

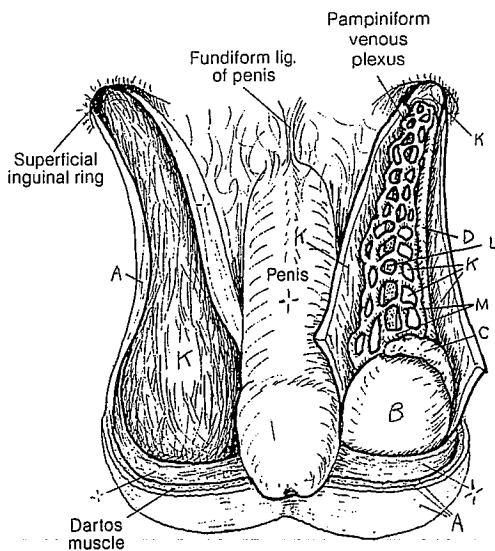
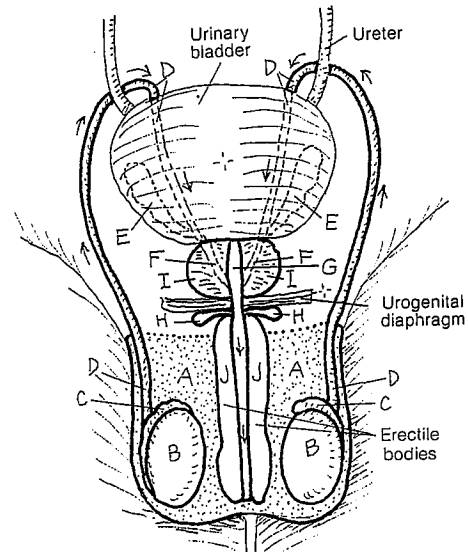
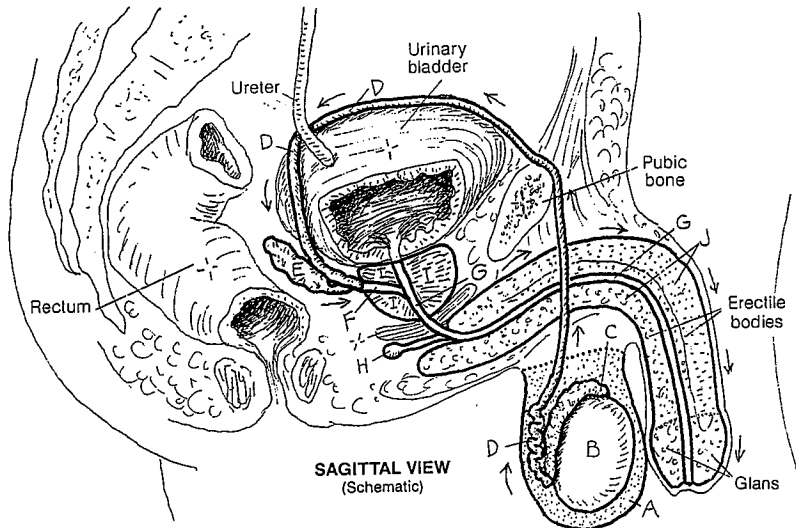
# MALE REPRODUCTIVE SYSTEM

CN: Use red for L, blue for M, and very light colors for A, J, and K.  
 (1) Color the upper views simultaneously. In the sagittal view, only the urethra is shown in the median plane. (2) The coverings of the spermatic cord in the illustration below actually consist of several layers (recall Plate 51). Color the parts of K and L seen deep to the pampiniform plexus (M).

- SCROTUM<sub>A</sub>
- TESTIS<sub>B</sub>
- EPIDIDYMISS<sub>C</sub>
- DUCTUS DEFERENS<sub>D</sub>
- SEMINAL VESICLE<sub>E</sub>
- EJACULATORY DUCT<sub>F</sub>
- URETHRA<sub>G</sub>
- BULBOURETHRAL GLAND<sub>H</sub>
- PROSTATE GLAND<sub>I</sub>
- PENIS<sub>J</sub>

The male reproductive system consists of the primary organs, the *testes* (testicles), suspended within a sac of skin and thin fibromuscular tissue (the *scrotum*); a series of ducts; and a number of glands. Development of the male germinating cells (sperm) in the testes requires a temperature slightly lower than that of the body (about 35° C or 95° F); this is achieved by their separation from the warmer body cavities. The temperature within the scrotum can be adjusted slightly by the contraction/relaxation of smooth muscle (dartos muscle) in the scrotal wall, tightening or loosening the tension of the wall about the testes. Mature sperm are stored in the *epididymis*; with stimulus, sperm cells are induced to move into and through the *ductus deferens* by rhythmic contractions of the smooth muscle in the ductal wall. Within the ductus deferens, the sperm pass through the abdominal wall (via the inguinal canal) and pelvic cavity to enter the prostatic *urethra* via the pencil-point-shaped *ejaculatory duct*. Here the nutrient-rich secretions of the *prostate gland* and *seminal vesicles* are added to the population of sperm in the prostatic urethra, forming semen. Prior to the release of the semen (ejaculation), the *bulbourethral glands* add secretions to the urethra. The *penis* and *scrotum* constitute the external genital organs.

Enlargement of the prostate is common (prostatic hypertrophy/hyperplasia) in men 50 years and older. The glands and connective tissues surrounding the urethra are subject to thickening and blocking urine flow (benign prostatic hypertrophy). Neoplastic growth (prostatic carcinoma) is less common (5–15% of men with prostatic hypertrophy) and occurs in the more peripheral tissues of the prostate.



- SPERMATIC CORD<sub>K</sub>
- COVERINGS<sub>L</sub>
- CONSTITUENTS<sub>M</sub>
- DUCTUS DEFERENS<sub>D</sub>
- TESTICULAR ARTERY<sub>K</sub>
- TESTICULAR VEIN<sub>M</sub>

