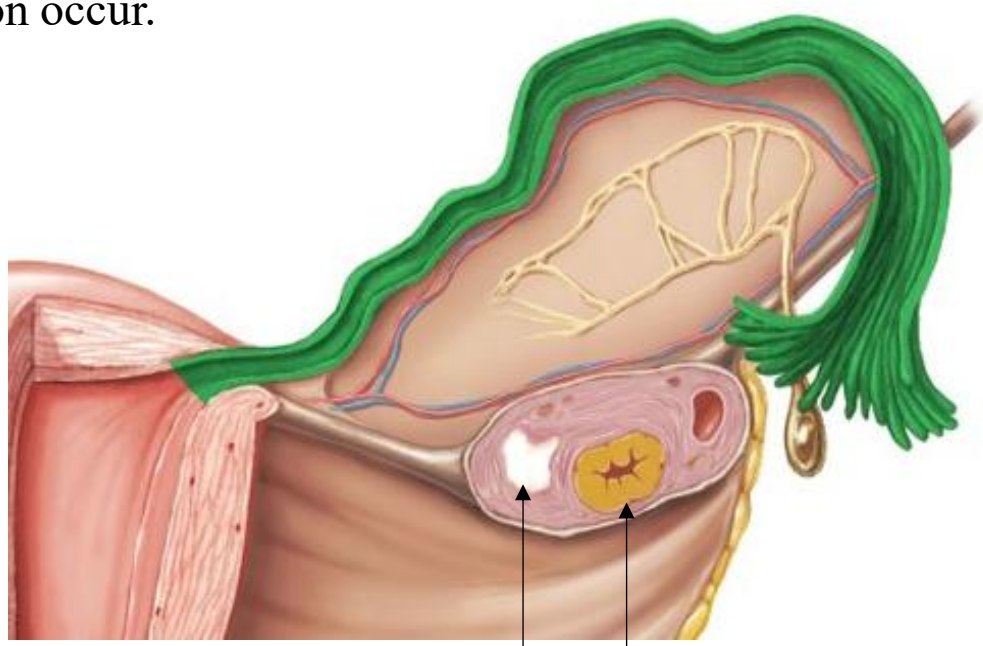
- ✓ Granulosa lutein and theca lutein cells undergo apoptosis.
- ✓ Steroid hormone production declines.

Drop in circulating Progesterone

As progesterone levels fall:

- ✓ Spiral arteries constrict.
- ✓ The functional layer of the endometrium is shed.
- ✓ Menstruation occurs.





The corpus luteum that persists for only one menstrual cycle is called the **corpus luteum of menstruation**. *10-14 days*
It gradually regresses and is replaced by fibrous scar tissue known as the **corpus albicans**. (L., white body) الجسم الأبيض

In the presence of pregnancy……..

✓ If pregnancy occurs, the uterine mucosa (endometrium) must not be allowed to undergo menstruation because the embryo would be lost.

To prevent the drop in circulating progesterone

↓↓↓

Trophoblast cells of the implanted embryo produce **human chorionic gonadotropin** (hCG).

Note: hCG is similar to LH

↓↓↓

hCG maintains and promotes further growth of the corpus luteum, stimulating secretion of progesterone to maintain the uterine mucosa (endometrium).

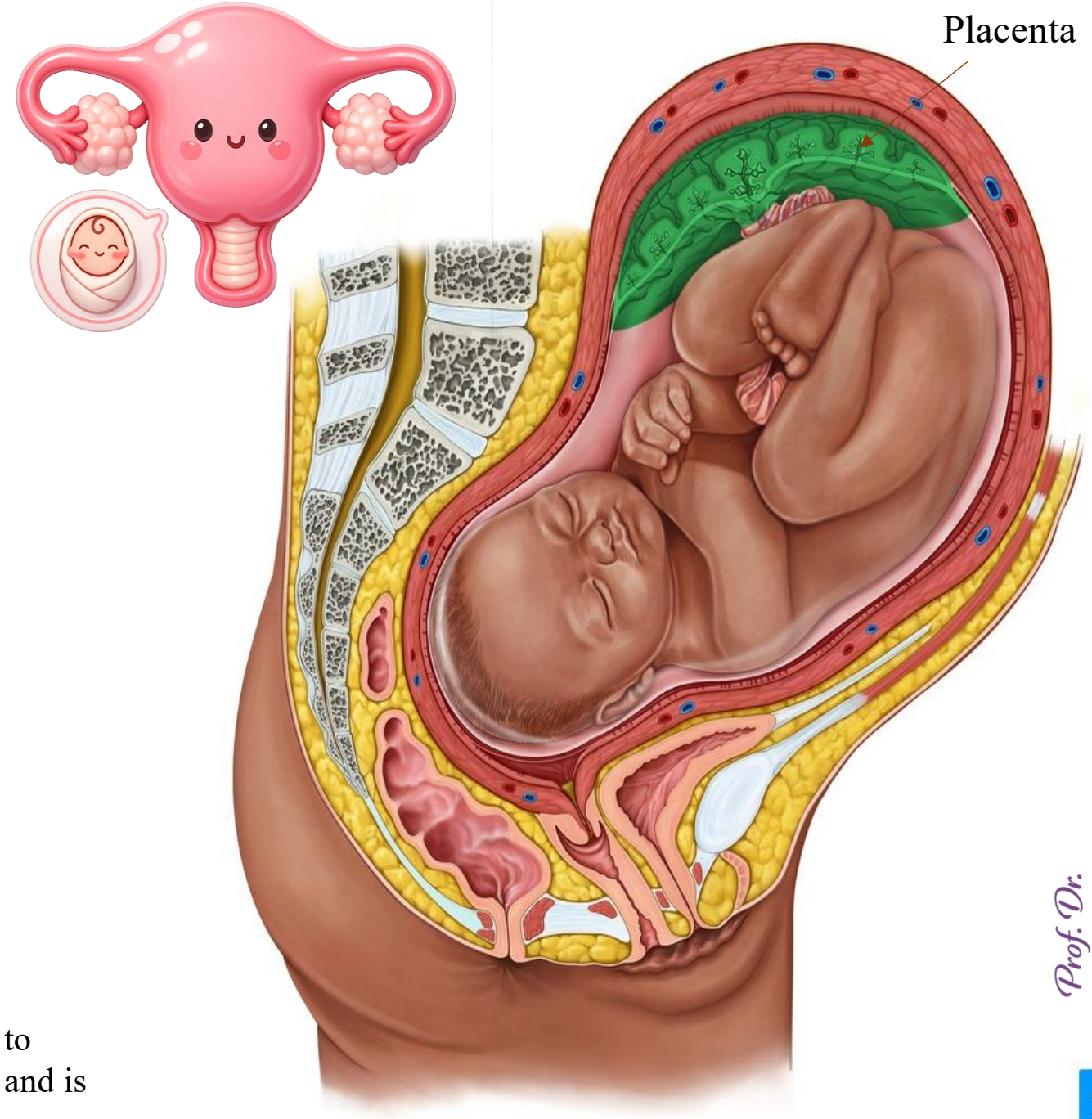
↓↓↓

This is called **corpus luteum of pregnancy**

It becomes very large and is maintained by hCG for ~3 months

After that….. ↓

The placenta itself produces progesterone at levels adequate to maintain the uterine mucosa (endometrium). It then degenerates and is replaced by a large corpus albicans.



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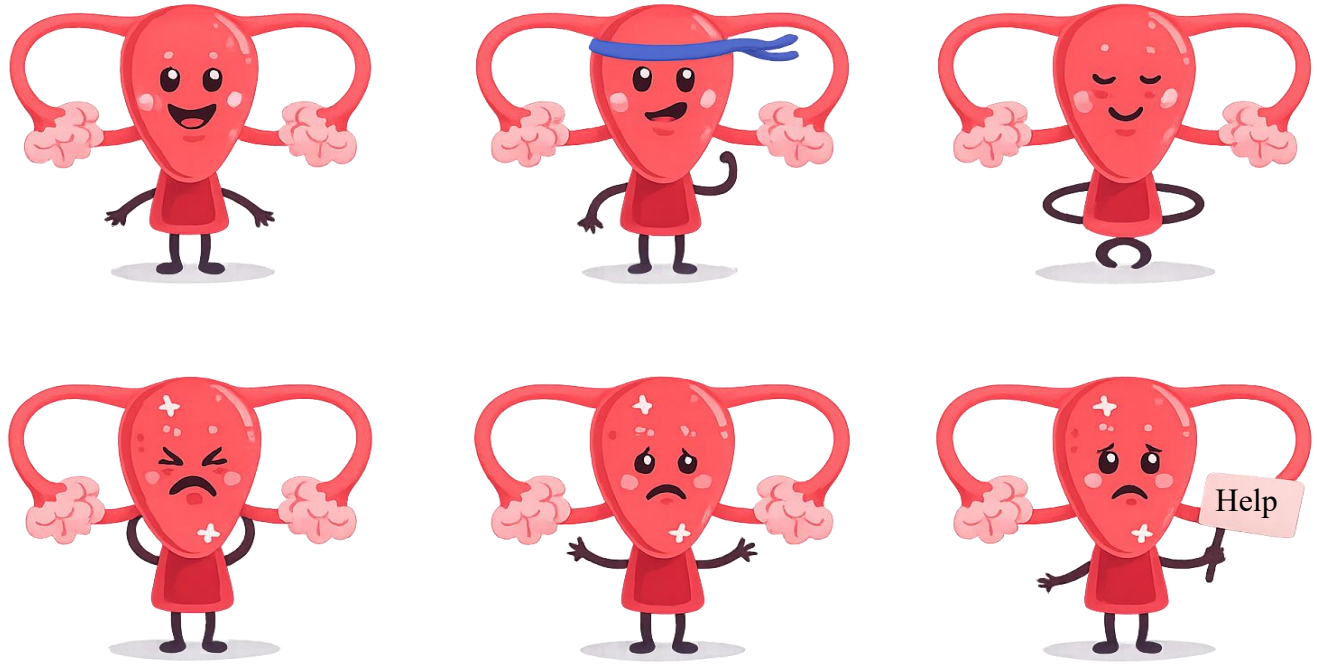
Before birth (embryonic and fetal period)

