THE UROGENITAL SYSTEM

The urinary and genital systems have distinct and unique functions. The first, the removal of nitrogenous wastes and the maintenance of water balance; the other, the reproduction of the species. However, due to their similar developmental origins and the sharing of common structures, they are usually considered as a single system.

The shark kidney and its ducts are quite different from those in higher vertebrates. The relationship between the urinary and genital structures is also quite different. Male and female sharks differ in their urinary as well as in their genital systems. The urogenital system of the shark illustrates a simpler stage of development.

The Dissection

Mature specimens make for the best dissections since the entire urogenital system will be fully developed. In immature specimens most structures are undifferentiated. If your animal is a male, you are also responsible for studying and knowing the urogenital system of an adult female shark, and vice versa.

Expose the pleuroperitoneal cavity. Remove almost the entire liver except for its anterior end. Cut the esophagus about a half inch from its entry into the body cavity. Then cut the colon about one and a half inches from its posterior end. Free the alimentary canal, pancreas, and spleen from their mesentery and vascular connections and remove entirely from the body. This will reveal the urogenital structures: gonads, kidneys, and associated ducts.

Further dissection in this chapter is minor and will be indicated in the text as each is approached.

We shall study the female first, then the male. This will be followed by a discussion of fertilization and development in the dogfish shark.

FEMALE

KIDNEYS — The *kidneys* are flattened, ribbon-like, darkly colored structures lying dorsally on either side of the midline, along the entire length of the pleuroperitoneal cavity. They lie *retroperitoneally,* behind the transparent peritoneum. A tough white glistening strip of connective tissue, the *caudal (innominate) ligament* is found between the kidneys in the midline.

In females, the upper portion of the kidney is nonfunctional; the formation of urine and the removal of wastes take place in the lower portion.

ARCHINEPHRIC DUCT (OPISTHONEPHRIC DUCT) (WOLFFIAN DUCT) — These urinary ducts are narrow in the female and difficult to see. They extend posteriorly along the ventral surface of each kidney. Distally, near the cloaca, the urinary ducts widen to form the *urinary vesicles,* then open by pores into the *urinary papilla*. In males, these ducts lose their urine transporting function and transport seminal fluids and sperm.

URINARY PAPILLA — This fleshy conical projection is readily seen emerging from the cloaca. It is the exit point for urine to the external environment.

OVARIES — Look within the anterior part of the pleuroperitoneal cavity, dorsal to the liver. Locate two cream-colored elongated organs on either side of the mid-dorsal line. Each *ovary* is supported by a mesenteric membrane known as the *mesovarium*. The shape of the ovaries will vary depending upon the maturity of the specimen. In immature females they will be undifferentiated and glandular in appearance. In mature specimens you may find two to three large eggs, about three centimeters in diameter, in each ovary. When these break the surface of the ovary, upon *ovulation*, they enter the body cavity and by means of peritoneal *cilia* are moved into the oviducts.

OVIDUCTS — The oviducts are elongated tube-like structures lying dorsolaterally the length of the pleuroperitoneal cavity, along the sides of the kidneys. In mature specimens they are more prominent, each suspended dorsally by a *mesotubarium*, a mesenteric membrane extending from the kidney. The distal half of the oviduct is enlarged to form the *uterus*. Trace one oviduct anteriorly. It passes dorsal to the ovary, then curves ventrally in front of the anterior portion of the liver. The oviducts from opposite sides unite near the anteroventral border of the liver. Here the *ostium* may be found.

Ostium — This is the single common opening of both oviducts. It is located within the *falciform ligament*, the membrane that connects the anteroventral portion of the liver to the parietal peritoneum. The *ostium* is located in the posterodorsal side of the ligament, and can be opened by spreading apart its edges. In immature specimens the ostium cannot readily be opened.

Shell Gland (Nidamental Gland) — Near the anterior end of the oviduct locate an enlarged short segment of the duct known as the *shell gland*. It serves a double purpose. As the eggs pass the gland it secretes a thin horny shell around a group of several eggs. The mass, then known as the *candle*, passes down the oviduct. The second function of the shell gland is to serve as a reservoir for the storage of sperm. Thus the eggs are fertilized and receive a light shell-like covering as they pass through the shell gland.

UTERUS — The posterior half of the oviduct becomes enlarged and is known as the *uterus*. Here the fertilized eggs develop into embryos. Upon completing their period of gestation (close to two years) the young are ready to be born. A fuller description of fertilization and development in the dogfish shark is given toward the end of this chapter.

CLOACA — This opening serves for the elimination of urinary and fecal wastes as well as an aperture through which the young "pups" are born. The two uteri open into the posterodorsal portion of the cloaca just ventral to the urinary papilla. The urogenital portion of the cloaca is known as the *urodeum* and is partly separated by means of horizontal lateral folds from the more anteroventral portion, where the rectum terminates, the *coprodeum*.

SUPRARENAL BODIES (ADRENAL GLANDS) — Although not readily located in the shark as distinct structures, they are identified as a series of pale spots found longitudinally upon the medial surface of the kidney, near the dorsal midline. Staining and microscopic examination are needed to verify their glandular nature.

