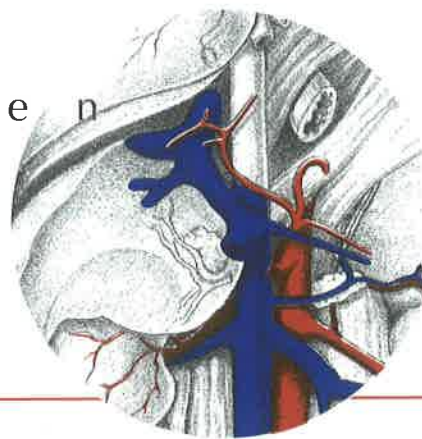


c h a p t e r s e v e n

THE UROGENITAL
SYSTEM

The urogenital system combines two systems, the urinary system and the reproductive system. The two systems are combined in this chapter because of the close anatomical relationship between them, which is common among mammals. As you will soon discover, several urinary organs lie in direct contact with reproductive organs, and in some cases, the functions of both systems take place within a common organ. The overall functions of the two systems are quite distinct, however.

The primary function of the urinary system is the formation of urine, which achieves several roles: the removal of nitrogen-containing materials that result from metabolic activities; the management of the water and salt balance of body fluids; and the regulation of blood pressure. Urine formation occurs in the kidneys, at the site of functional subunits called **nephrons**. Within the nephrons, blood is filtered, water is reabsorbed back into the bloodstream, and unwanted ions are secreted, resulting in a waste fluid known as urine. The remaining organs of the urinary system channel urine to the body's exterior. They are the ureters, urinary bladder, and urethra.

In contrast to urinary functions, the reproductive system performs the role of procreation. The system is unique in that the male and female structures are very different from each other, and are therefore said to exhibit **sexual dimorphism**. In the female, the reproductive organs are highly adapted for the production of the female gametes (**ova**) and for the internal fertilization process, the internal incubation of the developing embryo and fetus, and the birth process. In the male, reproductive organs are adapted for the production of the male gametes (**spermatozoa**) and for the internal semination process.

In this chapter, you will examine the urogenital system of the cat through dissection. The chapter begins with a study of the urinary system. Then, you will study the reproductive systems, including that of both sexes.

THE URINARY SYSTEM

With your cat specimen lying on its dorsal side, locate the following organs and features of the urinary system. The urinary organs include the kidneys, ureters, urinary bladder, and urethra.

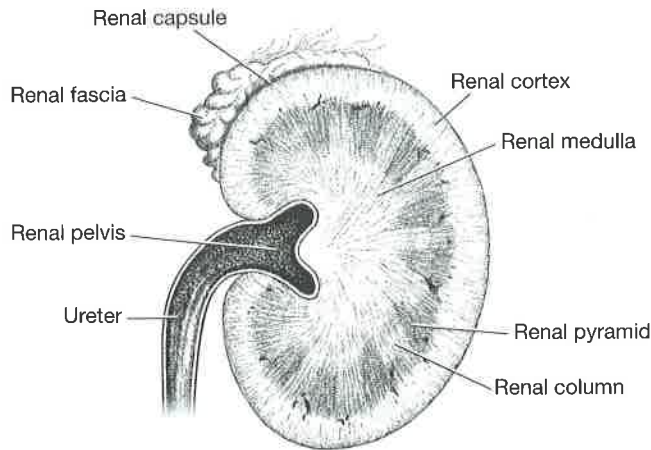
Kidneys

The kidneys are bean-shaped organs that lie partially embedded in fat against the dorsal body wall (Figures 7.1, 7.2, and 7.3). To observe them, you must first push the visceral digestive organs completely to one side. If you are dissecting on a wax tray, pin these organs to the tray for the

remainder of your study of the urogenital system. Note that the kidneys are not suspended within the abdominal cavity, as are the visceral digestive organs, but lie outside the parietal peritoneum. This positioning is called **retroperitoneal**. Also note the position of the **adrenal glands**, which lie slightly cranial and medial to each kidney.

Carefully remove the fat from one of the kidneys, section it along the frontal plane, and identify the following features (Figure 7.1).

RENAL FASCIA: the outer layer of connective tissue that anchors each kidney to the dorsal abdominal wall.



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Figure 7.1 – Kidney (sectioned along the frontal plane).

RENAL CAPSULE: a thin layer of transparent fibrous connective tissue that encloses each kidney and is deep to the renal fascia.

