SEM Seminiferous Tubules

Male Reproductive

CHAPTER 21

Sex Determination: More Complicated Than You Thought:
http://ed.ted.com/on/C1lWtSAb

Overview of the Reproductive System

Male reproductive system: produce sperm, introduces gametes into female

Female reproductive system: produces eggs, receives sperm, provides for the union of the gametes, harbors the fetus, and nourishes the offspring

Primary sex organs (**gonads**): Produce gametes (**testes** or **ovaries**)

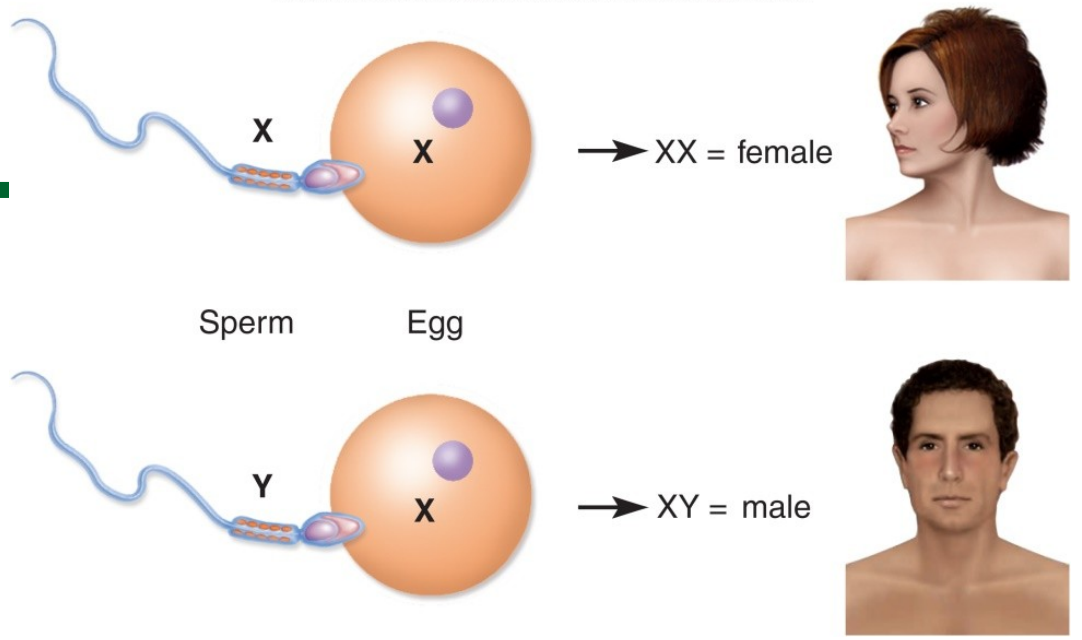
Secondary sex organs: necessary for reproduction, but don't produce gametes

- Male: system of ducts, glands; penis delivers sperm cells
- Female: uterine tubes, uterus, and vagina receive sperm and harbor developing fetus

TABLE 27.1 The External and Internal Genitalia

External Genitalia	Internal Genitalia
Male	
Penis	Testes (s., *testis*)
Scrotum	Epididymides (s., *epididymis*) Ductus deferentes (s., *ductus deferens*) Seminal vesicles Prostate Bulbourethral glands
Female	
Mons pubis	Ovaries
Labia majora (s., *labium majus*)	Uterine tubes
Labia minora (s., *labium minus*)	Uterus
Clitoris	Vagina
Vaginal orifice	
Vestibular bulbs	
Vestibular glands	
Paraurethral glands	

Sexual reproduction



Male parent: Y chromosome, gamete (sperm, spermatozoon) has motility

Female parent: lacks Y chromosome, gamete (egg, ovum) contains nutrients for developing embryo

Mammals: female parent provides sheltered internal environment and prenatal nutrition of the embryo

Androgen-Insensitivity Syndrome: XY chromosomes, testes produce normal male levels of testosterone but target cells lack receptors. External genitalia develop female anatomy as if no testosterone were present, presence of testes in the abdomen, no uterus or menstruation

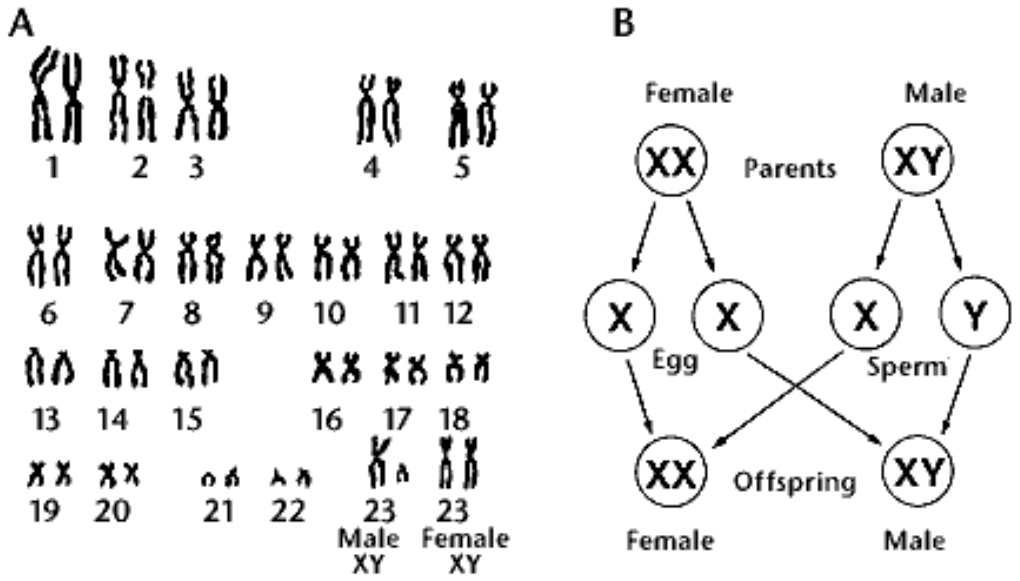
http://www.dailymail.co.uk/video/news/video-1155630/Doctors-explain-androgen-insensitivity-syndrome.html

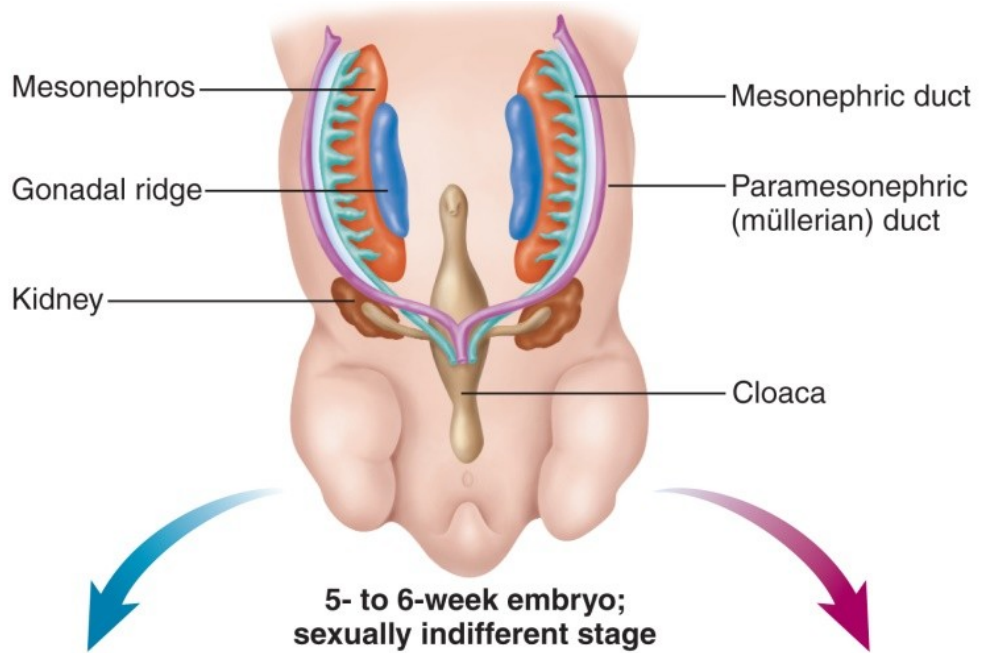
Chromosomes and Sex Determination

Human cells: 22 pairs of autosomes, 1 pair of sex chromosomes (XY males: XX females)

<u>Initially, a fetus is sexually undifferentiated</u>
SRY gene (sex-determining region of Y chromosome): codes for a protein, testes-determining factor (TDF), that initiates development of testes

Gonads begin to develop at 5 or 6 weeks as gonadal ridges

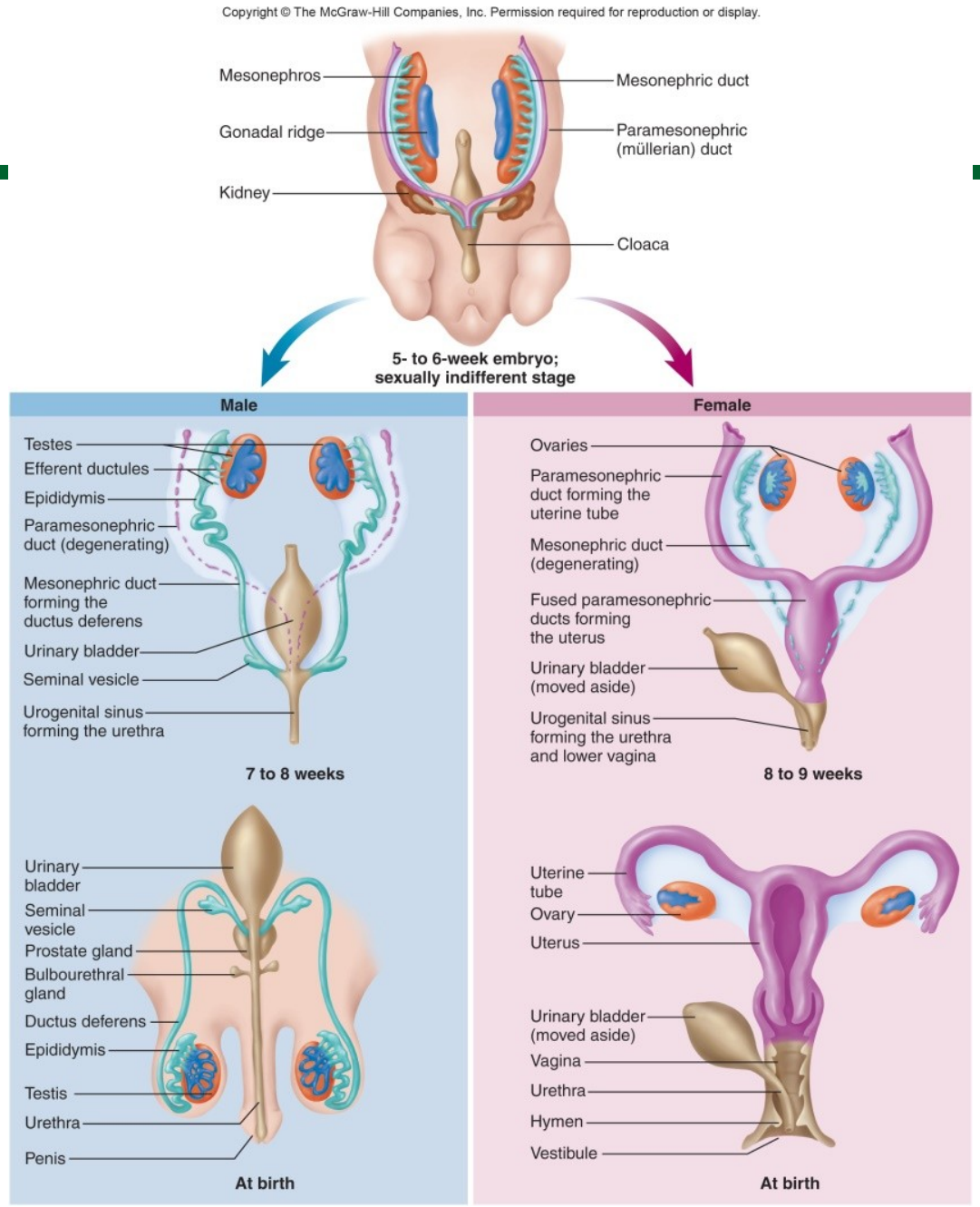




Sexual Differentiation

Male: gonads secrete testosterone at 8 to 9 weeks, **stimulate mesonephric (wolffian) ducts** → male reproductive system;
Testes secrete **müllerian-inhibiting factor** causing **paramesonephric ducts degeneration**
Female: Paramesonephric (müllerian) ducts → female reproductive tract; mesonephric ducts degenerate

If estrogen was the hormone that directed the female development, all fetuses would be feminized (estrogen levels are always high in pregnancy)



Similarity of external genitalia

Male:

Genital tubercle → head (glans) of penis

Urogenital folds encloses urethra → penis

Labioscrotal folds → scrotum

Female:

Genital tubercle → glans of clitoris

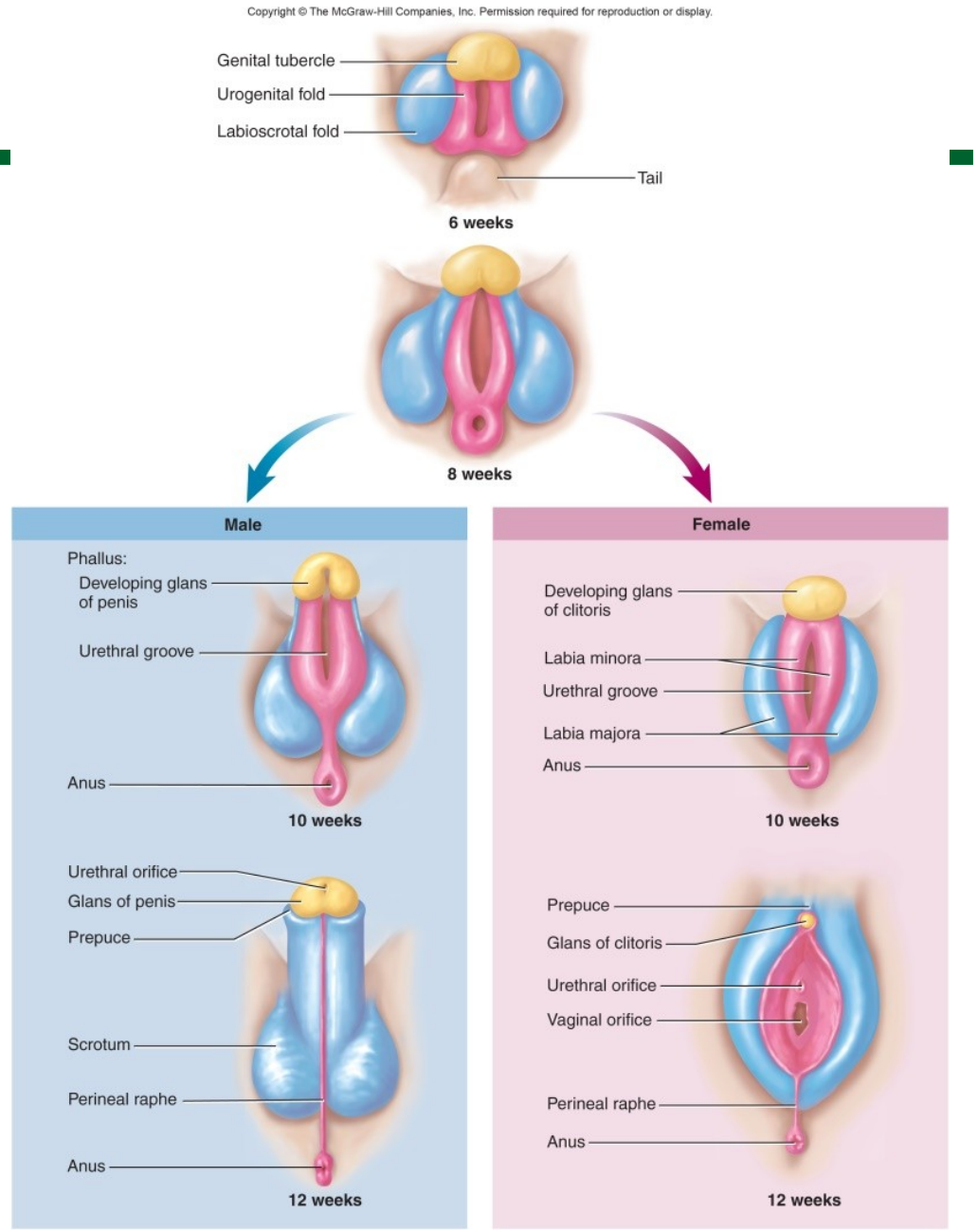
Urogenital folds → labia minora

Labioscrotal folds → labia majora

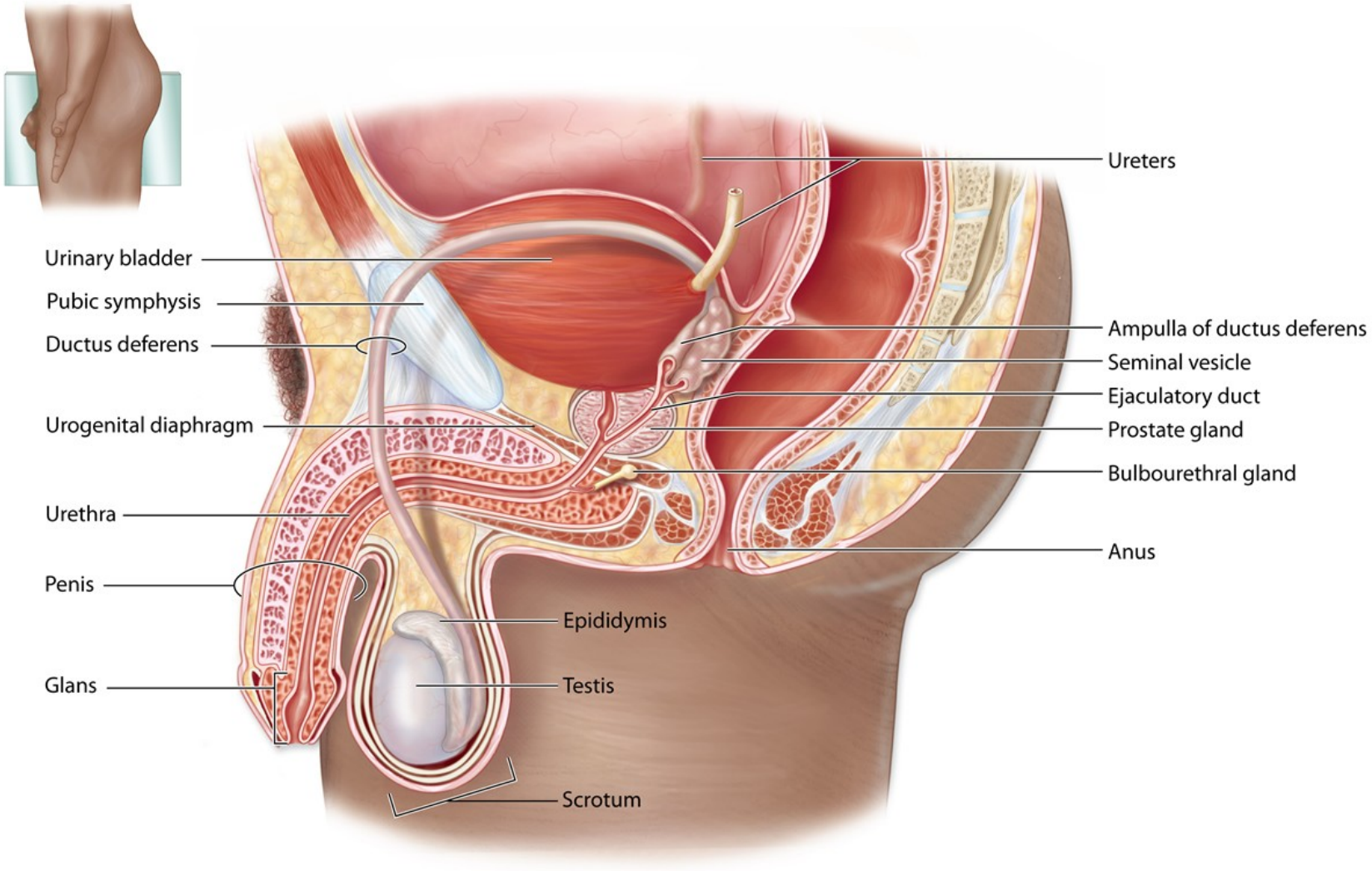
Genitalia formed by week 12

Male and female organs from same embryonic structure are homologous

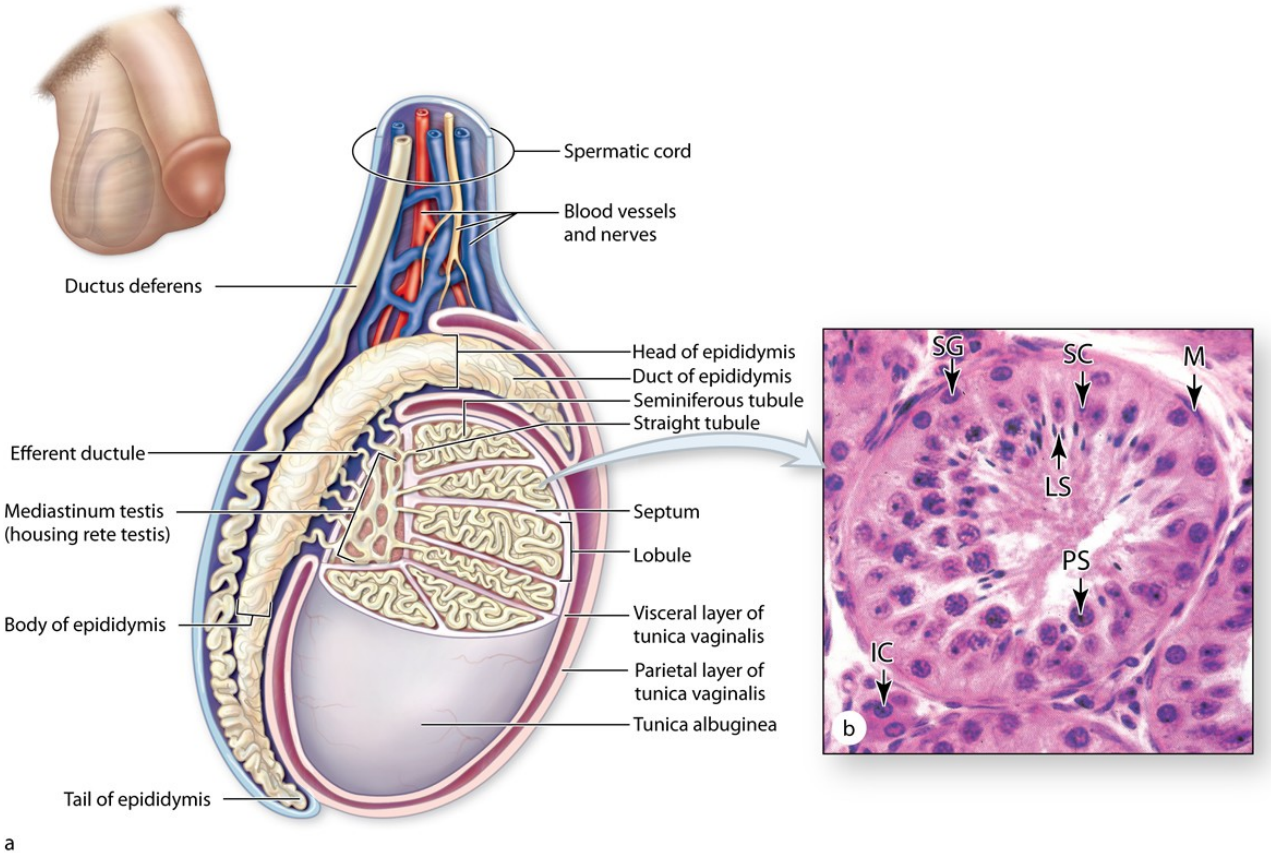
Penis~clitoris, scrotum~labia majora



The male reproductive system



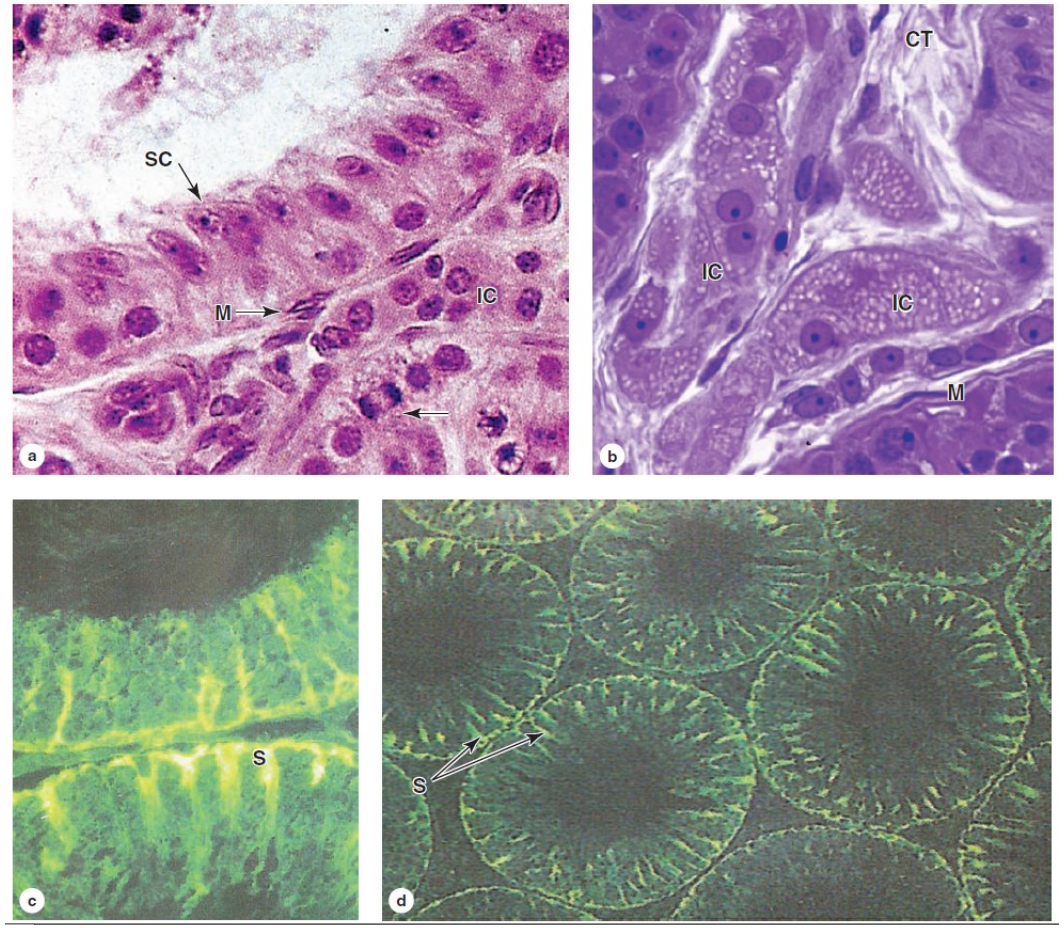
The Testes: (testicles: endocrine /exocrine glands that produce sex hormones and sperm



Spermatogonia (SG) **Sertoli Cells (SC)**
primary spermatocytes (PS) **late spermatids (LS)**
interstitial cells (IC)

Tunica Vaginalis: anterior cover
Tunica Albuginea: white fibrous capsule
Connective tissue septa: divides testes 250 to 300 lobules
Seminiferous tubules: 1 to 3 per lobule, lined with a thick germinal epithelium for sperm generation
Interstitial (Leydig) cells: between tubules produce testosterone
Sustentacular (Sertoli) Cells: between germ cells, protect the germ cells, and promote their development
Germ cells depend on them for nutrients, waste removal, growth factors, and other needs

Seminiferous tubule and interstitial cells



(a-b) Seminiferous tubules are surrounded by connective tissue (**CT**) containing many large interstitial cells (**IC**) that secrete androgens. Sertoli cells (**SC**),
Dividing spermatogenic stem cells with round nuclei (**arrow**).

(c-d) Immunohistochemistry (antibody against sulfated glycoprotein-1 of Sertoli cells (**S**) in the seminiferous tubules.

MEDICAL APPLICATION Both interstitial cell tumors and Sertoli cell tumors are rare. Most (95%) testicular cancer involves germ cell tumors, which only appear after puberty and are much more likely to develop in men with untreated cryptorchidism.

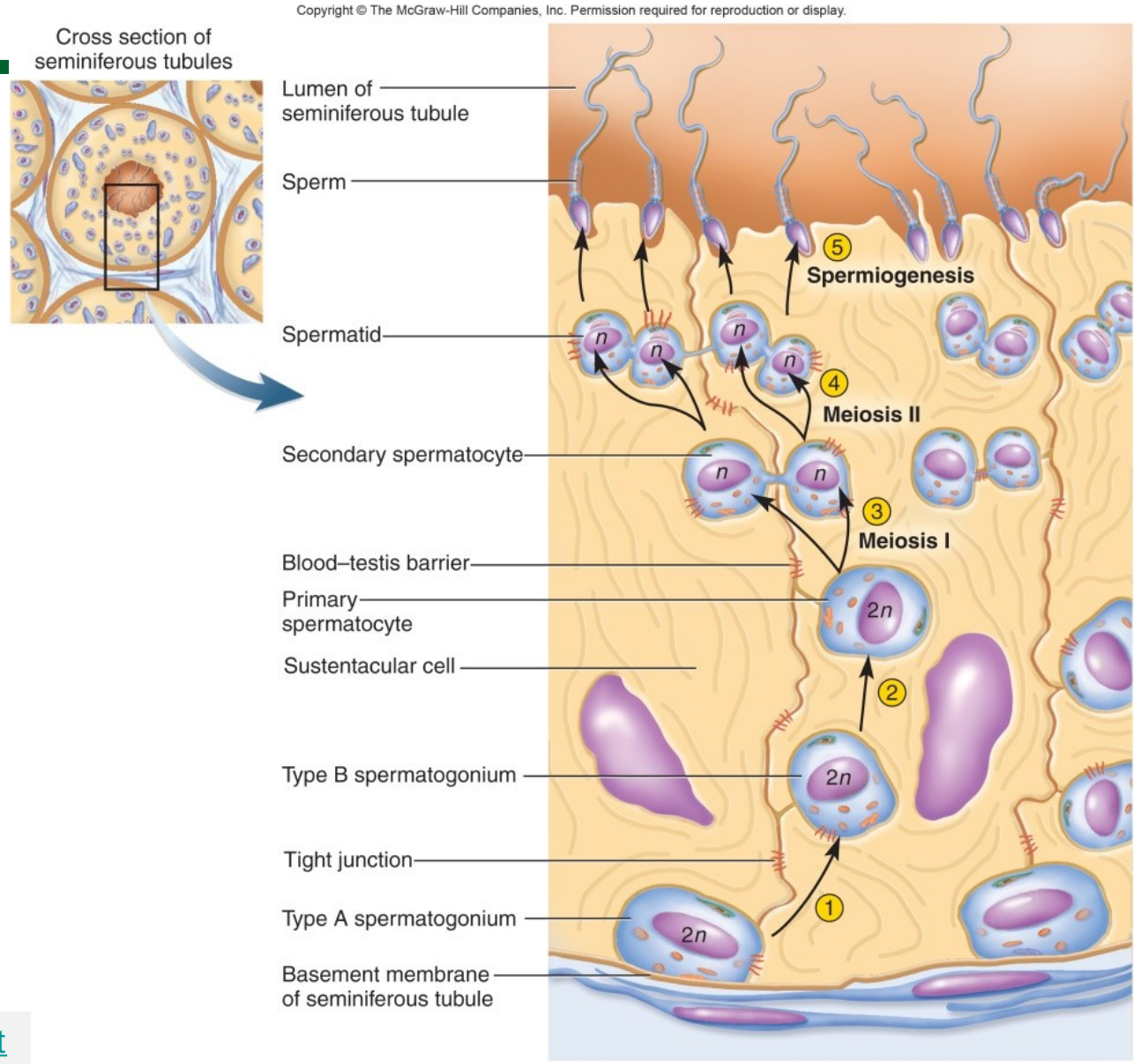
Spermatogenesis

Spermatogonia: divide by mitosis in seminiferous tubules

One daughter cell of each division remains in tubule wall as stem cell: **Type A spermatogonium**

Other daughter cell migrates slightly away from wall and is on its way to producing sperm: **Type B spermatogonium**

Primary spermactye (protected by the blood–testis barrier) → secondary spermacyte → spermatid → sperm



http://highered.mheducation.com/sites/0072495855/student_view0/chapter28/animation__spermatogenesis__quiz_1_.html

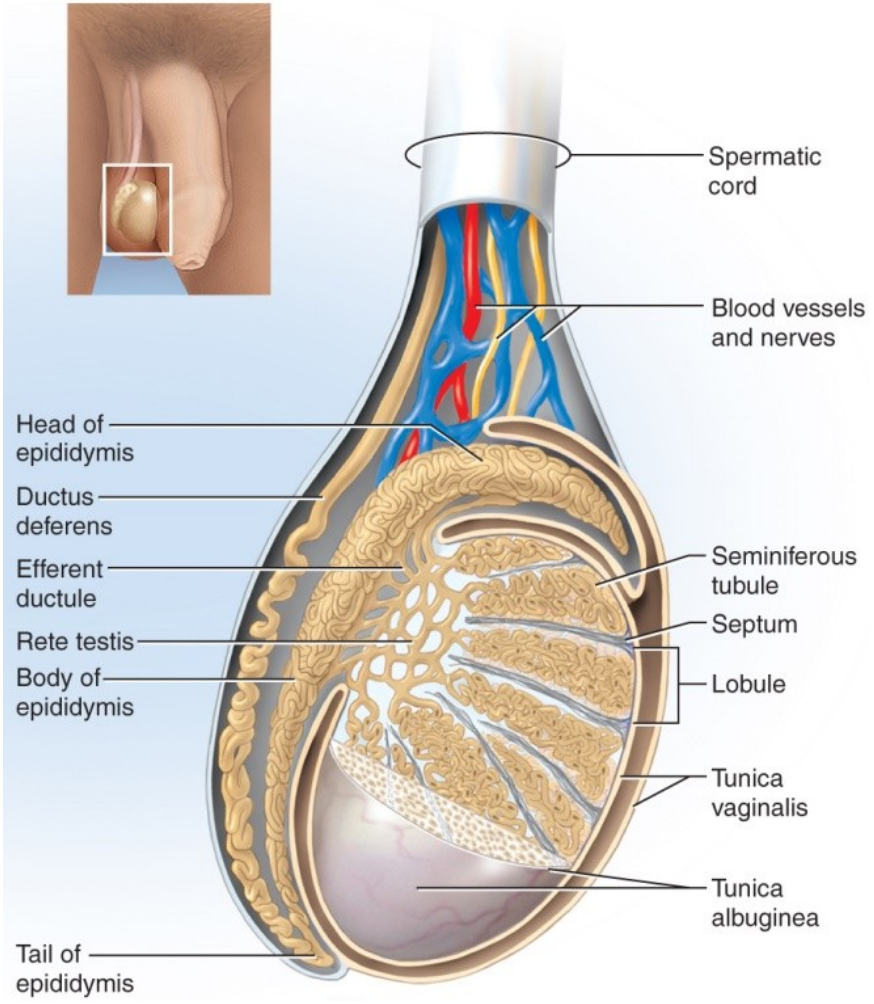
Rete Testes

Rete testis: collects sperm from seminiferous tubules, move with flow of fluid secreted by the sustentacular cells. Sperm do not swim while in the male reproductive tract.