- ✓ Oogonia are diploid cells (46 chromosomes) that are the origin of oocytes.
- ✓ Mitotic divisions of oogonia produce primary oocytes, which are diploid cells.
- ✓ Primary oocytes start the process of meiosis but are arrested in prophase I.



Childhood, from birth to puberty

- ✓ Ovary is inactive.
- ✓ It houses primordial follicles.
- ✓ Some atresia of primordial follicles occurs.

Monthly, from puberty to menopause

- ✓ Meiosis I arrested
- ✓ About 15-20 primordial follicles mature into primary follicles every month.
- ✓ Some primary follicles mature into secondary follicles.
- ✓ Follicles that do not mature undergo atresia.

To summarize…..
The surprisingly long journey of egg maturation

- ✓ Typically only one secondary follicle matures into a Graafian follicle, where the primary oocyte completes Meiosis I to produce a polar body and a secondary oocyte.
- ✓ The secondary oocyte is a haploid cell (23 chromosomes) that is arrested in metaphase of Meiosis II.

If the secondary oocyte is fertilized, it completes Meiosis II and becomes an ovum. If the secondary oocyte is not fertilized, it degenerates

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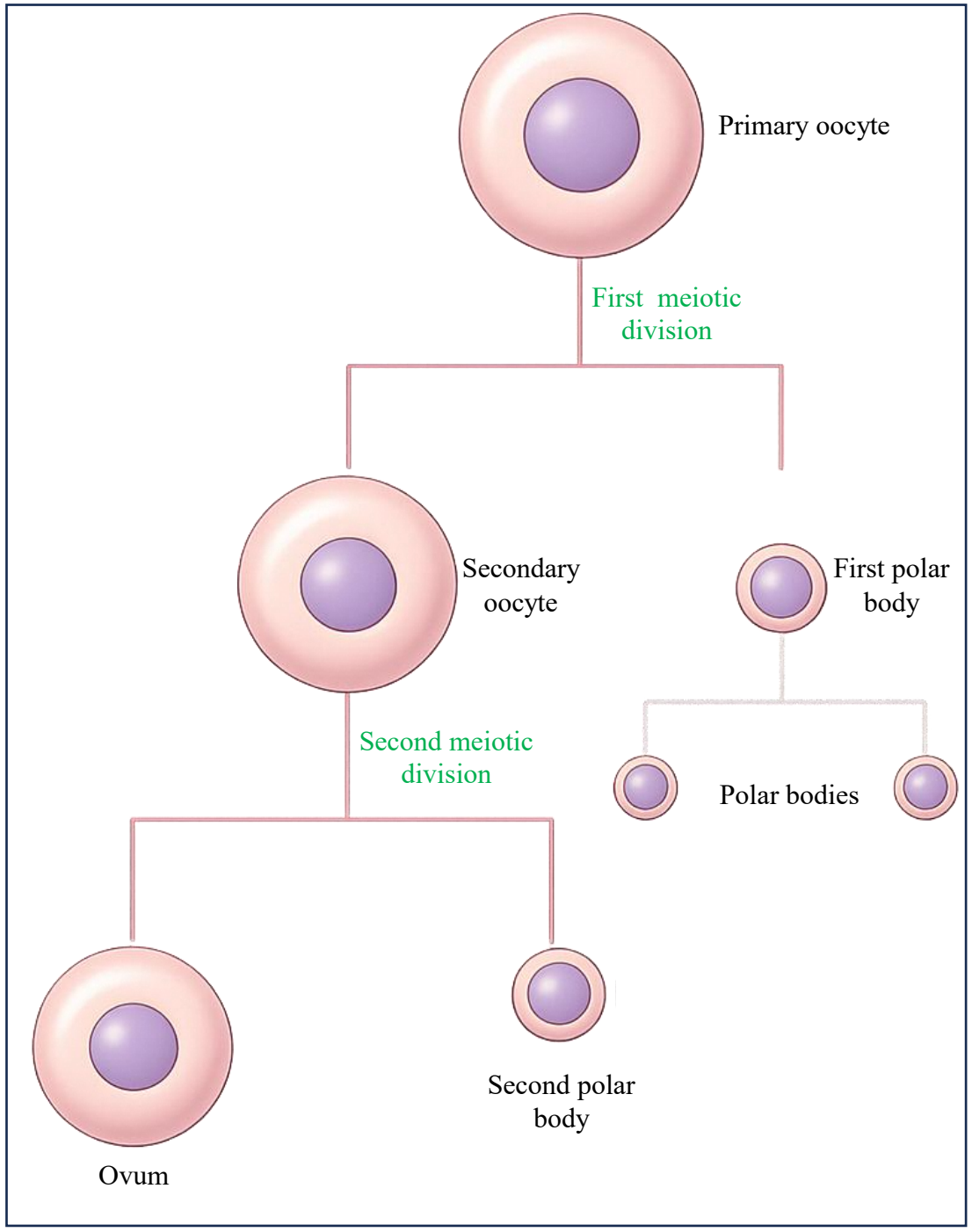
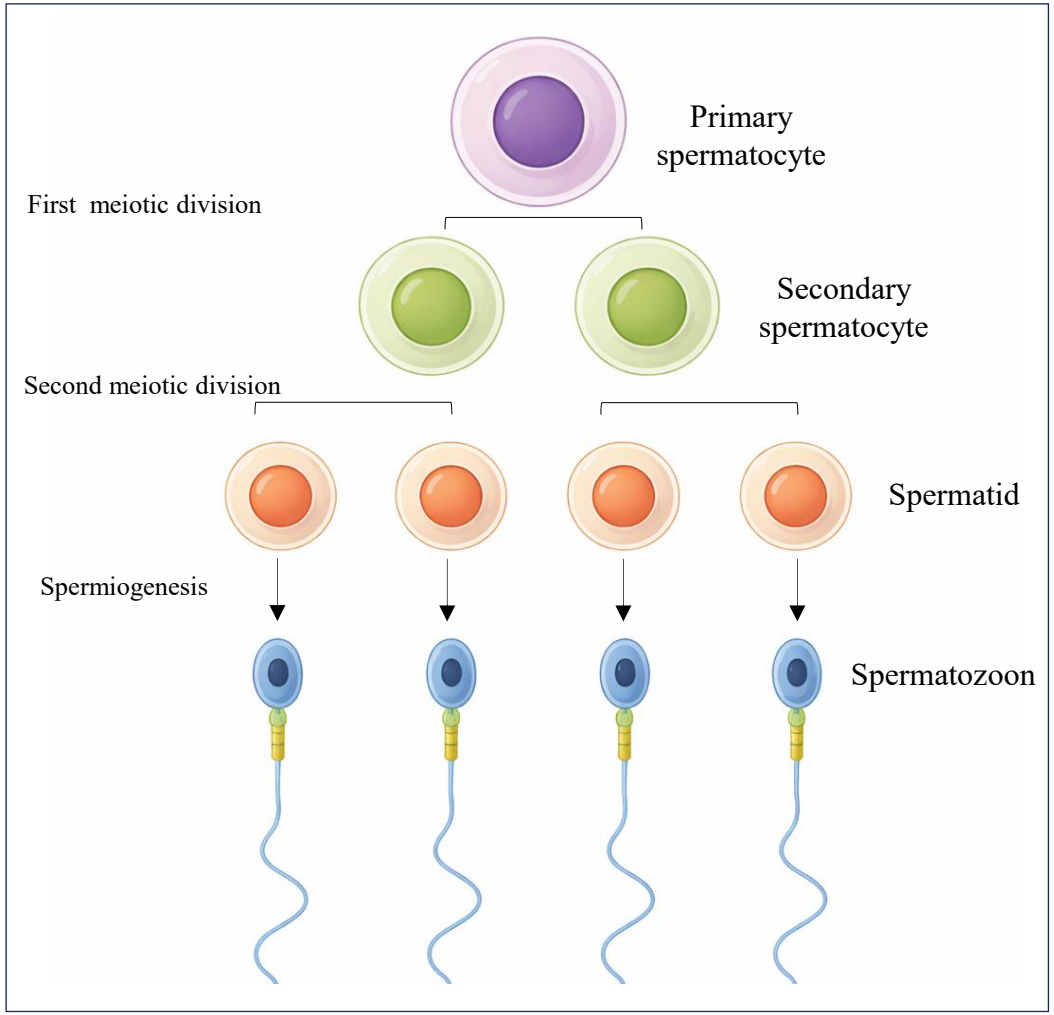
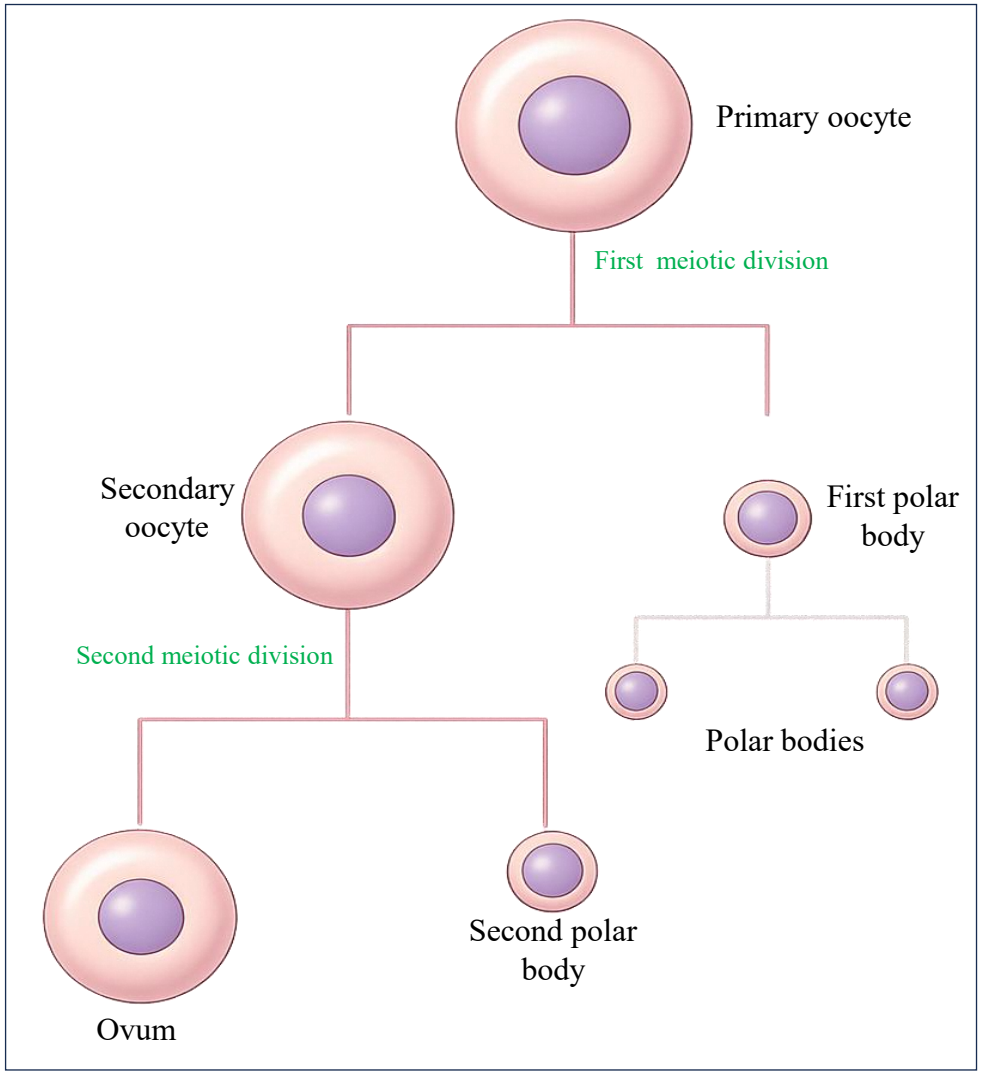
Feature	Spermatogenesis	Oogenesis
Start	Puberty	Before birth
Duration	Continuous	Cyclic
End product	4 sperm	1 ovum
Cytokinesis	Equal	Unequal
Arrest stages	None	Prophase I, Metaphase II
Gamete size	Small	Large



