

THE URINARY SYSTEM

Relationships of pronephros, mesonephros, and metanephros

1. Three major urinary organs appear in the vertebrates

- a. Pronephros is most primitive, functional as an excretory organ only in the lowest fishes.
- b. Mesonephros assumes the role of pronephros in the higher fishes and amphibia
- c. Metanephros supplants mesophros in the reptiles, birds, and mammals.

2. In a recapitulation of phylogeny, these three major kidney forms are formed in succession during avian and mammalian development.

- a. Pronephros is first, most anterior, wholly vestigial, completely disappears
- b. Mesonephros appears later, more caudal, functional in early embryonic life, disappears except for its duct which becomes a part of male reproduction.
- c. Metanephros appears last, most caudal, becomes functional in late embryonic life, and persists throughout adulthood.

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Ontogenetic history of the kidney

1. **Pronephros first appears as several pairs of tubules located in cephalic intermediate mesoderm.**
 - a. Forming in a cephalocaudal sequence, the tubules empty laterally on each side into a common duct called the primary nephric (pronephric) duct.
 - b. The primary nephric ducts elongate towards the cloaca, but never reaches it; with this progression new tubules are added.
2. **After just a few segments, the tubules gradually change into mesonephric tubules.**
 - a. With the onset of mesonephros, pronephric tubules begin to degenerate.
 - b. The primary nephric ducts are now called mesonephric (Wolffian) ducts because they open into the cloaca and are functional.

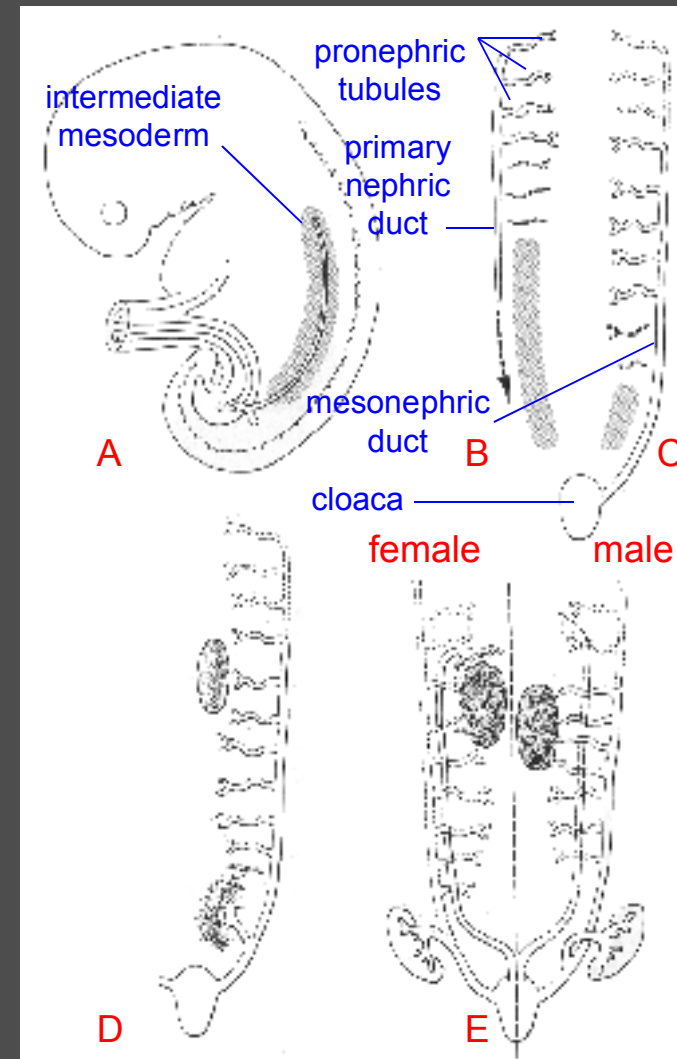


FIG. 18-1

THE URINARY SYSTEM

Ontogenetic history of the kidney

3. While the posterior mesonephros is still forming, a small outgrowth appears at the cloacal end of the mesonephric duct.
 - a. The metanephric diverticula (ureteric buds) push into the most posterior ducts of the intermediate mesoderm where they induce formation of the metanephric tubules.
 - b. Rather than being strung out along the dorsal body wall, metanephric tubules become aggregated into a compact mass which ultimately becomes the kidney.
 - c. As the metanephric tubules arise, the mesonephric tubules begin to degenerate.
 - (1) In the female the mesonephric tubules and duct degenerate into vestigial structures.
 - (2) In the male, some of the ducts and tubule are used to form ducts for sperm transport

