

UNIT 4



DIGESTIVE SYSTEM, URINARY SYSTEM, REPRODUCTIVE SYSTEMS

PART 1

This unit covers the final systems of the course which are the digestive, urinary, female and male reproductive systems. The digestive system is responsible for the breakdown and absorption of nutrients. The urinary system rids the body of waste and the reproductive systems produce the gametes (egg and sperm) to allow for reproduction.

DIGESTIVE TRACT

The digestive tract is also known as the gastrointestinal (GI) tract or the alimentary tract. It extends from the mouth to the anus. The liver, gallbladder, and pancreas support digestion.

Mouth

Food enters the digestive system through the mouth. In the mouth the food is torn apart by the teeth and mixed with saliva by the tongue to create a bolus of food to be swallowed. The saliva in the mouth is produced by 3 different pairs of salivary glands. The largest of the salivary glands are the **parotid glands** (PAHROT-id). They are located in the subcutaneous tissue anterior and inferior to the ears. The **submandibular glands** are located in the subcutaneous tissue beneath the rami of the mandibles. These glands produce the majority of the saliva. The last of the salivary glands are the **sublingual glands**, which are located beneath the tongue. These glands produce the least amount of saliva. After the food is mixed with saliva it is swallowed and passes through the oropharynx to the esophagus.

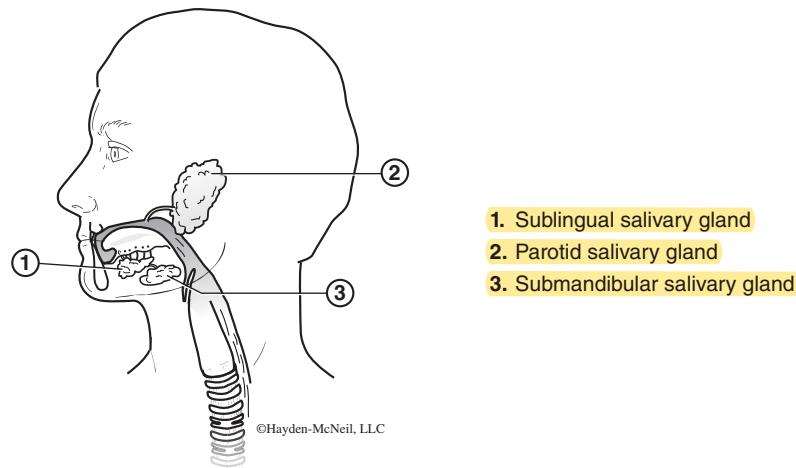


Figure 4.1. Salivary Glands

Esophagus

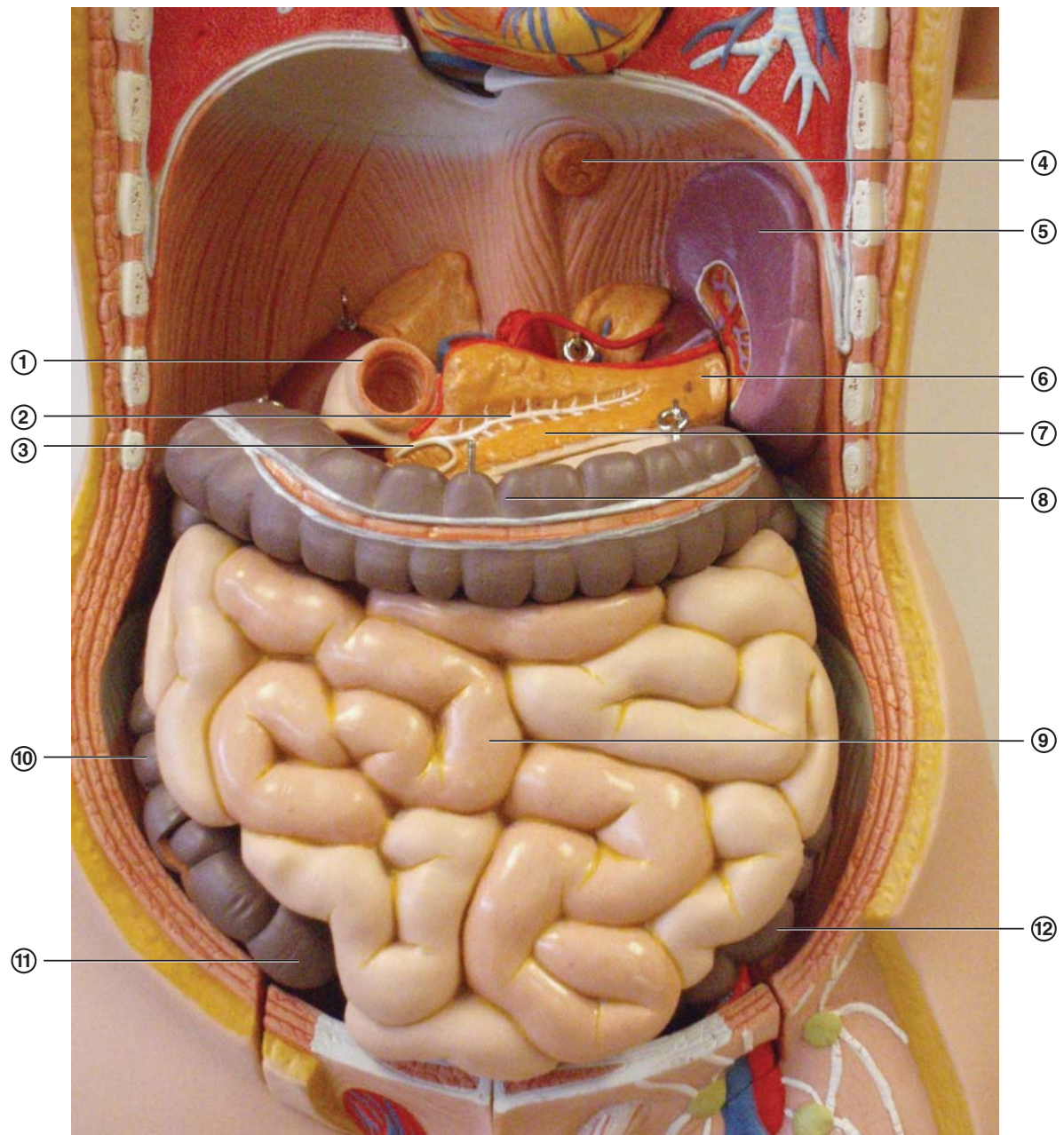
The **esophagus** (ESOF-ahgus) extends from the laryngopharynx through the diaphragm to the stomach. This is a muscular tube; the upper third is skeletal muscle and the remainder is smooth muscle. Food is moved down the esophagus by peristaltic waves.

Stomach

The **stomach** is located beneath the diaphragm on the left side of the abdomen. It is between the esophagus and the duodenum on the small intestine. It is a hollow smooth-muscle organ that is sometimes described as J-shaped. The stomach mixes the food with gastric juice by segmentation to create chyme. It begins protein digestion by denaturing the proteins and pepsin's action on peptide bonds. The stomach is able to absorb a small amount of some substances. It also moves the chyme into the small intestine by peristalsis.

The stomach has three parts: the fundus, the body, and the pylorus. The **fundus** (FUN-dus) of the stomach is the upper portion of the stomach that extends superior to the esophageal opening of the stomach. The **body** is the central region of the stomach. The **pylorus** (PIELOR-us) is the region that narrows as it approaches the opening to the small intestine.

Both openings in the stomach are controlled by a **sphincter** (SFINGK-tur). This is a circular band of smooth muscle that can restrict or allow the passage of food in and out of the stomach. At the junction of the esophagus and the stomach is the **lower esophageal** or **cardiac sphincter**. This sphincter prevents the food and stomach acid from flowing back into the esophagus. At the opening of the stomach in the duodenum of the small intestine is the **pyloric sphincter**. This controls the amount of chyme entering the duodenum for digestion. It usually only allows about a teaspoon of chyme at a time to enter the small intestine.



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- | | | |
|------------------------------|---------------------|------------------------------|
| 1. Duodenum | 5. Spleen | 9. Small intestine (jejunum) |
| 2. Pancreatic duct | 6. Tail of pancreas | 10. Ascending colon |
| 3. Accessory pancreatic duct | 7. Pancreas | 11. Cecum |
| 4. Esophagus | 8. Transverse colon | 12. Sigmoid colon |