- ✓ **Oogonium** – female germ cell (fetal life)
- ✓ **Primary oocyte** – enters meiosis I
  (arrested in prophase I (from fetal life → puberty))
- ✓ **Secondary oocyte** –enters meiosis II
  (arrested in metaphase II (ovulation → fertilization))
- ✓ **Ovum** – *strictly* the cell after completion of meiosis II (i.e., after fertilization)

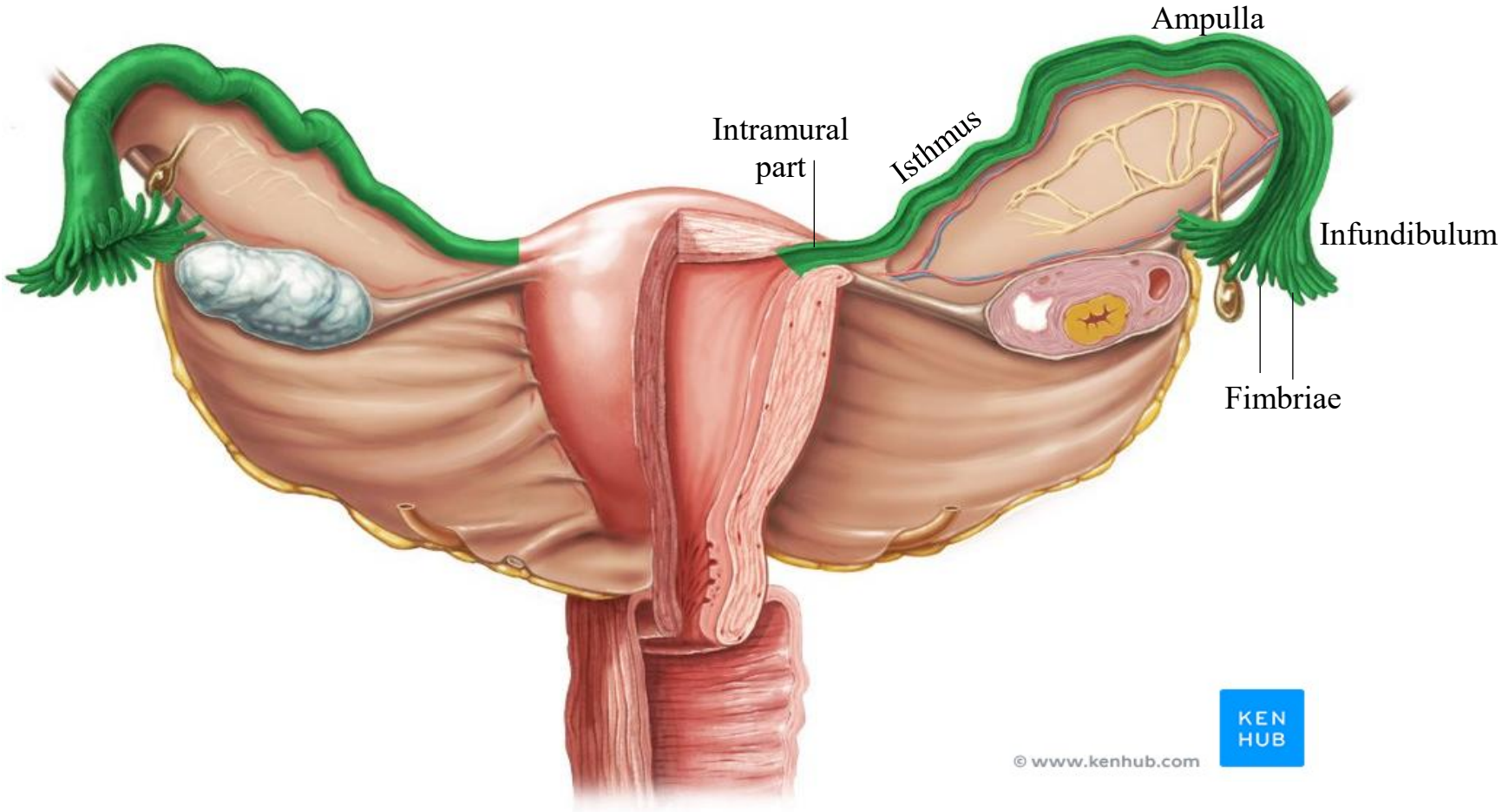




- ✓ **Spermatogonium** – male germ cell
- ✓ **Primary spermatocyte** – enters meiosis I
- ✓ **Secondary spermatocyte** – enters meiosis II
- ✓ **Spermatid** – haploid, immature cell
- ✓ **Spermatozoon** – mature, motile sperm cell

Fallopian tubes

- ✓ Are paired
- ✓ Called also uterine tubes, or oviducts
- ✓ Each tube measures about 10-12 cm in length
- ✓ Each tube opens into the peritoneal cavity near the ovary, with regions in the following sequence:



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The infundibulum: a funnel-shaped opening with fingerlike extensions called fimbriae (L., fringes) next to the ovary
The ampulla: the longest and expanded region where fertilization normally occurs
The isthmus: a narrower portion nearer the uterus
The uterine or intramural part: passes through the wall of the uterus and opens into it.

