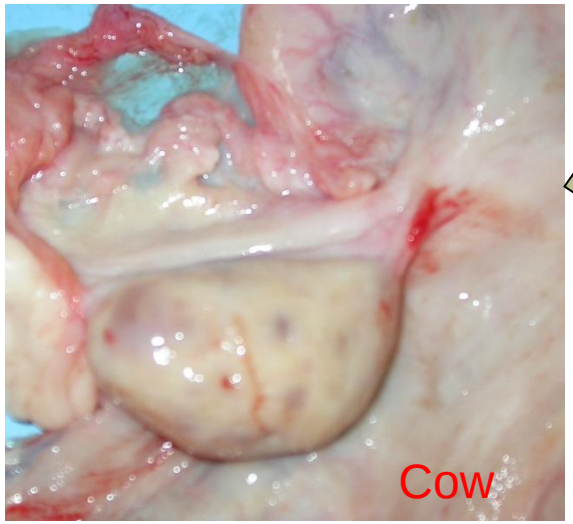
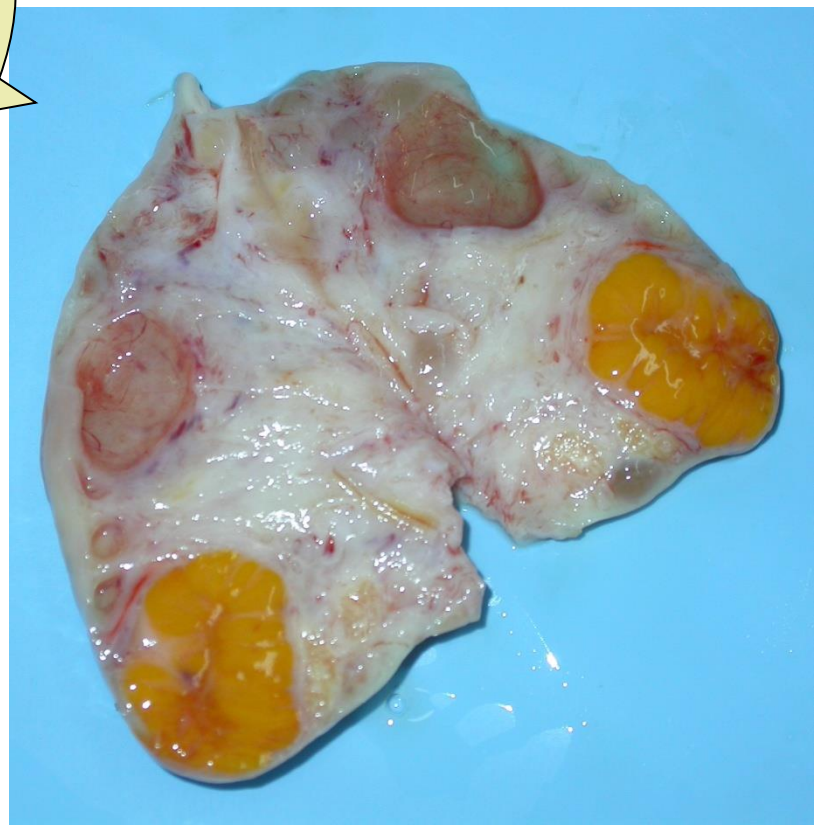
OVARY

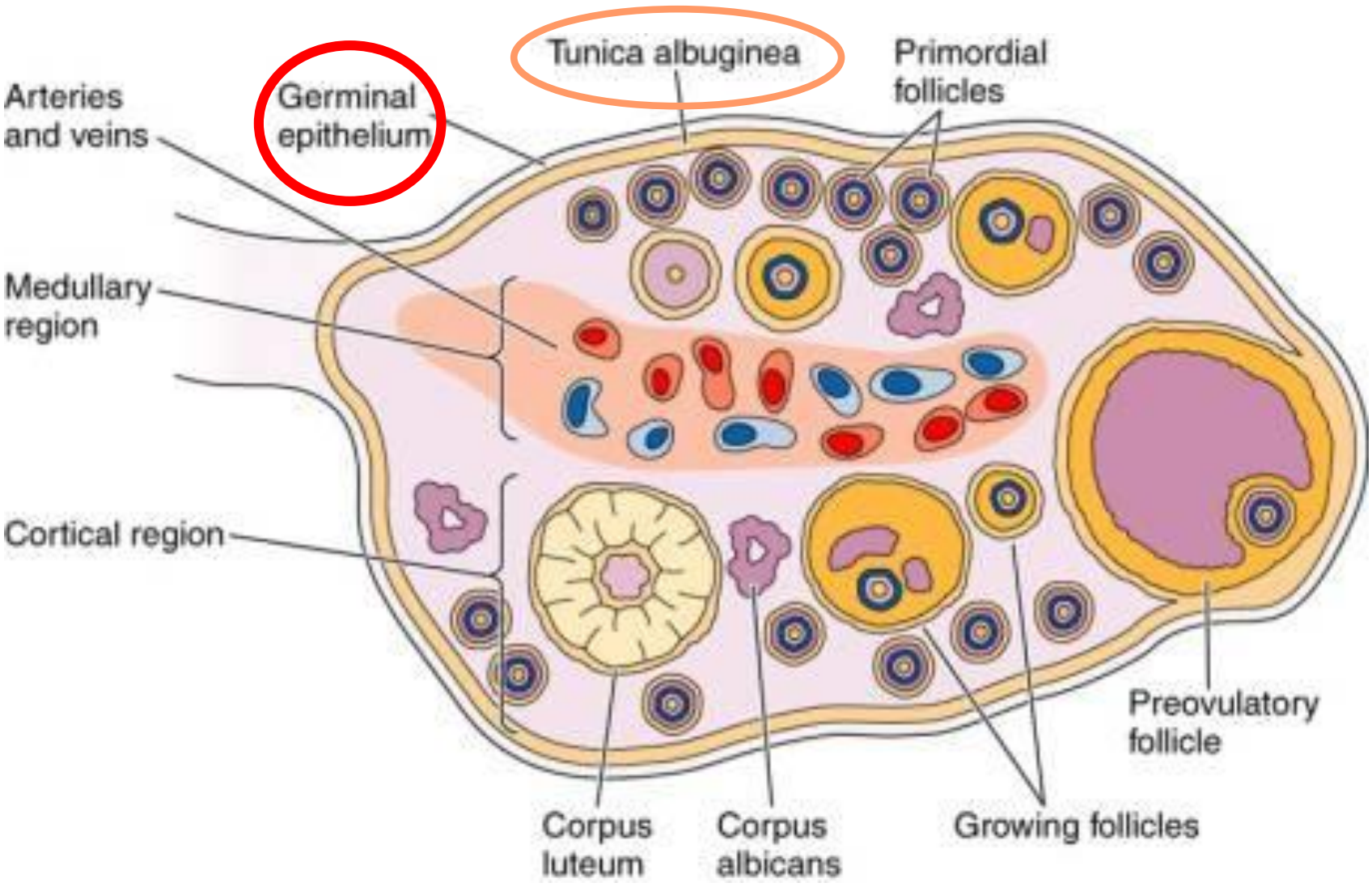




The ovary, or female gonad, is:

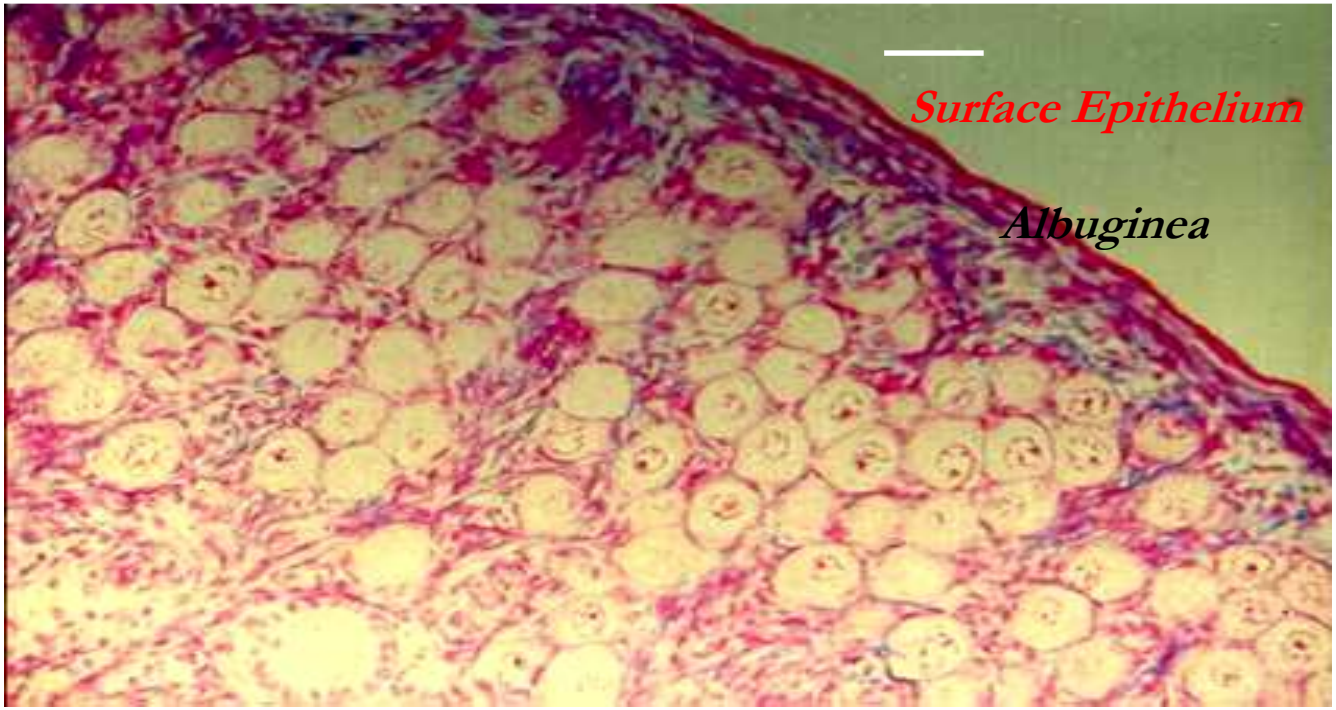
1. an exocrine gland, producing oocytes
2. an endocrine gland, secreting hormones, i.e., estrogen and progesterone

OVARY


Tunica albuginea
Primordial follicles
Arteries and veins
Germinal epithelium
Medullary region
Cortical region
Preovulatory follicle
Corpus luteum
Corpus albicans
Growing follicles

OVARY

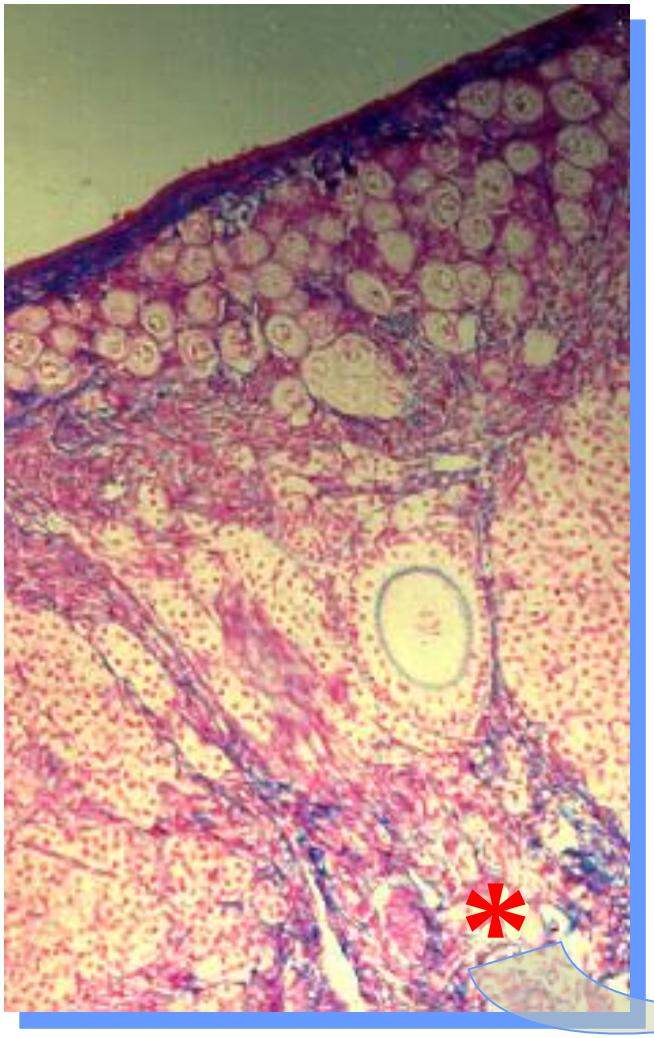
The surface of the ovary is covered with *surface epithelium*, a simple epithelium which changes from squamous to cuboidal with age.



Immediately beneath this surface epithelium there is a dense connective tissue sheath, the *tunica albuginea ovarii*

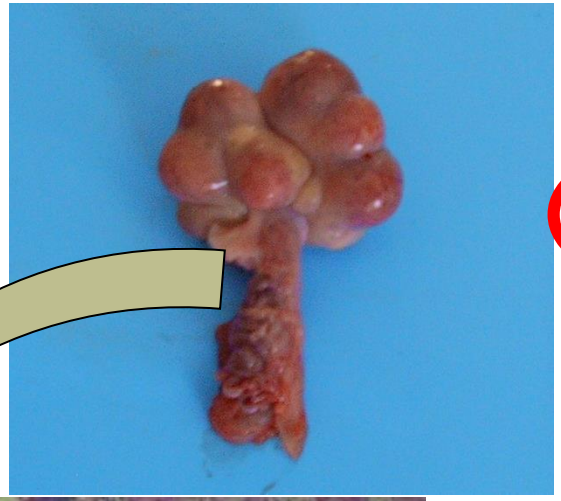
OVARY:

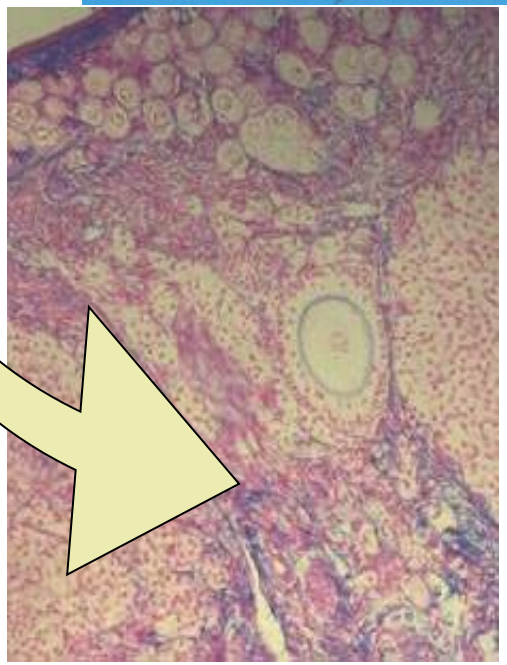
*MEDULLA

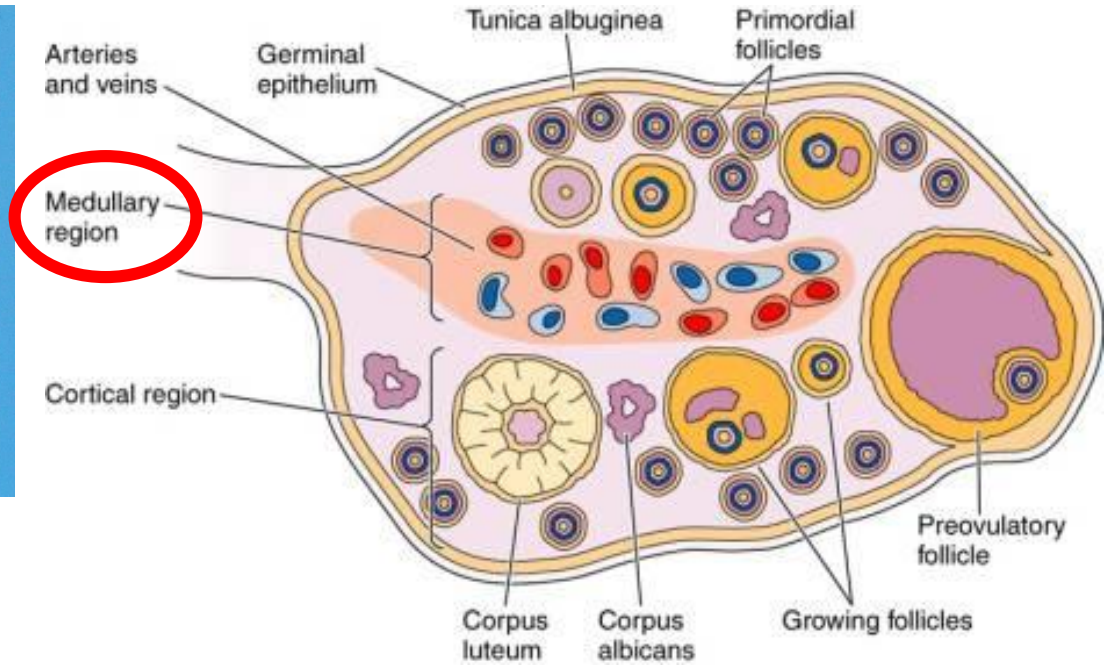


The **medulla** is composed of loose areolar connective tissue containing numerous elastic and reticular fibers, large blood vessels, nerves and lymphatics.

