KIDNEYS

The kidneys are ovoid. They remove excess water, salts, and wastes of protein metabolism from the blood. They also return nutrients and chemicals to the blood.

The kidneys lie retroperitoneally on the posterior abdominal wall. They are one on each side of the vertebral column. The right kidney is between the last thoracic vertebra and the third lumbar vertebra. The left kidney is between T11-L2. The levels of the kidneys change during respiration and with changes in posture. The kidneys form urine of 1.5-2 lt. from 1100-2000 lt. of coming blood. As they are the organs of filtration, via the two renal arteries on both sides, they receive the 20-25% of the entire blood pumped by the heart.

Each kidney has a smooth anterior and posterior surface covered by a fibrous capsule. This capsule is easily removable except during disease.

On the medial margin of each kidney is the hilum of kidney. It is a deep vertical slit. Through the renal hilum renal vessels, lymphatics, and nerves enter and leave the kidney. Internally, the hilum is continuous with the renal sinus. Perinephric fat continues into the hilum and sinus and surrounds all structures.

Each kidney consists of an outer renal cortex and an inner renal medulla. The renal cortex is a continuous band of pale tissue. It completely surrounds the renal medulla. Renal cortex extends into the inner aspect of the kidney. They are called as renal columns. They divide the renal medulla into triangular-shaped tissue (renal pyramids). The bases of the renal pyramids are directed outward, toward the renal cortex. The apex of each renal pyramid projects inward, toward the renal sinus. The apical projection (renal papilla) is surrounded by a minor calyx.

The minor calices receive urine and represent the proximal parts of the tube that will eventually form the ureter. In the renal sinus, several minor calices unite to form a major calyx, and two or three major calices unite to form the renal pelvis, which is the funnel-shaped superior end of the ureters.

Each kidney has anterior and posterior surfaces. Each kidney has medial and lateral margins. It also has superior and inferior poles. The renal pelvis is the flattened, funnel-shaped expansion of the superior end of the ureter. The apex of the renal pelvis is continuous with the ureter. The renal pelvis receives two or three major calices (calyces). Each major calyx divides into two or three minor calices. Each minor calyx is indented by a renal papilla at the apex of the renal pyramid. The urine is excreted through the renal papilla. The pyramids and their associated cortex form the lobes of the kidney.

SUPRARENAL GLANDS

The suprarenal (adrenal) glands are yellowish in living persons. They are located between the superomedial aspects of the kidneys and the diaphragm. The two glands are surrounded by connective tissue. This tissue contains considerable perinephric fat.

The suprarenal cortex secretes corticosteroids and androgens. These hormones cause the kidneys to retain sodium and water in response to stress, increasing the blood volume and blood pressure. They also affect muscles and organs such as the heart and lungs.

The suprarenal medulla is a mass of nervous tissue associated with the sympathetic nervous system. The chromaffin cells of the medulla secrete catecholamines (mostly epinephrine) into the bloodstream in response to signals from presynaptic neurons. The powerful medullary hormones epinephrine (adrenaline) and norepinephrine (noradrenaline) activate the body to a flight-or-fight status in response to traumatic stress. They also increase heart rate and blood pressure, dilate the bronchioles, and change blood flow patterns, preparing for physical exertion.
PELVIC VISCERA

The pelvic viscera include the distal parts of the urinary system and digestive tract, and the reproductive system. Although the sigmoid colon and parts of the small bowel extend into the pelvic cavity, they are abdominal rather than pelvic viscera. The bladder and rectum—true pelvic viscera—are inferior continuations of systems encountered in the abdomen. There are few differences between male and female pelvic urinary and digestive organs. The male urethra is shared by the excretory and reproductive tracts in males. The physical relationships of the reproductive organs in the pelvis are different between the two sexes.

The pelvic urinary organs are the:

- Pelvic portions of the ureters, which carry urine from the kidneys.
- Urinary bladder, which temporarily stores urine.
- Urethra, which conducts urine from the bladder to the exterior.

The ureters are muscular ducts (25-30 cm long) with narrow lumina that carry urine from the kidneys to the urinary bladder. They run inferiorly from the apices of the renal pelves at the hila of the kidneys. They then run along the lateral wall of the pelvis and enter the urinary bladder.

The urinary bladder, a hollow viscus with strong muscular walls, is characterized by its distensibility. The urinary bladder is a temporary reservoir for urine and varies in size, shape, position, and relationships according to its content and the state of neighboring viscera. When empty, the adult urinary bladder is lies on the pubic bones and pubic symphysis anteriorly and the prostate (males) or anterior wall of the vagina posteriorly.

The urinary bladder has an apex, fundus, body and cervix (neck). Toward the neck of the male bladder, the muscle fibers form the involuntary internal urethral sphincter. This sphincter contracts during ejaculation to prevent retrograde ejaculation (ejaculatory reflux) of semen into the bladder.

