UNORGANIZED SEDIMENT

CRYSTALS

A- IN ACID URINE

1. CALCIUM OXALATE

- Ca^{++} oxalate crystals are the most frequent observed crystals in acidic and neutral urine and slightly alkaline urine.
- They are **soluble** in HCl and **insoluble** in acetic acid.
- Most of the excreted oxalate are drived from the metabolism of ascorbate and aminoacids particularly glycine.

Causes of presence of Ca^{++} oxalate crystals:

A- These crystals are present in normal person, if :

- If the urine left to stand for sometimes or concentrated urine.
- Ingestion of ascorbic acid in high doses
- Ingestion of food reach in oxalic acid (tomatos, rhubarb, spinach, asparagus and tea).

B- Massive oxalate excretion (hyperoxaluria) may be due to:

- Ethylene glycol poisoning
- Primary hyperoxaluria (rare genetic disease).
- Pyridoxine deficiency (vit B6).
- Increased intestinal absorption of oxalates. Fatty acids are competing with oxalate for the intestinal calcium. In fat malabsorbtion, the increase of unabsorbed fatty acids mobilizes the calcium leaving the oxalate, free to be absorbed. Intestinal calcium limits the absorption of oxalate.

C- Also, Increased urinary calcium elimination (Hypercalciuria) due to:

- Increase of the fraction of the diet absorbed.
- Renal loss with a secondary increase in intestinal absorbtion.
- Idiopathic hypercalciuria.
- Excessive bone resorbtion.
- Primary hyperparathyroidism.

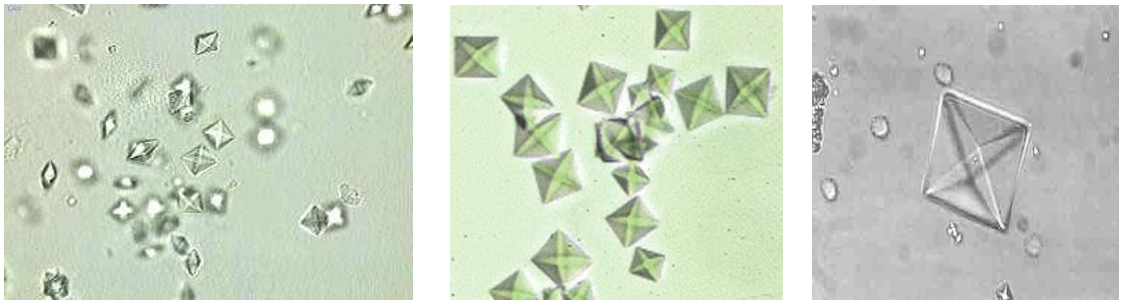
Types of Ca^{++} oxalate crystals

A- Calcium Oxalates Di-hydrate [Weddelites]

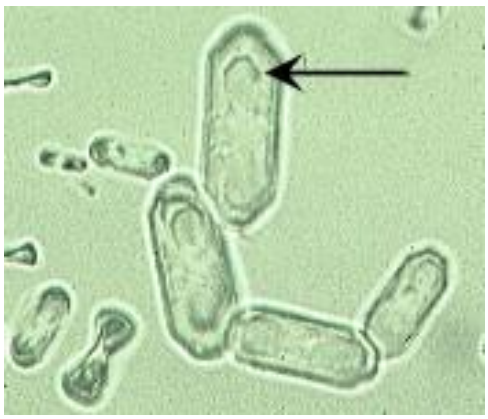
- **Shape**: The classic crystal shape is the eight-face bi-pyramid resembling mail envelope. However, The dumbbell shape is not rare.

B- Calcium Oxalates Mono-hydrate [Whewellites]

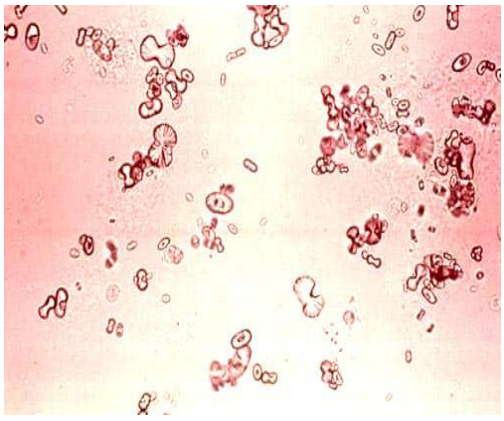
- The whewellite crystal is a **rare** form of crystallization of calcium oxalate.
- **Shape:** Oval egg shape. The dumbbell structure may be present



Ca^{++} oxalate monohydrate crystals (Mail Envelope shape)