Figure 4.2. Organs of Abdominal Cavity with Liver and Stomach Removed

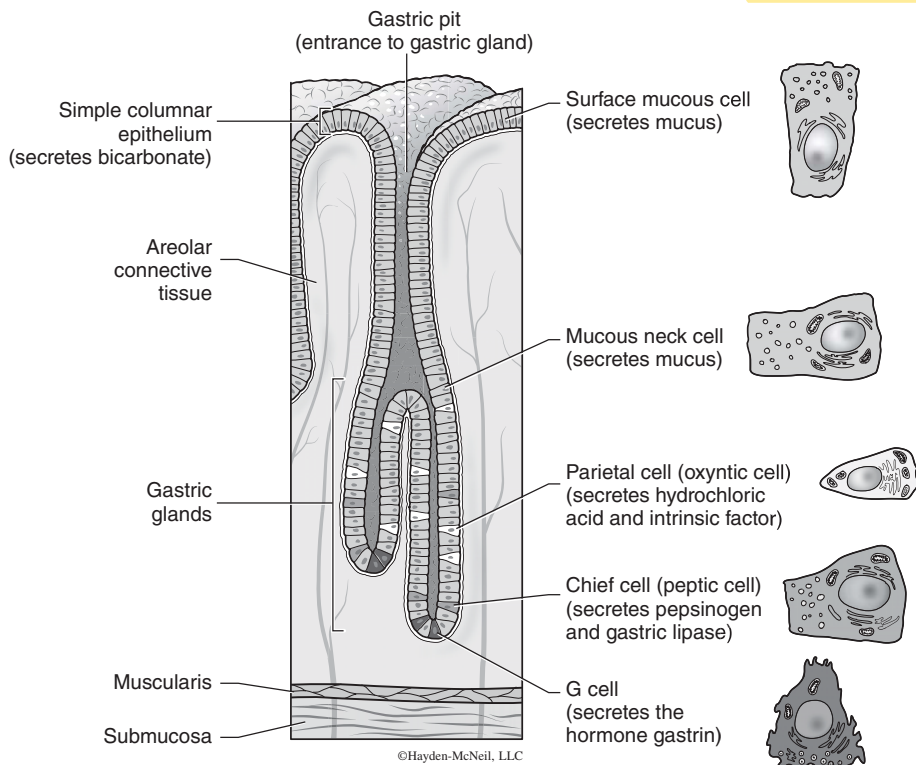
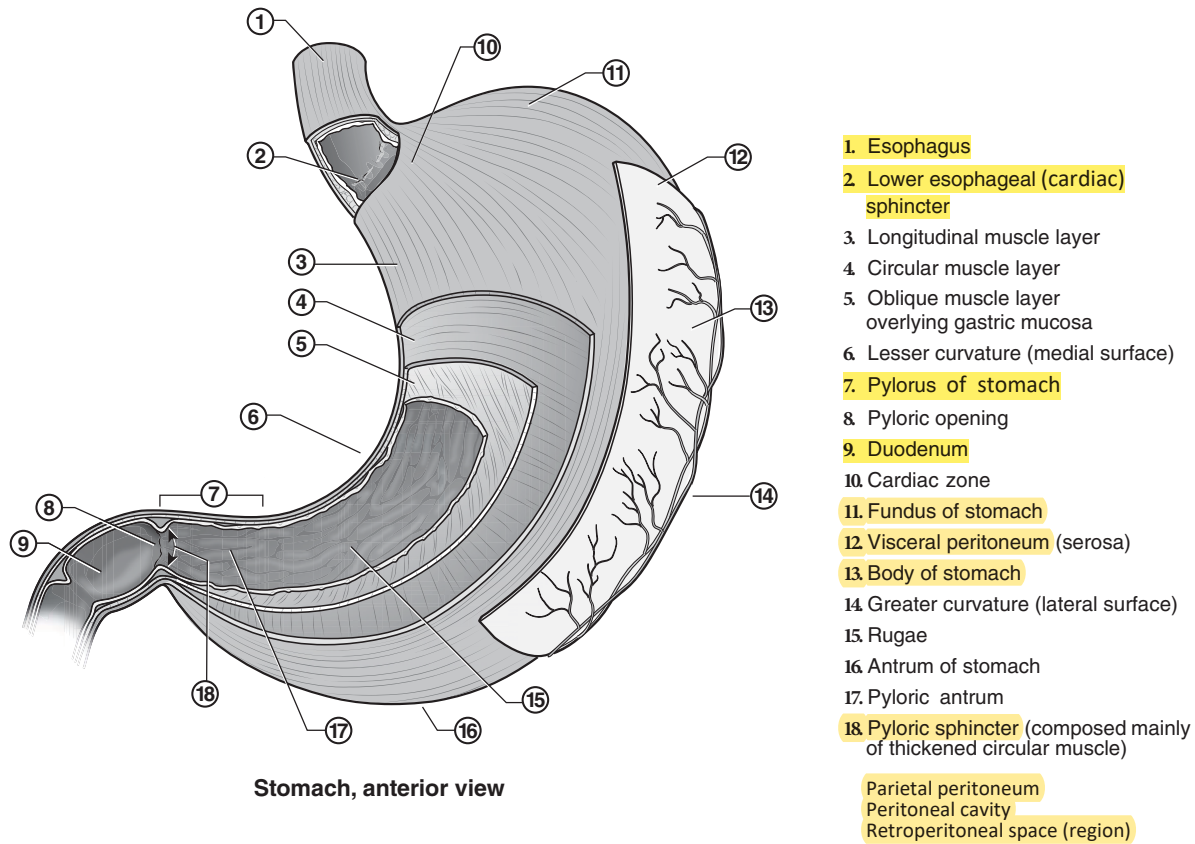


Figure 4.3. Stomach

Small Intestine

The **small intestine** extends from the stomach to the large intestine. It is called the small intestine because it is smaller in diameter than the large intestine; however, the small intestine is much longer than the large intestine. The small intestine completes the digestion and absorption of the nutrients. To assist in this function the small intestine receives secretions from the pancreas, liver, and gallbladder. The small intestine also moves the waste products into the large intestine.

There are 3 parts to the small intestine: the duodenum, the jejunum and the ileum. The **duodenum** (DOO-ahdee-num or doo-OD-inum) is the initial section of the small intestine. It is the location of the pancreatic duct and common bile duct openings. These ducts carry the pancreatic juice and bile to the duodenum so it can continue with the digestion of chyme. Bile allows the emulsification of fat so that it can be digested and pancreatic juice contains enzymes. The point at which the common bile duct and pancreatic duct meet there is a dilation which is the **ampulla of Vater** (am-PYU-lah FAT-er) or the **hepatopancreatic ampulla**. It opens into the duodenum inferiorly to the accessory pancreatic duct at the major duodenal papilla. The duodenum continues with the digestion of chyme as well as some absorption of nutrients. The majority of digestion occurs in the duodenum.

The middle section of the small intestine is the **jejunum** (JIJOO-num). Digestion is completed in the jejunum. The final section of the small intestine is the **ileum** (IL-ee-um). Its main function is absorption. There is a valve between the ileum and the large intestine, the **ileocecal valve** (IL-ee-OSEE-kahl), to prevent the backflow of waste material into the small intestine.

The small intestine mucosa consists of finger-like projections known as **villi** (singular **villus** (VIL-us)) that increase the surface area available for absorption. In the core of each villus is a **capillary bed**, a **lacteal** (LAK-tee-ahl), and nerves. The lacteal is a lymphatic vessel that carries the chylomicrons away from the small intestine.



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1. Liver

2. Gallbladder

3. Body of stomach

4. Pylorus of stomach

5. Transverse colon

6. Descending colon

7. Ascending colon

8. Cecum

9. Small intestine (jejunum)

10. Sigmoid colon

Figure 4.4. Abdominal Organs

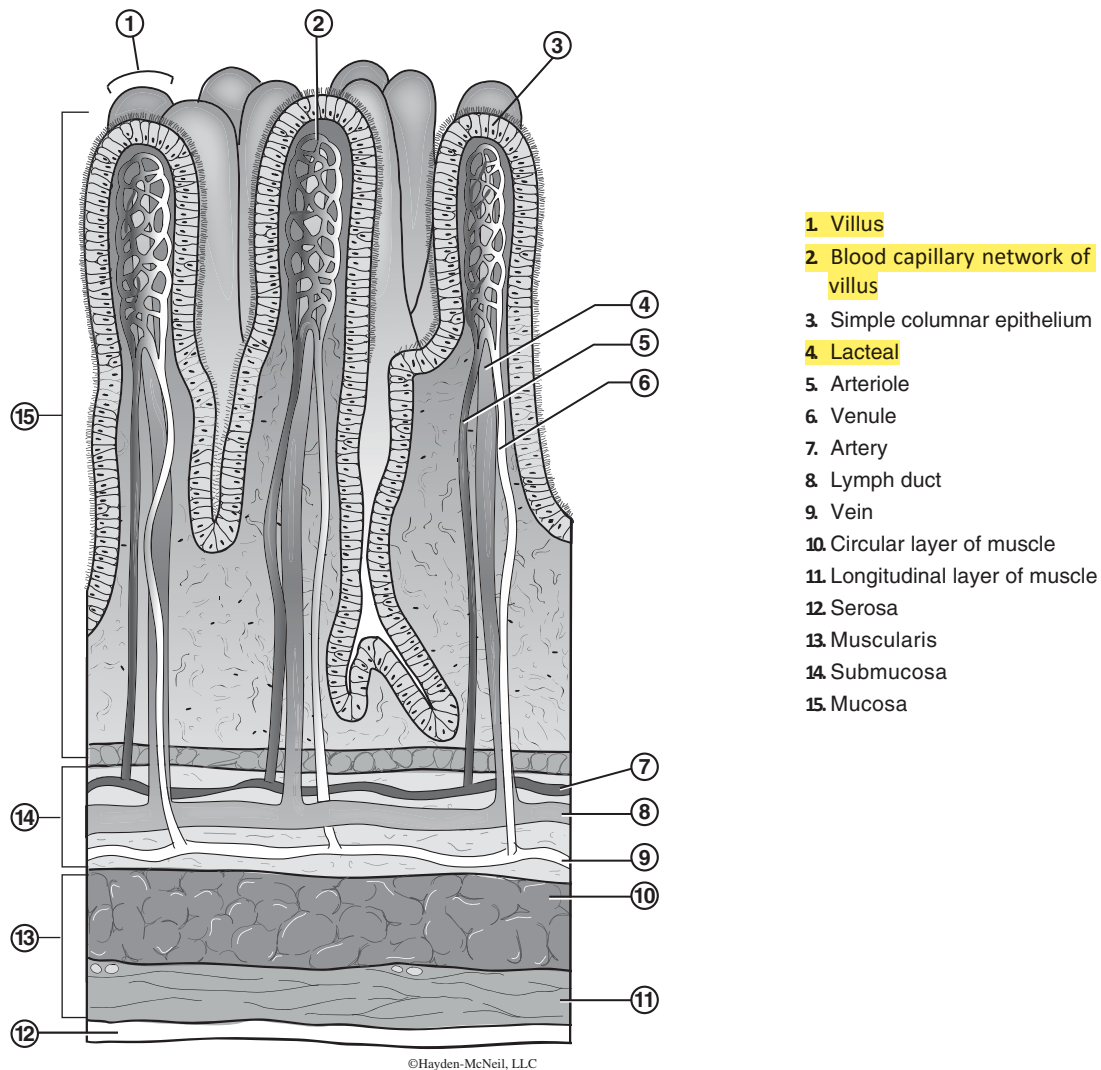


Figure 4.5. Villi of Small Intestine

Large Intestine

The large intestine, also known as the colon, extends from the small intestine to the anal canal. The large intestine prepares the watery waste material from the small intestine for excretion as feces. In doing so the colon reabsorbs water, some minerals, and some vitamins produced by colonic bacteria. There are seven parts to the large intestine: cecum, appendix, ascending colon, transverse colon, descending colon, sigmoid colon, and rectum. The **cecum** (SEE-cum) is a blind-end pouch that receives the waste material from the ileum through the ileocecal valve. The **appendix** is located on the posteroinferior aspect of the cecum.

The cecum leads into the **ascending colon**, which projects upward on the right side of the abdomen to just below the liver. It bends to the left at the hepatic flexure to become the **transverse colon**. The transverse colon spans the abdomen cavity until near the spleen where it bends inferiorly at the splenic flexure to become the **descending colon**. The descending colon travels down the left side of the abdomen. In the lower left quadrant at the edge of the pelvis the descending colon bends into an S-shaped curve known as the **sigmoid colon**. The sigmoid colon ends at the **rectum**. The rectum serves as a storage site for fecal material until defecation.

The rectum becomes the **anal canal** which ends with the **anus**, the opening to the exterior of the body. The anus has two sphincters to control the movement of fecal material. The first is the **interior anal sphincter** which is smooth muscle and involuntary. The second is the **external anal sphincter** which is skeletal muscle and usually is under voluntary control.

