

HUMAN ANATOMY AND PHYSIOLOGY-II

URINARY SYSTEM

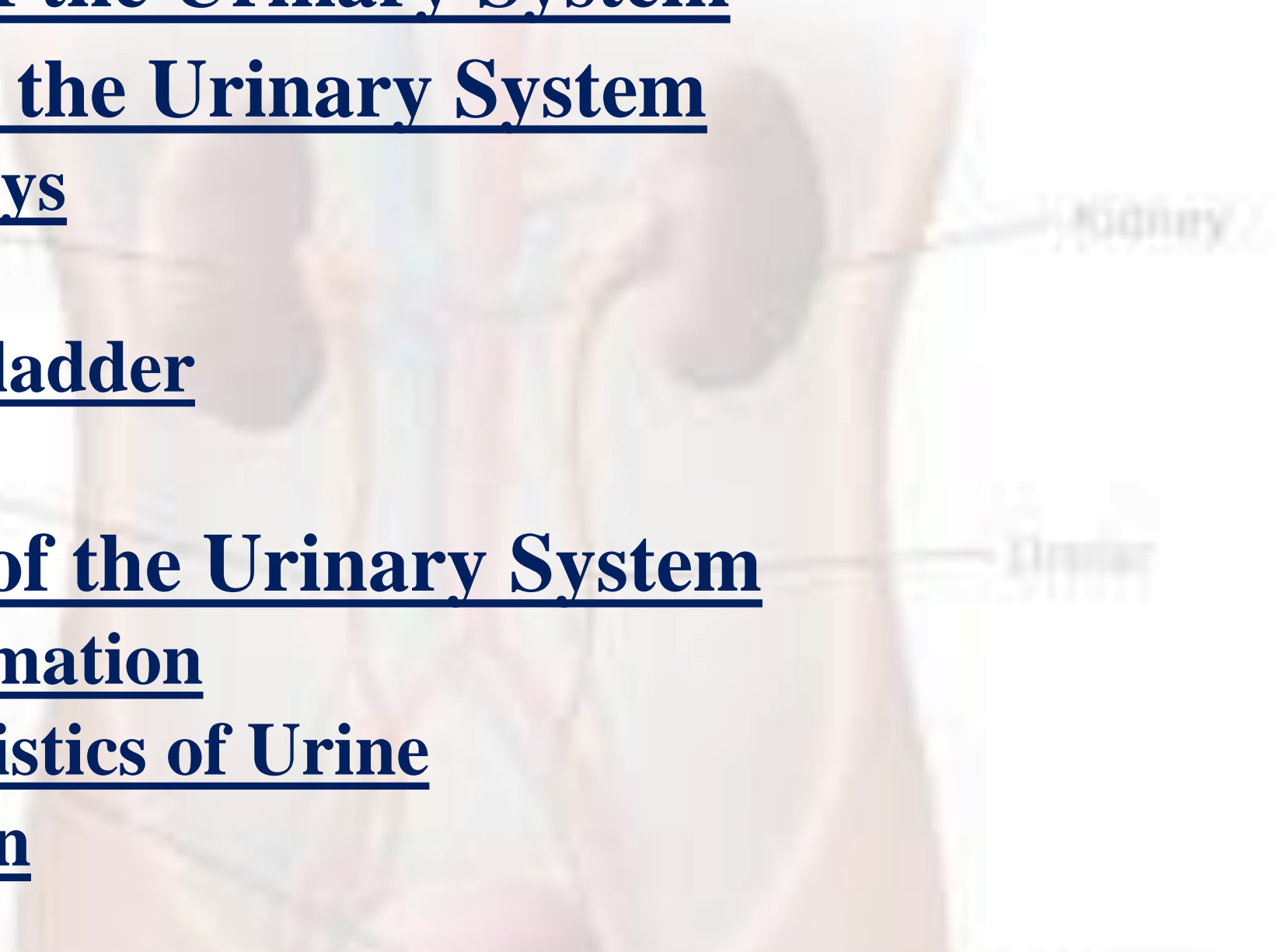


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*Shaping Lives...
Empowering Communities...*

