Female Reproductive System

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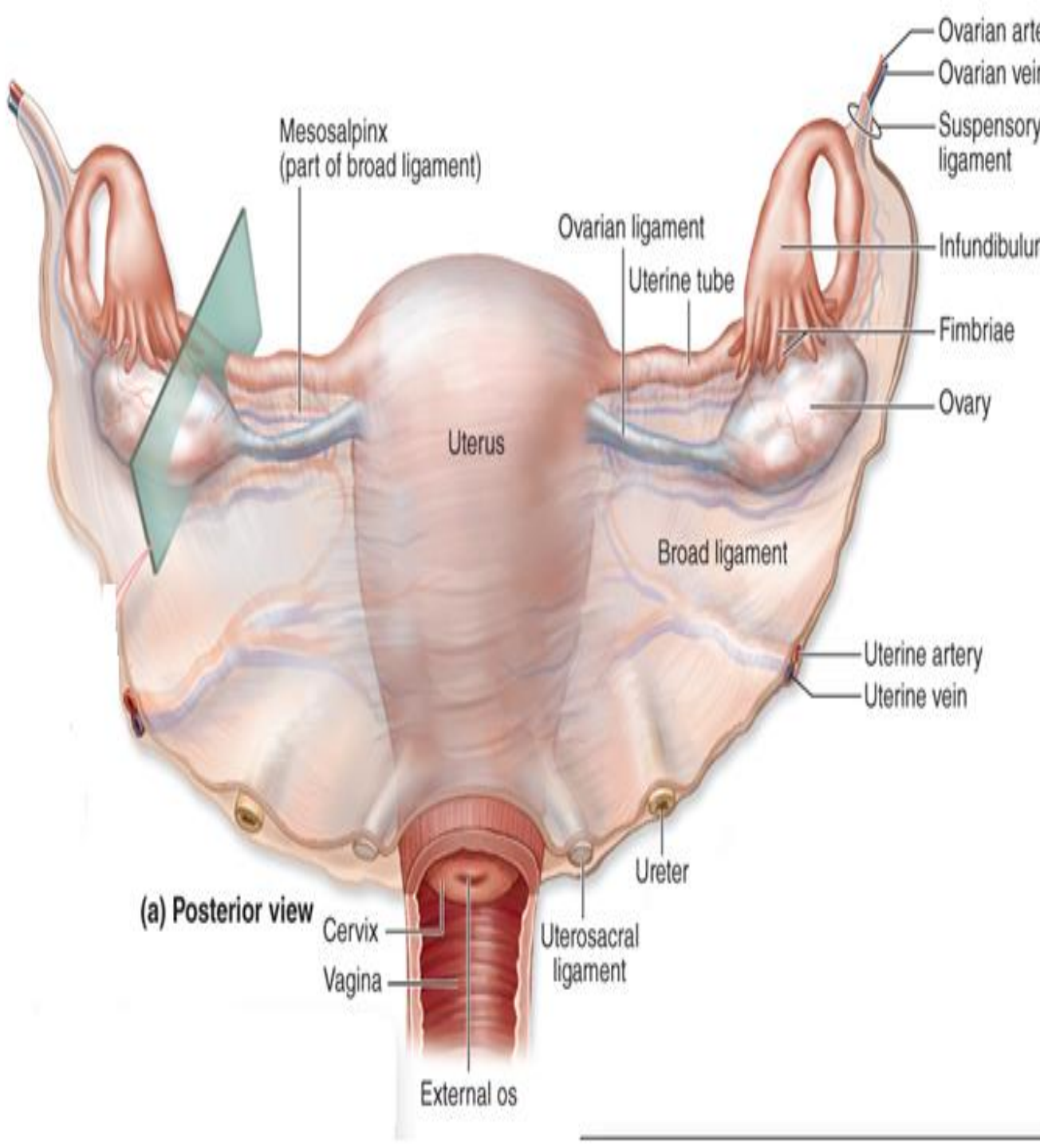
FEMALE REPRODUCTIVE SYSTEM

A. The female reproductive system consists of the paired **ovaries** and **oviducts;** the **uterus, vagina,** and **external genitalia;** and the paired **mammary glands.**

B. It undergoes marked changes at the onset of **puberty**, which is initiated by **menarche.**

C. It exhibits monthly menstrual cycles and menses from puberty until the end of the reproductive years, which terminate at **menopause.**

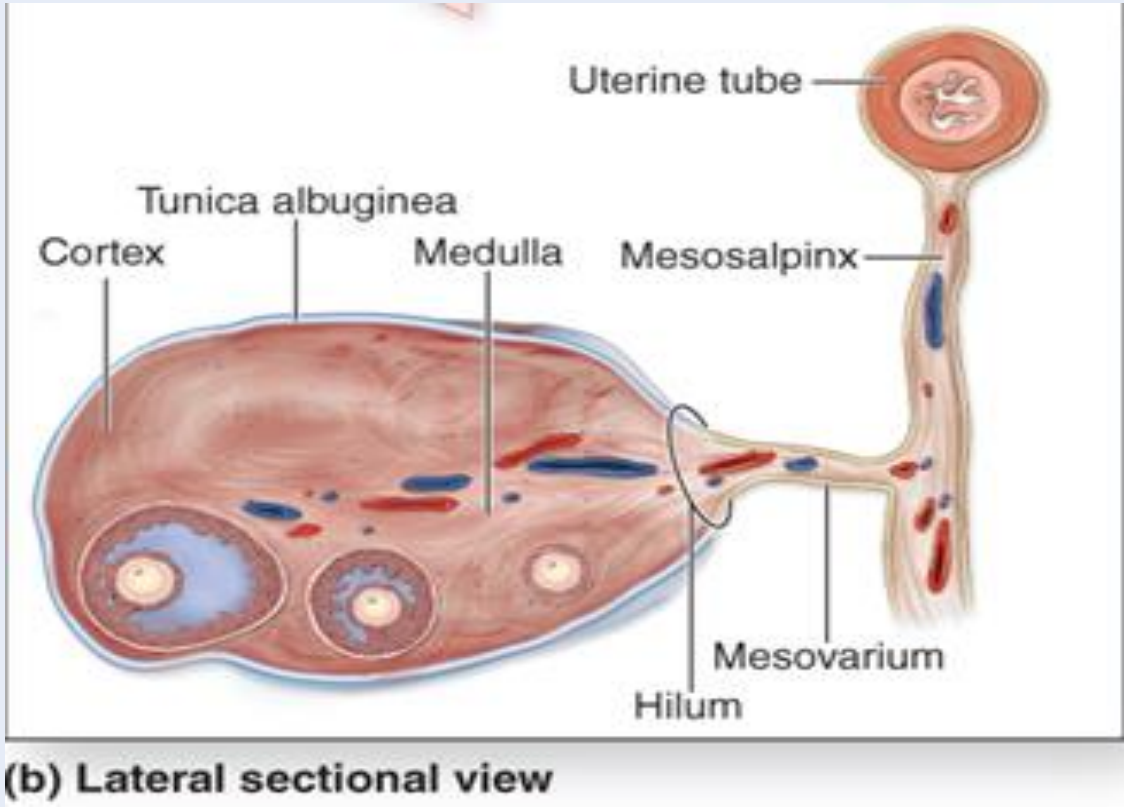


OVARIES

1. Ovaries are covered by a **simple cuboidal epithelium** called the **germinal epithelium.**

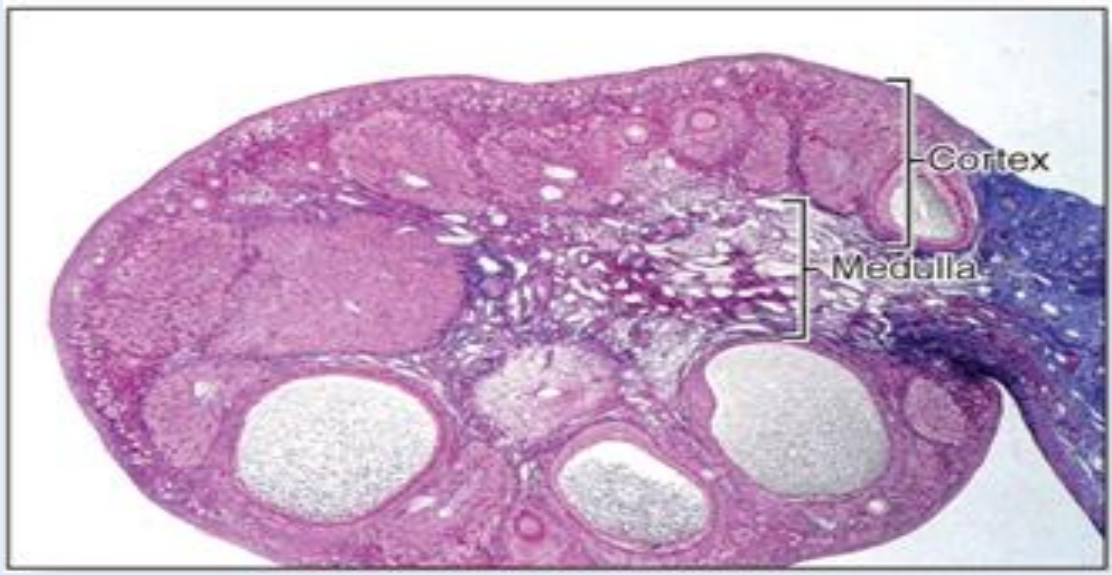
2. Deep to the germinal epithelium, the ovaries possess a **capsule**, the **tunica albuginea,** that is composed of a **dense, irregular collagenous connective tissue**.

3. Each ovary is subdivided into a **cortex** and a **medulla,** which are not sharply delineate.



(b) Lateral sectional view

A-The ovarian cortex consists of **ovarian follicles** in various stages of development and a connective tissue **stroma** containing cells that respond in unique ways to hormonal stimuli.