The male urethra is a muscular tube that conveys urine from the internal urethral orifice of the urinary bladder to the external urethral orifice, located at the tip of the glans penis in males. The urethra also provides an exit for semen (sperms and glandular secretions). The urethra has three parts. They are 1) Abdominal part, 2) Pelvic part, 3) Intramural part.

The female urethra passes anteroinferiorly from the internal urethral orifice of the urinary bladder, posterior and then inferior to the pubic symphysis, to the external urethral orifice. The musculature surrounding the internal urethral orifice of the female bladder is not organized into an internal sphincter. In females, the external urethral orifice is located in the vestibule. The vestibule is the cleft between the labia minora of the external genitalia. It is directly anterior to the vaginal orifice. The urethra lies anterior to the vagina. It forms an elevation in the anterior vaginal wall.

MALE GENITAL SYSTEM

The reproductive system in men has components in the abdomen, pelvis, and perineum. The major components are a testis, epididymis, ductus deferens, and ejaculatory duct on each side, and the urethra and penis in the midline. In addition, three types of accessory glands are associated with the system:

- a single prostate;
- a pair of seminal vesicles; and
- a pair of bulbourethral glands (Cowper’s glands).

The design of the reproductive system in men is basically a series of ducts and tubules. The arrangement of parts and linkage to the urinary tract reflects its embryological development.
Each seminal gland (vesicle) is an elongated structure that lies between the fundus of the bladder and the rectum. The seminal glands are obliquely placed superior to the prostate and do not store sperms, as the “vesicle” term implies. They secrete a thick alkaline fluid with fructose (an energy source for sperms) and a coagulating agent that mixes with the sperms as they pass into the ejaculatory ducts and urethra.

The **ejaculatory ducts** are slender tubes that arise by the union of **ducts of the seminal glands** with **ductus deferentes**.

The prostate is the largest accessory gland of the male reproductive system. The firm, walnutsize prostate surrounds the prostatic urethra. The glandular part makes up approximately two thirds of the prostate; the other third is fibromuscular. There are two lobes in the prostate; right and left lobes of the prostate.

The two pea-size bulbourethral glands (Cowper glands) lie posterolateral to the intermediate part of the urethra. Their ducts open into the urethra at the proximal part of the penis.

The spermatic cord contains structures running to and from the testis and suspends the testis in the scrotum. Spermatic cord passes through the inguinal canal, and ends in the scrotum at the posterior border of the testis.

The **scrotum** is a cutaneous sac consisting of two layers: heavily pigmented skin and the closely related dartos fascia, a fat-free fascial layer including smooth muscle fibers (dartos muscle) responsible for the rugose (wrinkled) appearance of the scrotum. Because the dartos muscle attaches to the skin, its contraction causes the scrotum to wrinkle when cold and assisting the cremaster muscles in holding the testes closer to the body, all of which reduces heat loss. The scrotum is the male homologue of the labia majora in women.

The **testes** (testicles) are the male gonads—paired ovoid reproductive glands that produce sperms (spermatozoa) and male hormones, primarily testosterone. The testes originally develop high on the posterior abdominal wall and then descend, normally before birth, through the inguinal canal in the anterior abdominal wall and into the scrotum of the perineum.

The **epididymis** is an elongated structure on the posterior surface of the testis. Efferent ductules of the testis transport newly developed sperms to the epididymis. At the tail of the epididymis, the ductus deferens begins as the continuation of the epididymal duct. In the lengthy course of this duct, the sperms are stored and continue to mature.

Superficial components of the genital organs in men consist of the scrotum and the penis. The **penis** is suspended from the front and sides of the pubic arch and containing the greater part of the urethra. The penis consists of a root and body. The body of penis is entirely covered by skin; the tip of the body is covered by the glans penis. The external urethral orifice is a sagittal slit, normally positioned at the tip of the glans.

**FEMALE GENITAL SYSTEM**

The **female internal genital organs** include the ovaries, uterine tubes, uterus, and vagina.

The **ovaries** are almond-shaped and -sized female gonads in which the oocytes develop. The ovaries lie adjacent to the lateral pelvic wall. They are also endocrine glands that produce reproductive hormones. Like the testes in men, the ovaries develop high on the posterior abdominal wall and then descend before birth, bringing with them their vessels, lymphatics, and nerves. Unlike the testes, the ovaries do not migrate through the inguinal canal into the perineum, but stop short and assume a position on the lateral wall of the pelvic cavity. The ovaries are the sites of egg production (oogenesis). Mature eggs are ovulated into the peritoneal cavity and normally directed into the adjacent openings of the uterine tubes by cilia on the ends of the uterine tubes.

