Blood Supply

Renal blood vessels

Renal artery arises directly from abdominal aorta and enters the kidney through the hilus. While passing through renal sinus, the renal artery divides into many segmental arteries.

Segmental Artery

Segmental artery subdivides into interlobar arteries .

Interlobar Artery

Interlobar artery passes in between the medullary pyramids. At the base of the pyramid, it turns and runs parallel to the base of pyramid forming arcuate artery.

Arcuate Artery

Each arcuate artery gives rise to interlobular arteries.

Interlobular Artery

Interlobular arteries run through the renal cortex perpendicular to arcuate artery. From each interlobular artery, numerous afferent arterioles arise.

Afferent Arteriole

Afferent arteriole enters the Bowman capsule and forms glomerular capillary tuft. After entering the Bowman capsule, the afferent arteriole divides into 4 or 5 large capillaries.

Glomerular Capillaries

Each large capillary divides into small glomerular capillaries, which form the loops. And, the capillary loops unite to form the efferent arteriole, which leaves the Bowman capsule.

Efferent Arteriole

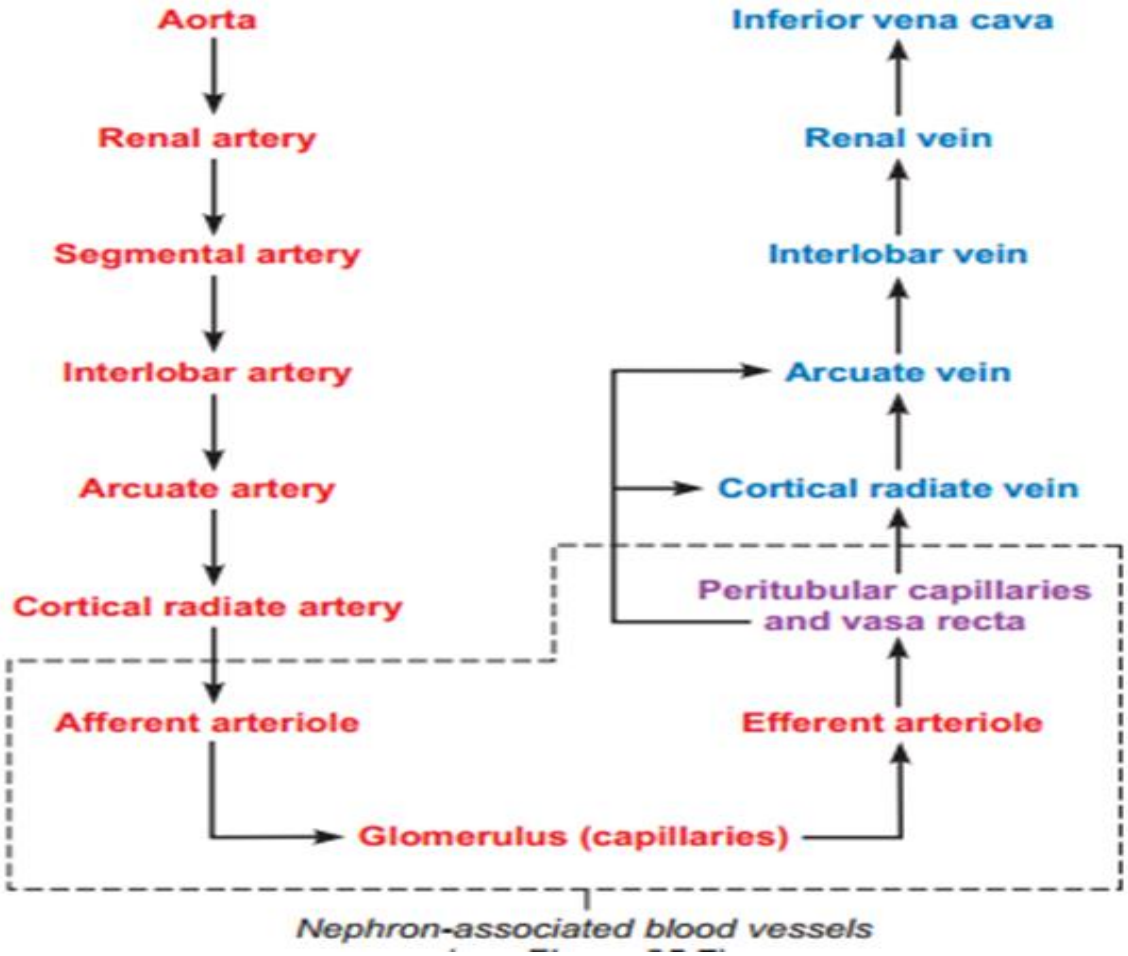
Efferent arterioles form a second capillary network called peritubular capillaries, which surround the tubular portions of the nephrons. Thus, the renal circulation forms a portal system by the presence of two sets of capillaries namely glomerular capillaries and peritubular capillaries.