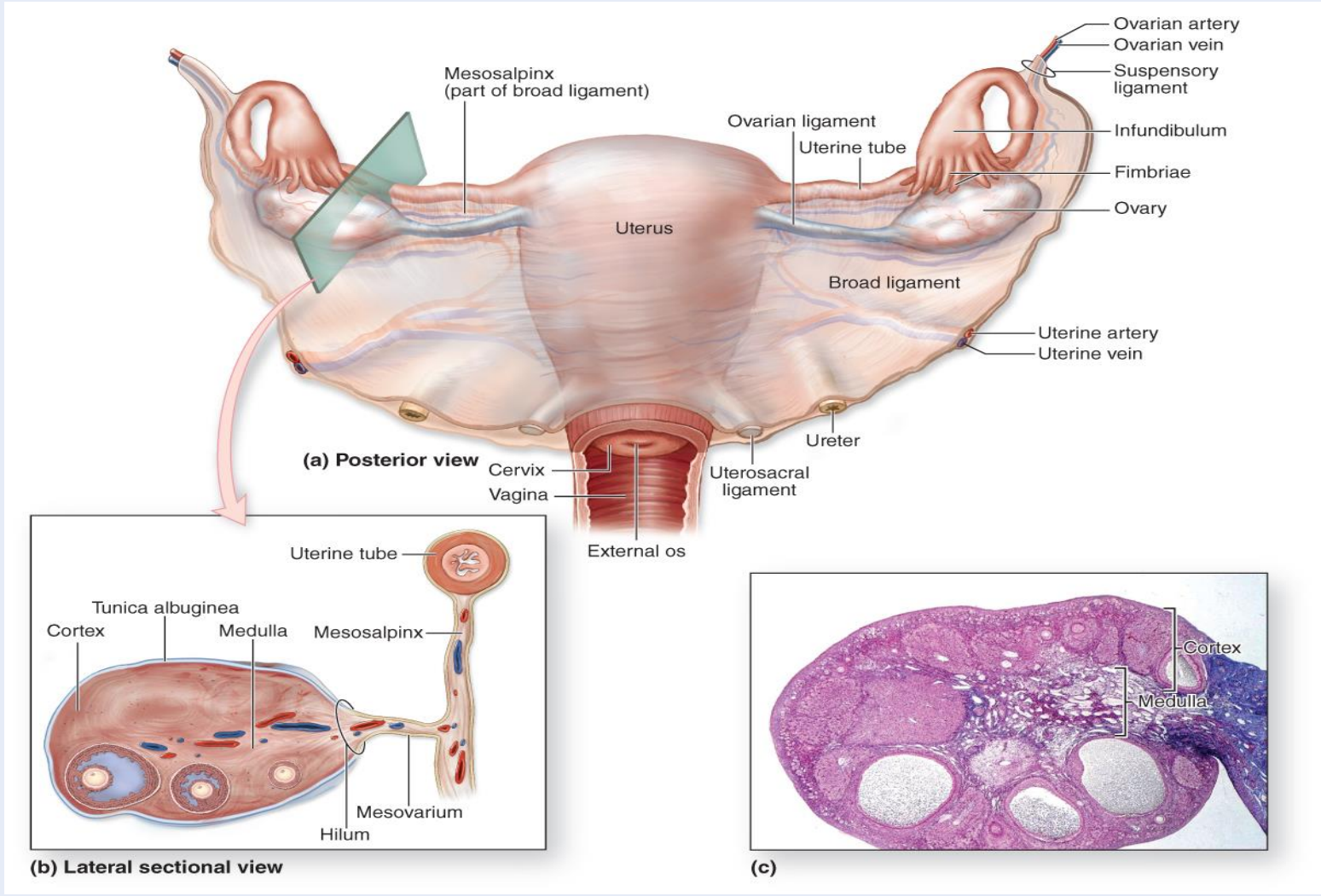
B-The ovarian medulla contains large blood vessels, lymphatic vessels, and nerve fibers in a loose connective tissue stroma. They also possess a small number of estrogen-secreting interstitial cells and a few androgen-secreting hilus cells (similar to Leydig cells in testis)

The female reproductive system and overview of ovary.

(a) The diagram shows the internal organs of the female reproductive system, which includes as the principal organs the **ovaries**, **uterine tubes**, **uterus**, and **vagina**.

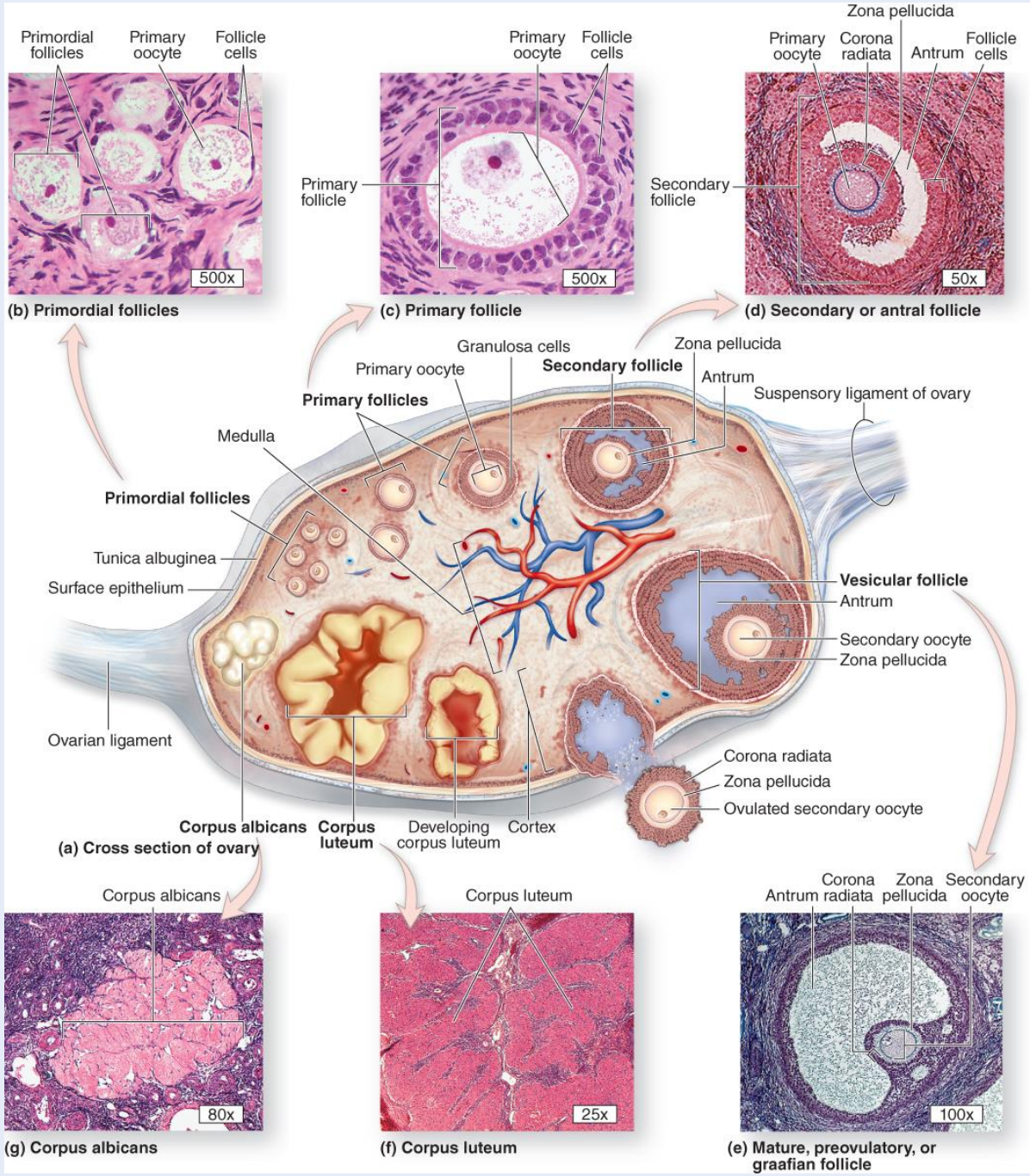
(b) A lateral sectional view of an ovary shows the ovary and the relationship of its main supporting mesenteries, the mesovarium and the mesosalpinx of the broad ligament.

(c) A sectioned ovary, indicating the medulla and cortex, with follicles of several different sizes in the cortex. X15. H&E.



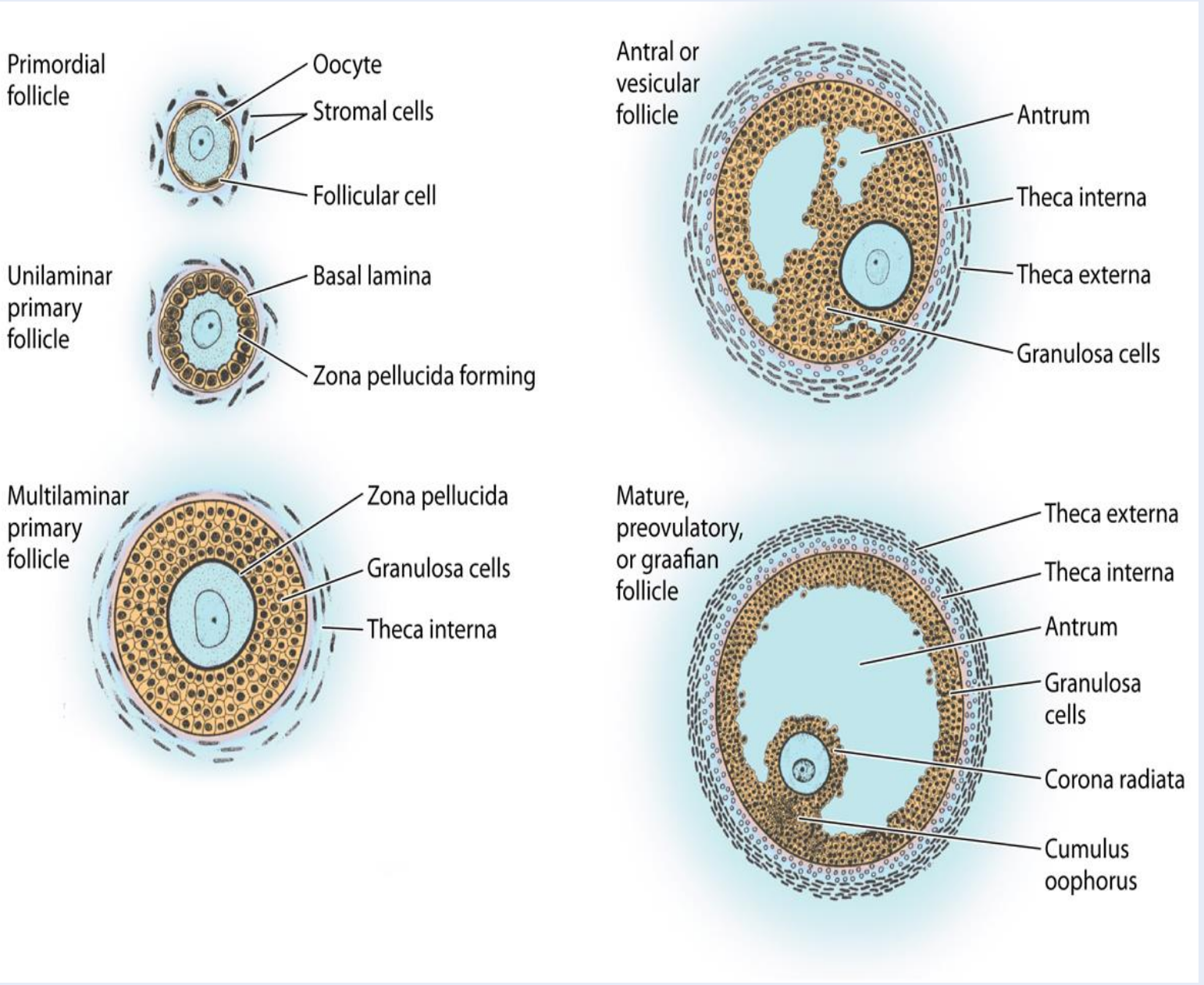
Follicle development and changes within the ovary.

The ovary produces both **oocytes** and **sex hormones**. A diagram of a sectioned ovary (a) shows the different stages of follicle **maturation**, **ovulation**, and **corpus luteum** formation and degeneration. All of the stages and structures shown in this diagram actually would appear at different times during the ovarian cycle and **do not occur simultaneously.** Follicles are arranged here for easy comparisons. The **primordial follicles** shown are greatly enlarged. The histologic sections identify **primordial follicles** (b), a **primary follicle** (c), a **secondary follicle** (d), and a large **vesicular follicle** (e). After ovulation, the portion of the follicle left behind forms the **corpus luteum** (f), which then degenerates into **the corpus albicans** (g). All H&E.



Stages of ovarian follicles, from primordial to mature.

Diagrams of sectioned ovarian follicles show the changing size and morphology of follicular/granulosa cells at each stage and the disposition of the surrounding thecal cells. **mature follicles** are much larger relative to the early follicles. Deep within each follicle is a single large, growing oocyte with a large nucleus and prominent nucleolus. Follicular or granulosa cells around the oocyte support that cell's rapid growth.