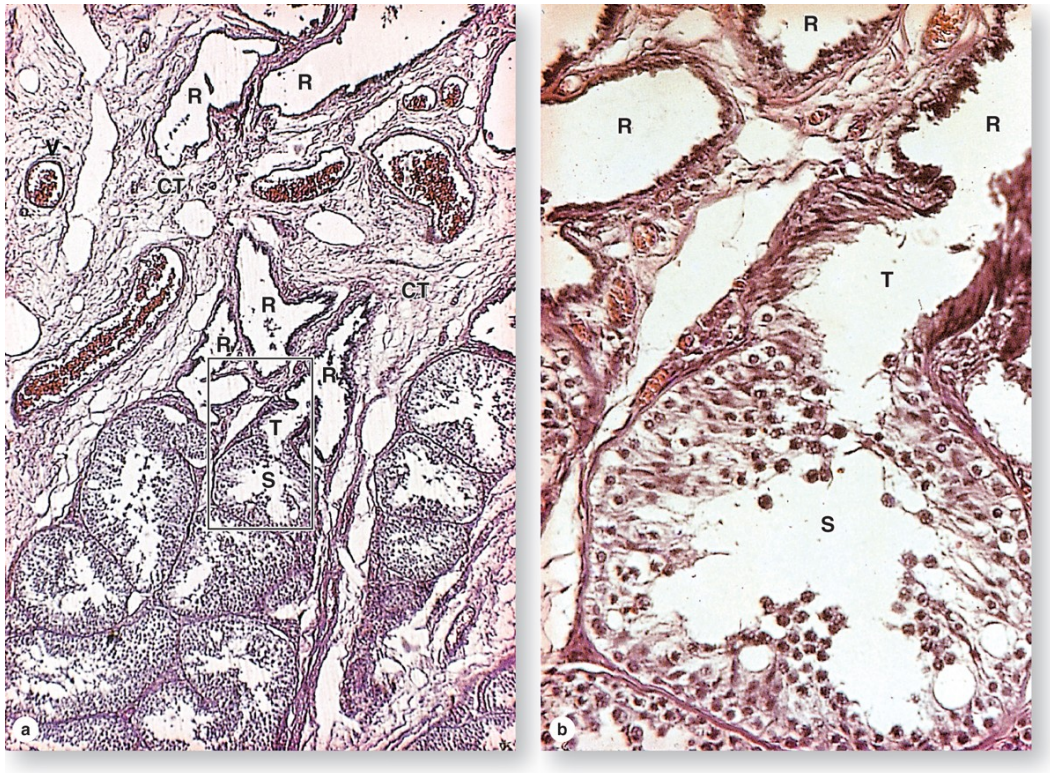
Testicular artery: Low BP, poor O2 supply to the testes.

Blood flow: Testicular artery → pampiniform → testicular veins → inferior vena cava (R) or left renal vein (L)

Blood–testis barrier (BTB): tight junctions between sustentacular cells, keeps Abs out, as germ cells are immunologically different from body cells and would be attacked by the immune system



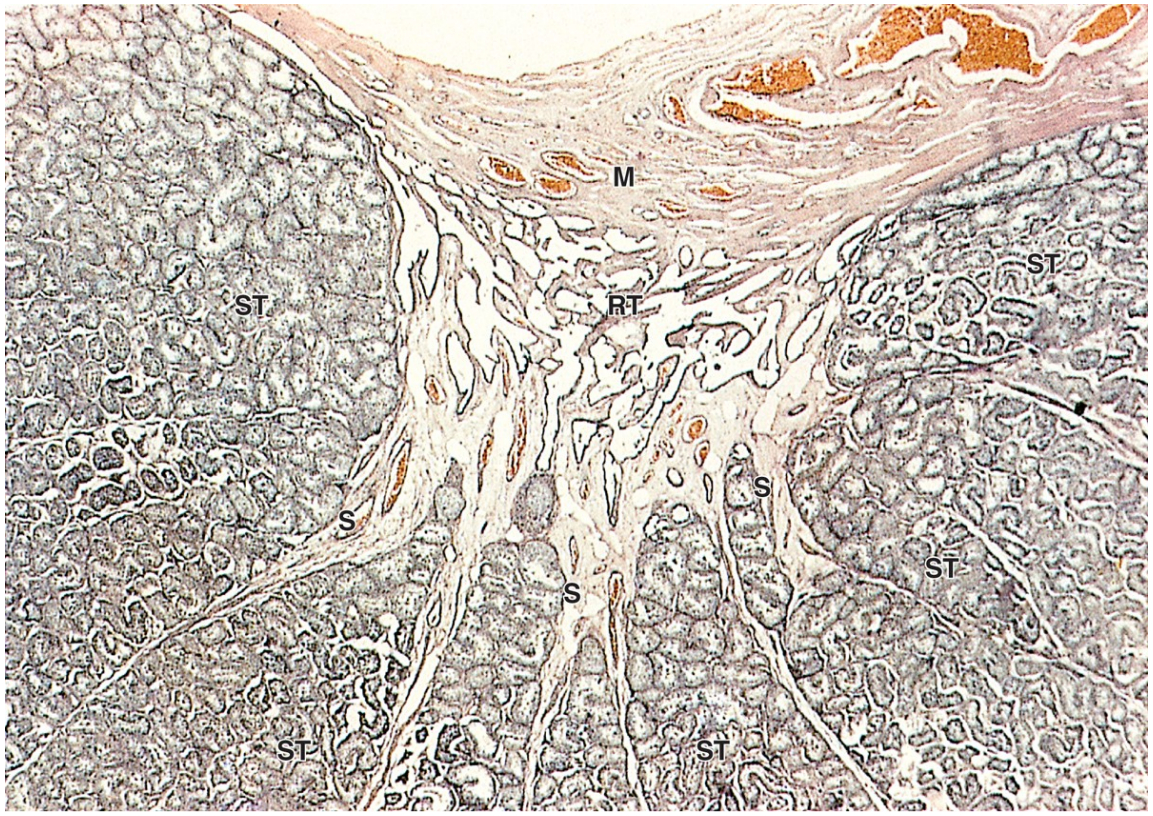
Seminiferous tubules, straight tubules and rete testis



(a) The seminiferous tubules (**S**) drain into short, much narrower straight tubules (**T**), which connect to the rete testis (**R**), a network of channels embedded along with blood vessels (**V**) in the connective tissue (**CT**) of the mediastinum testis.

(b) At higher magnification the enclosed portion of part **a** shows the transition from wide seminiferous tubule (**S**) to the straight tubule (**T**). Initially the straight tubule wall has only tall Sertoli cells devoid of germ cells. The wall becomes a **simple cuboidal epithelium** near its connection to the rete testis (**R**), which is also lined with simple cuboidal epithelium

Lobules converging at rete testis



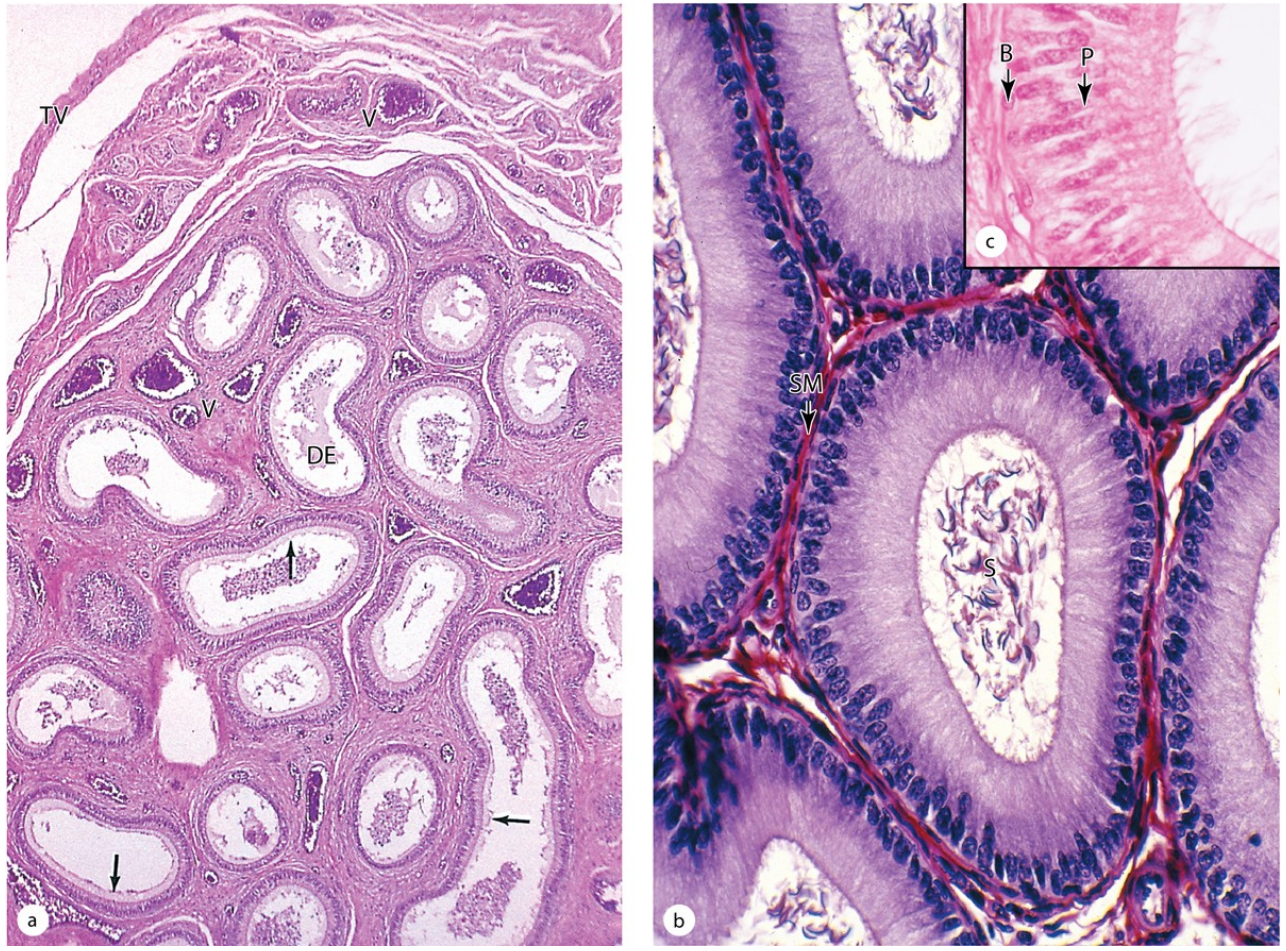
Mediastinum testis (**M**) form thin septa (**S**) to subdivide testis.
Seminiferous tubules (**ST**) form rete testis (**RT):** move sperm into the epididymis.

MEDICAL APPLICATION Acute or chronic inflammation of the testis ducts (**orchitis)** can be caused by urinary tract infection or *Chlamydia* or *Neisseria gonorrhoeae*.

Persistent inflammation (**epididymitis)** causes massive invasion by leukocytes into the infected duct, stimulating fibrosis that obstructs the epididymis and is a common cause of male infertility.

Killer Sex Disease Now DRUG RESISTANT! https://www.youtube.com/watch?v=0b2ngu5Vr4Y

Epididymis: sperm undergo maturation and short-term storage



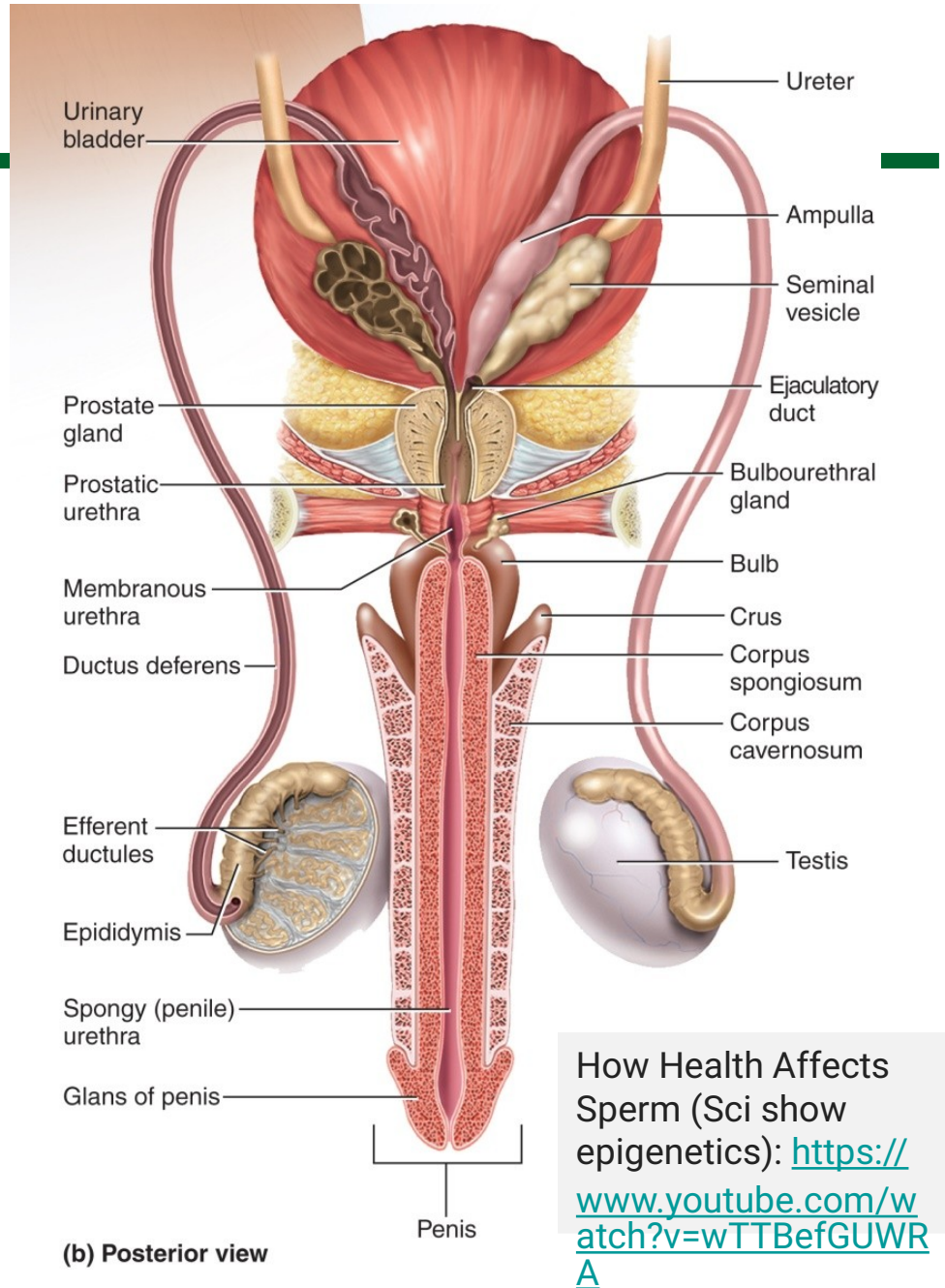
Epididymis (**DE**) is enclosed by connective tissue with many blood vessels (**V**) and covered by a capsule and the tunica vaginalis (**TV**). Lined by a pseudostratified columnar epithelium with long stereocilia (**arrows**).

The columnar epithelium of the epididymal duct is surrounded by a thin circular layer of smooth muscle (**SM**) cells and its lumen contains sperm (**S**).

The spermatic ducts: testis to urethra

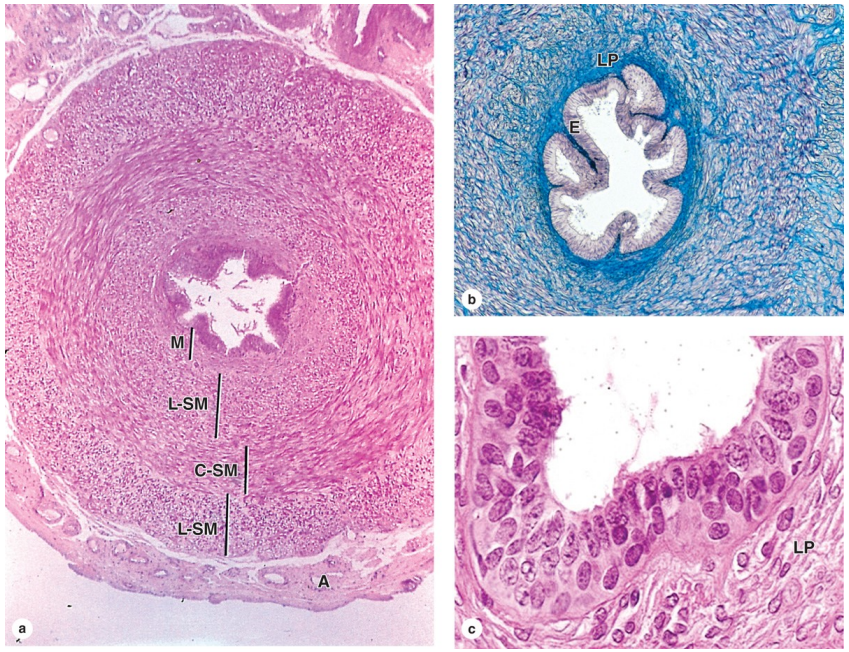
Efferent ductules: ~12 small ciliated ducts collecting sperm from rete testes and transporting it to epididymis
Duct of the epididymis: Site of sperm maturation and storage (fertile for 40 to 60 days)
Ductus (vas) deferens: from scrotum to bladder
Seminal vesicle: form semen secretion
Semen passes through prostate via **Ejaculatory duct** to empty into urethra

MEDICAL APPLICATION Male infertility is frequently idiopathic (unknown causes). Poor semen quality results from reduces sperm cell density, abnormal sperm morphology, and flagellar defects that impair sperm motility.



