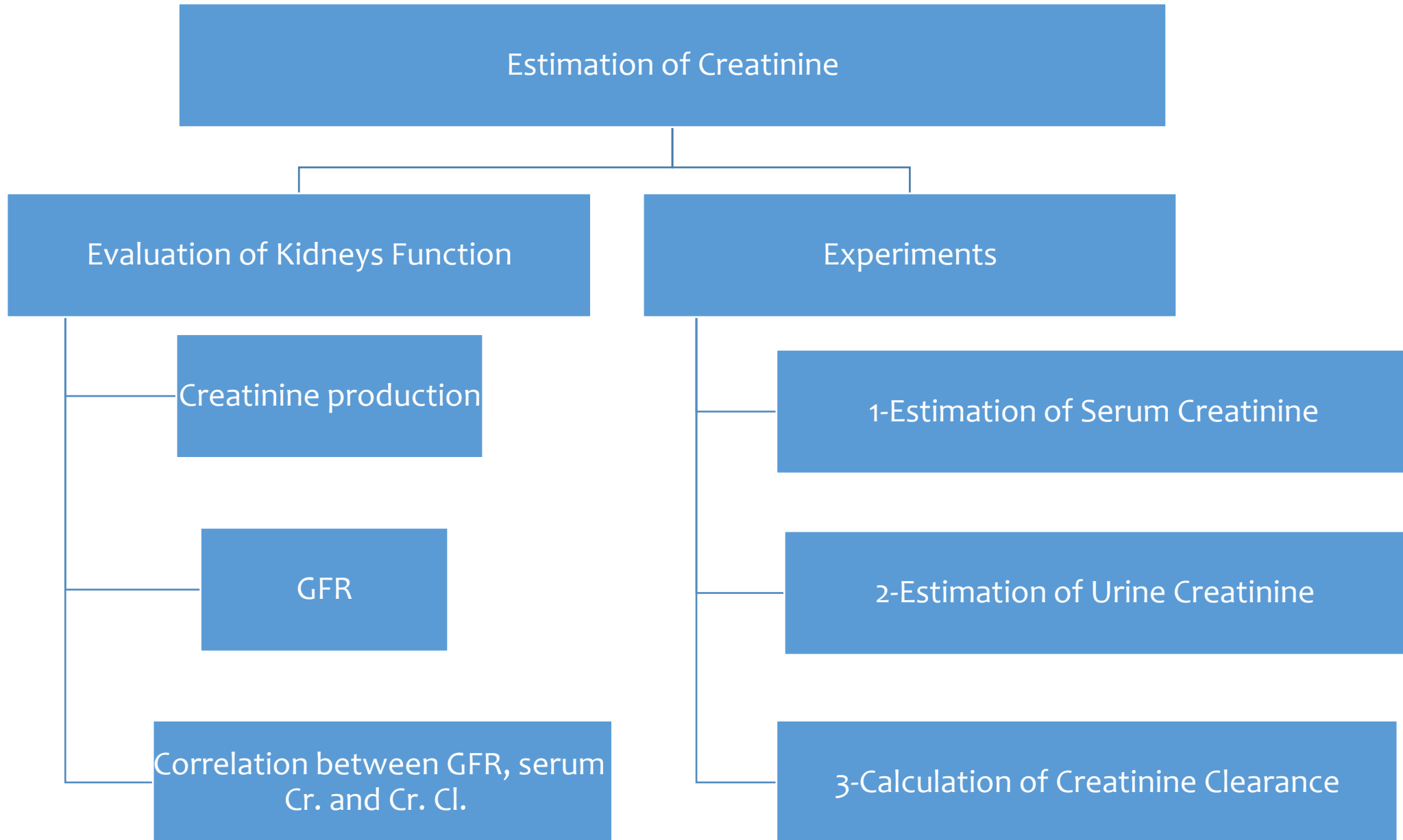


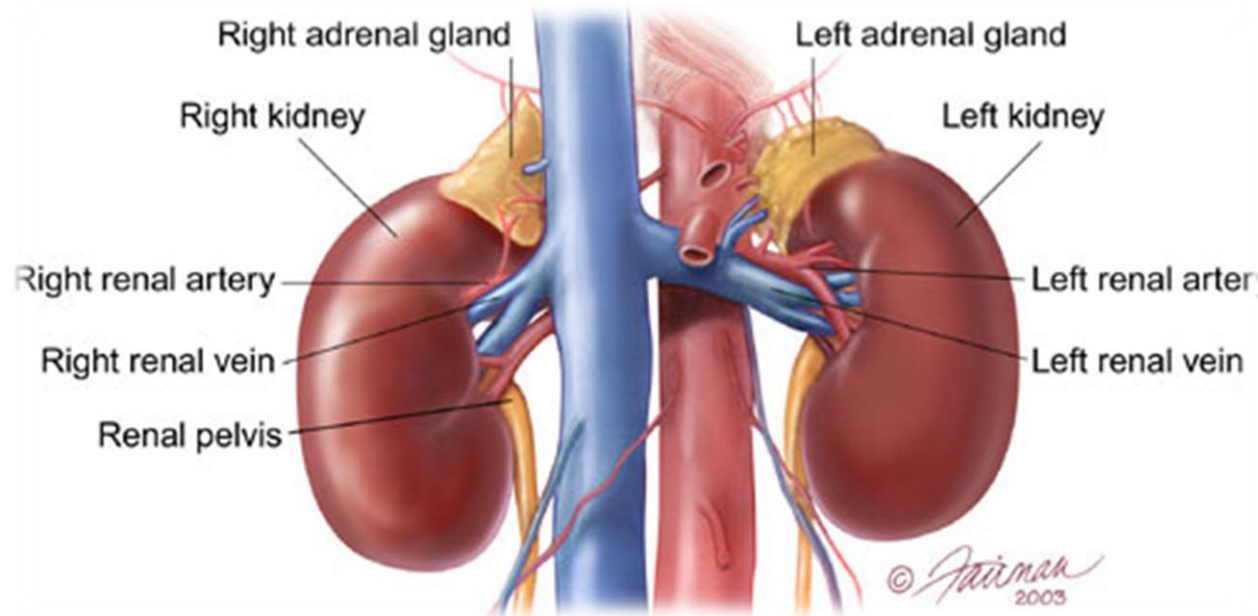
Estimation of Serum Creatinine, Urine Creatinine , and Creatinine Clearance

Lecture Over view



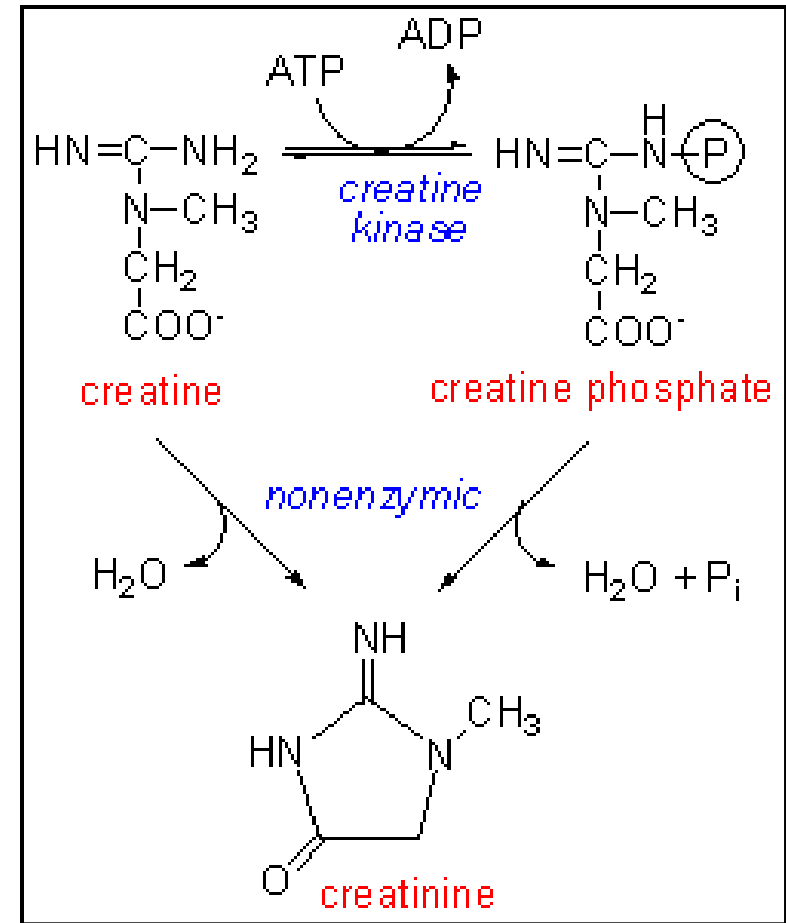
Evaluation of Kidneys Function

- Renal function tests are used to detect the presence of renal diseases and assess their progress. They are, however, of little use in determining the causes of renal disease.
- The most widely used test is to measure the glomerular filtration rate (GFR), that is, the rate of filtrate formation by the kidneys.