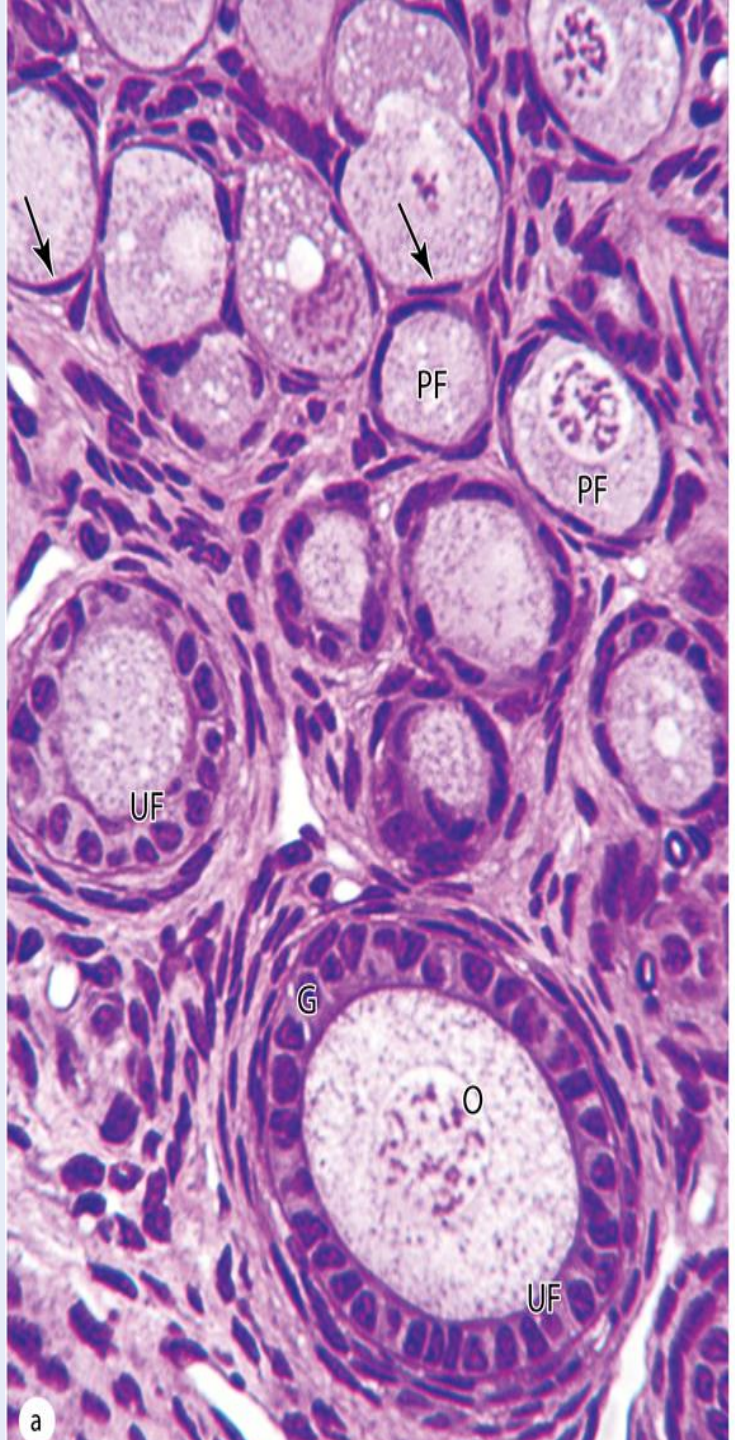
Primordial follicles.

The cortical region of an ovary is surrounded by the **surface epithelium (SE)**, a **mesothelium** with usually **cuboidal cells**. This layer is sometimes called the germinal epithelium because of an early erroneous (mistaken) view that it was the source of **oogonia** precursor cells. Underlying the epithelium is a connective tissue layer, **the tunica albuginea (TA)**. Groups of **primordial** follicles, each formed by an oocyte (O) surrounded by a layer of flat epithelial follicular cells (arrows), are present in the ovarian connective tissue (stroma). X200. H&E.

Primary follicles

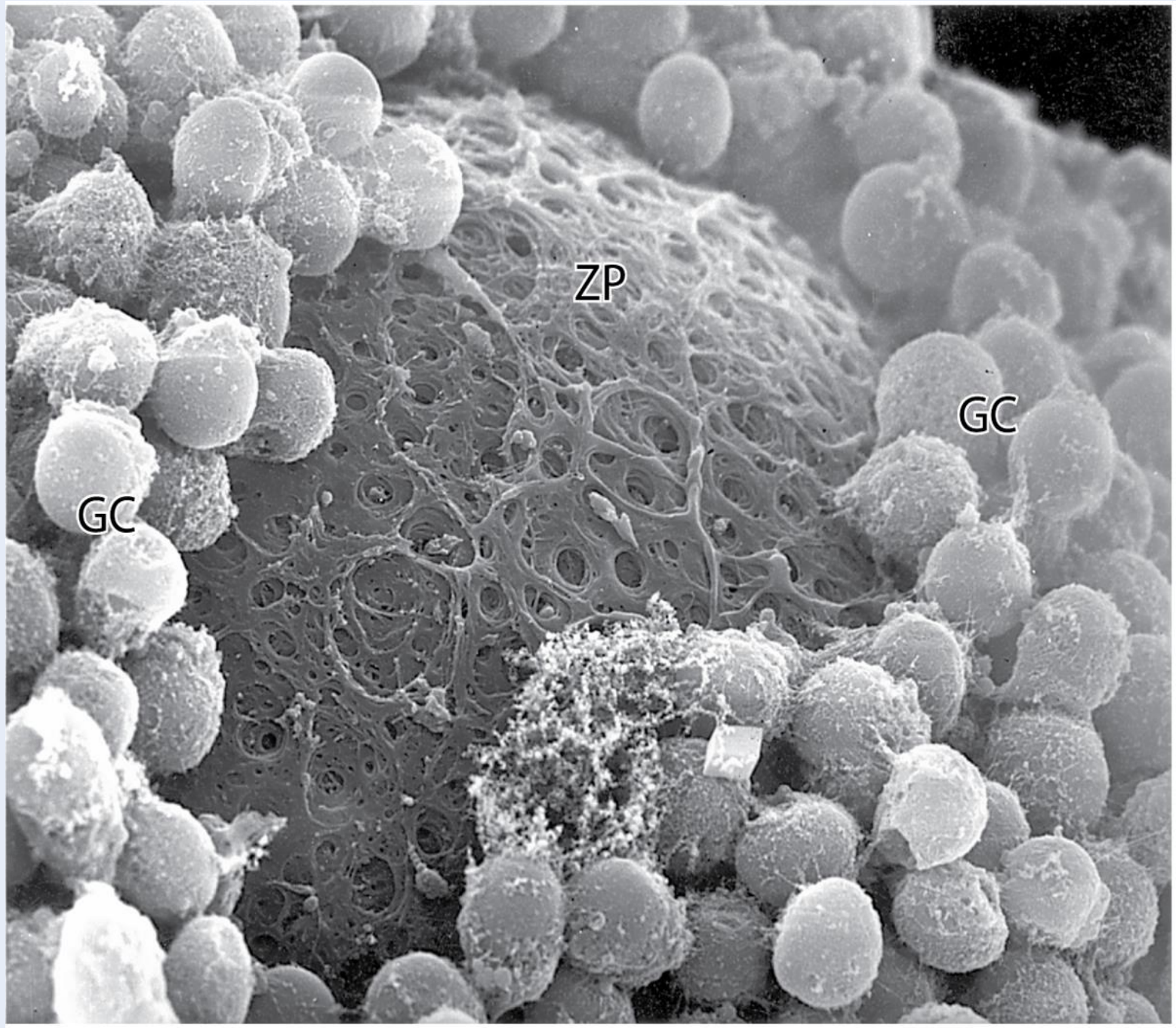
(a) A micrograph of ovarian cortex shows several **primordial follicles (PF)** and their flattened follicle cells (arrows), and two **unilaminar primary follicles (UF)** in which the follicle cells or granulosa cells (G) form a single cuboidal layer around the large primary oocyte (O). X200. PT.

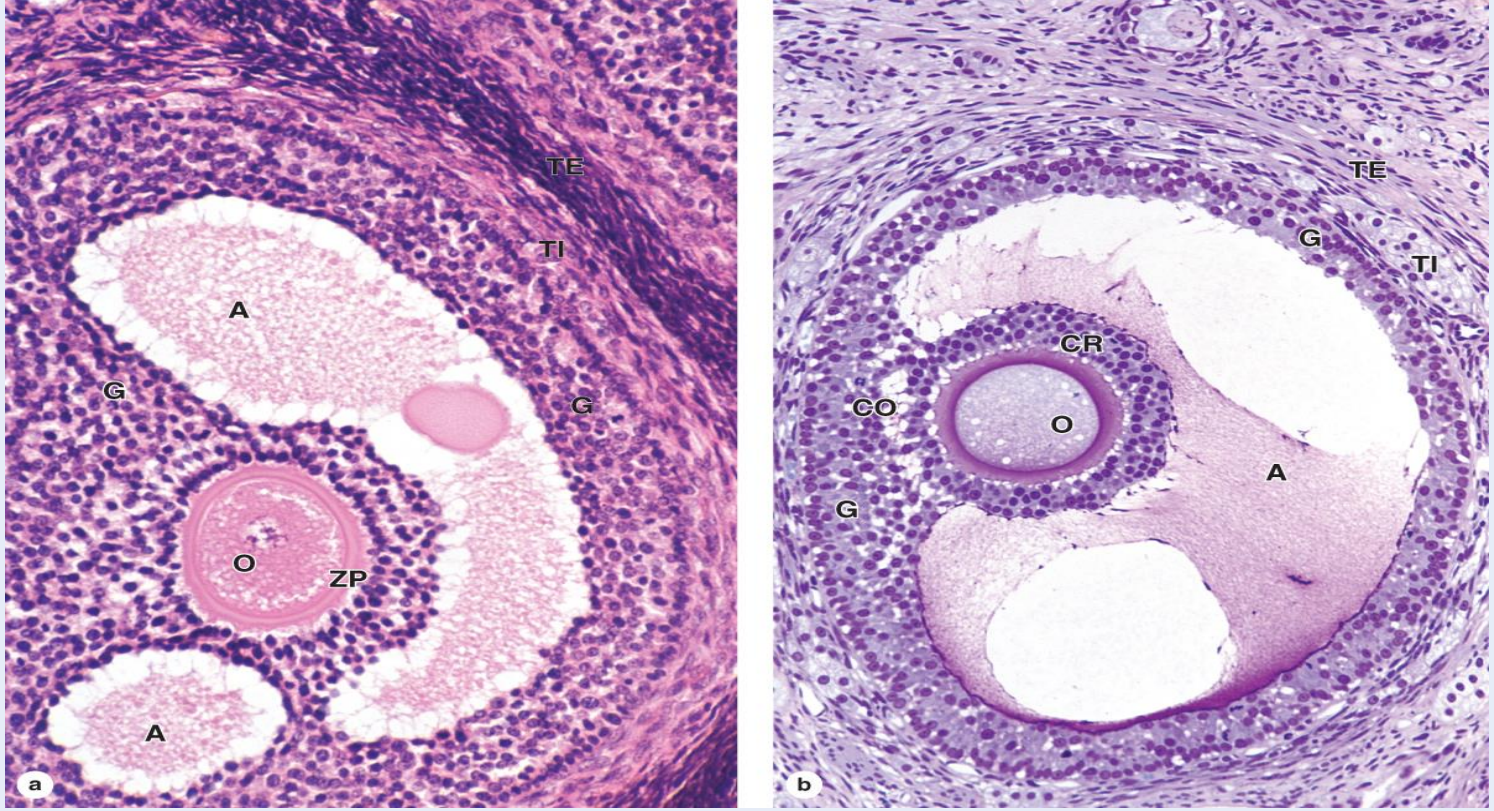
(b) This micrograph taken at the same magnification shows a **larger** multilayered primary follicle. **Granulosa cells (G)** have now proliferated to form several layers. Between them and the **oocyte (O)** is the 5- to 10-µm-thick **zona pellucida (ZP),** a glycoprotein layer produced by the oocyte that is required for **sperm binding** and **fertilization**. The primary oocyte is now a very large cell. With this stain, the basement membrane (BM) that separates the follicle from the surrounding stroma can also be seen. X200.



