URINE ANALYSIS

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TYPES OF URINE SAMPLE

Sample type	Sampling	Purpose
Random specimen	No specific time most common, taken anytime of day	Routine screening
Morning sample	First urine in the morning, most concentrated	Pregnancy test, microscopic test
Clean catch midstream	Discard first few ml, collect the rest	Culture
24 hours	All the urine passed during the day and night and next day Ist sample is collected.	used for quantitative and qualitative analysis of substances
Postprandial	2 hours after meal	Determine glucose in diabetic monitoring
Supra-pubic aspired	Needle aspiration	Obtaining sterile urine

Urine analysis

I. Physical properties of urine

- *Volume, Colour, Odour, Reaction, Aspect, Deposits, Specific Gravity.*

- **Volume**

- Normal urine volume is ***600 - 2 000 ml/day***.
- Normally, more urine is secreted during the day than at night.

Increased volume:

❖ ***Physiological increase***: - After excessive fluid intake.

❖ ***Abnormal increase(polyuria):*** More than 3 L/day

- Diabetes mellitus (may reach 5 L/day)
- Diabetes insipidus (10-15 L/day)

Urine analysis

I. Physical properties of urine: Volume

Decreased volume:

Physiological decrease: in summer due to increased sweating

Abnormal decrease (Oliguria): Less than 200 ml/day

- acute nephritis.
- heart failure.
- hemorrhage.

Anuria: *No urine* at all. In late stages of renal failure and heart failure.

Urine analysis

I. Physical properties of urine: Color

- Normal color is ***amber yellow*** due to pigments called *urochromes.*

Abnormal urine colors:

- ***Obstructive jaundice:*** Greenish brown due to presence of cholebilirubin (conjugated or direct bilirubin).
- ***Haemorrhage in urinary tract:*** reddish brown colour.
- ***Alkaptonuria:*** Black (homogentisic acid is oxidized to give black color when exposed to air).
- **Alkaptonuria:** Rare inherited genetic disorder of phenylalanine and tyrosine metabolism .It is an ***autosomal recessive*** condition. It is due to a defect in the enzyme ***homogentisate 1,2-dioxygenase.***

Urine analysis

Odor: Fresh urine is normally aromatic (urineferous). **Abnormalities:**

1. **Fruity odor:** uncontrolled DM & severe starvation
2. **Ammoniacal odour:** Urinary tract infection & Long standing exposed sample.

Reaction:

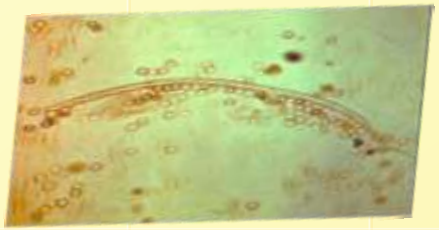
- The urine pH depends on the ratio of NaH_2PO_4 / Na_2HPO_4.
- **Acidic urine:** - Ketoacidosis.
- **Alkaline urine:** - Bacterial infection.

Aspect: Normal urine is ***clear (transparent).***

- It becomes **turbid and opaque** due to presence of ***albumin.***
- ***Exposed urine*** is a good medium for bacterial growth as its pH becomes alkaline, resulting in precipitation of phosphates.

Urine analysis: Deposits microscopic examination

- Normal urine is ***devoid from deposits***.
- In order to examine the deposit, we make centrifugation to urine then **microscopic examination**.
- The examination includes:



a) Organized elements

-cells:RBCs, WBCs and pus cells,

epithelial cells and neoplastic cells

- pasasites and ova:B , filariasis. -casts.

b) Non organized elements (crystalluria)

1-acidic urine: uric acid crystals, calcium oxalate.

2-alkaline urine: amorphous phosphate, triple phophate.