MALE

KIDNEYS — The kidneys of the male are essentially the same as those just described in the female. The posterior portion is involved in the manufacture and transport of urine, its role quite similar to that in females. The main difference lies in the anterior portion of the kidney, which in females is degenerate and functionless, but in males is an active part of the reproductive system.

TESTES — Paired *testes* lie near the anterior end of the pleuroperitoneal cavity, dorsal to the liver, adjacent to the anterior ends of the kidneys. Each testis is supported by a mesenteric membrane known as a *mesorchium*. It is across this membrane that sperm pass from the testes to the kidneys within narrow tubules called *efferent ductules*. They are too small to be seen without a hand lens.

EPIDIDYMIS — Sperm pass from the efferent ductules to the anterior ends of the kidneys. This portion of the kidney is known as the *epididymis*. It has virtually no urinary function.

DUCTUS DEFERENS (ARCHINEPHRIC DUCT) (WOFFIAN DUCT) — After passing through the epididymis the sperm enter the *ductus deferens* and pass posteriorly toward the cloaca. In mature male specimens the ductus deferens may be seen on the ventral surface of the kidneys as a pair of highly coiled tubules. The kidney right below the epididymis is known as *Leydig's gland*. Here the secretion from the testes is modified as a milky thick fluid analogous to the seminal fluid of higher vertebrates. This duct is also known as the Wolffian duct.

Note: While in the female this duct carries urine, in the male it transports spermatozoa and seminal fluid.

SEMINAL VESICLE — The posterior portion of the ductus deferens widens and straightens to form the paired *seminal vesicles*. Nick the surface of one with a pin and observe a thick white fluid oozing out. This is the *seminal fluid*.

SPERM SACS — These paired sacs at the posterior ends of the seminal vesicles receive the seminal secretions. They join to form the *urogenital sinuses* which exit through the fleshy conical *urogenital papilla* which may be seen extending from the cloaca.

ACCESSORY URINARY DUCTS — Since the archinephric (Wolffian) ducts in males collect and transport seminal fluid, another set of tubes, the *accessory urinary ducts,* collect and transport urine from the kidneys. These paired thin tubules may be found along the medial side of the posterior half of the kidney. It is necessary to push aside the seminal vesicles in order to see the urinary ducts. Small collecting tubules from the kidneys lead into the accessory urinary ducts along their lengths. They exit through the *urogenital sinus* and *urogenital papilla* just as the sperm sacs did.

UROGENITAL SINUS and **UROGENITAL PAPILLA** — As we have seen, the *urogenital sinus* serves as the receptacle for the seminal vesicle and for the accessory urinary ducts. The *urogenital papilla* also serves both urinary and genital systems. Thus, their names are well-deserved.

CLOACA — As in the female, this structure receives the rectal wastes as well as the genital and urinary products. As in the female, the cloaca is divided by horizontal lateral folds to form a *urodeum* portion where the urogenital products empty and a more anteroventral portion, the *coprodeum,* where the rectum terminates.

Two additional male structures will be studied. They have no homologues in females.

SIPHON — Make a transverse cut into the ventral surface of one pelvic fin. Find a thin-walled muscular sac, the *siphon*. It is a closed blind sac anteriorly, posteriorly it is connected to the *dorsal groove* of the *clasper*.

CLASPERS — They are modified extensions of the medial portions of the pelvic fins. They are inserted into the female's cloaca during copulation.

Clasper Tube — The finger-like claspers each have a dorsal groove, the *clasper tube (spermatic sulcus)* that carries the seminal fluid from the cloaca of the male to the cloaca of the female during mating.

It was originally thought that the *siphon sac* was filled with sea water, which during copulation was ejected along the *clasper tube* to help propel the sperm toward the female. It was subsequently shown, however, that the siphon sacs secrete large amounts of mucopolysaccharide which may lubricate the claspers and contribute to the seminal fluid.

FERTILIZATION AND DEVELOPMENT

We have already pointed out that fertilization in the dogfish shark is *internal,* usually taking place within the *shell gland* of the *oviduct*. The fertilized eggs continue to move posteriorly toward the *uterus*. Here the young develop.