Ultrastructure of primary follicle and zona pellucida.

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. X3000.





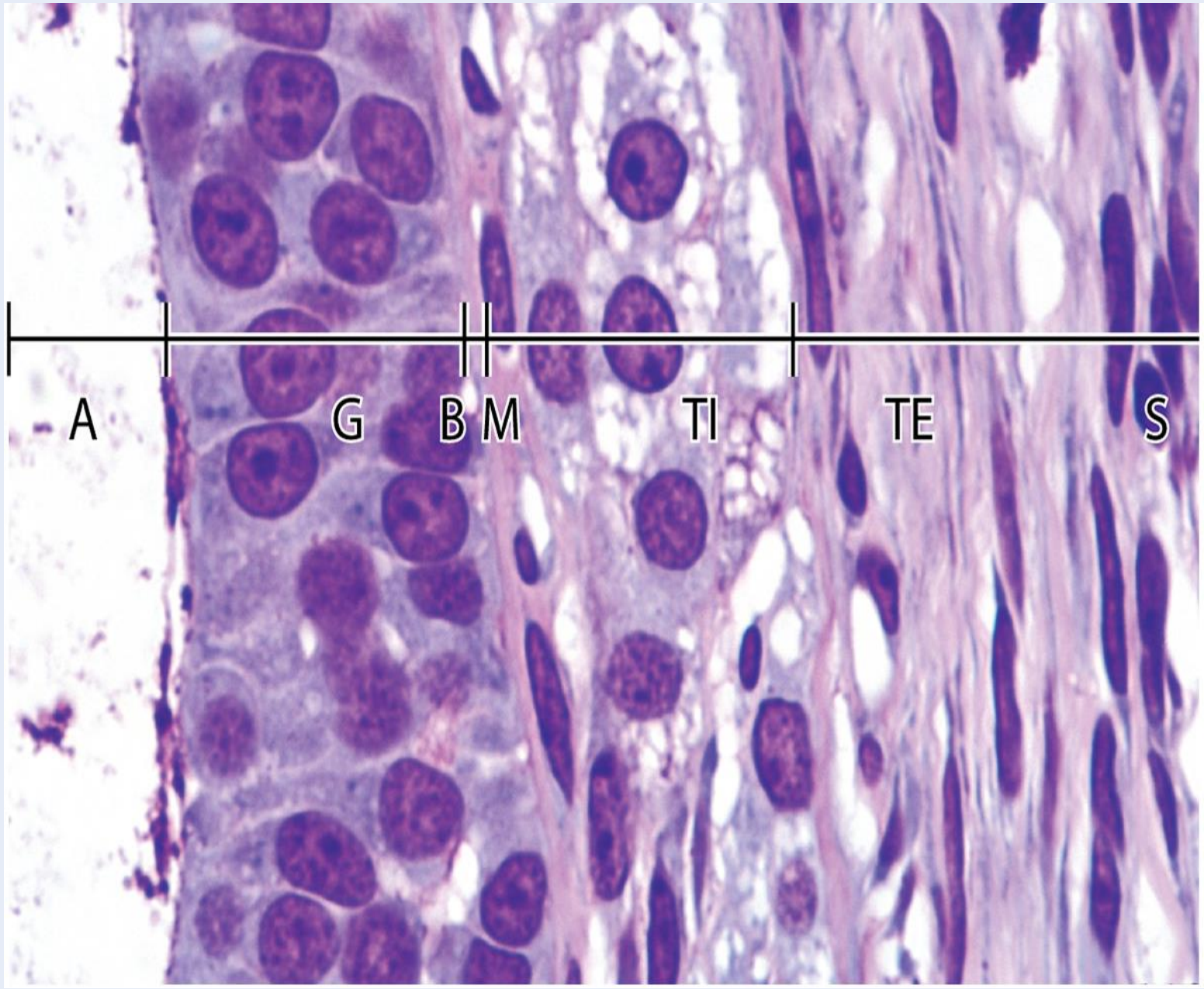
Antral follicle and preovulatory follicle.

(a) An **antral** follicle shows the large, fluid-filled **antral cavities** or vesicles (**A**) that form within the granulosa layer as the cells produce follicular fluid. The **oocyte** (**O**) is surrounded by the **zona pellucida** (**ZP**) and **granulosa cells** (**G**), which also line the wall of the follicle. Fibroblastic cells immediately outside the growing follicles have developed as a **steroid-secreting** theca interna (**TI**) and a covering theca externa (**TE**). X100. H&E.

(b) A slightly more developed **preovulatory** follicle shows a very large **single antrum** (**A**) filled with follicular fluid in which the proteins formed a thin film during fixation. The oocyte (**O**) now **projects** into this fluid-filled cavity, still surrounded by granulosa cells that now make up the **corona radiata** (**CR**). The corona radiata and oocyte are attached to the side of the follicle within a larger mass of granulosa cells called the **cumulus oophorus** (**CO**) which is continuous with the cells of the granulosa layer (**G**). Thecae interna (**TI**) and externa (**TE**) surround the whole follicle. X100

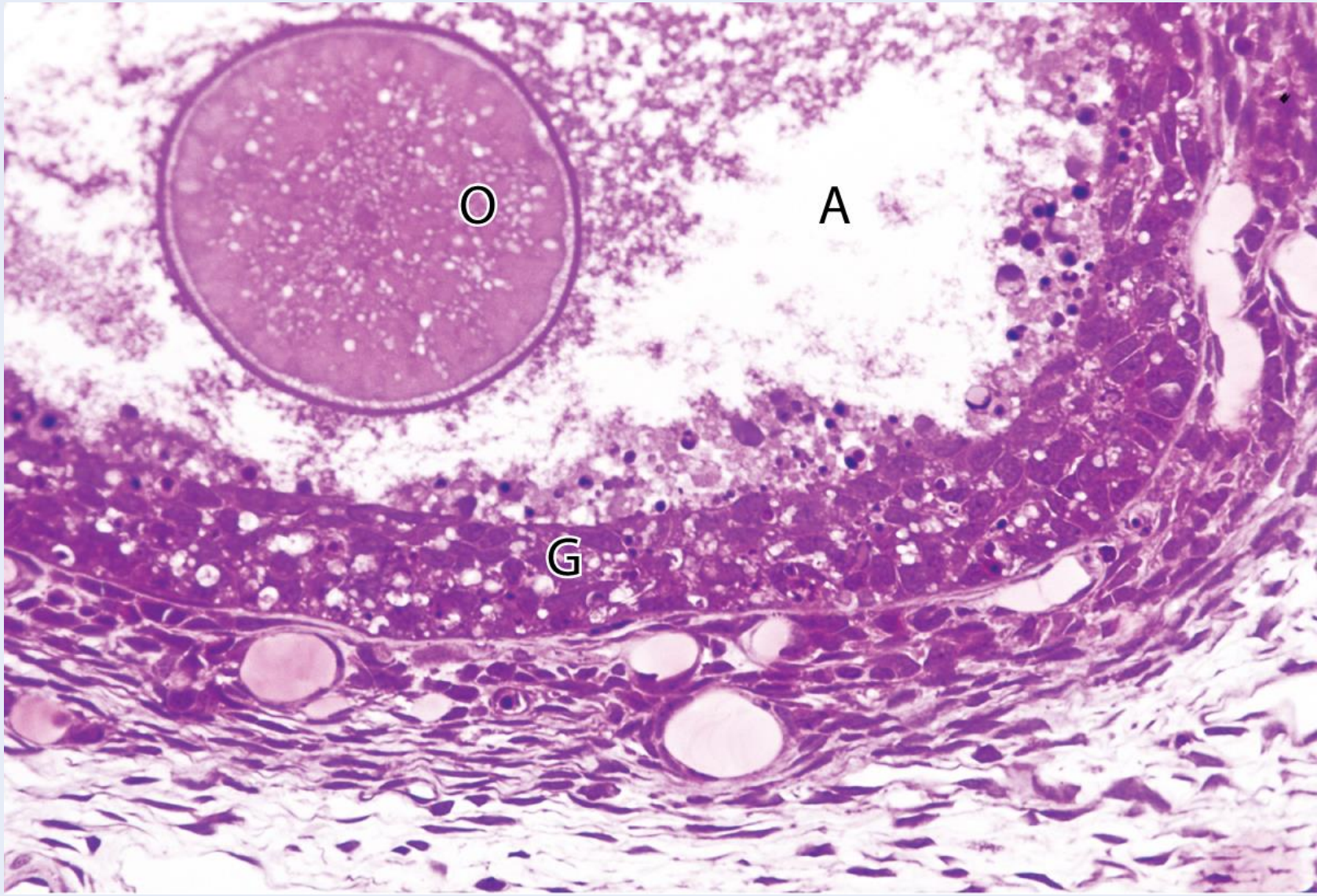
Wall of antral follicle.

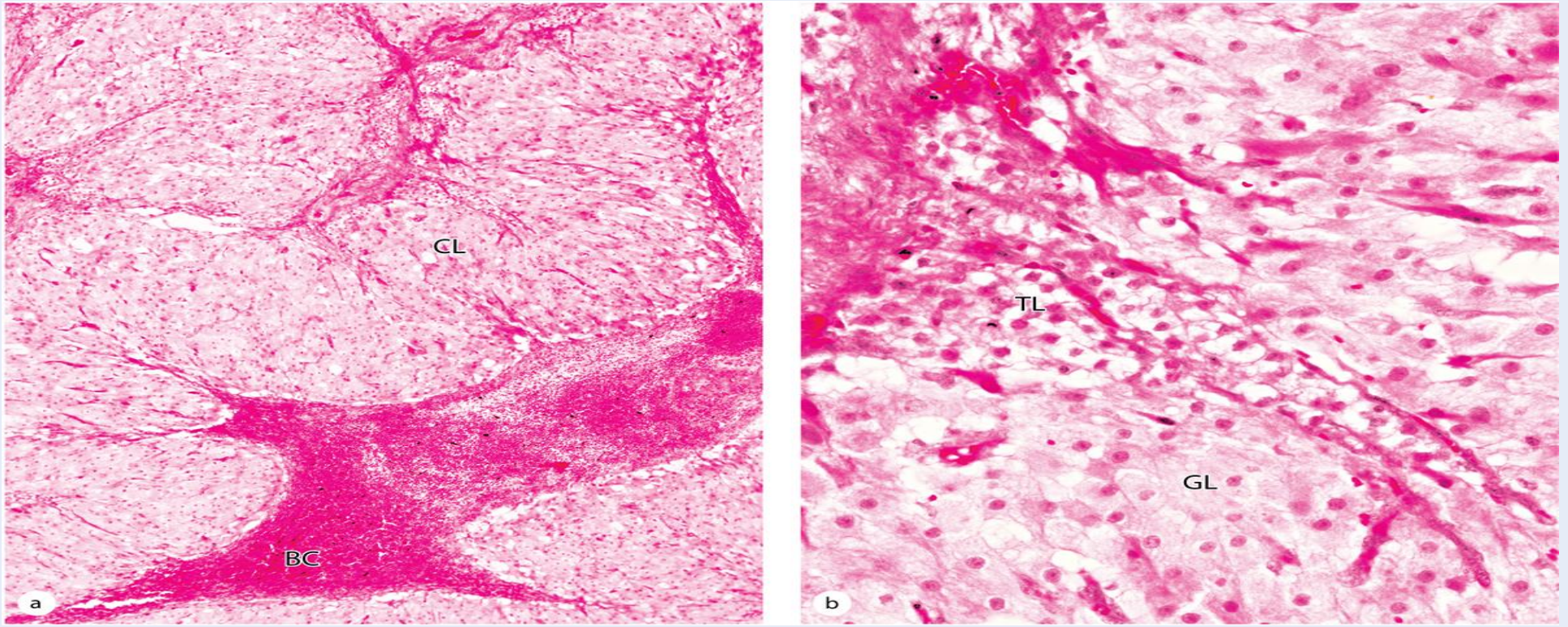
At higher magnification, a small part of the wall of an antral follicle shows the cell layers of the **granulosa** (G) next to the antrum (A), in which proteins have aggregated on cells in contact with the follicular fluid. The **theca interna** (TI) surrounds the follicle, its cells appearing vacuolated and lightly stained because of their **cytoplasmic lipid droplets**, a characteristic of **steroid-producing cells**. The overlying **theca externa** (TE) contains fibroblasts and smooth muscle cells and merges with the **stroma** (S). A **basement membrane** (BM) **separates** the theca interna from the granulosa, **blocking** vascularization of the latter. X400.