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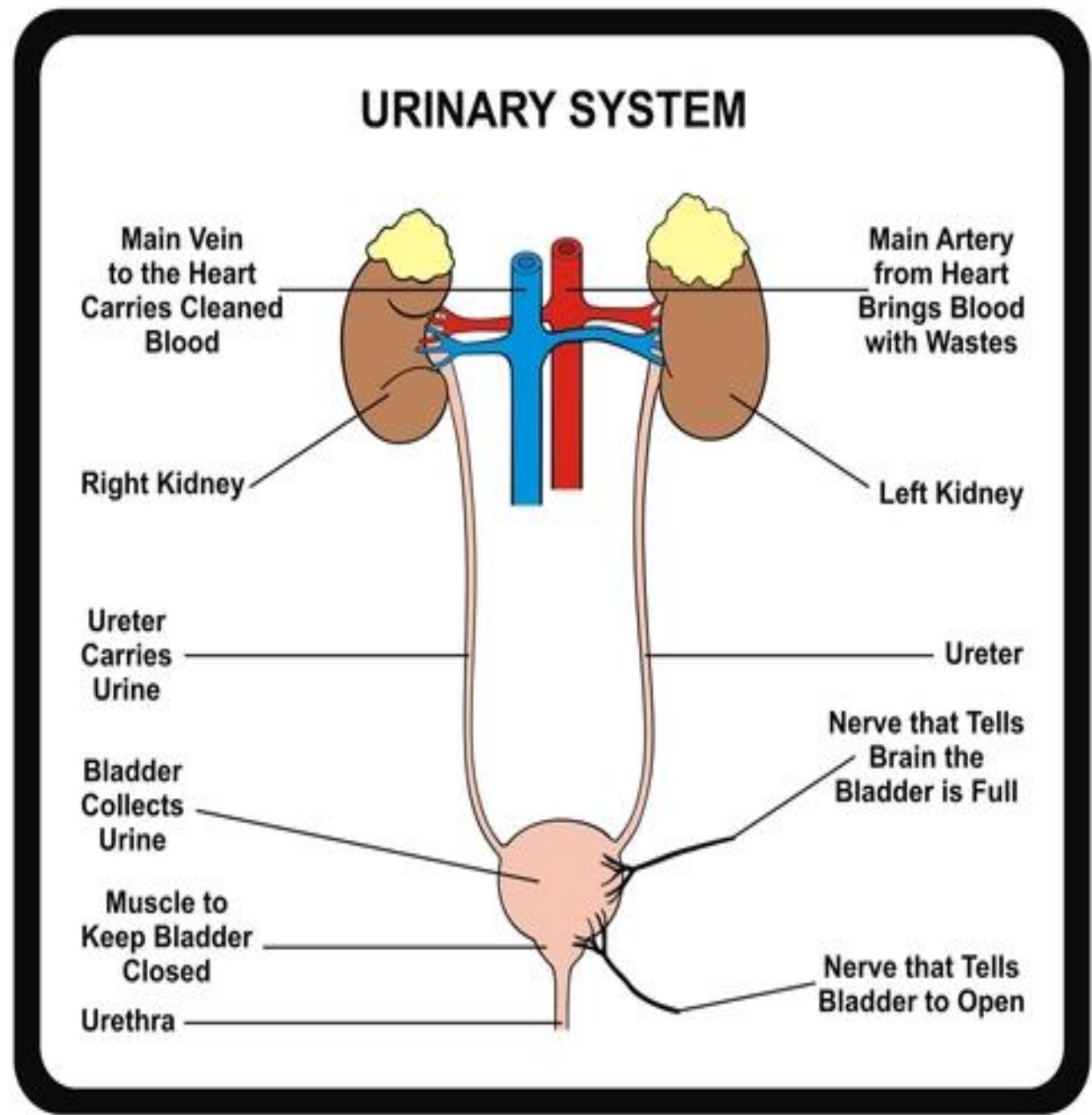
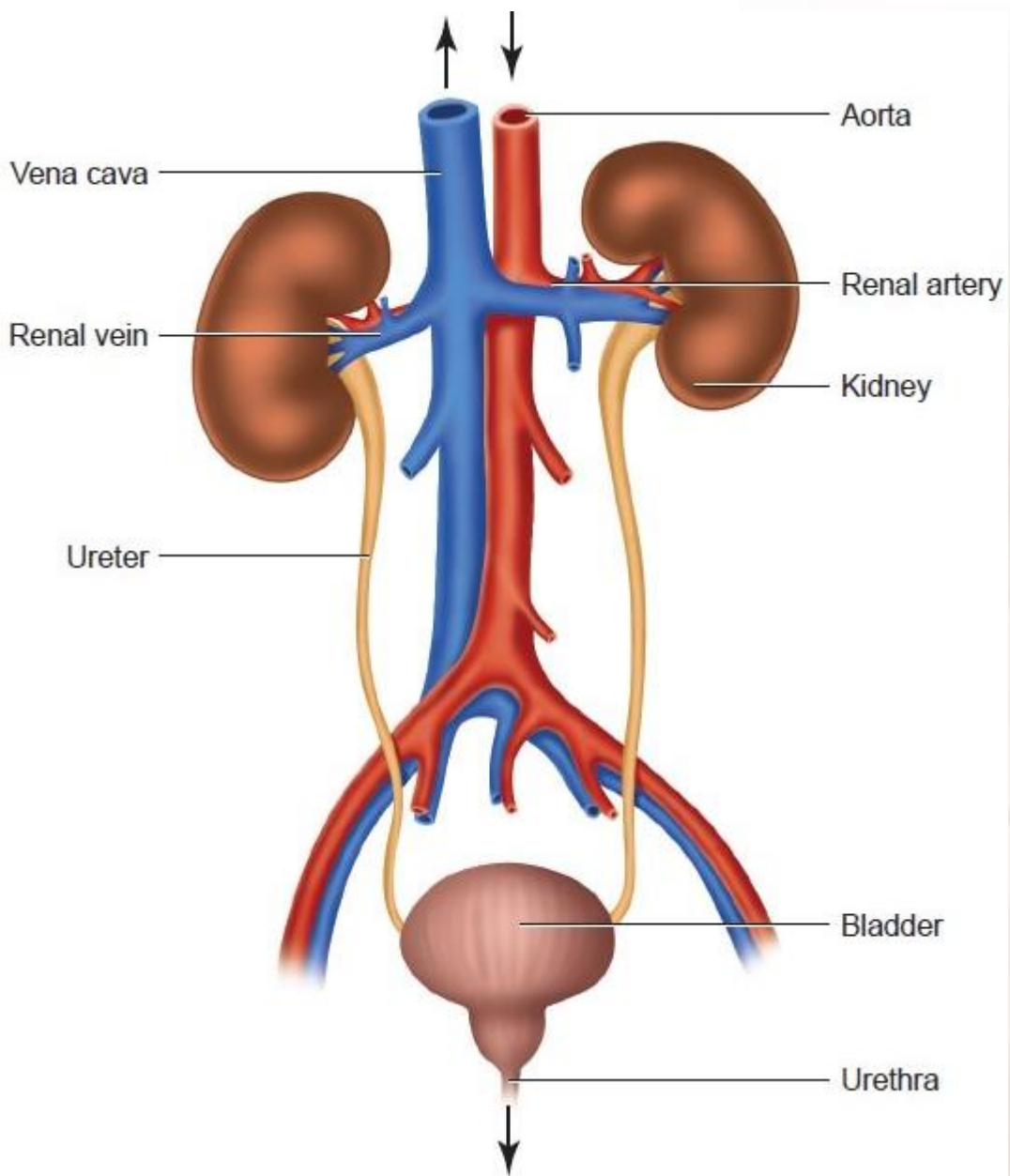
- **Functions of the Urinary System**
- **Anatomy of the Urinary System**
 - **The Kidneys**
 - **Ureters**
 - **Urinary Bladder**
 - **Urethra**
- **Physiology of the Urinary System**
 - **Urine Formation**
 - **Characteristics of Urine**
 - **Micturition**