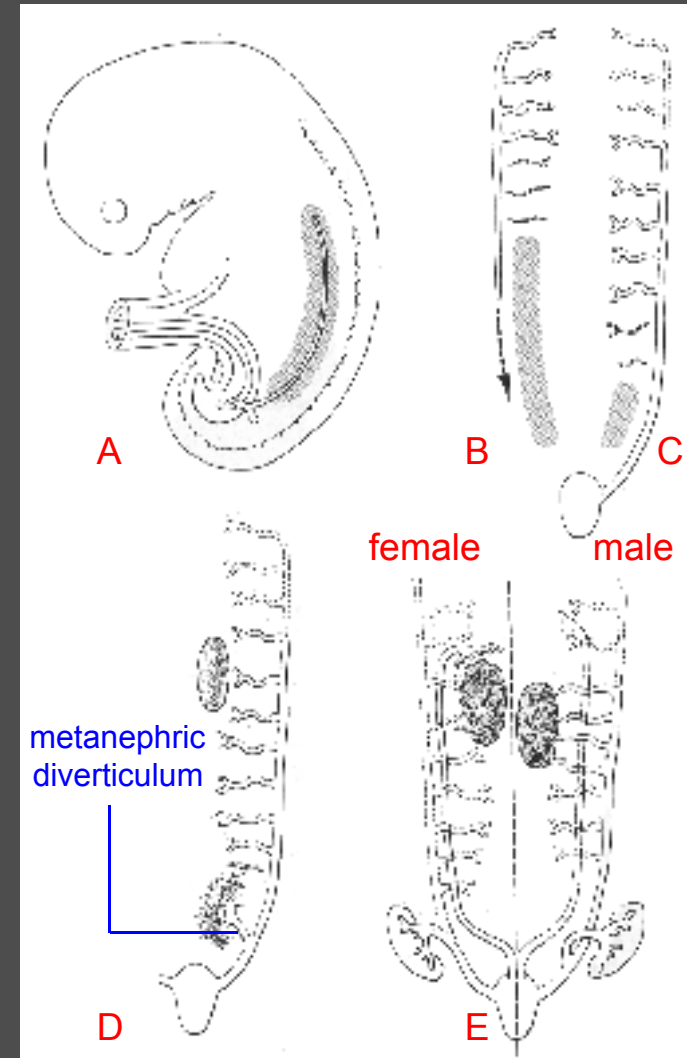


FIG. 18-1

THE URINARY SYSTEM

Development of the metanephros

1. Arises as a budlike outgrowth from the distal-most mesonephric duct
 - a. Called the metanephric diverticulum, it pushes into the posterior-most intermediate mesoderm, inducing it to form the metanephrogenic blastema.
 - b. From the blastema arise the metanephric tubules, which will become nephrons.
2. As the diverticulum grows cephalad, it is induced by the developing tubules to branch 14-15 times, ultimately giving rise to the ureter, the renal pelvis, and the collecting duct system