How Health Affects Sperm (Sci show epigenetics): https://www.youtube.com/watch?v=wTTBefGUWRA

Ductus deferens



Mucosa (**M**), a thick muscularis with inner and outer layers of longitudinal smooth muscle (**L-SM**) and an intervening layer of circular smooth muscle (**C-SM**), and an external adventitia (**A**). The muscularis is specialized for powerful peristaltic movement of sperm at ejaculation.

(b) The lamina propria (**LP**) is rich in elastic fibers and the thick epithelial lining (**E**) shows longitudinal folds. Mallory trichrome.

(c) Higher magnification of the mucosa shows that the epithelium is pseudostratified with basal cells and many columnar cells, some with stereocilia.

MEDICAL APPLICATION: In **vasectomy,** a small incision is made through the scrotal skin near the two ducts and the two ends (or only the end leading to the abdomen) are cauterized and tied. After vasectomy sperm are still produced, but they degenerate and are removed by macrophages in the epididymis (and in the scrotal sac if the short portion of the vas is left open-ended.)

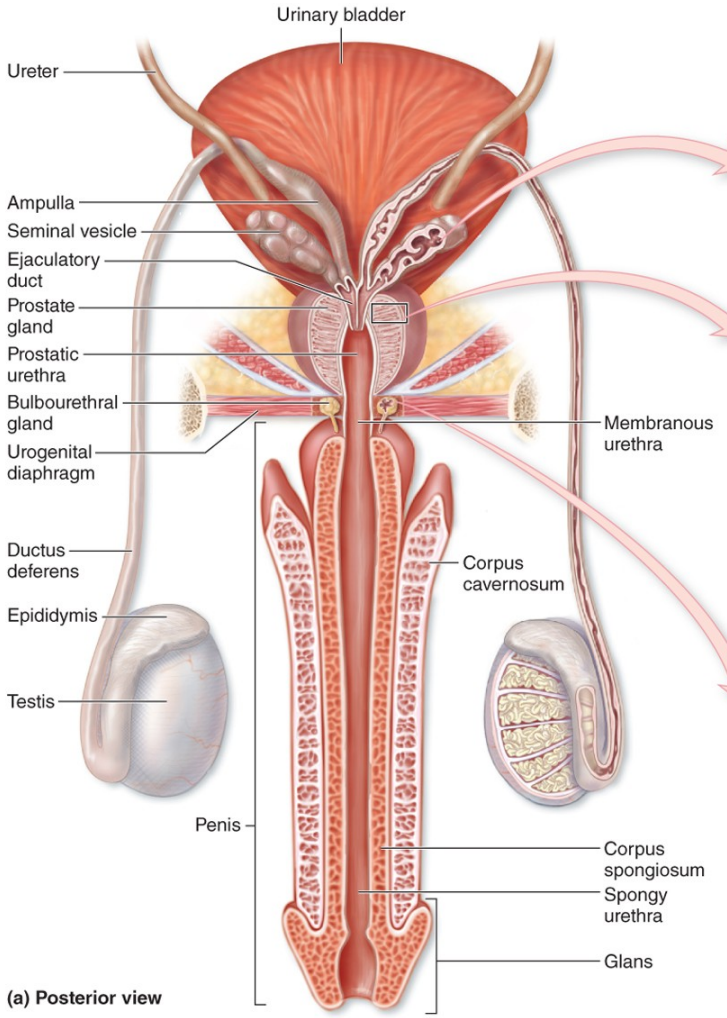
The Accessory Glands

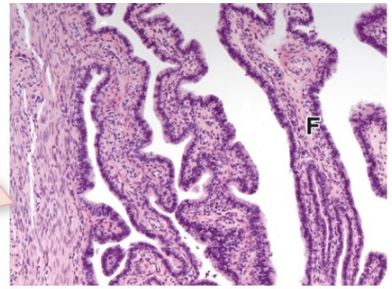
Seminal vesicles: Forms 60% of semen. Fructose (energy), prostaglandins (stimulates female activity), fibrinogen (semen coagulation)

Prostate gland: Thin milky secretion forms 30% of semen. Prostoglandins, enzymes

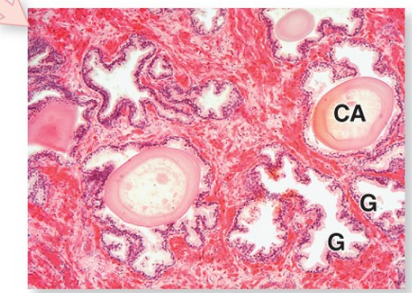
Bulbourethral (Cowper) glands: lubricates the head of the penis in preparation for intercourse, neutralizes acidity of residual urine in the urethra

MEDICAL APPLICATION Prostate cancer (adenocarcinoma), the most common cancer in nonsmoking men, occurrs mainly in glands of the peripheral zone.

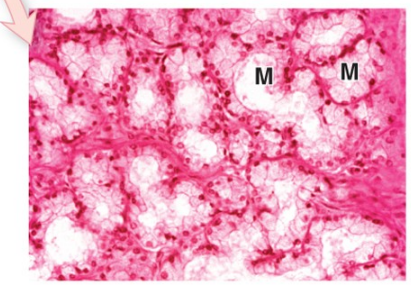




(b) Seminal vesicle



(c) Prostate gland

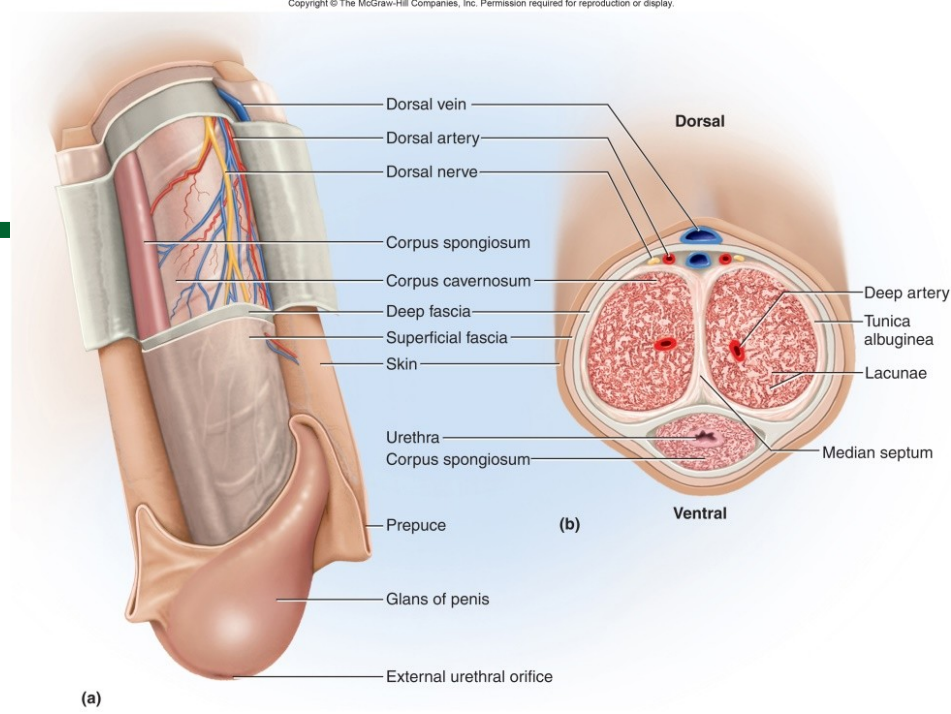


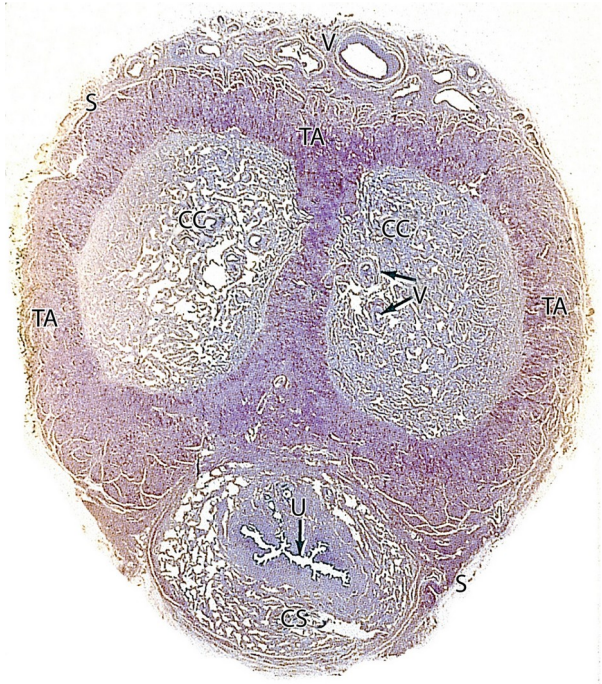
(d) Bulbourethral gland

The penis

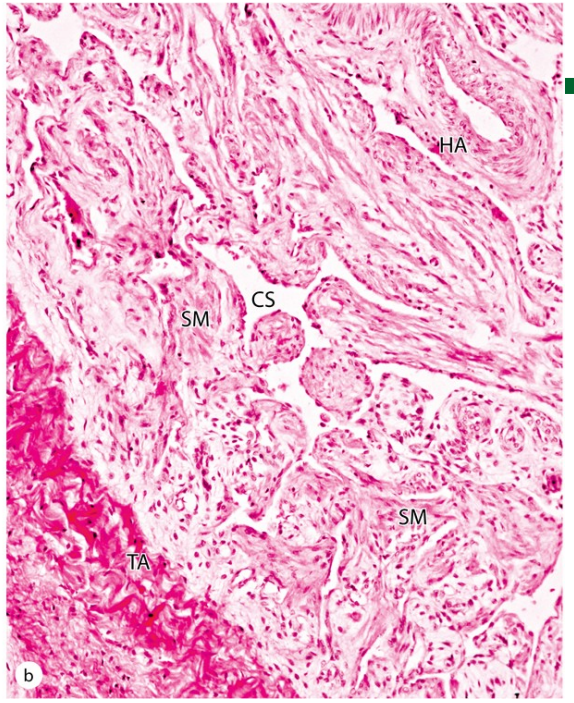
Foreskin: Extends over glans as **prepuce**, removed by circumcision
Three cylindrical bodies of erectile tissue: fill with blood during sexual arousal → enlargement → erection
Corpus spongiosum: encloses spongy (penile) urethra
Corpora cavernosa: Diverge like arms (crus) of a Y, attaches penis to pubic arch,
Lacunae: blood sinuses
Trabeculae: partitions between lacunae

corpus spongiosum (**CS**) urethra (**U**) corpora cavernosa (**CC**) tunica albuginea (**TA**) blood vessels (**V**) skin (**S**), which distally forms the large foreskin fold and becomes thin over the glans





Penile urethra and erectile tissue

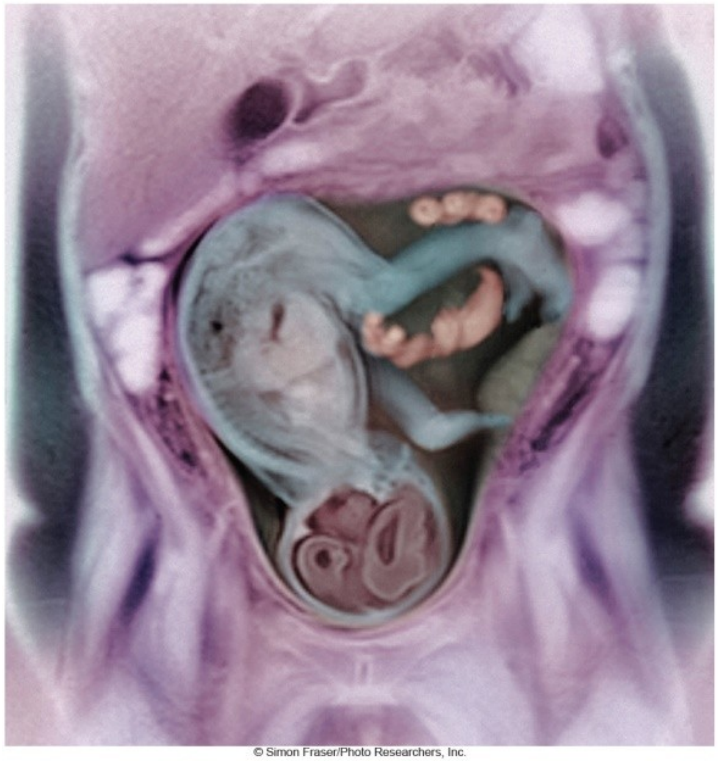


(a) The corpus spongiosum (**CS**) surrounds the longitudinally folded wall of the penile urethra (**PU**). Small urethral glands (**UG**) with short ducts to the urethra release mucus during erection, supplementing the similar secretion from the bulbourethral glands. The two dorsal corpora cavernosa (**CC**) are ensheathed by dense, fibrous tunica albuginea (**TA**) and in one here a small helicine artery (**HA**)
(b) A higher magnification of erectile tissue is shown with a small portion of tunica albuginea (**TA**) and fibrous, elastic connective tissue containing smooth muscle (**SM**) and many small, cavernous spaces (**CS**) lined by vascular endothelium. Very little blood normally passes through this vasculature due to constriction of the helicine arteries (**HA**) serving them.

MEDICAL APPLICATION: Acetylcholine from parasympathetic nerves causes the vascular endothelial cells of the helicine arteries and cavernous tissue to release nitric oxide (NO). NO causes surrounding smooth muscle cells to relax and promotes blood flow for the erection.

Erectile dysfunction , or impotence , can result from diabetes, anxiety, vascular disease, or nerve damage during prostatectomy. Drugs may alleviate the problem by inhibiting smooth muscle cells of helicine arteries and erectile tissue.

Duct	Location	Epithelium	Support Tissues	Function(s)
Seminiferous tubules	Testicular lobules	Spermatogenic, with Sertoli cells and germ cells	Myoid cells and loose connective tissue	Produce sperm
Straight tubules (tubuli recti)	Periphery of the mediastinum testis	Sertoli cells in proximal portions, simple cuboidal in distal portions	Connective tissue	Convey sperm into the rete testis
Rete testis	In mediastinum testis	Simple cuboidal	Dense irregular connective tissue	Channels with sperm from all seminiferous tubules
Efferent ductules	From rete testis to head of epididymis	Alternating patches of simple cuboidal nonciliated and simple columnar ciliated	Thin circular layer of smooth muscle and vascular loose connective tissue	Absorb most fluid from seminiferous tubules; convey sperm into the epididymis
Epididymal duct	Head, body, and tail of the epididymis	Pseudostratified columnar, with small basal cells and tall principal cells bearing long stereocilia	Circular smooth muscle initially, with inner and outer longitudinal layers in the tail	Site for sperm maturation and short-term storage; expels sperm at ejaculation
Ductus (vas) deferens	Extends from epididymis to ejaculatory ducts in prostate gland	Pseudostratified columnar, with fewer stereocilia	Fibroelastic lamina propria and three very thick layers of smooth muscle	Carries sperm by rapid peristalsis from the epididymis to the ejaculatory ducts
Ejaculatory ducts	In prostate, formed by union of ductus deferens and ducts of the seminal vesicles	Pseudostratified and simple columnar	Fibroelastic tissue and smooth muscle of the prostate stroma	Mix sperm and seminal fluid; deliver semen to urethra, where prostatic secretion is added



Female Reproductive System

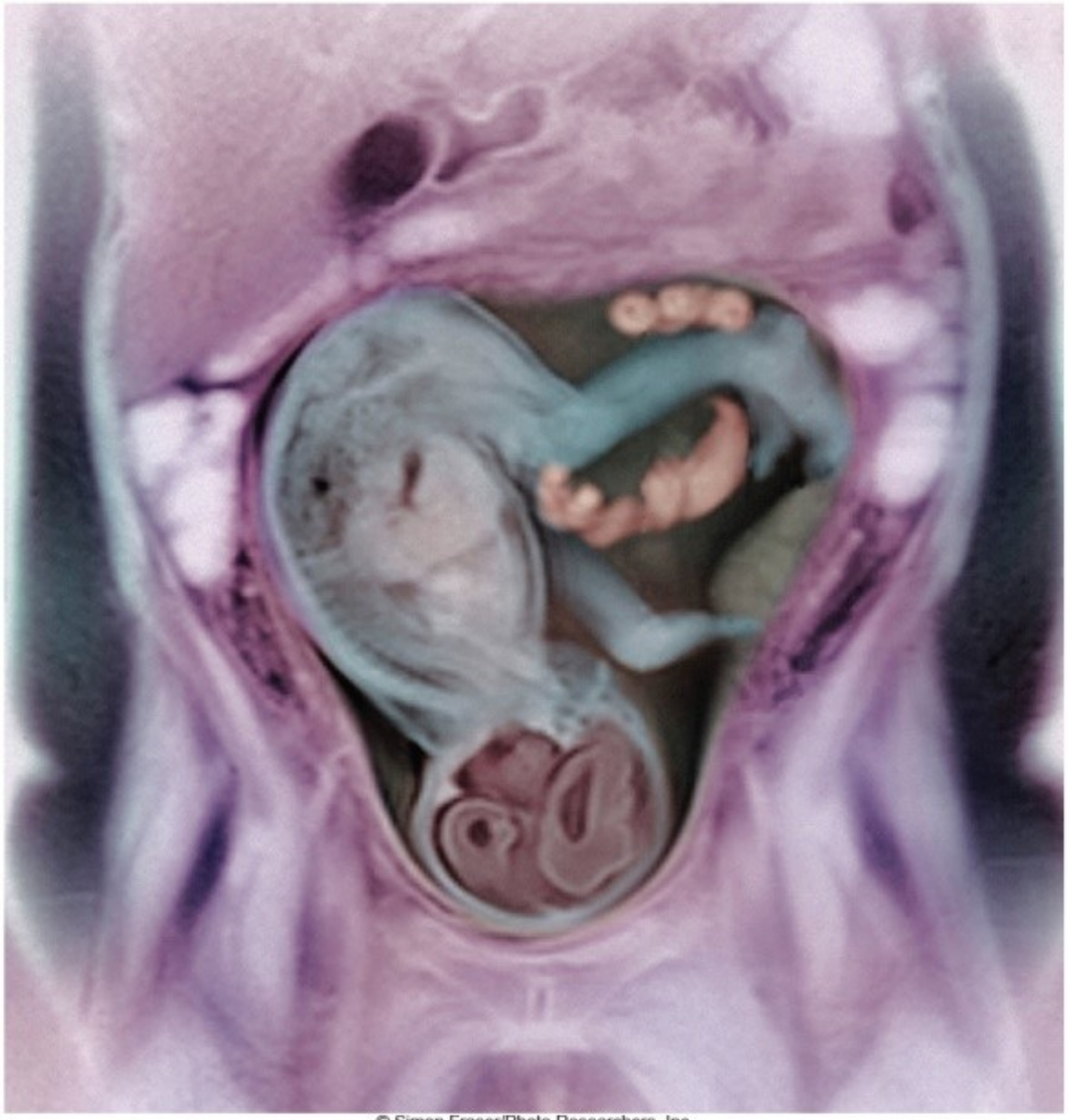
BI 455 CHAPTER 23

Introduction

The female reproductive system is more complex than the male system because it serves more purposes