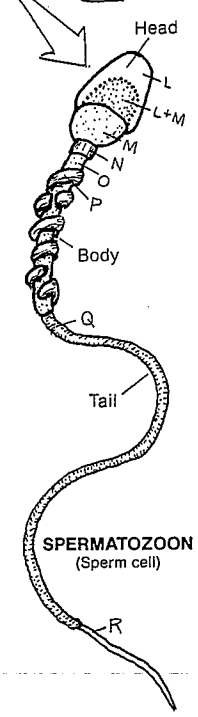
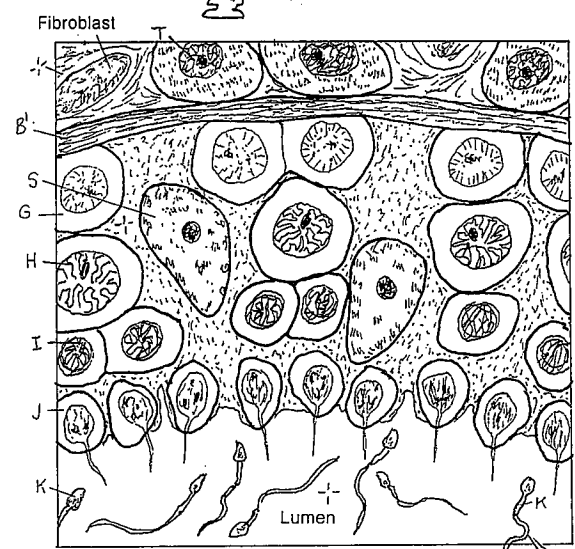
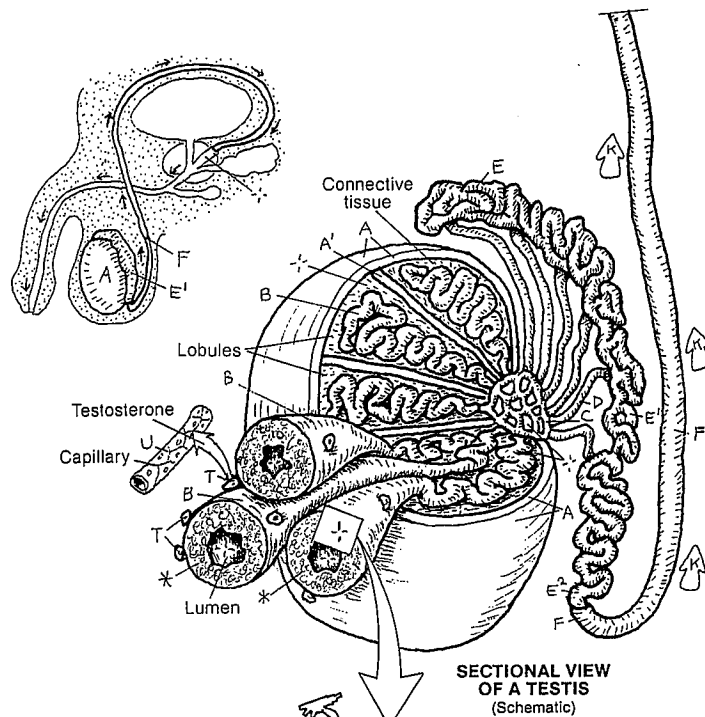
The testicular artery and vein, and some nerves and lymphatics, join the *ductus deferens* just before entering the deep ring (intra-abdominal orifice) of the inguinal canal. The collection of these form the constituents of the spermatic cord. Passing through the inguinal canal, they become invested by a representative layer from each of the abdominal wall layers (less rectus); these are the coverings of the spermatic cord and testes (here represented as one layer; see Plate 51). In a vasectomy procedure, the ductus deferens is identified within the cord and it alone is divided. A number of techniques (ligatures, cauterization, folding and burial, and so on) are used to prevent the natural tendency of the transected duct sections to recanalize.

ANTERIOR VIEW OF SCROTUM (With cord dissected)

# TESTIS

CN: Use the colors employed for the testis, epididymis, and ductus deferens on the previous plate with those same structures here (A, E, and F). Use red for U and light colors for G, H, I, S, and T. (1) Note that the spermatogenic epithelium is colored gray in the cross section through the tubules above and that the tubular lumen is not to be colored.

- TUNICA ALBUGINEA<sub>A</sub>
- SEPTUM<sub>A'</sub>
- SEMINIFEROUS TUBULE<sub>B</sub>
- RETE TESTIS<sub>C</sub>
- EFFERENT DUCT<sub>D</sub>
- EPIDIDYMIS HEAD<sub>E</sub> BODY<sub>E'</sub> TAIL<sub>E''</sub>
- DUCTUS DEFERENS<sub>F</sub>
  
- SPERMATOGENIC EPITHELIUM<sub>\*</sub>
  - SPERMATOGONIUM<sub>G</sub>
  - PRIMARY SPERMATOCYTE<sub>H</sub>
  - SECONDARY SPERMATOCYTE<sub>I</sub>
  - SPERMATID<sub>J</sub>
  - SPERMATOZOON<sub>K</sub>
    - HEAD<sub>L</sub>
    - ACROSOME<sub>L'</sub>
    - NUCLEUS<sub>M</sub>
    - TAIL<sub>N</sub>
      - NECK<sub>N'</sub>
      - MIDDLE PIECE<sub>O</sub>
      - MITOCHONDRION<sub>P</sub>
      - PRINCIPAL PIECE<sub>Q</sub>
      - END PIECE<sub>R</sub>
- SERTOLI (SUPPORTING) CELL<sub>S</sub>
- BASEMENT MEMBRANE<sub>B'</sub>
- INTERSTITIAL CELL (OF LEYDIG)<sub>T</sub>
- BLOOD VESSEL<sub>U</sub>



The testes (testicles) arise on the posterior abdominal wall during fetal development; as the developing body lengthens, they appear to "descend" into outpocketings of the anterior abdominal wall (scrotum). The testes have two principal functions: development of male germ cells (sperm or *spermatozoa*) and secretion of testosterone, the male sex hormone.

Each testis has a dense, fibrous, outer capsule (tunica albuginea) from which *septa* are directed centrally to compartmentalize the testis into lobules. One to four highly coiled *seminiferous tubules* exist in each lobule. These tubules converge toward the posterior side of the testis, straighten (tubuli recti), and join a network of epithelial-lined spaces (*rete testis*). *Efferent ducts* leave the rete to form the head of the *epididymis*. The convoluted epididymal duct (*head, body, tail*) is lined with pseudostratified columnar epithelium, one type of which contains long, immobile cilia (stereocilia). At the lower portion of the epididymis, the tubule turns upward to form the *ductus deferens*. The wall of the *ductus deferens*, lined with pseudostratified columnar epithelium with stereocilia, contains significant smooth muscle, the rhythmic contractions of which drive sperm toward the prostate gland during emission.

Each seminiferous tubule consists of a lumen with walls of compact, organized masses of cells (*spermatogenic epithelia* and *supporting*/(Sertoli) *cells*) encapsulated by a thin, fibrous basement membrane. The most immature of the sperm-developing cells are the *spermatogonia*. These divide, and the daughter

cells are pushed out toward the lumen of the tubule. These cells differentiate into *primary spermatocytes*, the largest of the developing germ cells. When they divide to become *secondary spermatocytes*, the chromosome number is reduced from 46 to 23 (meiosis). Each pair of newly formed secondary spermatocytes rapidly divides again to form four *spermatids*. These small cells mature by developing tails, condensing their nuclei and cytoplasm, and developing acrosomal caps (with enzymes to break down the wall of the ovum and permit penetration). The mature sperm cell (*spermatozoon*) consists of a *head* of 23 chromosomes (nucleus) including the acrosome, a *middle piece* containing mitochondria to power cell movement, and the rest of the *tail* (fibers containing microtubules; the end piece is essentially a single flagellum), whose flagellations provide the cell's motive force. However, early spermatozoa are essentially immobile and incapable of fertilizing ova. They are swept into the epididymis from the rete testis via the efferent ducts by ciliary action and fluid flow; there they mature into potent and motile sperm cells.

The interstitial cells dispersed in the vascular loose connective tissue around the tubules include fibroblasts as well as the secretory cells (*of Leydig*), which are known to produce and secrete testosterone into adjacent capillaries. This male sex hormone stimulates the development of ducts and glands of the reproductive tract at puberty (generally between 11 and 14 years of age) as well as secondary sex characteristics.