OVARY: HILUS

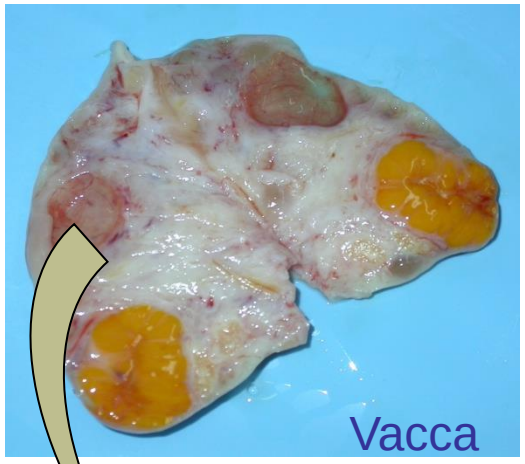




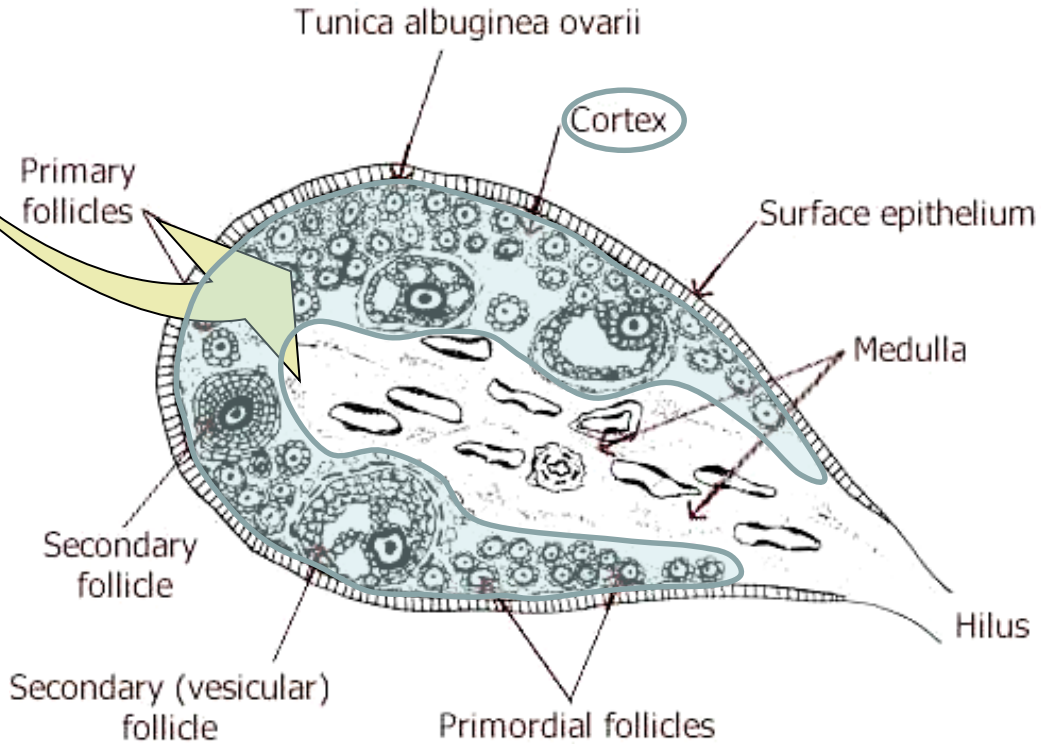


The **hilus** is the region through which blood vessels, lymphatics and nerves enter and leave the ovary. It is contiguous with and histologically similar to the medulla.

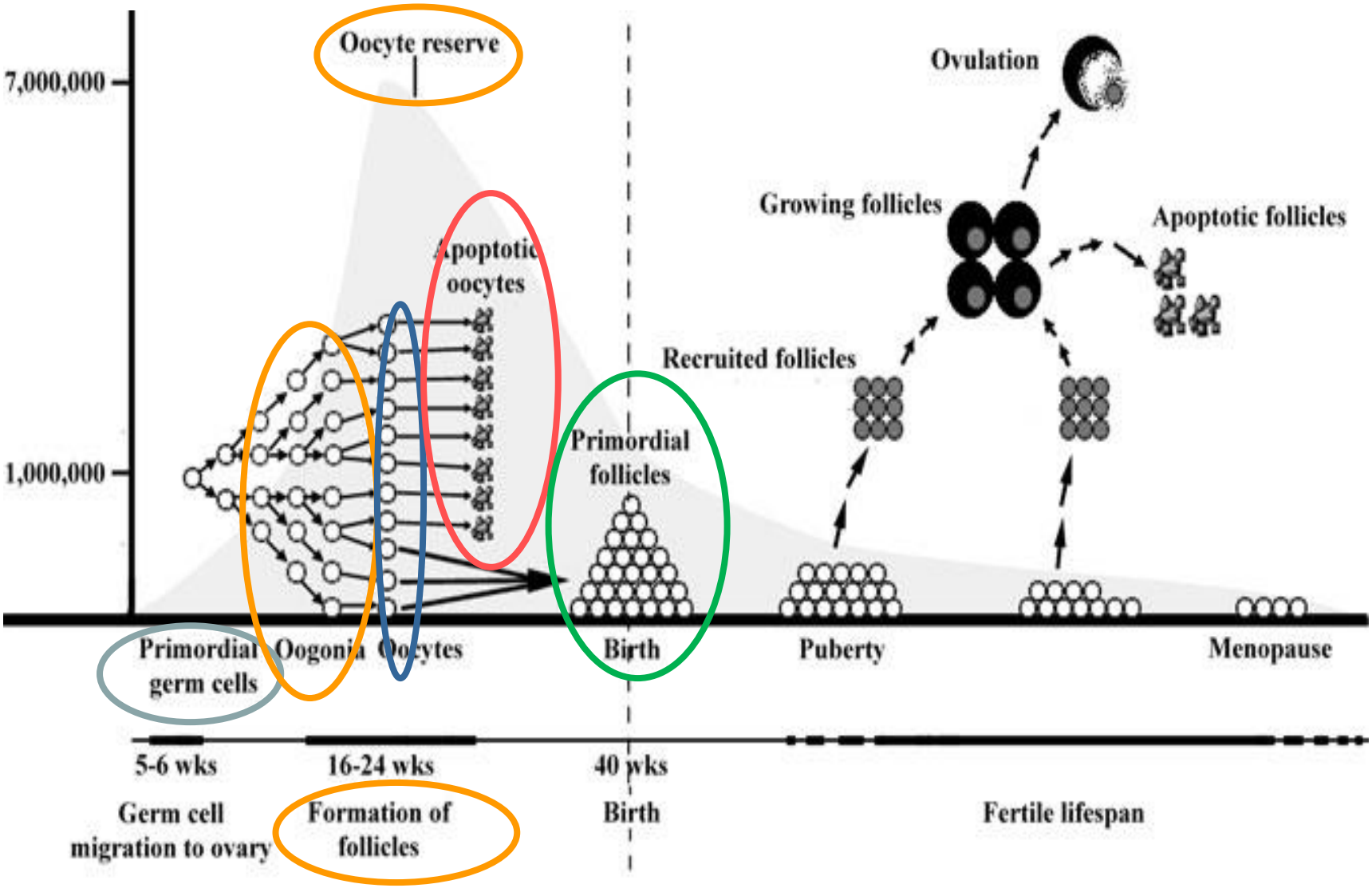
OVARY: CORTEX



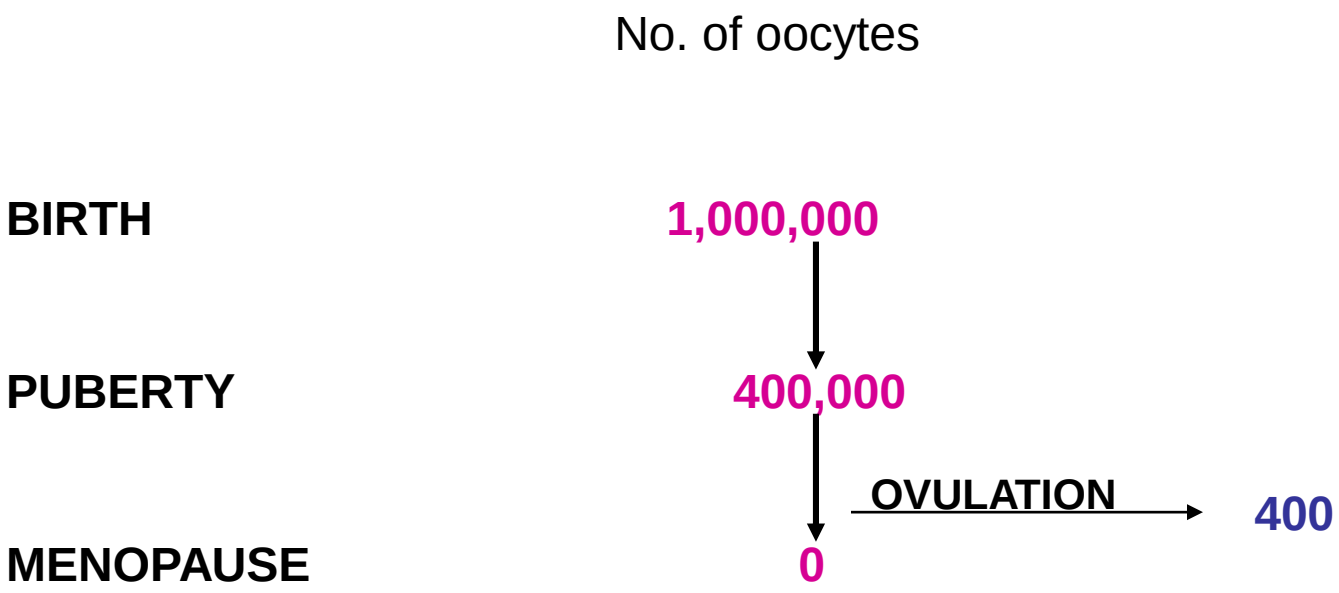
The cortex is composed of ovarian follicles, and stromal elements.
The cortex also contains atretic follicles



OVARY: OOGENESIS



ATRESIA IN HUMAN OVARY



OVARIAN FOLLICLES

PRIMORDIAL FOLLICLES

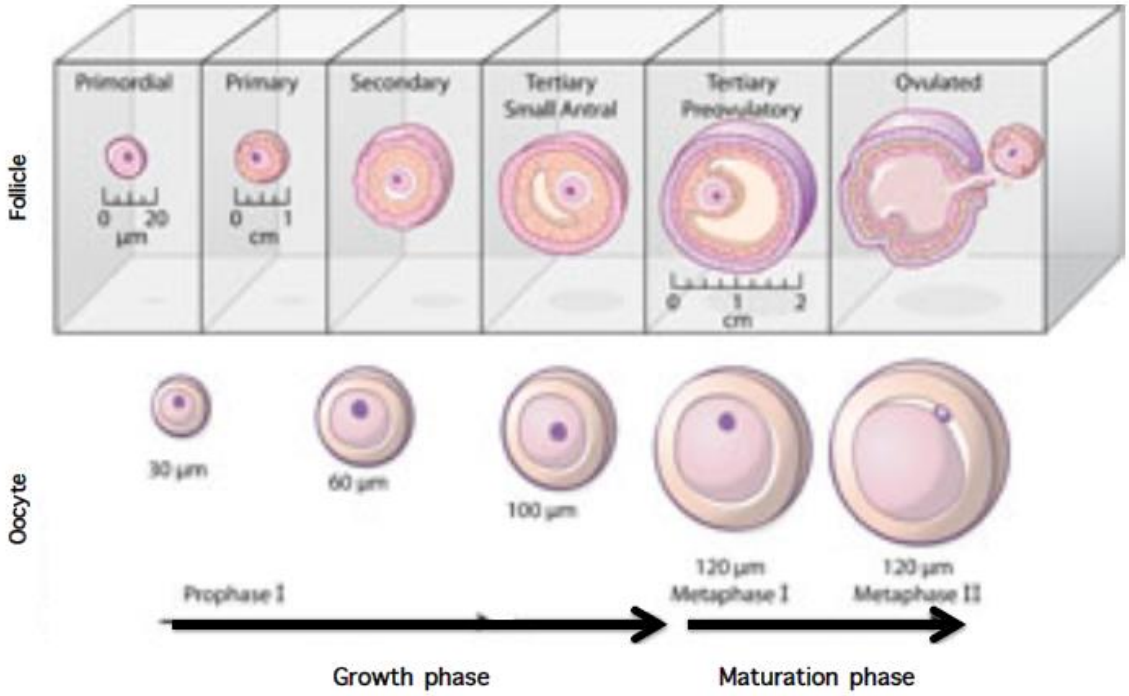
PRIMARY FOLLICLES

SECONDARY or PREANTRAL FOLLICLES

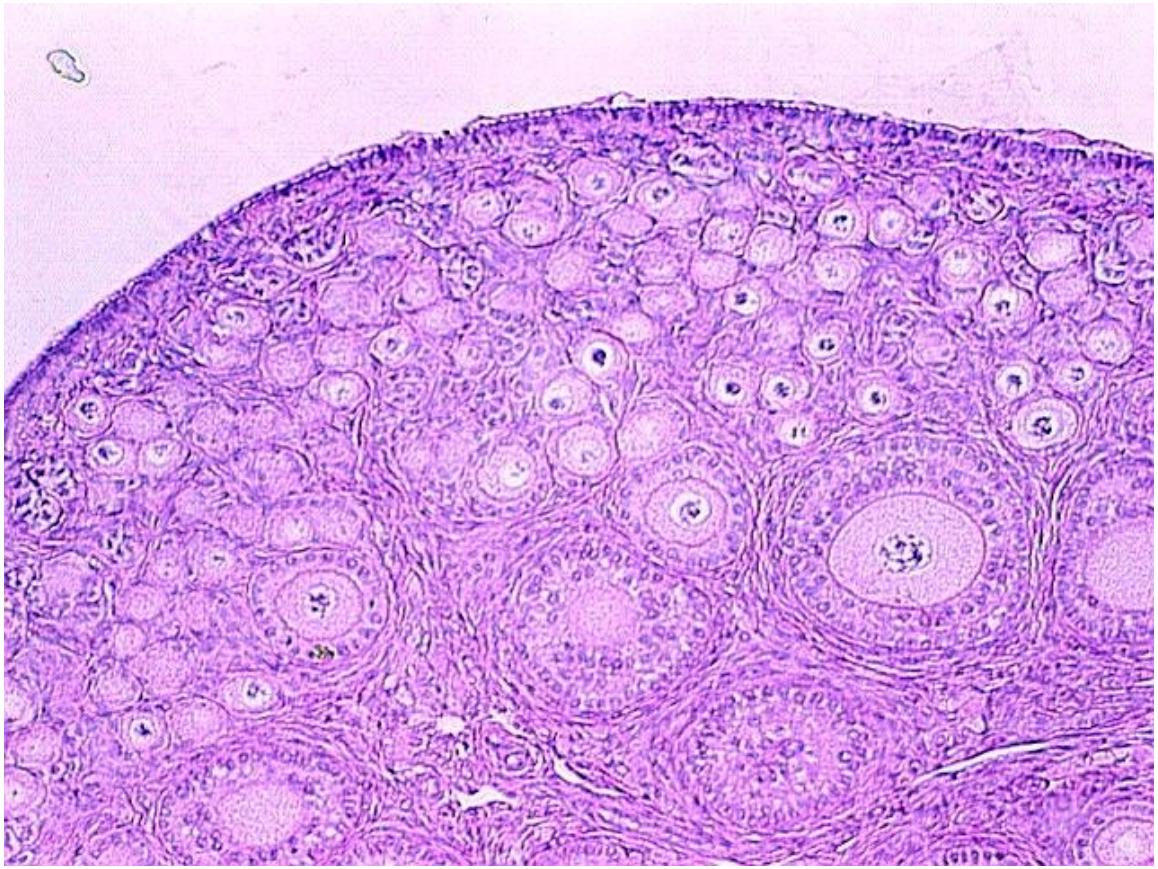
TERTIARY - EARLY ANTRAL

- ANTRAL FOLLICLES

(pre-ovulatory and peri-ovulatory antral follicles)

