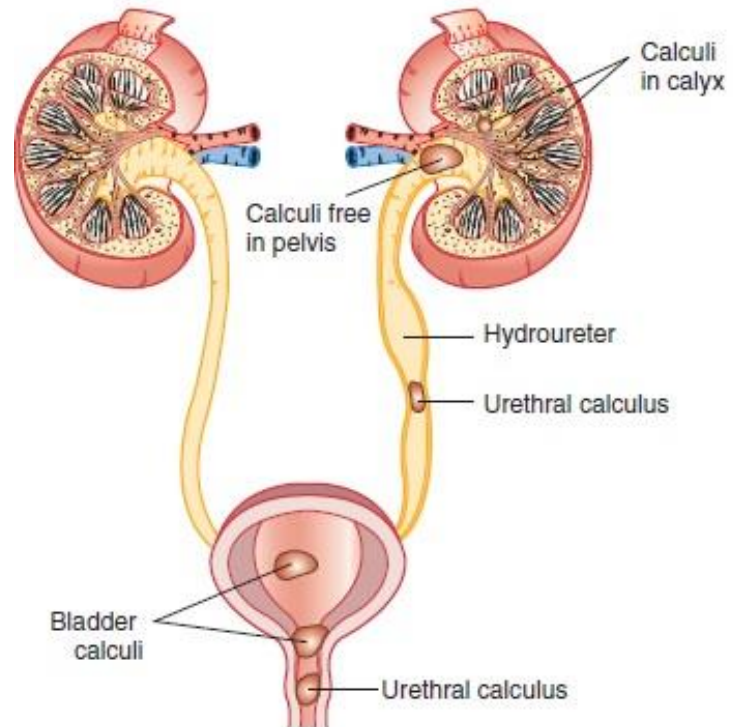


# Identification and Qualitative Analysis of Renal Calculi

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# -Renal Calculi:

- **Kidney stones** , **renal calculi** or **renal lithiasis** (stone formation) are small, hard deposits that form in the urinary system.
- 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).
- It is s common cause of **blood** in the urine and **pain** in the abdomen, flank, or groin.



# 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 **super-saturation** and **crystallisation** of stone-forming compounds. (In addition, low urine flow rates favour crystal deposition on the urothelium).  
**→Note:** Cystine stones formed only when its concentration increased in the urine.
- **Other: 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:

1. Chemical analysis of stones (simple test but is not an accurate).
2. Crystallography (better method ).

## 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, 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 stones (magnesium ammonium phosphate).
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
<b>Calcium stones</b>  <b>1. Calcium oxalate.</b> <b>2. Calcium phosphate.</b>	<ul style="list-style-type: none"> <li>Hyperparathyroidism.</li> <li>Hypercalcemia and Hypercalciuria.</li> <li>Hyperoxaluria. (some food eg. spinach, strawberries and large doses of Vitamin C may increase the amount of oxalate in your urine).</li> <li>Vitamin D toxicity.</li> </ul>	<ul style="list-style-type: none"> <li><b>Calcium oxalate</b> stones are more common.</li> <li><b>Calcium phosphate</b> stones are caused by the combination of high urine calcium and <b>alkaline urine</b> (because phosphate level increase in alkaline urine).</li> <li><b>Carbonate apatite (calcium carbonate and calcium phosphate )</b> is one kind of calcium phosphate stone.</li> </ul>
<b>Uric acid stones (Urate)</b>	<ul style="list-style-type: none"> <li>Form in acid urine with pH around 5.</li> <li>Gout.</li> <li>High purine diet.</li> <li>Excessive urinary uric acid.</li> </ul>	<ul style="list-style-type: none"> <li>Can treated by: <ul style="list-style-type: none"> <li>Increase fluid intake.</li> <li>Alkalinization of the urine.</li> </ul> </li> </ul>
<b>Struvite stones (magnesium ammonium phosphate stones)</b>	<ul style="list-style-type: none"> <li>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).</li> </ul>	<ul style="list-style-type: none"> <li>They can also be called <b>infection stones</b> if they occur with kidney or urinary tract infections (UTIs).</li> <li>Can treated by: <ul style="list-style-type: none"> <li>Increase fluid intake.</li> <li>Acidification of the urine</li> </ul> </li> </ul>
<b>Cystine stones</b>	<ul style="list-style-type: none"> <li>Develop in patients with cystinuria.</li> </ul>	<ul style="list-style-type: none"> <li>Less common.</li> <li>Can treated by: <ul style="list-style-type: none"> <li>Increase fluid intake.</li> <li>Alkalinization of the urine.</li> </ul> </li> </ul>



# Practical Part

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## 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  $\text{HNO}_3$ .

- **Method:**

1-Take a small amount of the sample.

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

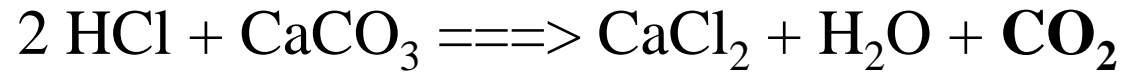
3- Heat in a water bath.



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

## (2) Test for carbonate :

- **Principle:**



- **Method:**

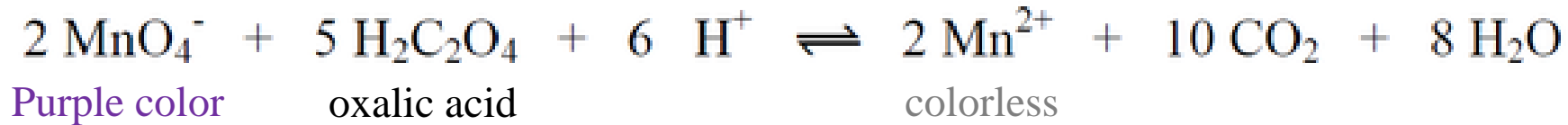
1- Add 0.5 ml con. hydrochloric acid to a small portion of the sample (Carefully).

➔ (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 diluted sulphuric acid (2M H<sub>2</sub>SO<sub>4</sub>) for 1 min.
- 2-Add 2 drops (one by one) of potassium permanganate (KMnO<sub>4</sub>) solution and mix.

➔ (The decolorization of potassium permanganate will confirm the presence of oxalate).

## (4) Test for phosphates:

- **Principle:**

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

- **Method:**

- 1- Dissolve a little of the sample in about 1.5 ml of concentrated nitric acid  $\text{HNO}_3$ .
- 2- Add an equal volume (1.5 ml) of ammonium molybdate solution.
- 3- Heat to boiling water bath.

➔ (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.

# Homework:

- A patient have been shown to has struvite stones (infection stone), what are your predictions for the following:
  1. Urinalysis test.
  2. Ultrasound imaging.

# References:

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