Atresia

Atresia or **degeneration** of a follicle can occur at **any stage** of its development and is shown here in a follicle that had developed a large antrum. Atresia is characterized by apoptosis of granulosa cells (**G**) and autolysis of the oocyte, with macrophages entering the degenerating structure to clean up debris. Many apoptotic cells are seen loose in the antrum (**A**) here and the cells of the corona radiata have already **disappeared**, leaving the degenerative oocyte (**O**) free within the antrum. X200.

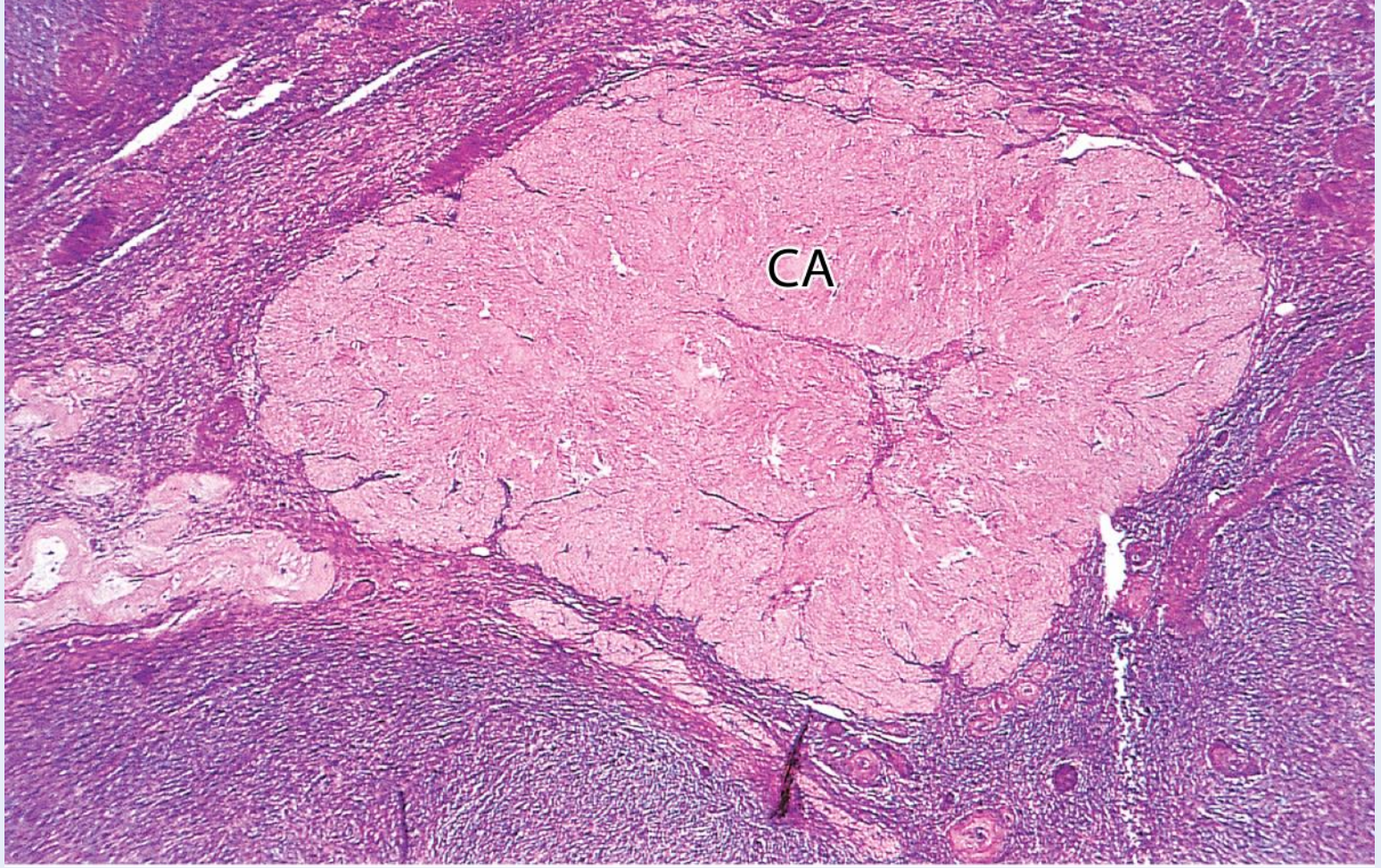




Corpus luteum.

The corpus luteum is a **large endocrine structure** formed from the remains of the large dominant follicle after it undergoes **ovulation**. **(a)** A low-power micrograph shows the corpus luteum (**CL**), characterized by **folds** of the former granulosa that collapses as the **theca externa contracts at ovulation**. The former antrum often contains a **blood clot** (**BC**) from vessels in the thecal layers disrupted during ovulation.

(b) Granulosa lutein cells (**GL**), seen at higher magnification here, undergo significant **hypertrophy**, producing most of the corpus luteum's increased size, and begin producing **progesterone**. The theca lutein cells (**TL**) increase only slightly in size, are somewhat **darker-staining** than the granulosa lutein cells, and continue to produce **estrogens**. Theca lutein cells, derived from the theca interna, are typically located within the folds that comprise the bulk of this tissue



Corpus albicans.

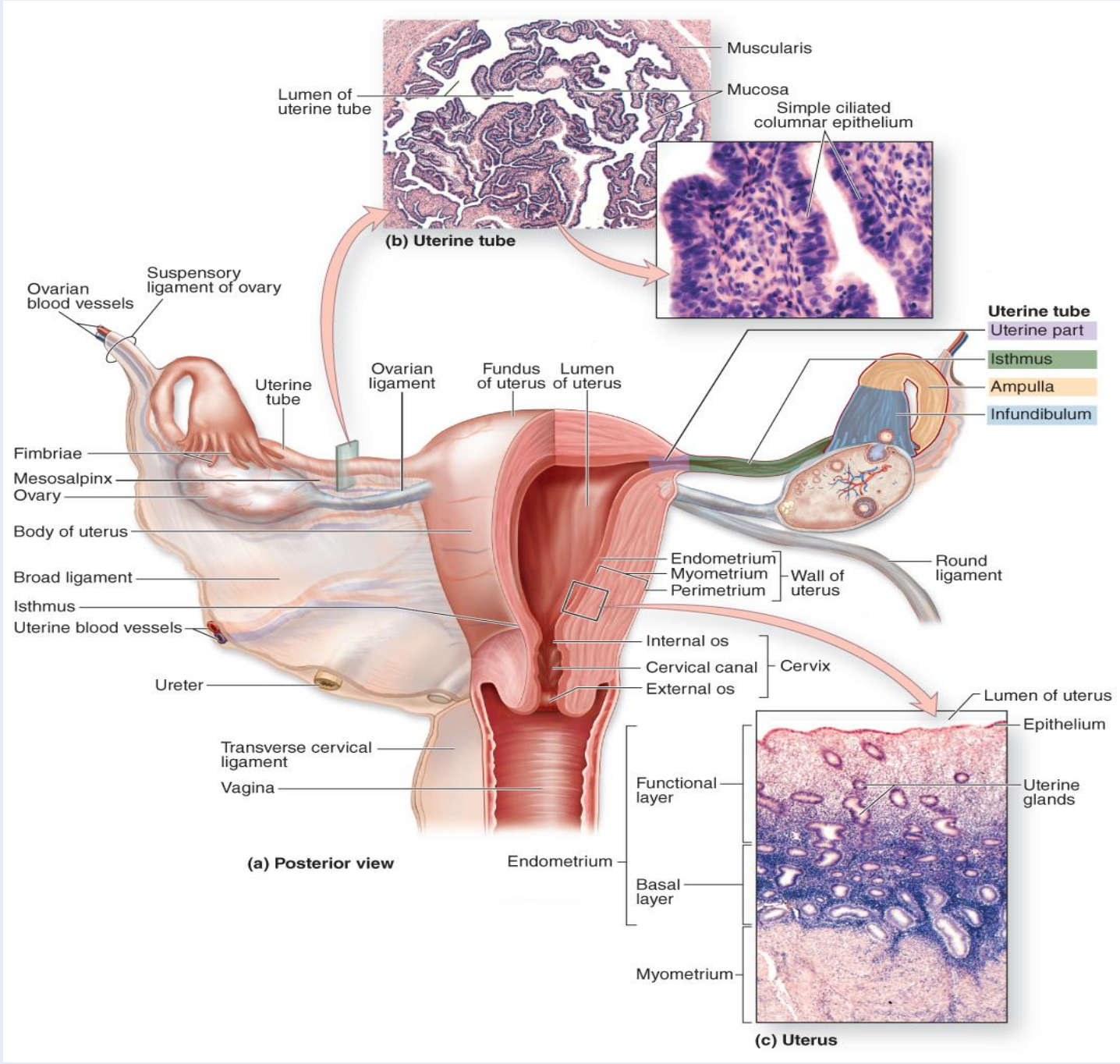
A corpus albicans (**CA**) is the **scar** of connective tissue that forms at the site of a corpus luteum after its **involution**. It contains mostly **collagen**, with few **fibroblasts** , and gradually becomes very small and lost in the ovarian stroma. Involution (shrinkage) of the corpus luteum does not involve atresia. X60. H&E.

Uterine tubes and uterus.

