# Renal function tests (RFT)

**Functions of Kidney**

**• Kidney maintains water and electrolyte balance (homeostasis):** with the help of Antidiuretic hormone (Water Balance) and renin – angiotensin – aldosterone mechanism (Electrolyte balance) and It also maintains acid base balance.

**• Excretion -** Kidney excretes metabolic waste products such as urea, creatinine and uric Acid.

**• Hormonal functions -** It produces erythropoietin which helps in promoting erythropoiesis In bone narrow and• It plays a role in calcium metabolism by activation of vit.D . Excretory and homeostatic functions are achieved through glomerular filtration and both Tubular reabsorption and secretion.

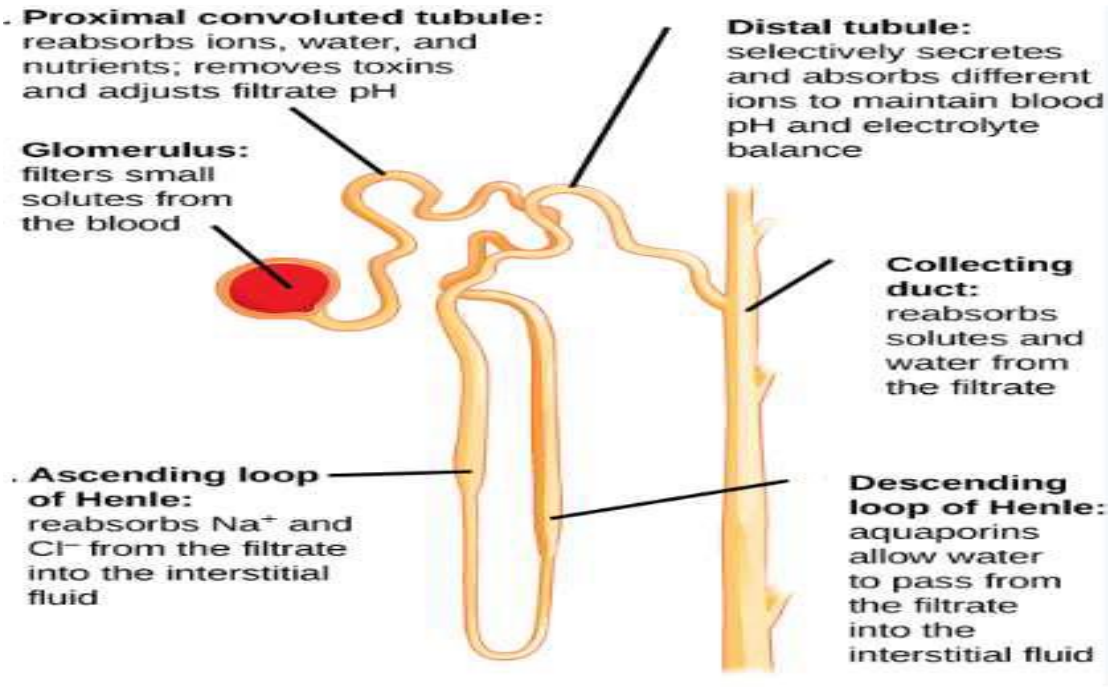
**Renal function test (RFT),** also known as kidney function test is a group of tests used to Assess the functions of kidney.

• It is used screen for, detect, evaluate and monitor acute and chronic kidney diseases.

• Monitoring the response of kidneys to treatment or progression of renal disease.