HILUM: a depression near the center of each kidney's concave medial border through which the renal artery, renal vein, lymphatic vessels, and nerves enter or exit.

RENAL PELVIS: a membrane-lined basin in the center of each kidney, which unites with the mucous membrane lining the ureter. Along its borders are cup-like extensions known as calyces, including major and minor. The calyces receive newly formed urine and channel it into the center of the renal pelvis.

RENAL CORTEX: the outermost region of the kidney. It is relatively smooth in texture, and outlines the internal periphery. The renal cortex extends from the renal capsule to the internal region of the kidney, the medulla (described next). The cortex is composed of blood vessels and renal corpuscles (ball-shaped components of nephrons that contain the filtration apparatus).

RENAL MEDULLA: the inner region of the kidney parenchyma. It includes from six to eighteen triangular, striated structures called **renal pyramids**. The bases of the pyramids

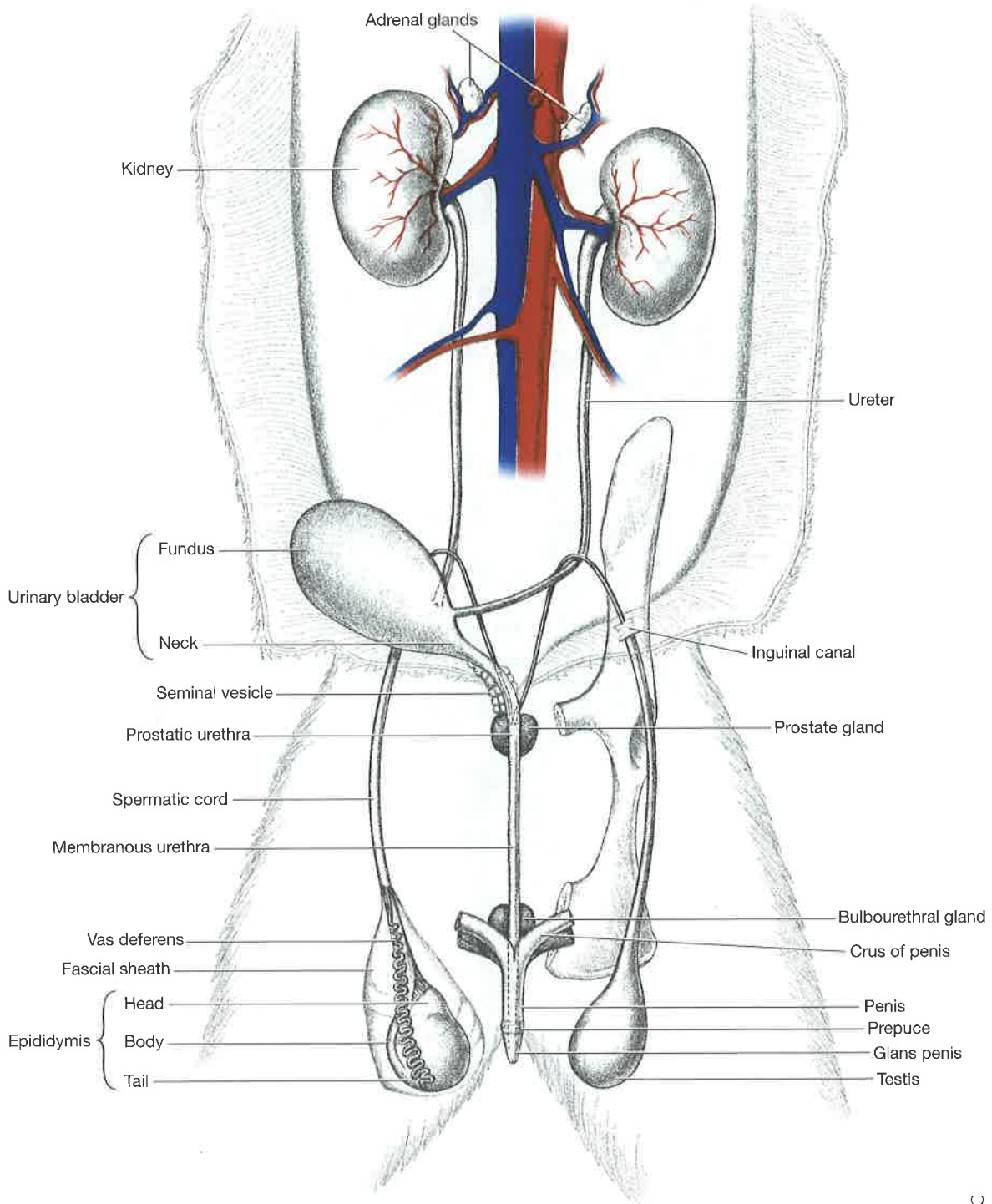
face the renal cortex, and the apices, or renal papillae, point to the renal pelvis. The areas between adjacent renal pyramids are called **renal columns**. The renal medulla is composed of blood vessels and renal tubules (lengths of tubes that form part of the nephron).

