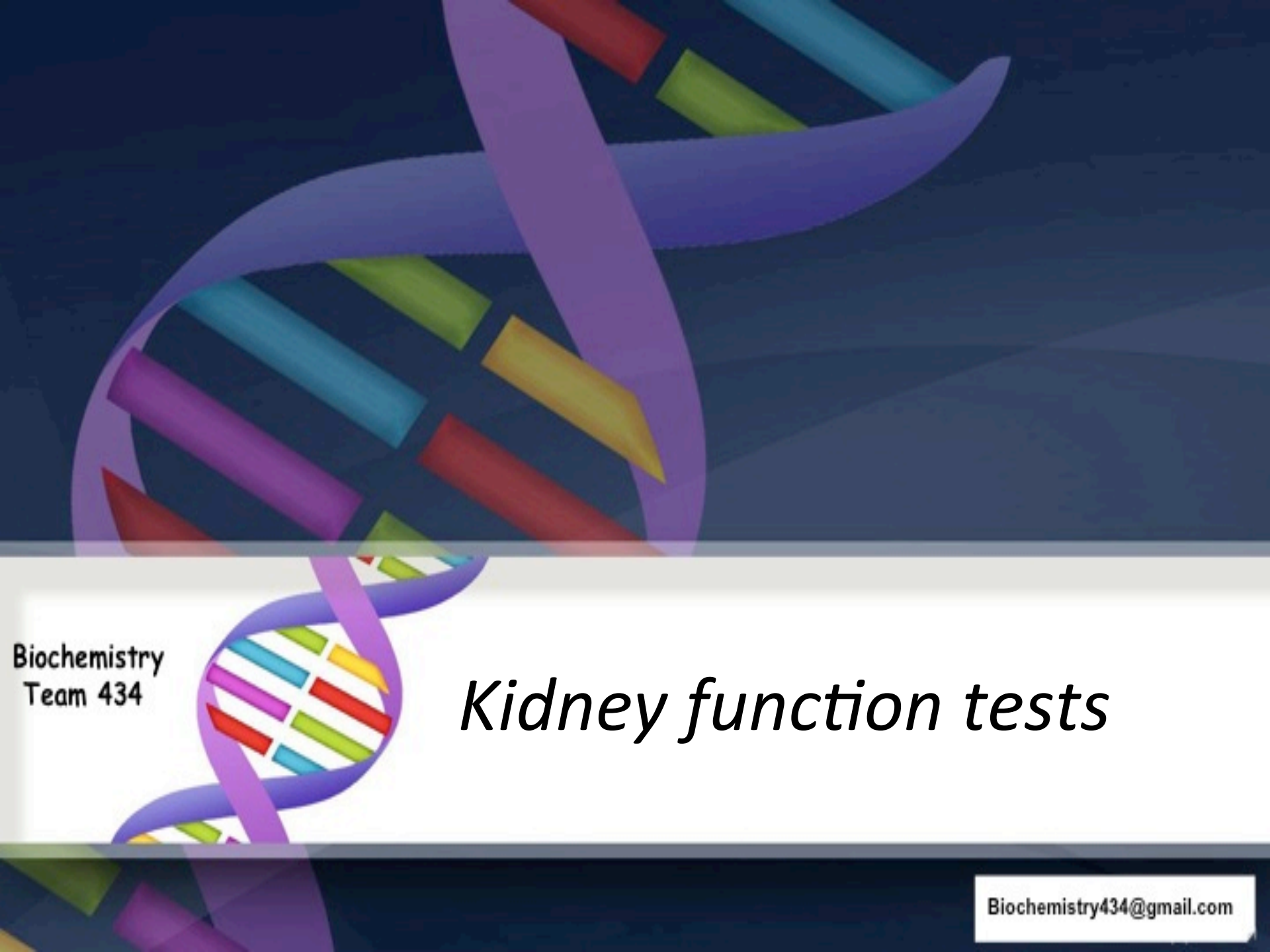

Biochemistry
Team 434

Kidney function tests

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- Important
- Explanation
- Extra Notes

Abbreviations:

GFR= Glomerular filtration rate.

Hrs= Hours

NEPHRON

Definition..?

Is the functional unit of the Kidney.

Composed of..?

Glomerulus ➔filtration

Renal tubules➔transport

How much..?