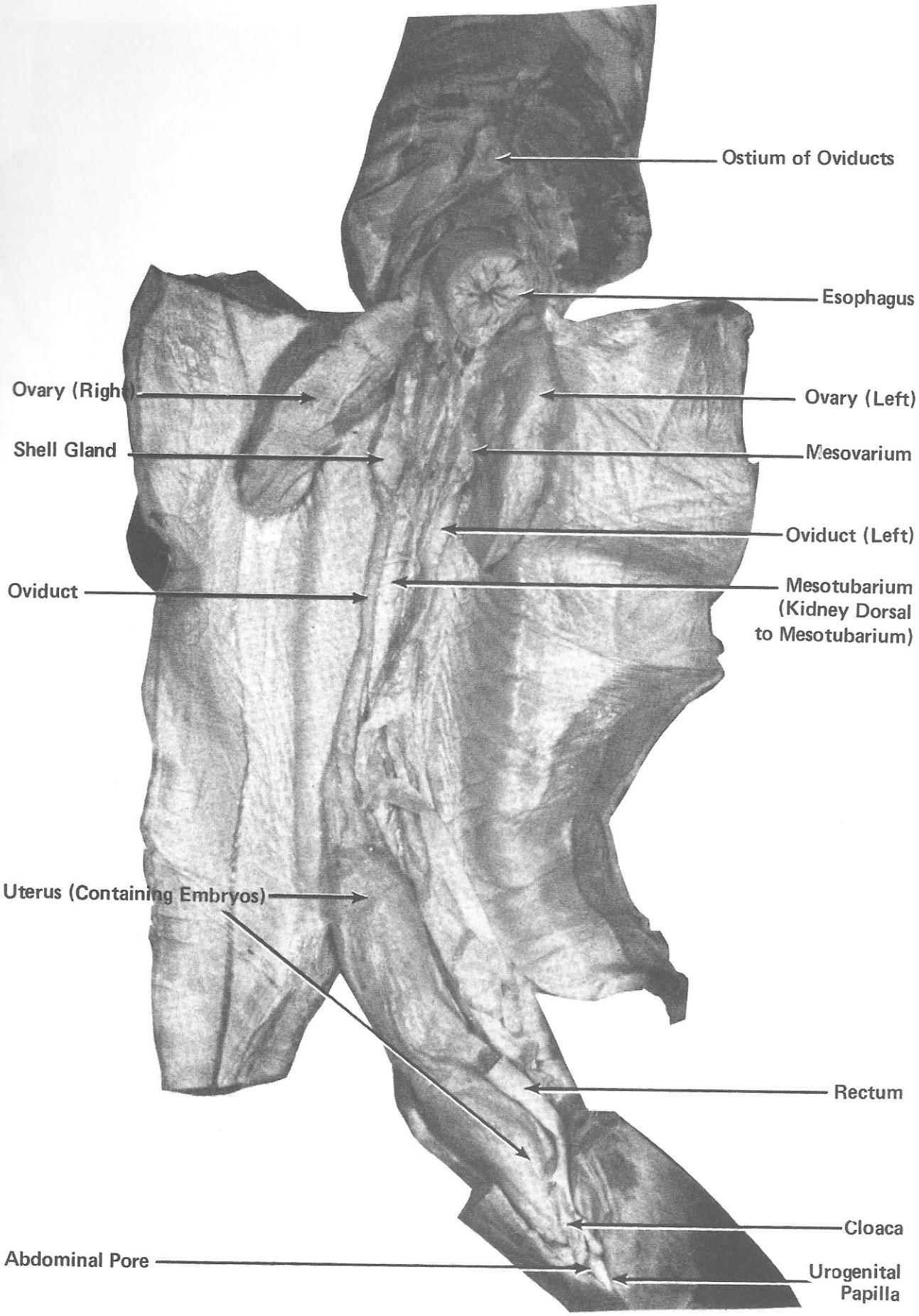
As they grow they are attached to the egg, now known as the *yolk sac,* by means of a stalk.

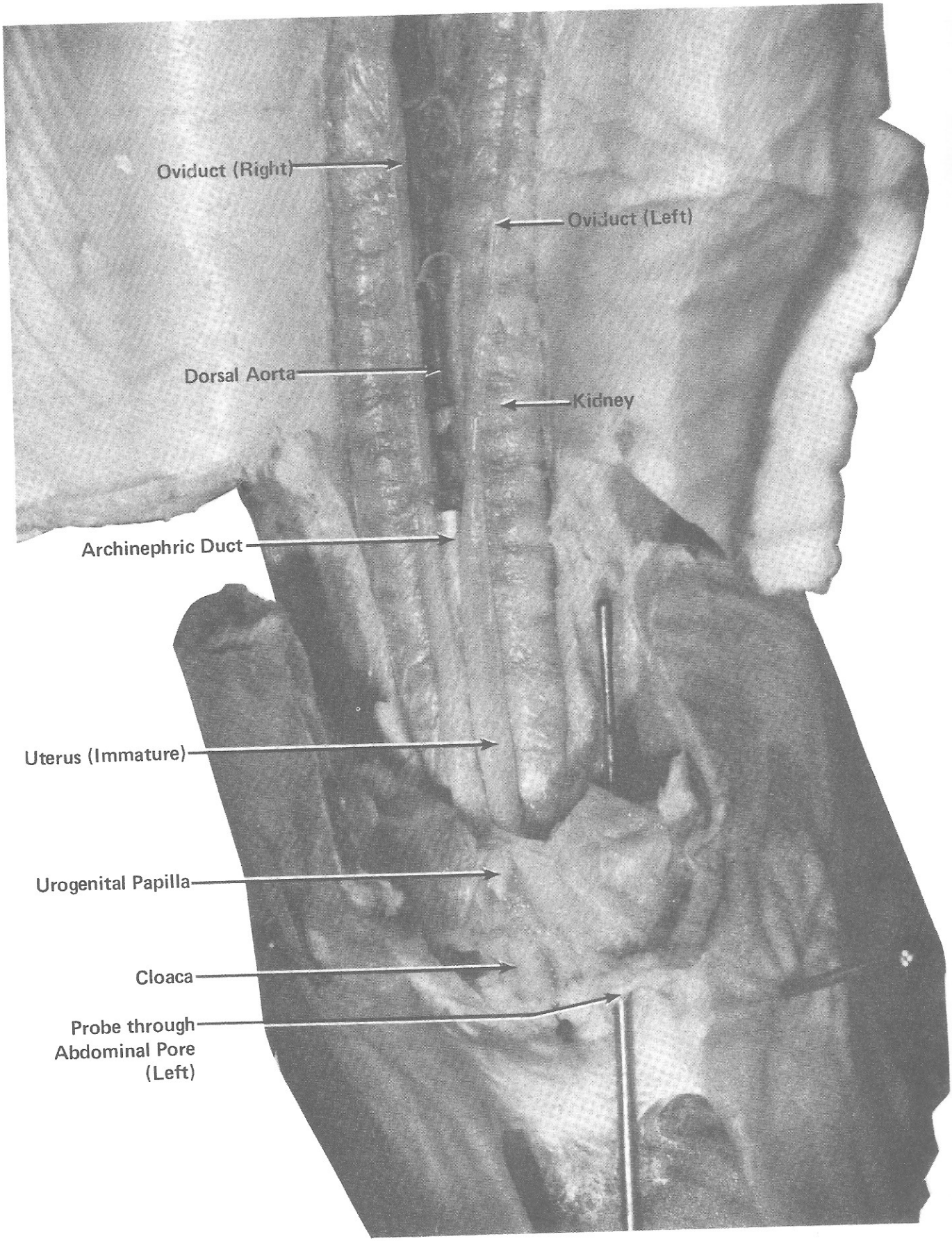
Dissect a "pup" of about 15 centimeters in length and note an *internal yolk sac,* continuous with the external yolk sac, connected to the alimentary canal.