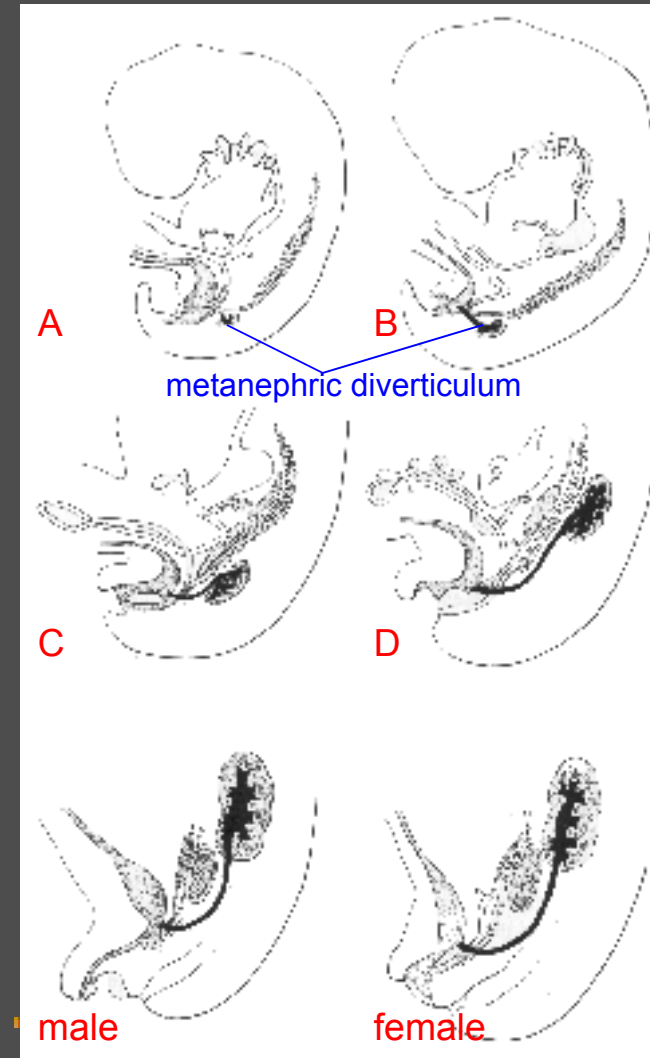


FIG. 18-6

THE URINARY SYSTEM

Development of the metanephros

3. Another view

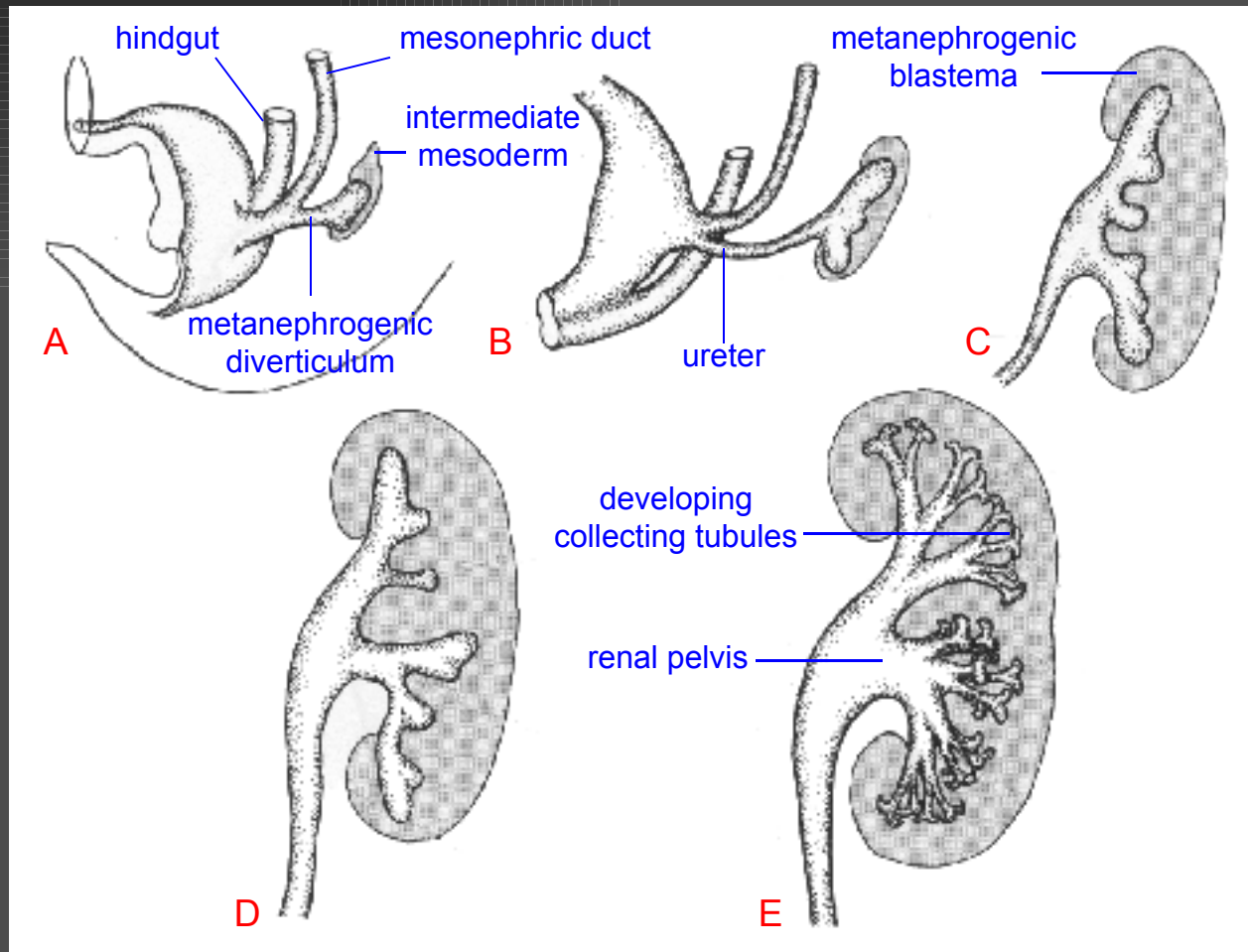


FIG. 18-11

THE URINARY SYSTEM

Function of the nephric tubules

1. Fluid enters proximal end of tubule either as filtrate of blood (metanephric) or as coelomic fluid via a nephrostome (pronephric and mesonephric)
2. As fluid flows through tubules it is processed into urine, with the good stuff being returned to the blood

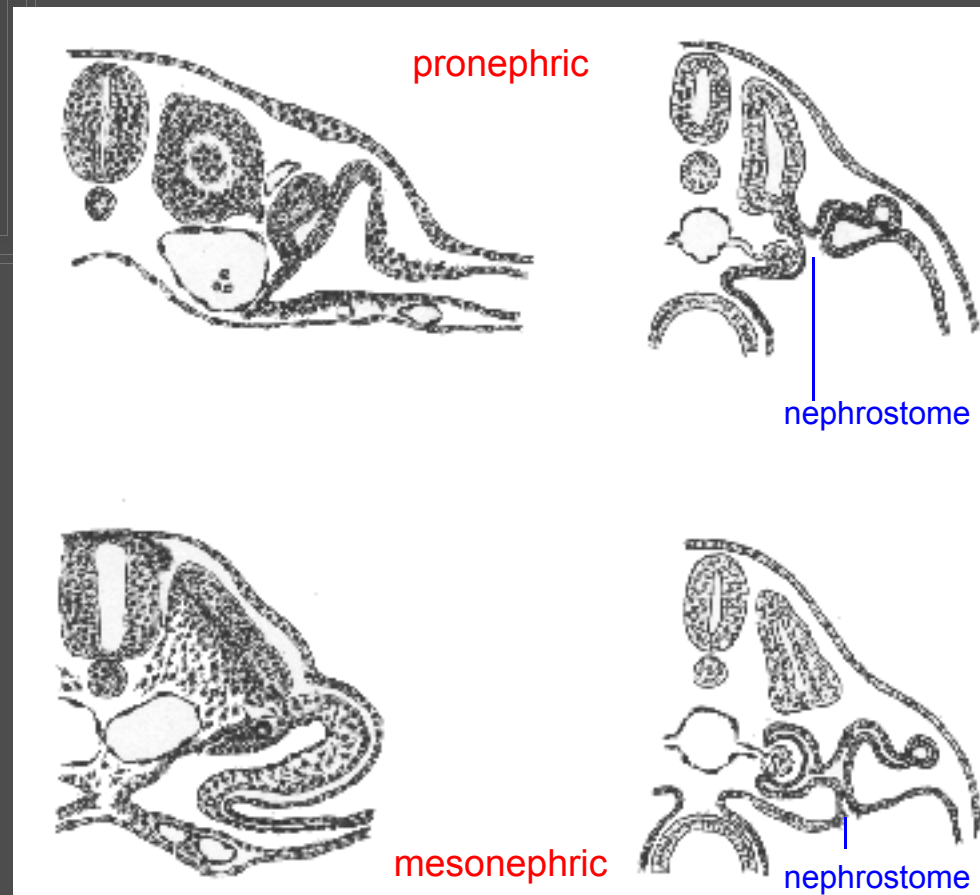


FIG. 18-6

THE URINARY SYSTEM

Formation of the cloaca and bladder

1. Caudal to the origin of the allantois, the hindgut enlarges to form the cloaca.
 - a. At this point, the hindgut is still a blind tube.
 - b. Under the root of the tail, the ectoderm sinks in as the proctodeum.
 - c. The cloacal (anal) membrane, the combined ectoderm and endoderm between the proctodeum and the cloaca, will rupture to provide communication to the outside.
2. A urorectal fold arises which cuts into the cloaca where allantois and hindgut meet.
 - a. This will eventually partition the cloaca into a rectum posteriorly and a urogenital sinus anteriorly (the upper part becomes the bladder).
 - b. Rupture of the proctodeum separates the two systems.