Each kidney contains about

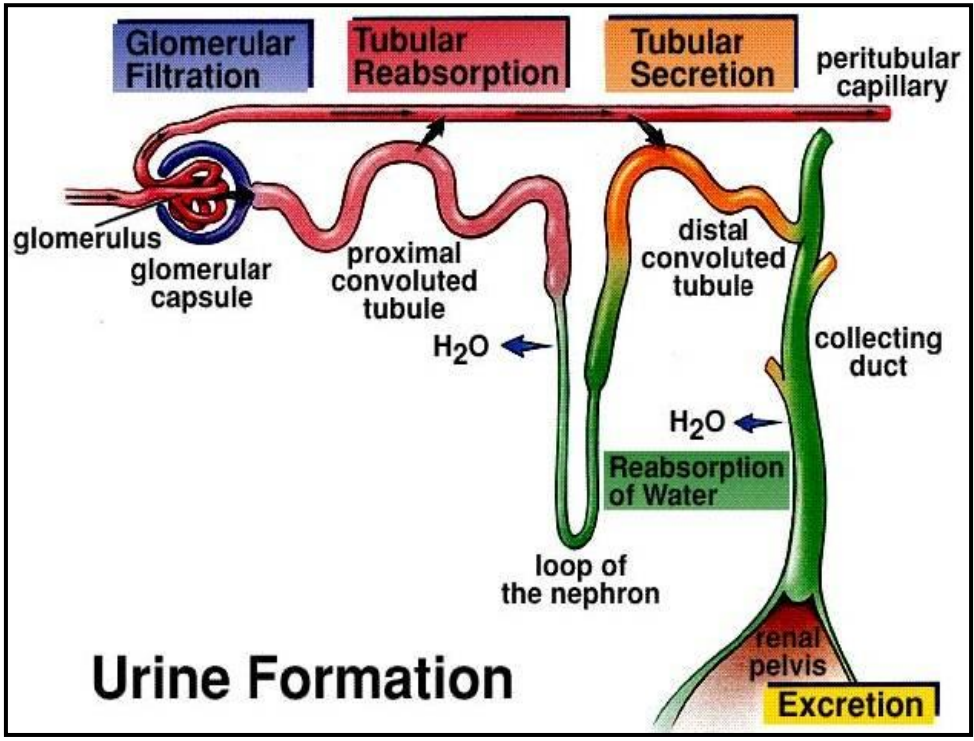
1,000,000 to 1,300,000 nephrons.

Function..?

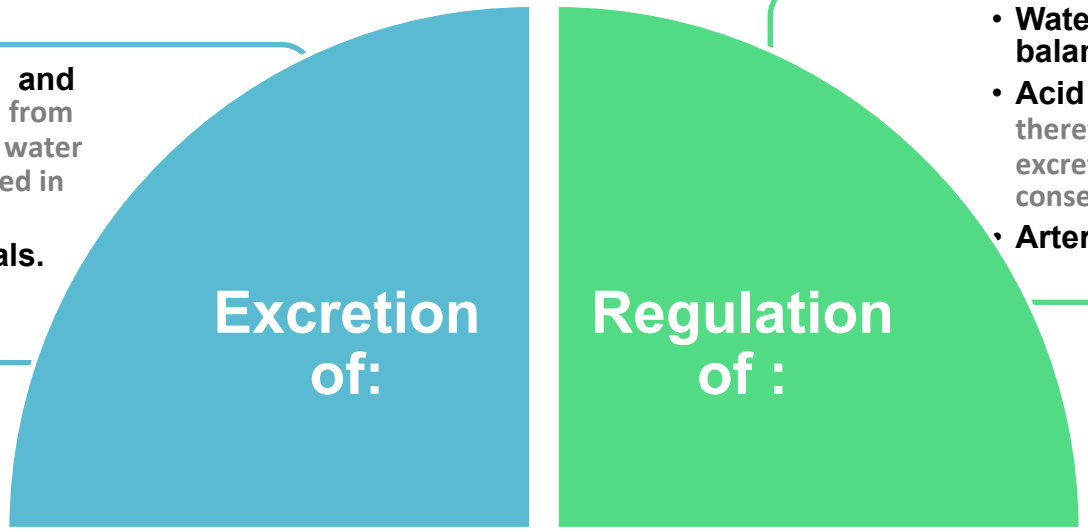
The nephron performs its homeostatic.

Ultra filtration at: Glomerulus.

Secretion and reabsorption at: Renal tubules.



Kidney Functions:



- **Metabolic waste and products.**(turned from water insoluble to water soluble and excreted in kidney)
- **Foreign chemicals.**

- **Water and electrolyte balance.**
- **Acid base balance.**(When there's acidosis, kidneys will excrete hydrogen ions and will conserve bicarbonate)
- **Arterial blood pressure.**

- **site for gluconeogenesis** (in prolonged fasting)

Secretion of erythropoietin

- **Activation of vitamin D**(considered hormone because hormones can be secreted by an organ and acts on different sites
- **Activation of angiotensinogen by renin**

Renal diseases:

Causes of Renal diseases:
1-Pre-renal
2-Renal
3-Post-renal
The pre and post affects some sites of the kidney or the nephron but renal causes will be in the kidney itself like malformation

Effects..?