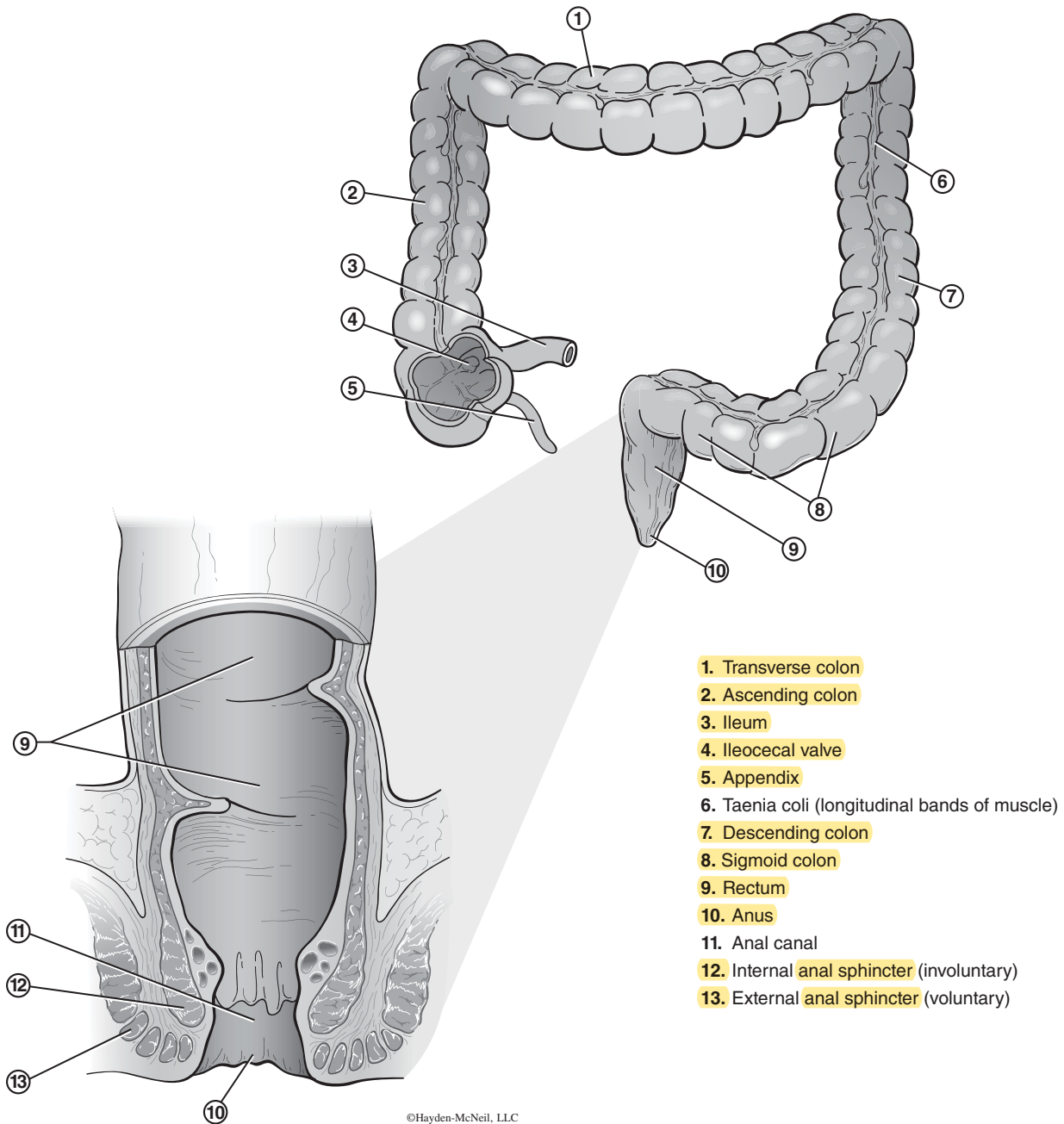
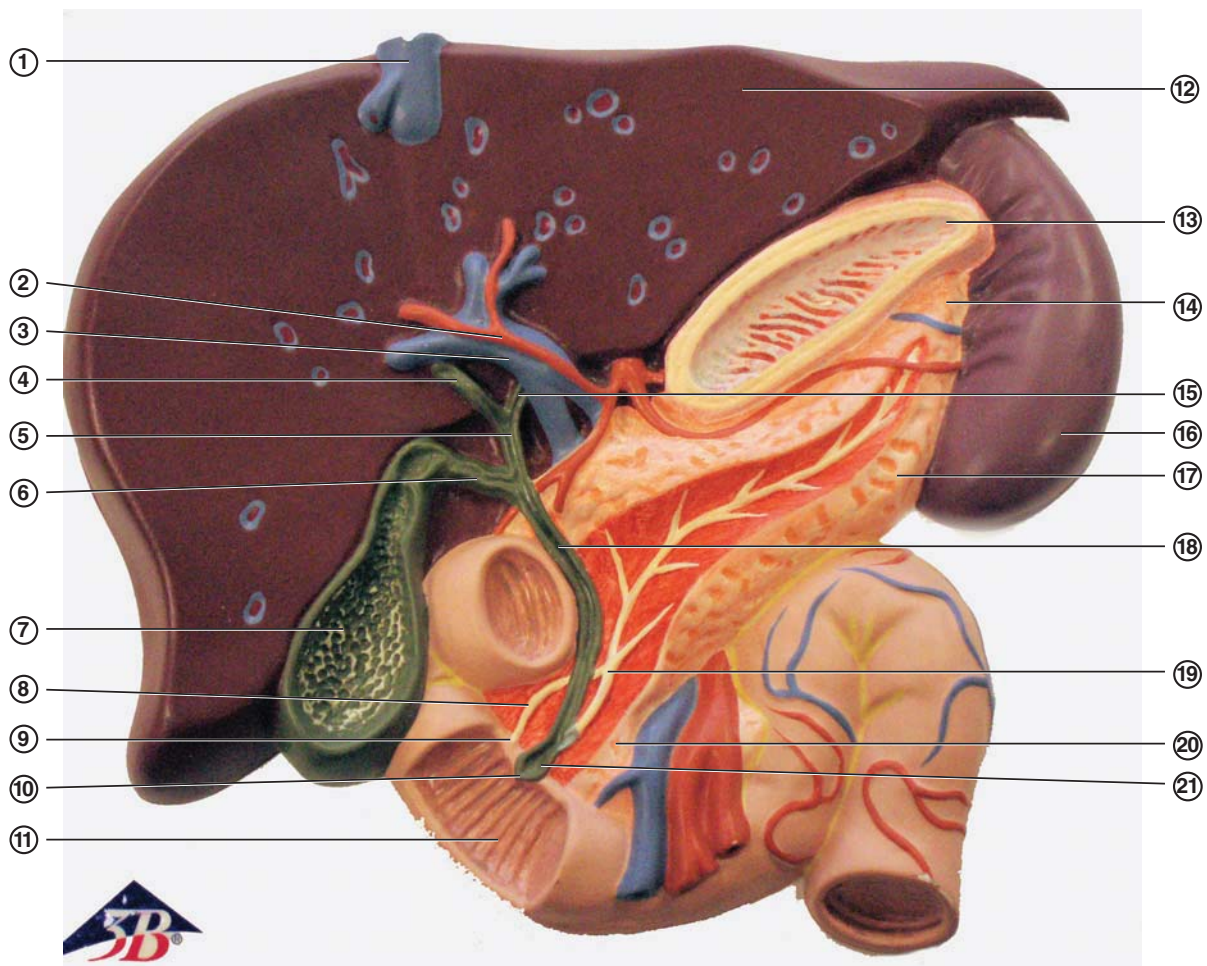


Figure 4.6. Large Intestine

Liver

The **liver** is the largest gland in the body. It assists with digestion by producing and secreting bile. It is located in the upper right quadrant of the abdomen beneath the diaphragm. Entering the bottom of the liver is the hepatic portal vein, covered in the last unit, and exiting the top of the liver are the hepatic veins that empty into the inferior vena cava. Bile is produced in the lobules of the liver and leaves the liver by way of the hepatic ducts. On the inferior surface of the liver the **right hepatic duct**, which drains the right lobe, and the **left hepatic duct**, which drains the left lobe unite to form the **common hepatic duct**. The hepatic duct unites with the **cystic duct** leaving the gallbladder to form the **common bile duct**.



Liver with Gall Bladder, Pancreas and Duodenum LT-VE315, 3B Scientific®

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|------------------------|------------------------------|---|
| 1. Inferior vena cava | 8. Accessory pancreatic duct | 15. Left hepatic duct |
| 2. Hepatic artery | 9. Minor duodenal papilla | 16. Spleen |
| 3. Hepatic portal vein | 10. Major duodenal papilla | 17. Pancreas |
| 4. Right hepatic duct | 11. Duodenum | 18. Common bile duct |
| 5. Common hepatic duct | 12. Liver | 19. Pancreatic duct |
| 6. Cystic duct | 13. Stomach | 20. Head of pancreas |
| 7. Gallbladder | 14. Tail of pancreas | 21. Hepatopancreatic ampulla (of Vater) |

Figure 4.7. Liver, Gallbladder, and Pancreas

Gallbladder

The **gallbladder** is a pear-shaped sac located on the inferior of the liver. It is a storage sac for bile. The bile leaves the gallbladder through the **cystic duct**. The cystic duct joins the common hepatic duct as mentioned earlier to form the **common bile duct**. The common bile duct carries bile to the duodenum. The common bile duct joins the **pancreatic duct** and enters the duodenum together. This can present a problem since the pancreatic duct can possibly be blocked by a gallstone that becomes lodged at the juncture of the common bile duct and the pancreatic duct. This can lead to acute pancreatitis.

Pancreas

The pancreas is located posterior to the stomach and extends from the spleen to the duodenum. Running down the center of the gland is the **pancreatic duct** and usually has a branch off it known as the **accessory pancreatic duct**. The pancreatic duct empties into the duodenum inferiorly to the accessory pancreatic duct. The pancreatic ducts carry the digestive enzymes and bicarbonate ion synthesized by the pancreas to the duodenum.

PART 2

URINARY SYSTEM

The urinary system consists of the kidney, ureters, urinary bladder, and urethra. The functional unit of the kidney is the nephron.

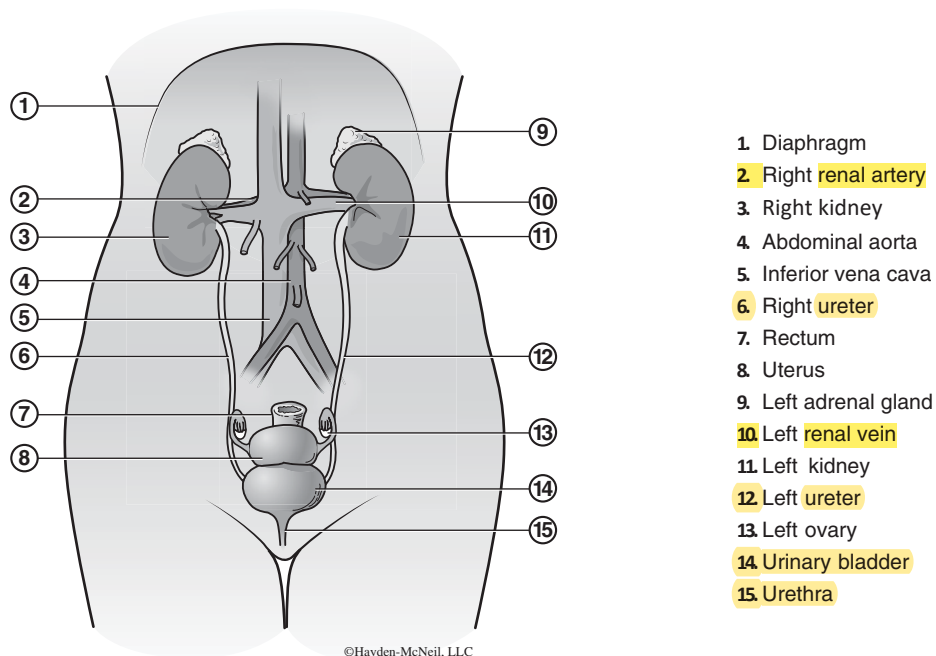


Figure 4.8. Urinary System

Kidneys

The kidneys remove waste products from the blood, form urine, and help regulate fluid and electrolytes as well as assist in acid–base balance. They are located on either side of the vertebral column on the posterior abdominal wall in the retroperitoneal space.