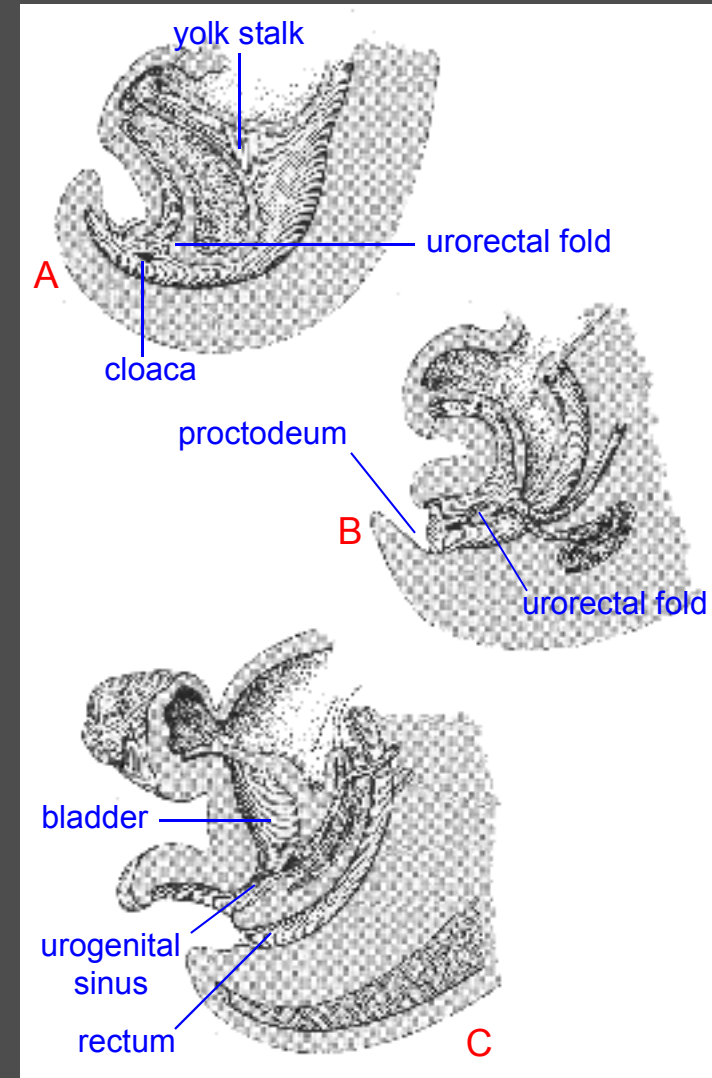


FIG. 18-14

THE URINARY SYSTEM

Formation of the cloaca and bladder

1. With bladder growth, the caudal portion of the mesonephric duct becomes incorporated into the bladder wall.
 - a. Process continues until origin of metanephric diverticulum has disappeared.
 - a. The end result is that the two sets of tubes open independently of one another, one into the bladder (ureters) and the other into the urogenital sinus (mesonephric ducts).

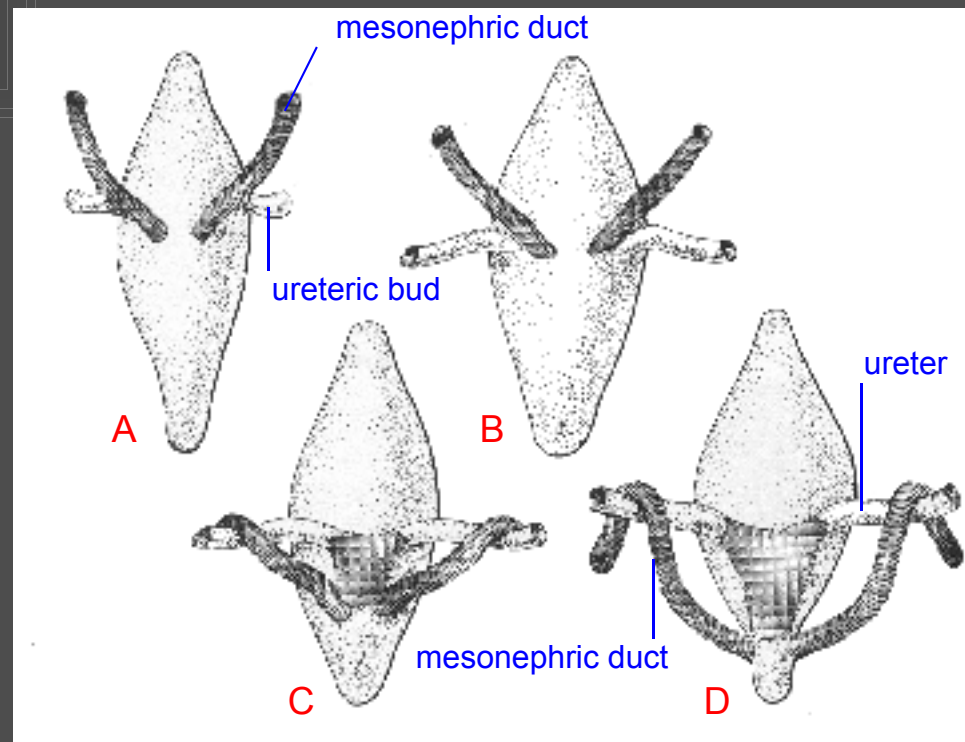


FIG. 18-15

THE REPRODUCTIVE SYSTEM

Factors involved in sexual differentiation

1. Two important generalizations regarding mammals.

- a. Gonads, ductwork, and external genitalia first pass through a morphologically indifferent stage in which they are neither male nor female.
- b. The inherent tendency of the indifferent structures is to develop female.

2. Four critical stages

- a. Genetic sex determined at fertilization
- b. Establishment of gonadal sex; transformation of indifferent gonad into testis or ovary
- c. Differentiation of somatic sex, in which the appropriate ducts are formed.
- d. Assignment of phenotypic sex and socialization according to gender

THE REPRODUCTIVE SYSTEM

Formation of the duct system

1. The original mesonephric duct persists even after the mesonephric tubules regress.
2. A second duct system, the Mullerian or paramesonephric ducts, develops parallel.
3. If XX, the mesonephric duct regresses completely and the Mullerian ducts develop into oviducts, uterus, and proximal vagina.
4. If XY, testosterone stimulates mesonephric duct to form the epididymis, vas deferens, and seminal vesicle; Mullerian ducts regress in response to anti-Mullerian duct factor from testis