# MALE UROGENITAL STRUCTURES

CN: Use blue for I, red for J, yellow for K, and very light colors for D, E, and G. (1) Color the two upper views simultaneously, noting that the superficial and deep fascia (G, H) have been omitted from the coronal view. (2) Color the structural view and the cross section.

## URETHRA:-

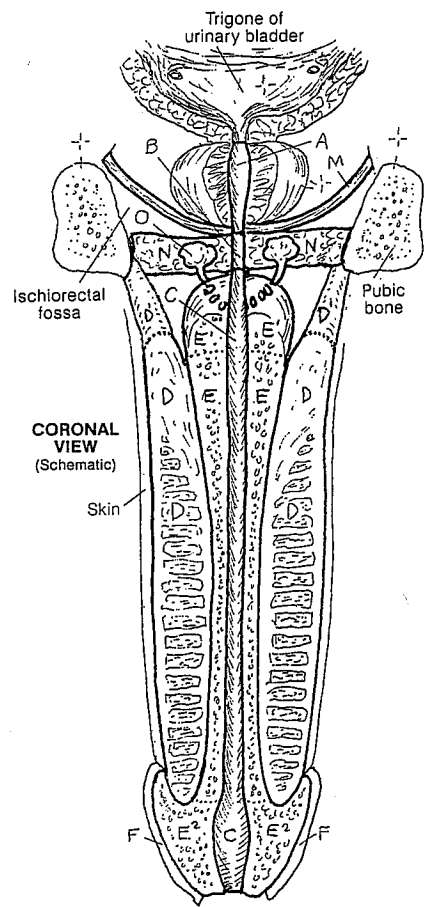
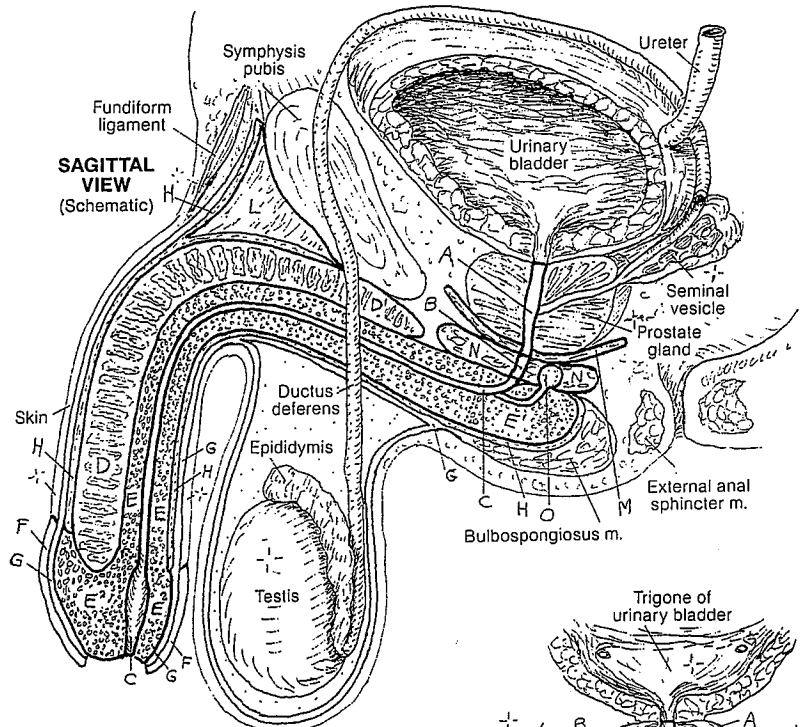
- PROSTATIC U.<sub>A</sub>
- MEMBRANOUS U.<sub>B</sub>
- SPONGY U.<sub>C</sub>

## PENIS:-

- CORPUS CAVERNOSUM<sub>D</sub>
- CRUS OF PENIS<sub>D</sub>
- CORPUS SPONGIOSUM<sub>E</sub>
- BULB OF PENIS<sub>E</sub>
- GLANS PENIS<sub>E<sup>2</sup></sub>
- PREPUCE (FORESKIN)<sub>F</sub>

## RELATED STRUCTURES:-

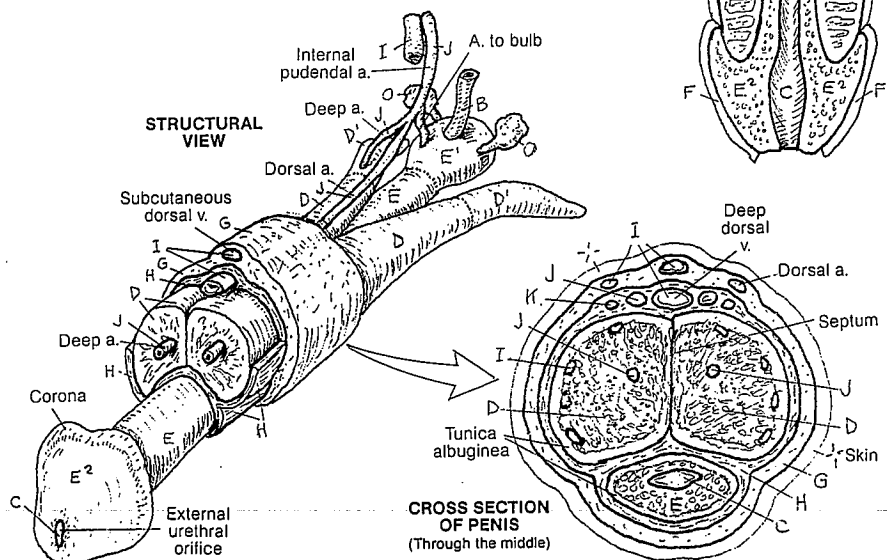
- SUPERFICIAL FASCIA<sub>G</sub>
- DEEP FASCIA<sub>H</sub>
- VEIN<sub>I</sub> ARTERY<sub>J</sub> NERVE<sub>K</sub>
- SUSPENSORY LIG.<sub>L</sub>
- LEVATOR ANI (PELVIC DIAPHRAGM)<sub>M</sub>
- UROGENITAL DIAPHRAGM<sub>N</sub>
- BULBOURETHRAL GLAND<sub>O</sub>



The urethra in the male has an extensive (20 cm or so) course from the neck of the bladder to the external urethral orifice at the end of the penis. The *prostatic urethra* receives urine from the urinary bladder, sperm from the ejaculatory ducts, seminal fluid from the seminal vesicles, and secretions from the prostate via several ducts. Reflex contraction of the bladder neck muscles prevents voiding of urine during the expulsion of semen. The urethra continues through the pelvic diaphragm and into the thin, fibromuscular urogenital diaphragm as the *membranous urethra*. The *spongy urethra* passes through the penis. Numerous mucus glands exist in the urethral mucosa.

layer of *superficial fascia*. The erectile tissue consists of lakes of veins (cavernous sinuses) bound by fibroelastic tissue and smooth muscle. These sinuses are fed by arteries in the erectile bodies. During sexual activity, these *arteries* dilate secondary to increased autonomic motor activity, and the volume of blood entering the sinuses increases, expanding the erectile tissue. As a result, the *veins* at the periphery of the erectile bodies deep to the tunica albuginea are pressed against the capsule (unable to drain blood) and the penis enlarges and becomes rigid (erection). The glans remains non-rigid.

