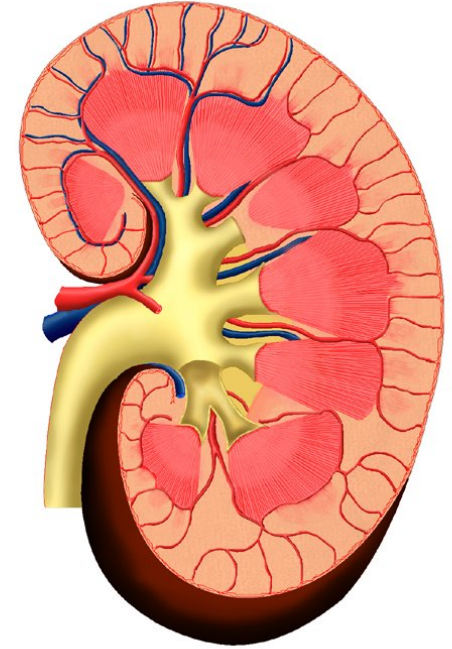


# Renal function test

## Lecture 1



Renal Block  
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- The nephron is the functional unit of the kidney
- Each kidney contains about 1,000,000 to 1,300,000 nephrons.
- The nephron is composed of glomerulus and renal tubules.
- The nephron performs its homeostatic function by ultra filtration (from glomerulus to bowman's capsule) and secretion (from blood stream to tubules) and reabsorption (from tubules to blood stream) at renal tubules.

# Kidney function

## Regulation of :

- water and electrolyte balance.
- acid base balance.
- arterial blood pressure.

**Excretion** of metabolic waste products and foreign chemicals.

## Hormonal Function:

Secretion of erythropoietin & activation of vitamin D and activation of angiotensinogen by renin

**Metabolic Function:** site for 10% of gluconeogenesis (90% in liver)

## Renal diseases

- Many diseases affect kidney.
- In some, several functions are affected.
- In others, there is selective impairment of glomerular function or one or more of tubular functions.
- Most types of renal diseases cause destruction of complete nephron.

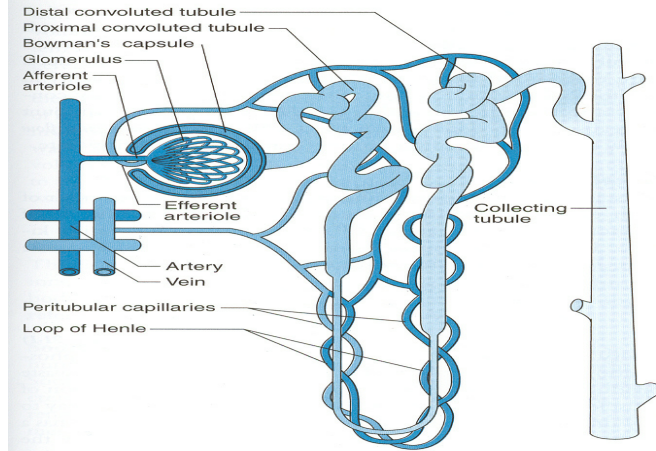


Figure 21-2. Representation of a nephron and its blood supply.

## Kidney function test

Routine kidney function test include the measurement of :

**1. Serum creatinine.**

**2. Creatinine clearance.**

- Both serum creatinine and creatinine clearance are used as kidney function tests to : 1- Confirm the diagnosis of renal disease. 2- Give an idea about the severity of the disease. 3- Follow up the treatment.

**3. Serum urea.**

## Serum Creatinine

- Creatinine is the end product of **creatine catabolism**.
- 98% of the body creatine is present in the muscles where it functions as store of high energy in the form of creatine phosphate.
- About 1-2 % of total muscle creatine or creatine phosphate pool is converted daily to creatinine through the **spontaneous, non enzymatic** loss of water or phosphate.
- Creatinine in the plasma is filtered freely at the glomerulus and secreted by renal tubules (10 % of urinary creatinine).
- Creatinine is **NOT reabsorbed** by the renal tubules.
- Plasma creatinine is an endogenous substance not affected by diet.
- Plasma creatinine remains fairly constant throughout adult life.

## Creatinine Clearance

- The glomerular filtration rate (GFR) provides a useful index of the number of functioning glomeruli.
- It gives an estimation of the **degree of renal impairment** by disease.
- Creatinine clearance is usually about 110 ml/min in the 20-40 year old adults.
- It falls slowly but progressively to about 70 ml/min in individuals over 80 years of age.
- In children, the GFR should be related to surface area, when this is done, results are similar to those found in young adults.

