

# Pathophysiology of kidneys and urinary system

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## 4.1 Introduction

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Pathophysiology of kidneys and the urinary system is one of the most important topics of contemporary pathologic physiology and of medicine in the most general aspect. It reflects the very important role of kidneys in the maintenance of the organism existence and in ensuring its crucial functions.

Renal diseases are frequent. They can lead to alterations in the organism, affecting so the functions of other organs and systems considerably. Very important fact is, that diseases of uropoietic system (the urinary tract infections, interstitial nephritis, nephrolithiasis and others) are often hidden and may lead in their terminal stage to uraemia, and uraemia uses to be lethal.

Renal diseases can be the underlying cause of systemic arterial hypertension with all its consequences and cause other serious alterations in organism. Renal impairment can be secondary, developing owing to an other basic illness (e.g. long-lasting hypotension, in shock, in endocrine and metabolic disorders, in cardiovascular diseases). Renal impairment can be caused often by toxic substances and drugs. Kidneys can be in fact, the "perpetrator" causing very serious alterations of organism, or to be the "victim" of other organ and system lesions.

In contrast to other organs, the functions of kidneys can be compensated or replaced by transplantation. Modern therapeutic procedures – the

haemodialysis, peritoneal dialysis and transplantation gained in last time important success. These therapeutic procedures are very expensive, therefore they can not be the main method of renal disease treatment. The transplantation of kidney can be the solution only in 4-6 per cent of patients.

Disorders of renal functions may be manifested by many various clinical symptoms and laboratory findings which can be understood only when the function of kidneys is well known. Kidney can be considered to be a mysterious house, about which we know who enters and leaves it, and from these facts we have to conclude what happens in it. Understanding the pathologic physiology of uropoietic system can influence considerably the therapeutic approach to the unfavorable development of uropoietic system diseases and therefore it has a most important extraordinary importance for clinical praxis.

### 4.1.1 Important tasks of uropoietic system

The functions accomplished in organism by uropoietic system contribute considerably and rather irreplaceably to maintenance of homeostasis. The homeostasis regulation concerns the maintenance of certain physiologic constants: the stability of body fluid volume (isovolaemia), concentration of electrolytes (isoionia), of osmotic active substances (isosmia), and of hydrogen ions (isohydria). It does not mean the maintenance of an unchangeable, stationary state in a closed system, but the maintenance of a dynamic steady-state in a complex, integrated open system – the living organism. With this dynamic steady-state

correspond relative stationary values of volume and composition of body fluid, varying in admissible limits.

These particular functions of kidneys are performed by its excretory capability based on elimination of useless substances. The needless, even harmful substances are excreted by mechanism of glomerular filtration and by tubular mechanisms. Kidney is in fact the only way how to excrete the waste products, the molecules containing nitrogen and sulfur. The most important substances are the products of protein metabolism (urea, aminoacids, uric acid, creatinine, creatine etc.). In renal failure the retention of these substances in organism followed by elevation of their concentrations in blood is developing.

In addition to this excretory function, kidney performs important functions, which could be thought to be endocrine. Kidney is not only the effector organ of several hormones (aldosterone, ADH, parathormone, angiotensin, prostaglandins etc.), but kidney is also the site of production of substances with hormonal or enzymatic activities (renin, renal erythropoietic factor, prostaglandins, kallikrein-kinin system).

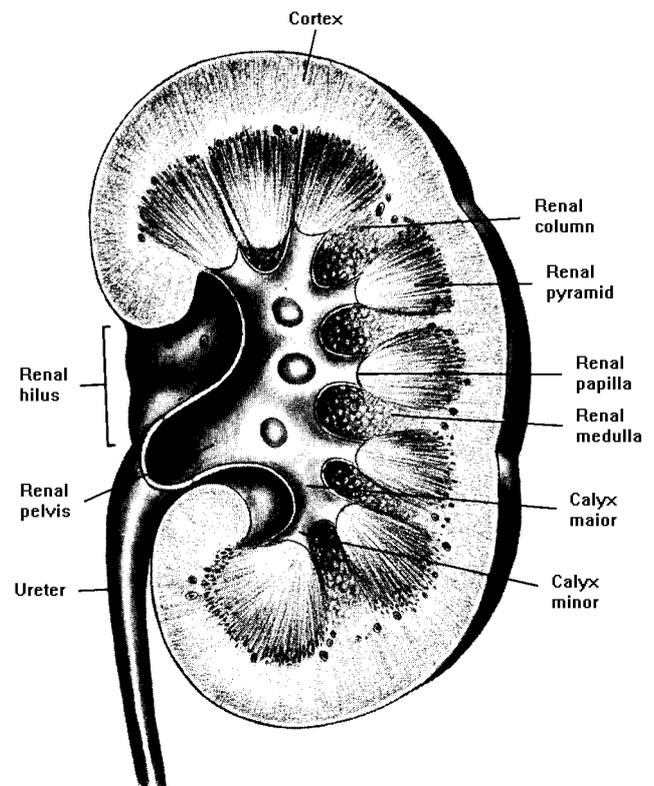


Figure 4.1: Longitudinal section of the kidney

## 4.2 Basic anatomic notes

Kidneys lies in the abdominal cavity retroperitoneally and paravertebrally, between the twelfth thoracic and third lumbar vertebra. The right kidney lies slightly lower than the left. In adult subjects each kidney weighs 120 to 170 g or more. Kidneys are covered by a thin, but firm fibrous capsule, adherent to the vessels and renal pelvis in the hilus. The capsule consists mostly of collagenous and less of elastic fibres. In this net of fibres some smooth muscle cells are found. Kidneys are surrounded by a lipid "cushion" - the panniculus. See figure 4.1, page 258.

**Renal cortex** is about 5 to 15 mm thick, not sharply demarcated from the medulla. The cortical substance forms longitudinal projections - columnae renales, penetrating the medullar substance and

reaching the calyces renales. Medulla renalis consists of 8-20 pyramidal formations separated by cortical projections. The tops of pyramids are oriented towards the renal hilus. Each pyramid with adjacent cortical layer forms the renal lobe - lobus renalis.

A. renalis enters kidney through the **hilus** dividing into 2-3 branches. Accessory arteries with an irregular course can be found sometimes, they can enter the kidney outside the hilus. After entering the kidney the branches of renal artery divide into arteriae interlobares passing between the pyramids into their bases where they branch and join in an arch-like shape, forming the arteriae arcuatae. They lie at the border between the cortex and medulla. From the arcuate arteries are derived the interlobular arteries - arteriae interlobulares - crossing the cortex to its surface. From interlobular arteries arise vertically short afferent arterioles into the glomeruli.

According their localization **two types of glomeruli** can be distinguished in kidneys. Most of them are localized superficially, designated as glomeruli corti-