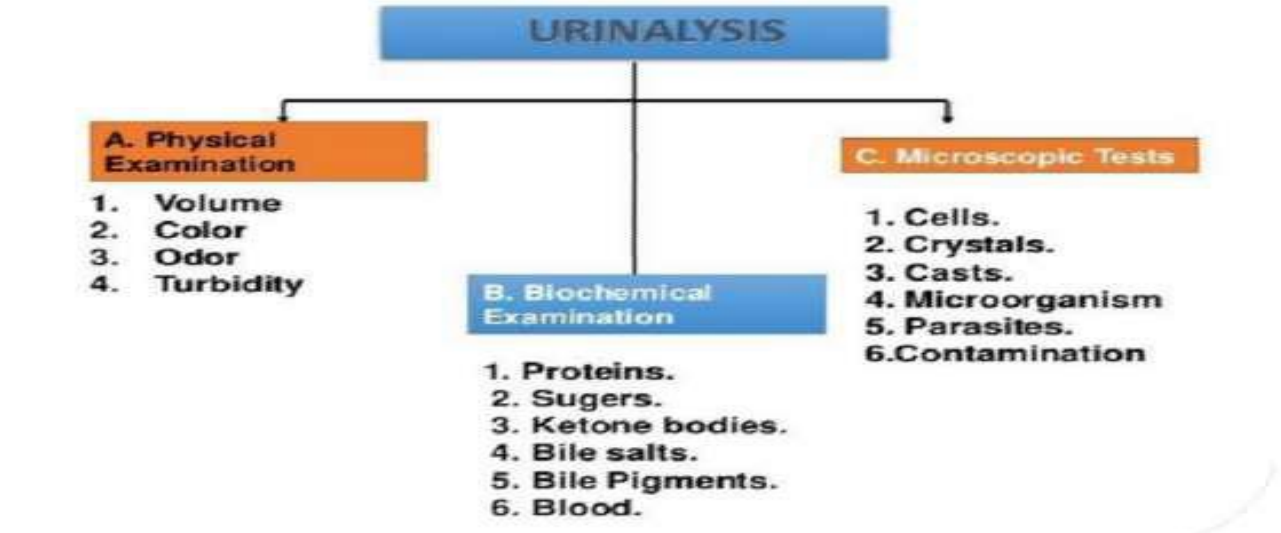
• And if you have other conditions that can harm the kidneys, such as diabetes or high blood Pressure

**-The Nephron** is functional unit of kidney. There are about one million nephrons per kidney, Each of which is made up of five main functional segments which described in figure below. The principal function of the glomeruli is to filtration which is permeable to water and low Molecular weight substances, but impermeable to macromolecules like proteins. This Permeability is determined by both size and charge of molecules, thus only proteins smaller Than albumin (68 kDa) pass into ultrafiltration and positively charged molecules are filtered More readily than those with negative charge water and low molecular weight components of The blood while retaining cells and high molecular weight components.




## Renal function tests classification

**1-Urine examination (Urinalysis)**:



## 2-Testing of glomerular function

The most practical tests to assess renal function is to get an estimate of the glomerular Filtration rate (GFR) and to check for proteinuria (albuminuria).

• Detectable amount of protein in urine indicates glomerular leak and is the first sign of Glomerular injury. Monitoring their progression, assessing therapeutic response or estimation The risk of renal failure as well as cardiovascular risk in patients.

**GFR** is Volume of blood filtered across glomerulus per unit time. Measurement of GFR is Based on a theoretical concept of **clearance**, which means the volume of plasma, from which A substance is completely removed during one pass through kidney per time unit (minute, Second). Accurate measurement of GFR requires a substance (optimally endogenous), which Is produced and removed from the body with constant rate and its plasma concentration does Not change during the investigation. If the substance is freely filtrated by glomeruli and is Neither secreted nor reabsorbed in tubules, then the clearance value is equal to GFR. Unfortunately, no endogenous substance fulfils these criteria, but creatinine is close to them. Under normal circumstances, about 700 ml of plasma (contained in 1300 ml of blood or Approximately 25% of entire cardiac output at rest) flow through the kidneys per minute and 120 ml of fluid are filtered into Bowman‘s capsule.

## Creatinine

The breakdown product of creatine and creatine phosphate released from skeletal muscle at a Steady rate. Not metabolized or excreted from the body other than by the kidney. Can Measure its clearance from plasma or excretion in urine. One blood sample required cheap And quick. Inversely proportional to GFR.