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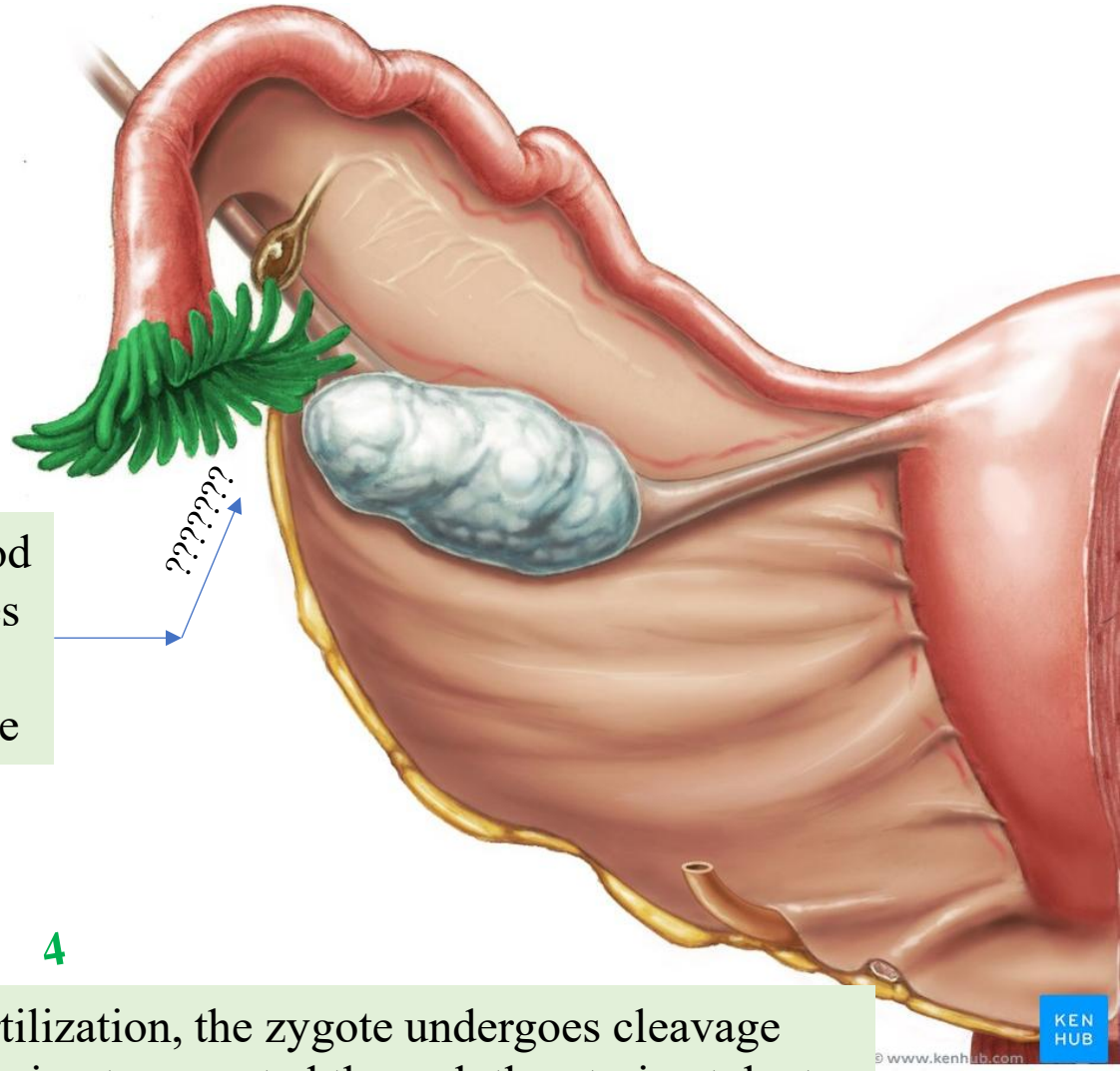


1 At the time of ovulation, mucosal hypertrophy and increased local blood flow have enlarged and moved the uterine tubes. The infundibulum lies very close to the ovary and the fimbriae partially surround that organ. This favors the transport of the ovulated secondary oocyte into the tube

2 Promoted by sweeping muscular contractions of the fimbriae and ciliary activity, the oocyte enters the infundibulum and moves to the ampulla.

3 The secretion covering the mucosa has nutritive and protective functions for both the oocyte and the sperm, including capacitation factors that activate sperm and make those cells able to fertilize an oocyte.

Fertilization

4 Following fertilization, the zygote undergoes cleavage divisions while being transported through the uterine tube to the uterus over approximately 3–4 days.

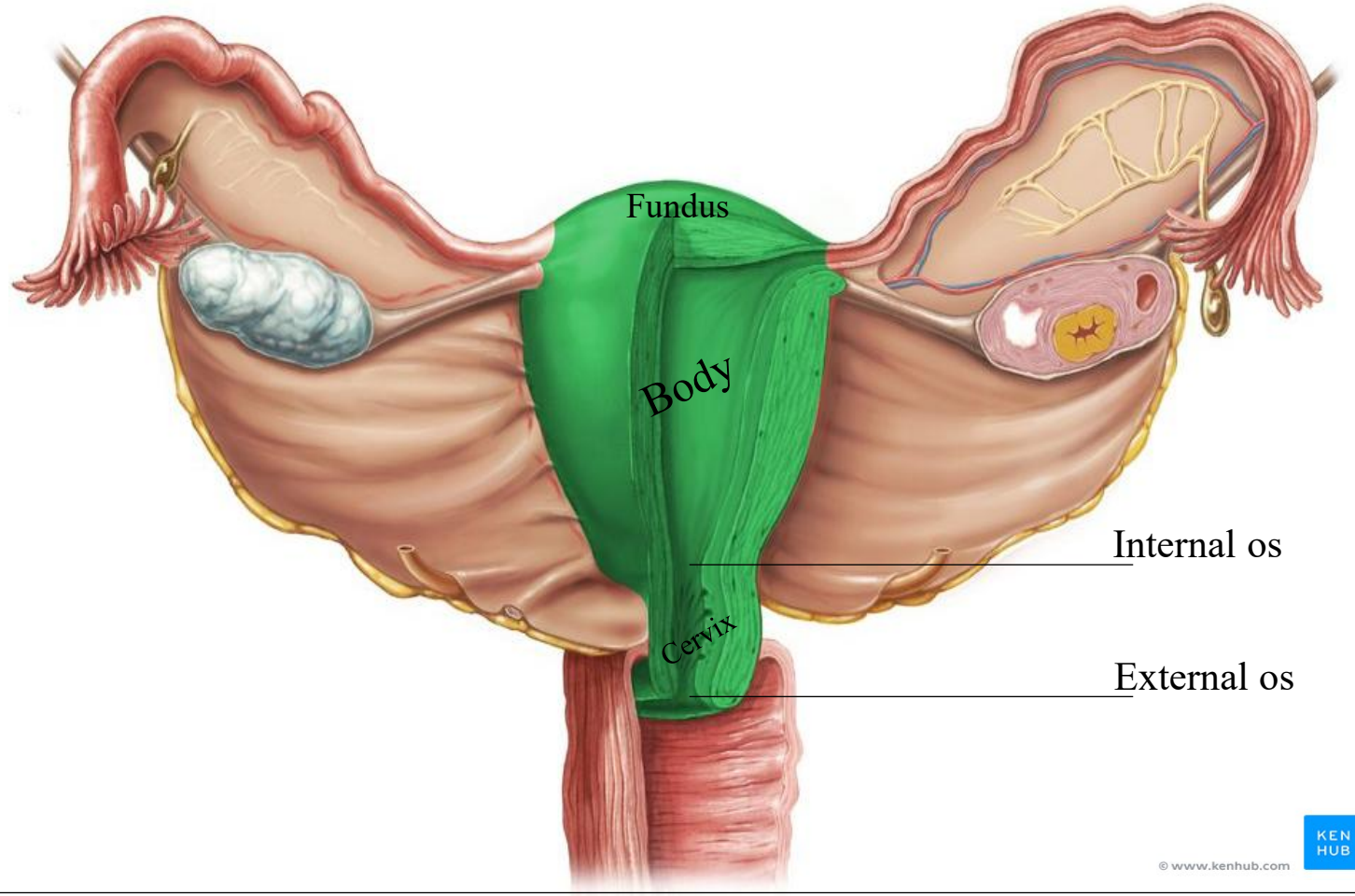
This transport occurs normally in women with immotile ciliary syndrome, indicating **a more important role for muscle** contractions in moving the embryo.