The kidney is a bean-shaped organ that is surrounded by a reddish brown fibrous **renal capsule**. Internally the renal tissue is composed of the cortex and the medulla. The **cortex** is the outer region, however in the kidney some cortex tissue is found between the medullary tissues. These regions of cortex are the **renal columns**.

The **medulla** regions are shaped like pyramids and as a result are called **renal pyramids**. The tips of the pyramids are the **papillae** (singular papilla). This is where the urine leaves the nephrons. The urine is collected in the **calyces** (singular **calyx**) which are cup-like structures situated over the papillae. A **minor calyx** collects urine from only one renal papilla. Several minor calyces merge to form one major calyx. A **major calyx** (KAY-likes) (plural: calyces (KAY-lah-seez)) collects urine from several minor calyces. The major calyces merge to form the **renal pelvis**. This is a funnel-shaped structure that is large at the top and narrows at the bottom to form the ureter.

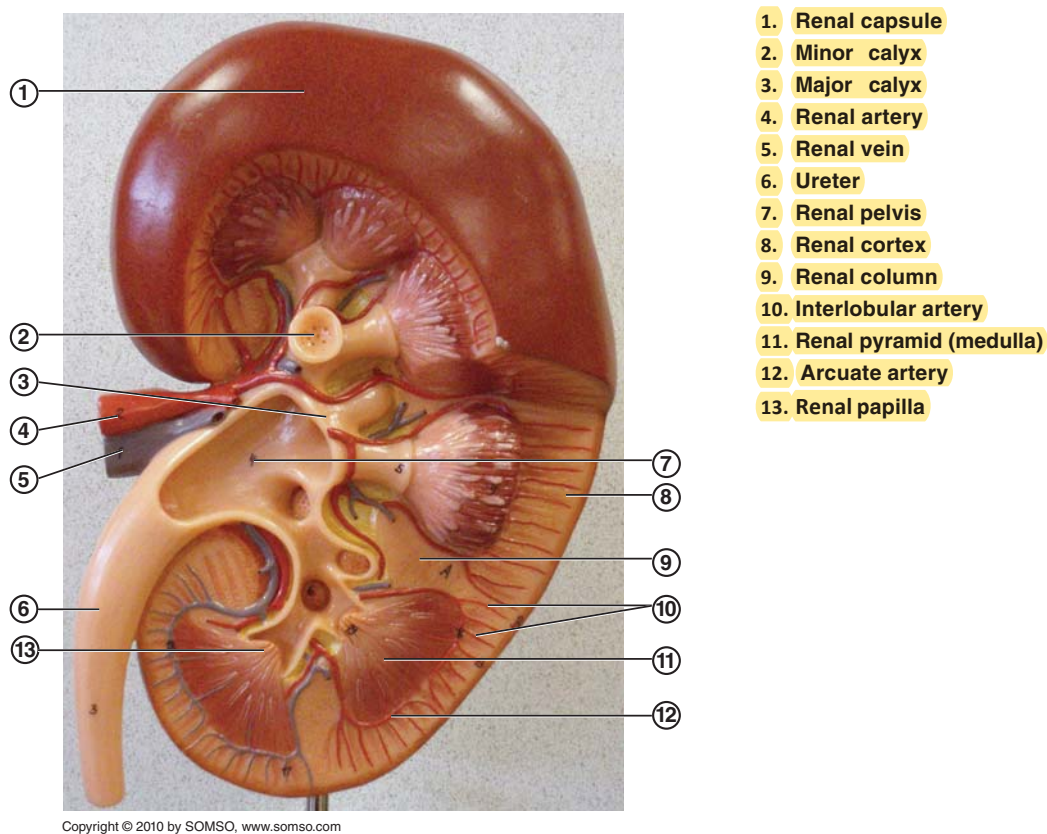


Figure 4.9. Frontal Section of Kidney

Ureters

The **ureters** (u-REE-ter) are muscular tubes that extend from the renal pelvis to the urinary bladder. They act as a duct to carry the urine formed in the kidneys to the urinary bladder. Urine is moved through the ureters by peristaltic waves.

Urinary Bladder

The **urinary bladder** is a hollow, distensible smooth muscle organ that serves as a reservoir for urine before it is excreted from the body. It is located in the pelvic cavity posterior to the pubic symphysis and the pubic bone.

The ureters enter through the posterior wall of the bladder in the region known as the **trigone**. The inferior narrowing area of the bladder is the neck of the bladder. This is where the urethra exits the bladder.

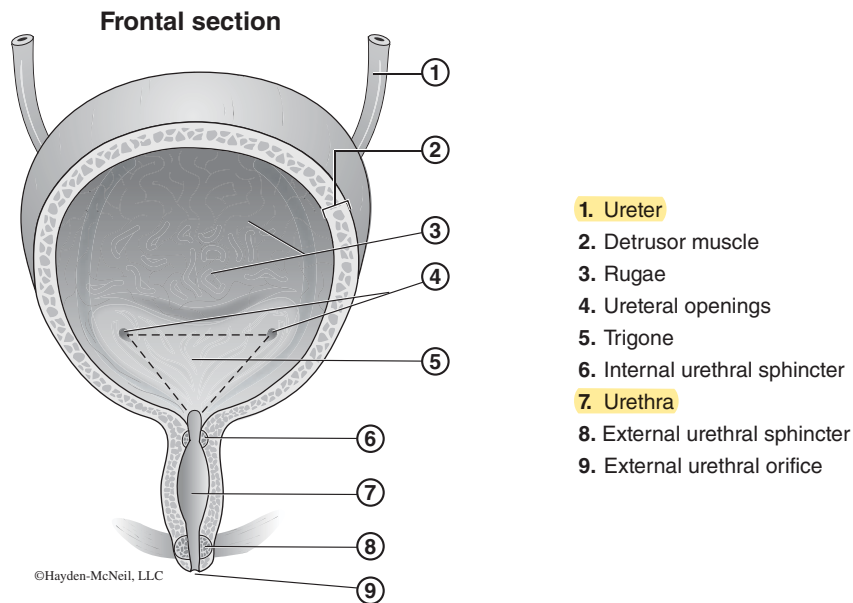


Figure 4.10. Bladder

Urethra

The **urethra** (u-REE-thrah) carries the urine from the bladder out of the body. The urethra in the female is very short and only serves as part of the urinary system. In the male the urethra is much longer and serves as part of both the urinary system and the male reproductive system. There are two sphincters controlling the movement of urine through the urethra. The internal urethral sphincter is smooth muscle and involuntary. The external urethral sphincter is skeletal muscle and under voluntary control.

Blood Flow through the Nephron

Blood enters the kidney through the **renal artery**. Once the renal artery enters the kidney it divides many times as it approaches the nephron. As the arteries branch at the base of the pyramids it becomes the **arcuate artery** (ARE-kyah-what). This is a branch of the **interlobar artery**. Branching off the arcuate artery is the **interlobular artery** that carries the blood toward the nephron. Branching off the interlobular artery is the **afferent arteriole** which carries the blood to be filtered into the glomerulus. The glomerulus is a specialized capillary bed that functions to filter the blood passing through it. After the blood is filtered it leaves the glomerulus by way of the **efferent arteriole**. The efferent arteriole is smaller in diameter than the afferent arteriole. The efferent arterioles lead into the **peritubular capillaries**. These capillary beds travel along with the tubules of the nephrons and take part in reabsorption and secretion as well as nourishing the nephron. The peritubular capillaries flow into venules that drain into the **interlobular veins**. The venous blood eventually makes its way to the **renal vein** which drains into the inferior vena cava.