Creatinine production

- Creatinine is a substance that, in health, is easily excreted by the kidney. It is the byproduct of muscle energy metabolism and is produced at a constant rate according to the muscle mass of the individual.
- Endogenous creatinine production is constant as long as the muscle mass remains constant



What is the Glomerular filtration rate (GFR)?

- *The GFR is determined* by measuring the concentration of a substance in the urine and plasma that is known to be completely filtered from the plasma at the glomerulus.
- The GFR depend on the net pressure across the glomerular membrane, the physical nature of the membrane and it's surface area which in turn reflects the number of functional glomeruli.
- All three factors may be modified by disease, but in the absence of large changes in the filtration pressure or in the structure of the glomerular membrane, the GFR provides a useful index of the number of functional glomeruli. It gives an estimate of the degree of renal impairment by disease.

Substances clearance used for Measuring GFR

	Inulin Clearance	Creatinine Clearance	Urea Clearance
Source	(a polymer of fructose - plant carbohydrate)	End-product of skeletal muscle creatine metabolism	end product of protein metabolism
Advantages	Not reabsorbed or secreted	An endogenous product of muscle metabolism; near constant production	An endogenous product of protein
Disadvantages	Not made by body; must be injected	Small amount is secreted	<ul style="list-style-type: none"> Partially reabsorbed synthesis varies with diet

- *The Inulin is suitable for measuring GFR for the following reasons:*
- *It is freely filterable by the glomeruli.*
- *It is not reabsorbed or secreted by the kidney tubules.*
- *It is not synthesized, destroyed, or stored in the kidneys*
- *It is nontoxic*
- *Its concentration in plasma and urine can be determined by simple analysis.*

Creatinine production and protein intake must be assumed to be constant . Creatinine excretion is due not only to filtration (90%-95%) by the kidney but also to secretion (5%-10%) by the distal tubule.