The urinary system:

- Thousands of metabolic processes in body cells produce hundreds of waste products.
- The urinary system removes them by filtering and cleansing the blood as it passes through the kidneys.
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- The urinary system removes them by filtering and cleansing the blood as it passes through the kidneys.

- The urinary system consists of two kidneys, two ureters, a urinary bladder, and a urethra.
- The kidneys alone perform the functions and manufacture urine in the process, while the other organs of the urinary system provide temporary storage reservoirs for urine or serve as transportation channels to carry it from one body region to another.
- **kidney 2: Produce urine**
- **Ureters 2: transport urine to bladder**
- **Urinary bladder store urine**
- **Urethra: transport urine to exterior**



- The kidneys, which maintain the purity and constancy of our internal fluids, are perfect examples of homeostatic organs.
- **Location.** These small, dark red organs with a kidney-bean shape lie against the dorsal body wall in a retroperitoneal position (beneath the parietal peritoneum) in the **superior lumbar region**; they extend from the T12 to the L3 vertebra, thus they receive protection from the lower part of the rib cage.
- **Positioning**: Because it is crowded by the liver, the **right kidney** is positioned slightly **lower** than the left.
- **Size.** An adult kidney is about **12 cm (5 inches) long, 6 cm (2.5 inches) wide, and 3 cm (1 inch) thick**, about the size of a large bar of soap.
- **Adrenal gland.** Atop each kidney is an adrenal gland, which is part of the endocrine system is a distinctly separate organ functionally.

- **Right kidney**

- Superiorly – the right adrenal gland
- Anteriorly – the right lobe of the liver, the duodenum and the hepatic flexure of the colon
- Posteriorly – the diaphragm, and muscles of the posterior abdominal wall