Ureters

The paired ureters are narrow tubes that transport urine from the hili of the kidneys to the urinary bladder at the base of the pelvic cavity (Figures 7.2 and 7.3). Each ureter arises from the renal pelvis of a kidney, and courses caudally in a retroperitoneal pathway until it unites with the dorsal wall of the bladder. Along the surface of each ureter is a thin layer of fibrous connective tissue that is continuous with the renal capsule of a kidney. Carefully pick away any remaining connective tissue and fat covering one of the ureters to expose it. In males, another small tube, the vas deferens, coils around the ureter near the base of the urinary bladder; avoid damaging the vas deferens for later study.

Urinary Bladder

Follow the path of the ureters to their caudal extremities. Here they unite with the sac-like uri-



THE UROGENITAL SYSTEM

Figure 7.2 - Urogenital system of the male cat.

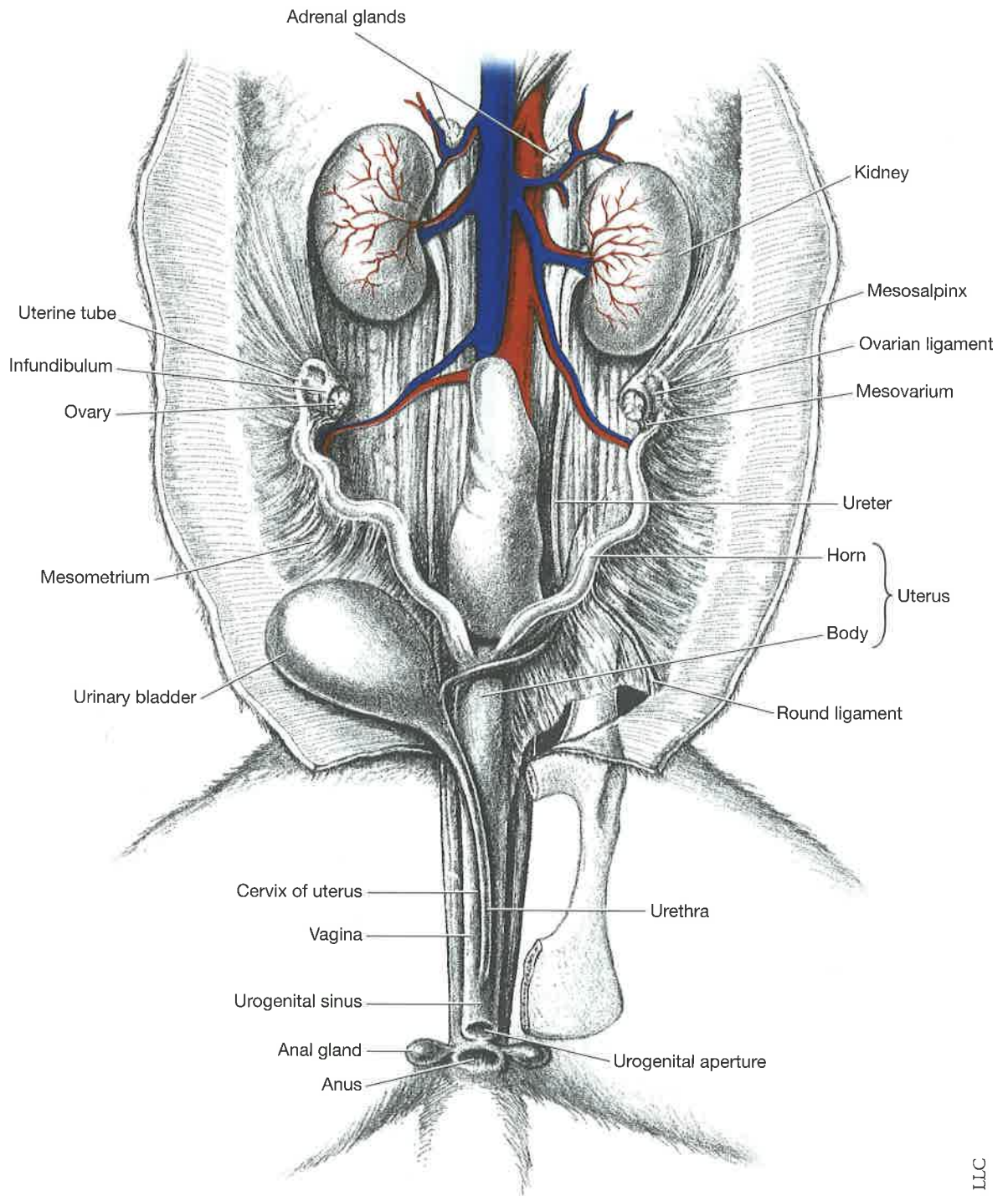


Figure 7.3 – Urogenital system of the female cat.

nary bladder (Figures 7.2 and 7.3). The urinary bladder is a reservoir for urine. In the preserved state, it is empty and reduced in size, but when it fills with urine, it expands about 5-fold. The expanded cranial portion is the **fundus**, and the narrow caudal portion is the **neck**. Section the bladder along the frontal plane and note the wrinkled texture of the internal surface. These “wrinkles” are called **rugae**. Also note the points of entry of the two ureters at the dorsal wall and the exit opening to the urethra. These three openings form an internal triangle known as the **trigone**. The bladder is held in position ventrally by a median ligament and on each side by lateral ligaments, and is protected by pads of fat.

Urethra

The urethra is the duct that transports urine from the urinary bladder to the exterior of the body. Because the urethra lies mainly in the pelvic canal, you will observe it during dissection of the reproductive system (Figures 7.2 and 7.3). The urethra exhibits sexual dimorphism because its length varies between males and females. In the female, it is a short duct that empties to the exterior by way of the **urogenital orifice**. The caudal portion of the female urethra is also the caudal portion of the vagina, and is called the **vaginal vestibule** (or **urogenital sinus**). The male urethra is much longer, extending from the urinary bladder to the tip of the penis, where it opens as the **urogenital orifice**. The male urethra is associated