

Renal Function Tests

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Lec. 2

Glomerular Filtration Rate (GFR)

- GFR is decreased when BP is below 80 mm of Hg

The GFR is reduced when there is obstruction to the renal flow (calculi, enlarged prostate, etc.). It also decreases with age.

- The **renal blood flow** is about 700 mL of plasma or 1200 mL of blood per minute.
- The glomerular filtration rate (GFR) is 120–125 mL/min. in a person with 70 kg body weight.
- Glomerular filtrate formed is about 170 to 180 liters per day, out of which only 1.5 liters are excreted as urine.

This means that most of the water content of glomerular filtrate is reabsorbed.

Functions of the Tubules

- When the glomerular filtrate is formed, it contains
- almost all the crystalloids of plasma. In the proximal convoluted tubules, about 70% water, Na⁺ and Cl⁻ as well as 100% glucose, amino acids and K⁺ are reabsorbed.
- Urea, phosphate and calcium are partially absorbed.

Renal Threshold and Tubular Maximum

- **threshold substances.** At normal or low plasma levels, they
- are completely reabsorbed and are not excreted in urine.

- But when the blood level is elevated, the tubular reabsorptive capacity is saturated, so that the excess will be excreted in urine.

- The renal threshold of a substance is the plasma level
- above which the compound is excreted in urine.
- For glucose, the **renal threshold is 180** mg/dL.
- In other words, glucose starts to appear in urine when blood level is
- more than 180 mg/dL. In abnormal conditions, the renal threshold
- may be lowered so that even at lower blood levels,
- compounds are excreted in urine, e.g. renal glucosuria
- (glucose); and renal tubular acidosis (bicarbonate).

Threshold value of some common substances excreted through urine

<i>Substance</i>	<i>Threshold value plasma level</i>
1. Glucose	180 mg/dL
2. Lactate	60 mg/dL
3. Bicarbonate	28 mEq/L
4. Calcium	10 mg/dl

Main functions of kidney tubules

<i>Segment of nephron</i>	<i>Reabsorption of</i>	<i>Secretion of</i>
Proximal convoluted tubule (PCT)	Sodium (85%), Chloride (85%), Bicarbonate (85%), Glucose (100%), Amino acids (100%), Uric acid, water (obligatory).	H ⁺ , Acids and bases, NH ₄ ⁺ , Diodrast, PAH
Loop of Henle	Na ⁺ , Cl ⁻ , Ca ⁺⁺ , Mg ⁺⁺	
Distal convoluted tubule (DCT)	Na ⁺ , Cl ⁻ , Water (facultative)	H ⁺ , K ⁺ , NH ₄ ⁺ , Uric acid

Physical Characteristics of Urine

- i. **Volume:** The average output of urine is about 1.5 liters/day. Urine volume may be increased in excess water intake, diuretic therapy, diabetes mellitus and in chronic renal diseases.
- Urine volume may be decreased in excess sweating,
- dehydration, edema of any etiology, kidney damage.
- Urine volume 1.5 L/24 h; typical in
- health, oliguria < 400 mL, anuria < 100 mL, polyuria > 3000 mL
- ii. **Specific gravity:** Described under tests for
- tubular function.

Chemical Characteristics of Urine

- *Reaction to Litmus*
- The pH of urine varies from 5.5 to 7.5. If diet is rich in proteins, sulfuric and phosphoric acids are produced from amino acids, and the urine becomes acidic.
- If the diet is rich in vegetables, urine is alkaline because the organic acids (citric and tartaric) present in vegetables are converted to bicarbonate in the body

- *Proteins*

- Proteinuria is an important index of renal diseases. In normal urine, protein concentration is very low, which can not be detected by the usual tests. These proteins are secreted by the tubular epithelial cells.
- The proteinuria is commonly assessed by the **heat and acetic acid test**. Now dipstick test is replacing the old methods.

- *Blood*
- **Hematuria** is seen in nephritis and postrenal haemorrhage.
- **Hemoglobinuria** is due to abnormal amount of hemolysis. Occultest tablets and Hemastix strips are available for rapid testing of blood in urine.
- *Reducing Sugars (Glycosuria)*
- **Benedict's test** may be used as a semiquantitative method for sugar estimation in urine. Dipstick is now replacing the old Benedict's test for detection of glucose in urine.
- *Ketone Bodies*
- They are acetoacetic acid, beta hydroxybutyric acid and acetone. Ketonuria is seen in diabetes mellitus, starvation, persistent vomiting, von Gierke's disease and in alkalosis. Ketone bodies are analyzed by **Rothera's test**. Nowadays, ketostix strips are available for rapid test for ketone bodies.

Abnormalities detected in dipstick

<i>Test and normal range</i>	<i>Interpretations</i>
1. Specific gravity 1.005–1.025	Low SG in renal tubular dysfunction; diabetes insipidus; polydipsia. High SG in inadequate water intake; volume depletion
2. pH 5.5–6.5	Low pH in high protein diet and acidosis, recent meal-alkaline tide, high pH in low protein diet
3. Blood	Menstruation, traumatic catheterization, glomerulonephritis, stones, tumor and trauma of urinary tract hemoglobinuria-hemolysis
4. Protein <150 mg/day	Fever, exercise, orthostatic proteinuria; glomerulonephritis, urinary tract infection, tubular diseases
5. Glucose	Diabetes mellitus, renal glucosuria; Fanconi's syndrome
6. Ketone bodies	Diabetes mellitus, starvation
7. Bilirubin	Hepatitis, obstructive jaundice
8. Urobilinogen <4 mg/day	Concentrated urine; hepatitis; intravascular hemolysis; low in obstructive jaundice
9. Bile salt	Obstructive jaundice
10. Nitrite	Urinary tract infection
11. Leukocyte esterase	Urinary tract infection, fever

Non-protein Nitrogen (NPN)

- These include urea, creatinine and uric acid. These compounds are excreted through urine.
- In kidney dysfunction,
- the levels of these compounds are elevated
- in plasma. Of the three, **creatinine estimation is the most specific** and sensitive index of renal function.
- Other minor components of NPN are urobilinogen,
- indican, ammonia and amino acids.

- Reference :
- CLINICAL BIOCHEMISTRY (Renal disease)
- Lecture Notes
- Simon Walker
- Geoffrey Beckett
- Peter Rae
- Peter Ashby
- 9th Edition