Specific gravity

- urinary specific gravity (SG) is a measure of the concentration of solutes in the urine. It measures the ratio of urine density compared with water density and provides information on the kidney's ability to concentrate urine.
- Measured by:
  - urinometer
  - refractometer
  - dipsticks

Specific gravity

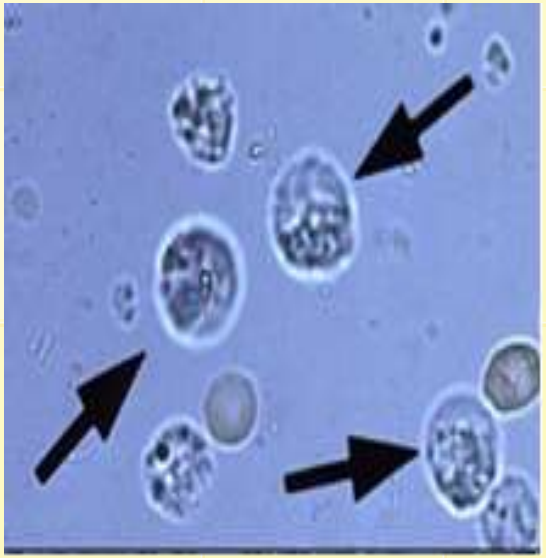
Normal :- 1.010- 1.030.

- Increase in Specific Gravity - Low water intake, Diabetes mellitus, Albuminuruia, Acute nephritis.
- Decrease in Specific Gravity - Absence of ADH, Renal Tubular damage.
- Fixed specific gravity (isosthenuria)=1.010

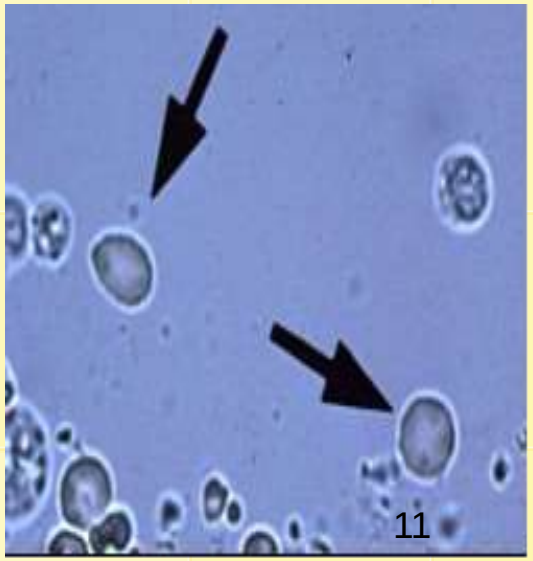
In chronic renal failure

Urine analysis
microscopic examination: Cells

- **Pus cells:**
  - Nucleus: disintegrated.
  - Normal urine contain from 2-4 pus cells.
  - Their presence in excess would point to infection.



- **Red Cells:**
  - Nucleus: non-nucleated.
  - Normal urine contain from **0-2 red cells**.
  - Their presence in excess is pathological and is due to the different causes of **hematuria** e.g. *bilharziasis*, urinary *tumors*, urinary *stones*.



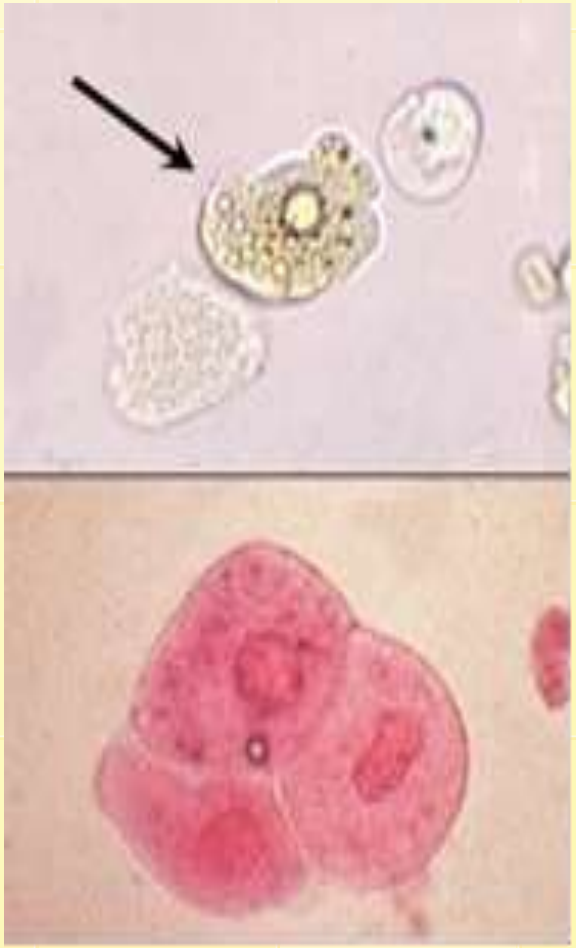
Urine analysis
microscopic examination: Cells