The penis consists of three bodies of erectile tissue, ensheathed in two layers of fasciae. The *corpora cavernosa* (the two lateral bodies) arise from the ascending rami of the pubic bones; the central *corpus spongiosum* arises as a *bulb* suspended from the inferior fascia of the *urogenital diaphragm* (perineal membrane). Each body consists of erectile tissue with a fibrous capsule (tunica albuginea); the corpus spongiosum contains the urethra as well. The three bodies are bound together in a dense stocking of *deep perineal fascia* and hang as a unit suspended by the *deep suspensory* and more superficial *fundiform ligaments*. Deep to the skin of the penis is a



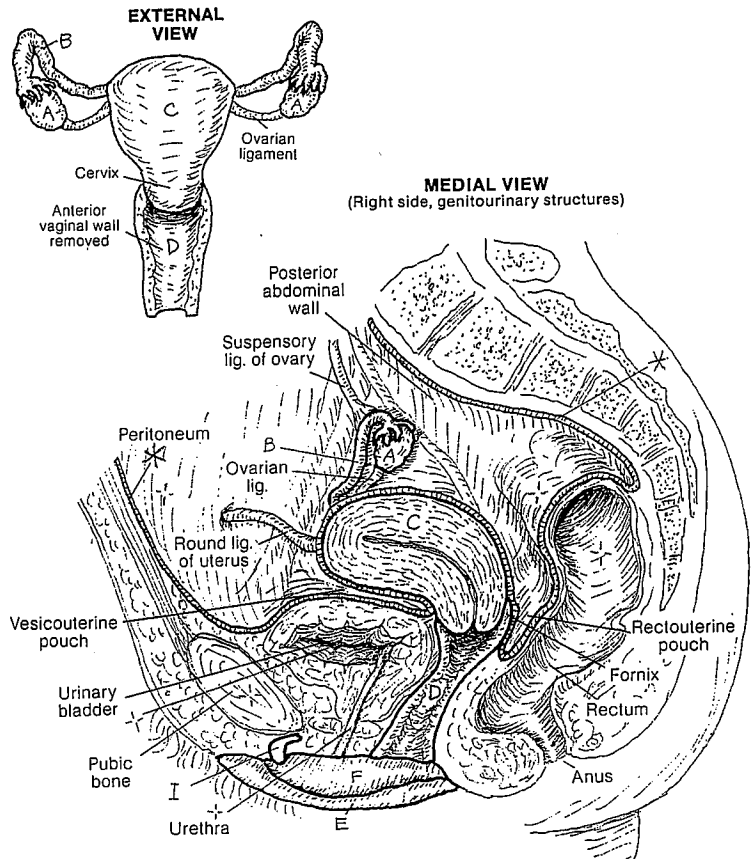
# FEMALE REPRODUCTIVE SYSTEM

CN: (1) Color the two (upper) views of the internal reproductive structures simultaneously. In the sagittal view, color the double line representing the peritoneum in gray. (2) In the lower drawings, color the vestibule (N) gray after coloring the other structures located in that area (L-P). (3) In the dissected view of the external structures, take note of the surrounding musculature, none of which is colored.

## INTERNAL STRUCTURES

- OVARY <sub>A</sub>
- UTERINE (FALLOPIAN) TUBE <sub>B</sub>
- UTERUS <sub>C</sub>
- VAGINA <sub>D</sub>

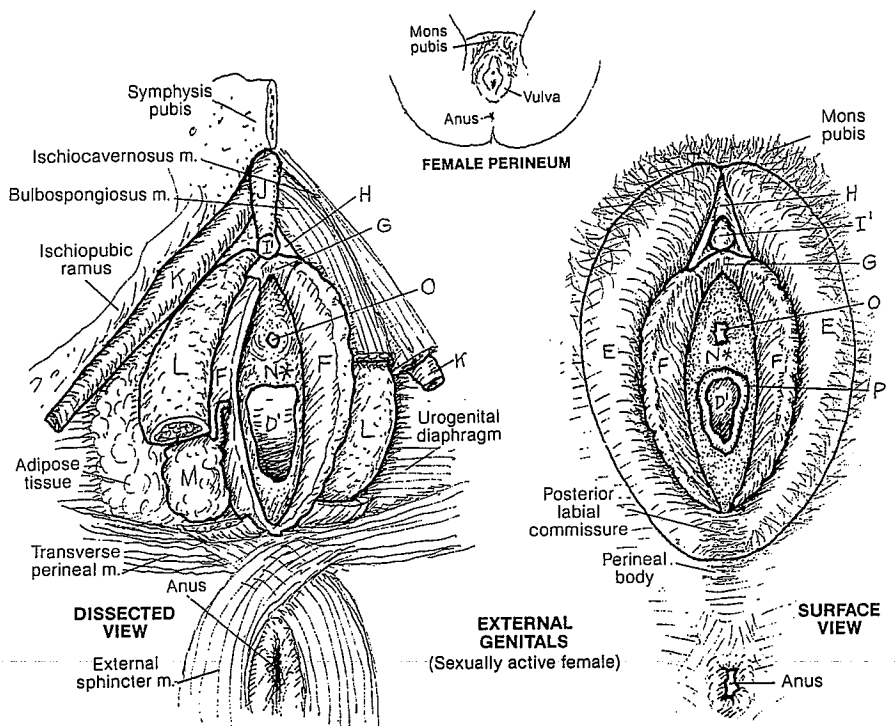
The primary organ of the female reproductive system is the *ovary*, which produces the female germ cells (ova) and secretes the hormones estrogen and progesterone. Each ovary, like the testis, arises on the posterior abdominal wall (adjacent to the kidneys) during early fetal development. It also descends along that wall, like the testis, but is interrupted early in its journey by a ligament and is retained in the pelvis. The *uterus* serves as a site for implantation and nourishment of the embryo/fetus. The *uterine tubes* provide a conduit for the freshly fertilized or unfertilized ovum enroute to the uterus. The *vagina*, a fibromuscular sheath, receives the semen from the penis and transmits it to the uterus and acts as a birth canal from the uterus to the outside for the newborn.