- **Many diseases affect renal function.**
- **In some, several functions are affected.**

Site..?

In others, there is selective impairment of glomerular function or one or more of tubular functions.

Can cause..?

Most types of renal diseases cause destruction of complete nephron

Tests..? Listed according to priority, importance and accuracy

Routine Kidney Tests :	Used to:
1-Serum creatinine.	1) Confirm the diagnosis of renal disease. 2) Give an idea about the severity of the disease. 3) Follow up the treatment
2-Creatinine clearance.	
2-Serum urea.	Effected in dehydration

1-Serum creatinine (55-120 μmol/L in adult):

Where..?

98% of the body creatine is present in the muscles.

Creatinine is the end product of creatine catabolism. So it must be excreted.

Why..?

It functions as store of high energy in the form of creatine phosphate.

How?

About 1-2 % Muscle Creatine(creatine phosphate) → Creatinine

By?

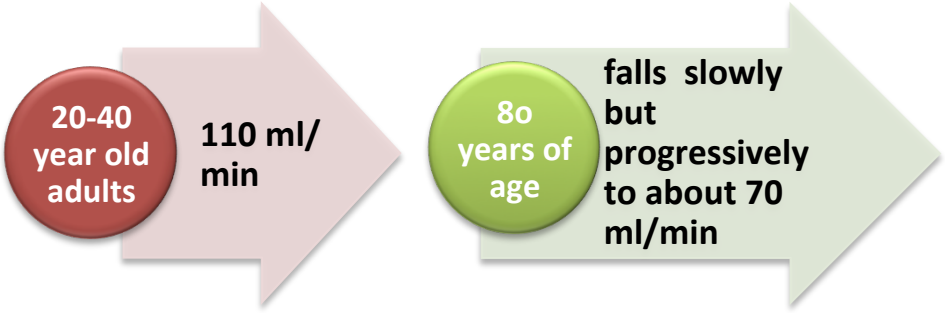
the spontaneous, non enzymatic loss of water or phosphate.

What makes plasma Creatinine very unique ☺ ..?*

1. **Creatinine in the plasma is filtered:**
   a) **Freely at the glomerulus (90 % of urinary creatinine)**
   b) **Secreted by renal tubules (10 % of urinary creatinine).** Should be neglected if we want to measure GFR.
2. **Creatinine is not reabsorbed by the renal tubules.**
3. **Plasma creatinine is an endogenous substance not affected by diet.**
4. **Plasma creatinine remains fairly constant throughout adult life.**

2-Creatinine Clearance(110 ml/min in the 20-40 year old adults):

- **GFR provides a useful index of the number of functioning glomeruli.** We can also use this way to calculate GFR.
- **It gives an estimation of the degree of renal impairment by disease.**



- **In children, the GFR should be related to surface area, when this is done, results are similar to those found in young adults.**

*Very important, this is why it's chosen

How to Calculate Creatine Clearance. .?

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

-It could be calculated from the following equation:

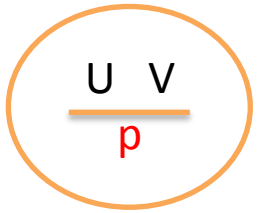
* **Clearance (ml/min) =** $\frac{U \times V}{P}$

U = Concentration of creatinine in urine μmol/l

V = Volume of urine per min

P = Concentration of creatinine in serum μmol/l

* Face



Accurate measurement of GRF 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.**
we want to check its function without it getting any help from other
3. **Its concentration in plasma needs to remains constant throughout the period of urine collection.**
Not changed by time(constant).
4. **Better if the substance is present endogenously.**
Produced by our bodies, Not Exogenous which can be affected if you eat or not
5. **Easily measured.**

✓ Creatinine meets most of these criteria.

Active filtration : filtration of the blood using energy.
Passive filtration: filtration of the blood using osmolality .
Free filtration: filtration of the blood using the high pressure of afferent.*

*Cockcroft-Gault Formula for Estimation افتراض of GFR (eGFR):

Difference between the two methods..?

As indicated before, 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.

We don't need collection of urine..

Limitations: not used if..

1. Serum creatinine is changing rapidly : the diet is unusual, e.g., strict vegetarian
2. Low muscle mass, e.g., muscle wasting
3. **Obesity**

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.
K is lower in females , because they have lower muscle mass.