The Uterus

- ✓ The uterus is a pear-shaped organ with thick, muscular walls.
- ✓ Its largest part, **the body**, is entered by the left and right Fallopian tubes
- ✓ The curved, superior area between the tubes is called **the fundus**.
- ✓ The uterus narrows and ends in a lower cylindrical structure, **the cervix**.
- ✓ The lumen of the cervix, **the cervical canal**, has constricted openings at each end:

The **internal os** opens to the main uterine lumen

The **external os** opens to the vagina (L. os, mouth)



The uterine wall has three major layers:

The endometrium: Simple columnar epithelium & lamina propria (Mucosa)

The myometrium: A thick layer of smooth muscle (Muscularis)

The perimetrium: An outer connective tissue layer (Serosa)

These three layers are continuous with their counterparts in the Fallopian tubes.

Note: The thickness and structure of the endometrium is influenced cyclically by the shifting levels of ovarian hormones

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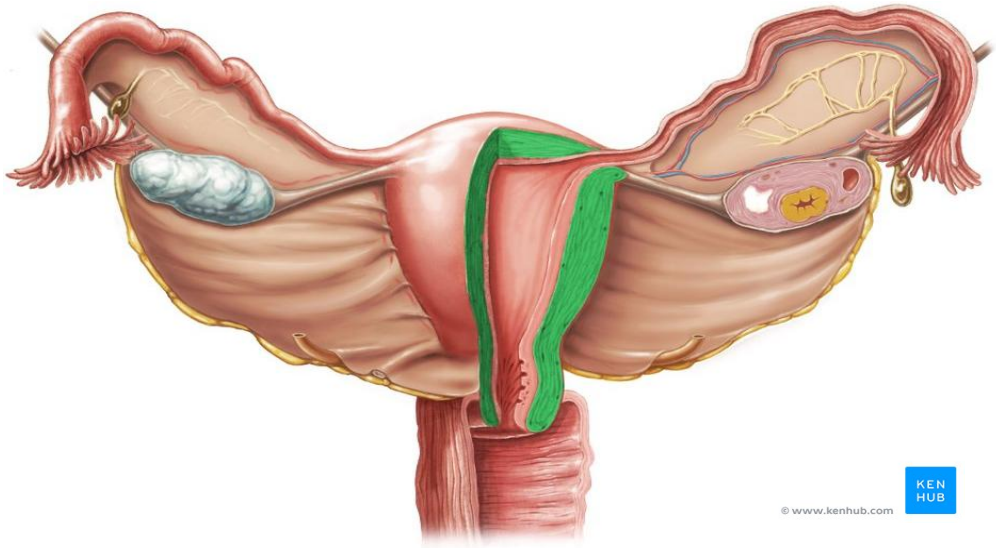
Myometrium (The Muscularis of Uterus)

(Gr. myo, muscle + metra, uterus)



- ✓ The thickest layer of the uterus, shows bundles of smooth muscle fibers parallel to the long axis of the organ, separated by connective tissue (collagen fibers!!)
- ✓ During pregnancy, the myometrium goes through a period of extensive growth involving:

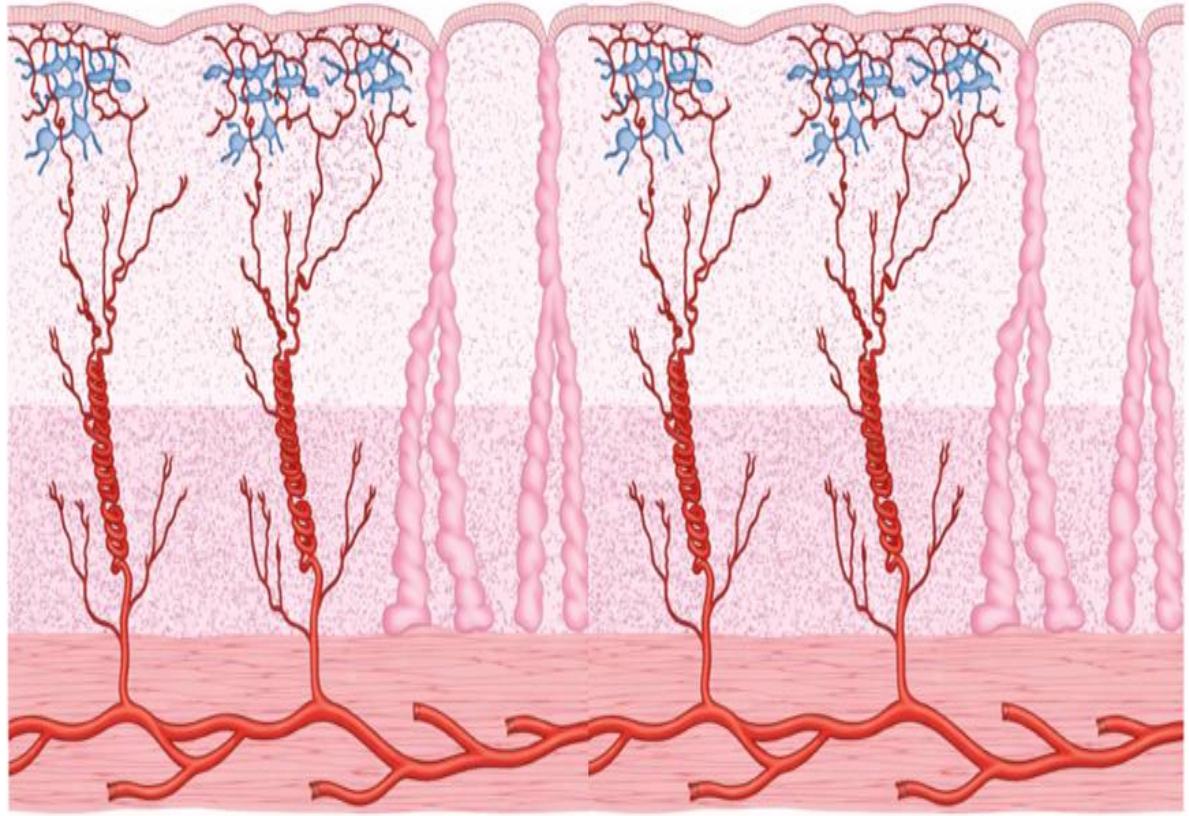
1- Hyperplasia (increasing the number of smooth muscle cells)

2- Hypertrophy (increasing the size of smooth muscle cells)

3- Increased collagen production (strengthening the uterine wall)

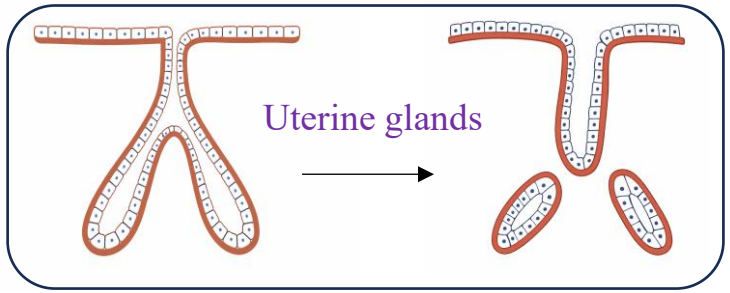
This well-developed uterine myometrium contracts very forcefully during parturition to expel the infant from the uterus.

After pregnancy, uterine smooth muscle cells shrink and many undergo apoptosis, with removal of unneeded collagen, and the uterus returns almost to its prepregnancy size.



