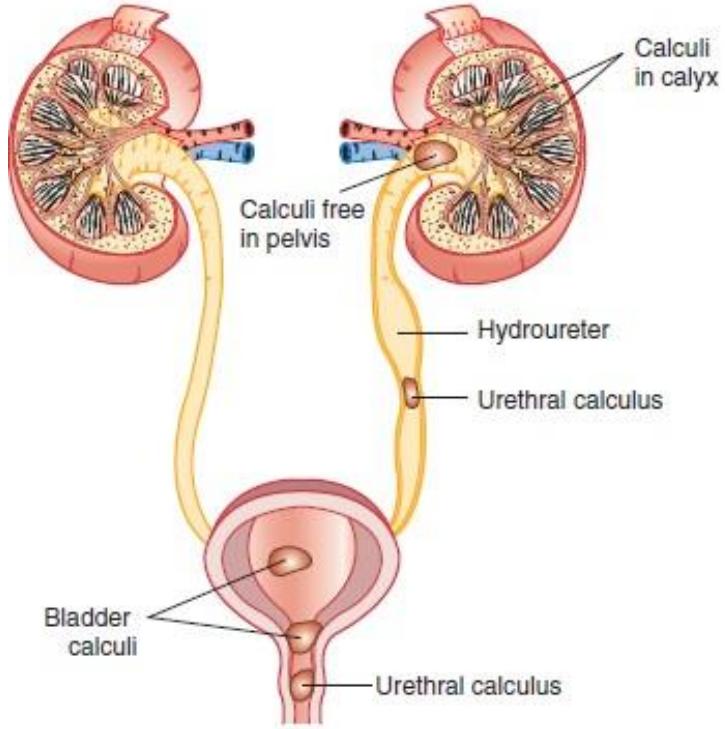
Identification and qualitative Analysis of Renal Calculi

-Renal Calculi:

- Kidney stones , renal calculi or renal lithiasis (stone formation) are small, hard deposits that form inside your kidneys.

- The stones are made of mineral and acid salts.

- Kidney stones have many causes and can affect any part of your urinary tract kidneys, ureters, bladder, and urethra).



- Pathogenesis of renal stones :

- There are two basic aspects in the pathogenesis of renal stones:

1. Increased urinary excretion of stone forming elements: like calcium, phosphorus, uric acid, oxalate, and cysteine.

2. Low fluid intake: a low fluid intake results in the production of **concentrated urine**, causing supersaturation and crystallisation of stone-forming compounds.

- **Physio-chemical changes which influence stone formation like:** pH of urine, stone matrix, and protective substances in the urine.

- Risk factors:

1. Low fluid intake:

- The single most important determinant of stone formation is low fluid intake.
- A low fluid intake results in the production of concentrated urine.

2. High Salt diet.

3. Repeating, or recurrent, urinary tract infections.

4. Blockage of your urinary tract.

- Investigation of Renal Calculi:

1-Urine analysis and Urine culture:

-It may show crystals, red blood cells, and/or pus cells in urine.

2-Stone analysis:

-Chemical analysis of stones is a simple test but is not an accurate method.(will be done in today's lab).

-Better method is crystallography.

3-Biochemical investigations:

-Serum calcium, phosphorus, uric acid, and renal function tests.

-24-hour urine for calcium, phosphorus, uric acid, oxalate, citrate, and cystine.

-Investigations for special clinical situations like hyperparathyroidism and gout should also be included.

- **The main objectives in investigation are to find out :**

1. The composition of stones.
2. Cause of stone formation.
3. Functional status of kidney.
4. Presence/absence of obstruction in urinary tract.
5. Evidence of possible urinary infection.

-Types of Calculi :

- There are four basic types of kidney stones :

1. Calcium stones (calcium oxalate and calcium phosphate).
2. Uric acid stones.
3. Struvite (magnesium ammonium phosphate) stones.
4. Cystine stones.

- Most kidney stones (70% to 80%) are calcium stones – calcium oxalate, calcium phosphate, or a combination of the two materials.