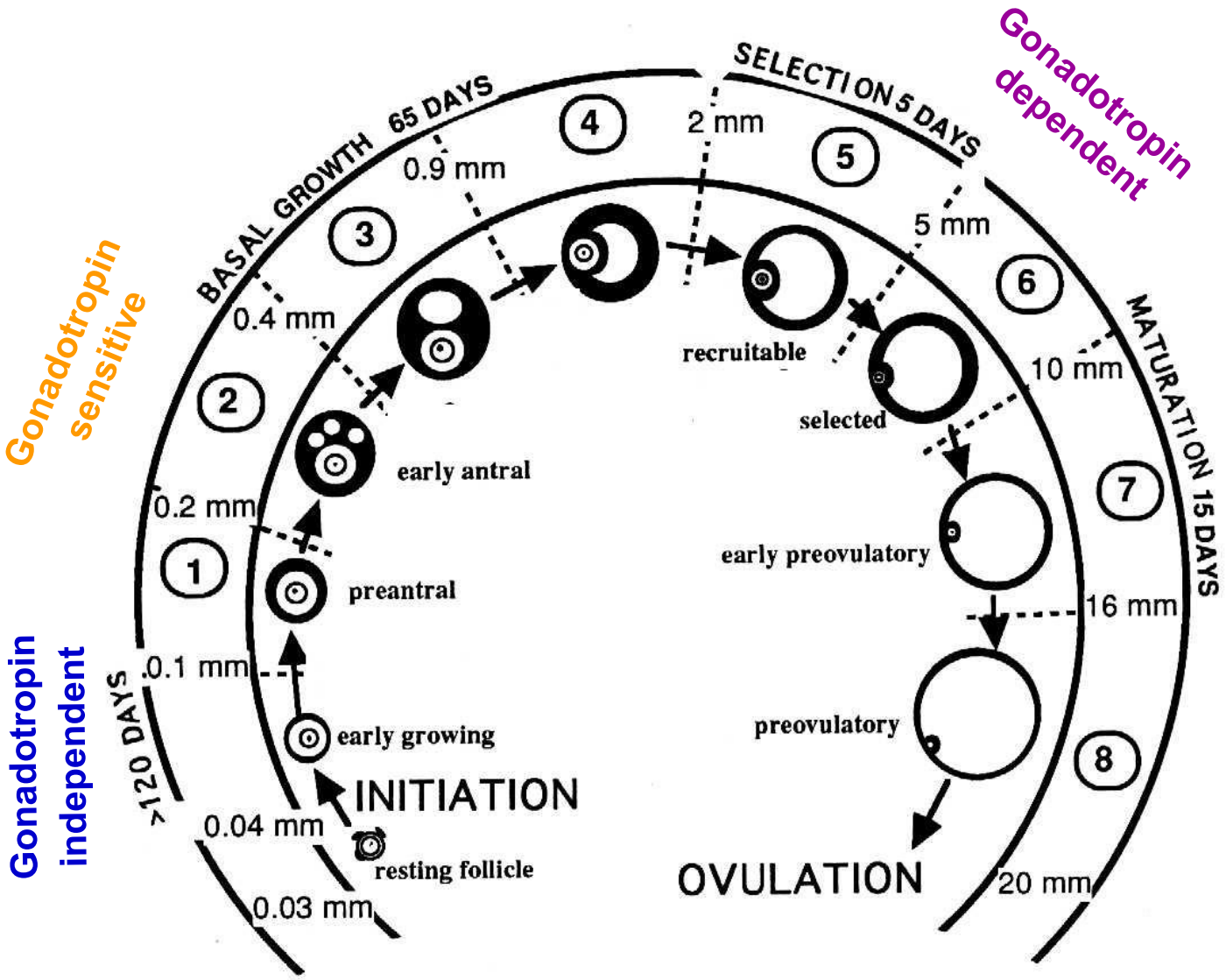

Follicle
Primordial
Primary
Secondary
Tertiary
Small Antral
Tertiary
Preovulatory
Ovulated
0 20
µm
0 1
cm
0 1 2
cm
Oocyte
30 µm
60 µm
100 µm
120 µm
Metaphase I
120 µm
Metaphase II
Prophase I
Growth phase
Maturation phase

OVARIAN FOLLICLES



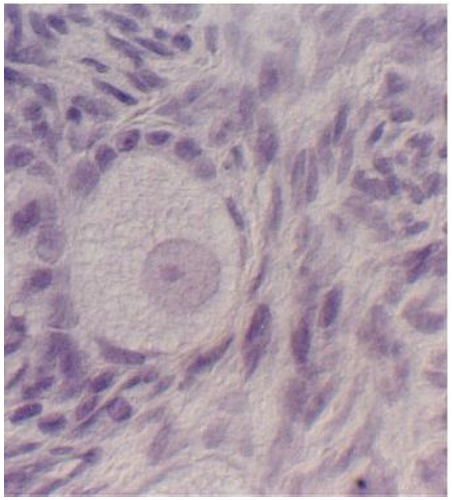
In ovarian follicles there are primary oocytes arrested in prophase of Meiosis I

FOLLICULOGENESIS

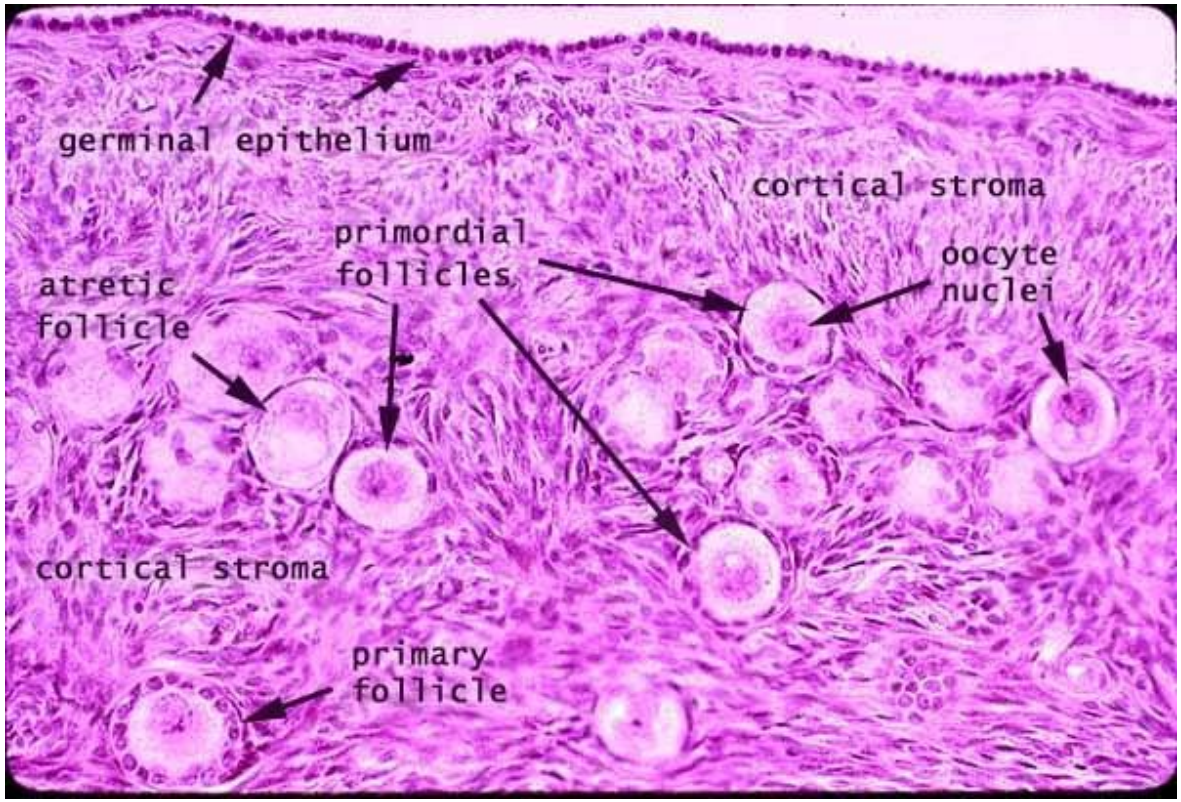


Follicular Growth

PRIMORDIAL FOLLICLES

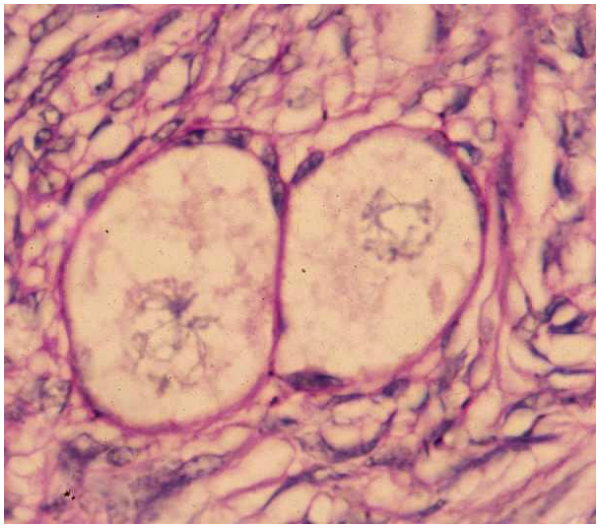


The primary oocyte is surrounded by a single layer of flattened cells called follicular cells.



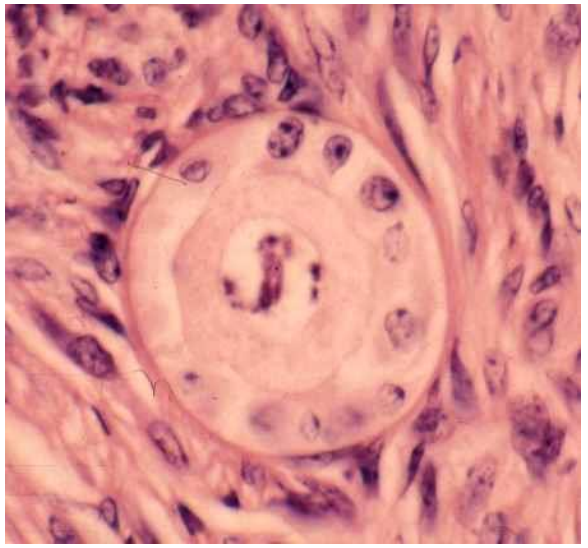
FOLLICLE GROWTH INITIATION

PRIMORDIAL FOLLICLE



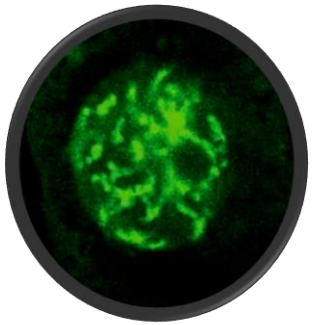
quiescent
resting
non-growing

PRIMARY FOLLICLE



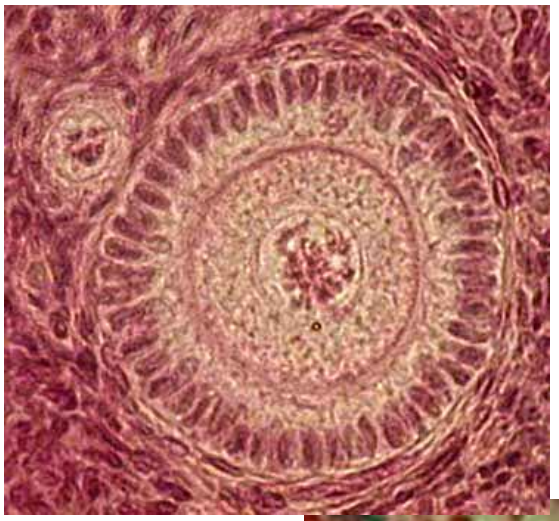
growing

PRIMARY FOLLICLES

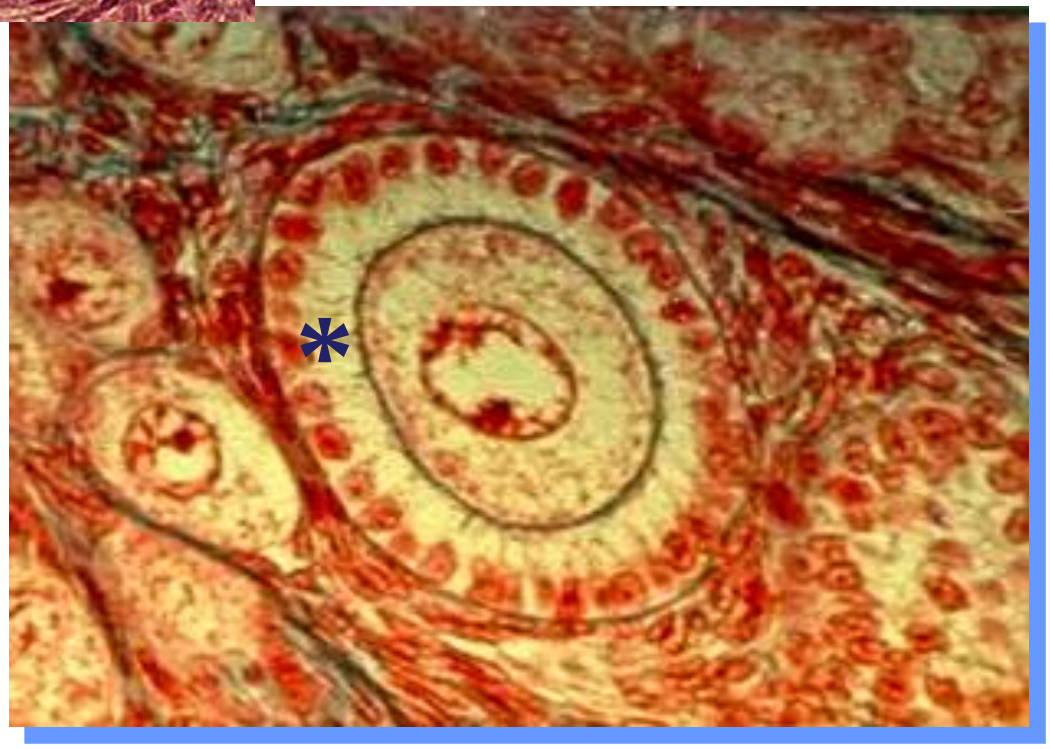


GV

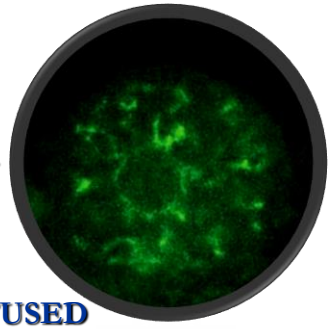
DIFFUSED CHROMATIN



The primary oocyte and its nucleus grow in diameter. The nucleus of the oocyte can now be called germinal vesclicle (GV). The follicular cells are now cuboidal and are referred to as *granulosa cells.



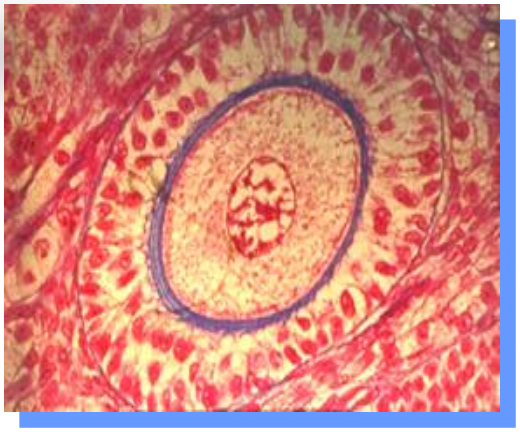
SECONDARY or PREANTRAL FOLLICLES



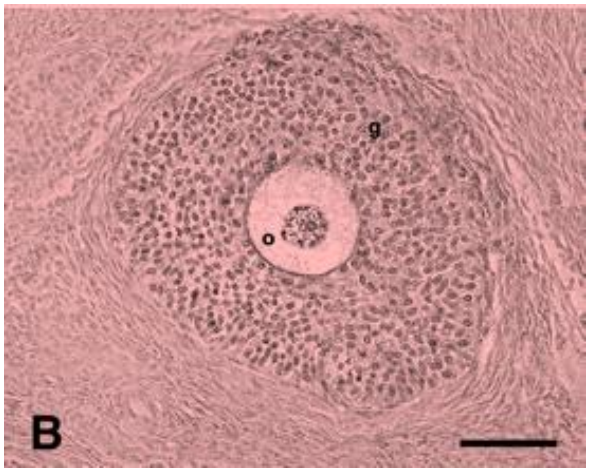
GV

DIFFUSED CHROMATIN

Granulosa cells proliferate.
The *zona pellucida* forms between the primary oocyte and the membrana granulosa. It is a glycoprotein layer secreted by both the oocyte and the granulosa cells. This latter ones send cytoplasmic projections within the oocyte and comunicate through *gap junctions*.