- Produces and delivers gametes
- Provides nutrition and safe harbor for fetal development
- Gives birth
- Nourishes infant

Female system is more cyclic, and the hormones are secreted in a more complex sequence than the relatively steady secretion in the male



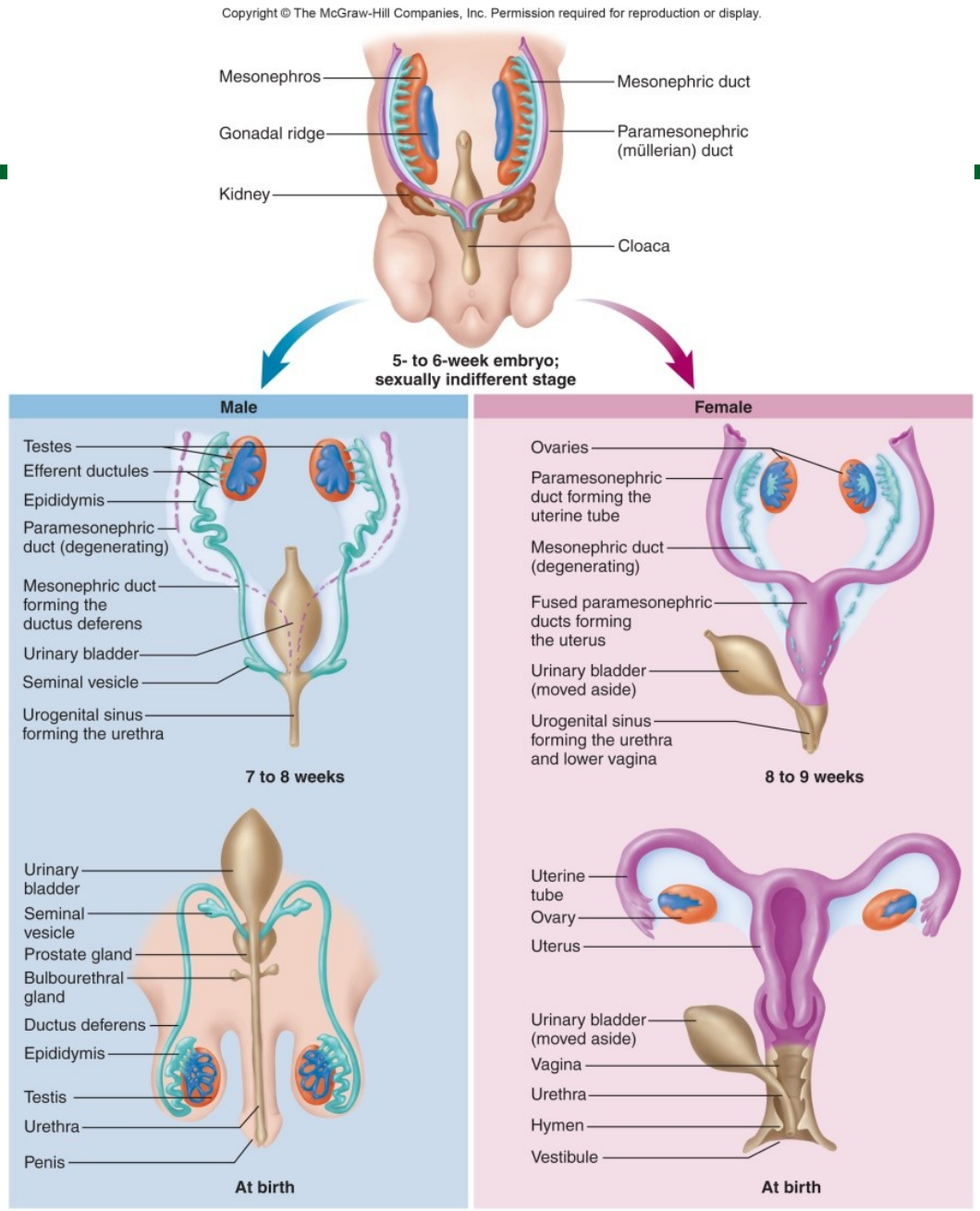
Sexual Differentiation: indistinguishable for 8 to 10 weeks

Female reproductive tract develops from the paramesonephric ducts in absence of testosterone and müllerian-inhibiting factor (MIF)

Without testosterone:

- Mesonephric ducts to degenerate
- Genital tubercle becomes the glans clitoris
- Urogenital folds become the labia minora
- Labioscrotal folds develop into the labia majora

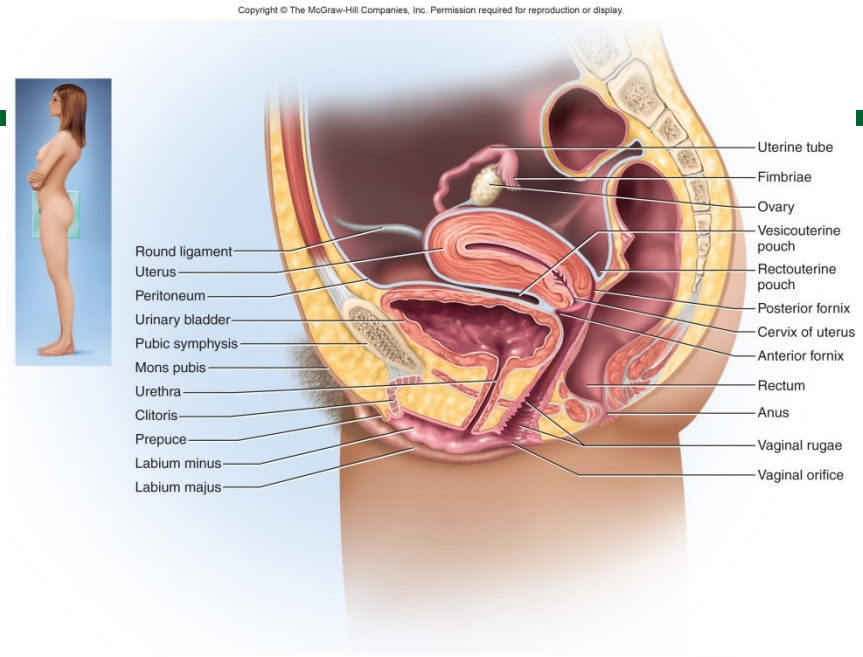
Without MIF: Paramesonephric ducts develop into the uterine tubes, uterus, and vagina

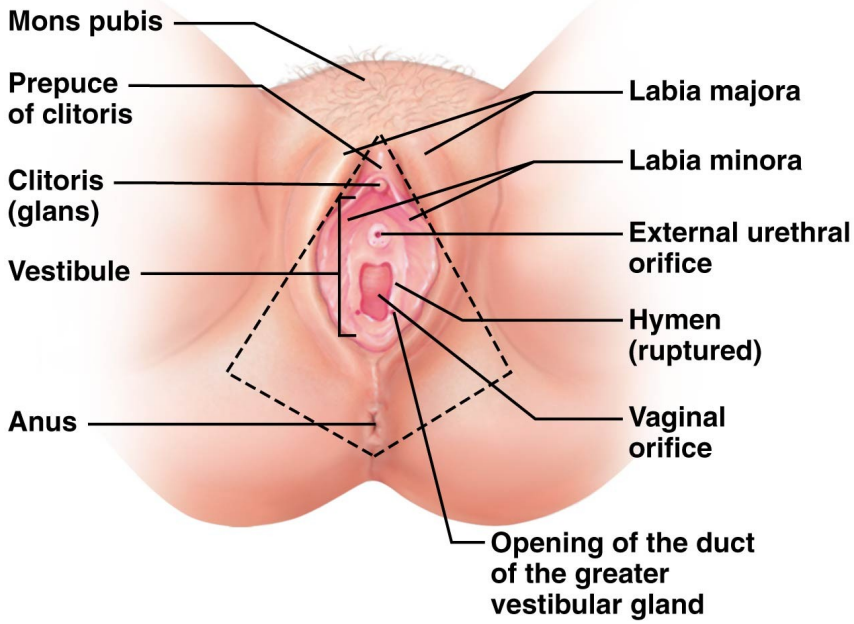


The Genitalia

- Internal genitalia: Ovaries, uterine tubes, uterus, and vagina
- External genitalia: Clitoris, labia minora, and labia majora

- **Primary sex organs**: Ovaries
- **Secondary sex organs**: Other internal and external genitalia

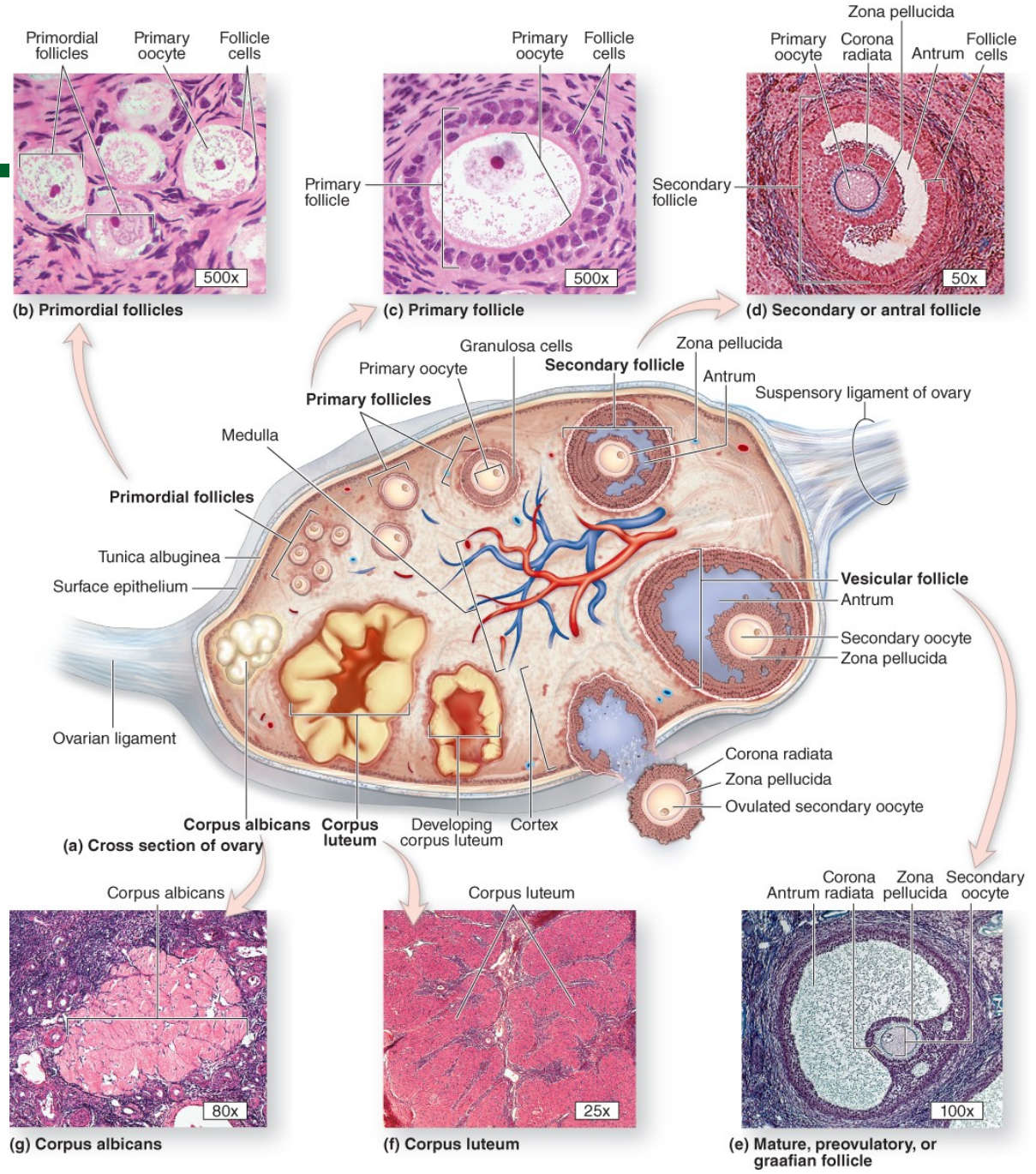




The ovary produces both oocytes and sex hormones.

Tunica albuginea: capsule, like on testes
Outer cortex: germ cells develop
Inner medulla: major arteries and veins.
Ovulation: bursting of the follicle and releasing the egg

primordial follicles **(b)** → primary follicle **(c)** → secondary follicle **(d)** → large vesicular follicle **(e)**. After ovulation, remains form corpus luteum **(f)** → degenerates into the corpus albicans **(g)**



Embryonic development of ovary

Females are born with lifetime supply of **primary oocytes,** surrounded by simple squamous **primordial follicles**: arresting in early meiosis I

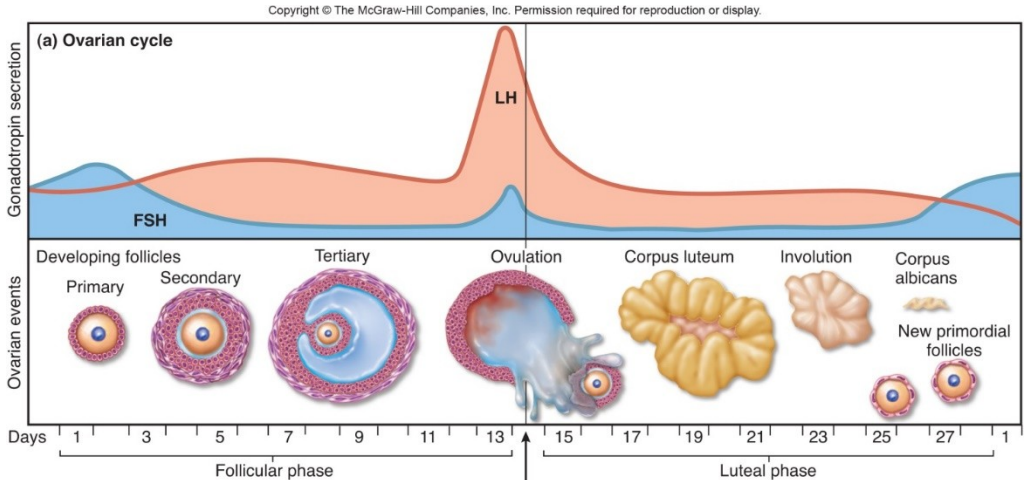
Egg, or ovum: any stage from the primary oocyte to the time of fertilization

FSH: stimulates monthly cohorts of oocytes to complete meiosis I

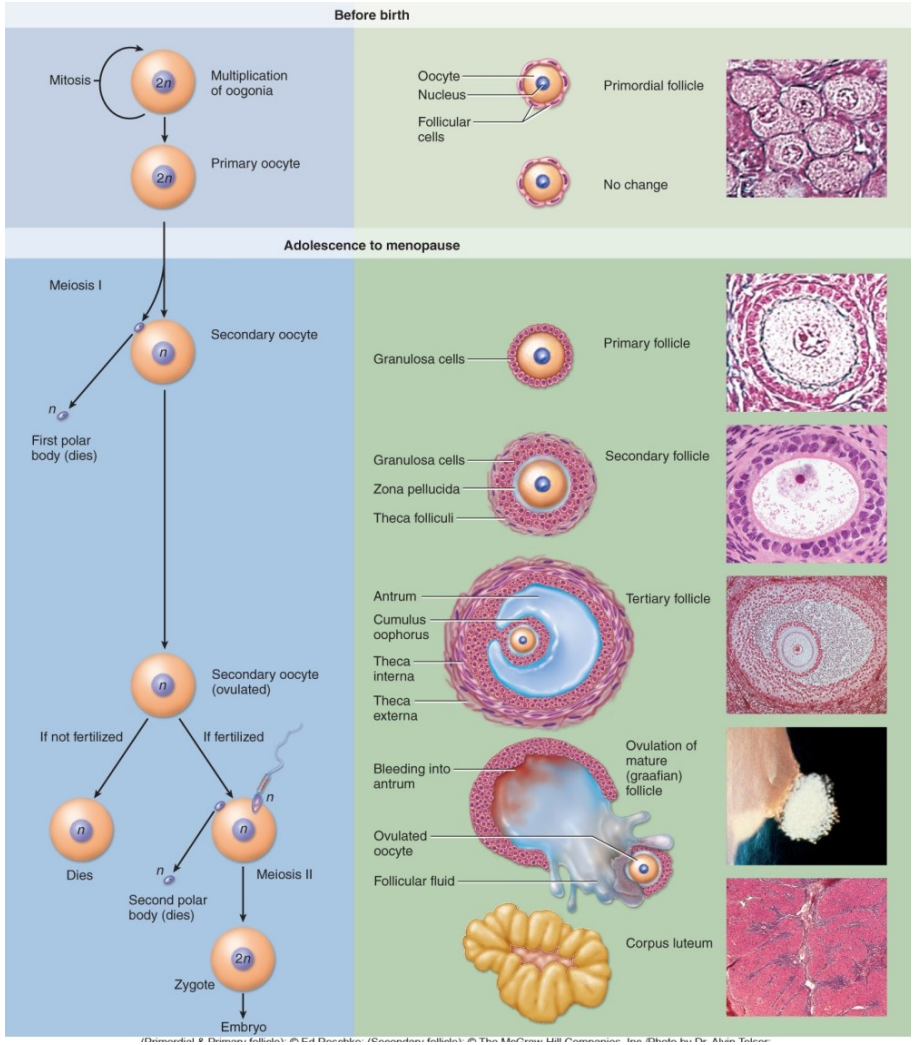
First polar body: Disintegrates after meiosis I