with both urinary and reproductive functions, since it transports urine and semen. It is divided into three portions: the proximal portion is the **prostatic urethra**, the middle portion is the **membranous urethra**, and the distal portion extending through the penis is the **spongy urethra**. *The human urethra is very similar, except it opens to the exterior as the urinary meatus.*

THE REPRODUCTIVE SYSTEM

Your study of the reproductive system is divided into the male and female systems. On the basis of the descriptions that follow, determine the sex of your specimen, if you have not yet done so, and

follow the appropriate dissection protocol. Then locate a specimen of the opposite sex within your lab, and examine it also.

Male Reproductive Structures

The organs of the male reproductive system include the male gonads, known as the testes, which are located within the scrotum. They also include the penis, a series of tubes that carry spermatozoa and fluids collectively called semen, and the glands that produce the fluid. The tubes include the epididymus, vas deferens, and urethra, and the glands are the seminal vesicles, prostate gland, and bulbourethral gland. Locate the following components of the male reproductive system in your male specimen (Figure 7.2).

Scrotum

The scrotum lies hidden beneath the fur of the region caudal to the penis and ventral to the pelvis. It is an integumentary sac that hangs below the pelvic wall and contains the male **gonads** (sex organs), the **testes**. Carefully make a cut through the dorsal wall of one side of the scrotum and, using scissors, cut the skin to the ventral margin. Repeat this cut on the opposite side. Now, peel the skin away to expose the two testes. Note the median septum that divides the scrotum internally in half, providing a separate chamber for each testis, known as the **cremasteric pouch**. Notice that the pouch narrows into a tubular structure at its ventral end. This structure is the **spermatic cord**, which contains the vas deferens, the spermatic artery and vein, and nerves.

Testes

The paired testes are the organs that produce the male **gametes**, or sex cells, and the male sex hormone, **testosterone**. Their outer coat, called the **tunica albuginea**, gives the testes a white, marbled appearance. With a sharp scalpel, cut one testis in half and notice the coiled tubules within. These are the **seminiferous tubules** and are the site where the male gametes, called **spermatozoa**, are produced.