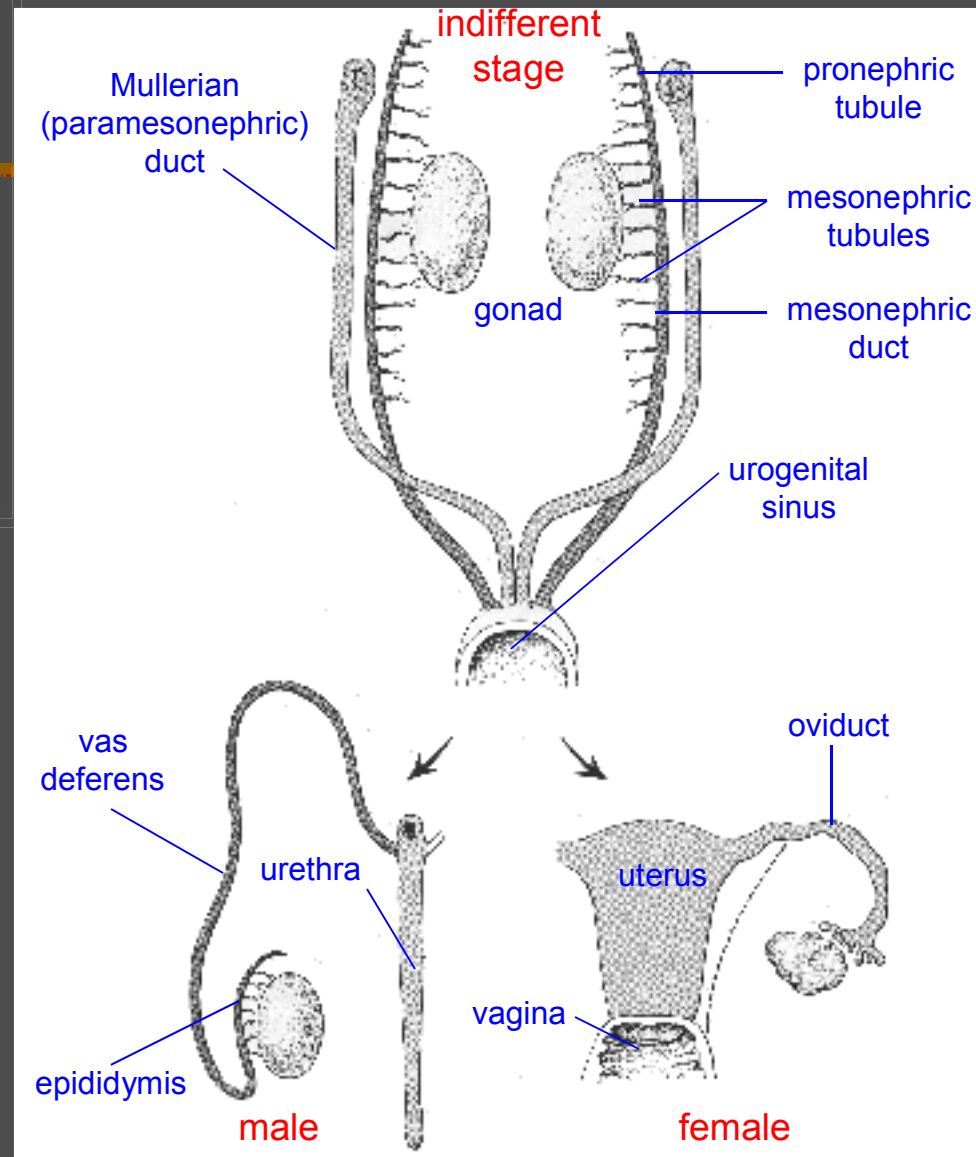


FIG. 18-17

THE REPRODUCTIVE SYSTEM

Major events leading to male phenotype formation

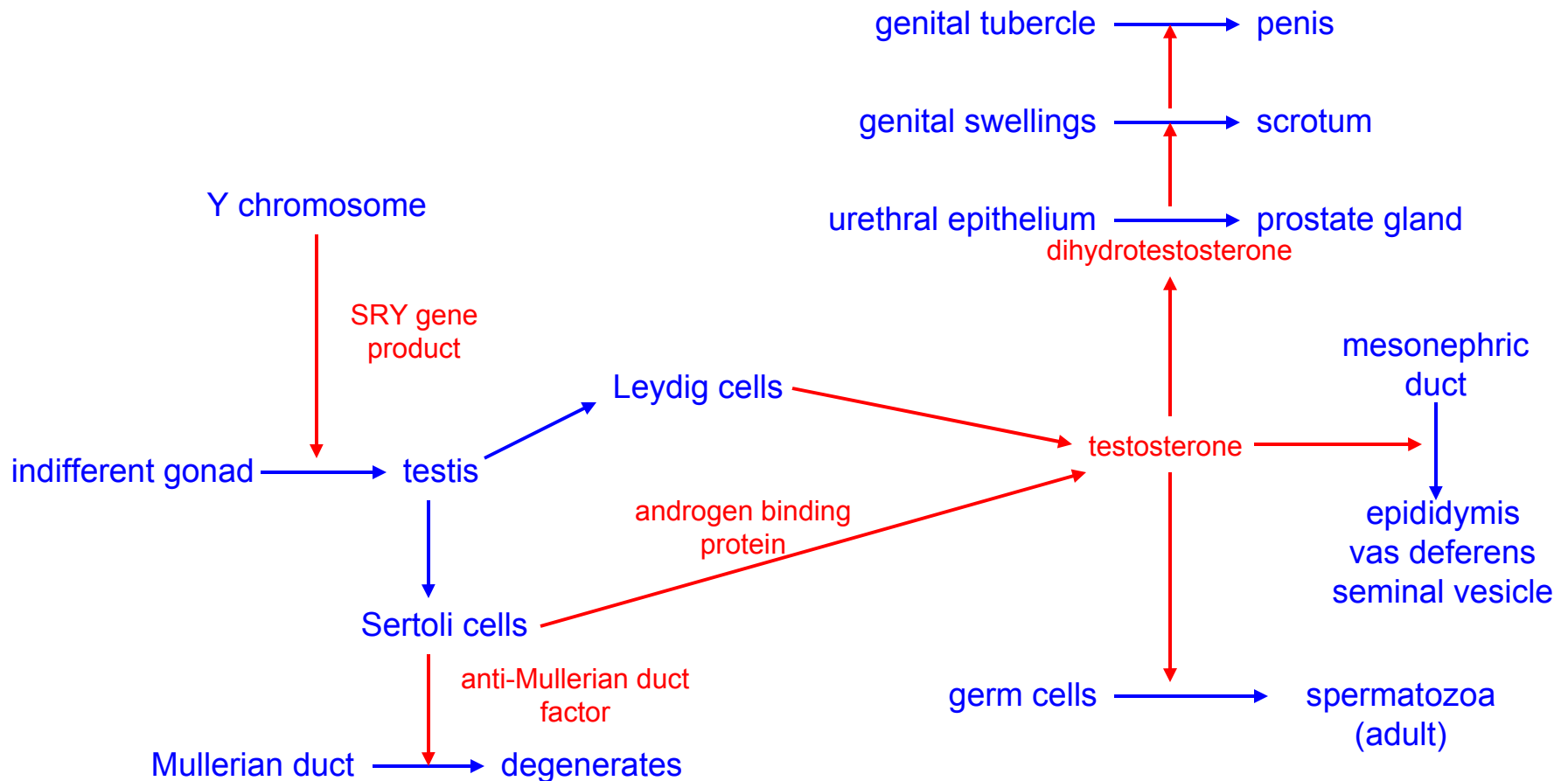


FIG. 18-18

THE REPRODUCTIVE SYSTEM

Early differentiation of the gonads

1. From their earliest appearance, gonads are intimately associated with the nephric system.
 - a. The gonads arise from mesoderm on the ventromedial side of the mesonephros as thickenings called the gonadal ridges.
 - b. At this stage, the gonad consists of a mesoderm core covered by an epithelium.