- **Epithelial cells:**

➢ Shape: large irregular cells

➢ Nucleus: large, intact and central.

➢ Normal urine may contain **few epithelial cells**, but excess of these cells in urine point to the presence of an inflammatory condition.



Urine analysis
microscopic examination: Casts

- The casts are the molds of renal tubules.
- **Normal urine** does not contain casts and so their appearance in urine is important and diagnostic for certain diseases.
- There are various types of casts which may appear in urine.

  The material or cells that form a cast may have:

  - come through a ***damaged glomerulus.***
  - been part of an ***interstitial inflammatory infiltrate***.
  - have been ***dead tubular cells***.
- The cast is expelled into the urine, and **maintains the shape of the tubule** in which it formed.
- Casts reflect conditions of the **kidney proper** and not the lower urinary tract.

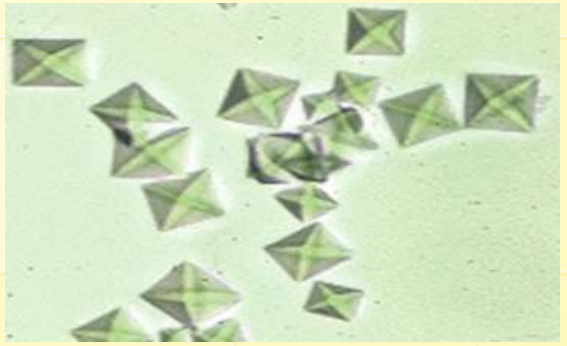
Urine analysis: microscopic examination: Casts

- **Hyaline casts:** They are colorless, homogenous and empty. In *nephritis* and also in *heart failure.*
- **Blood casts:** in *acute nephritis.*
- **Pus casts:** in *pyelonephritis.*
- **Epithelial casts:** in *acute nephritis.*
- **Granular casts:** in *chronic nephritis.*

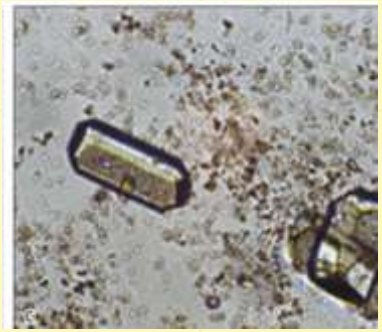
Urine analysis
microscopic examination: Crystals

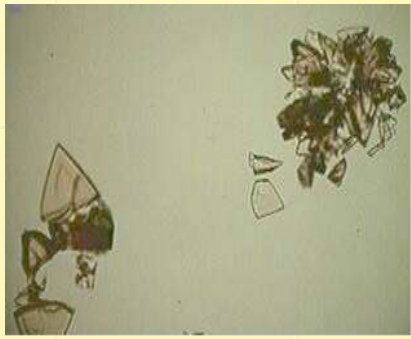
Crystals in acidic urine:

- **Calcium oxalate:**
  - Shape: envelope shaped or in the form of dumb-bells.
  - Color: colorless.