## BUT

- Not sensitive (Serum creatinine only starts to increase above normal when kidney Function drops by half).
- The muscle mass size, food intake (meat) and liver function (synthesis of creatine) Influence serum creatinine concentration.
- pathological muscle mass can result in incorrect values in determining GFR.

## ***Blood Urea Nitrogen (BUN)***

Urea or BUN is a nitrogen-containing compound formed in the liver as the end product of Protein metabolism and the urea cycle. About 85% of urea is eliminated via kidneys; the rest Is excreted via the gastrointestinal (GI) tract. Serum urea levels increase in conditions where Renal clearance decreases (in acute and chronic renal failure/impairment). Urea may Also increase in other conditions not related to renal diseases such as upper GI bleeding, Dehydration, catabolic states, and high protein diets. Urea may be decreased in starvation, low-protein diet, and severe liver disease. Serum creatinine is a more accurate assessment of Renal function than urea; however, urea is increased earlier in renal disease.

The ratio of BUN: creatinine can be useful to differentiate pre-renal from renal causes when The BUN is increased. In pre-renal disease, the ratio is close to 20:1, while in intrinsic renal Disease, it is closer to 10:1. Upper GI bleeding can be associated with a very high BUN to Creatinine ratio (sometimes >30:1).

## 3-Examination of tubular function tests:

- **Tests to assess distal tubular function**

1-urine specific gravity 2-urine osmolality 3-water deprivation test

4--ammonium chloride loading test

- **Some tests to assess prioxmal tubular function**

1-glycosuria 2-phosphaturia 3-aminoaciduria

4- alpha-1 microglobulin and beta-2 microglobulin

**Urine osmolality and tubular concentrating ability** :The healthy kidney is able to change urine osmolality in the wide range 40 – 1200 mmol/kg. The basic laboratory examination Includes urine osmolality, which is directly proportional to the concentrating work done by Kidney and indirectly reflects activity of ADH. Urinary osmolality >800 mmol/kg in random Urine sample confirms an adequate renal concentrating function and excludes the need to Perform further diagnostic tests.

**water deprivation test :** assess the ability of the kidney to produce concentrated urine in Response to fluid deprivation and vasopressin administration, respectively. Normally, there is No increase in serum osmolality (275 − 295 mmol/kg) throughout water deprivation, whereas

Urine osmolality increases to double values. If fluid restriction itself is not enough to increase urine osmolality, a synthetic analogue of vasopressin - DDAVP (1-deamino-8-Darginine Vasopressin) is administered to the patient. After DDAVP administration, urine Osmolality is measured every hour for 3 h, and values should reach maximal target value According to the age of a patient. Concentrating tests are useful in distinguishing among Hypothalamic-pituitary, psychogenic and renal causes of polyuria.

## Proteinuria

Normal urinary protein excretion is less than about 150 mg/24 h .**Proteinuria** is defined as excretion of protein > 150 mg/day . However, early renal disease is reflected by lesser degrees of proteinuria.

**Assessment of Proteinuria:** To screen for excess protein in the urine, to help evaluate and

Monitor kidney function, and to detect kidney damage. Elevated levels may be seen

Temporarily with conditions such as **infections, stress, pregnancy, fever or heavy exercise.**