## EXTERNAL STRUCTURES

- LABIUM MAJUS <sub>E</sub>
- LABIUM MINUS <sub>F</sub>
- FRENULUM <sub>G</sub>
- PREPUCE <sub>H</sub>
- CLITORIS <sub>I</sub>
- GLANS <sub>J</sub>
- BODY <sub>K</sub>
- CRUS <sub>L</sub>
- BULB OF THE VESTIBULE <sub>M</sub>
- VESTIBULAR GLAND/DUCT <sub>N</sub>
- VESTIBULE <sub>N\*</sub>
- URETHRAL ORIFICE <sub>O</sub>
- VAGINAL ORIFICE <sub>P</sub> / HYMEN <sub>P</sub>

The female external genitals collectively constitute the vulva. They are located within the perineum. The *labia majora* are fat-filled folds of skin largely obscuring the cavity/space between them (vestibule) that contains the *urethral* and *vaginal orifices*. Medial to the labia majora are thin folds of skin (*labia minora*) that approach the *clitoris* anteriorly and split around it, forming the *frenulum* and *prepuce* of the clitoris. Like the penis, the clitoris has a *crus* (pl. crura) arising from each ischiopubic ramus; the two crura join in the midline to form the *body* or *corpus*. The body is capped by a skin-covered, vascular, sensitive *glans*. These clitoral components contain erectile tissue (less in the glans) enclosed in fascial coverings; their erection or rigidity is accomplished by the same mechanism operative in the penis. The clitoris, unlike the penis, does not incorporate the urethra. The bulbs of the *vestibule* are homologous to the bulb of the penis, but separated into two erectile bodies. They are covered by the bulbospongiosus muscle and protrude into the vagina during sexual stimulation. The *vaginal orifice* is completely or incompletely covered or surrounded by a rim of mucosa called the *hymen*. Remnants of it (as shown) are often retained in the sexually active female.



# OVARY

CN: Use the colors from the preceding plate for the ovary (A) and uterine tube (M). Use red for K and R, yellow for L, blue for S, and very light colors for C-J, M, O, and P. (1) Color the development of the female germ cell in both upper and lower views of the sectioned ovary. The oocyte (C) is colored through ovulation. In the large illustration, color the background stroma (B) gray; do not color the blood vessels in the stroma.

## OVARIAN STRUCTURES

EPITHELIUM / TUNICA ALBUGINEA A

CONNECTIVE TISSUE STROMA B\*

OOCYTE DEVELOPMENT

OOCYTE / OVUM C

PRIMORDIAL FOLLICLE D

PRIMARY FOL. E

SECONDARY FOL. F

MATURING FOL. G

MATURE (GRAAFIAN) FOL. H

RUPTURED FOL. I

DISCHARGED OVUM C'

ATRETIC FOL. J

CORPUS HEMORRHAGICUM K

YOUNG CORPUS LUTEUM L

MATURE CORPUS LUTEUM L'

CORPUS ALBICANS L<sup>2</sup>+

## RELATED STRUCTURES

UTERINE TUBE M / FIMBRIAE M'

BROAD LIGAMENT N

MESOSALPINX O

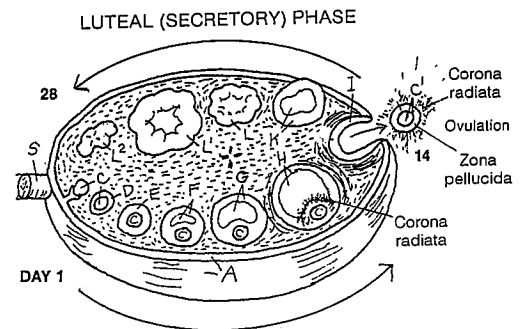
MESOVARIUM P

SUSP. LIG. OF OVARY Q

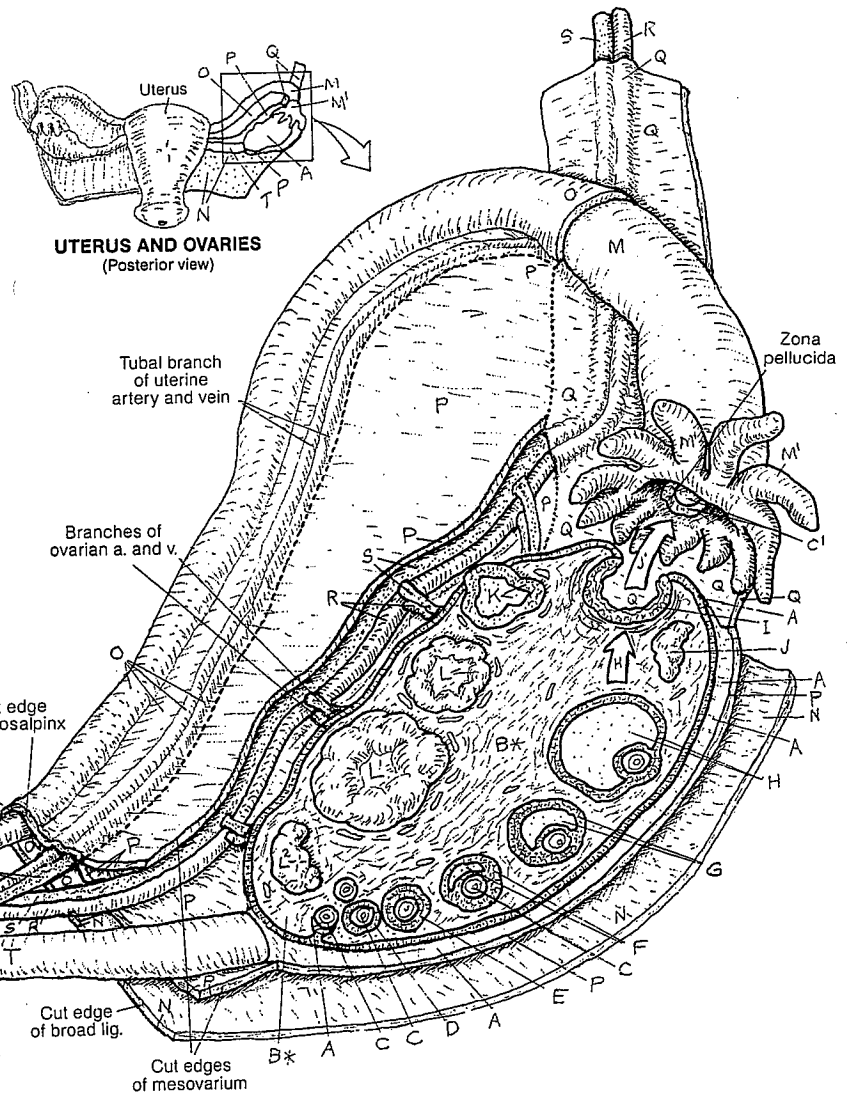
OVARIAN A. R / V. S

UTERINE A. R' / V. S'