Endometrium (The Mucosa of Uterus)

The functional layer thickens and then is shed during menstruation



Epithelium: Simple columnar epithelium

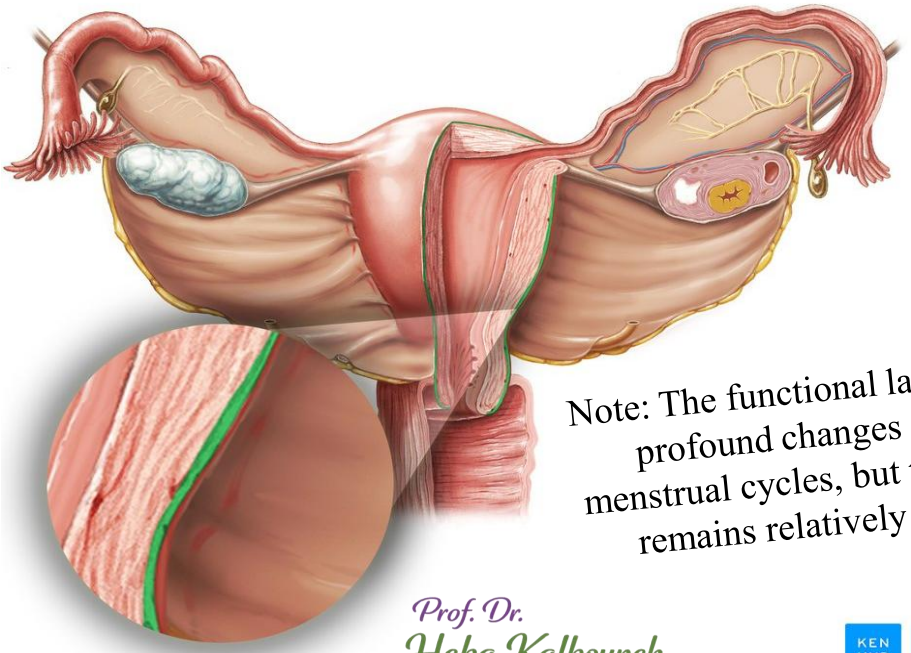
Lamina propria: Loose connective tissue rich in type III collagen fibers

The endometrium has numerous tubular uterine glands, which penetrate the full thickness of the endometrium

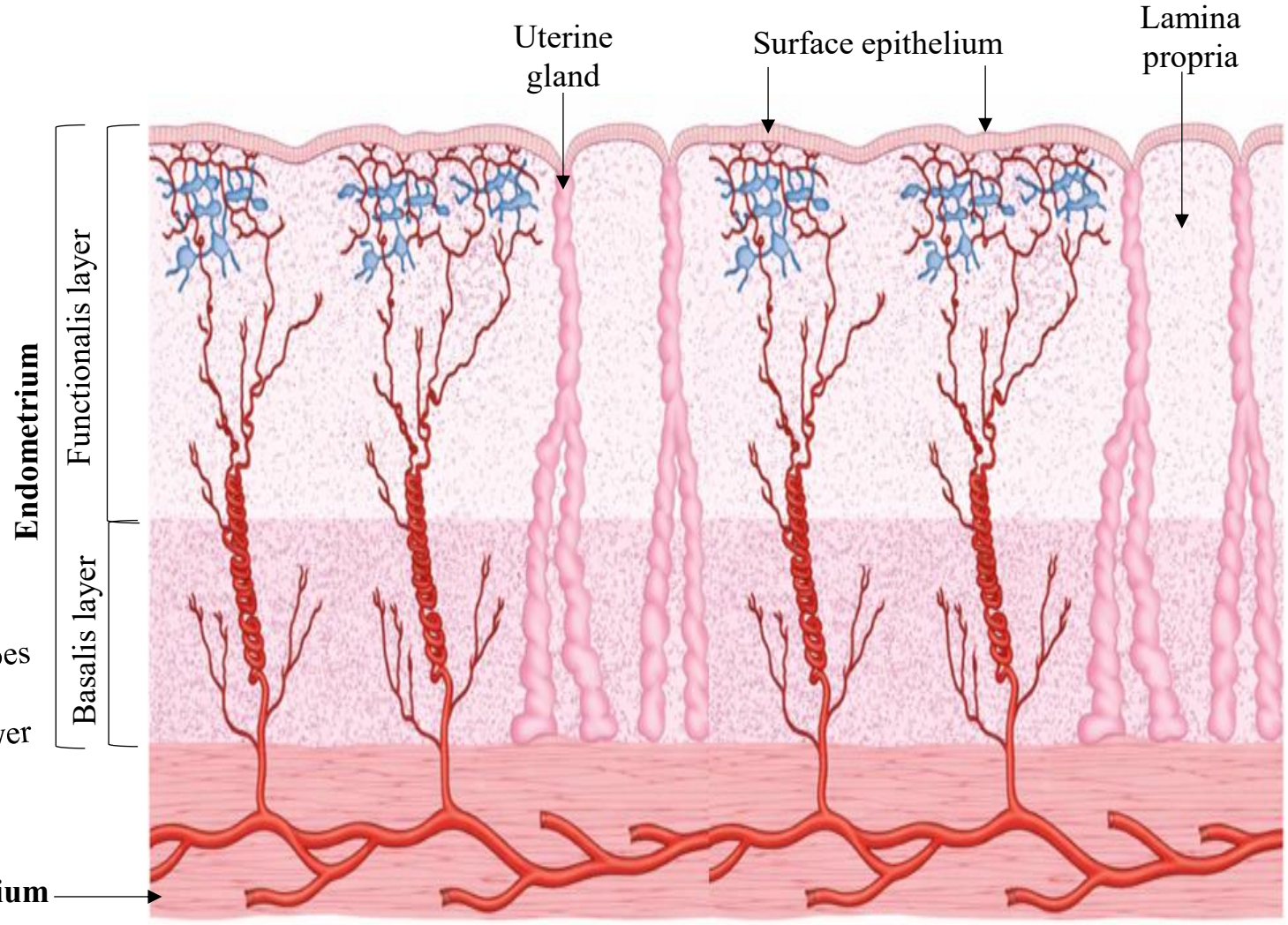
The endometrium has two zones:

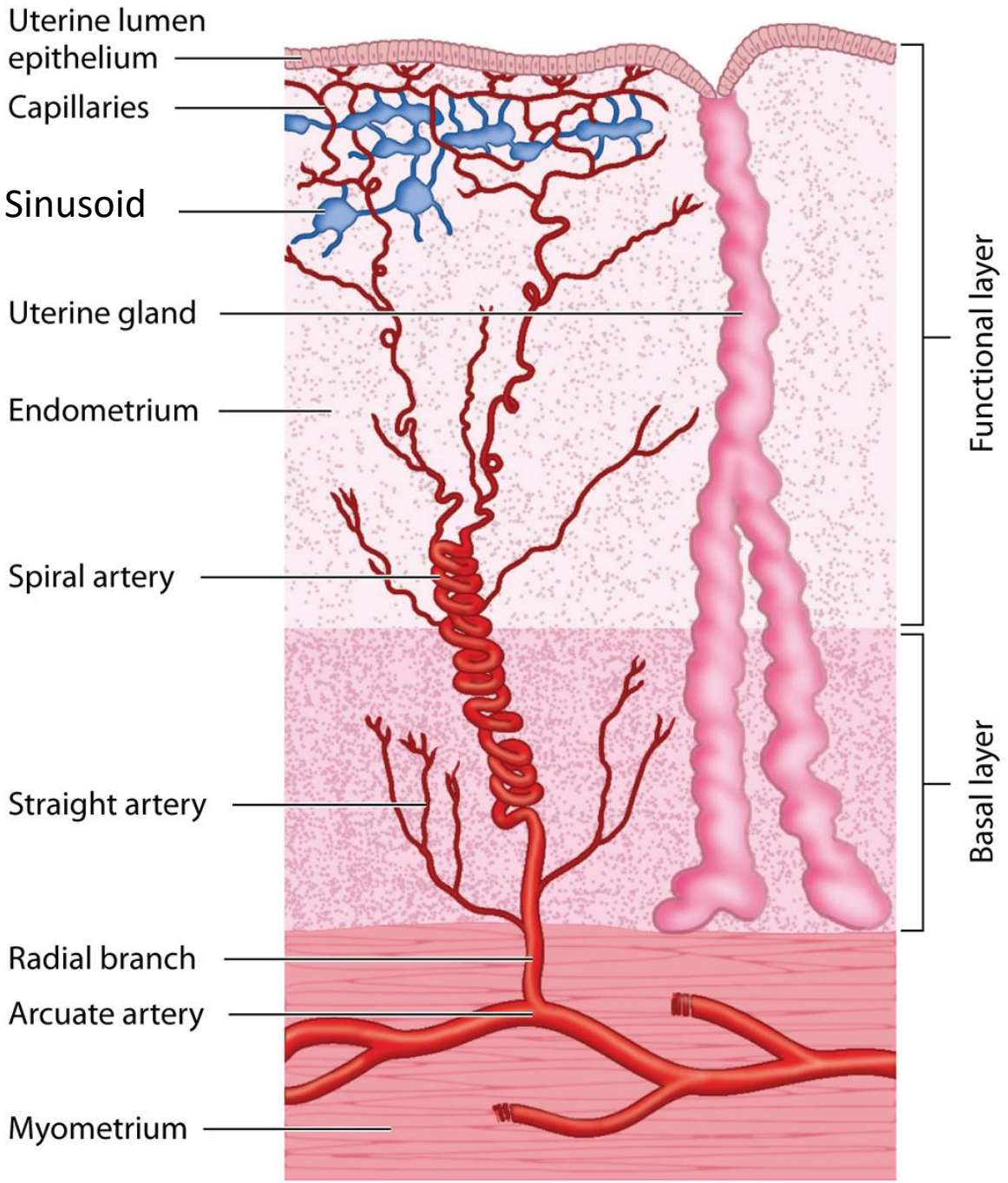
The superficial functional layer (Functionalis): has a spongier lamina propria, richer in ground substance, and includes most of the length of the glands

The basal layer (Basalis): contains the basal ends of the uterine glands



Note: The functional layer undergoes profound changes during the menstrual cycles, but the basal layer remains relatively unchanged





Arterial supply to the endometrium.