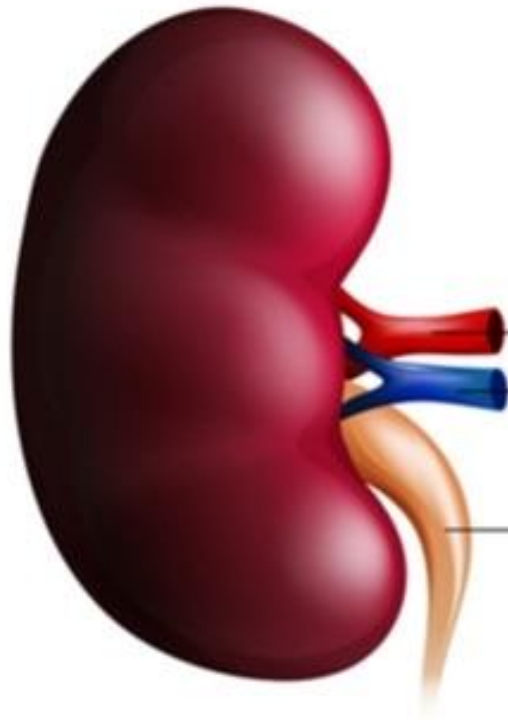
- **Left kidney**

- Superiorly – the left adrenal gland
- Anteriorly – the spleen, stomach, pancreas, jejunum and splenic flexure of the colon
- Posteriorly – the diaphragm and muscles of the posterior abdominal wall