OVARIAN LIG. T



FOLLICULAR (PROLIFERATIVE) PHASE  
OVARIAN CYCLE



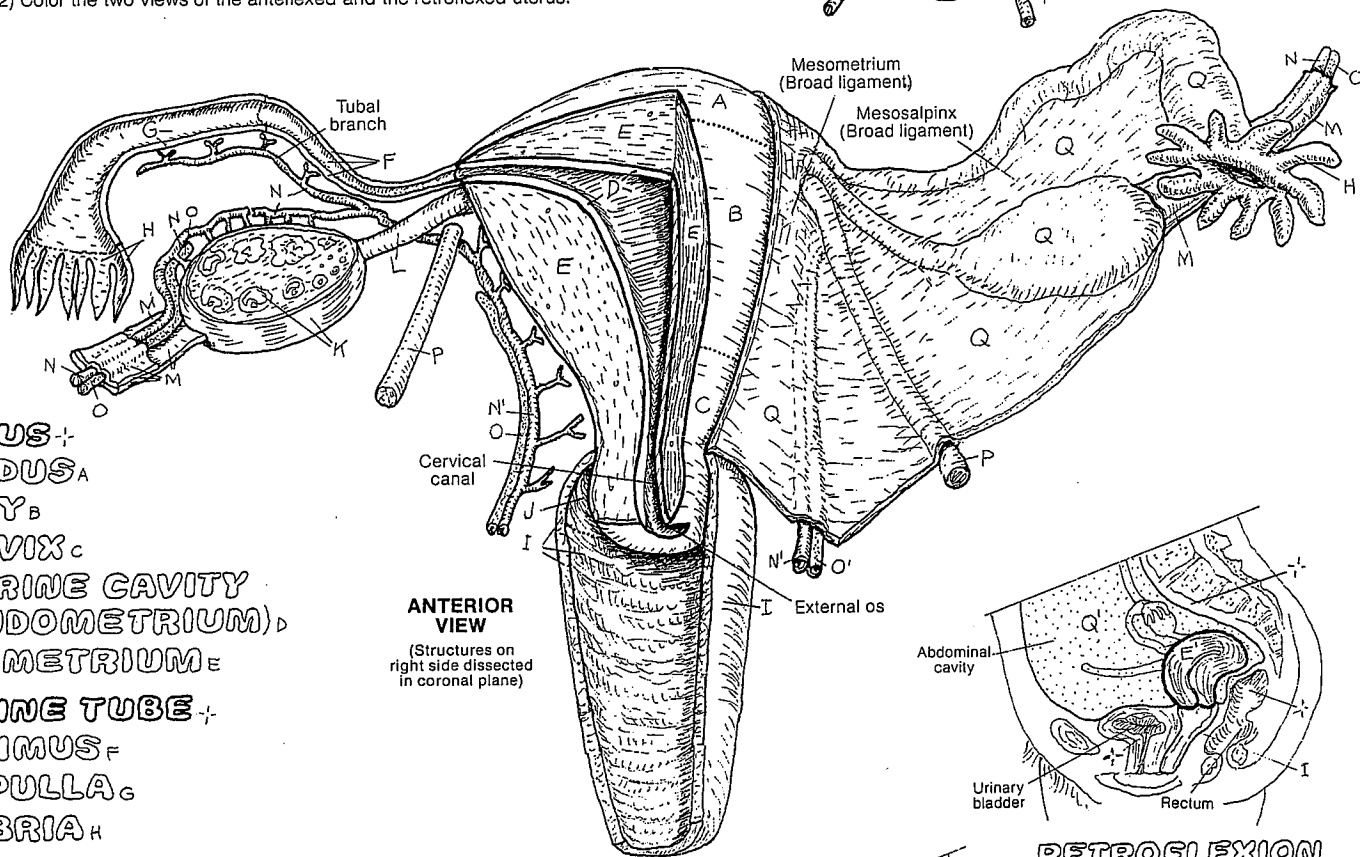
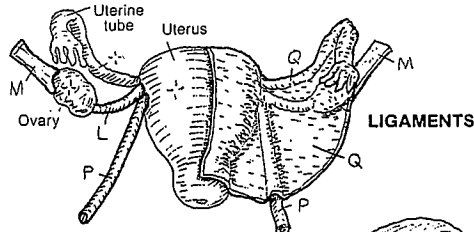
POSTERIOR VIEW  
(Schematic)

Development of female germ cells and the secretion of the hormones estrogen and progesterone are the functions of the ovary. Confined by the thin but dense fibrous *tunica albuginea*, lined with epithelium, many ovarian follicles in various stages of development can be seen in the *connective tissue stroma*. A follicle consists of an immature epithelial germ cell (*oocyte*) surrounded by one or more layers of non-germinating cells. These germ cells were seeded in the ovary early in development—over 400,000 of them. Of these, only 500 or so will mature, the rest stopping short in their development and degenerating with their follicular cells (*atretic follicles*). Development of an ovum starts with the *primordial follicle*—an oocyte with one layer of follicular cells. The oocyte increases in size and maturity as the follicle cells increase in number. In *secondary follicles*, a small cavity (antrum) filled with follicular fluid appears. This antrum continues to increase/expand at the expense of the follicle cells, which are pushed away from the oocyte

except for a layer of cells (*mature follicle*). Those cells in the outermost part of the follicle secrete estrogen during the proliferative phase of the reproductive cycle. On about the 14th day of that cycle, the ovum (surrounded by a glycoprotein coat—the *zona pellucida*—and a "corona radiata" of follicular cells) bursts from the follicle into the waiting fingers (*fimbriae*) of the *uterine tube*. The *ruptured follicle* involutes, and some bleeding and clotting goes on (*corpus hemorrhagicum*) as the follicle cells transition, characterized by accumulating large amounts of lipid. This newly formed structure (*corpus luteum*) secretes estrogen and progesterone during the secretory phase of the cycle; in the event of pregnancy, it will support the developing embryo/fetus for up to three months with these secretions. Should pregnancy not ensue, the corpus luteum will involute and degenerate as the *corpus albicans*. Follicles or corpora albicans/lutea collectively relating to two or three different but sequential cycles can be seen in the ovary at one time.

# UTERUS, UTERINE TUBES & VAGINA

CN: Use red for N, blue for O, and light colors for D, E, and Q. (1) Begin with the left half of the large illustration. Only parts of the ovarian and uterine veins are shown. Nerves and lymph vessels that may accompany arteries and veins are not shown. (2) Color the two views of the anteverted and the retroverted uterus.



UTERUS +  
 FUNDUS A  
 BODY B  
 CERVIX C  
 UTERINE CAVITY (ENDOMETRIUM) D  
 MYOMETRIUM E

UTERINE TUBE +  
 ISTHMUS F  
 AMPULLA G  
 FIMBRIA H

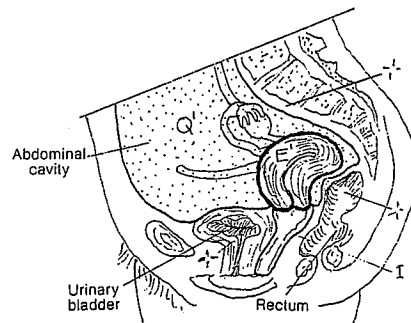
VAGINA I  
 FORNIX OF VAGINA J

RELATED STRUCTURES +

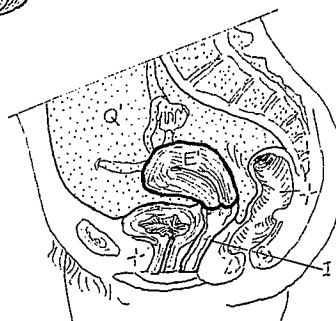
OVARY K  
 OVARIAN LIG. L  
 SUSPENSORY LIG. OF OVARY M  
 OVARIAN ART. N VEIN O

ROUND LIG. OF UTERUS P  
 UTERINE ART. N' VEIN O'  
 BROAD LIG. Q (PERITONEUM) Q'

ANTERIOR VIEW  
 (Structures on right side dissected in coronal plane)



RETROFLEXION (TIPPED) E'



ANTEFLEXION (NORMAL) E'

POSITION OF THE UTERUS (Sagittal view)

The ovaries, uterus, uterine tubes, and vagina make up the internal organs of reproduction in the female. The ovaries are suspended on the posterior layer of the *broad ligament* by a peritoneal extension (mesovarium), and supported by the *suspensory ligament of the ovary* (a lateral extension of the broad ligament and mesovarium), the *ovarian ligament*, and the *round ligament* (from the lateral wall of the uterus to the medial wall of the ovary). In this view, the ovaries have been brought to the horizontal to better clarify their relationship to the uterine tubes. The uterine tubes, suspended in a part of the broad ligament (mesosalpinx), are lateral extensions of the uterus, lined with ciliated columnar epithelium supported by connective tissue and smooth muscle. The rhythmic contractions of this muscle aid the ovum in its trek from the *fimbriae* to the *uterine cavity*, and the lining cells support it nutritionally. The tube shows three rather distinct parts: the distal *fimbriae* (finger-like projections), which "catch" the discharged ovum and whisk it into the tubular lumen; the *ampulla* or widest part of the tube; and the *isthmus*, whose lumen narrows as it enters the uterine wall/cavity.