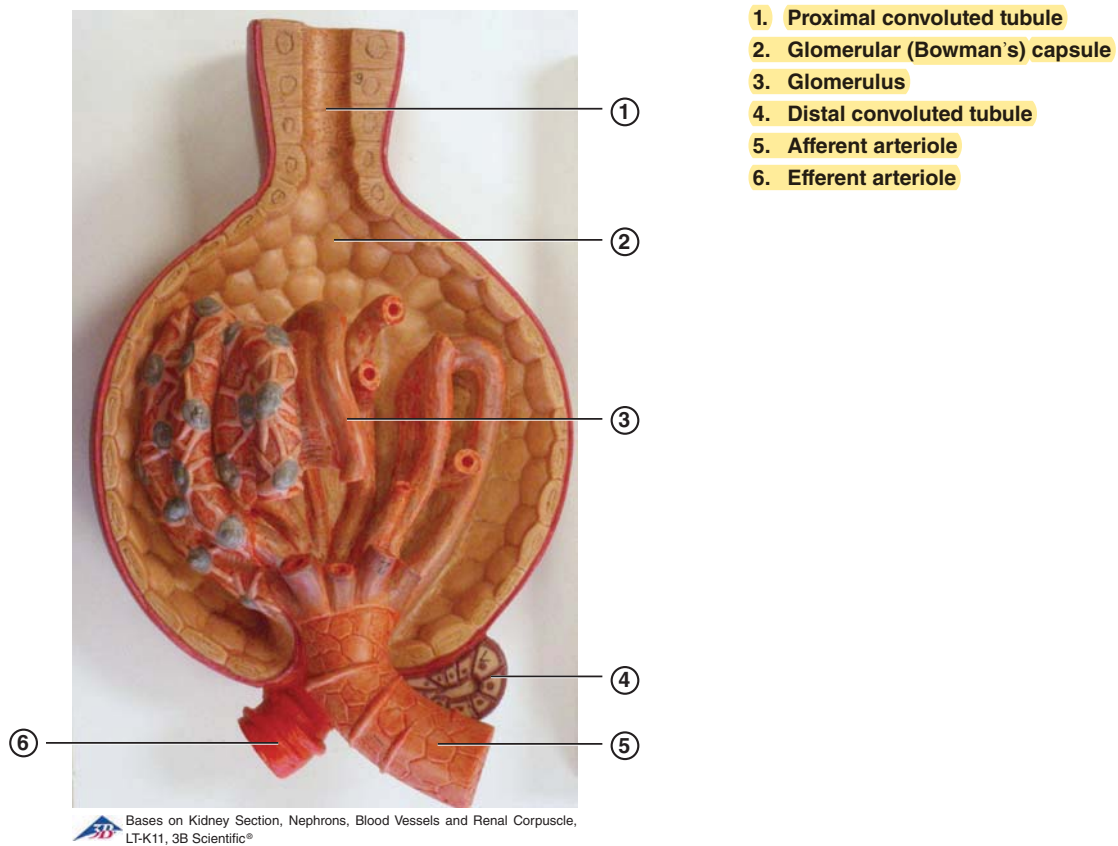


Figure 4.11. Glomerulus and Glomerular Capsule

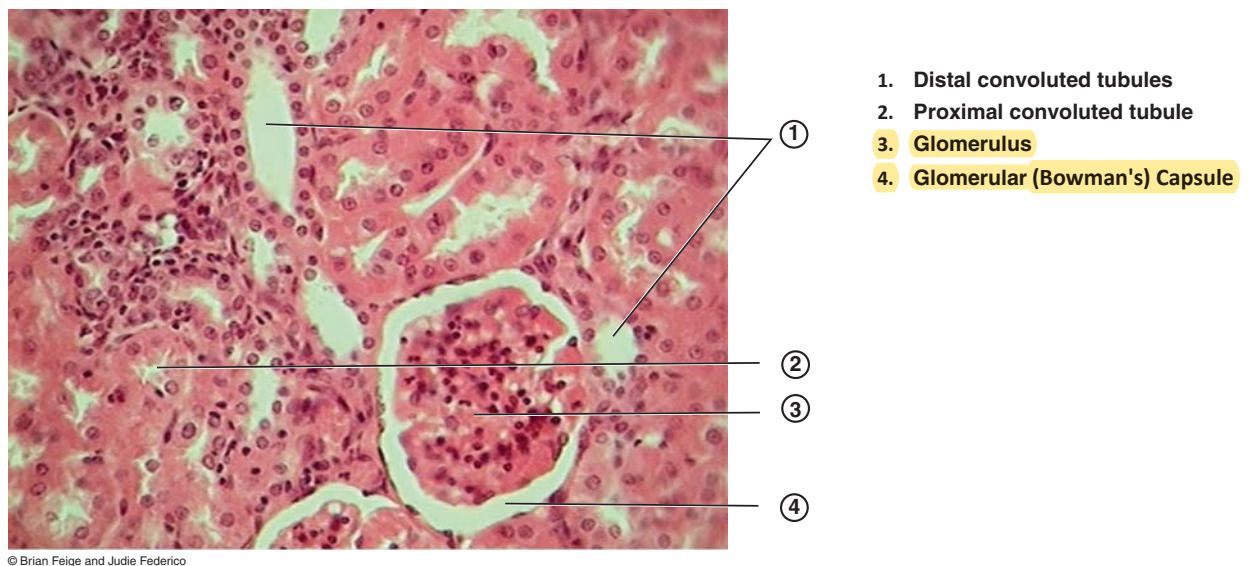


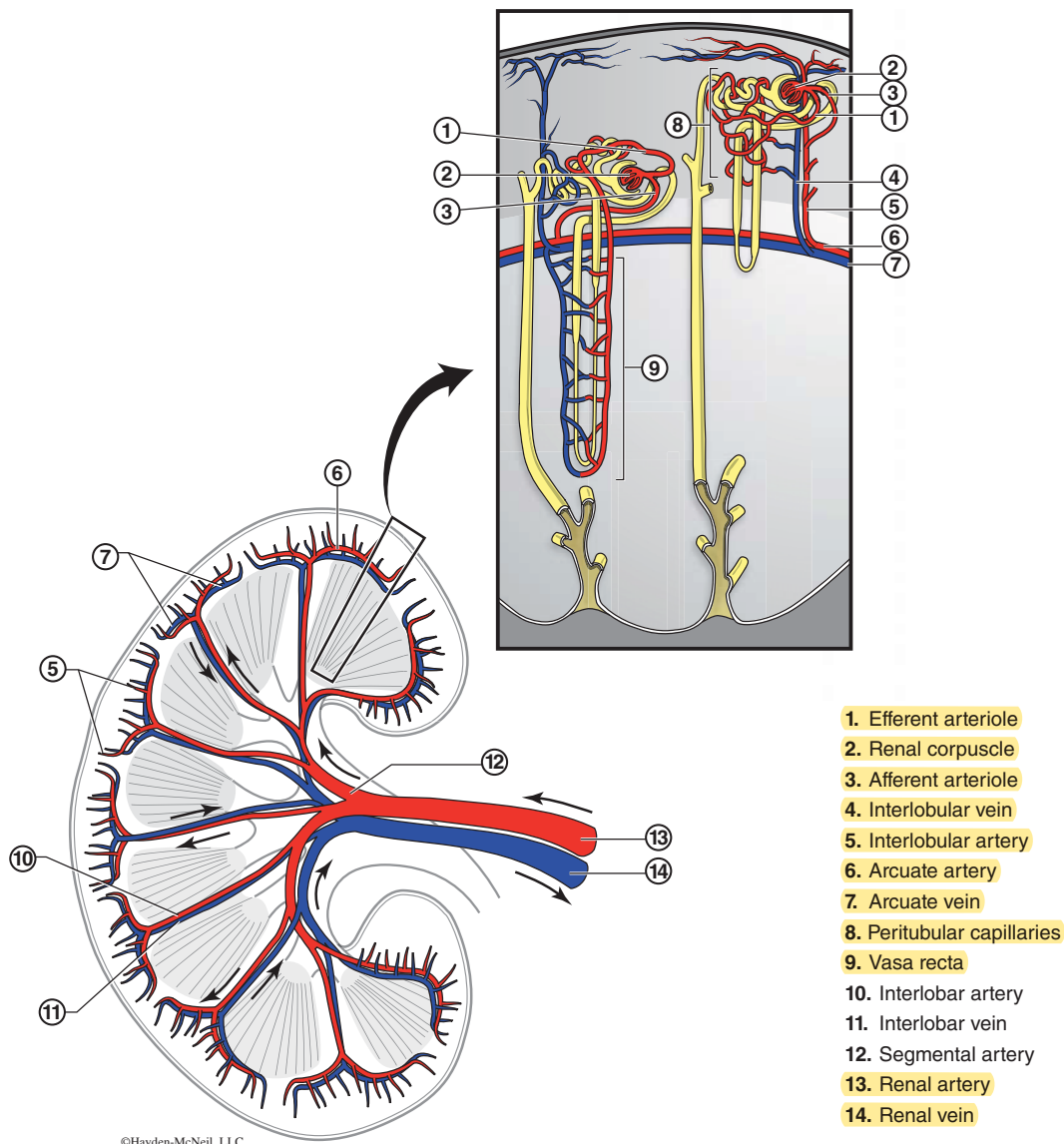
Figure 4.12. Renal Cortex 400X

Nephron

The **nephron** is the functional unit of the kidney. This is where the filtration of blood occurs as well as the reabsorption and secretion that occurs in the formation of urine.

The beginning of the nephron is the **renal corpuscle**. This structure consists of the **glomerulus** (glo-MER-u-lus) and the **Bowman's capsule** or **glomerular capsule** that will catch the filtrate formed from the blood passing through the glomerulus. As mentioned earlier the glomerulus is a specialized capillary bed. The Bowman's capsule is the beginning of the tubular structure of the nephron.

The filtrate leaves the Bowman's capsule and enters the **proximal convoluted tubule**. The majority of the reabsorption occurs here. The filtrate then flows into the **nephron loop (of Henle)**. First, it travels down the **descending limb**, around the bottom of the loop and into the **ascending limb**. The next tubule is the **distal convoluted tubule**. Secretion may occur here as well as in the **collecting duct**. The urine leaves the distal convoluted tubule and enters the collecting duct. Many nephrons empty into the same collecting duct. The collecting duct will carry the urine out of the nephron through the papillae of the pyramids into the calyces.



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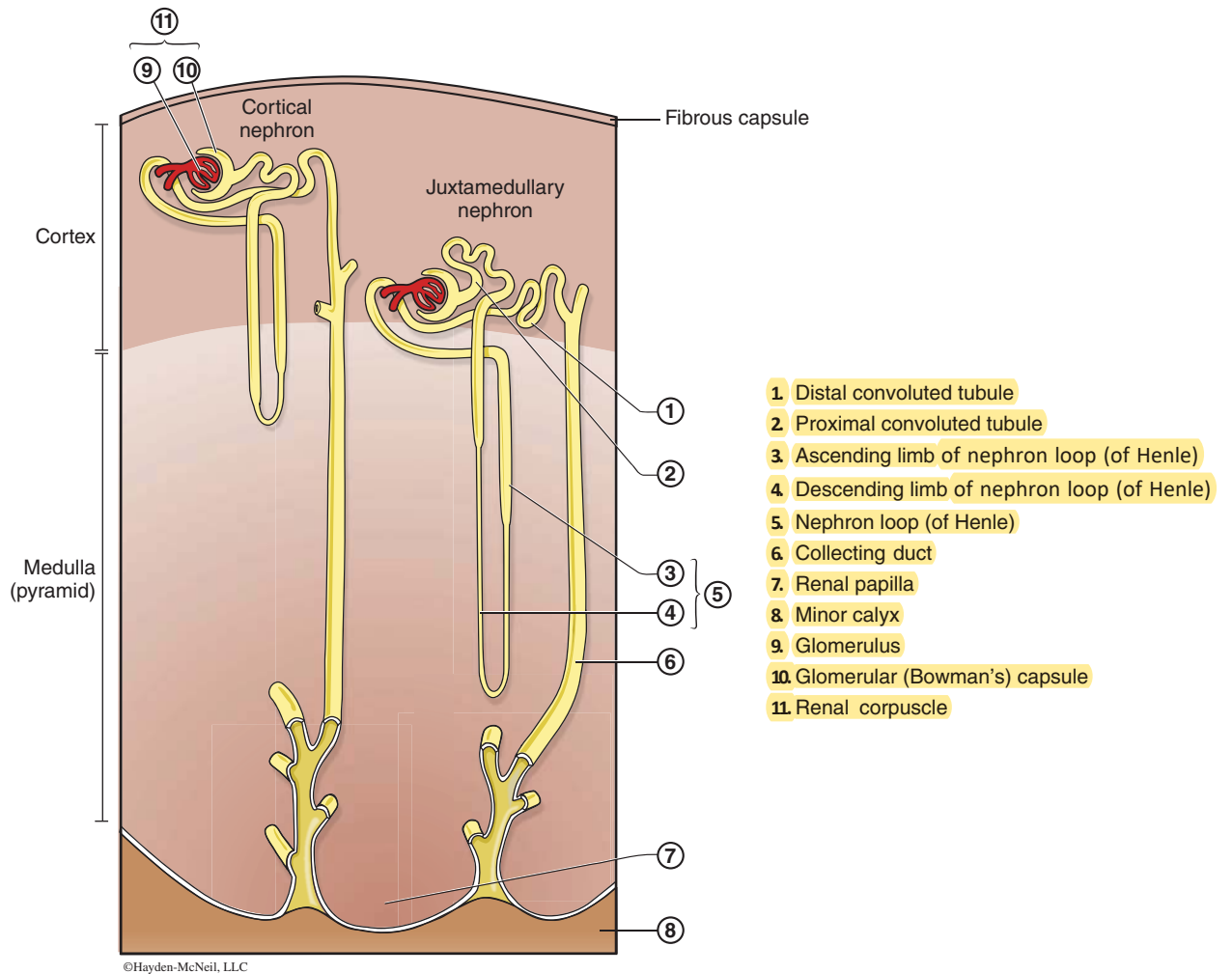


Figure 4.14. Cortical and Juxtamedullary Nephrons

FEMALE REPRODUCTIVE SYSTEM

The female reproductive system includes the ovaries, uterus, fallopian tubes, vagina, and the external genitalia.