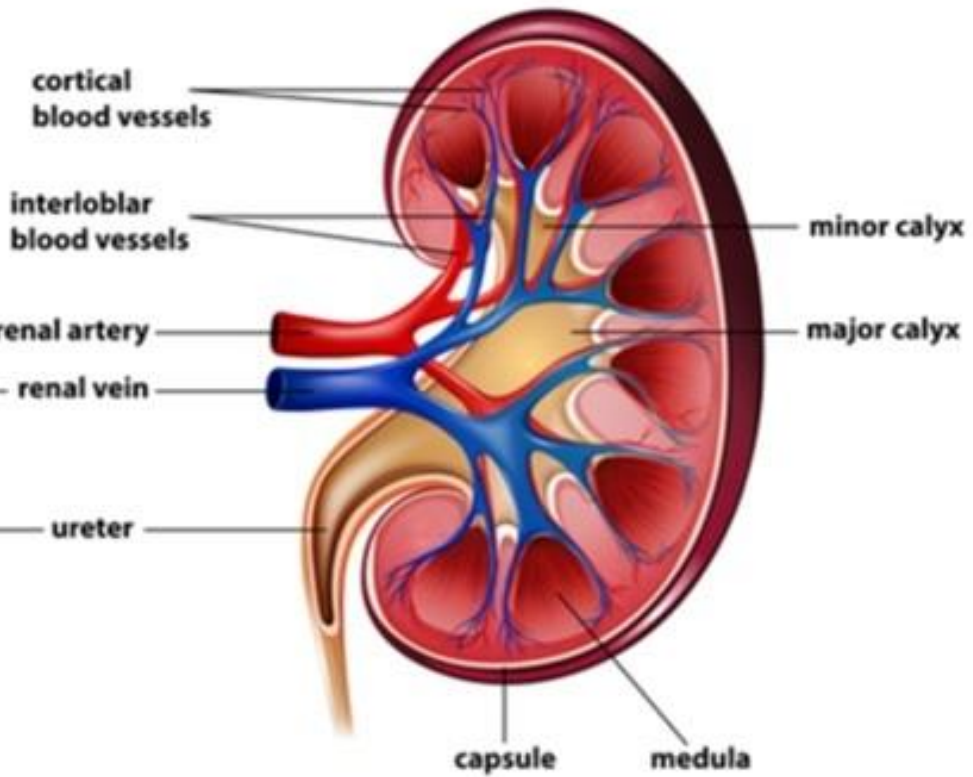
Gross structure of the kidney

Human Kidney Anatomy

External View



Internal View



cortical
blood vessels

interlobular
blood vessels

renal artery

renal vein

ureter

minor calyx

major calyx

capsule

medula

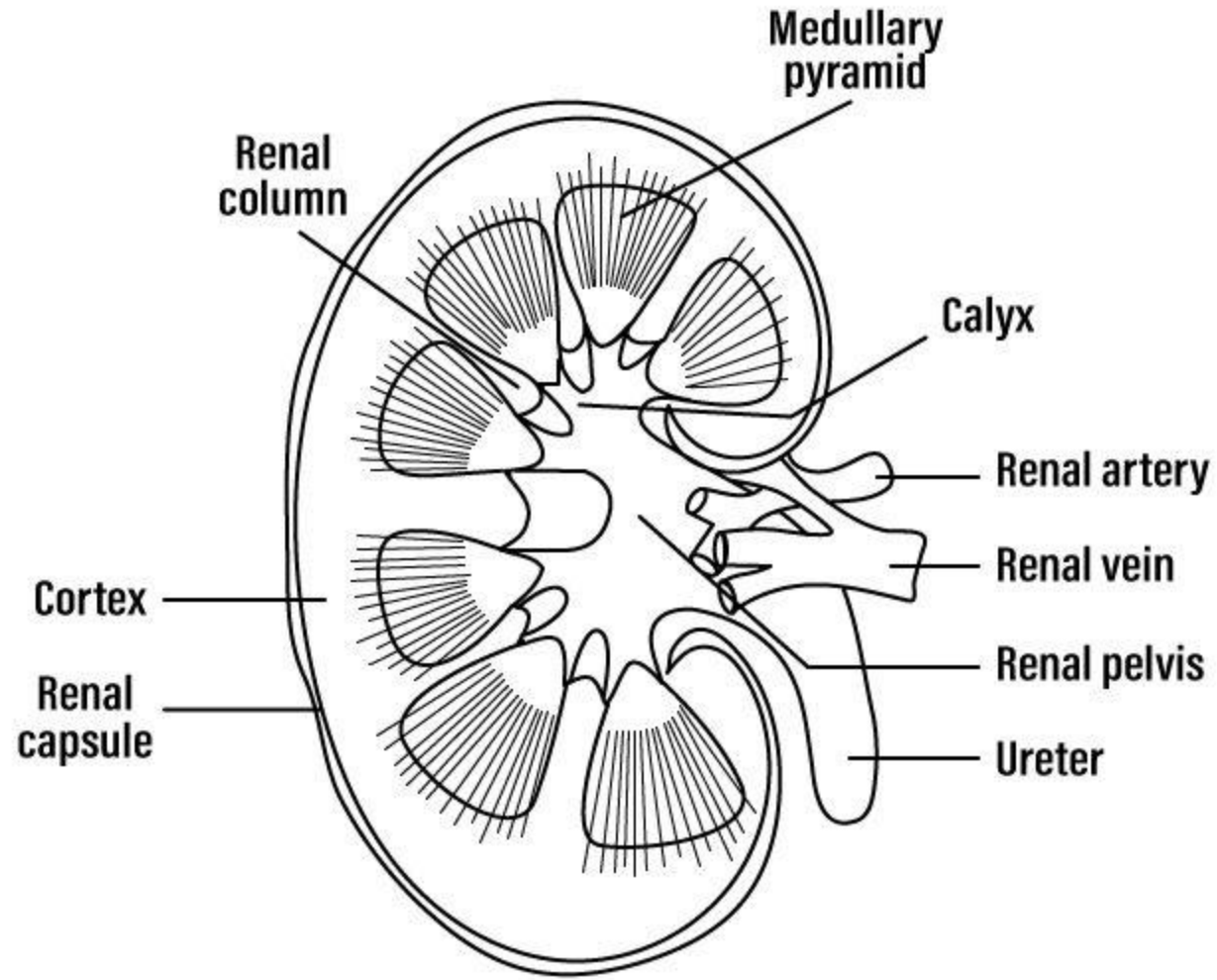


Figure 2. Longitudinal section (Diagrammatic of Kidney)

Kidney is Protected by three connective tissue

- Renal fascia Attaches to abdominal wall
- Adipose capsule Fat cushioning kidney
- Renal capsule Fibrous sac