Clearance is the **volume of plasma cleared** from the substance excreted in urine per minute.

$$\text{Clearance (ml/min)} = (U \times V) \div P$$

**U** = Concentration of creatinine in urine  $\mu\text{mol/l}$

**V** = Volume of urine per min

**P** = Concentration of creatinine in serum  $\mu\text{mol/l}$

Accurate measurement of GFR by clearance tests requires determination of the concentration in plasma and urine of a substance that is:

1. Freely filtered at glomeruli.
2. Neither reabsorbed nor secreted by tubules.
3. Its concentration in plasma needs to remain constant throughout the period of urine collection.
4. Better if the substance is present endogenously.
5. Easily measured.

Creatinine meets most of these criteria .

# Cockcroft-Gault Formula for Estimation of GFR

- As indicated above, the creatinine clearance is measured by using a 24-hour urine collection, but this does introduce the potential for errors in terms of completion of the collection.
- An alternative and convenient method is to employ various formulae devised to calculate creatinine clearance using parameters such as serum creatinine level, sex, age, and weight of the subject.
- An example is the Cockcroft-Gault Formula:

$$\text{GFR} = \frac{K \times (140 - \text{age}) \times \text{Body weight}}{\text{Serum creatinine } (\mu\text{mol/L})}$$

where **K** is a constant that varies with sex: 1.23 for male & 1.04 for females. The constant K is used as females have a relatively lower muscle mass.

- It should **NOT** be used if
  - 1) Serum creatinine is changing rapidly
  - 2) the diet is unusual, e.g., strict vegetarian
  - 3) Low muscle mass, e.g., muscle wasting
  - 4) Obesity

Creatinine clearance equation is limited by the volume of urine per min while Cockcroft-Gault Formula is limited by unusual diet, low muscle mass and obesity.

## **Serum creatinine is a better kidney function test than creatinine clearance because :**

1. Serum creatinine is more accurate.
2. Serum creatinine level is constant throughout adult life

## **Creatinine clearance is only recommended in the following conditions:**

1. Patients with early ( minor ) renal disease.
2. Assessment of possible kidney donors.
3. Detection of renal toxicity of some nephrotoxic drugs.

- **Normal adult reference values:**

Urinary excretion of creatinine **is 0.5 - 2.0 g** per 24 hours in a normal adult, varying according to muscular weight.

- Serum creatinine: 55 – 120  $\mu\text{mol/L}$

- Creatinine clearance: 90 – 140 ml/min (Males)

80 – 125 ml/min (Females)

- A raised **serum creatinine** is a good indicator of impaired renal function. But normal serum creatinine does not necessarily indicate normal renal function as serum creatinine may not be elevated until GFR has fallen by as much as 50%

## Serum Urea ( 2.5-6.6 mmol/L) in adult:

- Urea is formed in the liver from **ammonia** released from deamination of amino acids.
- Urea is increased due to dehydration + .
- As a kidney function test, serum urea is inferior to serum creatinine because:
  1. High protein diet increases urea formation.
  2. Any condition of  $\uparrow$  proteins catabolism (Cushing syndrome, diabetes mellitus, starvation, thyrotoxicosis)  $\rightarrow \uparrow$  urea formation.
  3. 50 % or more of urea filtered at the glomerulus is passively reabsorbed by the renal tubules.

## Normal values of Internal Chemical Environment controlled by the Kidneys:

Sodium	135 to 145 mEq/L
Potassium	3.5 to 5.5 mEq/L
Chloride	100 to 110 mEq/L
Bicarbonate	24 to 26 mEq/L
Calcium	8,6 to 10 mg/dl
Magnesium	1.6 to 2.4 mg\dl
Phosphorus	3.0 to 5.0 mg/dl
Uric acid	2.5 to 6.0 mg/dl
pH	7.4
Creatinine	0.8 to 1.4 mg/dl
BUN (Blood urea nitrogen)	15 to 20 mg/dl

\* You don't have to memorize all the values in this table

# MCQS

Q1: Which of the following characteristics belongs to Creatinine?

- A: Main source is food (exogenous)
- B: Not reabsorbed
- C: variable throughout adult life.
- D: A + B

Q2: Accurate measurement of GFR requires:

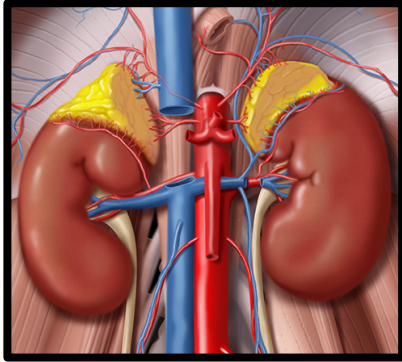
- A: Not reabsorbed substance.
- B: endogenous substance.
- C: Easily to measure
- D: All

Q3: which one of the following statements is NOT correct about Serum creatinine :

- A: filtered freely.
- B: its clearance takes longer time in male.
- C: The best indicator for acute kidney disease.

Ans: 1-B 2-D 3-B (its clearance **time** is equal in male and female)

# GOOD LUCK



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