During its period of gestation, which is nearly two years, the yolk is slowly absorbed by the shark "pup." At about 25 centimeters in length the external yolk sac has been completely absorbed, although some of the internal yolk sac is still present. At birth the young are about 23 to 29 centimeters long.

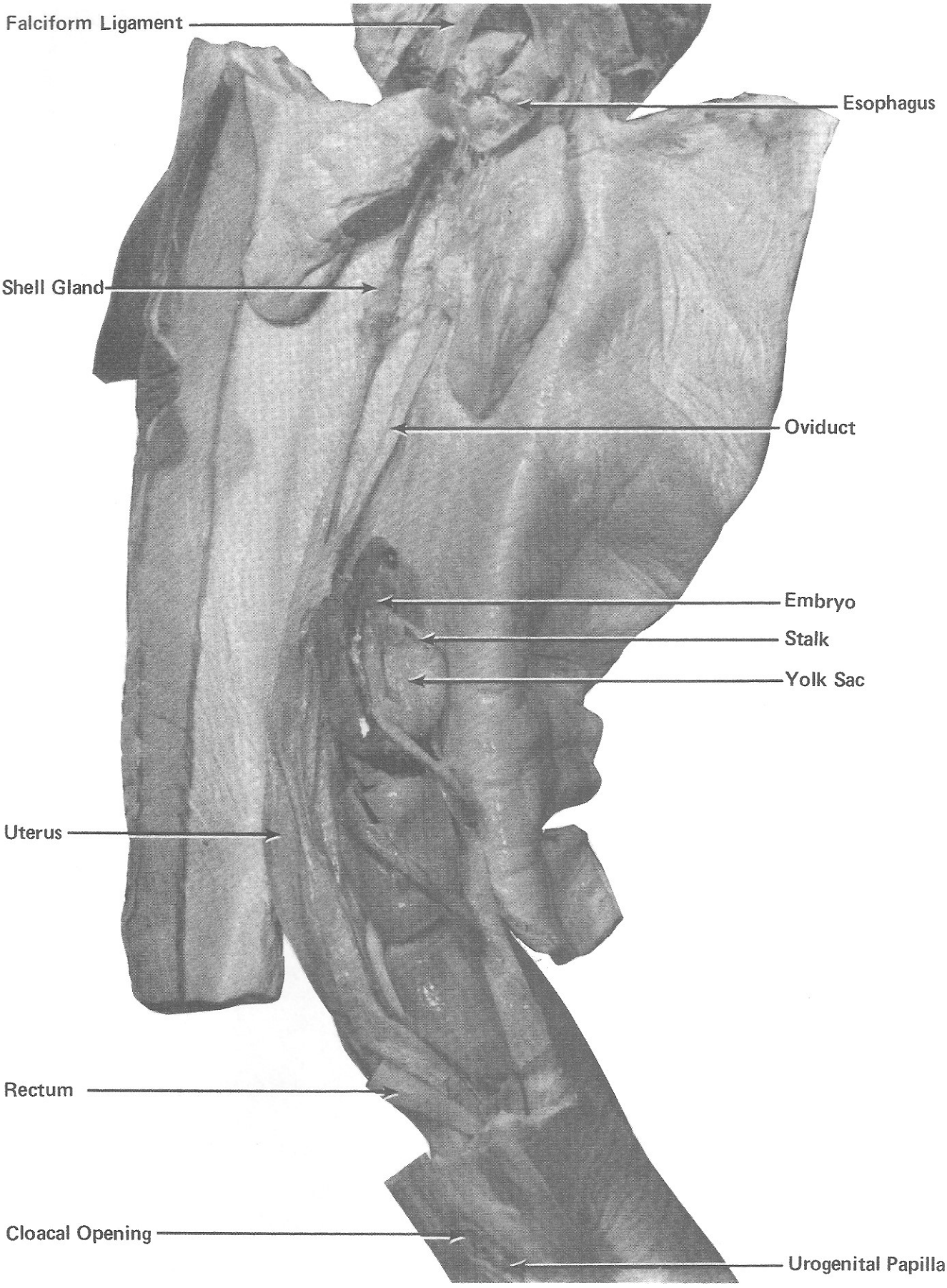
Numerous uterine *villi,* finger-like projections from the uterine wall, make contact with the surface of the developing embryo and its yolk sac. It is believed that these provide the embryo with water; all other nutrients are supplied by the yolk.