The **uterine tubes** (formerly called oviducts or fallopian tubes) conduct the oocyte, discharged monthly from an ovary during child-bearing years, from the periovarian peritoneal cavity to the uterine cavity. They also provide the usual site of fertilization. The tubes extend laterally from the uterine horns and open into the peritoneal cavity near the ovaries.

The uterine tubes are divisible into four parts, from lateral to medial:
**Infundibulum**: opens into the peritoneal cavity through the abdominal ostium.

**Ampulla**: widest and longest part of the tube, which begins at the medial end of the infundibulum; fertilization of the oocyte usually occurs in the ampulla.

**Isthmus**: a thick-walled part of the tube, which enters the uterine horn.

**Uterine part**: short intramural segment, opens via the uterine ostium into uterine cavity at the uterine horn.

The **uterus** (womb) is a thick-walled, pear-shaped, hollow muscular organ. The embryo and fetus develop in the uterus. Its muscular walls adapt to the growth of the fetus and then provide the power for its expulsion during childbirth. The non-gravid (non-pregnant) uterus usually lies in the lesser pelvis, with its body lying on the urinary bladder and its cervix between the urinary bladder and rectum.

The uterus is a very dynamic structure, the size and proportions of which change during the various changes of life. When the bladder is empty, the uterus typically lies in a nearly transverse plane. The position of the uterus changes with the degree of fullness of the bladder and rectum, and stage of pregnancy. The uterus is divisible into two main parts: the **body** and **cervix**. The **uterine horns** (L. cornua) are the superolateral regions of the uterine cavity, where the uterine tubes enter. The uterine cavity continues inferiorly as the **cervical canal**. The wall of the body of the uterus consists of three coats, or layers:

- Perimetrium
- Myometrium
- Endometrium—the inner mucous coat—is firmly adhered to the underlying myometrium.

The **vagina**, a distensible musculomembranous tube, extends from the middle cervix of the uterus to the vaginal orifice, the opening at the inferior end of the vagina. The vagina:

- serves as a canal for menstrual fluid,
- forms the inferior part of the birth canal,
- receives the penis and ejaculate during sexual intercourse, and
- communicates superiorly with the cervical canal and inferiorly with the vestibule of the vagina.

The vagina lies posterior to the urinary bladder and urethra, the latter projecting into its inferior anterior wall. It lies anterior to the rectum.

**EXTERNAL PART OF THE FEMALE GENITAL SYSTEM**

In women, the **clitoris** and **vestibular apparatus**, together with a number of skin and tissue folds, form the **vulva**. On either side of the midline are two thin folds of skin termed the **labia minora**. Lateral to the labia minora are two broad folds, the **labia majora**, which unite anteriorly to form the mons pubis. The **mons pubis** overlies the inferior aspect of the pubic symphysis and is anterior to the vestibule and the clitoris.

**VESSELS & NERVES OF THE UROGENITAL SYSTEM**

A single large renal artery, a lateral branch of the abdominal aorta, supplies each kidney. Multiple renal veins contribute to the formation of the left and right renal veins, both of which are anterior to the renal arteries. The ureters receive arterial branches from adjacent vessels as they pass towards the bladder.

The major artery of the pelvis and perineum is the **internal iliac artery** on each side. Other vessels that originate in the abdomen and contribute to the supply of pelvic structures include the **median sacral artery** and, in women, the **ovarian arteries**.

Pelvic veins follow the course of all branches of the internal iliac artery except for the umbilical artery and the iliolumbar artery. Within the pelvic cavity, extensive interconnected venous plexuses are associated with the surfaces of the viscera (bladder, rectum, prostate, uterus, and vagina). Together, these plexuses form the **pelvic plexus of veins**. The part of the venous plexus surrounding the rectum and anal canal drains via superior rectal veins (tributaries of inferior mesenteric veins) into the hepatic portal system, and via
middle and inferior rectal veins into the caval system. This pelvic plexus is an important portacaval shunt when the hepatic portal system is blocked.

**Sympathetic fibers**
- innervate blood vessels;
- cause contraction of smooth muscle in the internal urethral sphincter in men and the internal anal sphincters in both men and women;
- cause smooth muscle contraction associated with the reproductive tract and with the accessory glands of the reproductive system; and
- are important in moving secretions from the epididymis and associated glands into the urethra to form semen during ejaculation.

**Parasympathetic fibers** enter the pelvic plexus in pelvic splanchnic nerves that originate from spinal cord levels S2 to S4. They:
- are generally vasodilatory;
- stimulate bladder contraction;
- stimulate erection; and
- modulate activity of the enteric nervous system of the colon distal to the left colic flexure (in addition to pelvic viscera, some of the fibers from the pelvic plexus course superiorly in the prevertebral plexus, or as separate nerves, and pass into the inferior mesenteric plexus of the abdomen).