Ovaries

The **ovaries** are the gonads or reproductive organs of the female reproductive system. They are oval shaped and measure about 3.5 cm in length, 2 cm in width, and 1 cm in thickness. They are located on either side of the uterus just below the opening of the fallopian or uterine tubes. They are attached to the uterus by the **ovarian ligaments** and are also attached to the broad ligament. The ovaries are responsible for producing the female gametes, the egg or ovum, as well as the female sex hormones: estrogens and progesterone.

Uterus

The **uterus** is a hollow pear-shaped organ with thick muscular walls located in the pelvic cavity. It is located between the urinary bladder and the rectum. It usually flexes forward over the bladder. The portion of the uterus superior to the entrance of the uterine tubes is known as the **fundus**. The majority of the uterus forms the **body** of the uterus, located between the fundus and the cervix. The narrow lower segment of the uterus is the **cervix**. This segment projects into the vagina.

The uterus is held in place by eight ligaments, four of which are the two broad and the two round ligaments. The **broad ligament** is a fold of the peritoneum that attaches to the uterus, uterine tubes, and ovaries. It extends from the uterus to the pelvic walls and floor. Within the broad ligament is the **round ligament**, which attaches the superior portion of the uterus and extends to the anterior pelvic wall. By connecting the uterus to the pelvic wall it helps to stabilize or maintain the position of the uterus.

The wall of the uterus has three layers. The innermost layer is the **endometrium** (EN-DOEMEE-tree-um). The superior portion of this layer is shed during menses. The middle layer is the **myometrium** (MI-OMEE-tree-um), a very thick smooth muscular layer that is responsible for uterine contractions. The outer layer, which is not complete, is made up of the peritoneum and is known as the perimetrium. It does not completely cover the cervix.

Uterine/Fallopian Tubes

The **uterine** or **fallopian tubes** extend from ovaries to the uterus. They open near the ovaries and enter the uterus in the upper region of the body, just below the fundus of the uterus. It serves as a channel for the transport of the ovum from the ovary to the uterus. It is also the site of fertilization.

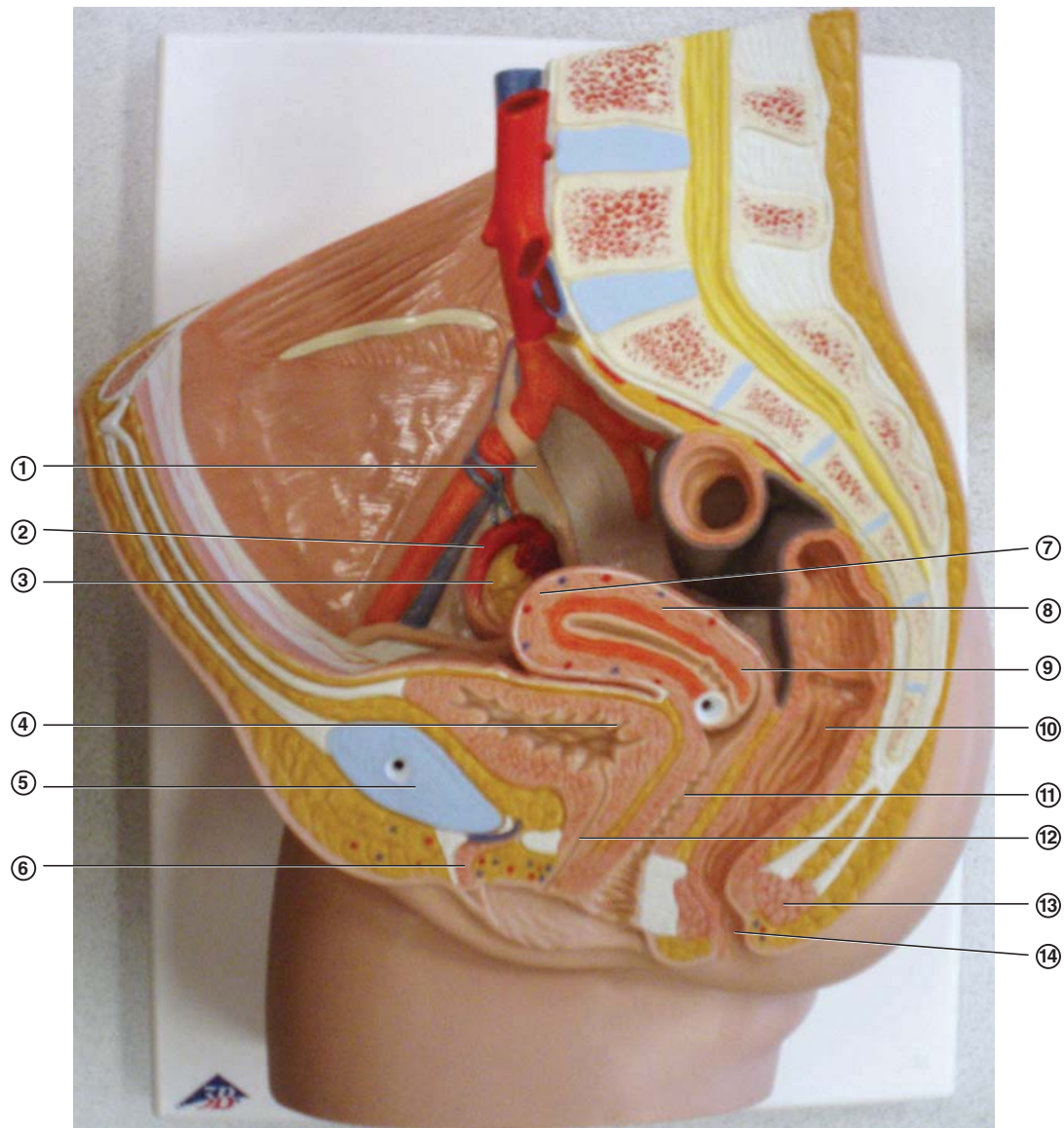
The narrowest portion of the uterine tube that is located adjacent to the uterus is the **isthmus** (IS-mahs). The widest and longest portion of the uterine tube is the **ampulla**. It extends from the isthmus to the infundibulum. The uterine tubes expand near the ovaries into the **infundibulum** (IN-fund-DIB-u-lum). At the end of the infundibulum are finger-like projections called the **fimbriae** (FIM-bre). Beating of the fimbriae directs the ovum to the opening of the uterine tube. Peristaltic contractions and ciliary action moves the ovum towards the uterus.

Vagina

The **vagina** is a hollow muscular tube that extends from the cervix to the exterior of the body. It surrounds the cervix of the uterus and is located between the bladder and the rectum. The vagina serves as a receptacle for the semen, an exit route for the endometrial tissue during menstruation, and the lower part of the birth canal.

Vulva

The **vulva** is the female external genitalia. It includes the labia majora, the labia minora, and the clitoris. The **labia majora** (singular, labium) are skin covered rounded folds of adipose tissue that protect the external genitalia. The **labia minora** are flat folds of tissue inside the labia majora. They surround the urethral and vaginal orifices. Anteriorly they merge to form the prepuce of the clitoris. The **clitoris** (KLIT-o-ris) is a small projection inside the labia minora in the anterior vulva. It is erectile tissue that becomes engorged with blood when stimulated.



Female Pelvis, 2-part LT-H10, 3B Scientific®

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|--|---------------------|--------------------|
| 1. Ureter | 6. Clitoris | 11. Vagina |
| 2. Ampulla of uterine (Fallopian) tube | 7. Fundus of uterus | 12. Urethra |
| 3. Ovary | 8. Body of uterus | 13. Anal sphincter |
| 4. Urinary bladder | 9. Cervix of uterus | 14. Anal canal |
| 5. Symphysis pubis | 10. Rectum | |