Protects from trauma and infection

Gross anatomy

i. Renal parenchyma Outer cortex & Inner medulla

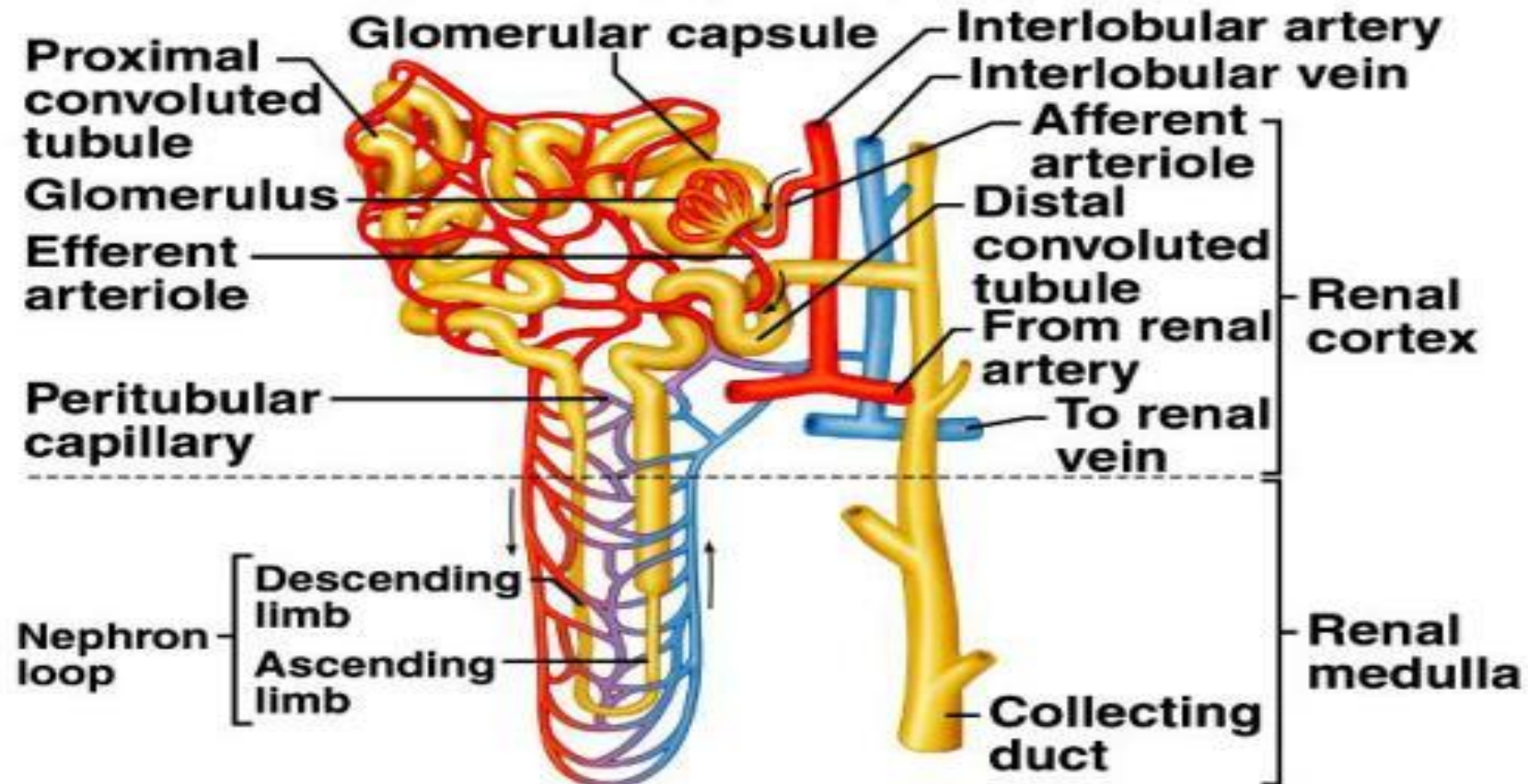
ii. Renal sinus

- Superficial outer cortex and inner medulla :The medulla consists of 6-18 renal pyramids The cortex is composed of roughly 1.25 million nephrons
- Renal sinus :Surrounded by renal parenchyma Contains blood & lymph vessels, nerves, urine-collecting structures, Hilus On concave surface Vessels and nerves enter and exit

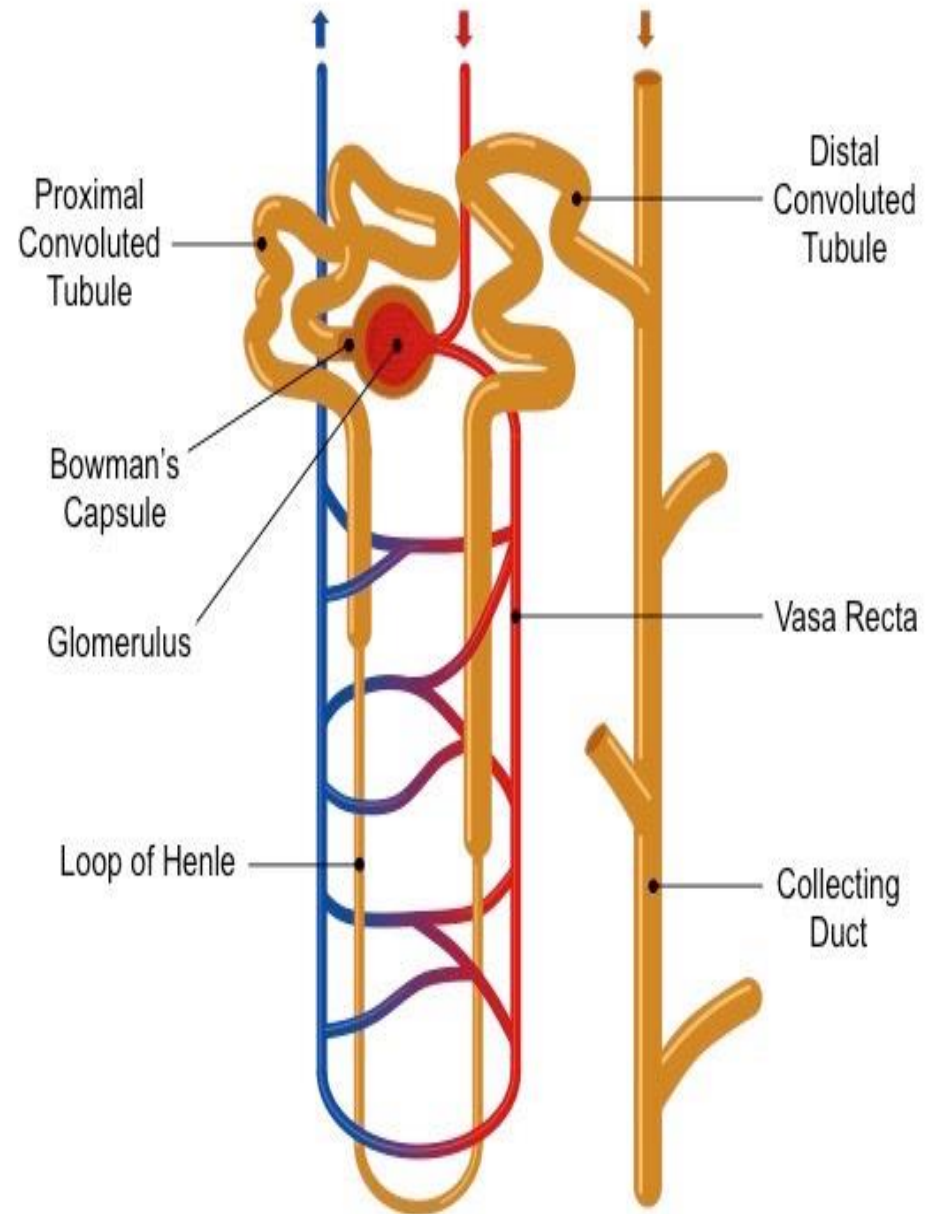
- renal pelvis :funnel-shaped structure that collects urine formed by the kidney
- Urine formed in the kidney passes through a renal papilla at the apex of a pyramid into a minor calyx, then into a major calyx before passing through the renal pelvis into the ureter.
- The walls of the pelvis contain smooth muscle and are lined with transitional epithelium.
- The kidney is composed of about 1–2 million functional units, the nephrons, and a smaller number of collecting ducts.
- The collecting ducts transport urine through the pyramids to the calyces and renal pelvis, giving the pyramids their striped appearance
- The collecting ducts are supported by a small amount of connective tissue, containing blood vessels, nerves and lymph vessels.