Secondary oocyte: proceeds to metaphase II. Simple cuboidal **primary follicles,** stratified cuboidal granulosa cells in **secondary follicles,** hormone secreting **Tertiary follicles**

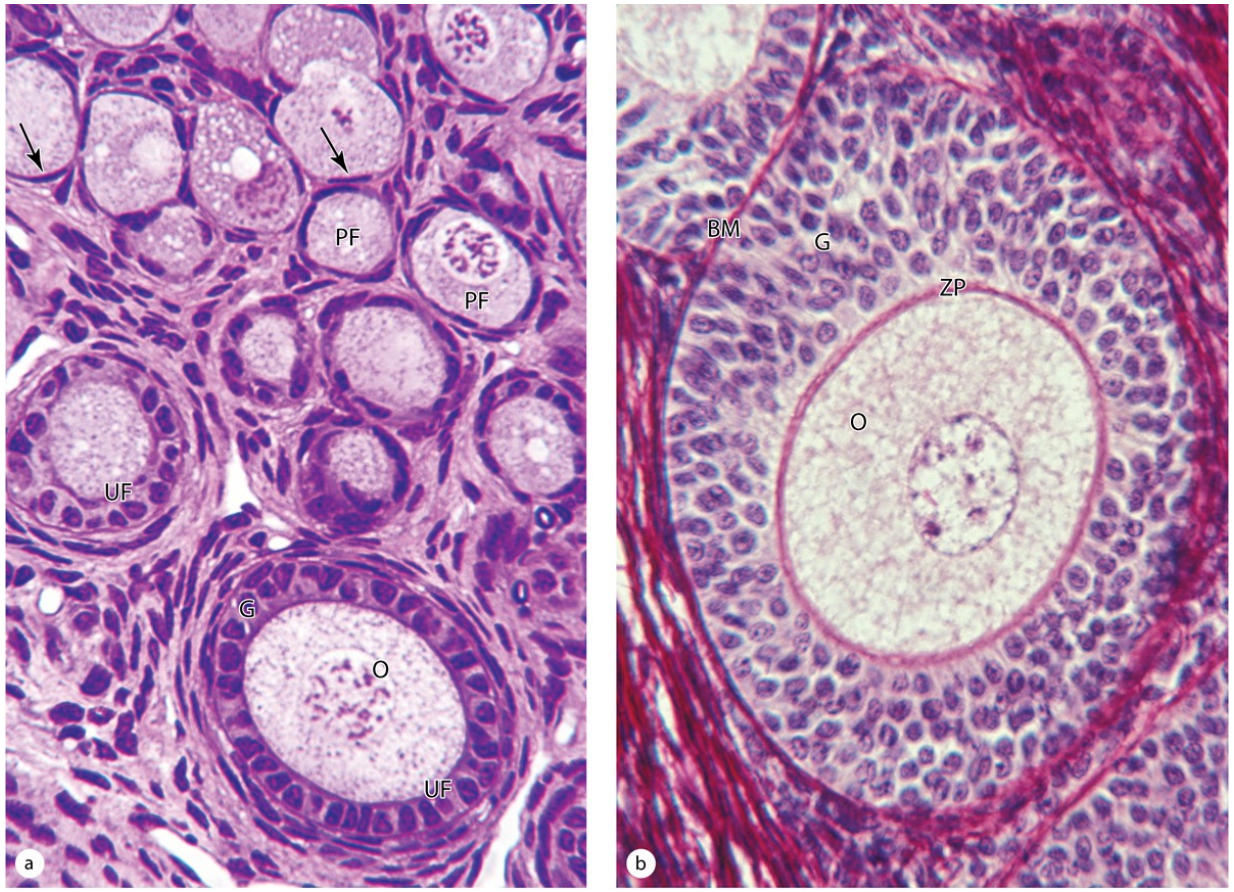
Fertilization triggers completion of Meiosis II



http://highered.mheducation.com/sites/0072495855/student_view0/chapter28/animation__maturation_of_the_follicle_and_oocyte.html



(a) Primordial and (b) Primary follicles



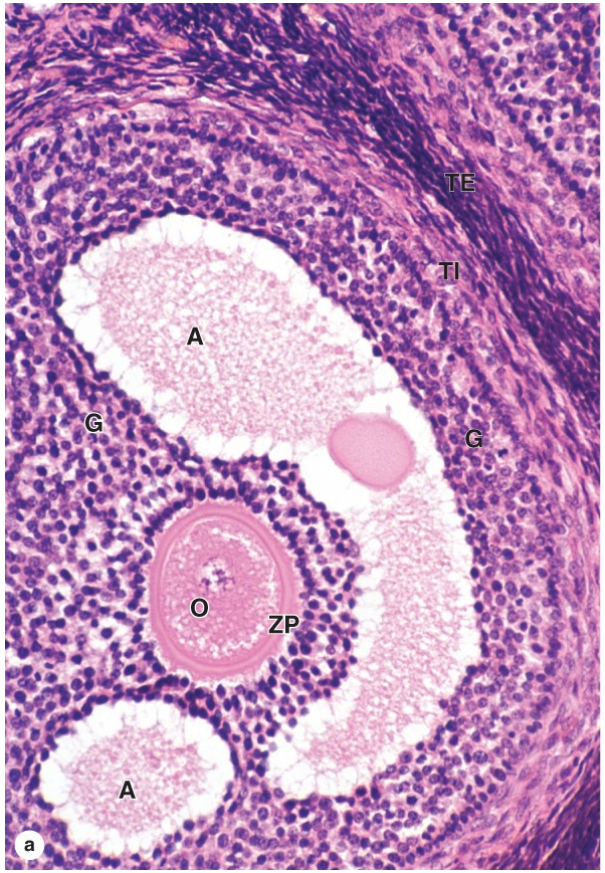
(a) primordial follicles (**PF**) and their flattened follicle cells (**arrows**)
granulosa cells (**G**) form a single cuboidal layer around the large primary oocyte (**O**)

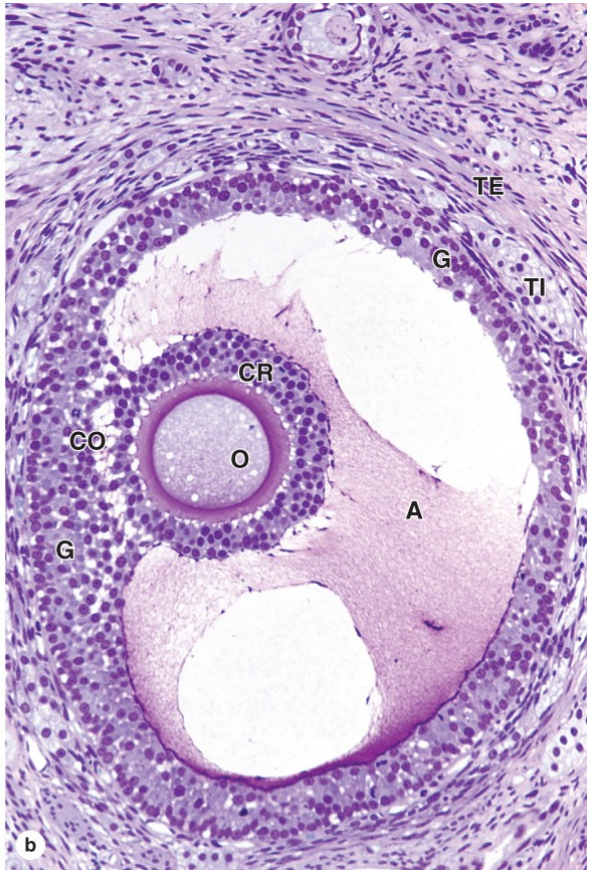
(b) larger multilayered primary follicle. Granulosa cells (**G**) have now proliferated to form several layers. zona pellucida (**ZP**): glycoprotein layer produced by the oocyte that is required for sperm binding and fertilization. The primary oocyte is now a very large cell. basement membrane (**BM**)

MEDICAL APPLICATION Polycystic ovary syndrome (PCOS) is characterized by enlarged ovaries with numerous cysts and an anovulatory state (with no follicles completing maturation successfully).
Increased androgen production by the ovaries or adrenals is likely involved.
PCOS is a common cause of **infertility** in women.

(a) An antral follicle shows the large, fluid-filled antral cavities or vesicles (**A**)
The oocyte (**O**) is surrounded by the zona pellucida (**ZP**) and granulosa cells (**G),** Steroid-secreting theca interna (**TI**) and a covering theca externa (**TE**).

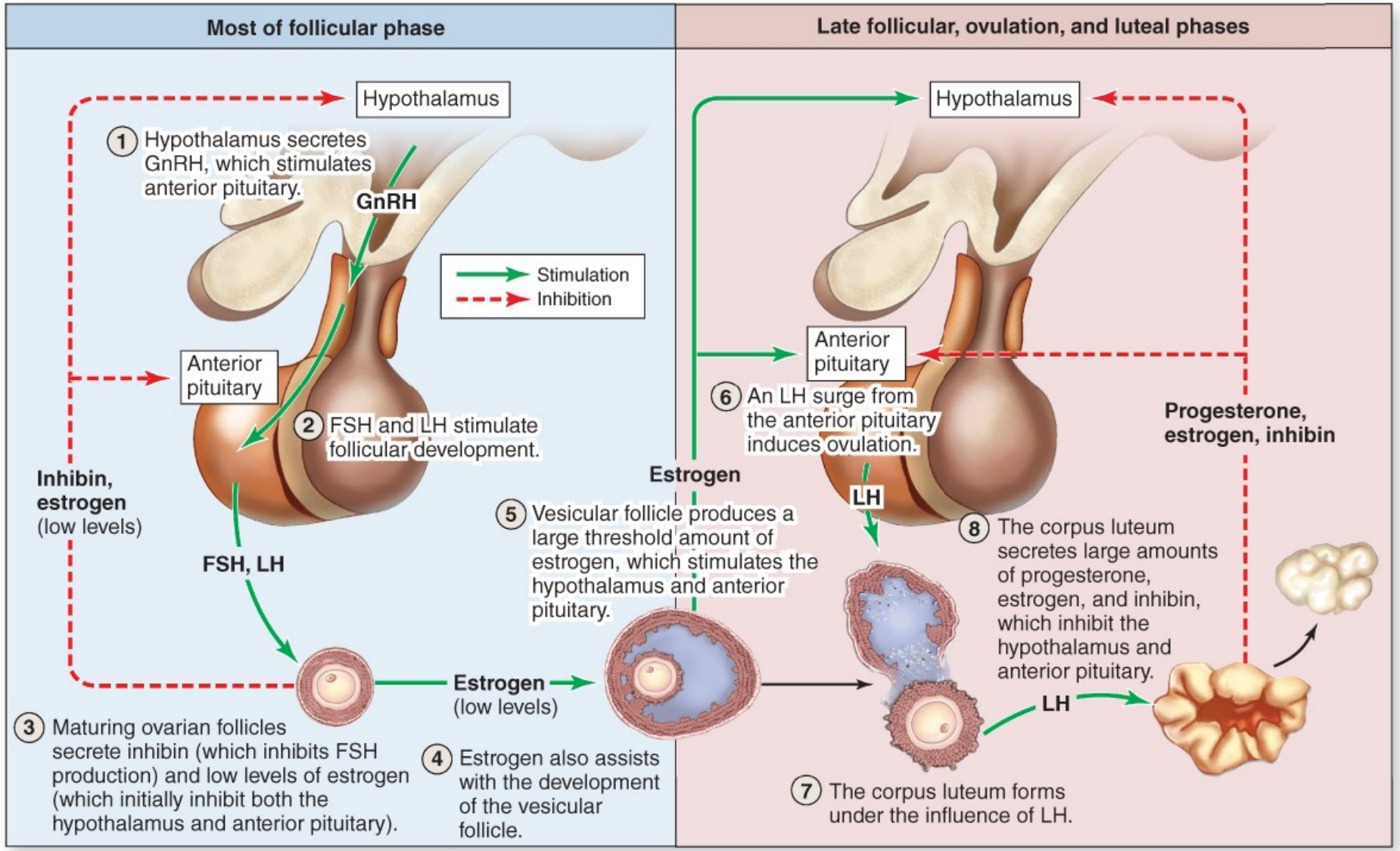
(b) A slightly more developed preovulatory follicle shows a very large single antrum (**A**). The oocyte (**O**) is surrounded by granulosa cells that now make up the corona radiata (**CR**). The corona radiata and oocyte are attached to the side of the follicle within a larger mass of granulosa cells called the **cumulus oophorus** (**CO**)





MEDICAL APPLICATION Late primary or antral follicles can produce **follicular cysts**, which are thin-walled, fluid-filled structures with both granulosa and thecal endocrine cells. Follicular cysts are common and usually benign, but can produce high estrogen levels and lead to menstrual irregularities. If cyst formation disrupts blood vessels blood enters the fluid, often rapidly, and produces a **hemorrhagic cyst**.

The ovarian cycle is initiated by hypothalamic GnRH, causing the AP to secrete FSH and LH

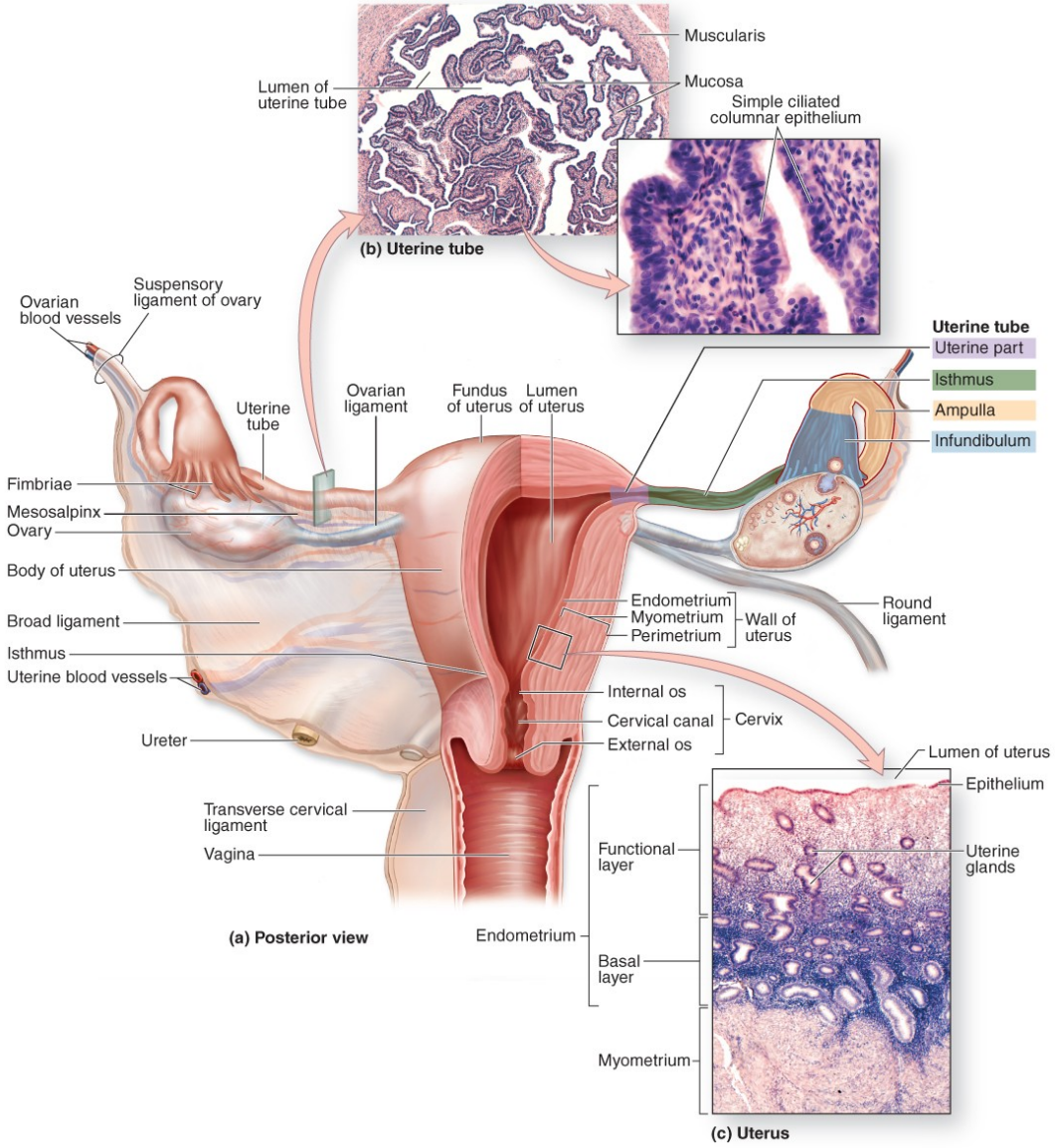


Uterine tubes and uterus

The uterine tubes 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.