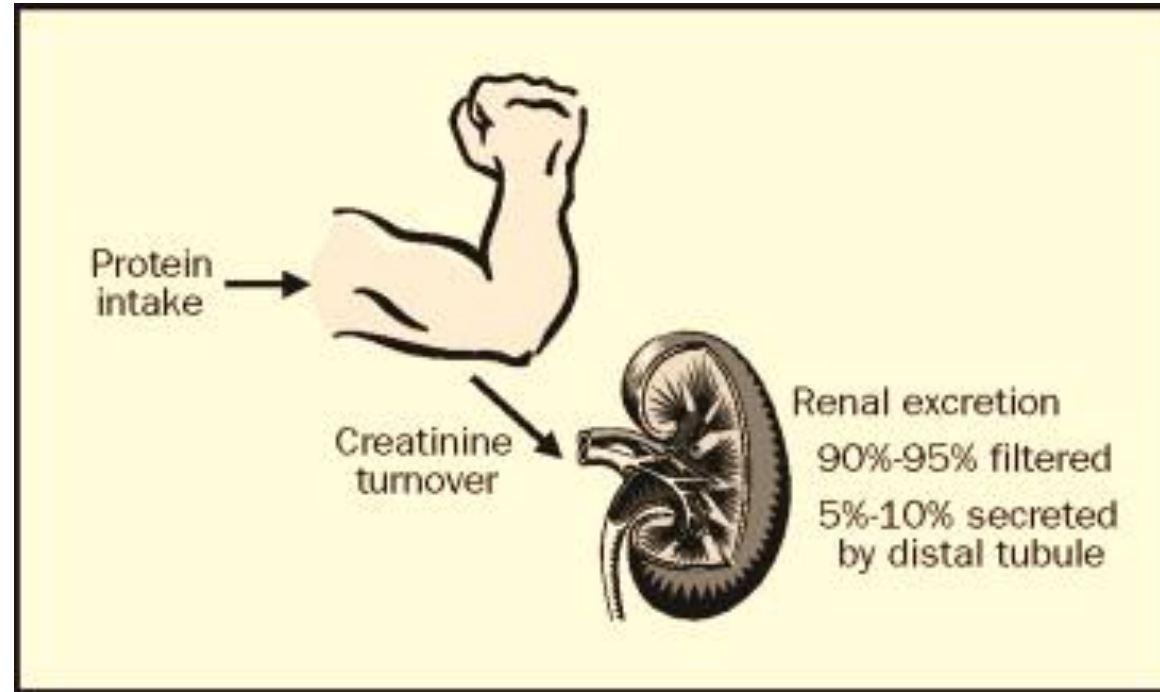
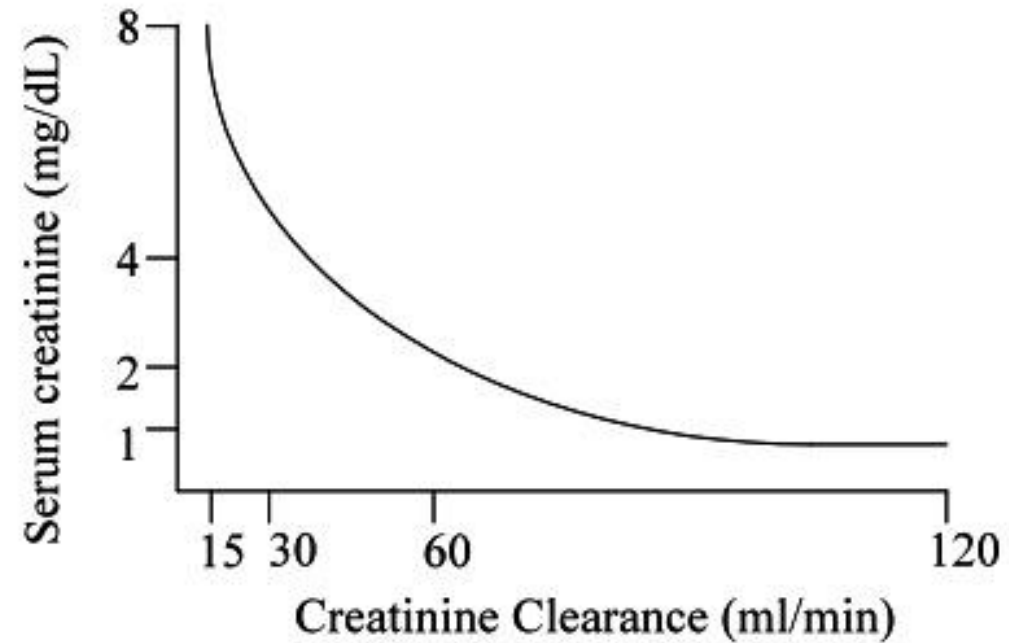


FIGURE:

Balance between muscle production and renal excretion of serum creatinine. As the glomerular filtration rate decreases, the percentage of creatinine excreted via secretion increases.

Correlation between serum creatinine and creatinine clearance

- The relationship between serum creatinine and creatinine clearance is logarithmic. Thus, initially, for small numeric changes in serum creatinine, there are significant numeric changes for creatinine clearance. In later stages of uremia, small numeric changes in the clearance are associated with significant changes in serum creatinine.



1-Estimation of Serum Creatinine

High plasma creatinine

Plasma creatinine tends to be higher in subjects with a large muscle mass. Other non-renal causes of increased plasma creatinine include the following :

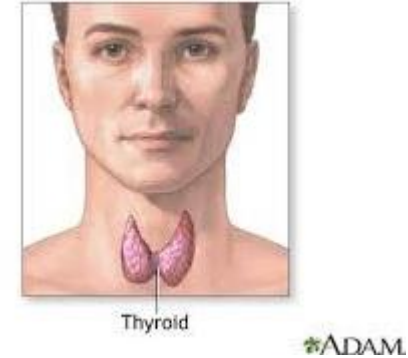
- A high meat intake can cause a temporary increase.
- Transient, small increases may occur after vigorous exercise .
- Some drugs (e.g.salicylates) compete with creatinine for its tubular transport mechanism, thereby reducing tubular secretion of creatinine and elevating plasma creatinine.