Nephron and Associated Blood Vessels

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- The nephron consists of a tubule closed at one end, the other end opening into a collecting tubule.
- The closed or blind end is indented to form the cup-shaped **glomerular capsule (Bowman's capsule)**, which almost completely encloses a network of tiny arterial capillaries, the glomerulus.
- Continuing from the glomerular capsule, the remainder of the nephron is about 3 cm long and is described in three parts
 - i. The proximal convoluted tubule
 - ii. the medullary loop (loop of Henle)
 - iii. the distal convoluted tubule, leading into a collecting duct



- The kidneys receive about 20% of the cardiac output. After entering the kidney at the hilum the renal artery divides into smaller arteries and arterioles.
- In the cortex an arteriole, the afferent arteriole, enters each glomerular capsule and then subdivides into a cluster of tiny arterial capillaries, forming the glomerulus.
- Between these capillary loops are connective tissue phagocytic mesangial cells, which are part of the monocyte–macrophage system
- The blood vessel leading away from the glomerulus is the efferent arteriole.
- The afferent arteriole has a larger diameter than the efferent arteriole, which increases pressure inside the glomerulus and drives filtration across the glomerular capillary walls
- The efferent arteriole divides into a second peritubular (meaning ‘around tubules’) capillary network, which wraps around the remainder of the tubule, allowing exchange between the fluid in the tubule and the bloodstream
- This maintains the supply of oxygen and nutrients to the local tissues and removes waste products.
- Venous blood drained from this capillary bed eventually leaves the kidney in the renal vein, which empties into the inferior vena cava

Renal Vein :

- drain the kidney.
- connect the kidney to the inferior vena cava.
- Because the inferior vena cava is on the right half of the body, the left renal vein is generally the longer of the two.
- Unlike the right renal vein, the left renal vein often receives the left gonadal vein (left testicular vein in males, left ovarian vein in females).

Renal Artery:

- normally arise off the abdominal aorta and supply the kidneys with blood.
- The arterial supply of the kidneys are variable and there may be one or more renal arteries supplying each kidney.
- Due to the position of the aorta, the inferior vena cava and the kidneys in the body, the right renal artery is normally longer than the left renal artery.
- The renal arteries carry a large portion of the total blood flow to the kidneys. Up to a third of the total cardiac output can pass through the renal arteries to be filtered by the kidneys.

Functions of the Urinary System

The function of the kidneys are as follows:

- **Filter:** Every day, the kidneys filter gallons of fluid from the bloodstream.
- **Waste processing:** The kidneys then process this filtrate, allowing wastes and excess ions to leave the body in urine while returning needed substances to the blood in just the right proportions.
- **Elimination:** Although the lungs and the skin also play roles in excretion, the kidneys bear the major responsibility for eliminating nitrogenous wastes, toxins, and drugs from the body.
- **Regulation:** The kidneys also regulate the blood's volume and chemical makeup so that the proper balance between water and salts and between acids and bases is maintained.
- **Other regulatory functions:** By producing the enzyme renin, they help regulate blood pressure, and their hormone erythropoietin stimulates red blood cell production in the bone marrow.
- **Conversion:** Kidney cells also convert vitamin D to its active form.