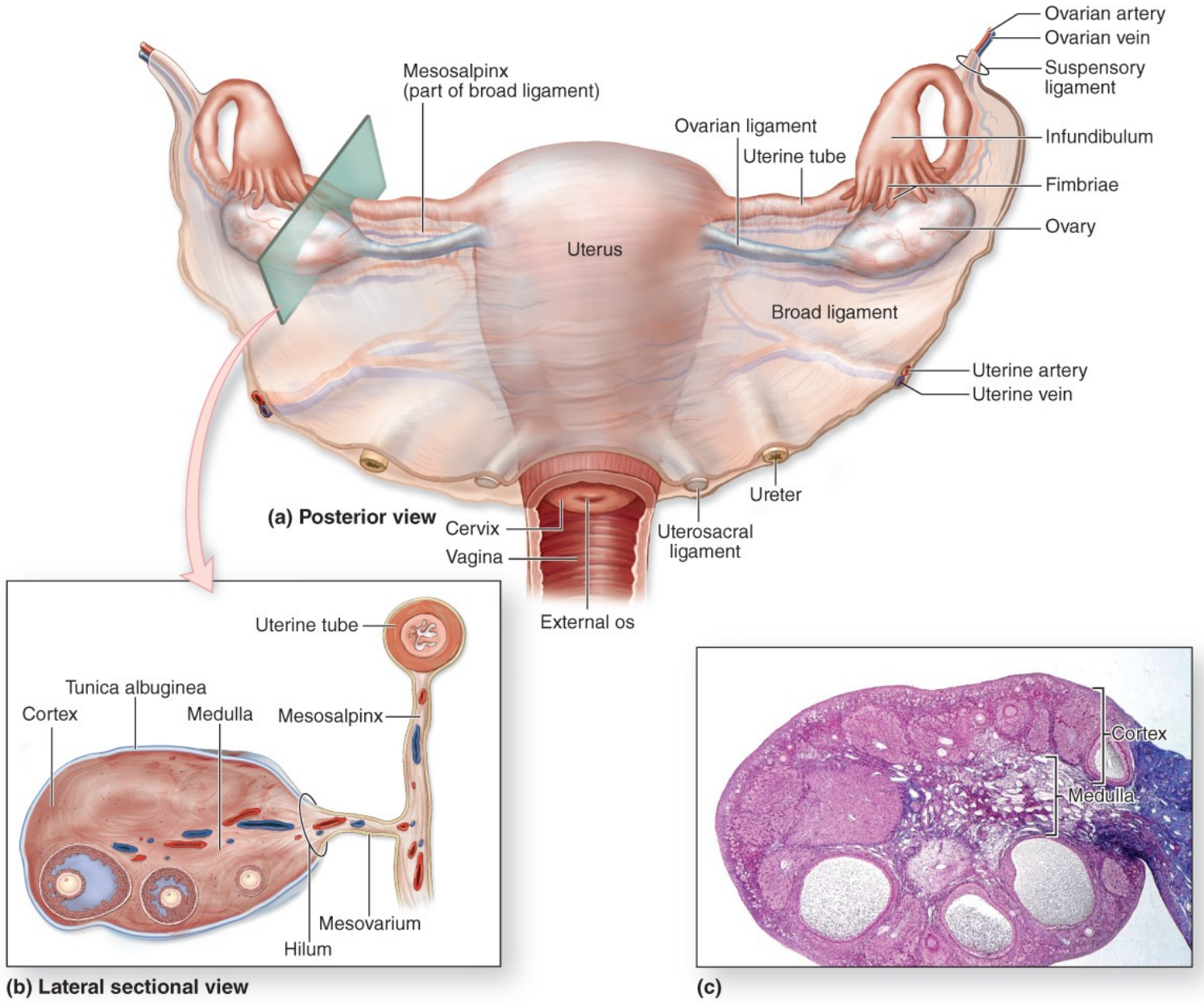
MEDICAL APPLICATION: Mucosal damage or adhesions can lead to i**nfertility** or an **ectopic (tubal) pregnancy** if there is blockage of oocyte or embryo transport to the uterus.
The tube cannot contain the growing embryo and will rupture, causing potentially fatal hemorrhage.

Tubal ligation is a common surgical type of contraception.

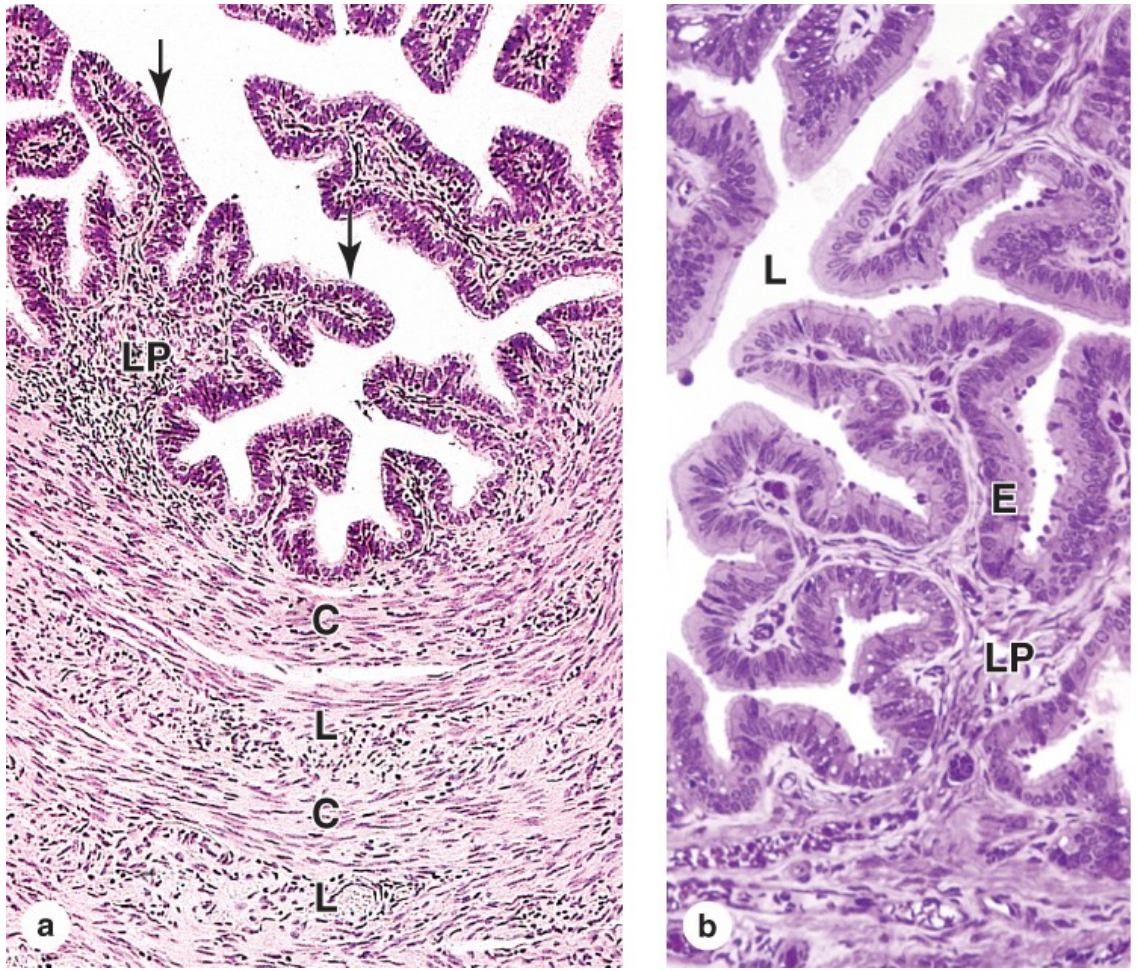


The Uterine Tubes (Oviduct/Fallopian Tube): Muscular tube lined with ciliated cells

Highly folded into longitudinal ridges
Infundibulum: flared, trumpet-shaped distal (ovarian) end
Fimbriae: feathery projections on infundibulum
Mesosalpinx: the superior portion of the broad ligament that enfolds uterine
Ovarian ligament: ovaries → uterus
Suspensory ligament: ovaries → pelvic wall. Contains ovarian artery, vein, and nerves
Mesovarium: ovaries → broad ligament



Mucosa of the uterine tube wall

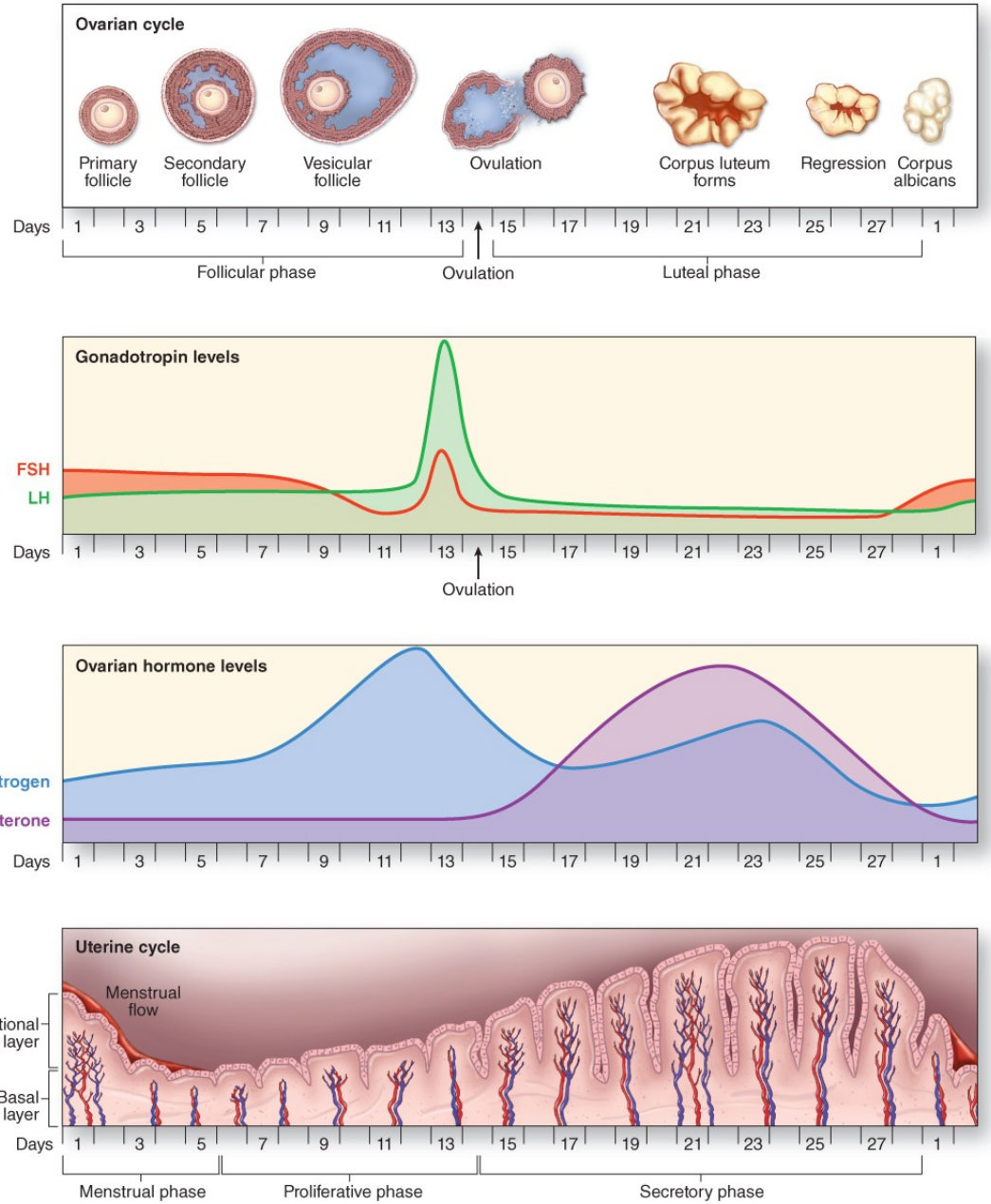


(a) A cross section of the uterine tube at the ampulla shows the interwoven circular (**C**) and longitudinal (**L**) layers of smooth muscle in the muscularis and in the complex of folded mucosa, the lamina propria (**LP**) underlying a simple columnar epithelium (arrows).

(b) The oviduct mucosa, with folds projecting into the lumen (**L**), has simple columnar epithelium (**E**) on the lamina propria (**LP**).

MEDICAL APPLICATION: Endometriosis results when endometrial tissue grows on the ovaries, oviducts, or elsewhere. Under the influence of estrogen and progesterone, the ectopic tissue grows and degenerates monthly but cannot be removed effectively from the body. In addition to pain endometriosis can produce inflammation, ovarian cysts, adhesions, and scar tissue that can cause infertility

Correlation of ovarian and menstrual cycles with levels of their controlling hormones.



The cyclic development of **ovarian follicles** and the **corpus luteum**, controlled by the pituitary **gonadotropins** FSH and LH, lead to cyclic shifts in the levels of the major ovarian hormones: steroidal **estrogens and progesterone**.

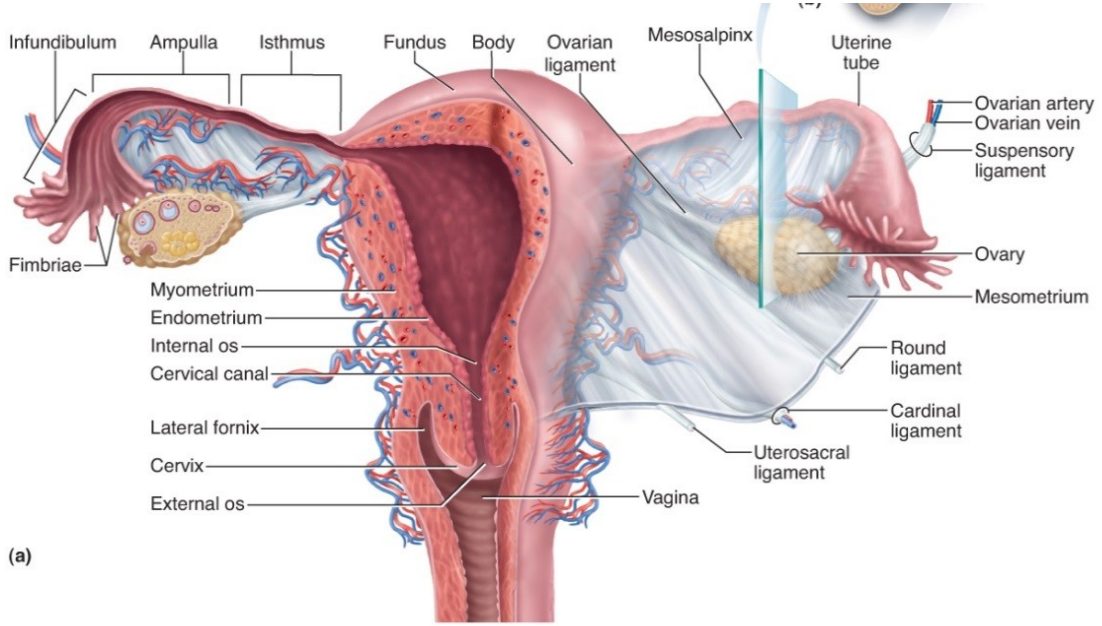
Estrogen stimulates the proliferative phase of the uterine cycle and its level peaks near the day of ovulation,
After ovulation the corpus luteum forms and produces both progesterone and estrogens, which together promote growth and development of the endometrial **functional layer.**

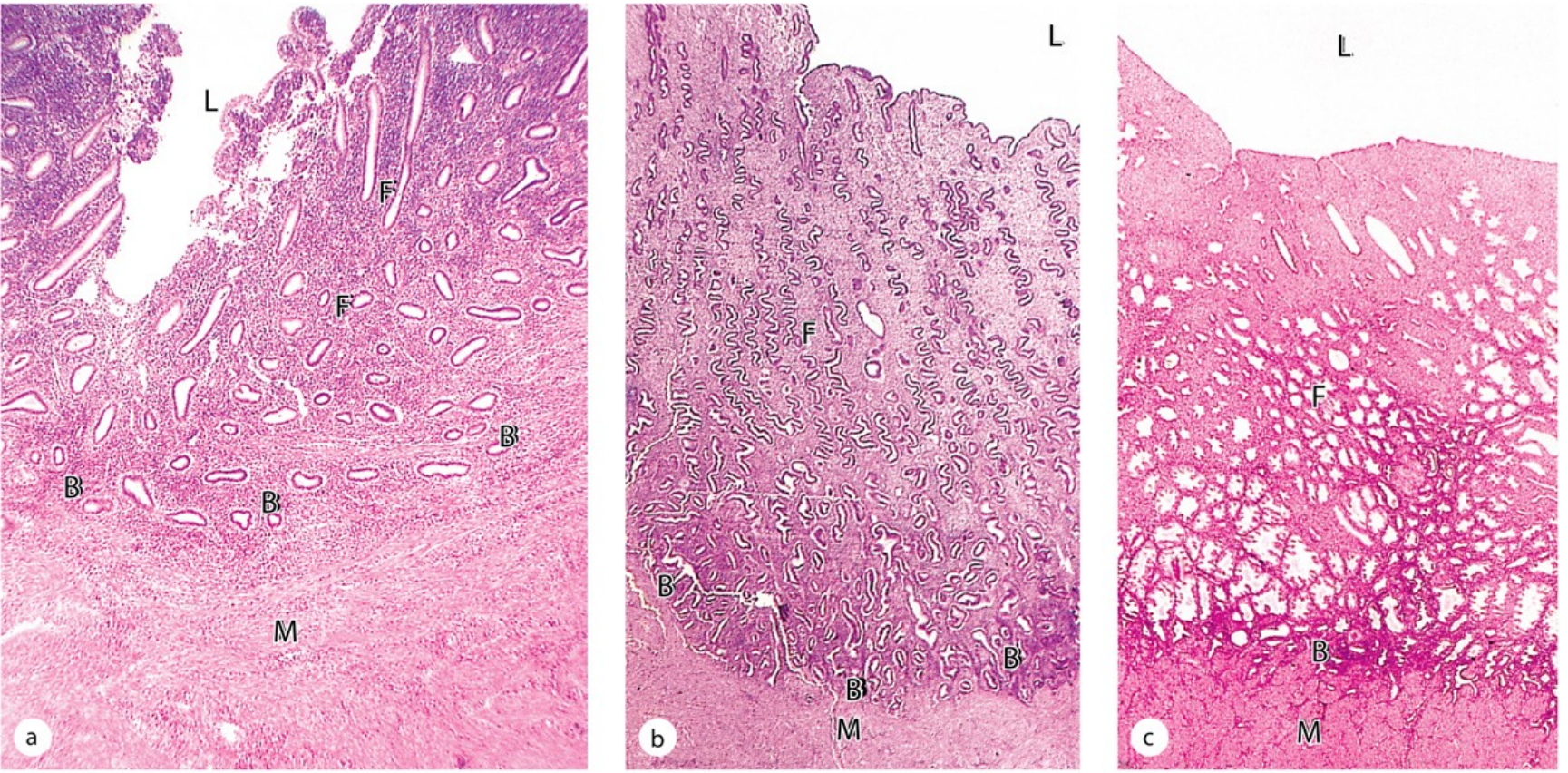
Without fertilization, regression of the corpus luteum leads to declining levels of the steroid hormones endometrial issue sloughs off as the menstrual flow,

http://ed.ted.com/lessons/how-menstruation-works-emma-bryce

Fundus: broad superior curvature
Body (corpus): middle portion
Cervix: cylindrical inferior end
Lumen is roughly triangular
Upper two corners are openings to **uterine tube**
Cervical canal connects lumen to vagina
Internal os: superior opening of canal into body of uterus
External os: inferior opening of canal into vagina
Cervical glands: secrete mucus that prevents spread of microorganisms from vagina to uterus

The Uterus: thick muscular chamber that opens into roof of the vagina and usually tilts forward over the urinary bladder





Proliferative, secretory, and premenstrual phases in the uterus.