- **Uric acid:**
  - Shape: various forms e.g. rosettes or barrels.
  - Color: brownish or colorless.

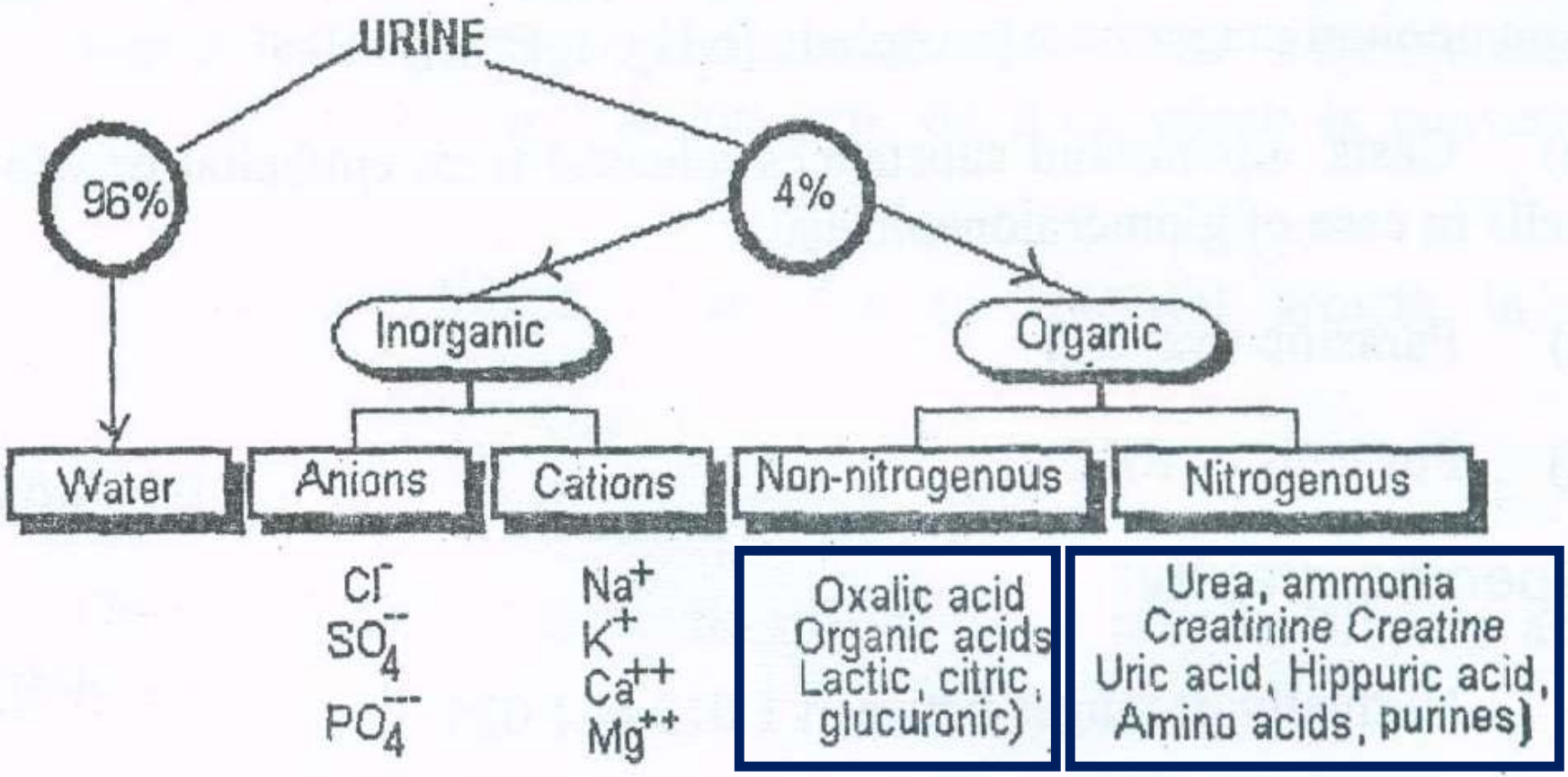




Crystals in alkaline urine

- **Triple phosphate:**
  - Shape: prismatic
  - Color: colorless

Normal constituents of urine



Constituents of urine:
Organic constituent

Nitrogenous:

1. urea: 2. uric acid 3. creatinine 4. ammonia

5. proteinuria :<150mg/24h

6. albuminuria :<30mg/24h

7. urinary pigment (urobilinogen).