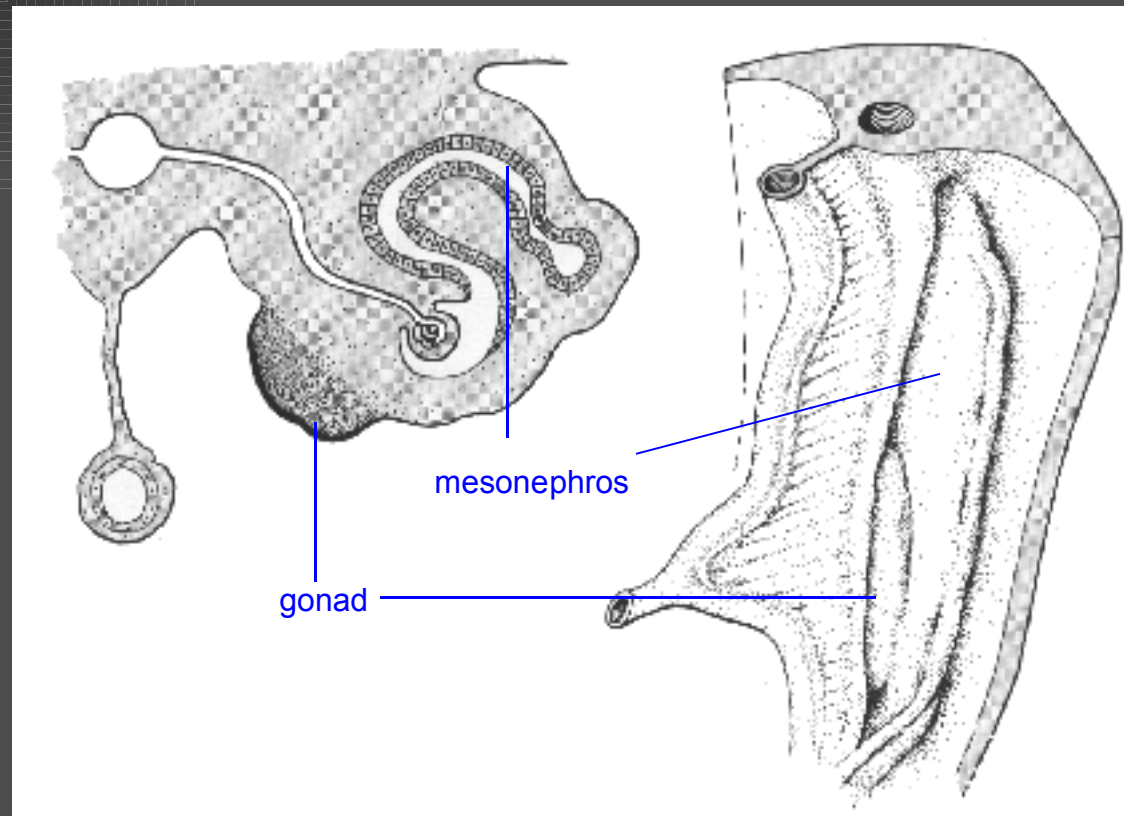


FIG. 18-16

THE REPRODUCTIVE SYSTEM

Early differentiation of the gonads

2. Differentiation into testes or ovaries occurs after the primordial germ cells (from the yolk sac endoderm) have invaded the tissue.

- a. Male – testicular cells (both mesodermal and germ) aggregate themselves into rudimentary seminiferous tubules with Leydig cells in between.
- b. Female – late in gestation the ovaries depart from their indifferent appearance and the germ cells associate themselves with mesodermal follicle cells to form primordial follicles.

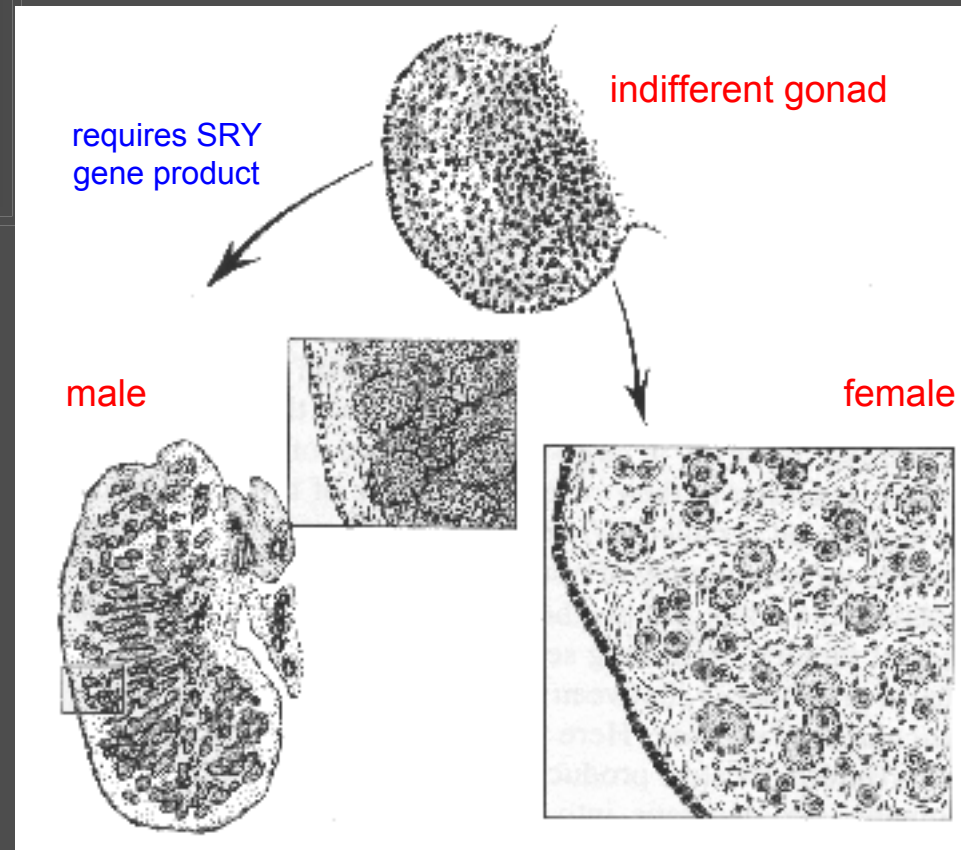


FIG. 18-20

THE REPRODUCTIVE SYSTEM

Descent of the gonads

1. Both gonads arise high up on the body wall associated with the mesonephros, but then migrate posteriorly related to differential growth.
2. The testes pass down the posterior body wall, behind the peritoneum, coming to lie in the forming scrotal pouches.
 - a. Covering the front of each testis is the processus vaginalis, an extension of the peritoneal membrane.
 - b. In most mammals this canal closes, forming the tunica vaginalis.
3. Ovaries descend as well, but come to rest in the pelvic cavity.