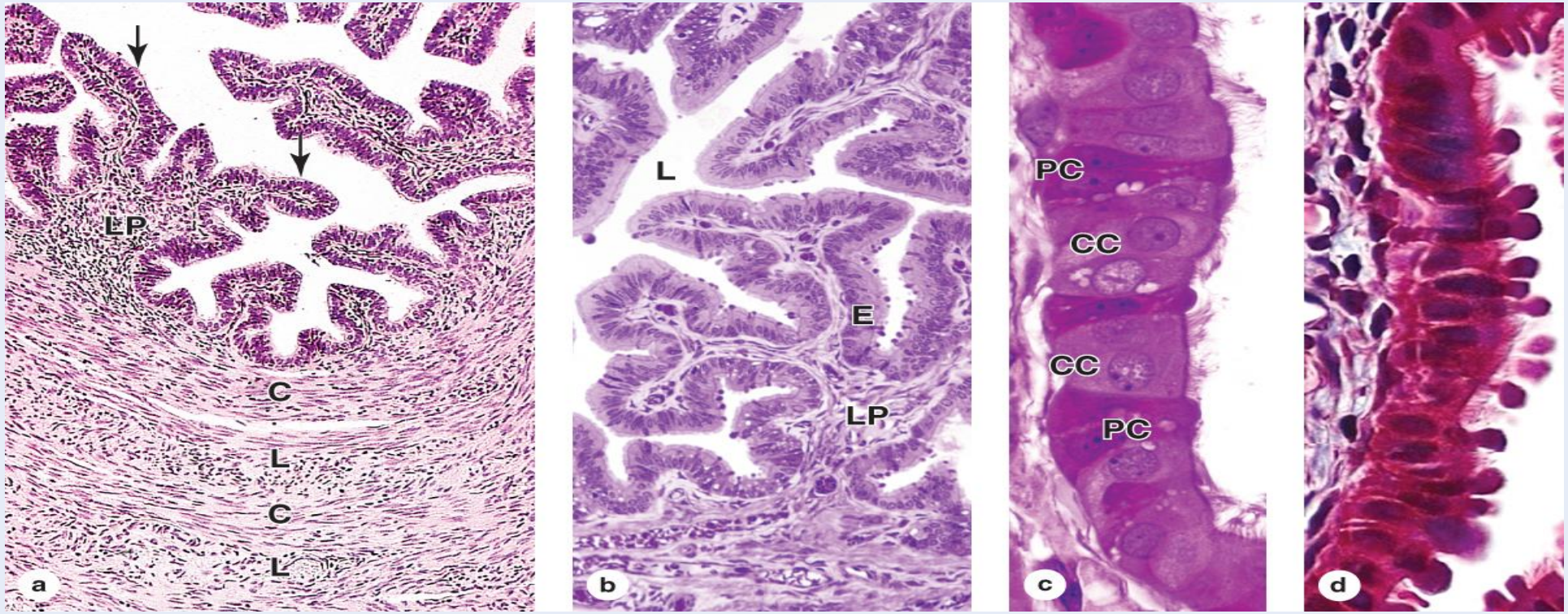
The uterine tubes or **oviducts** **(Fallopian tubes)**are paired ducts that **catch** the ovulated **secondary oocyte**, nourish both the **oocyte** and **sperm**, provide the microenvironment for **fertilization**, and **transport** the **embryo** undergoing cleavage to the **uterus**. **(a)** The diagram shows the relationship between the uterine tubes and the uterus in an intact posterior view (left) and in a cutaway view (right).

(b) Shown here is a cross section of **uterine tube** with a high magnification of the mucosa (**simple ciliated columnar epithelium**). X35 and 400. H&E.

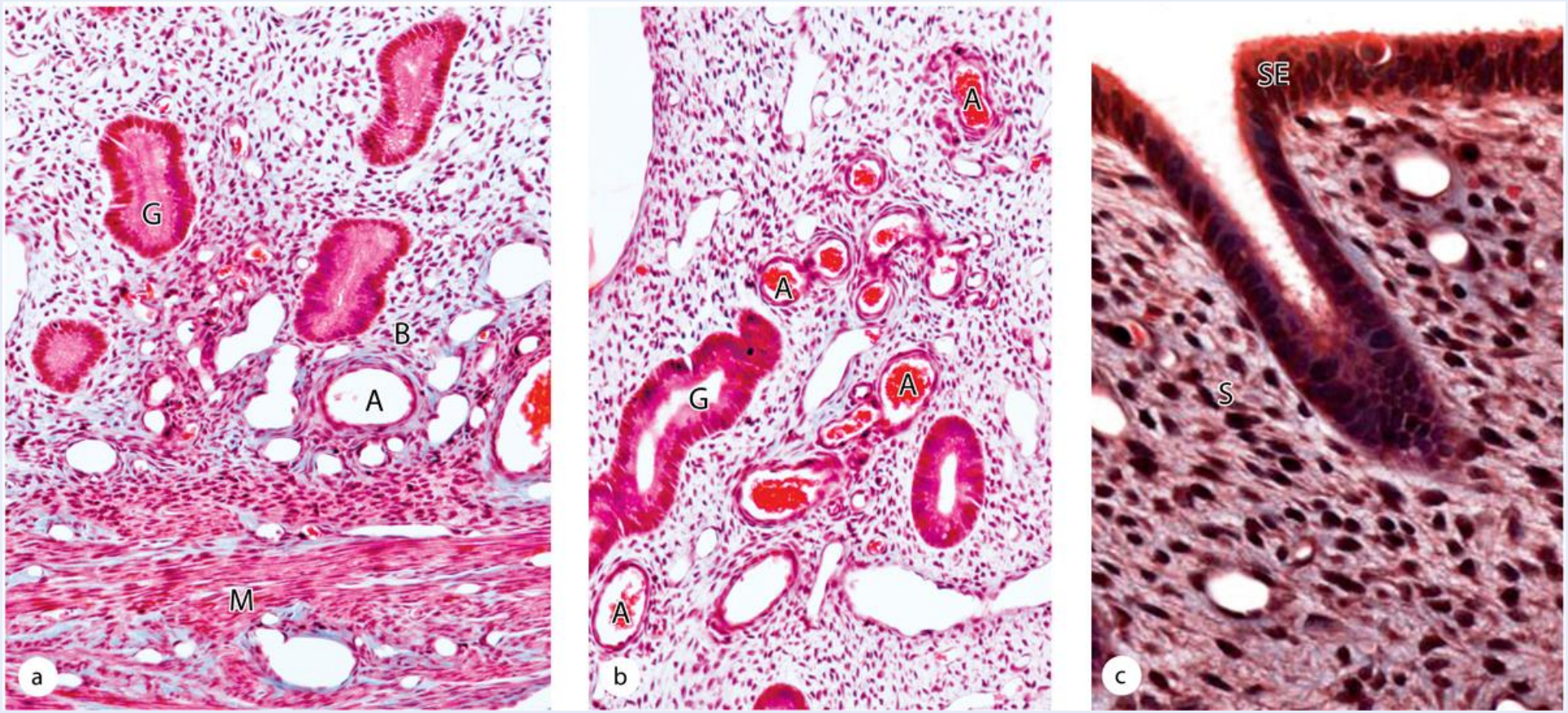
(c) the uterine wall with the myometrium and the two layers of the endometrium. X45. H&E



Mucosa of the uterine tube wall.



(a) A cross section of the uterine tube at the ampulla shows the interwoven circular (**C**) and longitudinal (**L**) layers of smooth muscle in the muscularis and in the complex of folded mucosa, the lamina propria (**LP**) underlying a simple columnar epithelium (arrows).**(b)** The oviduct mucosa, with folds projecting into the lumen (**L**), has simple columnar epithelium (**E**) on the lamina propria (**LP**). (**c, d**) Higher magnification of the epithelium shows **two** cell types: **ciliated cells (CC)** interspersed with the **secretory peg cells** (**PC**), which produce the **nutritive fluid** covering the epithelium. These cells' histologic and functional features vary during the ovarian cycle due to hormonal fluctuations. In **(d)** the **peg cells** shown are at their most developed and most active state in the period shortly after ovulation when an embryo might be present



Uterus.

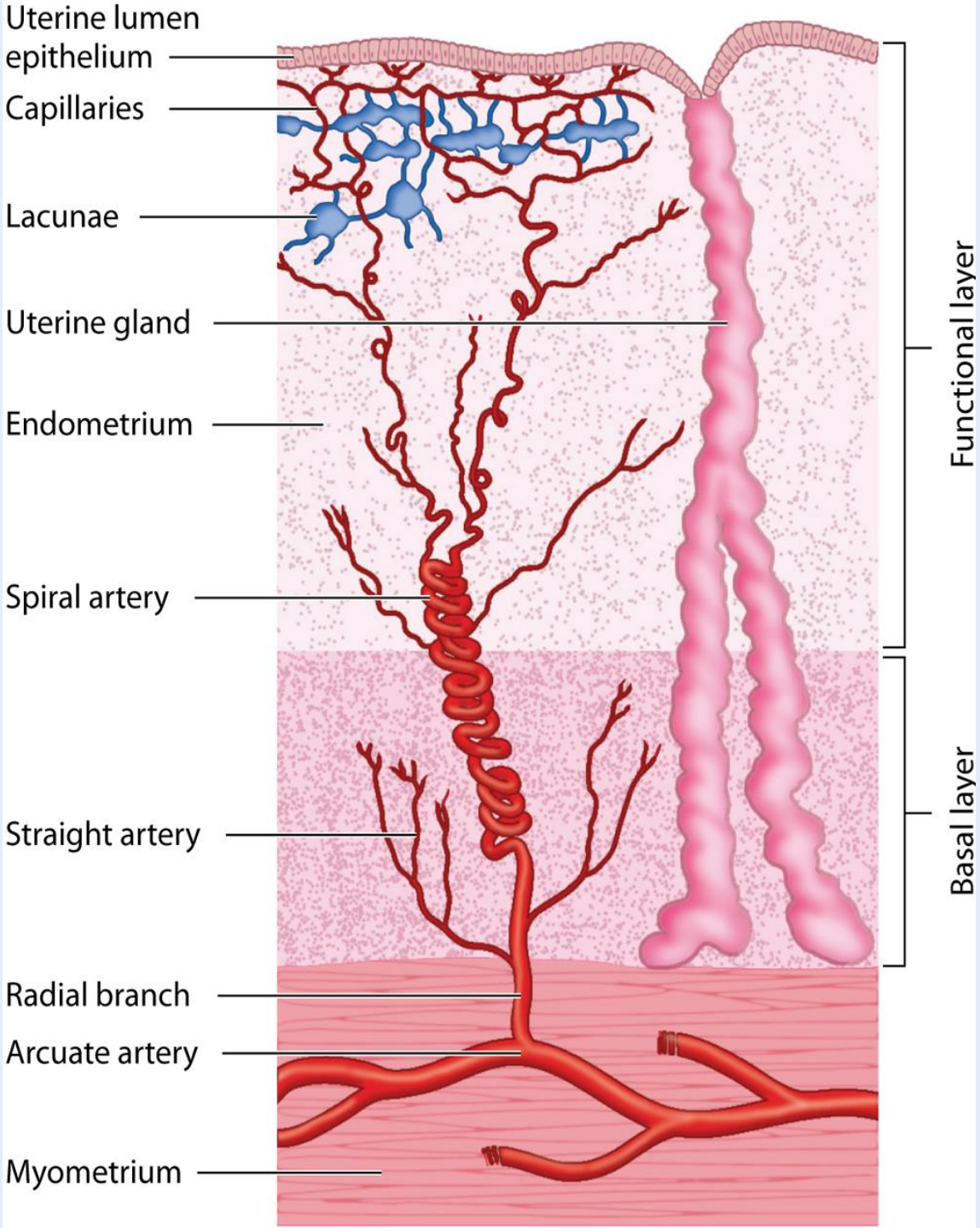
(a) The basal layer (**B**) of the endometrium, bordering the myometrium (**M**), contains the basal ends of the **uterine glands** (**G**) and many **small arteries** (**A**) embedded in a distinctive connective tissue stroma with many fibroblasts, ground substance and primarily fine **type III collagen**, but no adipocytes. X100. Mallory trichrome.