The endometrium contains a unique system of blood vessels that undergo marked changes during the menstrual cycle.

Arcuate Arteries: 6 to 10 branches of the uterine artery that encircle the uterus in the myometrium.

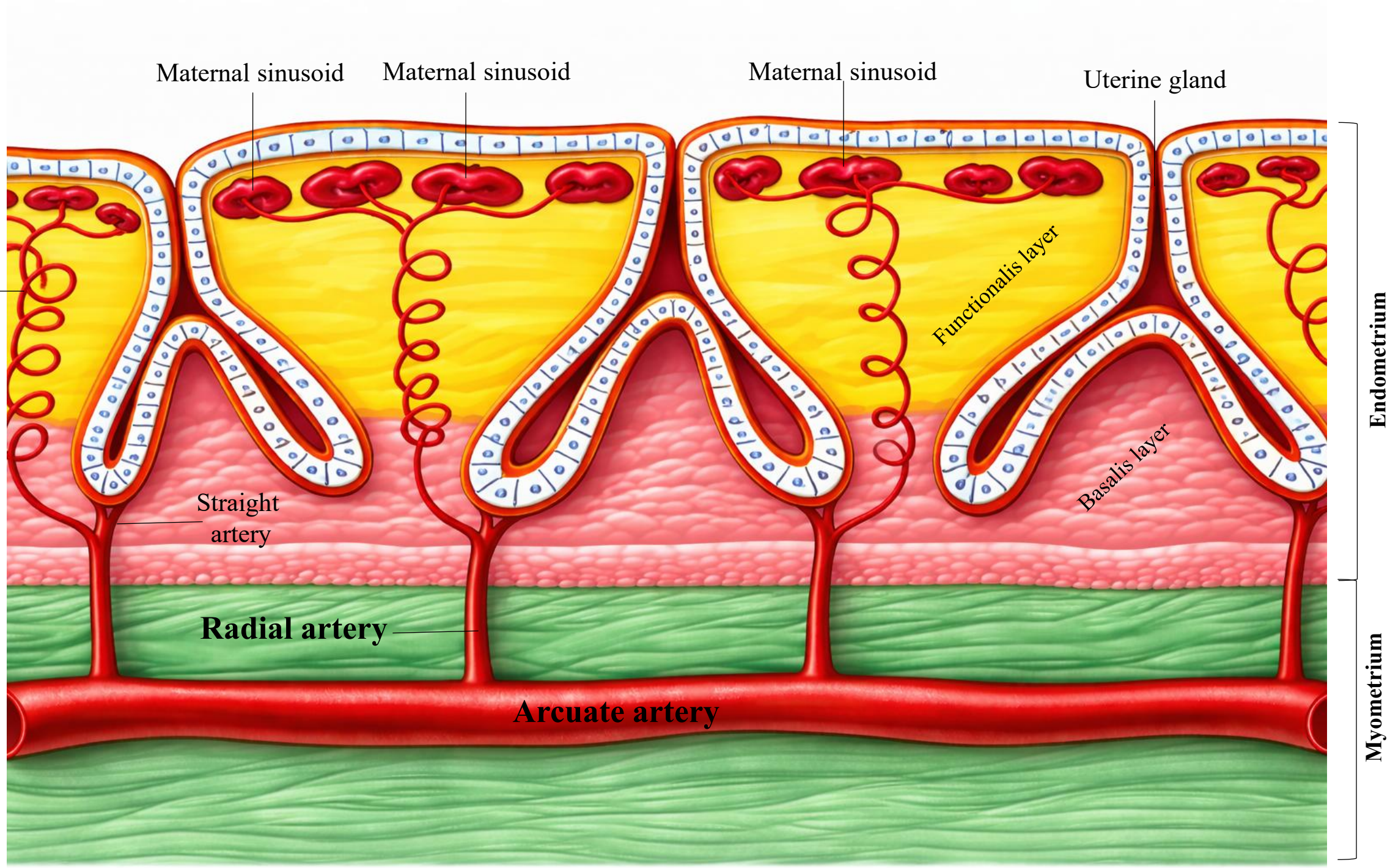
Radial Arteries: branches of arcuate arteries that ascend into the endometrium and give rise to:

Straight Arteries: supply the basal layer.
Spiral (or Coiled) Arteries: supply the functional layer.
Terminal Capillaries: dilated capillaries that arise from spiral arteries (maternal sinusoids).

↓ ↓ ↓

These sinusoids are thin-walled, blood-filled vascular spaces that contribute to menstrual shedding when they rupture.

Because the two layers of the endometrium have separate blood supplies, the basal layer is unaffected by the loss of blood to the functional layer during menstruation.



Test your Knowledge

Which feature is characteristic of the corpora albicans but not of atretic follicles?

a. May contain degenerating granulosa cells floating in remnants of follicular fluid
b. Resemble large collagenous scars
c. Eventually removed by macrophages and replaced by stroma
d. Are remnants of follicles that degenerate before maturation
e. May contain degenerating oocytes

Which stage of ovarian follicle development is characterized by an initial period of follicular fluid accumulation?

a. Graafian follicle
b. Mature follicle
c. Primordial follicle
d. Oocyte
e. Secondary follicle

Endometrial glands are typically most fully developed and filled with product during which day(s) or phase of a woman's menstrual cycle?

a. Menstrual phase
b. Days 1-4
c. The day ovulation occurs
d. Proliferative phase
e. Days 15-28

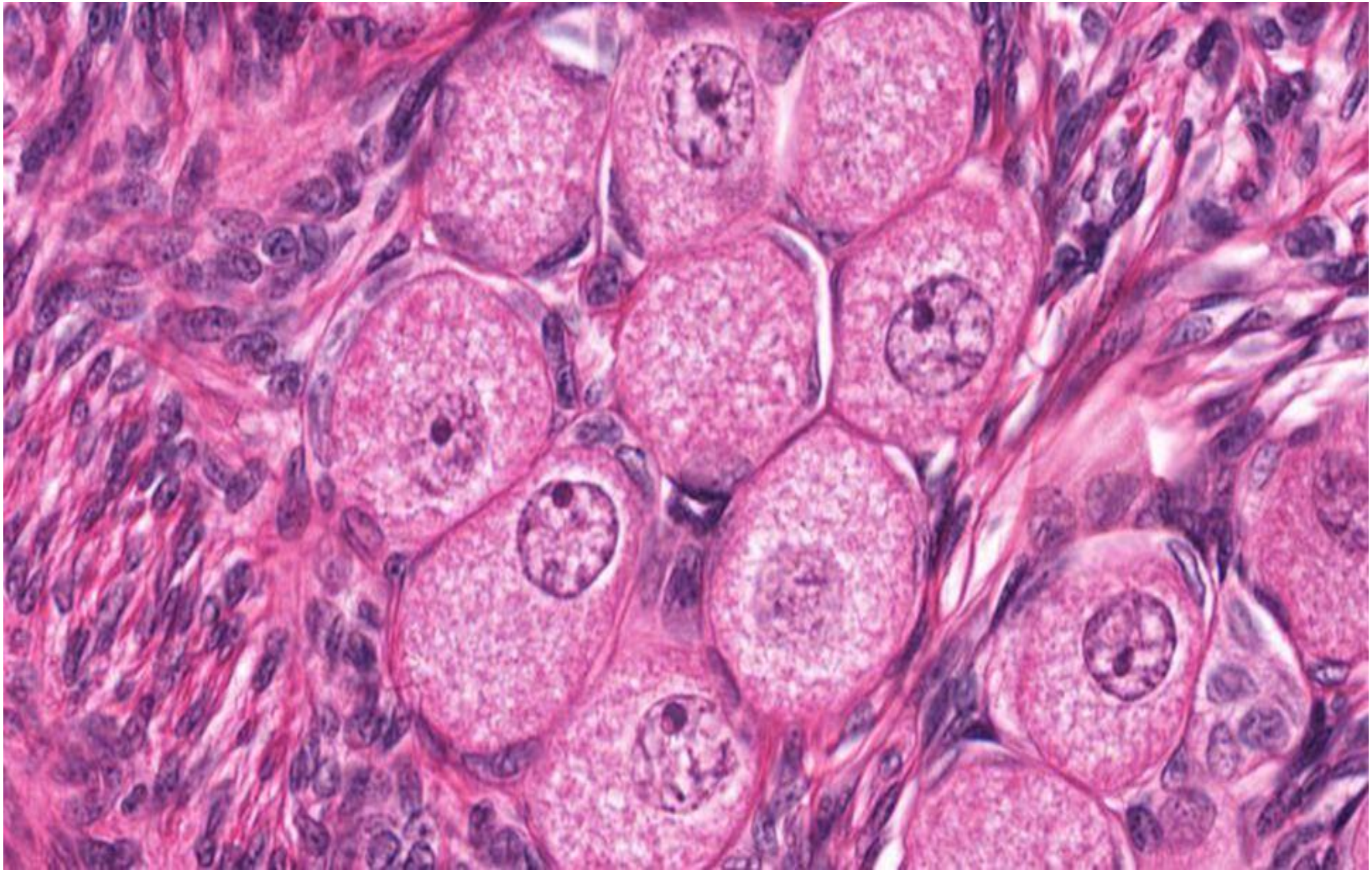
Which feature is characteristic of the endometrium's basal layer but not of its functional layer?