Endometrium:
Functional layer (**F**)
closest to the lumen (**L**)
Basal layer (**B**)

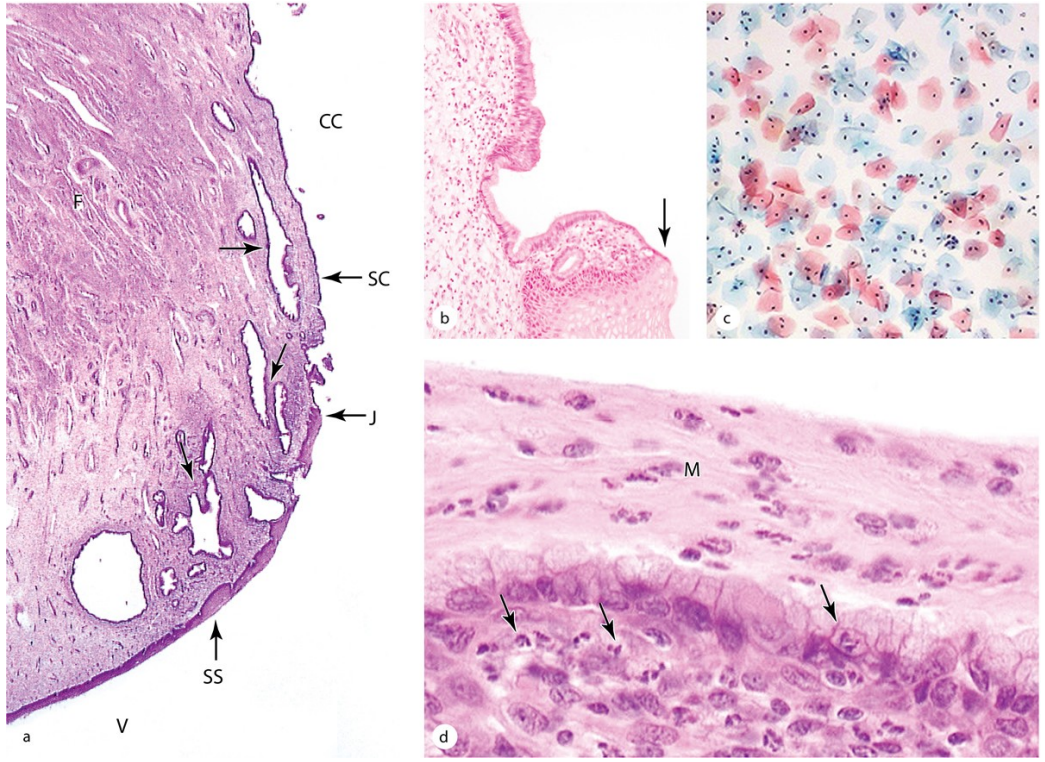
Myometrium (**M**).

(a) proliferative phase: the functional layer is still relatively thin, the stroma is more cellular, and the glands (**G**) are relatively straight, narrow, and empty.
(b) secretory phase: functional layer is four times thicker than the basal layer. The tubular glands have wider lumens containing secretory product and coil tightly up through the stroma
(c) premenstrual phase: constriction of arteries produces hypoxia. Glands (**G**) dissolve, breakdown of the stromal matrix.

TABLE 22–1 Summary of events of the menstrual cycle.

	Stage of Cycle			
	Proliferative	Secretory or Luteal		Menstrual
Main actions of pituitary hormones	Follicle-stimulating hormone stimulates rapid growth of ovarian follicles	Peak of luteinizing hormone at the beginning of secretory stage, secreted after estrogen stimulation, induces ovulation and development of the corpus luteum		
Main events in the ovary	Growth of ovarian follicles; dominant follicle reaches preovulatory stage	Ovulation	Development of the corpus luteum	Degeneration of the corpus luteum
Dominant ovarian hormone	Estrogens, produced by the growing follicles, act on vagina, tubes, and uterus	Progesterone, produced by the corpus luteum, acts mainly on the uterus		Progesterone production ceases
Main events in the endometrium	Growth of the mucosa after menstruation	Further growth of the mucosa, coiling of glands, secretion		Shedding of part of the mucosa about 14 days after ovulation

Cervix



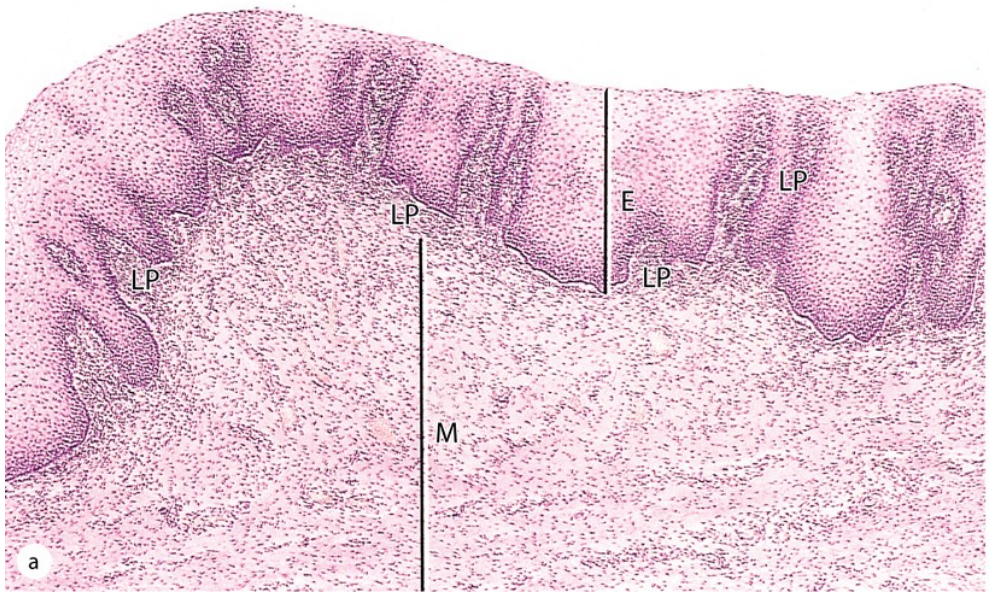
The mucosa of the cervical canal (**CC**) is continuous with the endometrium and like that tissue is lined by simple columnar epithelium (**SC**) and cervical mucous glands (**arrows**).

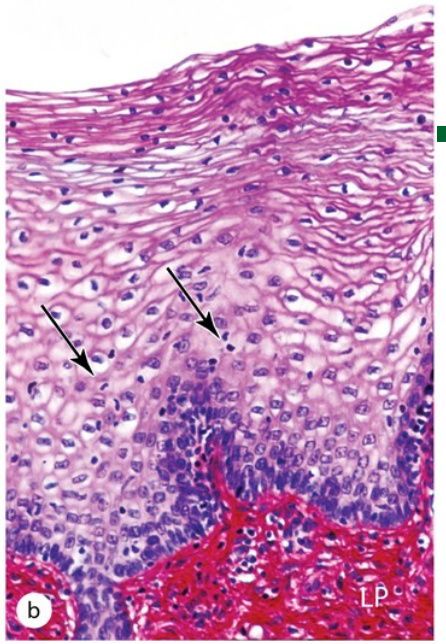
At the external os, columnar epithelium → stratified squamous epithelium (**SS**) covering the exocervix and vagina.

(c) Exfoliative cytology of epithelial cells from the exocervical mucosa in a routine cervical smear. The squamous cells, 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.

(d) The endocervical mucosa is exposed to a relatively high population of microorganisms and normally has a large number of neutrophils and other leukocytes (**arrows**)

MEDICAL APPLICATION: The incidence of cervical cancer worldwide has been greatly reduced by widespread, routine screening by exfoliative cytology to examine for dysplasia of the cervical epithelium. The test called the Pap smear after its developer George Papanicolaou, who introduced this diagnostic technique in the 1920s, uses cells that have been lightly scraped from cervix. Abnormal cells suggestive of precancerous changes in the epithelium are then detected microscopically. The epithelial dysplasia that precedes squamous cell neoplasia, the most common type of cervical cancer, occurs in metaplastic cells of the transformation zone at a mean age of 54 years. The human papillomas virus (HPV) is strongly implicated in the pathogenesis





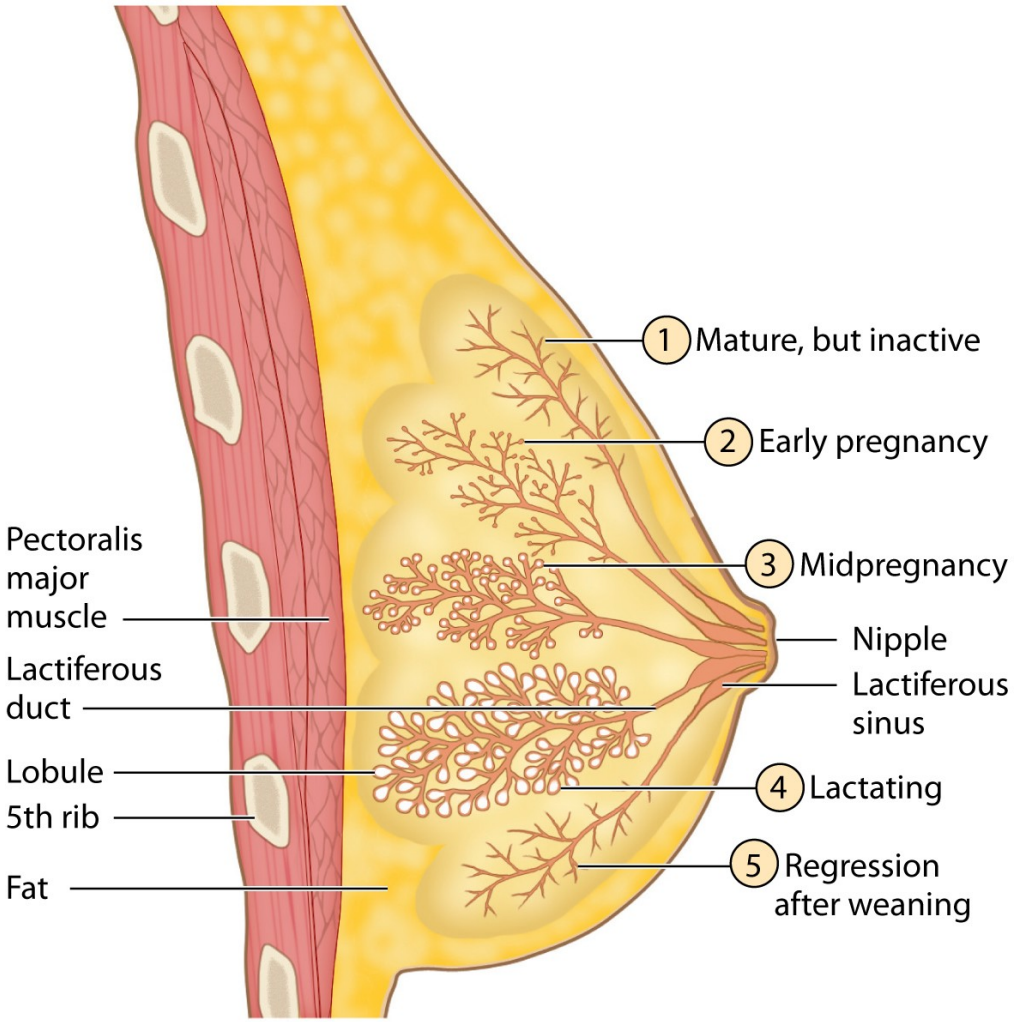
Vagina

The vagina has mucosal, muscular, and adventitial layers.
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

❯❯ MEDICAL APPLICATION

Atrophic vaginitis involves thinning or atrophy of the vaginal epithelium caused by diminished estrogen levels and occurs most often in postmenopausal woman. This change allows the more frequent inflammation and infections characteristic of this condition. Primary squamous cell carcinoma of the vagina occurs rarely, with most vaginal malignancies having spread secondarily from the cervix or vulva.

Mammary gland

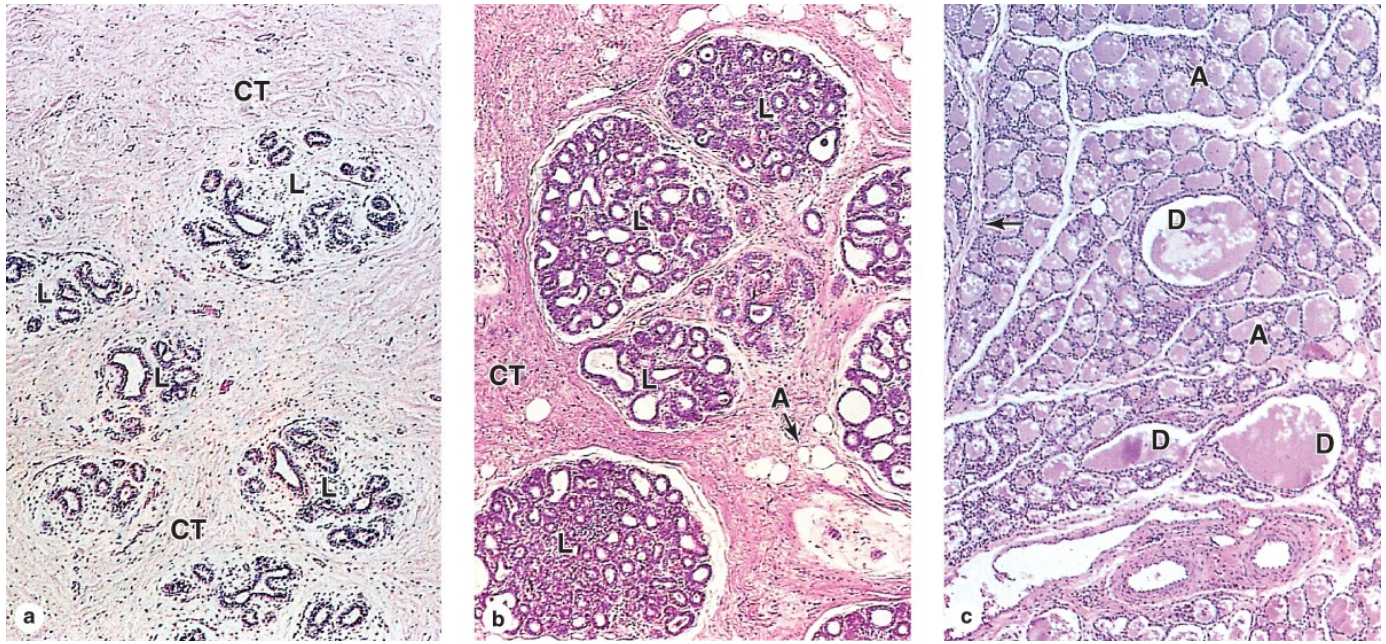


(**1**) Before pregnancy, the gland is inactive, with small ducts and only a few small secretory alveoli.
(**2**) Alveoli develop and begin to grow early in a pregnancy.
(**3**) By midpregnancy, the alveoli and ducts have become large and have dilated lumens.
(**4**) At parturition and during the time 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.

MEDICAL APPLICATION When a woman is breast-feeding, the nursing action of the child stimulates tactile receptors in the nipple, resulting in liberation of the posterior pituitary hormone **oxytocin.** This hormone causes contraction of the smooth muscle of the lactiferous sinuses and ducts, as well as the myoepithelial cells of alveoli, resulting in the milk-ejection reflex.

Negative emotional stimuli, such as frustration, anxiety, or anger, can inhibit the liberation of oxytocin and thus prevent the reflex.

Alveolar development in the breast during pregnancy



(a) Nonpregnant glands inactive, with small ducts and few lobules (**L**) having secretory alveoli which are not well-developed.
(b) During pregnancy: duct system grows, secretory units much larger and more extensively branched.
(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.

MEDICAL APPLICATION Breast cancer is almost always derived from epithelial cells in the terminal lobules of the glands. **Invasive ductal carcinoma**: intralobular ducts invade the surrounding stroma, forming a fixed, palpable mass. If the treatment is mastectomy, axillary lymph nodes are usually also removed surgically and examined histologically for the presence of metastatic mammary carcinoma cells. Early detection (eg, through self-examination, mammography, ultrasound, and other techniques) and consequent early treatment have significantly reduced the mortality rate.
Bacterial infection of a mammary gland, or **acute mastitis**, may occur in the lactating or involuting breast, usually
after obstruction by milk left within small components of the duct system.