If non-renal cause can be excluded, an increased plasma creatinine indicates a fall in GFR, which can be due to pre-renal, renal or post-renal causes as follows

2-Estimation of Urine Creatinine

Decreased urine creatinine is found in:

- a. Hyperthyroidism
- b. Anemia
- e. Inflammatory muscle disease
- f. Advanced renal disease, renal stenosis



Increased urine creatinine is found in:

- a. Diabetes mellitus
- b. Hypothyroidism



3- Estimation of Creatinine Clearance

The blood sample is sent to a lab. There, the creatinine level in the blood sample is tested. The lab specialist combines your creatinine level with several other factors to estimate your (GFR). Different formulas are used for adults and children. The formula includes some or all of the following: Age, Blood creatinine, Gender, Height and Weight

Interfering Factors

- 1. Exercise may increase creatinine clearance and urine creatinine.
- 2. Pregnancy substantially increases creatinine clearance.
- 3. A diet high in meat may elevate the urine creatinine concentration.
- 4. Proteinuria and advanced renal failure make creatinine clearance an unreliable method for determining GFR.



- *Clinical Implications*

- 1. *Decreased creatinine clearance is found in any condition that decreases renal blood flow:*

- a. Impaired kidney function
 - b. Shock, dehydration
 - c. Hemorrhage
 - d. Chronic obstructive lung disease
 - e. Congestive heart failure

- 2. *Increased creatinine clearance is found in:*

- a. State of high cardiac output
 - b. Pregnancy
 - c. Burns
 - d. Carbon monoxide poisoning

Reference Values

Urine creatinine :1- 2 g/ 24h

(serum) creatinine: 0.6–1.2 mg/dL

Normal creatinine clearance= 100-130 ml/min/1.73m²

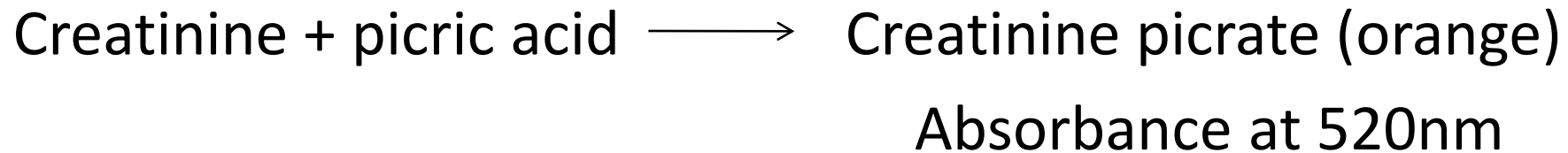
Objective

- 1- To estimate creatinine in serum and urine.
- 2- To calculate creatinine clearance value.

Principle:

(Jaffe's method):

Colorimetric estimation of creatinine using the alkaline picrate method.



Materials

A. Chemicals:

- Serum standard (3mg/dl)
- Urine standard (0.75mg/dl)
- Serum Sample
- Urine Sample
- Picric acid
- 2.5 M NaOH
- Dis.H₂O

B. Instruments:

- Pipette with different volume capacity
- Cuvette
- Water bath
- Test tubes
- Aluminium foil
- Vortex
- Spectrophotometer

Method:

1-Set up a series of test tube as follows:

Chemical	Standard(serum)		Test (serum)		Standard (Urine)		Test (urine)		Blank
	(A)	(B)	(C)	(D)	(A)	(B)	(C)	(D)	
Water	1.5 ml	1.5 ml	1.5 ml	1.5 ml	1.5 ml	1.5 ml	1.5 ml	1.5 ml	2 ml
Standard(serum)	0.5 ml	0.5 ml	-	-	-	-	-	-	-
Serum Sample	-	-	0.5 ml	0.5 ml	-	-	-	-	-
Standard(Urine)	-	-	-	-	0.5 ml	0.5 ml	-	-	-
Urine Sample	-	-	-	-	-	-	0.5 ml	0.5 ml	-
Picric acid	6 ml	6 ml	6 ml	6 ml	6 ml	6 ml	6 ml	6 ml	6 ml

2-Immerse the Tubes carefully in the boiling water bath for 40 seconds.

3-Set another 8 test tube labeled A- D twice and transfer 4 ml of each tube into the new set.

4- Pipette 0.2 ml of NaOH to all tube

5- Let the tubes stand for 20 min.