8. Amino acids:

- **Large amounts of amino acids are excreted in case of:**

➢ **- extensive destruction of the liver:** chloroform and tetrachlorocarbon poisoning.

➢ **- inborn error** known as (***cystinuria***) which is a tubular defect in reabsorption of **cystine, arginine, lysine and ornithine.**

ABNORMAL CONSTITUENTS OF URINE

- Proteins
- Sugars
- Ketone bodies
- Bile
- Blood
- Porphyrins

Abnormal constituents of urine

1. Proteins (proteinuria)

Albuminuria:

- Increased amount of albumin in urine is called ***albuminuria*** ,which can be:

A. Physiological (less than 500 mg/day): after severe muscle exercise.

B. Pathological:

- ***Prerenal:*** e.g. heart failure.
- ***Renal:*** intrinsic in the kidney, e.g. nephritis and nephrosis.
- ***Postrenal:*** in the lower urinary tract, e.g. cystitis.

Bence-Jones Proteins.

- It is ***Abnormal globulins*** which is detected in multiple myeloma a bone marrow cancer, leukemia and lymphoma.

Proteinuria

- **Normally** excretion in most healthy adults is between **20-150 mg** of protein in **urine over 24 hrs**.
- Proteinuria more than 3.5 gm/day is taken to be diagnostic of ***nephrotic syndrome***.
- Panels of protein measurement including albumin, ***macroglobulin***, ***IgG*** and ***β 2- microglobulin*** have been employed in differential diagnosis of prerenal and postrenal disease.

Abnormal constituents of urine

2. Sugars

- ***Glucose (glucosuria):*** Normally glucose <0.5 g/day. **Glucosuria.** In most cases glucosuria is a symptom of diabetes mellitus, when level of glucose in blood more than kidney threshold (180 mg/dl).

- ***Galaclose (galactosuria):*** in congenital galactosemia (deficiency of galactose-1-phosphate uridyl transferase enzyme).
- ***Lactose (lactosuria):*** During *pregnancy and lactation*, may appear in mothers and infants.

Abnormal constituents of urine
Familial renal glycosuria

- ***Glucose is present in urine*** even its ***level in blood is normal***.
- It is characterized by decreased renal reabsorption of glucose.
- In most cases this abnormality is due to mutations in the ***SLC5A2* gene**, which encodes for the **sodium glucose co-transporter 2**, SGLT2 (SGLT2 is the major glucose co-transporter in the proximal tubule responsible for 90% of the renal glucose reabsorption).

Abnormal constituents of urine

3. Ketone bodies (ketonuria)

- Normally ***3-15 mg*** are excreted in urine per day.
- Ketonuria is the presence of excessive amounts of ketone bodies in urine (*acetone, aceto-acetate, 3-hydroxybutyrate).*
- This may occur in:

➢ uncontrolled diabetes mellitus

➢ prolonged starvation.

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Abnormal constituents of urine

4. Bile

- ***Bile pigments*** : appear in urine in ***hepatic, obstructive and haemolytic jaundice.***
- ***Bile salts***: Bile salts appear **only** in ***obstructive jaundice.***

5. Blood

Hematuria in: - ***blood diseases. - renal stones. - renal tumors.***

Hemoglobinuria: which is less common, is due to excessive hemorrhage in the urinary tract.

6. Porphyrin

Porphyrias: the occurrence of uroporphyrins as well as increased amount of coproporphyrins in urine .