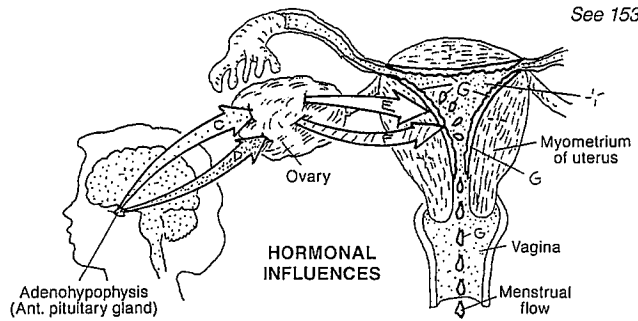
The uterus is a pear-shaped structure whose neck (*cervix*) fits into the upper part of the vagina and whose body (*fundus*) is bent (*anteverted*) and tilted (*anteverted*) anteriorly over the bladder. Backward bending/tilting

(*retroflexion/retroversion*) of the uterus is not uncommon, particularly in women who have given birth. The retroflexed uterus predisposes to mild slipping into the vagina (prolapse) when the uterus is more in the axis of the cervix/vagina. Such an event is generally resisted by the pelvic and urogenital diaphragms, the perineal body, and numerous fibrous ligaments (broad ligament, and condensations of the pelvic fasciae, not shown) mooring the uterus and its tubes to the pelvic wall and sacrum. The wall of the uterus is largely smooth muscle (*myometrium*) lined with a glandular surface layer of variable thickness (*endometrium*) that is extremely sensitive to the hormones estrogen and progesterone.

The vagina is an elastic, fibromuscular tube with a mucosal lining of stratified squamous epithelium. The anterior and posterior mucosal surfaces are normally in contact. The anterior vaginal wall incorporates the short (4 cm) urethra. Remarkably, the mucosa of the vagina lacks glands; secretory activity during sexual stimulation is derived from a transudate of plasma from the local capillaries and from glands of the cervix. The vaginal lining reveals few sensory receptors. Where the cervix fits into the vagina, a circular moat or trough is formed around it (*fornix*, fornices). The fibroelastic posterior fornix is capable of significant expansion during intercourse.

# MENSTRUAL CYCLE

CN: Use yellow for B, red for G, and a very light color for A. (1) Color the time bar of the menstrual cycle at the bottom of the main diagram. Color the arrows C and D in the drawing on hormonal influences above. Then color the hormonal curves C and D in the main diagram, followed by the different follicular stages of the ovarian cycle (A, B), noting how these hormones influence the follicular changes. (2) Color the arrows E and F and the endometrium in the diagram above. Color the curves E and F in the main diagram, followed by the uterine structures in the menstrual cycle, noting how these hormones influence endometrial growth and menstruation. Color only the epithelial surface, glands, and vessels of the endometrium. (3) The days indicated are approximate. The hormonal curves reflect relative plasma hormone levels and are not absolute values.



## OVARIAN CYCLE

- PRIMORDIAL FOL<sub>0</sub>A
- PRIMARY FOL<sub>0</sub>A<sup>1</sup>
- SECONDARY FOL<sub>0</sub>A<sup>2</sup>
- MATURE FOL<sub>0</sub>A<sup>3</sup>
- OVULATION A<sup>4</sup>
- CORPUS LUTEUM<sub>B</sub>,B<sup>1</sup>
- CORPUS ALBICANS<sub>B</sub><sup>2</sup>

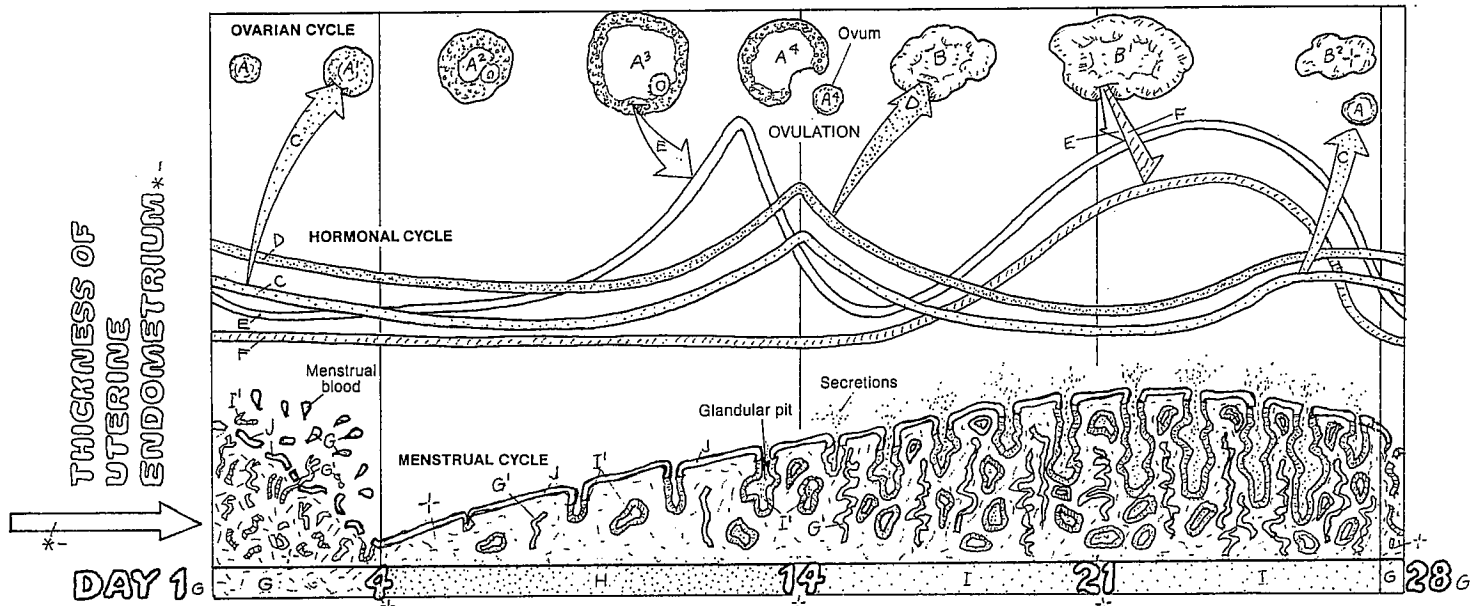
## HORMONAL CYCLE

- HYPOPHYSEAL HORMONES
- FSH<sub>C</sub>
- LH<sub>D</sub>
- OVARIAN HORMONES
- ESTROGEN<sub>E</sub>
- PROGESTERONE<sub>F</sub>