Epididymus

On the dorsal part of each testis is an arrangement of tightly coiled tubules known as the **epididymus**. Locate the epididymus of your cat on the unsectioned testis. It is a comma-shaped organ that curves around the dorsal margin of the testis. From ventral to dorsal, it is divided into a **head**, a **body**, and a **tail**. The coiled tubule that forms the main part of the epididymus is called the **ductus epididymus**, which extends from the head region to the tail region, where it continues as the **vas deferens**.

Vas Deferens

The **vas deferens**, which may also be called the **ductus deferens**, extends from the epididymus to the urethra. From each testis, it begins as a coiled tube at its union with the ductus epididymus and continues in a cranial direction into the ventral body wall along with the spermatic artery, vein, and nerves as the **spermatic cord**. Follow the vas deferens to its point of entry into the body wall. Note that it passes through an opening called the **inguinal canal**. Once within the body cavity, it passes ventrally toward the ureter and turns medially until it reaches the dorsal wall of the urinary bladder. Do not attempt to trace the vas deferens further at this point in the dissection; you will need to open the pelvic cavity, which will be done soon. At the base of the bladder is a membranous, elongate sac called the **seminal vesicle**, which empties its secretions into the vas deferens via a small duct. Near the neck of the bladder, the vas deferens passes with its counterpart from the opposite side to the **prostate gland**, which is a glandular thickening of the dorsal wall of the seminal vesicle. The seminal vesicle and the prostate contribute fluids to form the semen. The vas deferens then passes through the prostatic tissue to unite with the urethra near its origin from the bladder.

Urethra

To observe the urethra and the male glands that contribute to semen, it is necessary to cut through the symphysis pubis. To do this, carefully make a 2.5-cm-long (1-inch) incision through the abdominal wall along the margin of the pelvis. With your fingers, find a slight depression in the midline between the pubic bones and with a

sharp scalpel, cut into the depression and adjacent muscles. Plunge the scalpel deeply as you cut. Now separate the pelvic bones by grasping the hind limbs and push them laterally, completing the separation of the pelvis. Clean up the area by removing connective tissue and fat. With good technique, you should now be observing the organs of the pelvic wall, including the seminal vesicles at the base of the bladder and the whitish prostate gland immediately ventral to it. The tube extending from the urinary bladder to the prostate gland, emerging to extend through the penis, is the urethra. As described previously, it consists of a **prostatic urethra**, a **membranous urethra**, and a **spongy urethra**. The prostatic urethra is the proximal portion, extending from the urinary bladder through the prostate gland. The membranous urethra and spongy urethra are also known as the urogenital urethra. The membranous urethra extends a short distance to the base of the penis. It receives secretions from a small gland known as the **bulbourethral gland**, which contributes to semen. The spongy urethra extends through the penis. It opens to the exterior at the **urogenital orifice**, *which is called the urinary meatus in humans*.

Penis

The penis of the cat is obscured by a sheath of skin, which surrounds it. To observe the penis, grasp the opening of the sheath with a pair of forceps and make a cut through its ventral wall with scissors. Continue this cut along the ventral wall of the sheath, cutting through connective tissue to expose the penis completely. Of course, be careful to avoid cutting the penis at this point. The penis encloses the spongy urethra, which lies outside the pelvic canal. The free end of the penis, called the **glans penis**, lies within a pocket of skin called the **prepuce**. Cut open the prepuce to reveal completely the glans and the opening of the spongy urethra. Then cut through the penis along the longitudinal plane. Notice the columns of erectile tissue, which contain blood sinuses that fill with blood to produce erection. The columns are called **corpora cavernosa**. Their proximal ends are attached to the ischia by tough bands of connective tissue, known as **crura** (crus in the sin-

gular form). *The human penis is not contained within a sheath as in the cat, but hangs freely from its attachments to the pubic symphysis by way of the crura.*

The reproductive system of the cat includes **anal glands**, which are located near the anus. In male cats, contraction of the glands and nearby muscles causes fluid to spray outward, marking the cat's territory.