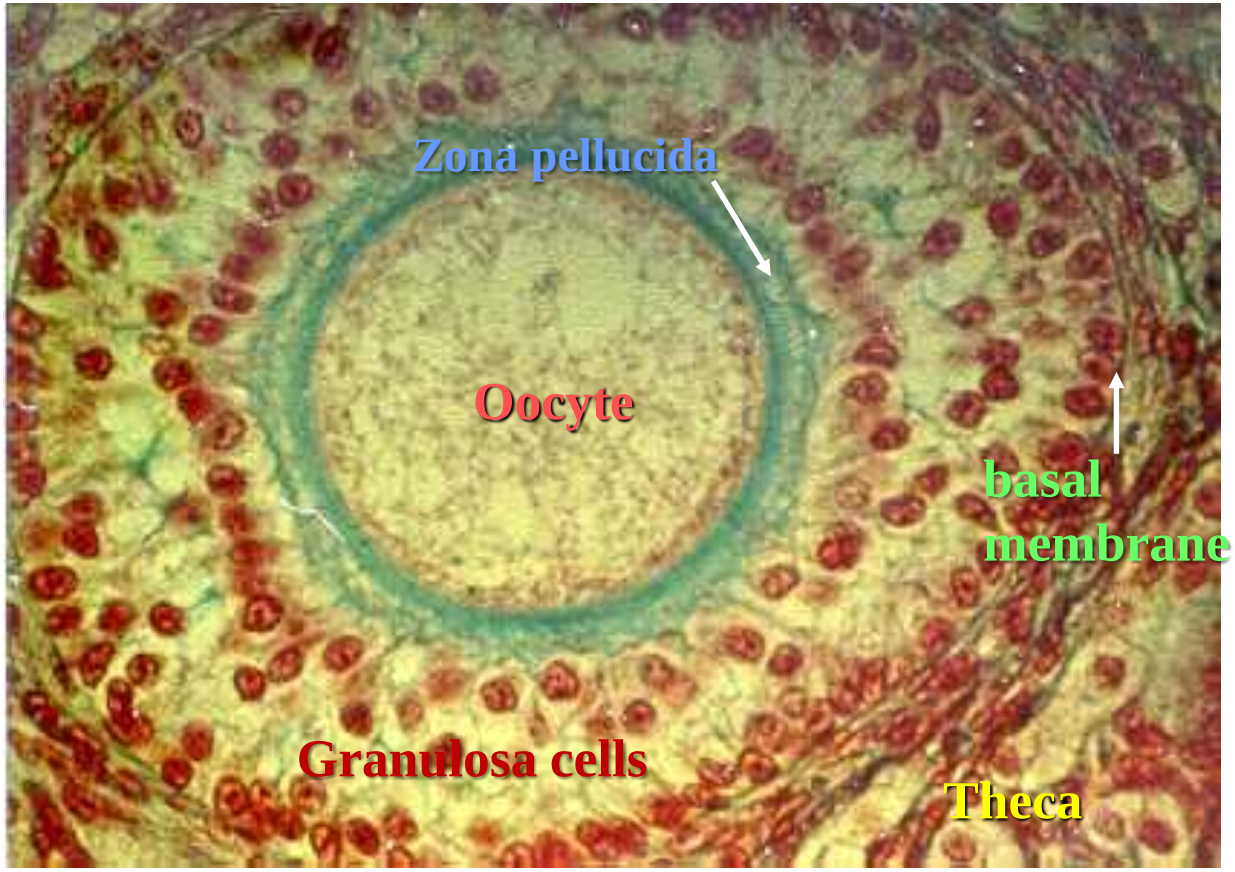


Small preantral



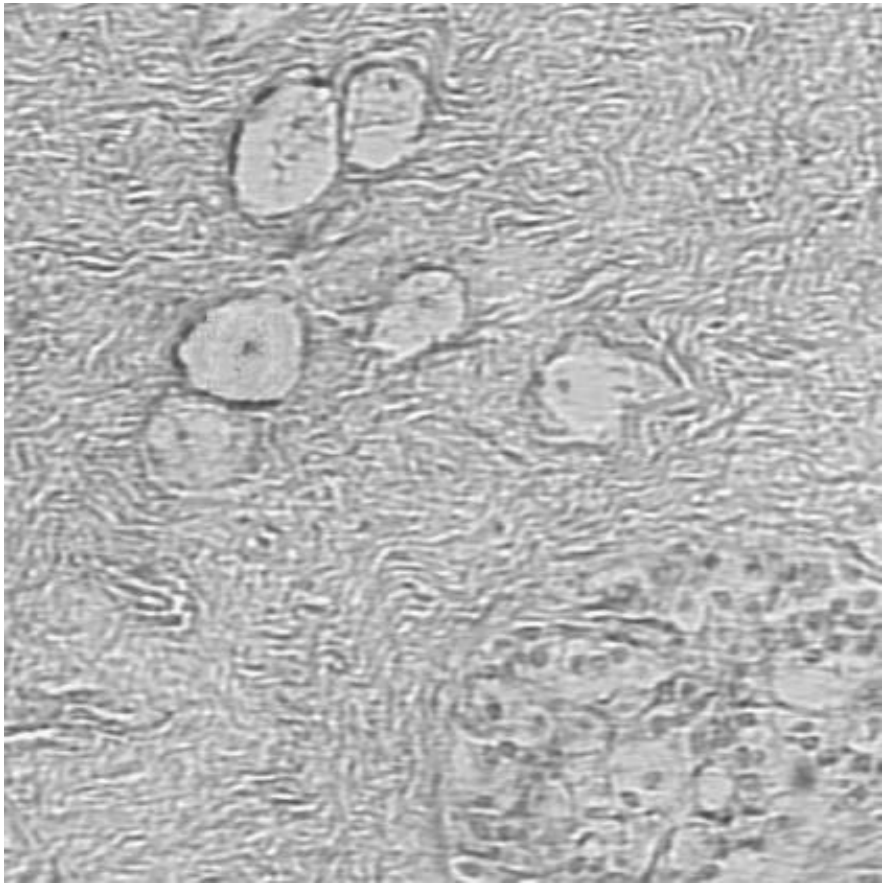
Large preantral

SECONDARY or PREANTRAL FOLLICLES

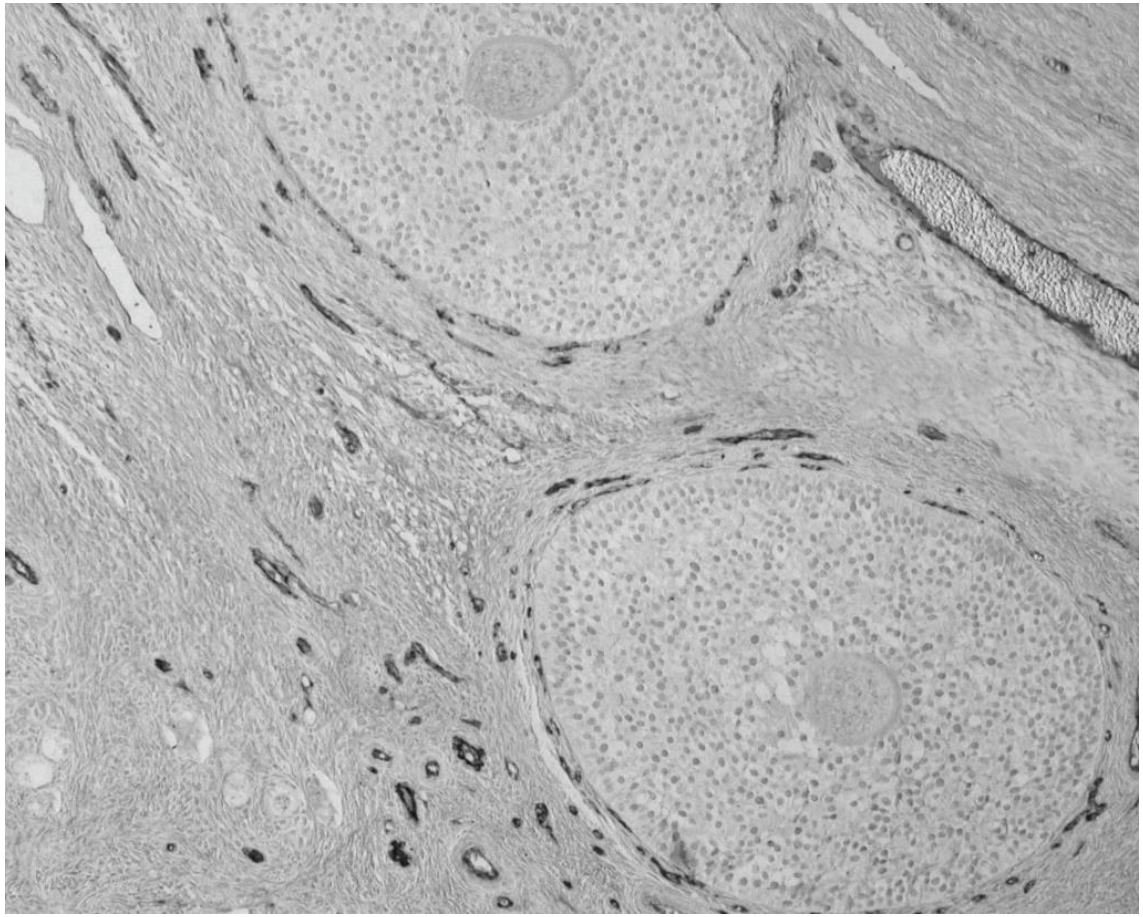


Stromal cells develop around the follicle forming the theca layer.
The theca layer is divided in: the *theca interna* and the *theca externa*.
Theca cells are separated from the membrana granulosa cells of the follicle by a *basement membrane*.

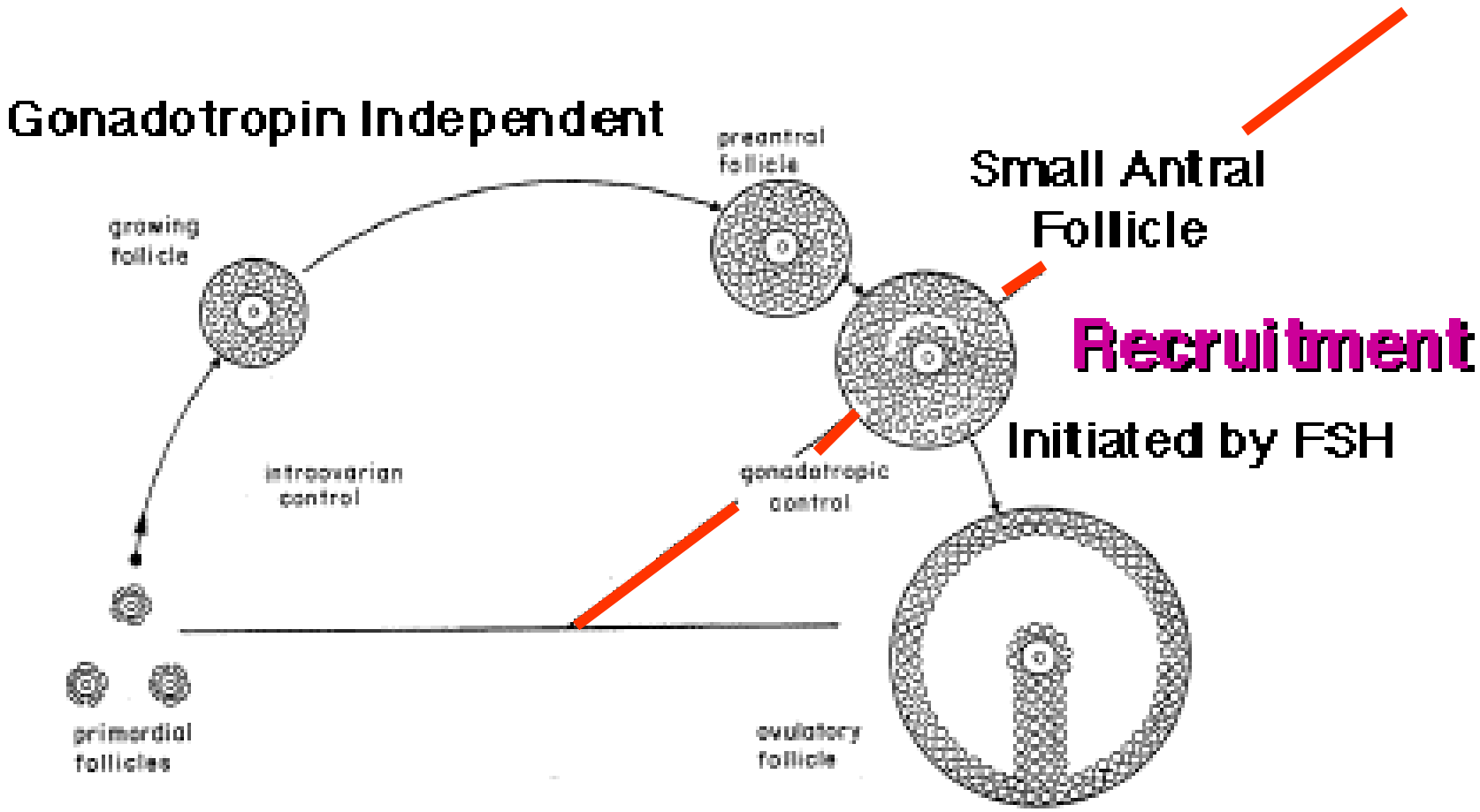
VASCULARIZATION IN
PRIMORDIAL, PRIMARY, AND SMALL PREANTRAL FOLLICLES



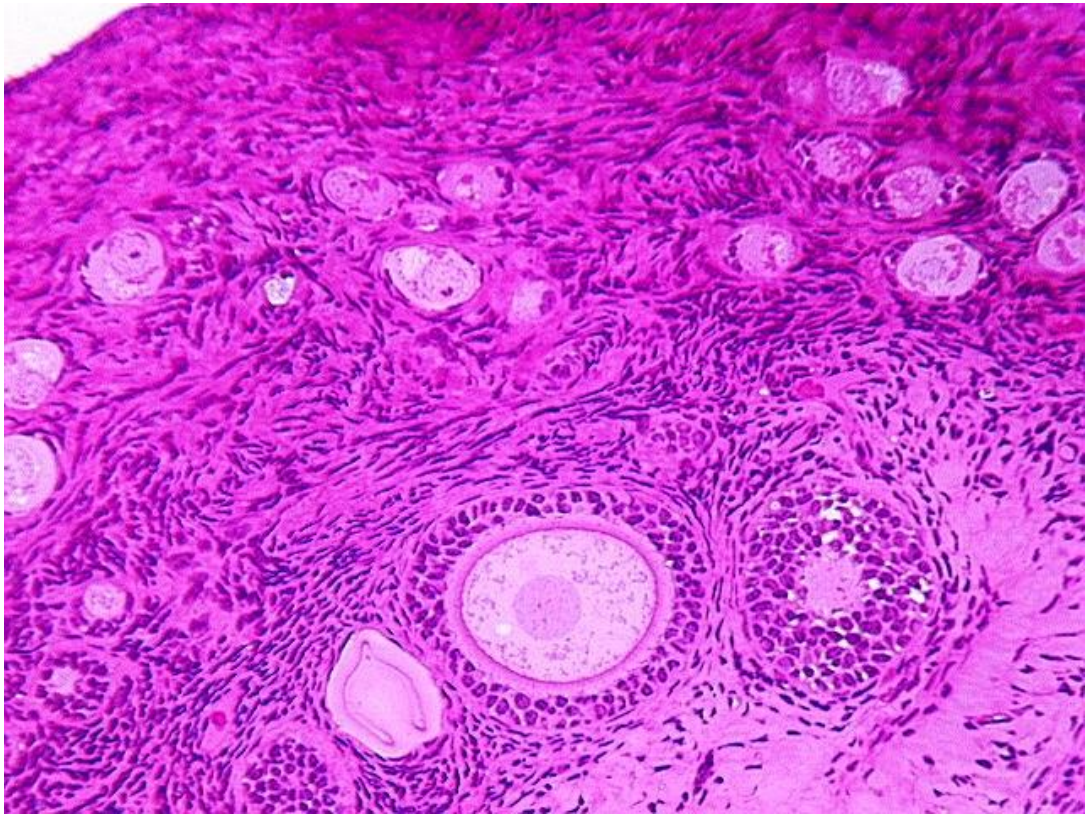
VASCULARIZATION IN
LARGE PREANTRAL FOLLICLES



Follicular Growth



SECONDARY or PREANTRAL FOLLICLE

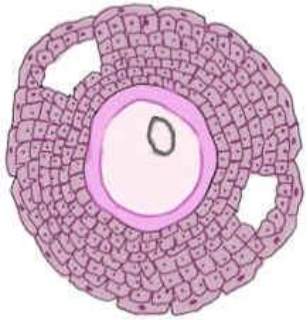


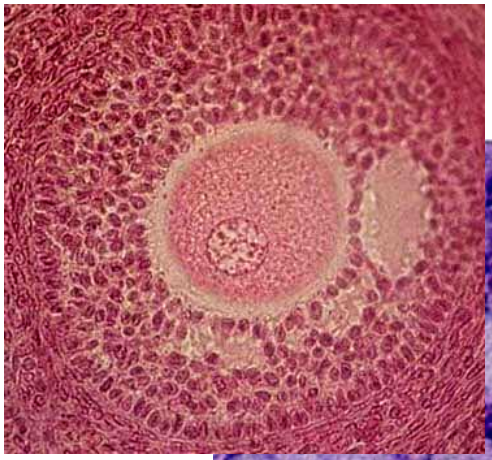
Follicular growth (granulosa cells proliferation) depends on FSH secretion

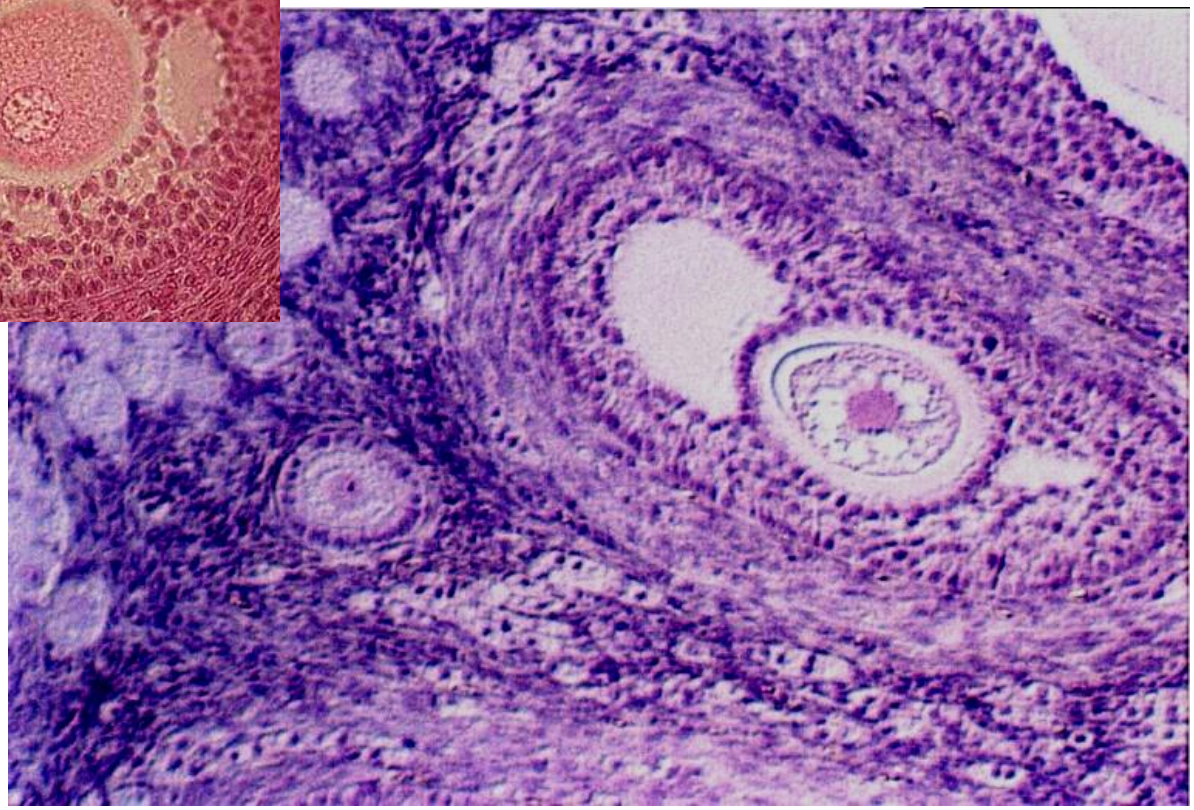
(follicle-stimulating hormone secreted by the pituitary gland).