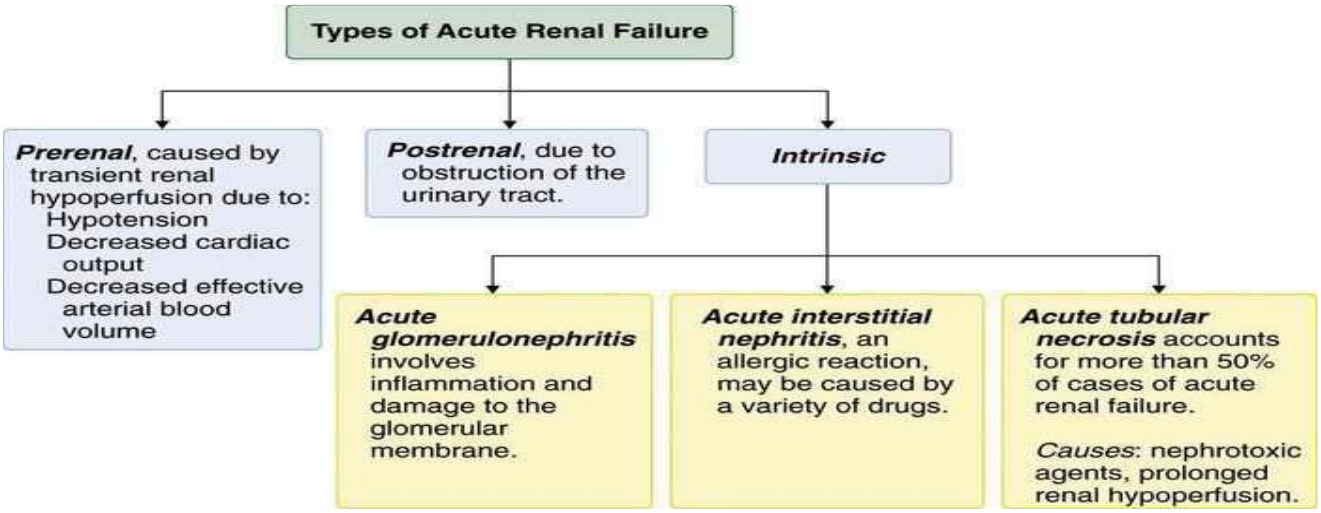
## Types of proteinuria

• **Glomerular proteinuria**: increased filtration of macromolecules (such as albumin) Across the glomerular capillary wall.
• **Tubular proteinuria**: excretion of low-molecular-weight proteins, such as beta2-Macroglobulin, immunoglobin light chains, retinol-binding protein and polypeptides Derived from breakdown of albumin
• **Overflow proteinuria**: increased excretion of low-molecular-weight proteins; almost Always due to immunoglobin light chains in multiple myeloma, lysozymes in AML, or Myoglobin in rhabdomyolysis
• **Secreted proteinuria**: due to secretion by kidney or epithelium of urinary tract ,e.g.Tamm-Horsfall protein

**Nephrotic syndrome :** The nephrotic syndrome is caused by increased glomerular basement membrane permeability, resulting in protein loss, usually more than 3 g a day (or a urine protein to creatinine ratio of > 300 mg/mmol), with consequent hyperproteinemia, Hypoalbuminemia and peripheral edema.

**Acute renal failure (ARF)** is characterized by a rapid loss of renal function, with retention Of urea, creatinine, hydrogen ions and other metabolic products and usually but not always,

Oliguria (<400 mL urine/24 h). Although potentially reversible, the consequences to Homoeostatic mechanisms are so profound that this condition continues to be associated with A high mortality. Furthermore, ARF often develops in patients who are already severely ill. ARF is conventionally divided into three categories, according to whether renal functional Impairment is related to a decrease in renal blood flow **(pre renal)**, to intrinsic damage to The kidneys **(intrinsic**), or to urinary tract obstruction **(post renal)**. Should any of these occur In a patient whose renal function is already impaired, the consequences are likely to be more Serious.




**Biochemical changes in plasma in acute renal failure**

| Increased | Decreased |
|---|---|
| potassium | sodium |
| urea | bicarbonate |
| creatinine | calcium |
| phosphate | |
| magnesium | |
| hydrogen ion | |
| urate | |

## Chronic renal failure

Many disease processes can lead to progressive, irreversible impairment of renal Function. Glomerulonephritis, diabetes mellitus, hypertension, pyelonephritis and Polycystic kidneys account for the majority of cases where a cause can be determined. In Effect, all these conditions lead to a decrease in the number of functioning nephrons.