• **Urinary Bladder**

The urinary bladder is a smooth, collapsible, muscular sac that stores urine temporarily.

- **Location:** It is located retroperitoneally in the pelvis just posterior to the symphysis pubis.
- **Function:** The detrusor muscles and the transitional epithelium both make the bladder uniquely suited for its function of urine storage.
- **Trigone:** The smooth triangular region of the bladder base outlined by these three openings is called the trigone, where infections tend to persist.
- **Detrusor muscles:** The bladder wall contains three layers of smooth muscle, collectively called the detrusor muscle, and its mucosa is a special type of epithelium, transitional epithelium.

- **Ureters**

- The ureters do play an active role in urine transport.
- **Size:** The ureters are two slender tubes each 25 to 30 cm (10 to 12 inches) long and 6 mm (1/4 inch) in diameter.
- **Location:** Each ureter runs behind the peritoneum from the renal hilum to the posterior aspect of the bladder, which it enters at a slight angle.
- **Function :** Essentially, the ureters are passageways that carry urine from the kidneys to the bladder through contraction of the smooth muscle layers in their walls that propel urine into the bladder by peristalsis and is prevented from flowing back by small valve-like folds of bladder mucosa that flap over the ureter openings.

- **Urethra**

- The urethra is a thin-walled tube that carries urine by peristalsis from the bladder to the outside of the body.
- **Internal urethral sphincter:** At the bladder-urethral junction, a thickening of the smooth muscle forms the internal urethral sphincter, an involuntary sphincter that keeps the urethra closed when the urine is not being passed.
- **External urethral sphincter:** A second sphincter, the external urethral sphincter, is fashioned by skeletal muscle as the urethra passes through the pelvic floor and is voluntarily controlled.
- **Female urethra:** The female urethra is about 3 to 4 cm (1 1/2 inches) long, and its external orifice, or opening, lies anteriorly to the vaginal opening.
- **Male urethra:** In me, the urethra is approximately 20 cm (8 inches) long and has three named regions: the prostatic, membranous, and spongy (penile) urethrae; it opens at the tip of the penis after traveling down its length.

Physiology of the Urinary System

Every day, the kidneys filter gallons of fluid from the bloodstream. The normal physiology that takes place in the urinary system are as follows:

Urine Formation:

Urine formation is a result of three processes:

Glomerular filtration. Water and solutes smaller than proteins are forced through the capillary walls and pores of the glomerular capsule into the renal tubule.

Tubular reabsorption. Water, [glucose](#), amino acids, and needed ions are transported out of the filtrate into the tubule cells and then enter the capillary blood.

Tubular secretion. Hydrogen, [potassium](#), [creatinine](#), and drugs are removed from the peritubular blood and secreted by the tubule cells into the filtrate.

Characteristics of Urine

- In 24 hours, the marvelously complex kidneys filter some 150 to 180 liters of blood plasma through their glomeruli into the tubules.
- **Daily volume:** In 24 hours, only about 1.0 to 1.8 liters of urine are produced.
- **Components:** Urine contains nitrogenous wastes and unneeded substances.
- **Color:** Freshly voided urine is generally clear and pale to deep yellow.
- **Odor:** When formed, urine is sterile and slightly aromatic, but if allowed to stand, it takes on an ammonia odor caused by the action of bacteria on the urine solutes.
- **pH :** Urine pH is usually slightly acidic (around 6), but changes in body metabolism and certain foods may cause it to be much more acidic or basic.
- **Specific gravity:** Whereas the specific gravity of pure water is 1.0, the specific gravity of urine usually ranges from 1.001 to 1.035.
- **Solutes:** Solutes normally found in urine include sodium and potassium ions, urea, uric acid, creatinine, ammonia, bicarbonate ions, and various other ions.

Micturition

- Micturition or voiding is the act of emptying the bladder.
- **Accumulation:** Ordinarily, the bladder continues to collect urine until about 200 ml have accumulated.
- **Activation:** At about this point, stretching of the bladder wall activates stretch receptors.
- **Transmission:** Impulses transmitted to the sacral region of the spinal cord and then back to the bladder via the pelvic splanchnic nerves cause the bladder to go into reflex contractions.
- **Passage:** As the contractions become stronger, stored urine is forced past the internal urethral sphincter into the upper part of the urethra.
- **External sphincter :** Because the lower external sphincter is skeletal muscle and voluntarily controlled, we can choose to keep it closed or it can be relaxed so that urine is flushed from the body.