We finished two tests now lets compare between them☺

Serum creatinine	Creatinine clearance
More accurate	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.(see the effectiveness of dialysis)
Creatinine level is constant throughout adult life	

Normal adult reference values:

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

Serum creatinine	55 – 120 μmol/L	
Creatinine clearance	90 – 140 ml/min	(Males)
	80 – 125 ml/min	(Females)

Notice that: The unit here is μmol/L while the serum urea unit is mmol/L

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 **Falling of GFR ≥ 50% ➔ then serum creatinine will be raised..**

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

Formation..?

In liver

Protein➔ amino acids ➔ ammonia ➔Urea..

The order of it..?

Serum urea is **inferior** (في مرتبة أدنى) to serum creatinine .

Why?

Because 50% of Urea is reabsorbed by the tubules.

Because..?

1. High protein diet increases urea formation.
2. Any condition of ↑ proteins catabolism

(Cushing syndrome, diabetes mellitus,starvation, thyrotoxicosis)→↑ urea formation.

3. 50 % or more of urea filtered at the glomerulus is passively reabsorbed by the renal tubules.

We do not have to memorize the numbers, we only need to know some of the electrolytes, just for your information..

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

Electrolytes affect the amount of water in your body, the acidity of your blood (pH), your muscle function, and other important processes. You lose **electrolytes** when you sweat.

Summery..

Routine kidney function test include the measurement of

- Serum creatinine.
- Creatinine clearance.
- Serum urea.

Both serum creatinine and creatinine clearance are used as kidney function tests to

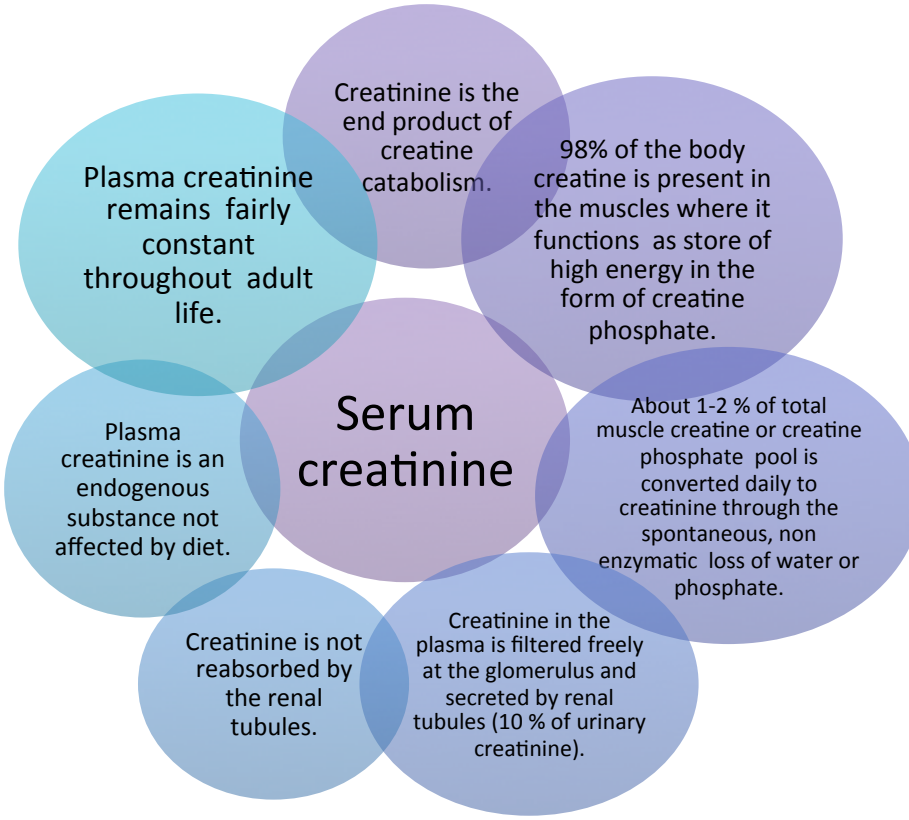
- Confirm the diagnosis of renal disease.
- Give an idea about the severity of the disease.
- Follow up the treatment.

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

- Serum creatinine is more accurate.
- Serum creatinine level is constant throughout adult life

Creatinine clearance is only recommended in the following conditions:

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



MCQs :

This video is 30min long, But, it's so useful and explains with details

https://www.youtube.com/watch?v=a_Iuh4-unjk

1-Accurate measurement of GFR requires:

A: Not reabsorbed substance.

B: endogenous substance.

C: Easily to measure

D: All

2-Which of the following is true about serum creatinine?

a) It is more than serum urea

b) It is affected by diet

c) It is not reabsorbed by renal tubules

SAQs:

In Which conditions Creatinine clearance is recomnded?

Patient with early (minor) renal disease.

Assessment of possible kidney donors.

Detection of renal toxicity of some nephrotoxic drugs

Answers:
1- D
2- C

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