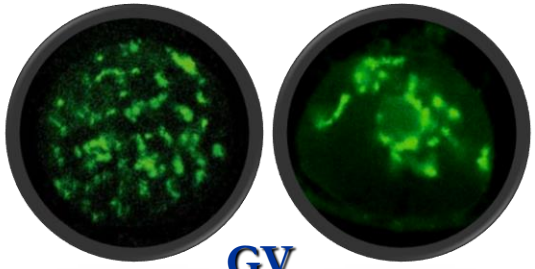
In preantral follicles several granulosa layers form around the oocyte.

TERTIARY EARLY ANTRAL FOLLICLES



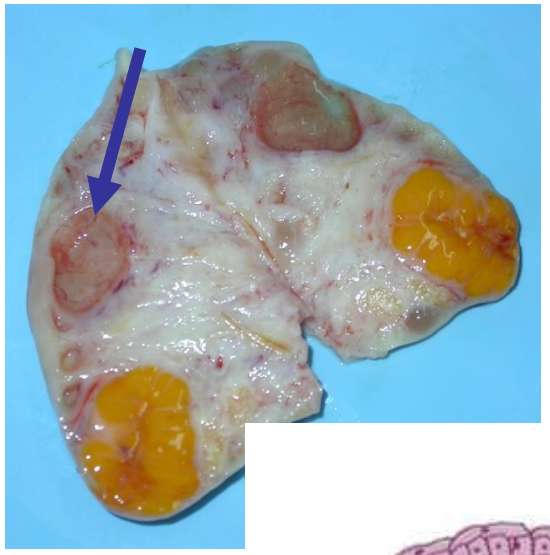


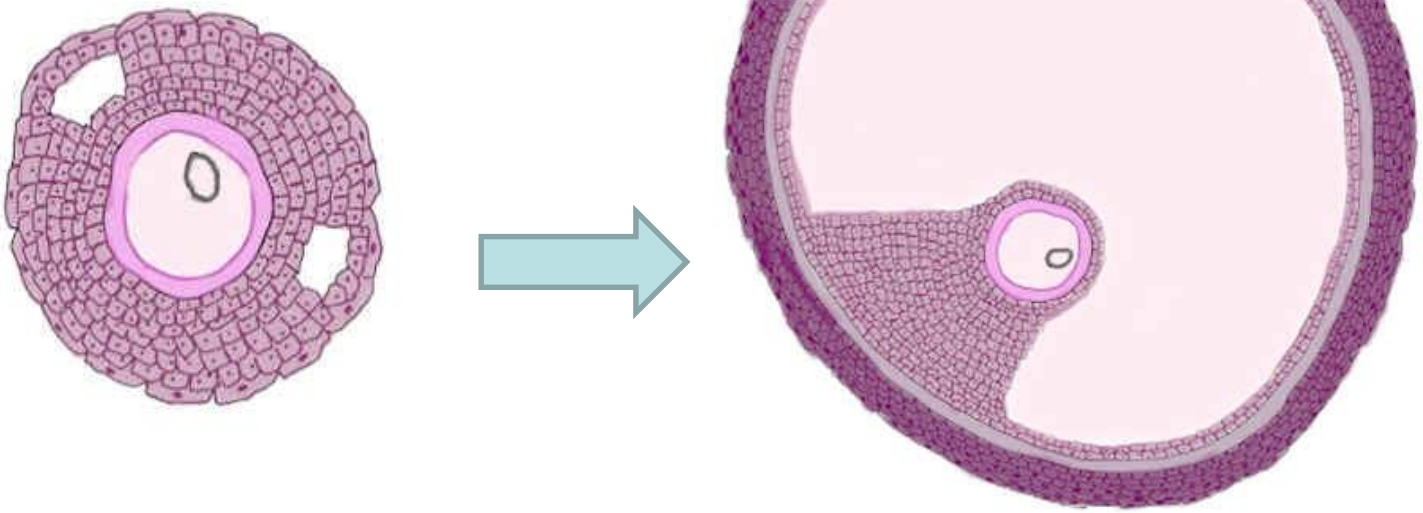




As the follicle grows pockets of follicular fluid within the membrana granulosa. The follicular fluid is a plasma exudate containg glycosaminoglycans and steroid binding proteins as well as hormones and molecules produced by granulosa cells and the oocyte.

TERTIARY or PREOVOLUTARY ANTRAL FOLLICLES

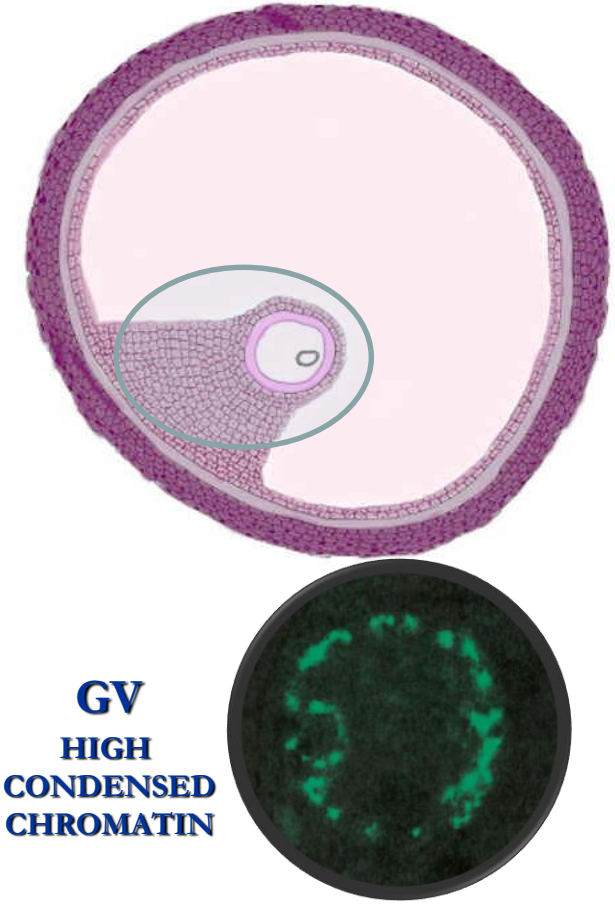




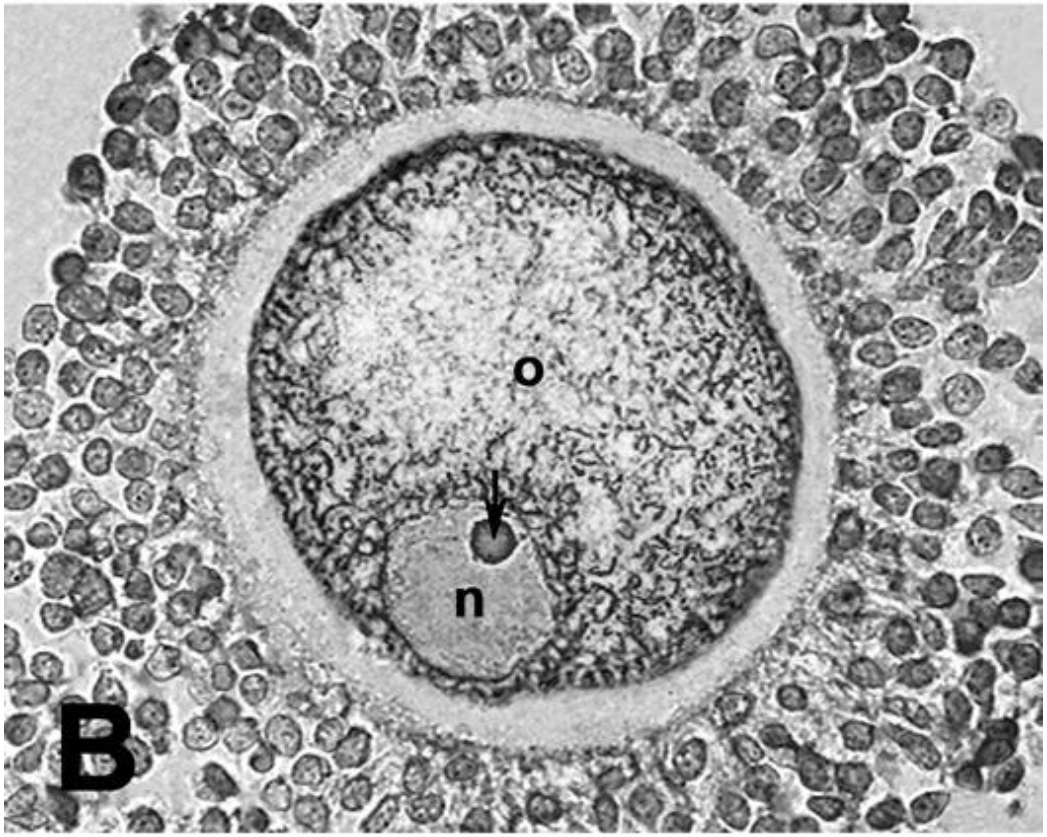
As the follicle continues to develop, the separated pockets fuse to form one large pocket of fluid called the *follicular antrum*.

TERTIARY or ANTRAL FOLLICLES

CUMULUS OOPHORUS



GV
HIGH CONDENSED CHROMATIN

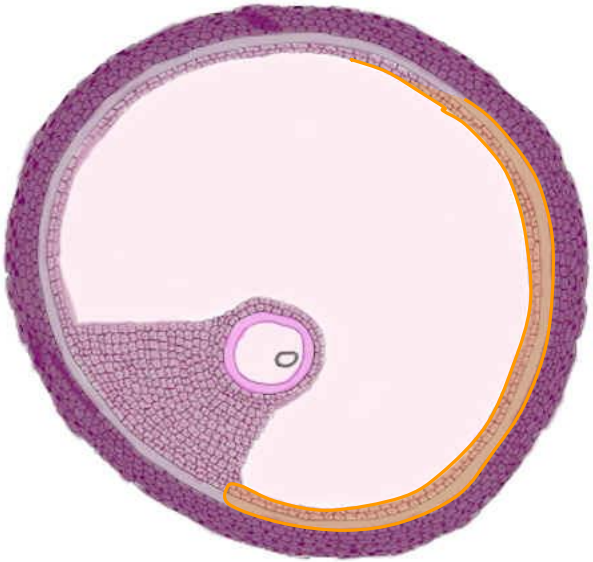


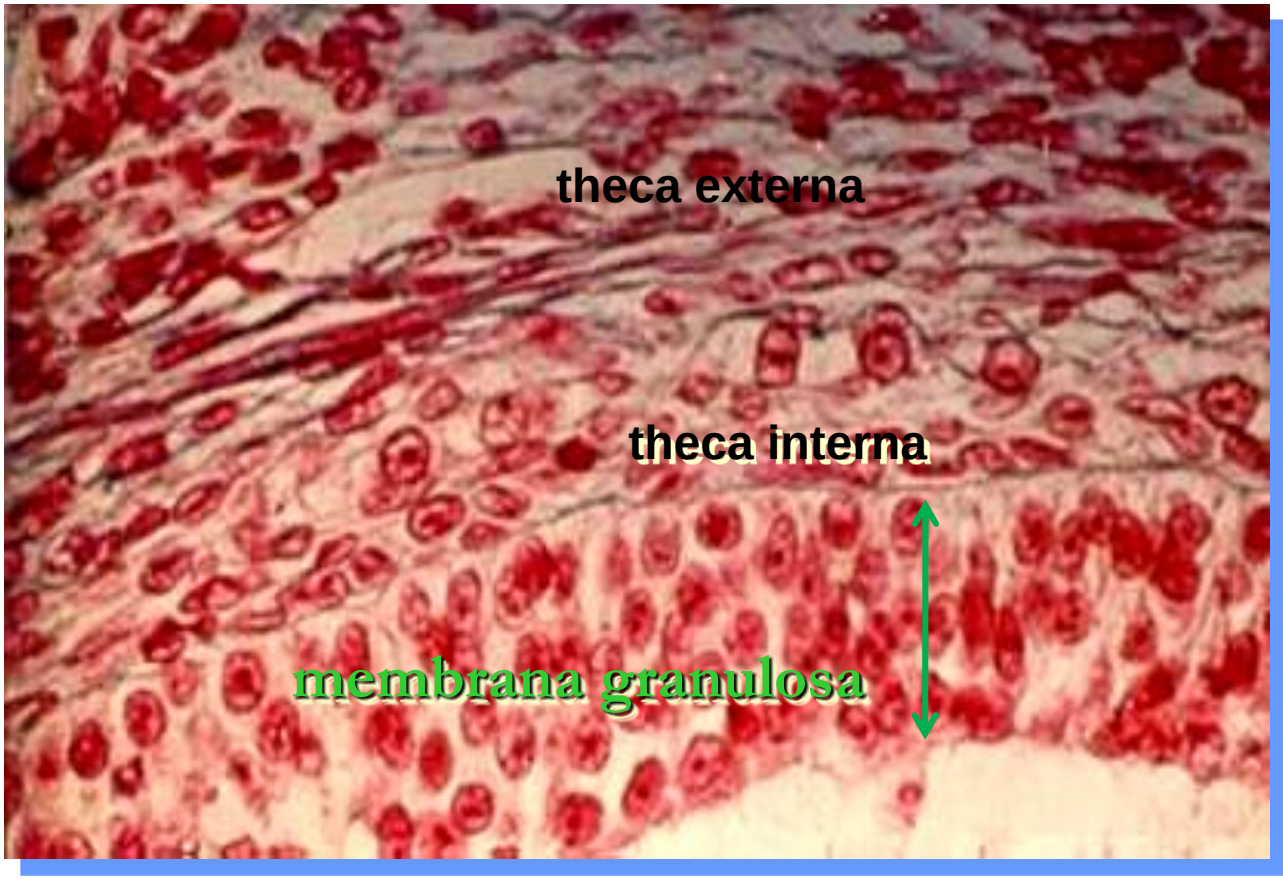
Granulosa cells that surround the oocyte form *the cumulus oophorus* which projects towards the antrum.

Cumulus oophorus cells which remain attached to the oocyte form the *corona radiata*

TERTIARY or ANTRAL FOLLICLES

MEMBRANA GRANULOSA

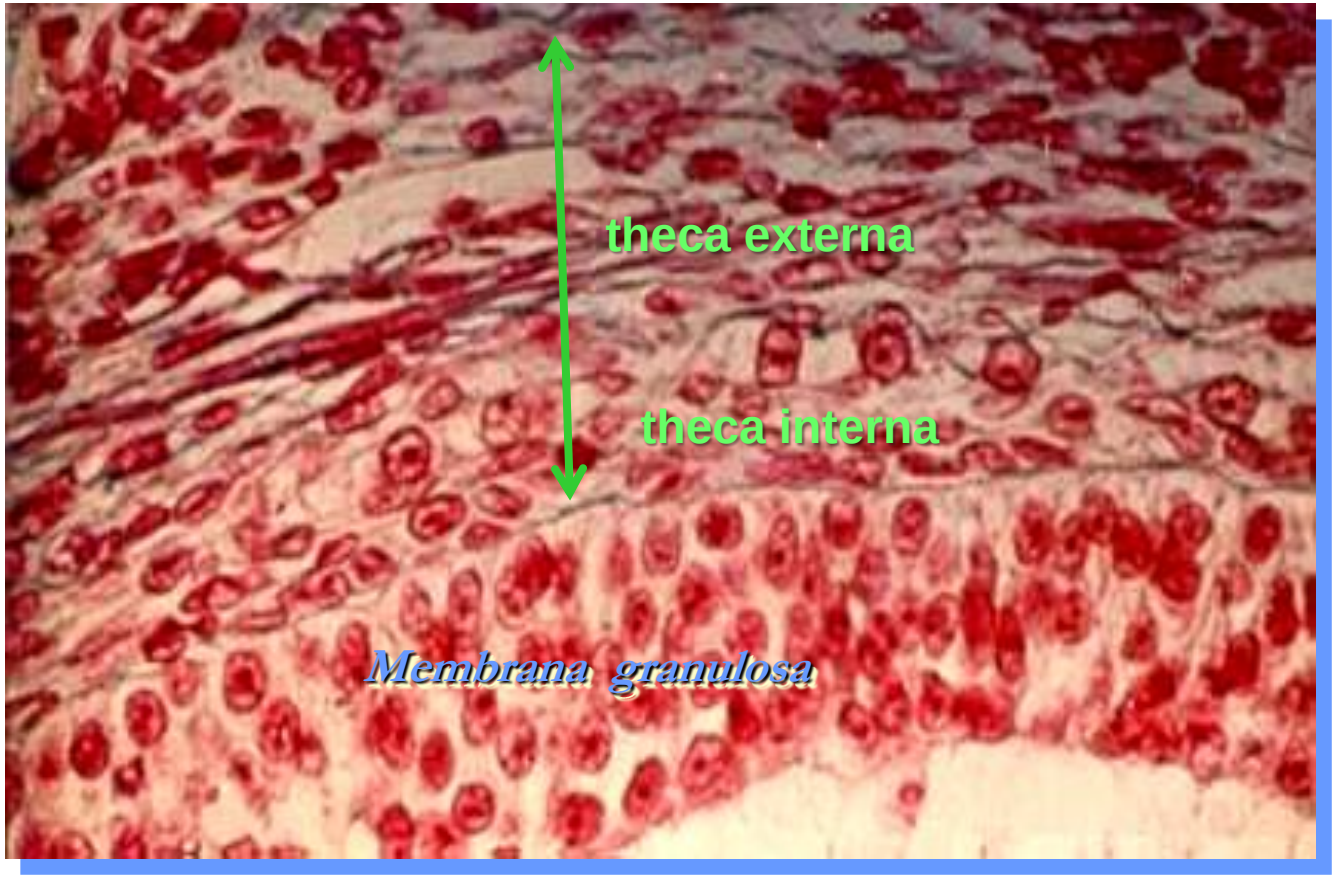




Granulosa cells that form a layer around the periphery of the follicle are the **membrana granulosa**