## MENSTRUAL CYCLE

### PHASES

- MENSTRUATION<sub>G</sub>
- PROLIFERATIVE<sub>H</sub>
- SECRETORY<sub>I</sub>
- ENDOMETRIUM
- EPITHELIUM<sub>J</sub>
- GLAND<sub>I</sub><sup>1</sup>
- SPIRAL ARTERY<sub>G</sub><sup>1</sup>



The 28-day human female reproductive cycle, initiated and maintained by hormones, involves significant alterations in ovarian (follicular) and uterine (endometrial) structure. The cycle is characterized by periods of endometrial breakdown and discharge (*menstruation*), which begin at about 12 years of age (menarche) and end at about 45 years of age (menopause). The progressive changes that occur in the ovary and uterus during each cycle serve to develop and release the female germ cell for possible fertilization by the male germ cell and to prepare the *endometrium* for implantation of the fertilized ovum.

The menstrual period constitutes the first five days of the cycle. Note the loss of endometrial tissue and attendant bleeding during this time. Endometrial regrowth begins on about the 5th day of the menstrual cycle and is precipitated by hormones from the ovarian follicles. The ovarian cycle is regulated by hormones from the adenohypophysis (anterior pituitary gland), specifically *follicle stimulating hormone (FSH)* and *luteinizing hormone (LH)*. During the last few days of the previous cycle and the first several days of the next, these hormones stimulate follicular development.

As the selected follicle develops, it begins to produce *estrogen* on about the 7th day. Estrogen enters the circulation and influences endometrial growth (*proliferative phase*). On about the 14th day of the menstrual cycle, the combined "spikes" of increased concentrations of FSH, LH, and estrogen induce *ovulation*: bursting of the mature follicle and release of the immature ovum into the fimbriae of the uterine tube. After ovulation, the burst follicle undergoes significant reconstruction (*corpus luteum*)

influenced by LH. On about the 21st day, this body secretes *progesterone* as well as estrogen, a combination with remarkable influence on endometrial glandular development (*secretory phase*). This phase is characterized by the development of numerous secretory cells in the *epithelium*, a connective tissue stroma edematous with secretions from developing *glands*, and *spiral arteries* taking a tortuous course about the many glands—a condition conducive to nutritional support for an implanted fertilized ovum. If fertilization occurs (on about day 16), the corpus luteum becomes the principal source of hormones supporting development of the embryo and will continue as such for the next 90 days or so or until the placenta is capable of producing its own hormones.

In the absence of fertilization, on about day 26 the corpus luteum begins to involute (forming a *corpus albicans*), and estrogen/progesterone levels drop. Lacking hormonal stimulation, the endometrium experiences reduced glandular secretion in the presence of continued fluid absorption by the local veins, and the tissues collapse. The spiral arteries are flexed by these events, rupture, and hemorrhage with considerable hydraulic force; epithelial lining, glands, and fibrous tissues are disrupted and the structural integrity of the endometrium is largely destroyed. The vessels rapidly constrict, and bleeding is generally limited. The broken tissue (menstruum, mostly glandular tissue and secretions), blood, and one or more unfertilized ova gravitate toward the vagina. After 3–5 days of menstruation, only about 1 mm (in height) of endometrium is left for regeneration. Within the next two weeks, it will regenerate 500% to a height of about 5 mm!

# BREAST (MAMMARY GLAND)

CN: Use yellow for E, pinks, tans, or browns for J and K, and light colors for A, D, E, and G. (1) Color the two illustrations of the breast and underlying breast structures simultaneously. (2) Color the arrows indicating the direction of lymph flow and the lymph nodes of the chest. If you wish, you may color over the network of lymph vessels. (3) Color the diagrams of breast development. (4) Color the enlargement of glands and ducts in the lower right corner.

- RIB<sub>A</sub> CLAVICLE<sub>A'</sub>
- INTERCOSTAL MUSCLE<sub>B</sub>
- PECTORALIS MAJOR M<sub>C</sub>
- DEEP FASCIA<sub>D</sub>
- SUPERFICIAL FASCIA (FAT)<sub>E</sub>
- SUSPENSORY LIGAMENT<sub>F</sub>
- GLANDULAR LOBE<sub>G</sub>
- LACTIFEROUS DUCT<sub>H</sub>
- LACTIFEROUS SINUS<sub>I</sub>
- NIPPLE<sub>J</sub>
- AREOLA<sub>K</sub>

## LYMPHATIC DRAINAGE<sub>L</sub>

The breast (in both males and females) is an area of fatty (adipose and loose areolar) fibrous tissue, with associated nerves and blood and lymphatic vessels, in the subcutaneous fascia overlying the pectoralis major muscle on the anterior chest wall. The fatty tissue is supported by extensions of the deep fascia overlying the muscle (*suspensory ligaments*) and functions most prominently in the young, well-developed, post-pubescent (after puberty) female breast. Packed within the adipose tissue is a collection of branching ducts (*lactiferous ducts*). In the male and in the non-pregnant (non-lactating) female, these ducts are undeveloped. There are few or no glands (alveoli) associated with the ducts in those populations. At puberty, the increased secretion of estrogen from the ovaries (and perhaps the adrenal glands) in the female influences an enlargement of the *nipple* and *areola* and a generally marked increase in local fat proliferation. As a result, the breast enlarges to some degree (highly variable).

In the early stages of pregnancy, the lactiferous duct system undergoes profound proliferation, and small, inactive tubular and alveolar (*tubuloalveolar*) glands form, opening into alveolar ducts. A *lobule* consists of a number of these ducts and glands; a *lobe* (of which there are 15-20) consists of a number of lobules and an interconnecting *interlobular duct*. The interlobular ducts converge to form as many as 20 lactiferous ducts. These ducts dilate to form *lactiferous sinuses* just short of the nipple, then narrow again within the nipple. These sinuses probably function as milk reservoirs during lactation. The nipple consists of pigmented skin with some smooth muscle fibers set in fibrous tissue. Erection of the nipple may enhance flow of milk through the ducts. The circular areola, also pigmented more highly than the surrounding skin, contains sebaceous glands that may act as a skin lubricant during periods of nursing. In the latter stages of pregnancy, the alveolar glands undergo maturation and begin to form milk. Milk production peaks after delivery of the newborn as the result of the action of several hormones influencing the gland cells. The letdown and excretion of milk results from a neuro-endocrine reflex mechanism initiated by the baby's sucking on the nipple.

The lymphatic vessels are an important part of the breast: they drain the fat portion of the milk produced during lactation. They also transfer infected material or neoplastic (cancer) cells from the breast to more distant parts. The potential lymphatic avenues for metastasis or spread of infection are shown above.