(b) Superficial to the basal layer of the endometrium is its **functional layer**, the part that changes **histologically and functionally** depending on **estrogen levels**. This micrograph shows only the functional layer and includes parts of the long **uterine glands** (**G**) as well as one **spiral artery** (**A**). X100. Mallory trichrome.

(c) The **surface epithelium** (**SE**) lining the endometrium is **simple columnar**, with many cells having **cilia**. The underlying stroma (**S**) has an extensive microvasculature, much ground substance, and fibroblastic cells with large, active nuclei. X400. Mallory trichrome.

Arterial supply to the endometrium.

The **basal and functional layers** of the endometrium are supplied by different sets of small arteries emerging from the uterine arcuate arteries in the myometrium: the **straight arteries** and **spiral arteries**, respectively. The spiral arteries are uniquely sensitive to **progesterone**, growing rapidly in a spiral fashion as the functional layer thickens under the influence of that luteal steroid and providing blood to a microvasculature that includes many lacunae lined by thin endothelium

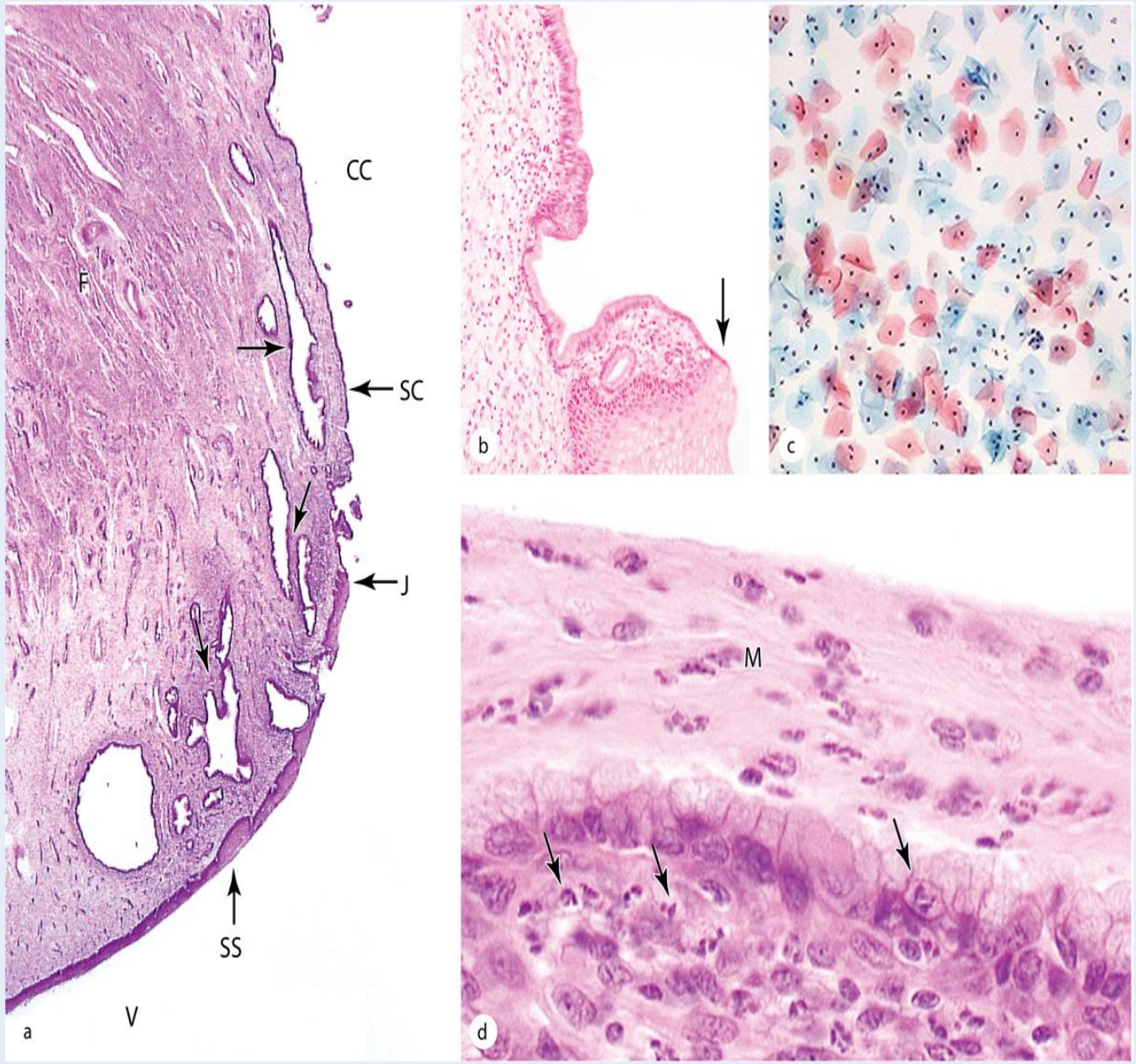


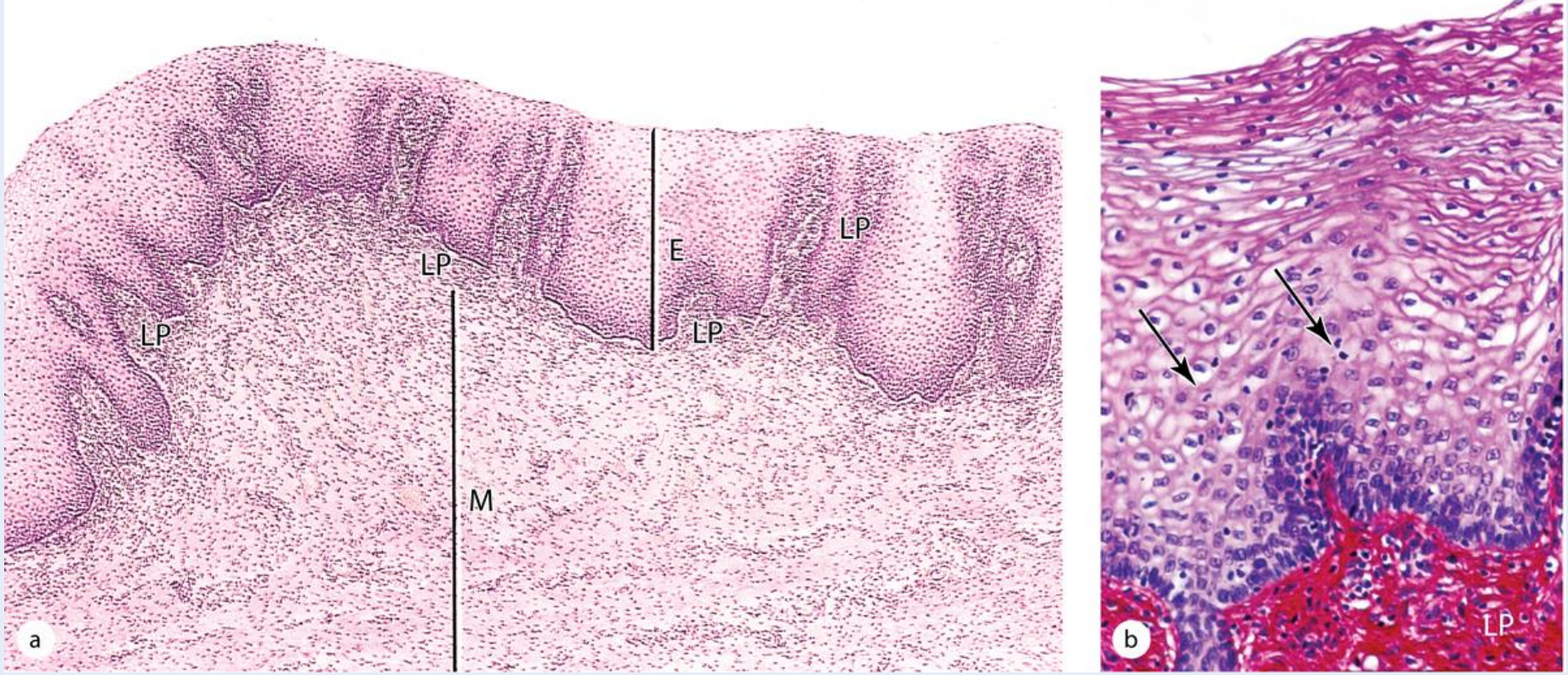
Cervix.

(a) The mucosa of the cervical canal (**CC**) is continuous with the endometrium and is lined by **simple columnar epithelium (SC).** This endocervical mucosa includes many large **branched cervical mucous glands** (**arrows**). At the external , the point at which the cervical canal opens into the vagina (**V**), there is an abrupt **junction** (**J**) between the columnar epithelium and the stratified squamous epithelium (**SS**) covering the exocervix and vagina. Deeper, the cervical wall is primarily fibromuscular tissue (**F**). **(b)** The epithelial junction (**arrow**) is seen more clearly. X50. H&E.

(c) **Exfoliative** cytology of epithelial cells from the exocervical mucosa in a routine **cervical smear**. The squamous cells, stained on a slide by the Papanicolaou procedure using **hematoxylin**, **orange G,** and **eosin**, stain differently according to their content of **keratins**. Cells with atypical nuclei or other abnormalities can be detected by this method that is used routinely to check for cervical carcinoma. X200. Papanicolaou stain.

(d) The endocervical mucosa is exposed to a relatively high population of microorganisms and normally has a large number of **neutrophils** and other **leukocytes**. Such cells occur in the lamina propria and epithelium (**arrows**





Vagina.

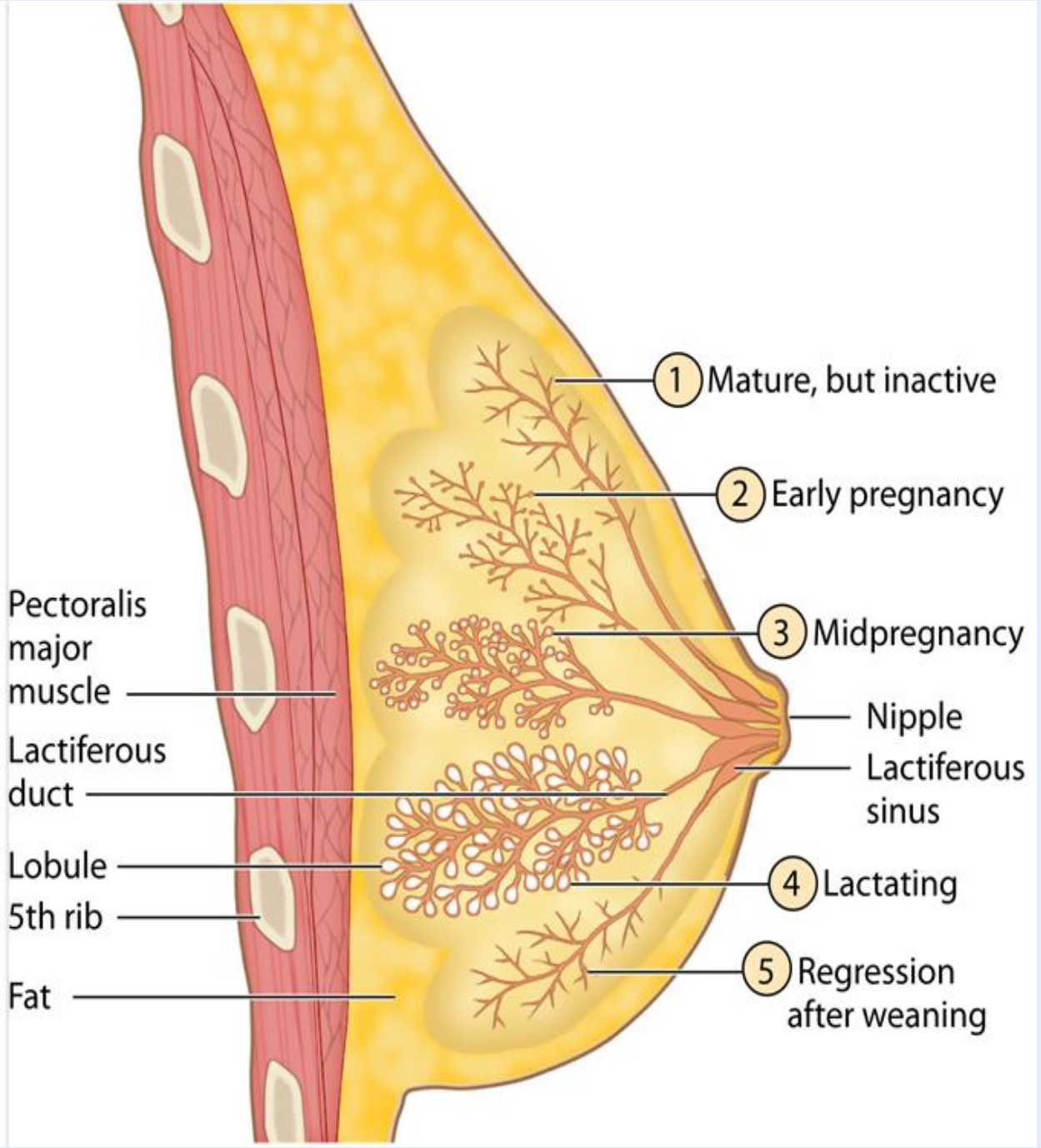
The vagina has **mucosal**, **muscular**, and **adventitial** layers.