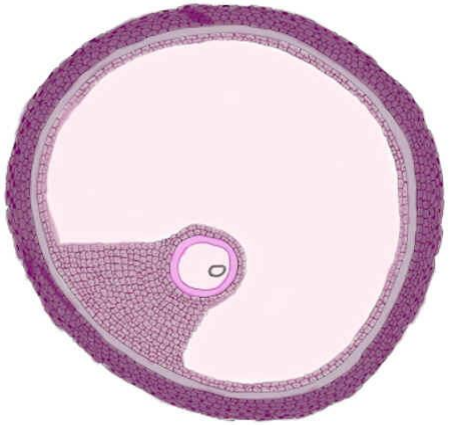
TERTIARY or ANTRAL FOLLICLES

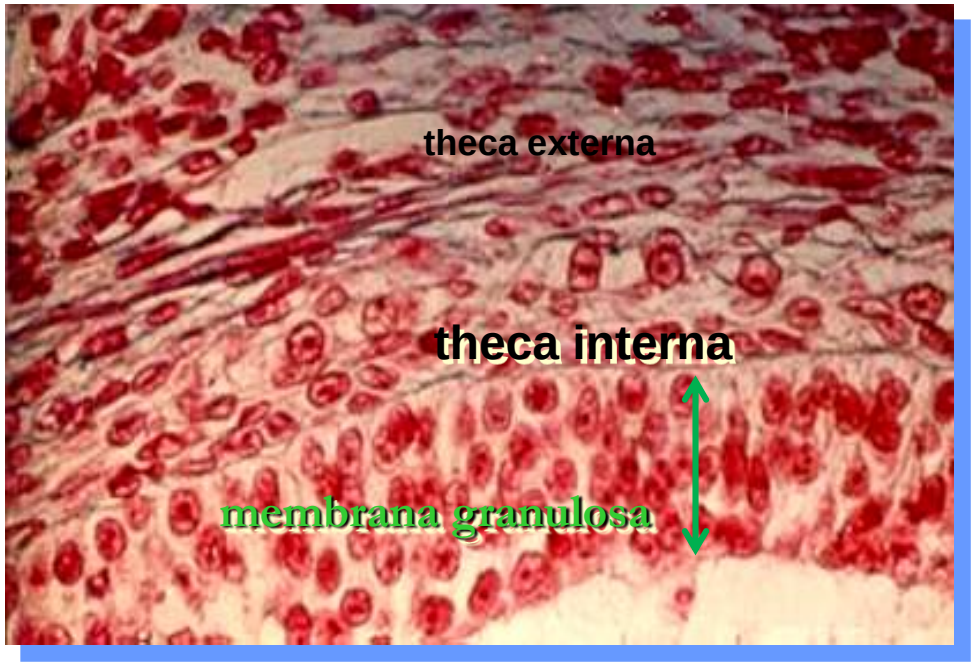
THECA



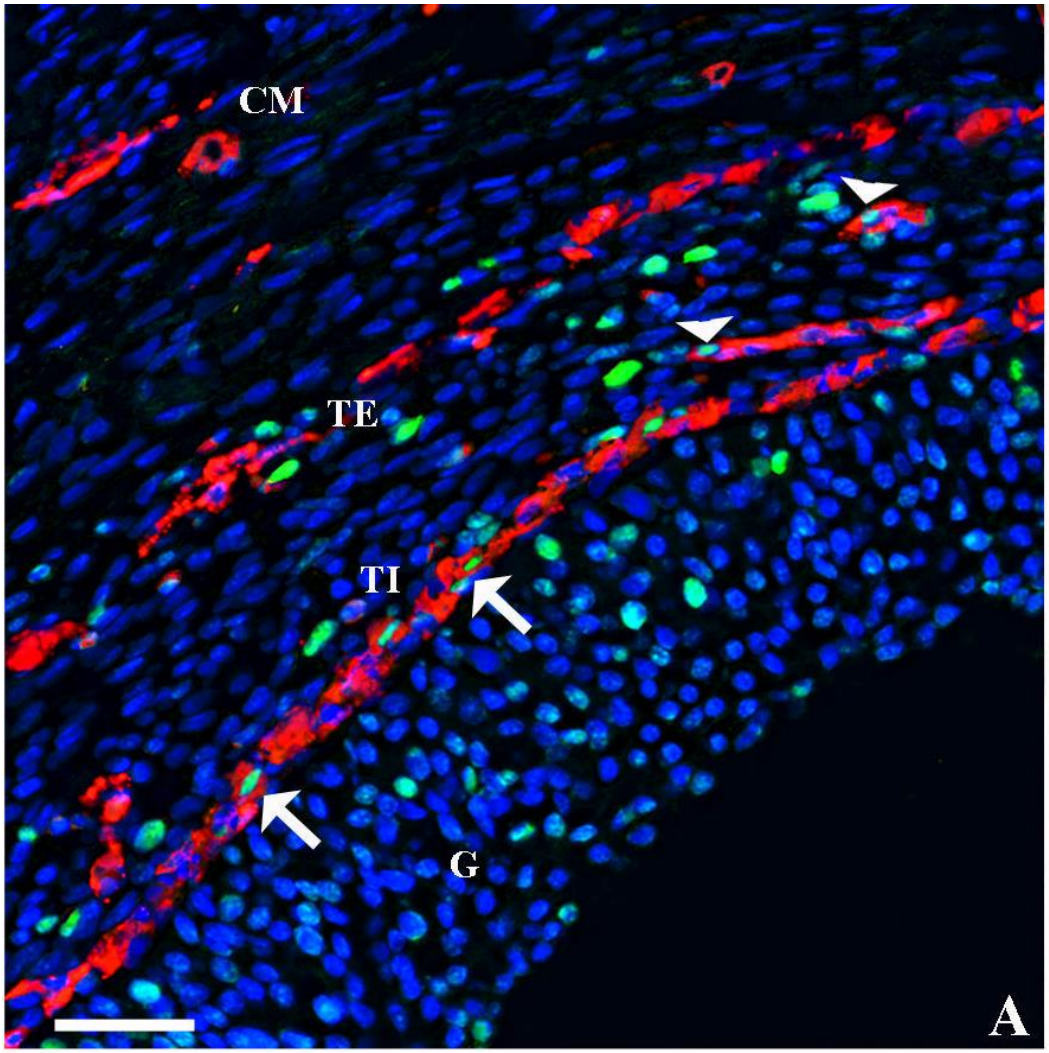
Also the theca interna and externa continue to grow.
Within the theca are present the blood vessels that will nourish the granulosa which is avascular.

TERTIARY or ANTRAL FOLLICLES





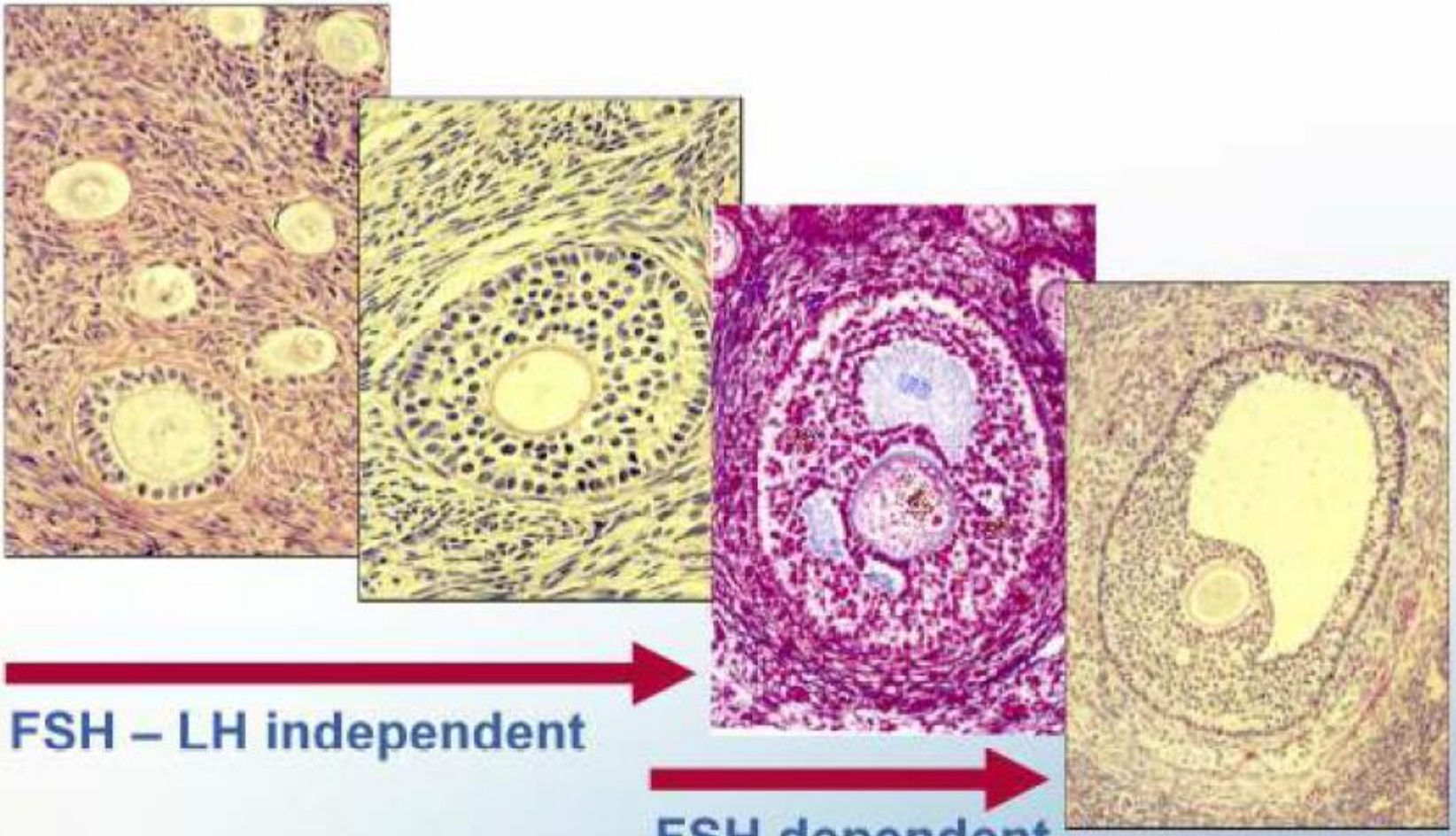
VASCULARIZATION IN
PREOVULATORY ANTRAL FOLLICLES



TERTIARY or ANTRAL FOLLICLES: transition from antral to dominant follicle

FSH receptors are expressed exclusively in granulosa cells

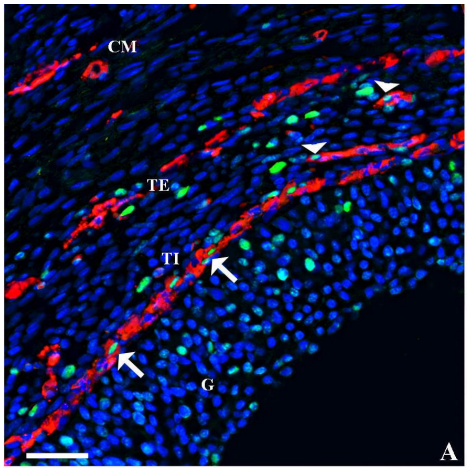
LH receptors are expressed exclusively in theca cells up to the stage of follicular dominance (Periovolutaory follicles), when they start to be expressed also in granulosa cells (initiated by FSH and estrogens).