-Types of Calculi :

Stone type and composition	Contributing factors	Notes
Calcium stones **- calcium oxalate** **- calcium phosphate**	• Hyperparathyroidism. • Hypercalcemia and Hypercalciuria. • Hyperoxaluria. (some food eg. spinach, strawberries and large doses of Vitamin C may increase the amount of oxalate in your urine). • Vitamin D toxicity.	• Calcium oxalate stones are more common. • Calcium phosphate stones are caused by the combination of high urine calcium and alkaline urine (because phosphate level increase in alkaline urine). • **Carbonate apatite (calcium carbonate and calcium phosphate)** is one kind of calcium phosphate stone.
Uric acid stones (Urate)	• Form in acid urine with pH around 5. • Gout. • High purine diet. • Excessive urinary uric acid.	• Can treated by: - Increase fluid intake. - Alkalinization of the urine.
Struvite stones (magnesium ammonium phosphate stones)	• Urea-splitting urinary tract infection UTIs (Some urinary bacteria can split the urea in urine to form ammonium and also to make urine less acidic).	• They can also be called **infection stones** if they occur with kidney or urinary tract infections (UTIs). • Can treated by: - Increase fluid intake. - Acidification of the urine
Cystine stones	• Develop in patients with cystinuria.	• Less common. • Can treated by: - Increase fluid intake. - Alkalinization of the urine.

Practical Part

- Objective:

- Identification and qualitative analysis of kidney stones.

- **General Principle:**

- Each test based on the chemical properties of the stone-forming substance.

- Experiments:

1. Test for uric acid.
2. Test for carbonate.
3. Test for oxalate.
4. Test for phosphates.
5. Test for calcium.
6. Test for magnesium.

(1) Test for Uric acid :

- **Principle:**

Uric acid undergoes oxidation when treated with HNO_3.

- **Method**:

1-Put a small amount of the sample.

2-Add 5-7 drops of concentrated nitric acid (Carefully).

3- Heating in a water bath.

➔ (the positive result is yellow to orange color on the inner surface of the test tube).

(2) Test for carbonate :

- **Principle:**

2 HCl + CaCO3 --> CaCl2 + H2O + **CO2**

- **Method:**

1- Add 0.5 ml con. hydrochloric acid to a small portion of the sample (Carefully).

➔ (Gas bubbles will indicate the presence of carbonate).

(3) Test for oxalate:

- **Principle:**

In sulfuric acid solution, oxalate combines with hydrogen to form oxalic acid.

- **Method:**

1- Heat a part of the sample with 2 ml dilutes sulphuric acid (2M H_2SO_4) for 1 min.

2-Add 2 drops (one by one) of, potassium permanganate ($KMnO_4$) solution and Mix.

➔ (The decolonization and evolution of bubbles will confirm the presence of oxalate).

(4) Test for phosphates:

- **Principle:**

Phosphate ions react with ammonium molybdate to produce a characteristic yellow precipitate, ammonium phosphomolybdate.

- **Method:**

1- Dissolve a little of the sample in about 1.5 ml of concentrated nitric acid HNO3.

2- Add an equal volume (1.5 ml) of ammonium molybdate solution.

3- Heat to boiling.

➔ (If phosphates are present, a yellow precipitate of ammonium phosphomolybdate is obtained)

(5) Test for calcium :

- **Principle:**

calcium is precipitated as calcium oxalate using ammonium oxalate.

- **Method:**

1- Dissolve small amount of the sample by heating with 2 ml dilute hydrochloric acid (2M HCL).

2- Add 1 ml ammonium oxalate.

➔ (A white precipitate of calcium oxalate shows the presence of calcium).

(6) Test for magnesium :

- **Principle:**

The combination between titan yellow and magnesium hydroxide to produce an orange colour.

- **Method:**

1- On a few amount of magnesium, add 1ml of titan followed by 1 ml potassium hydroxide (to be strongly alkaline).

➔ (An orange to red color indicates the presence of magnesium).

-Results:

Component	Observation
Uric acid	
Carbonate	
Oxalate	
Phosphate	
Calcium	
Magnesium	

-Discussion:

- Comment in each results you obtained and mention whether the sample contains these component or not?
- What type of stone can be formed by each substance.
- What the disease that cause each type of stone.