This type of development, where the young are born as miniature adults but have received hardly any nutrition directly from the mother's uterus, is known as *ovoviviparous*. By contrast, human development is *viviparous*.

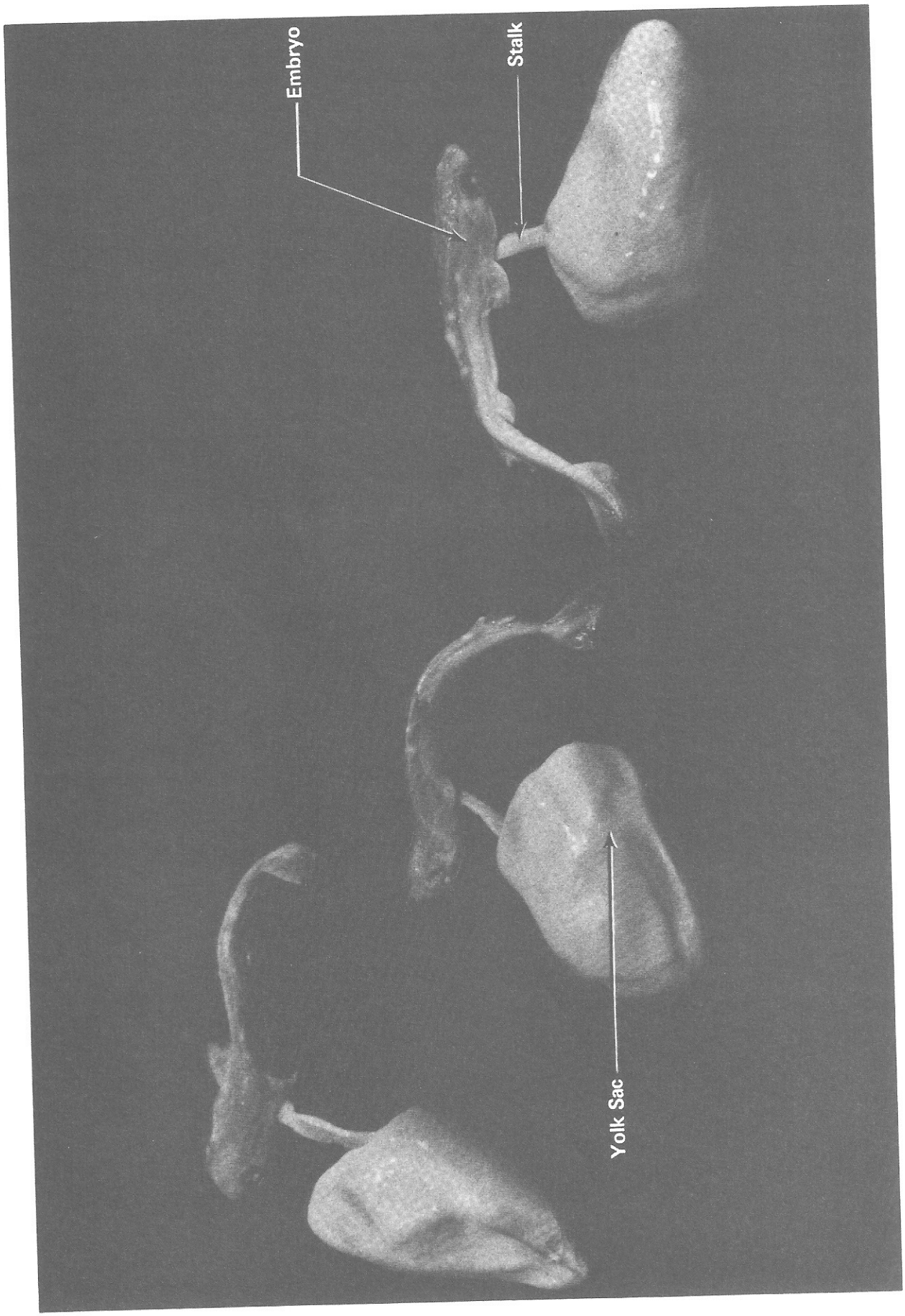

Ostium of Oviducts
Esophagus
Ovary (Right)
Ovary (Left)
Shell Gland
Mesovarium
Oviduct (Left)
Oviduct
Mesotubarium
(Kidney Dorsal
to Mesotubarium)
Uterus (Containing Embryos)
Rectum
Cloaca
Abdominal Pore
Urogenital
Papilla



