



Advanced Physiology

Lec.3 Renal physiology

By: Pro D
muneef Saab Ahmed

2026

Introduction to renal structure

The kidneys are primarily responsible for the maintenance of the internal environment of the human body. They share the following structural features:

- 1- They are paired retroperitoneal organs.
- 2- They weigh 110–170g each in the adult male, are 10–12cm long, 5–7.5cm wide and 2.5–3cm thick.
- 3- They receive 20%–25% of the cardiac output, which corresponds to 1000–1200 ml/minute, but only account for about 10% of the oxygen consumption of the body.
- 4- The kidneys thereby receive the highest blood flow per gram of organ weight in the human body, while accounting for only 0.4% of the body weight. The entire plasma volume is cycled through the glomerular system 20 times per hour.
- 5- Their internal structure consists of an outer cortex and an inner medulla. The medulla consists of ten pyramids, with their bases near the cortex and apices (papillae) which project into the calyceal sinuses. The pyramids are separated by columnar extensions of the cortex. Ninety per cent of the renal blood supply goes to the cortex.
- 6- The cortex comprises glomeruli and proximal convoluted tubules, while the medulla comprises the loops of Henle, the distal convoluted tubules and the collecting ducts.

Functional components of the kidneys

The functional components of the kidney are the nephrons (each kidney contains one million nephrons), collecting ducts and the microvasculature.

1- nephron, the structural and functional unit of the kidneys, demonstrates functional segmentation and consists of:

2-Renal corpuscle, which comprises Bowman's capsule and the glomerular capillary tuft. The glomerular tuft has three cell types: mesangial cells, capillary endothelial cells and podocytes (visceral epithelium of Bowman's capsule).

3-Renal tubule, which comprises:

Proximal convoluted tubule;

Proximal straight tubule (pars recta);

Descending thin limb of loop of Henle (in long-loop nephrons only);

Medullary thick ascending limb of loop of Henle;

Cortical thick ascending limb of loop of Henle;

Distal convoluted tubule.

4-The collecting duct system comprises the connecting tubule, cortical collecting duct, outer and inner medullary collecting ducts.

Types of nephrons

Superficial and mid-cortical nephrons, which comprise 85% of the total. They possess short loops of Henle and their peritubular capillaries carry nutrients to the tubules.

Juxtamedullary, which possess long loops of Henle specialised for the concentration of urine. These loops extend into the medulla. The efferent glomerular capillaries form vasa recta, which function as counter-current exchangers.

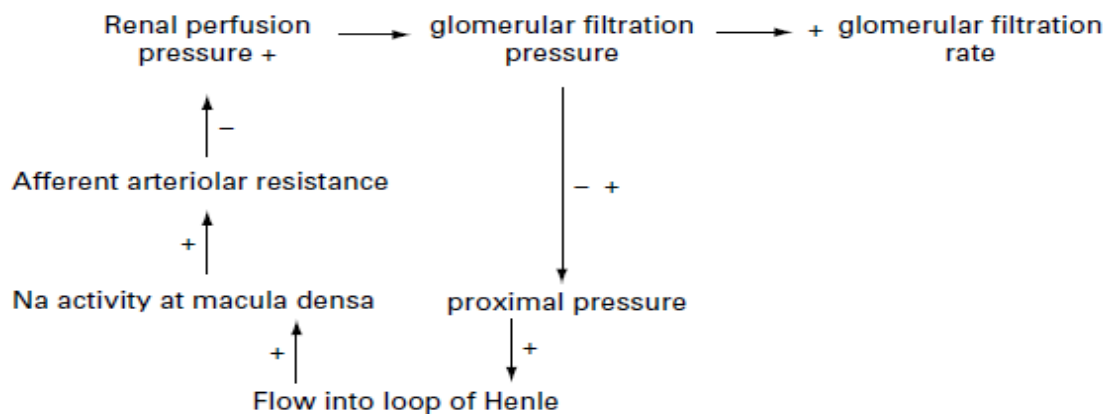


Figure 4.1 Pathway for glomerular feedback.

Functions of the kidney

Excretory and regulatory

- 1-Removal of water-soluble nitrogenous waste products of metabolism (urea, creatinine, urate) and catabolic turnover of cells, and the elimination of drugs and toxins;
- 2-Maintenance of water, electrolyte (ion concentrations) and acid–base balance (pH of body fluids);
- 3-Regulation of extracellular fluid volume;
- 4-Maintenance of body fluid composition;
- 5-Maintenance of blood pressure.

Metabolic.

Gluconeogenesis

Endocrine

- Renin production;
- Erythropoietin production: control of erythropoiesis;
- Synthesis of 1,25-dihydroxycholecalciferol;
- Catabolism of polypeptide hormones (e.g., parathyroid hormone, insulin);
- Prostaglandin synthesis.

Characteristics of erythropoietin

This glycoprotein hormone of molecular weight 34 000 daltons is synthesised by renal cortical interstitial cells, which account for about 80% of the body's production.

Production is stimulated by tissue hypoxia.

It is a major regulator of red blood cell production, binding to specific cell surface receptors and promoting erythroid differentiation.

The renal circulation

This consists of, in sequence, several orders of branches of the renal artery, including:

1. Interlobar arteries
2. Arcuate arteries
3. Cortical radial (interlobular) arteries
4. Afferent arterioles
5. Glomerular capillary tufts
6. Efferent arterioles
7. Descending vasa recta
8. Capillary plexus at medullary level
9. Ascending vasa recta
10. Arcuate veins
11. Interlobular veins
12. Arcuate veins
13. Interlobar veins

The kidney is unique in possessing two capillary networks in series, each with a preceding arteriole. These are the glomerular bed and the peritubular capillary bed. The glomerular capillary pressure is much higher than that of any other capillary bed in the body, this being a reflection of its interposition between two arteriolar systems.

Effects of renal circulation on urine production

The renal circulation affects urine formation in the following ways:
The glomerular filtration rate is an important determinant of solute and water excretion.

The peritubular capillaries in the cortex return reabsorbed solutes and water to the systemic circulation and can modulate the degree of proximal tubular reabsorption and secretion.

The vasa recta capillaries return reabsorbed salt and water to the systemic circulation and participate in the counter-current mechanism.
Abnormalities of renal haemodynamics may be involved in the genesis of acute renal failure, associated with a reduction in total renal blood flow and with the redistribution of intrarenal blood flow away from cortical to juxtamedullary nephrons in order to protect the medulla.