Female Reproductive Structures

The female gonads are the ovaries. Other female organs include the uterine tubes, uterus, vagina, and vulva. Locate and identify the following components of the female reproductive system in a female cat (Figure 7.3):

Ovaries

The ovaries are paired, oval organs that lie slightly caudolateral to the kidneys in the abdominopelvic cavity. They are anchored to the ventral body wall by the **suspensory ovarian ligament** and to the dorsal body wall by the larger **ovarian ligament**. The ovarian ligament connects each ovary to the cranial end of the uterus. A third ligament, the **mesovarium**, provides an additional connection between each ovary and the corresponding uterine horn. As the female gonads, the ovaries produce the female gametes, the **ova**, and the female sex hormones, estrogen and progesterone. During ovulation, or release of an ovum from an ovary, the ovum bursts through the ovarian wall to enter the abdominal cavity. Ideally, the ovum is then swept into the nearby opening to the uterine tube by ciliary currents.

Uterine tubes

Also known as oviducts, or fallopian tubes, the paired uterine tubes transport ova that have been released during ovulation from the ovaries. If fertilization is to occur, it usually occurs within the upper one-third of a uterine tube. The fertilized ovum, called a zygote, is then transported by ciliary currents within the tube to the uterus for implantation. Carefully reflect the ovary and uterine tubes to the side, and notice that the cranial extremity of each uterine tube curves laterally over each ovary to form a hood-like expansion

called the **infundibulum** and opens medially by way of the **ostium tubae**. The outer margins of the infundibulum contain finger-like projections, called **fimbriae**. Each uterine tube is attached to the dorsal body wall by a broad ligament known as the **mesosalpinx**. The distal end of each uterine tube merges with a uterine horn, which is larger in diameter. *The uterine tubes of the human female are comparatively much greater in length, extending from the infundibulum surrounding an ovary to the pelvic cavity to unite with the uterus.*

Uterus

The uterus of the cat includes two **uterine horns**, right and left, that begin as continuations of the uterine tubes. They descend into the pelvic cavity, where they unite to form the **body** of the uterus. The combination of the uterine horns and body form the Y-shaped uterus. The mesentery supporting the uterus is known as the **mesometrium**, and an additional structure, called the **round ligament**, adds strength to the mesometrium as it extends diagonally across it. The distal end of the uterus is slightly tapered, forming the **cervix**, which unites with the vagina. *The uterus of the human female is not Y-shaped, but resembles the shape of a pear, instead. It receives the right and left uterine tubes at its superior border, which is a rounded area known as the fundus. The constricted part of the uterus is known as the cervix, and its internal channel is the cervical canal. Also, the junction of the uterus and vagina is a distinct separation between the two organs.*

Vagina

To view the vagina and other caudal parts of the reproductive system, you will need to expose the pelvic cavity. Begin by making a 2.5-cm-long (1-inch) incision horizontally along the pelvic rim, cutting through muscles and fat. Insert a finger to find the symphysis pubis, which will feel like a shallow groove near the midventral line. Once you've located it, cut through it with a pair of scissors or bone cutters, but be careful to avoid plunging the instrument too deeply. You will be cutting through deep muscles and the cartilage of the symphysis pubis, if you are cutting correctly.

After cutting, grasp the hindlimbs and separate the pelvic bones to expose the pelvic wall. Carefully clean away connective tissue and fat, and find the body of the uterus once again. Trace it to its narrowed distal part, the cervix, which protrudes into the vagina. The vagina extends from its origin near the cervix to its opening to the **urogenital sinus** at the **vaginal orifice**. Because the urogenital sinus also receives the opening of the urethra, the **urethral orifice**, it is a common channel for the urinary and reproductive fluids.

Vulva

The vulva is the female external structure that includes the urogenital aperture, labia, and clitoris. The **urogenital aperture** is the exterior opening from the urogenital sinus, which is com-

mon to the urinary and reproductive systems. Bordering the urogenital aperture on both sides are the small **labia**, which are very small in the cat and, therefore, difficult to observe. However, you should be able to identify the **clitoris**, represented as a small projection at the cranial union of the labia. It rests in a shallow, midventral depression. The clitoris is the homologous structure to the penis, although in most mammals, the urethra does not pass through it. Similar to the male, **anal glands** are present on either side of the anus. *The human vulva contains two pairs of labia, majora and minora, rather than a single pair, as seen in the cat. Also, the human clitoris is a more prominent structure. Finally, the urethra and vagina enter the vulva as separate openings in human females: as the urethral orifice and the vaginal orifice.*