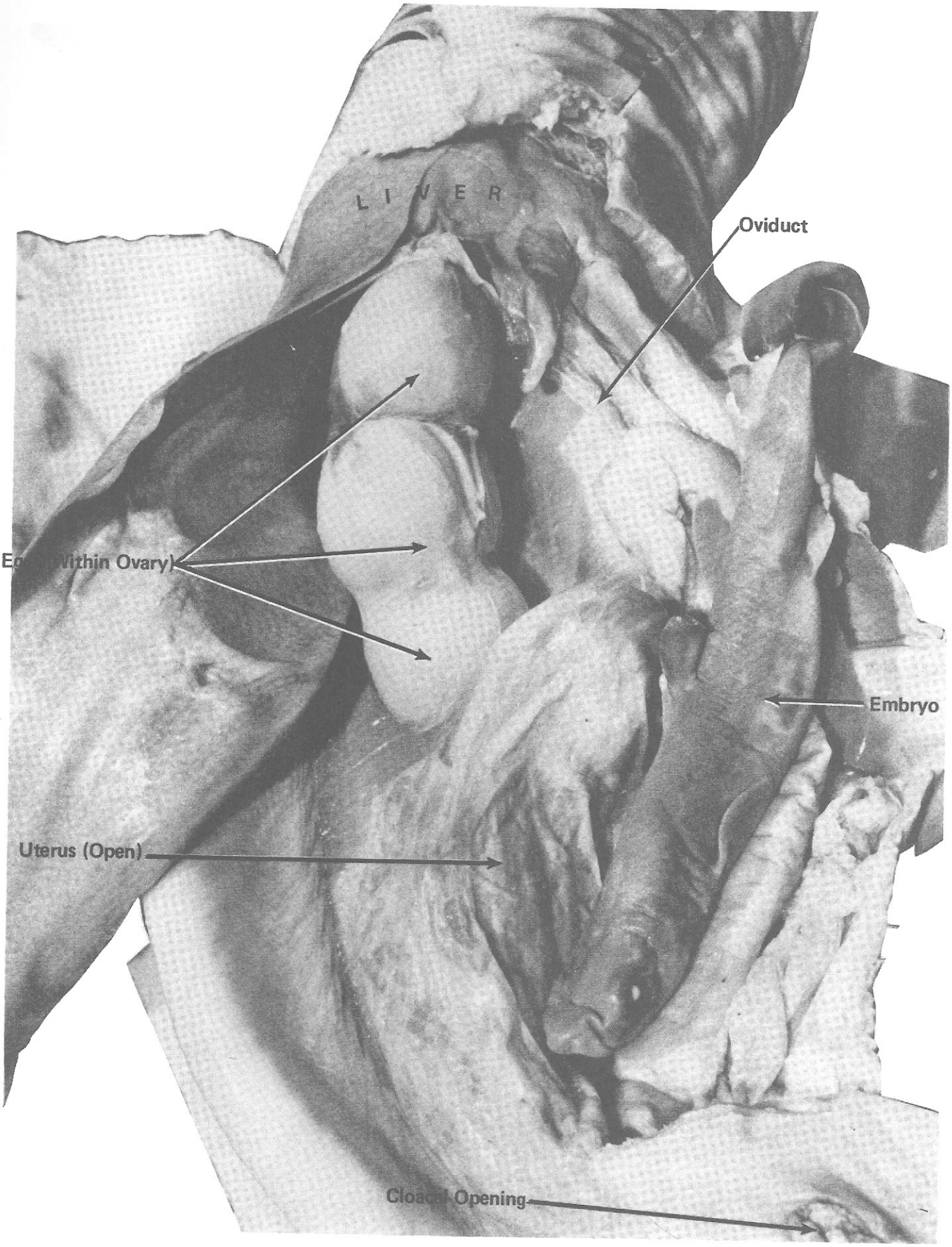
THE FEMALE UROGENITAL SYSTEM (CLOSE-UP)