Figure 4.15. Sagittal Section of Female Reproductive System

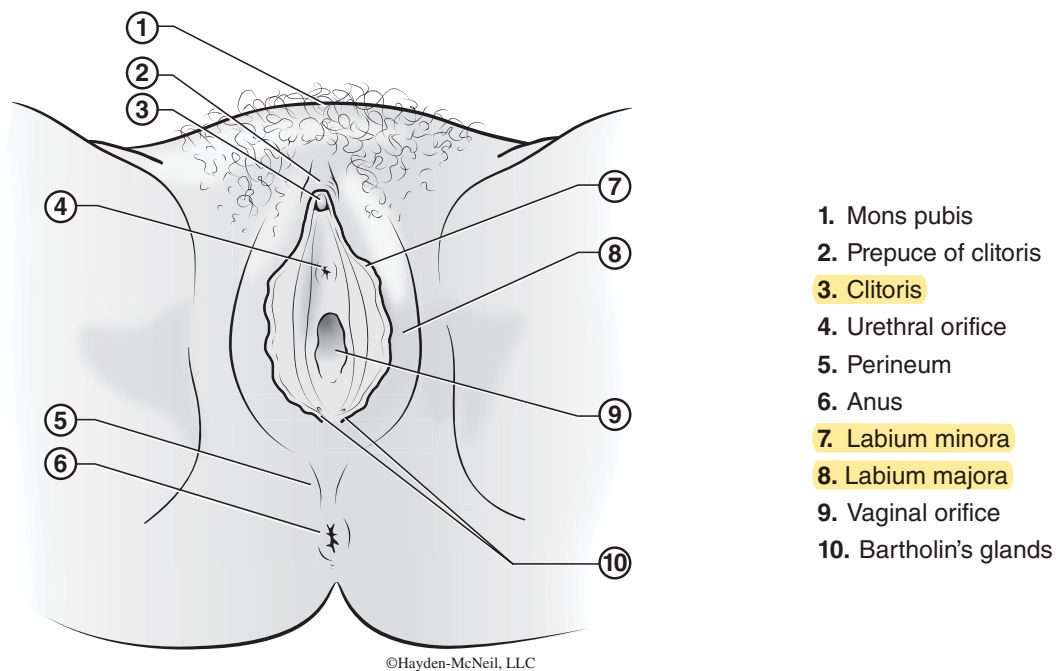


Figure 4.16. Vulva

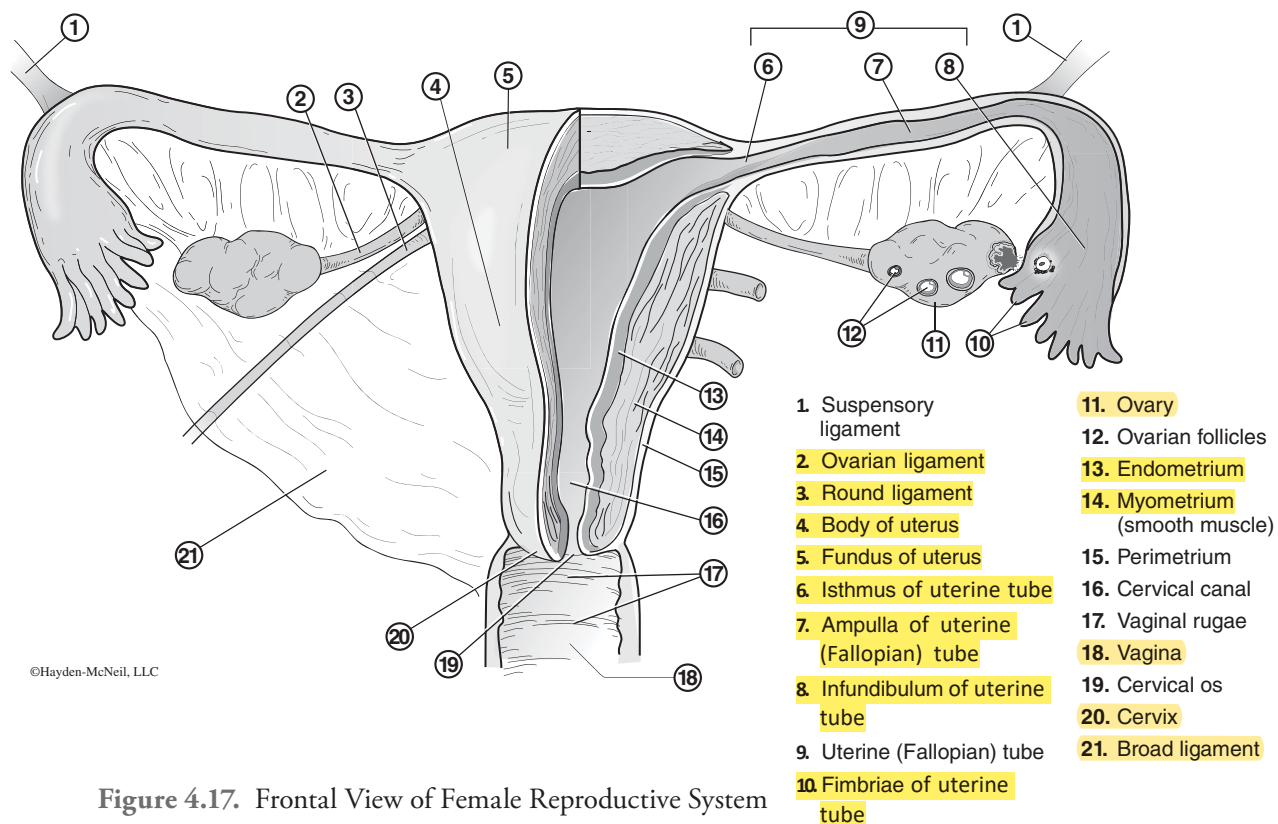


Figure 4.17. Frontal View of Female Reproductive System

PART 4

MALE REPRODUCTIVE SYSTEM

The male reproductive system consists of the gonads, the testes. There is also a series of ducts that carry the sperm: the epididymis, vas deferens, ejaculatory duct, and urethra. In addition to the gonad and ducts there are the glands that produce seminal fluid: the seminal vesicles, prostate, and bulbourethral/Cowper's glands. The support structures include the penis, the spermatic cord, and the scrotum.

Testes

The **testes** (TES-tez) (singular, **testis** (TES-tis)) are the organs responsible for producing both the sperm and testosterone. They are located outside the body in the **scrotum**. The scrotum is a skin covered pouch that contains blood vessels, muscles, and nerves in addition to the testis. The testes are located outside the body because the temperature needs to be 3–5 degrees below body temperature to properly produce sperm.

The testes are divided into lobules that contain the **seminiferous tubules** (SEM-INIF-ahrus). The sperm are produced in these tubules. The interstitial cells between the seminiferous tubules produce testosterone. This hormone is responsible for the secondary sex characteristics in males.

Epididymis

Epididymis (EP-IDID-imis), (plural, epididymides) is a long, tightly coiled tube that exits the top of each testis, descends posteriorly and then ascends to become the vas deferens. The epididymis is located in the scrotum with the testis. This duct stores the sperm produced in the testis until maturity and transports the sperm to the vas deferens which is continuous with the epididymis.

There are three regions of the epididymis: the head, the body, and the tail. The tail is not as tightly coiled as the rest of the epididymis and becomes the vas deferens.

Vas Deferens

The **vas deferens** (DEF-er-ENS) (plural, vasa deferentia) is also known as the ductus deferens. It continues from the epididymis and carries the sperm away from the testis. The vas deferens passes through the spermatic cord into the pelvic cavity behind the bladder and merges with the seminal vesicles.

The vas deferens enlarges as it unites with the duct of the seminal vesicle; this is the **ampulla of the vas deferens**. The **common ejaculatory duct** is formed by the union of the ampulla of the vas deferens and the seminal vesicle duct. This duct passes through the prostate gland and empties into the urethra. The **urethra** will carry the sperm and the seminal fluid, now known as semen out of the body.

Spermatic Cord

The connective tissue structure that creates a passageway for structures to pass between the abdominal cavity and the scrotum is the **spermatic cord**. It contains the vas deferens, arteries, veins, lymphatics, nerves as well as the cremaster muscle. It begins in the abdominal cavity, passes through the inguinal canal, and enters the scrotum to reach the testis.

Seminal Vesicles

The **seminal vesicles** (SEM-inahl) are two convoluted sac-like glands located on the posterior surface of the urinary bladder near the base. These glands produce a seminal fluid that contains alkaline fluid, fructose, and prostaglandins. This fluid is added to the sperm in the vas deferens and moves into the ejaculatory duct.

Prostate Gland

The **prostate gland** is a singular gland that surrounds the urethra just below the bladder. It produces alkaline seminal fluid that is added to the sperm and seminal fluid already present. It is about the size of a walnut and is located near the rectum which allows a physician to palpate the gland during a physical exam. The portion of the urethra that passes through this gland is called the **prostatic urethra**. The portion of the urethra between the prostate gland and the penis is the **membranous urethra**.

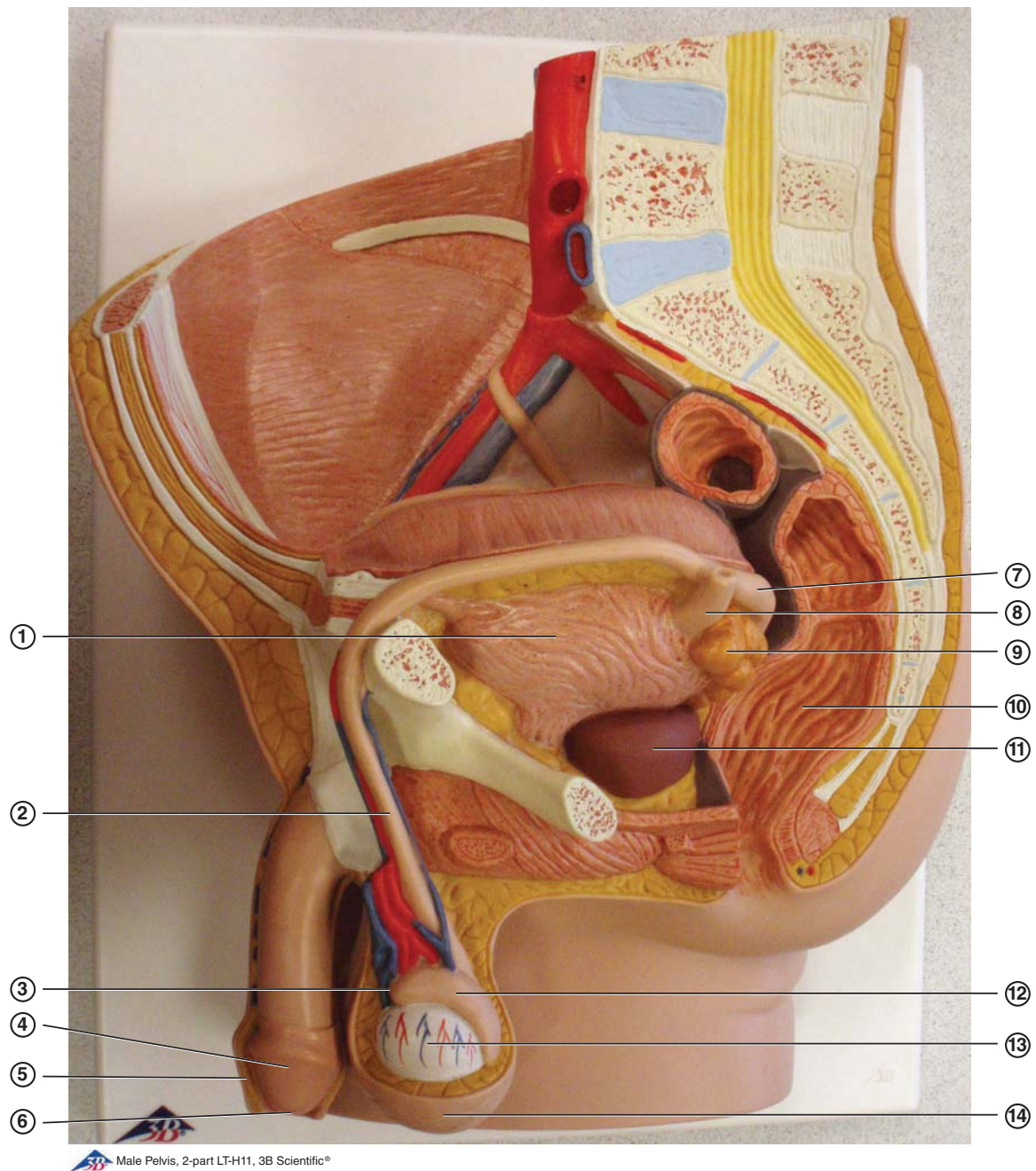
Bulbourethral Glands

The **bulbourethral** (BUL-bo-u-REE-thral) or **Cowper's glands** are two small glands located inferiorly to the prostate and posterior to the urethra. These glands also produce seminal fluid. The main component they add is mucus which helps lubricate the end of the penis.

Penis

The **penis** is the external sex organ of the male. It contains three columns of erectile tissue. In the posterior penis there are two columns of tissue known as the **corpora cavernosa** (KORE-pour-ah KAV-ahr-nosa) (singular: corpus). Extending through the center of each of these cylinders of erectile tissue are arteries that dilate during erection. In the anterior penis is a singular column known as the **corpus spongiosum** (KORE-pus SPON-jee-O-sum). In the center of the cylinder is the urethra. This portion of the urethra is known as the **penile urethra**.