FSH – LH independent
FSH dependent
LH dependent

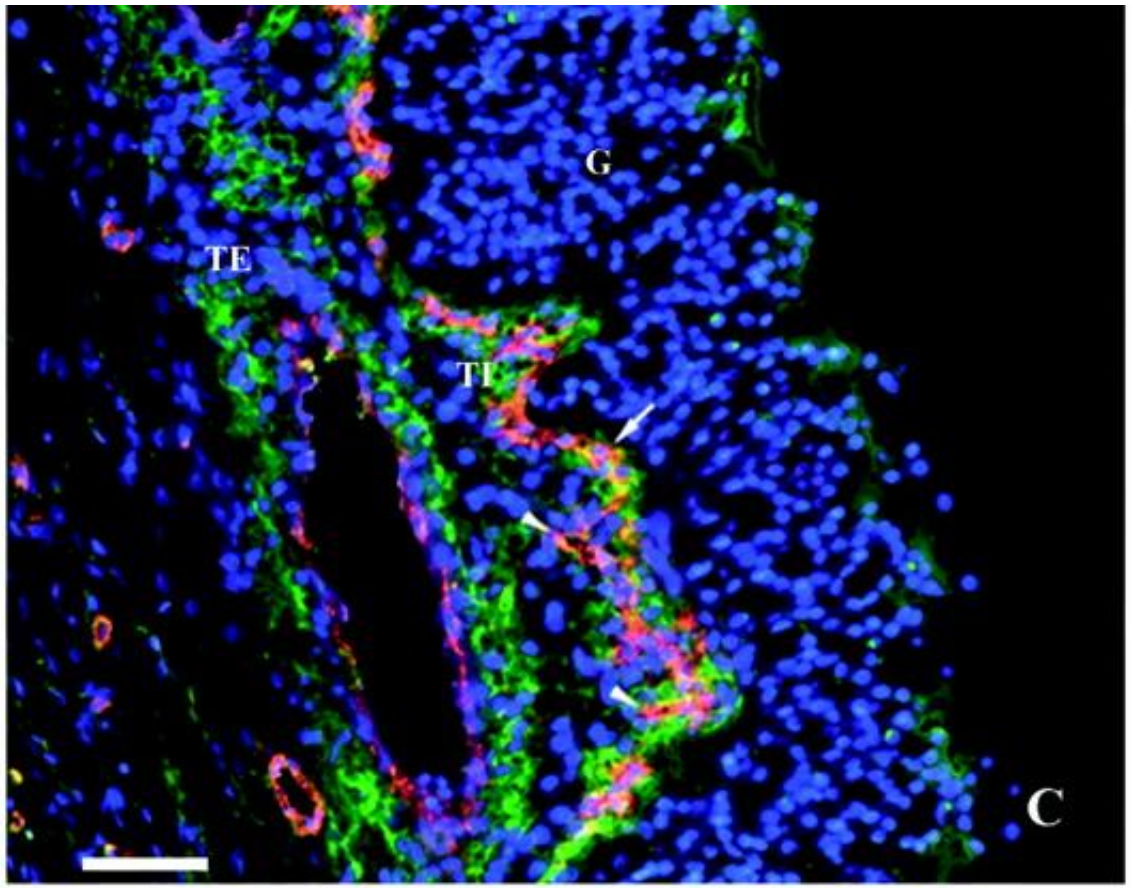
TERTIARY or ANTRAL FOLLICLES

PERIOVULATORY ANTRAL FOLLICLES

DOMINANT FOLLICLE



Follicular maturation

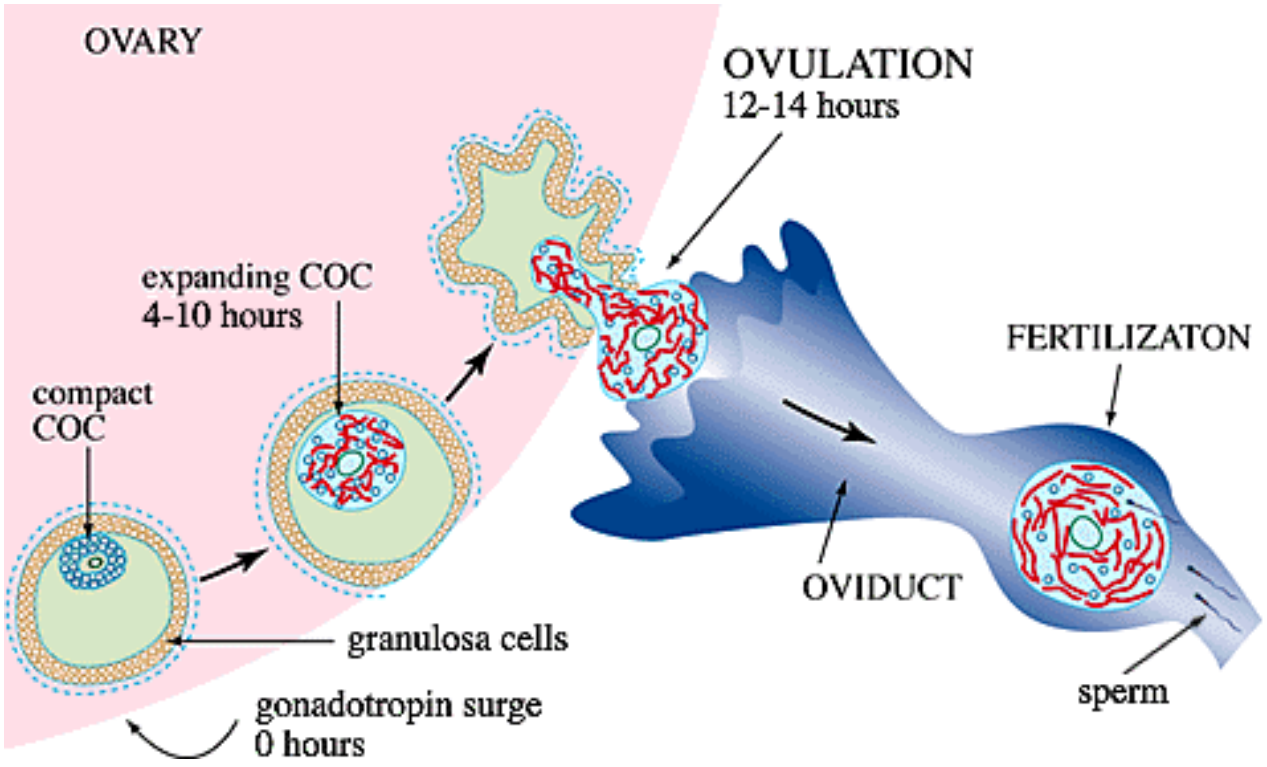


TERTIARY or ANTRAL FOLLICLES

PERIOVULATORY ANTRAL FOLLICLES

DOMINANT FOLLICLE

Cytoplamic oocyte maturation

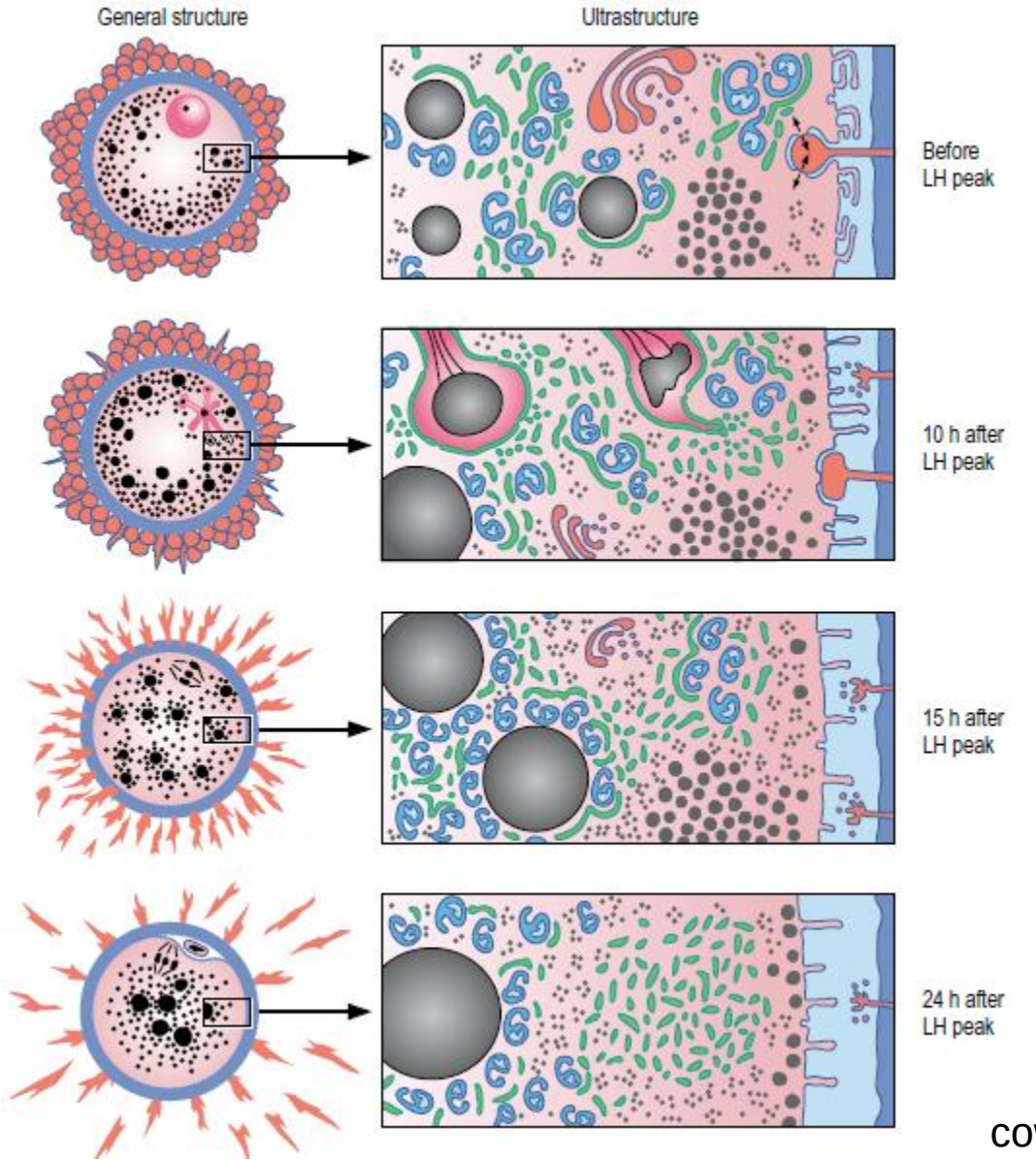


TERTIARY or ANTRAL FOLLICLES

PERIOVULATORY ANTRAL FOLLICLES

DOMINANT FOLLICLE

Cytoplamic oocyte maturation

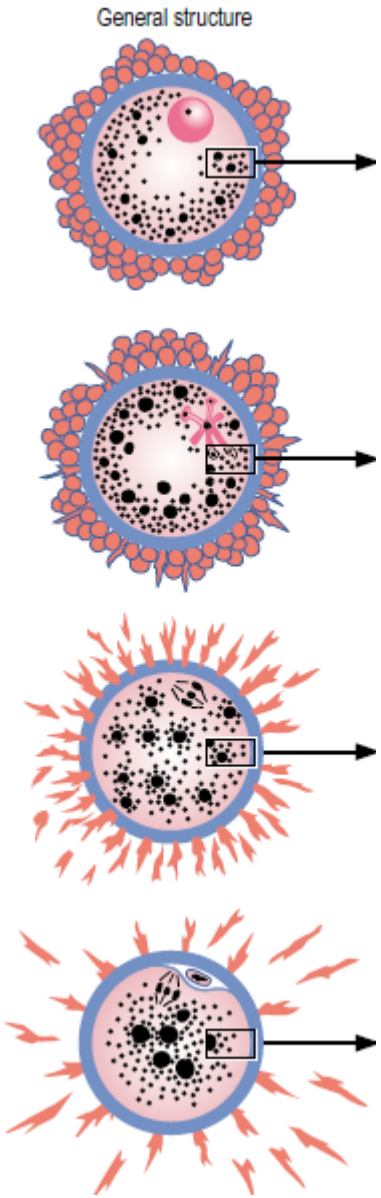


COW

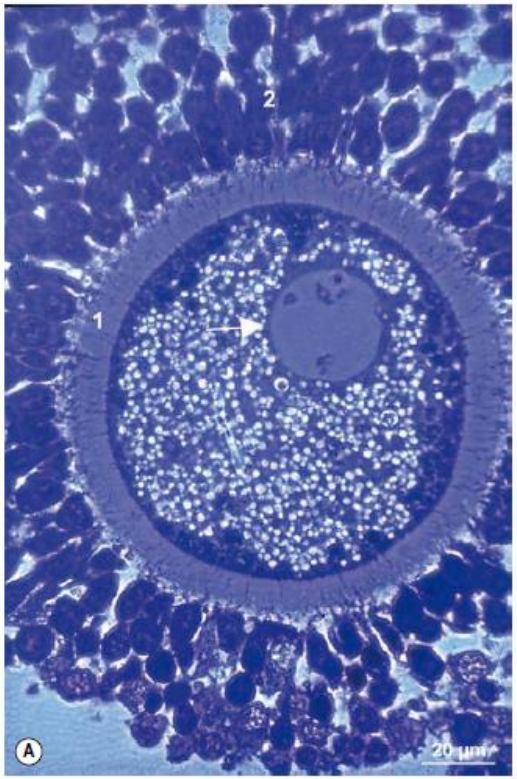
TERTIARY or ANTRAL FOLLICLES

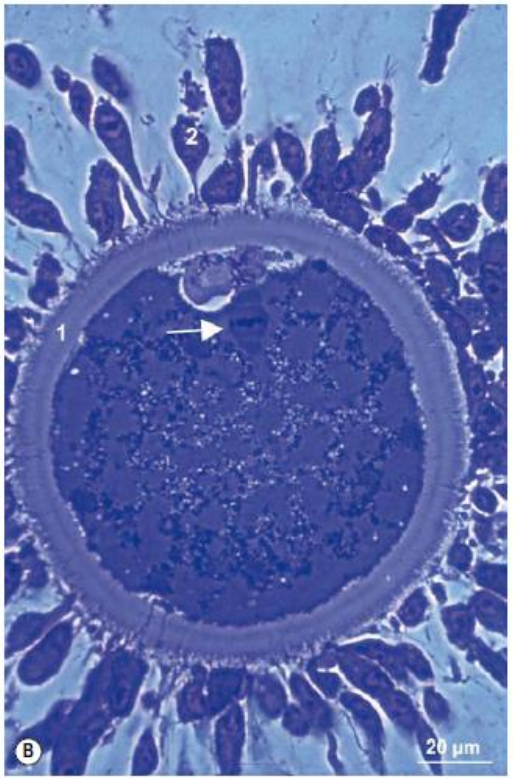
PERIOVULATORY ANTRAL FOLLICLES

DOMINANT FOLLICLE



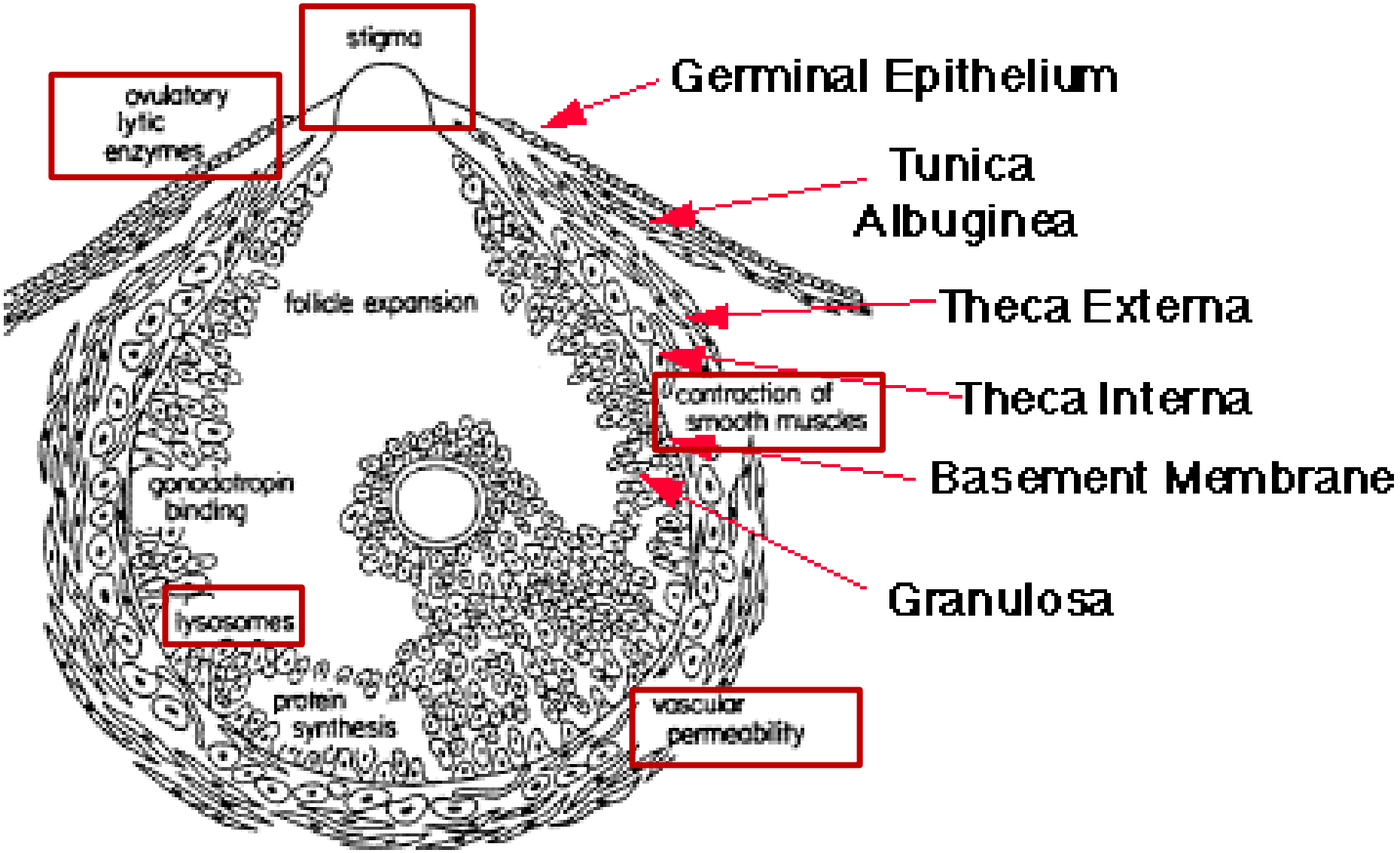
Nuclear oocyte maturation





OVULATION

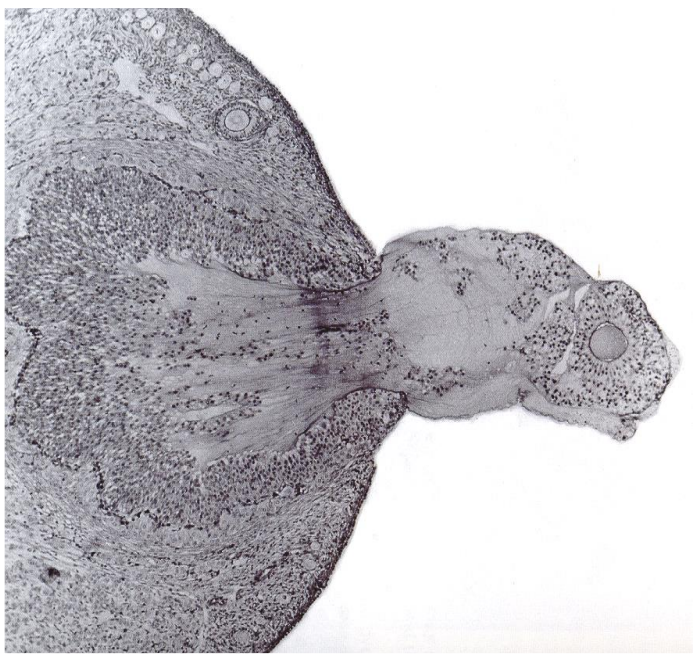
OVULATION


stigma
ovulatory lytic enzymes
Germinal Epithelium
Tunica Albuginea
follicle expansion
Theca Externa
contraction of smooth muscles
Theca Interna
Basement Membrane
gonadotropin binding
Granulosa
lysosomes
protein synthesis
vascular permeability

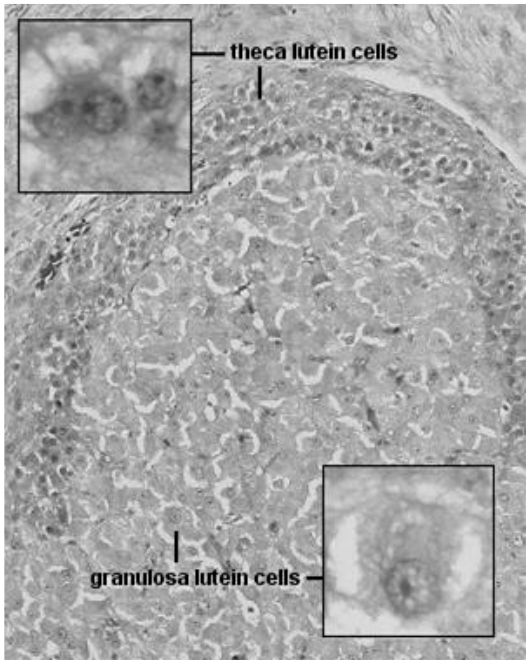
OVULATION

- An increase of intrafollicular pressure,
- Proteolytic enzyme activity on the follicular wall,
- Morphological changes in the stigma,
- Perifollicular ovarian smooth muscle contractions and
- Vascular modifications in the perifollicular vessels.