6- Read the absorbance at 520 nm.

Results:

Tube	Standard(serum)		Test (serum)		Test (urine)		Standard(Urine)	
	(A)	(B)	(C)	(D)	(A)	(B)	(C)	(D)
Absorbance at 520 nm								
Average(Mean of Absorbance)								

Calculation:

1-Serum creatinine =

(Mean Absorbance of Urine ÷ Mean Absorbance of Standard) X concentration of Serum standard
= mg / dl

2-Urine creatinine =

(Mean Absorbance of Urine ÷ Mean Absorbance of Standard) X concentration of Urine standard X **DF**
= mg / dl

To compare with normal range, convert from mg/dl to g/24 h

3- Creatinine Clearance :=

$$U.V / P$$

U is Urine creatinine

V is Volume of urine in 24 h *e.g 100 ml / 1440 min.*

P is Serum creatinine

Creatinine Clearance

Find the Creatinine Clearance = if you know that the Urine creatinine $U = 488 \text{ mg/dl}$, Serum creatinine $P = 2.32 \text{ mg/dl}$, Volume of urine in 24 h $= 100 \text{ ml}$ and $A = 1.6 \text{ m}^2$

3- A- Creatinine Clearance: = $U.V / P$

For example:, $U = 100 \text{ ml/24 h}$

$$(488 \text{ mg/dl} \div 2.32 \text{ mg/dl}) \times (100 \div 1440) = 14.6 \text{ ml/min}$$

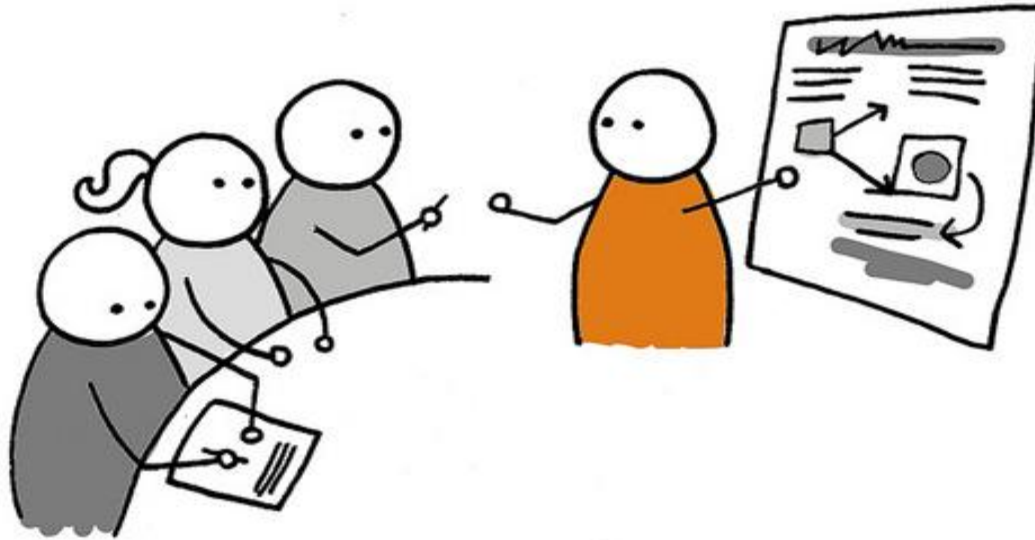
14.6 ml/ min in 1.73 m^2 find Cr.Cl in this person who have a surface area = 1.6
 $= (14.6 \times 1.73) \div 1.6 = 15.7 \text{ /min/1.73m}^2$

3- B- Creatinine Clearance: = $(U \times V \times 1.73) / (P \times 1440 \times A)$

$$(488 \text{ mg/dl} \times 100 \times 1.73) / (2.32 \times 1440 \times 1.6) \\ = 15.7 \text{ ml/min /1.73m}^2$$

Discussion

- Comment on the concentration of **creatinine in serum**.
- Comment on the concentration of **creatinine in urine**.
- Comment on the value of **Creatinine Clearance** .



Questions?

A man aged 35 years presenting loin pain has a serum creatinine of $150\mu\text{mol/L}$. A 24 h urine of 2160 ml is collected and found to a creatinine concentration of $7500\mu\text{mol/L}$

Calculate the creatinine Clearance

References

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