At the distal end of the penis the corpus spongiosum extends over the ends of the corpora cavernosa to form the tip known as the **glans penis**. This contains the external urethral orifice. The glans is covered by a loose fold of skin called the **prepuce** (PRE-pyoos) or foreskin. This is the tissue that is removed during a circumcision.



1. Urinary bladder
2. Vas deferens
3. Head of epididymis
4. Glans penis
5. Prepuce

6. External urethra orifice
7. Ampulla of vas deferens
8. Ureter
9. Seminal vesicle
10. Rectum

11. Prostate
12. Epididymis
13. Testis
14. Scrotum

Figure 4.18. Sagittal View Male Reproductive System

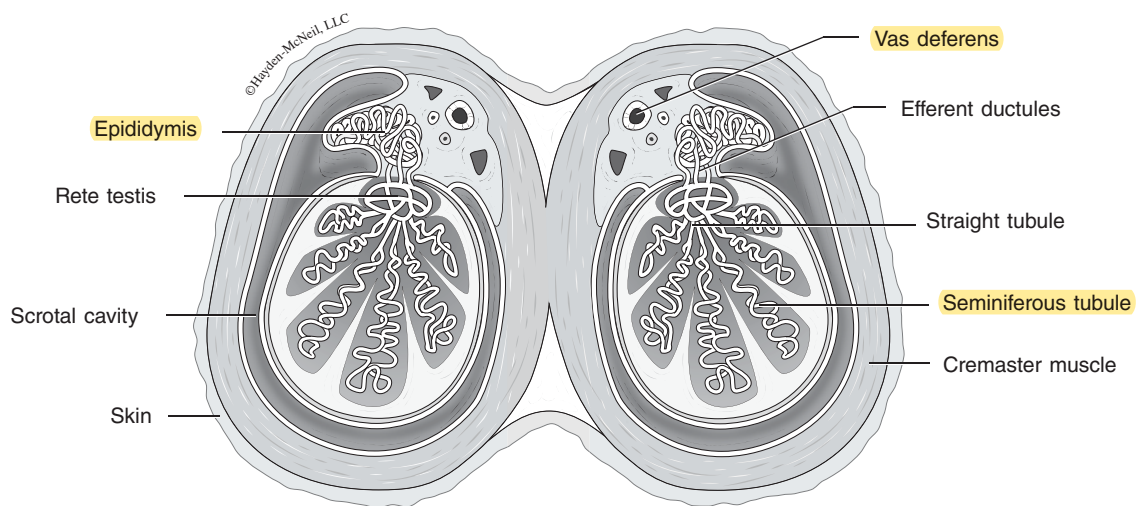
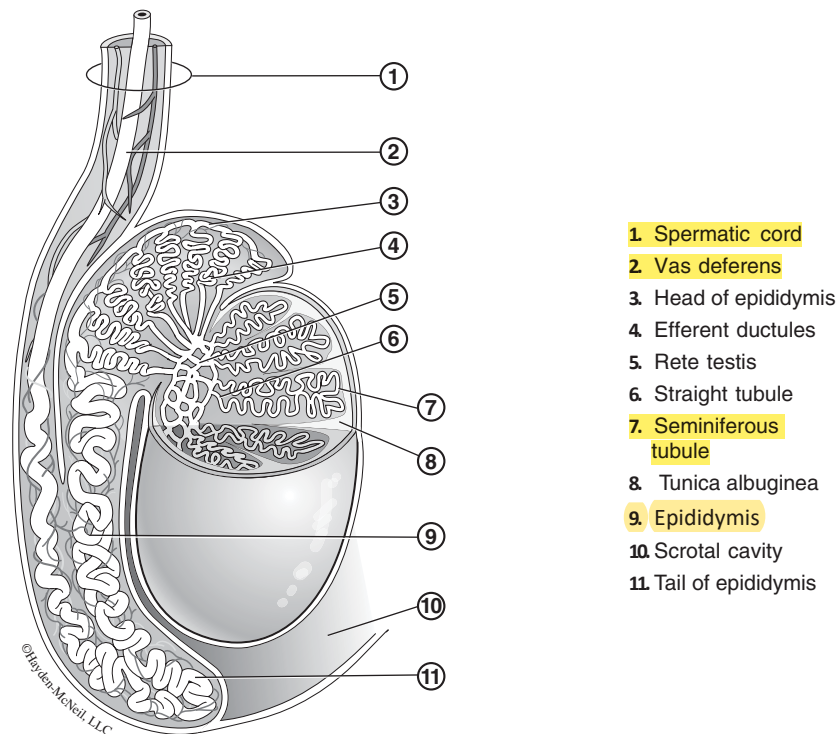
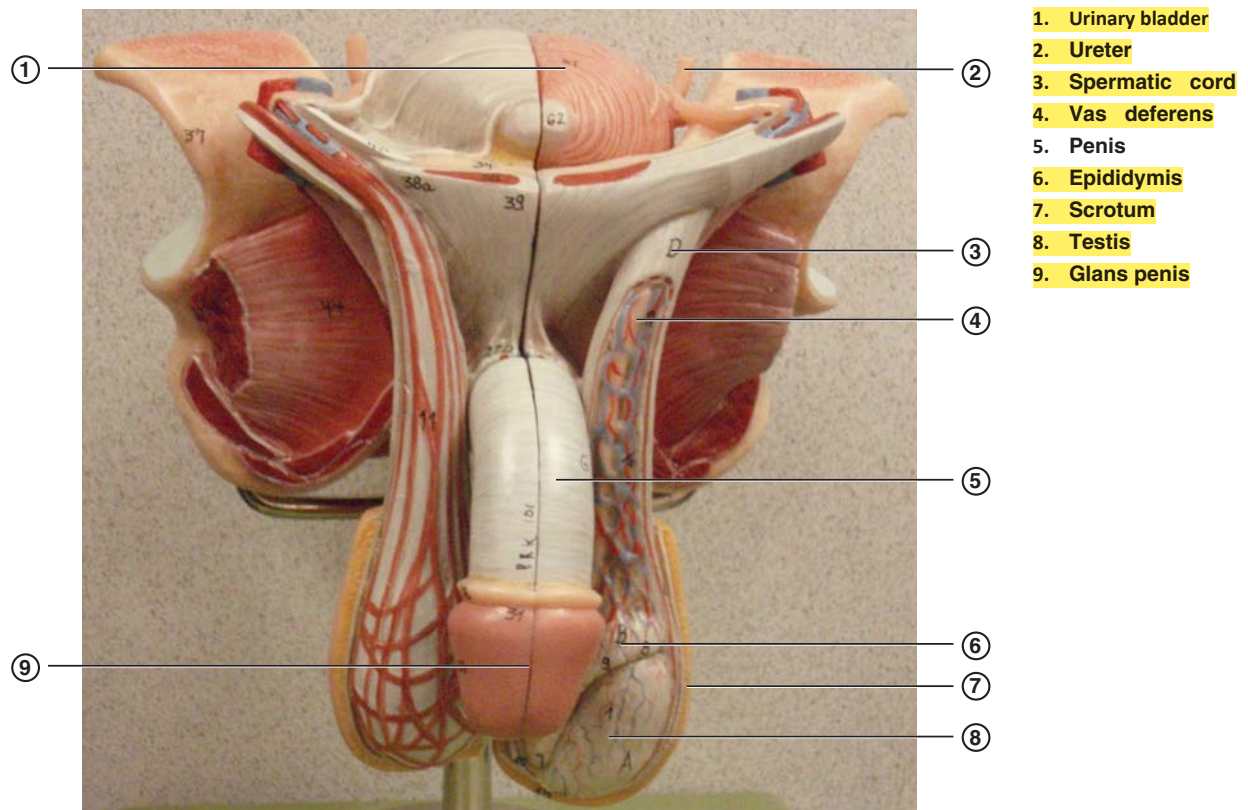
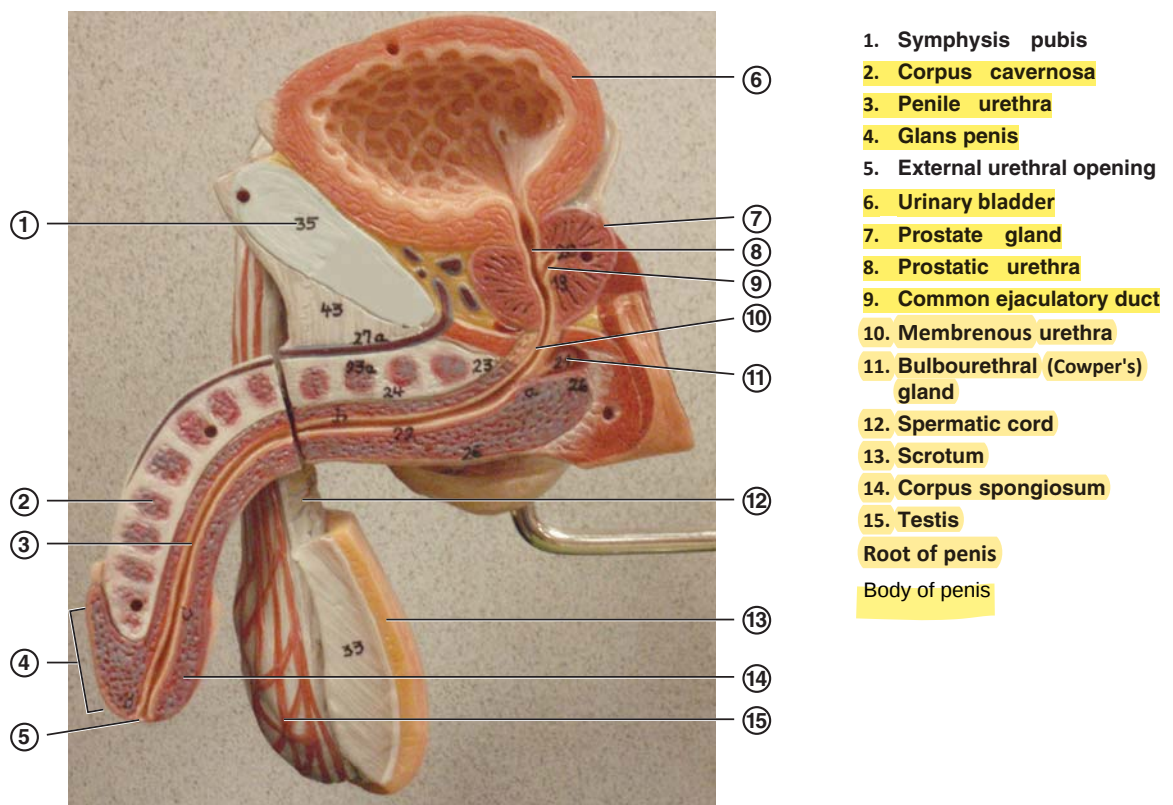


Figure 4.19. Frontal View of Testes and Epididymis



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Figure 4.20. Male Reproductive System