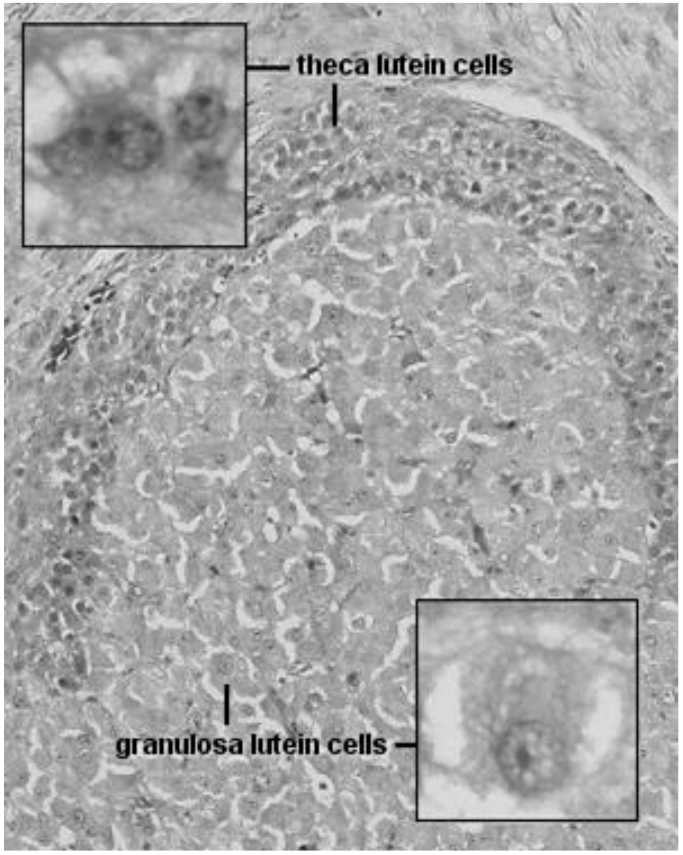
CORPUS LUTEUM



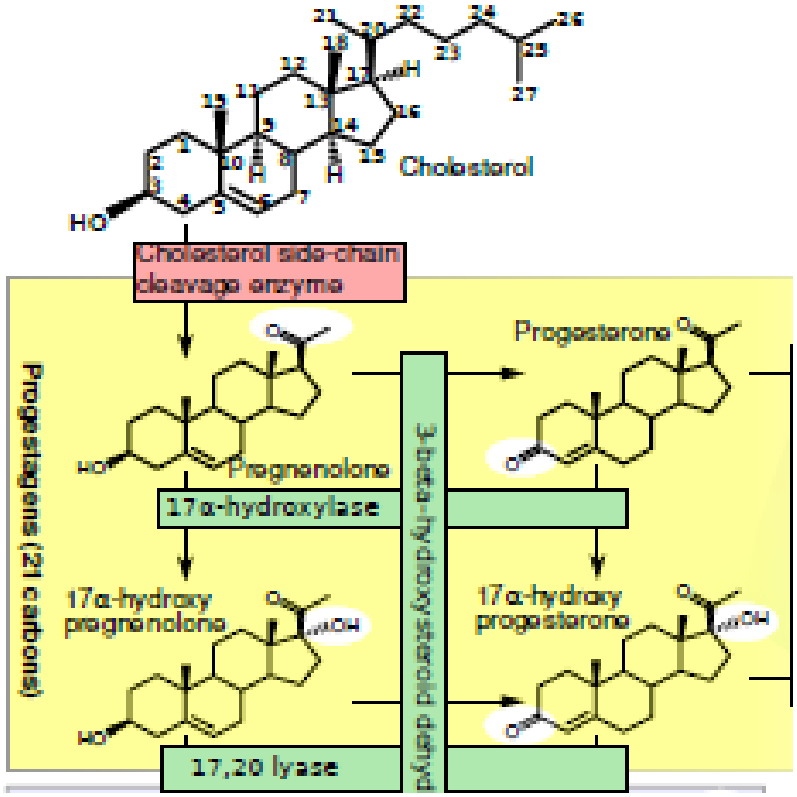
TRANSFORMATION



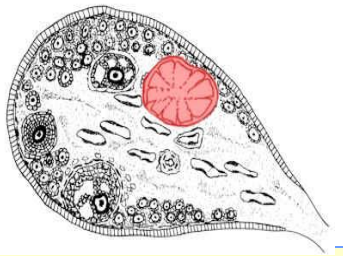
CORPUS LUTEUM



PROGESTERONE



OVULATION



Corpus Luteum hemorrhagicum

Mature Corpus Luteum

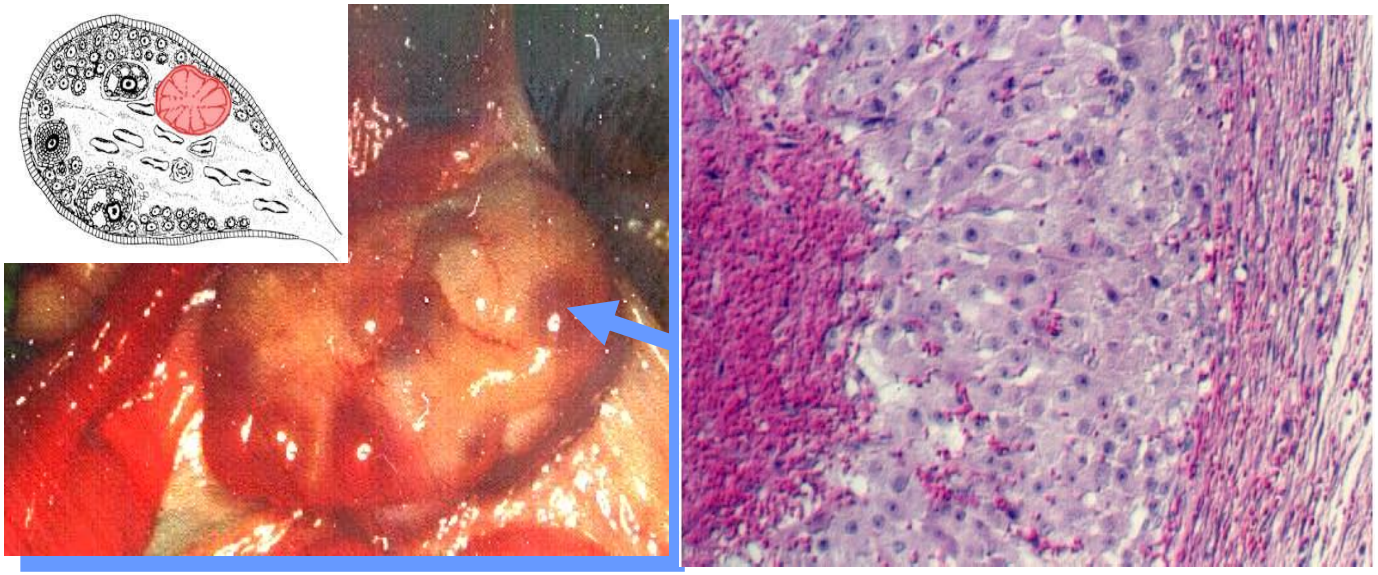
Regression Corpus Luteum

Corpus Albicans

Corpus Luteum

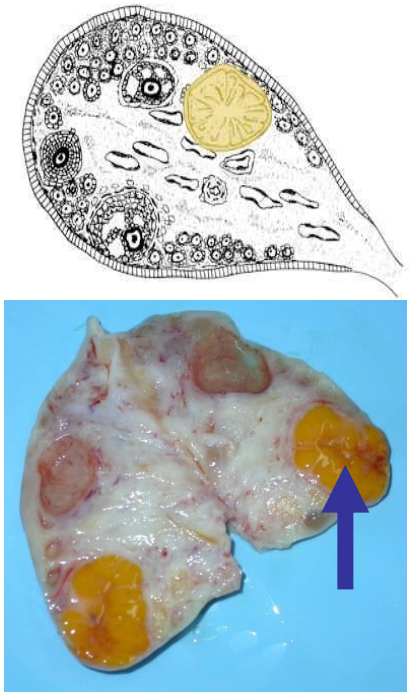
Corpus Luteum graviditatis

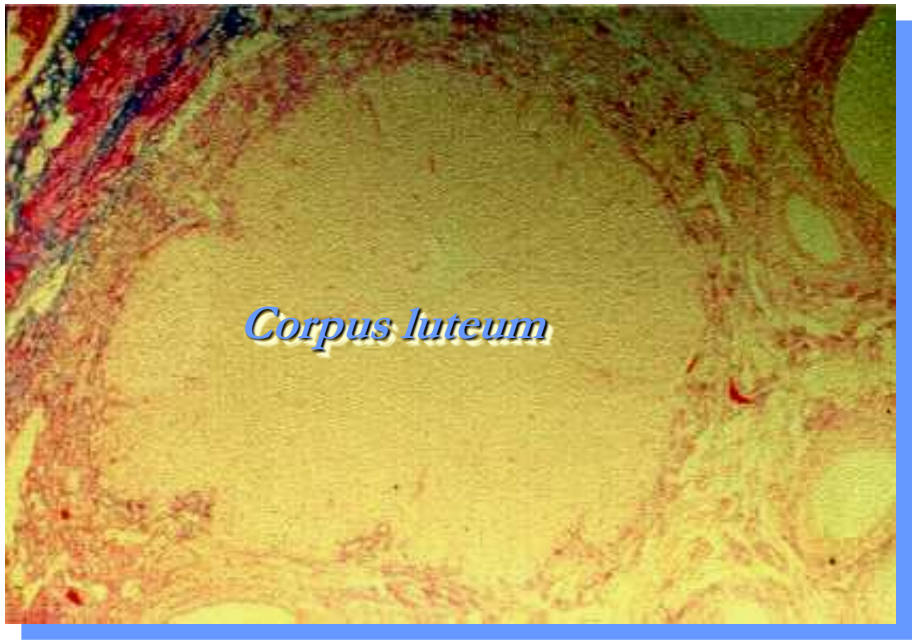
CORPUS LUTEUM: C.L. hemorrhagicum



It is a temporary structure formed immediately after ovulation from the ovarian follicle as it collapses and is filled with blood that quickly clots.

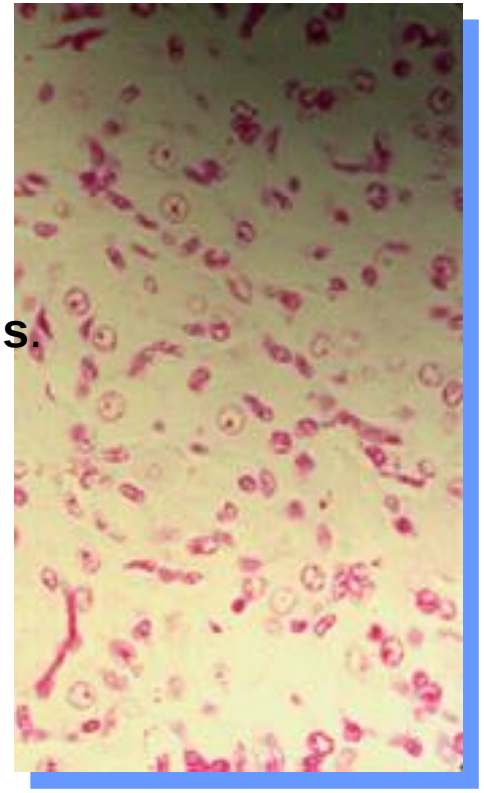
MATURE CORPUS LUTEUM: Structure





Corpus luteum secretes progesterone (P4), and in less extent estrogens (E2). It is higly vascularized.

MATURE CORPUS LUTEUM: luteal cells

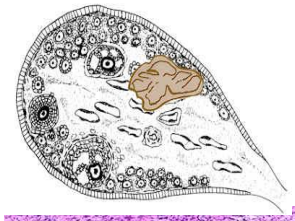


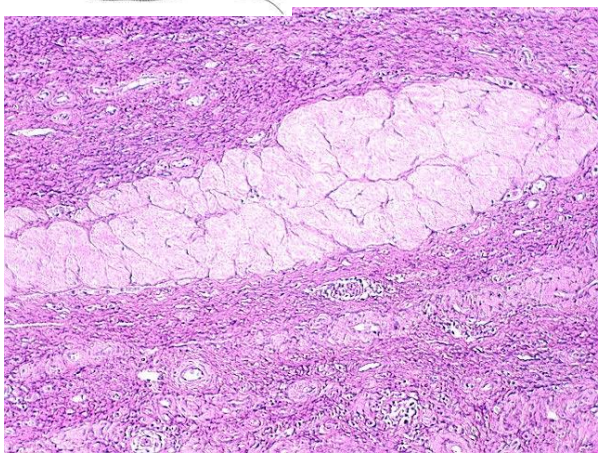
CL is made up two cell groups:

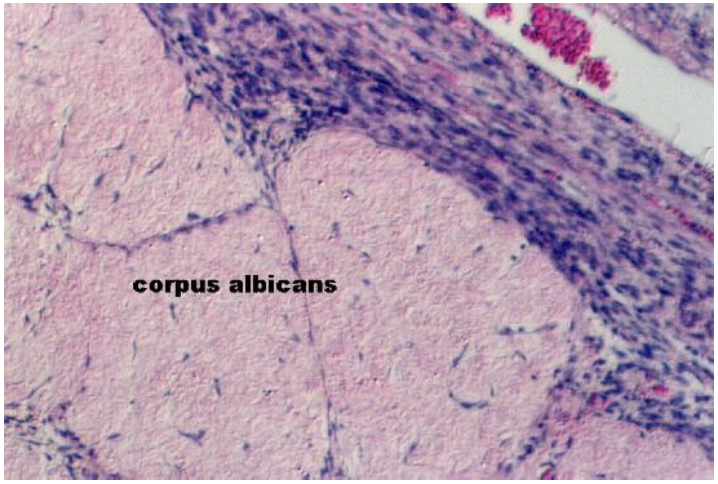
The **large luteal cells**, which originated from **granulosa cells**.

The **small luteal cells** which originated from **theca cells**.

CORPUS ALBICANS

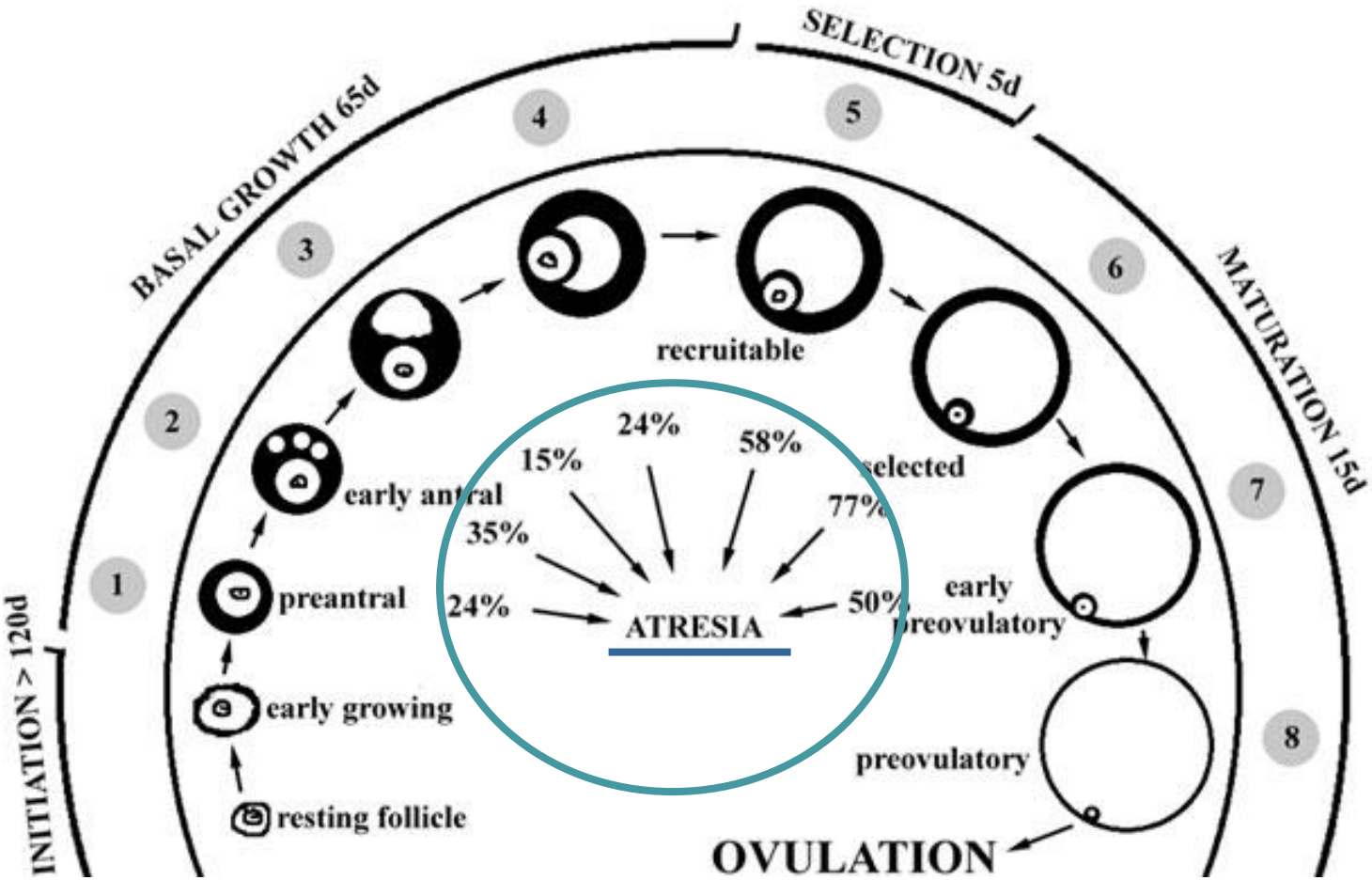






A fibrous scar tissue forms: **corpus albicans**

ATRETIC FOLLICLES



Each reproductive cycle a pool of follicles will grow (folliculogenesis), but only one (mono-ovulatory species) or few (poli-ovulatory species) will ovulate; most of them will undergo to atresia