(a) The lamina propria (**L**) is highly cellular and **extends** narrow papillae into the thick, **nonkeratinized stratified squamous epithelium** (**E**). The muscular layer (**M**) has bundles of smooth muscle arranged in a **circular** manner near the mucosa and **longitudinally** near the adventitia. X60. H&E.

(b) Higher magnification of the epithelium and lamina propria (**LP**) shows invasion of leukocytes (**arrows**) between epithelial cells from the connective tissue.

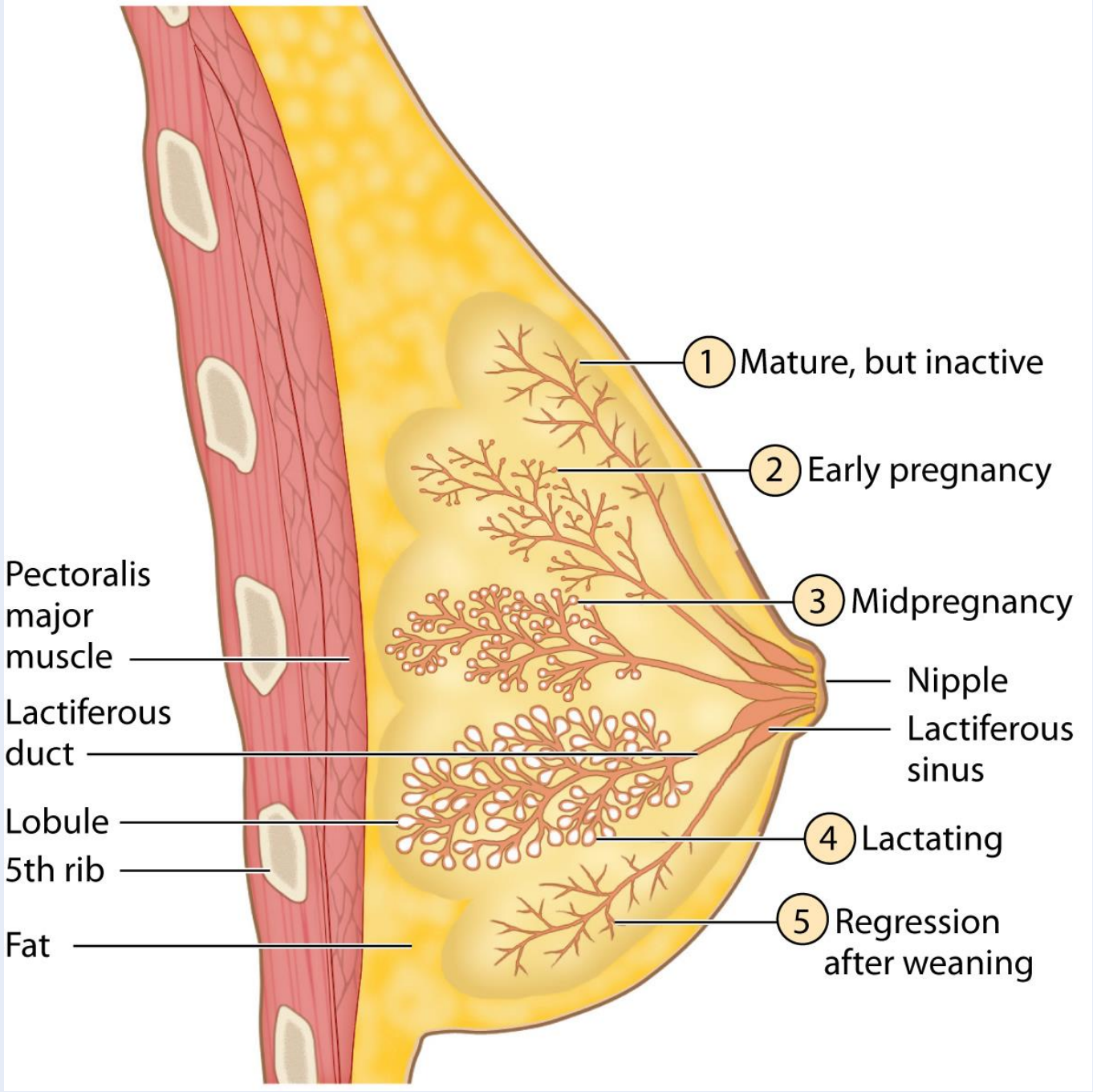
MAMMARY GLANDS

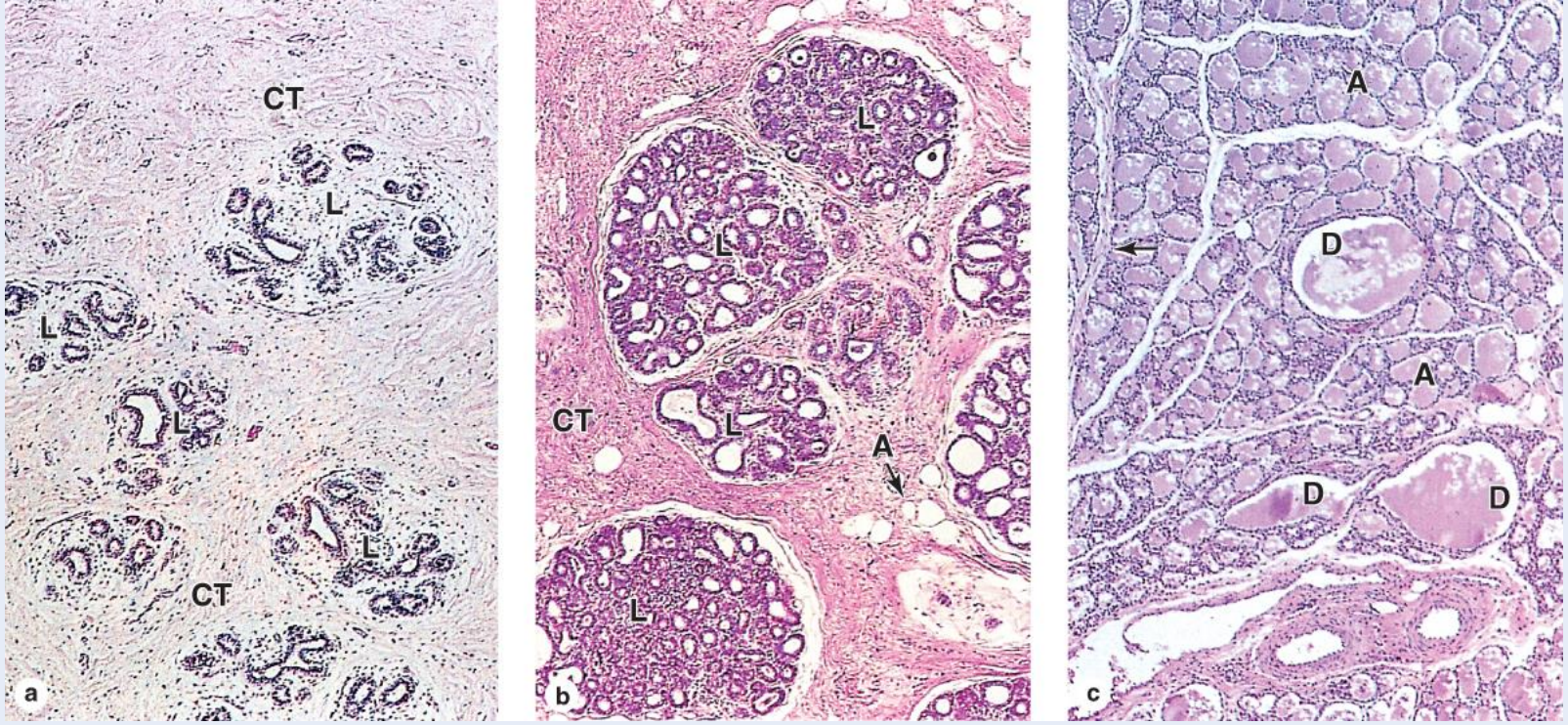
Mammary glands of both genders are **identical** for the first decade or so of life, **but** when the female reaches **puberty**, the flow of **estrogens** and **progesterone** as well as lactogenic hormone induces the mammary gland to **enlarge** and develop a **system of lobules and terminal ductuless** as well as an **increase** in the connective tissue mass and a deposit of adipose tissue. Each mammary gland of the postpubertal female is composed of numerous **compound tubuloalveolar glands**, each with its own lactiferous sinus and a duct that opens at the apex of the nipple.



Mammary gland.

Shown here is the **sequence of changes** that occur in the alveolar secretory units and duct system of mammary glands before, during, and after pregnancy and lactation. (**1**) **Before pregnancy**, the gland is inactive, with small ducts and only a few small secretory alveoli. (**2**) Alveoli develop and begin to grow **early in a pregnancy**. (**3**) By **midpregnancy**, the alveoli and ducts have become large and have dilated lumens. (**4**) At **parturition** and during the time of lactation, the alveoli are greatly dilated and maximally active in production of milk components. (**5**) After weaning, the alveoli and ducts regress with apoptotic cell death.





Alveolar development in the breast during pregnancy.

(a) The mammary glands of adult, nonpregnant women are inactive, with small ducts and few lobules (L) having secretory alveoli which are not well-developed. The structure with the large lumen in each lobule is part of the duct; the smaller structures are the small, undeveloped alveoli. The breasts are composed largely of connective tissue (CT), having considerable fat.

(b) The glands become active during pregnancy, with the duct system growing rapidly and the secretory units of each lobule becoming much larger and more extensively branched. In this micrograph adipocytes (A) are included, but these are only a small fraction of those present.

(c) During lactation, the lobules are greatly enlarged and the lumens of both the numerous glandular alveoli (A) and the excretory ducts (D) are filled with milk. The intralobular connective tissue is more sparse and difficult to see, except for small septa (arrows). All X60, H&E