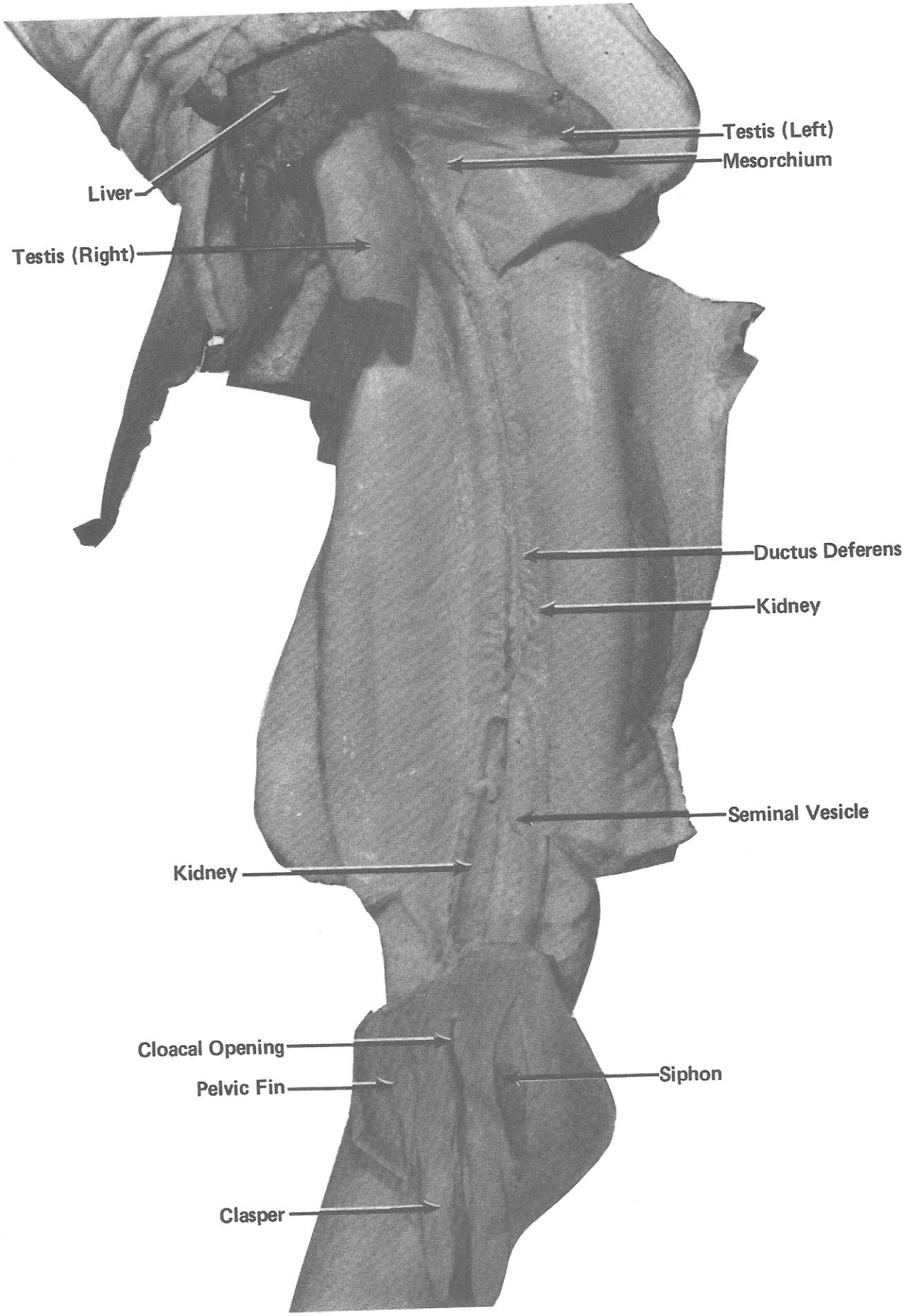
EMBRYOS WITHIN UTERUS



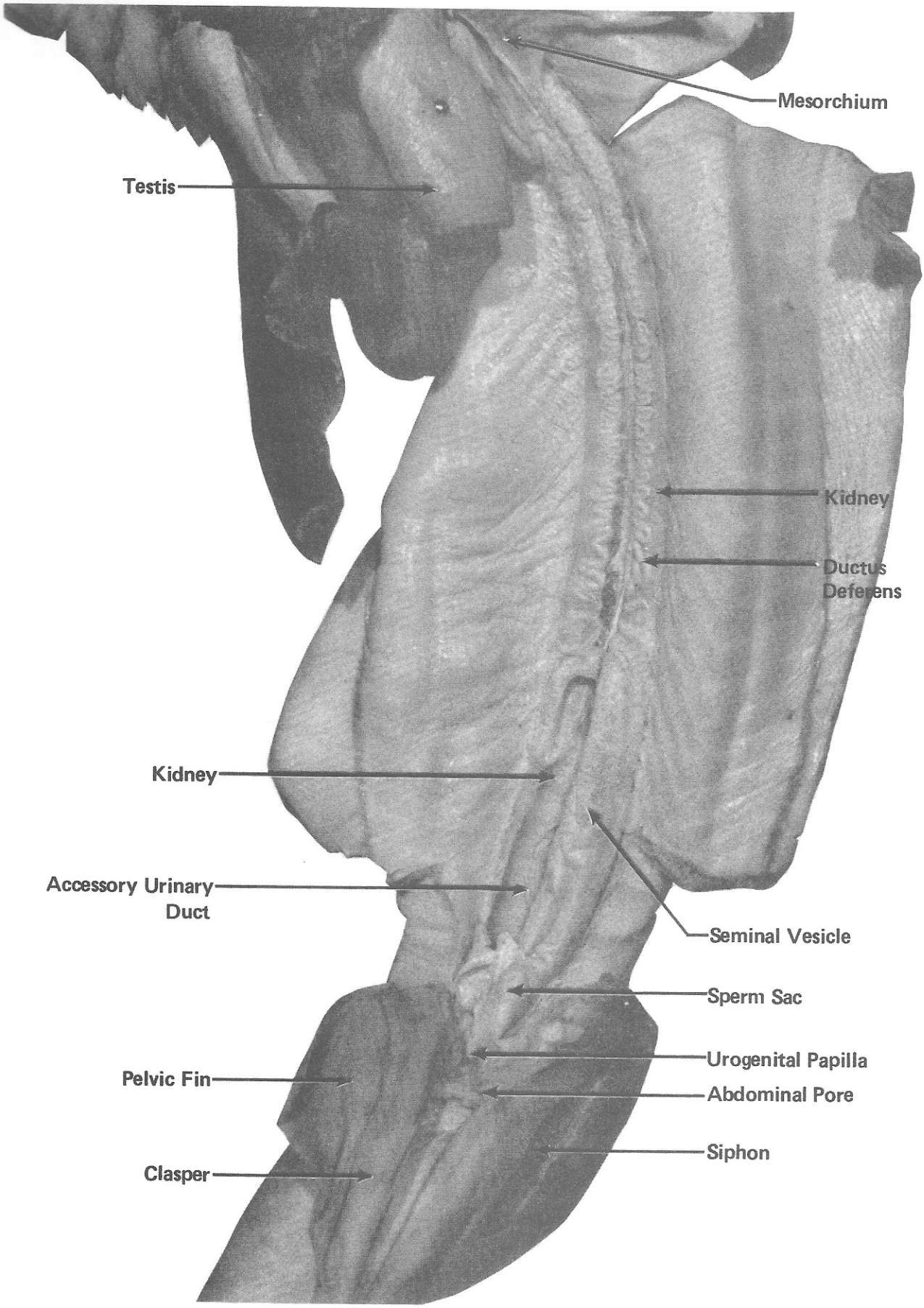
EMBRYOS REMOVED FROM UTERUS



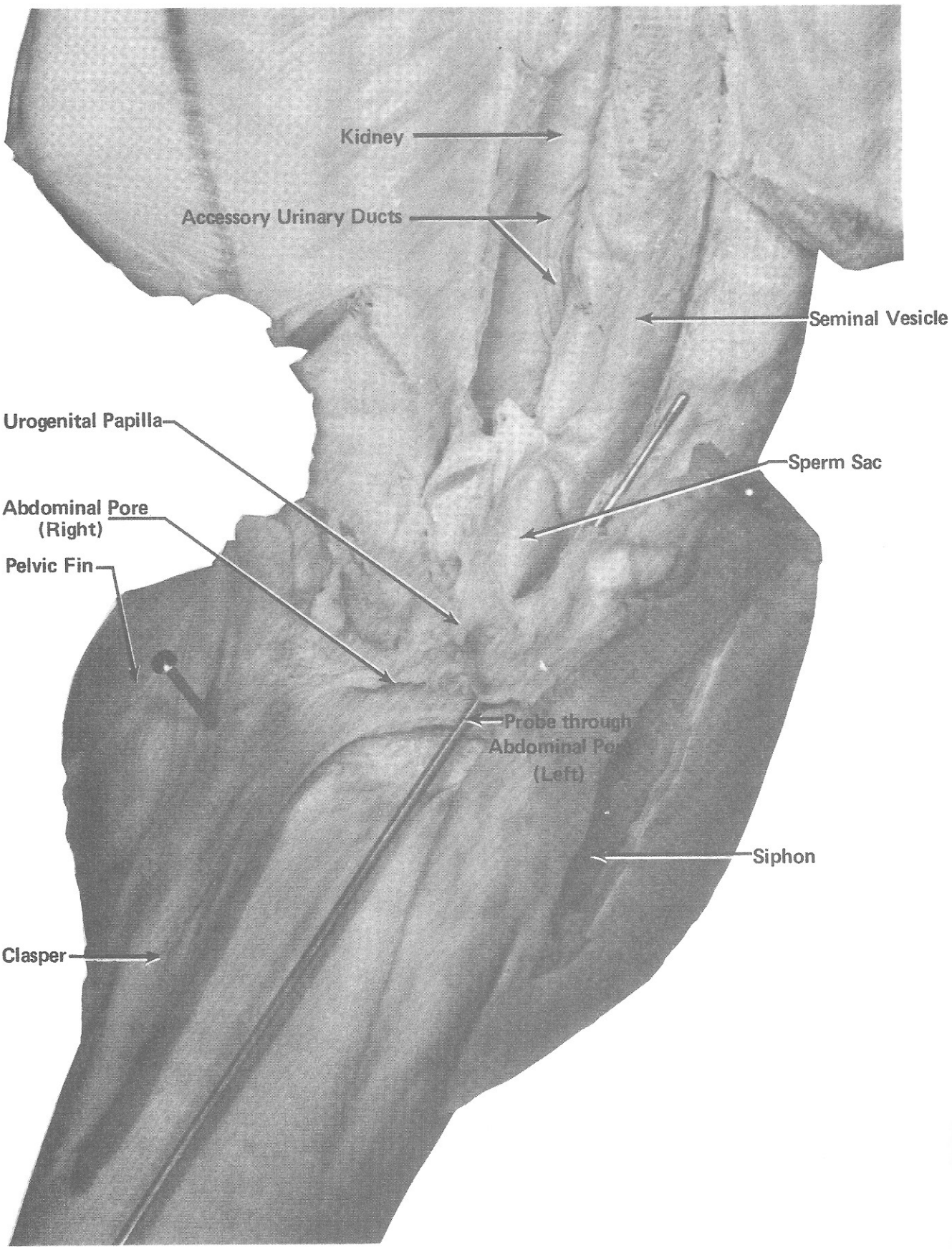
MATURE EMBRYO IN UTERUS



THE MALE UROGENITAL SYSTEM



THE MALE UROGENITAL SYSTEM (CLOACA EXPOSED)



THE MALE UROGENITAL SYSTEM (CLOSE-UP)