Peritubular Capillaries and Vasa Recta

Peritubular capillaries are found around the tubular portion of cortical nephrons only. The tubular portion of juxtamedullary nephrons is supplied by some specialized capillaries called vasa recta. These capillaries are straight blood vessels hence the name vasa recta. Vasa recta arise directly from the efferent arteriole of the juxtamedullary nephrons and run parallel to the renal tubule into the medulla and ascend up towards the cortex.

Venous System

Peritubular capillaries and vasa recta drain into the venous system. Venous system starts with peritubular venules and continues as interlobular veins, arcuate veins, interlobar veins, segmental veins and finally the renal vein . Renal vein leaves the kidney through the hilus and joins inferior vena cava.



Regulation of acid-base balance

About 85 to 90% of the filtered bicarbonate is reabsorbed in the proximal tubule and the rest is reabsorbed by the distal tubule and collecting ducts.

Effectively, H^+ and $HCO3^-$ are formed from CO_2 and H_2O in a reaction catalyzed by **enzyme carbonic anhydrase**. The actual reaction involved is probably formation of H^+ and OH^- from water, then reaction of OH^- with CO_2 (catalyzed by carbonic anhydrate) to produce $HCO3^-$.

The H^+ leaves enters the Proximal convoluted tubule (PCT) lumen by two mechanisms:

- Via a Na^+-H^+ antiporter (major route)
- Via H^+-ATPase (proton pump)

Filtered $HCO3^-$ cannot cross the apical membrane of the PCT cell. Instead it combines with the secreted H^+ (under the influence of brush border carbonic anhydrase) to produce CO_2 and H_2O. The CO_2 is lipid soluble and easily crosses into the cytoplasm of the PCT cell. In the cell, it combines with OH^- to produce bicarbonate.

The net effect is the reabsorption of one molecule of HCO_3 and one molecule of Na^+ from the tubular lumen into the blood stream for each molecule of H^+ secreted. This mechanism does not lead to the net excretion of any H^+ from the body as the H^+ is consumed in the reaction with the filtered bicarbonate in the tubular lumen.

The 4 major factors which control bicarbonate reabsorption are:

- Luminal HCO_3^- concentration
- Luminal flow rate
- Arterial pCO_2
- Angiotensin II (via decrease in cyclic AMP)

Hormones and enzyme control the kidney work

Hormones are chemical "messengers" secreted by endocrine glands that control or coordinate the activities of other tissues, organs, and organ systems in the body. Therefore there are hormones that affect the urinary system help it regulate the amount of water and mineral ions in urine. By extension, this action also regulates the pressure in the bloodstream and the concentration of mineral ions in the blood . as follow :-

1- Antidiuretic hormone (ADH),

Excessive water loss in the urine is controlled by the ADH hormone which is released by the pituitary gland If an individual a lot, fails to drink enough water, or loses water through diarrhea, special nerve cells in the hypothalamus detect the low water concentration in the blood. They then signal the pituitary gland to release ADH into the blood, where it travels to the kidneys. With ADH present, the renal tubules are stimulated to reabsorb more water from the renal filtrate and return it to the blood. The volume of water in the urine is thus reduced, and the urine becomes more concentrated.

The action of ADH also controls blood volume and pressure. As more water is removed from the urine and transported into the bloodstream, blood volume and pressure increase. This is an important safeguard against low blood volume and pressure, which might be brought about by an injury.

On the other hand, if an individual takes in too much water, production of ADH decreases. The renal tubules do not reabsorb as much water, and the volume of water in the urine is increased. Alcohol and liquids containing caffeine (coffee, tea, and cola drinks) inhibit ADH production (these substances are called diuretics).

2- Aldosterone

Another hormone that helps to control blood volume by acting on the kidneys is aldosterone. Aldosterone is a steroid hormone secreted by the adrenal cortex A decrease in blood pressure or volume, a decrease in the sodium ion level in blood, and an increase in the potassium ion level in blood all stimulate the secretion of aldosterone. Once released, aldosterone spurs the cells of the renal tubules to reabsorb sodium from the urine and to excrete potassium instead. Sodium is then returned to the

bloodstream. When sodium is reabsorbed into the blood, water in the body follows it, thus increasing blood volume and pressure.

3- Renin

When blood pressure around the kidneys decreases below normal, the cells of the renal tubules react by secreting the enzyme renin which in turn, stimulates an inactive blood protein to change into a hormone that causes blood vessels to constrict or narrow, which immediately raises blood pressure.