a. Includes the uterine surface epithelium
b. Includes connective tissue
c. Contains cells that replace the surface epithelium after menstruation
d. Relies solely on spiral arteries for its blood supply
e. Undergoes cyclic thickening and shedding

A 17-year-old girl with a history of pelvic inflammatory disease presents at the emergency department with severe pain in her lower right side that came on fairly quickly. Upon questioning she replies that her last menstrual period was 6 weeks ago and that she has never missed a period before. The doctor suspects she has an ectopic pregnancy and this is quickly confirmed by ultrasound testing. The surgeon removes her right uterine tube that is inflamed, scarified, and contains the implanted embryonic tissue in the region where fertilization normally occurs. Where is this?

a. The uterine part of the oviduct
b. The ampulla region with highly folded mucosa
c. The only oviduct region attached to the mesosalpinx
d. The infundibulum region with fimbriae
e. The isthmus region

Identify the follicular stage:



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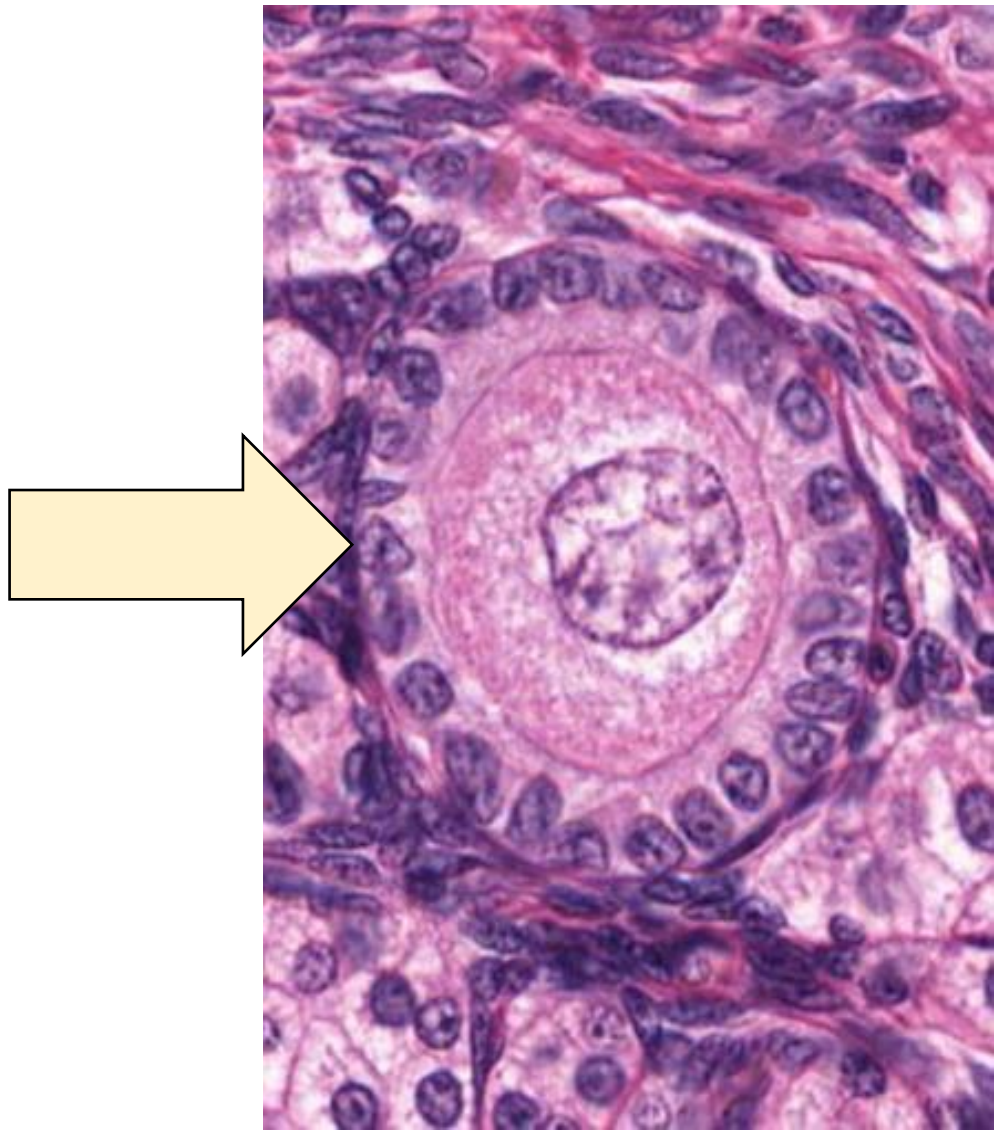
Heba Kalbouneh

Identify the follicular stage:



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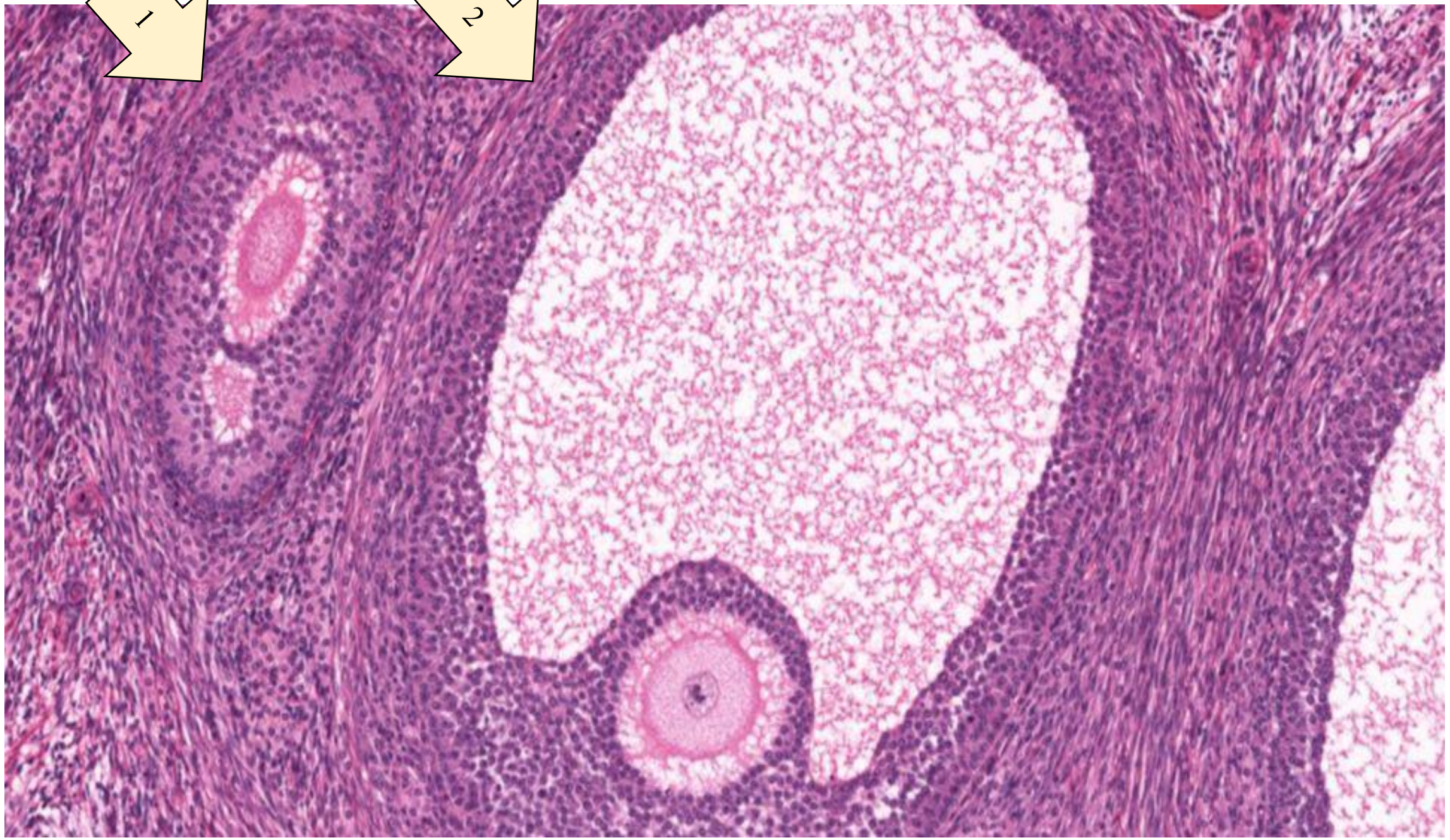
Identify the follicular stages:



Prof. Dr.
Heba Kalbouneh