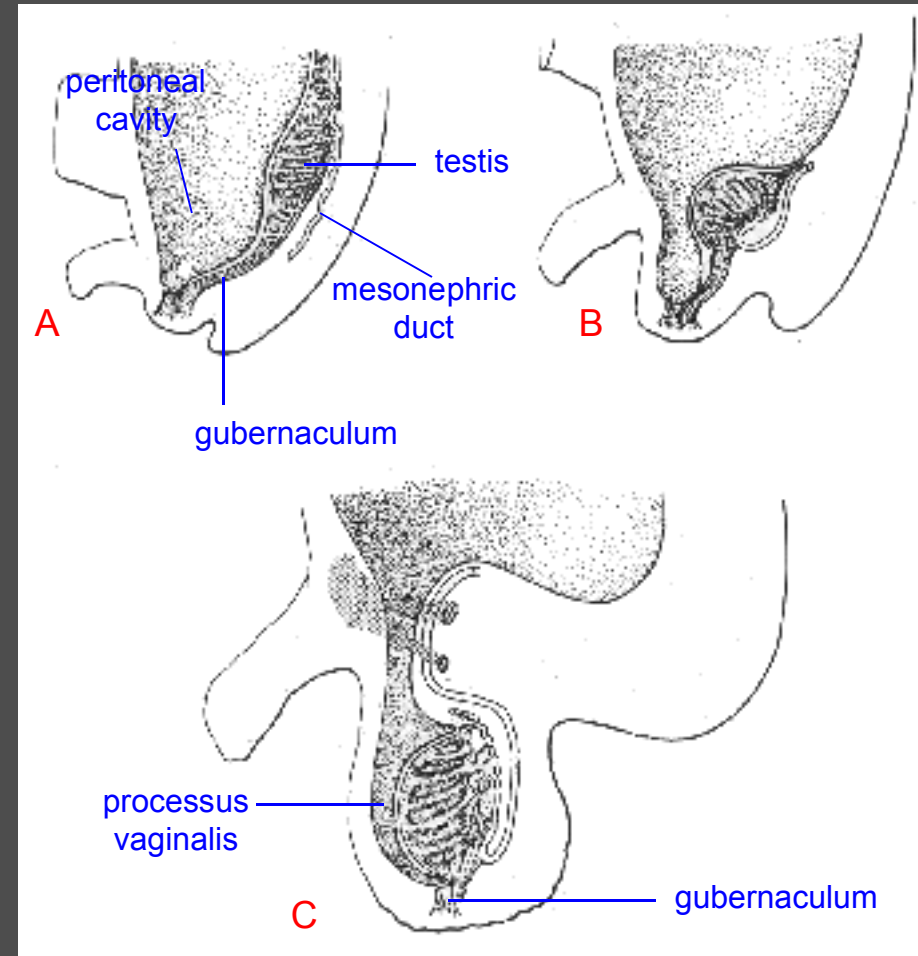


FIG. 18-28

THE REPRODUCTIVE SYSTEM

Comparison of male and female gonads and ducts

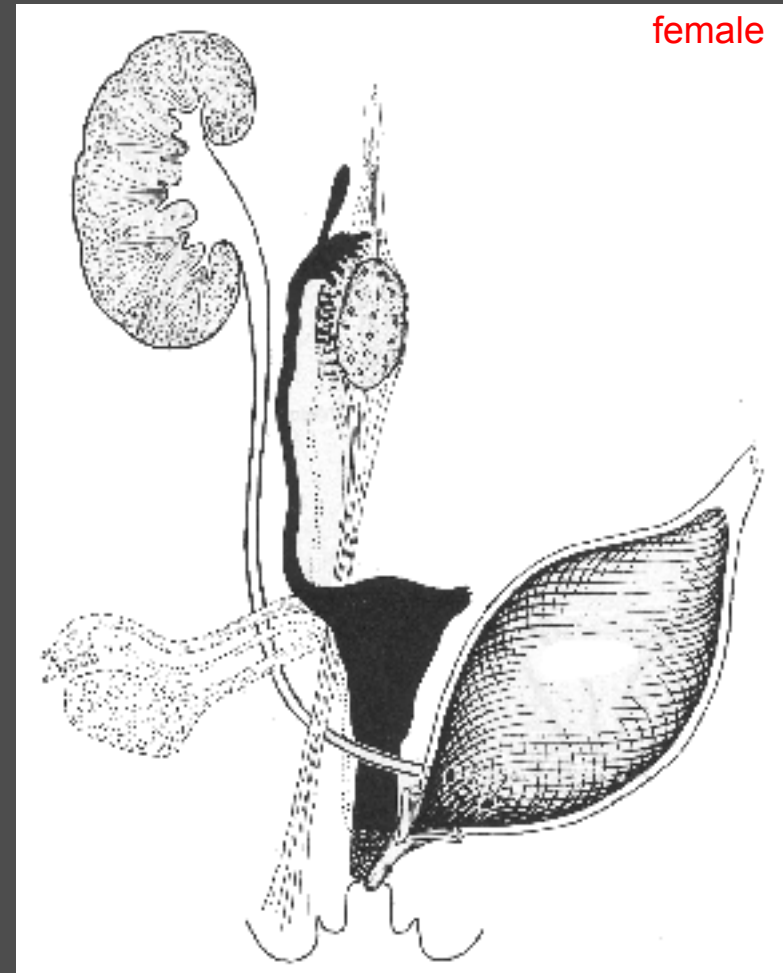
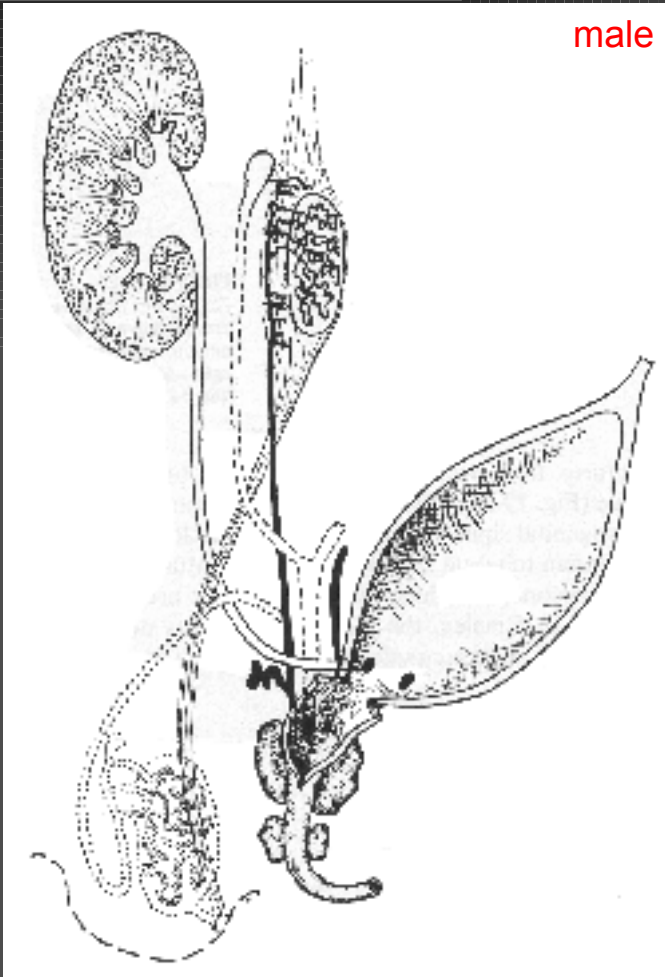


FIG. 18-22 and 18-25

THE REPRODUCTIVE SYSTEM

Male and female homologous structures

Male derivative

testis
spermatozoa
seminiferous tubules
efferent ductules
epididymis, vas deferens
degenerates
bladder, prostatic urethra
lower urethra
penis
floor of penile urethra
scrotum

Indifferent structure

gonad
primordial germ cells
sex cords
mesonephric tubules
mesonephric duct
paramesonephric duct
upper urogenital sinus
lower urogenital sinus
genital tubercle
genital folds
genital swellings

Female derivative

ovary
ova
follicular cells
epoophoron
degenerates
oviducts, uterus, upper vagina
bladder, urethra
vestibule
clitoris
labia minora
labia majora

THE REPRODUCTIVE SYSTEM

Male and female genitalia

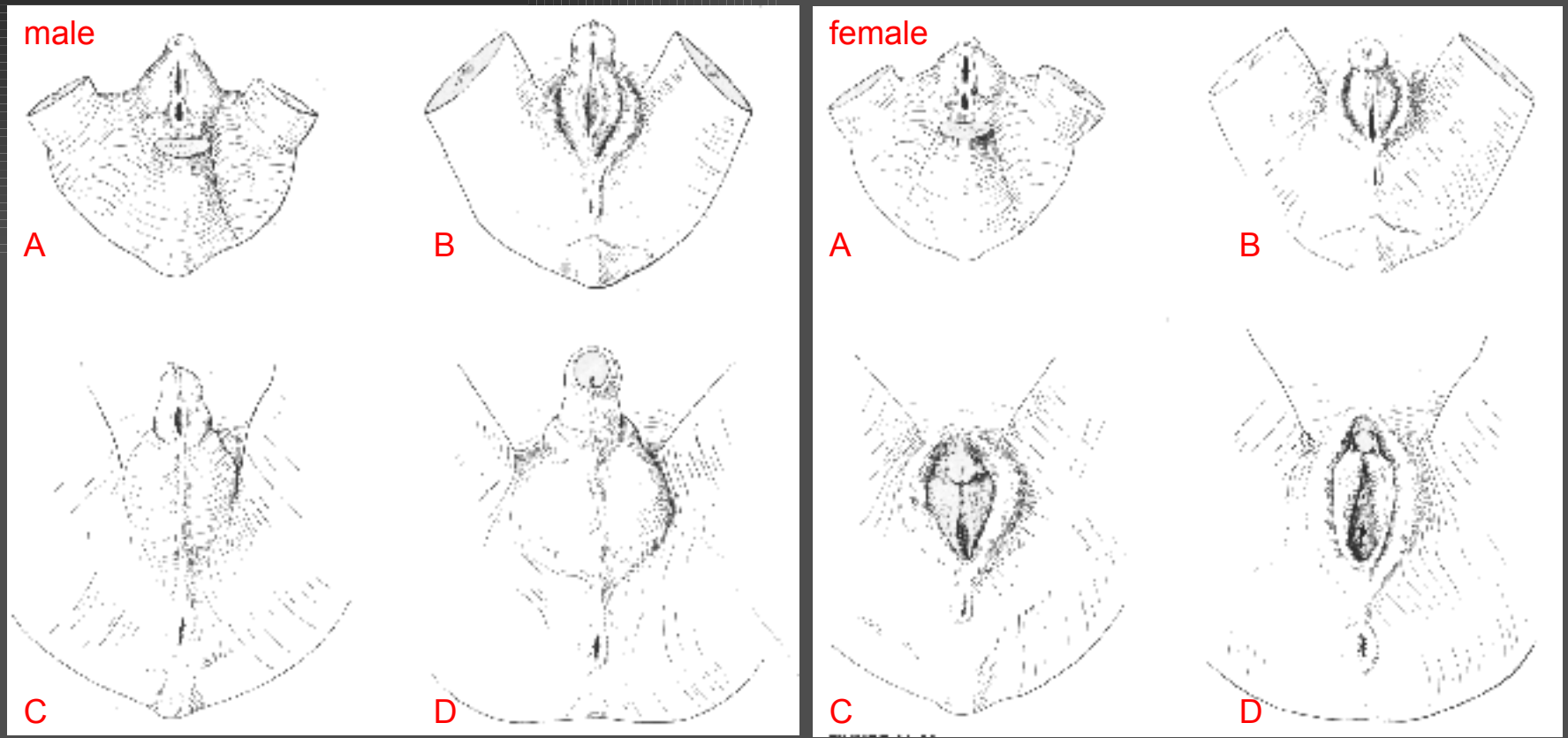


FIG. 18-31 and 32