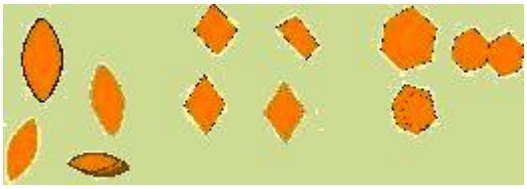


Ca^{++} oxalate monohydrate Crystals

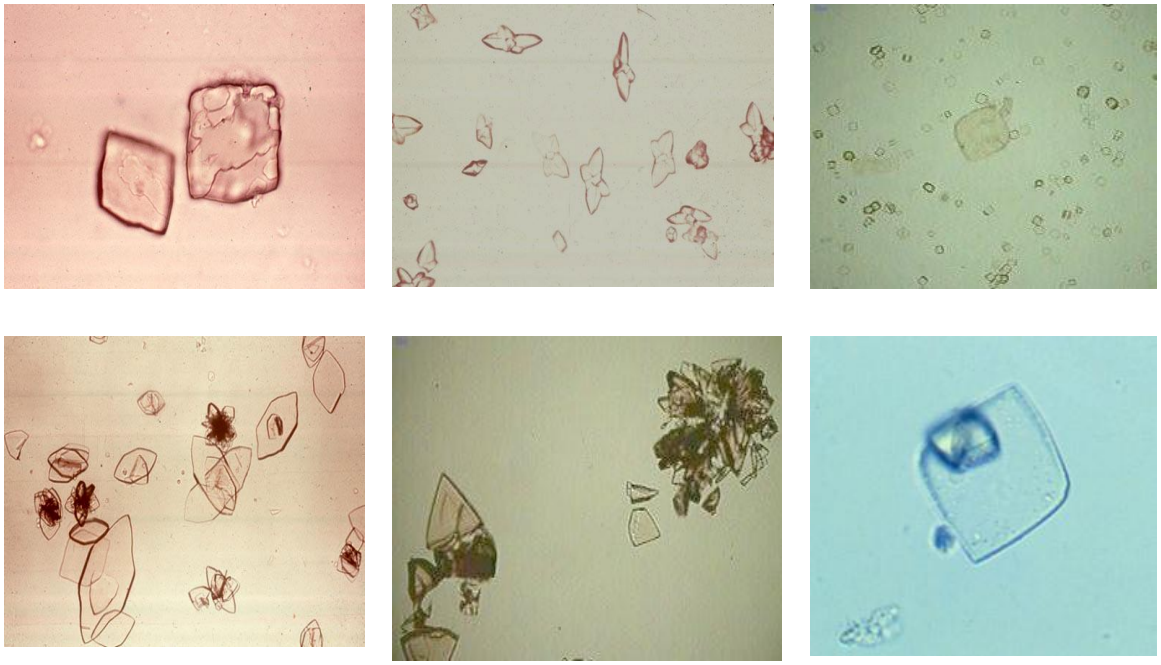


Ca^{++} oxalate monohydrate crystals (Dumbbell Shape)

2. URIC ACID



- **Shape:** Uric acid crystals are the most pleomorhic of all urine crystals and can appear under several shapes. The classic crystals are thin **rhomboid** shaped plates with more or less eroded tops. The other forms are the **prisms**, **hexagons**, **plates, needles and rossetts**.
- Easily **dissolved** by heating.
- They are **soluble** in NaOH (alkaline media), but **insoluble** in HCl.
- They are associated with **renal stones**, but their presence in normal person is common.
- Uric acid crystals usually have a characteristic **yellow color**. The intensity of the color depends on the thickness of the crystal, thus very thin plates seem colorless, while the massive crystals have a color that tends to be **brown**.

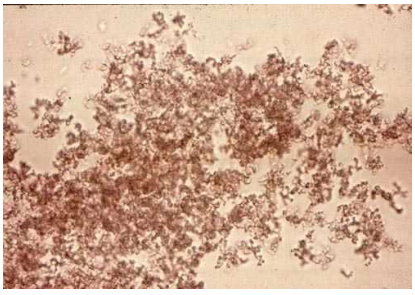
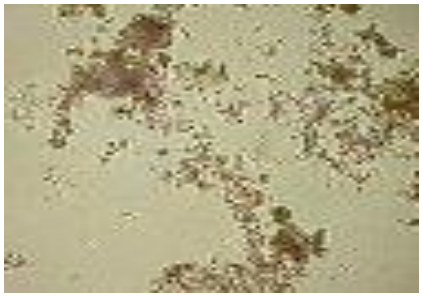


Uric Acid Crystals

Amorphous urates

- Both Sodium and Potassium urates.
- Amorphous urates are of little clinical value.

- Sodium urates are often in the form of **thorn apples**.
- The amorphous urates seen in urine specimens and are, most of the time, the result of **refrigeration**.
- Under the microscope, amorphous urates appear as yellow-brown mass of small rounded particles.

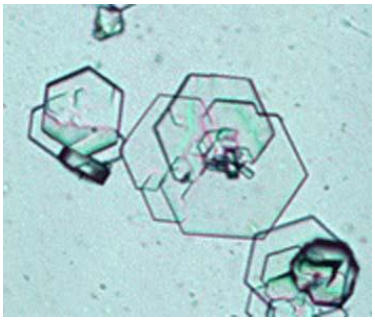
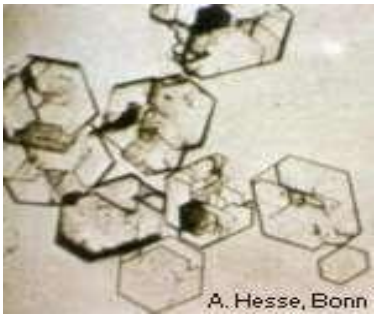
Amorphous urates

3. CRYSTAL OF ABNORMAL METABOLISM

Include: Cystine, cholesterol, leucine, tyrosine and bilirubin

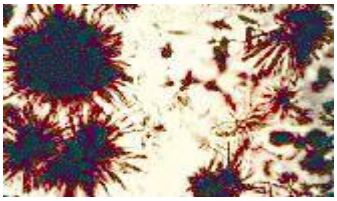
A. Cystine. Crystals

- The cystine is seen as colorless highly refractile **hexagonal** plates.
- These colorless crystals can be difficult to distinguish from the hexagonal plate form of uric acid crystals.
- **Soluble** in HCl but **insoluble** in acetic acid. The solubility of the cystine is much larger in alkaline urine, with the result that the former is rarely found in alkaline urine.
- When present they are diagnostic for a rare inborn error of metabolism termed **cystinuria**, In which there's inherited disorder (autosomal-recessive trait) that prevents the reabsorption of the amino acids cystine by the epithelial cells of the nephron . It's frequently associated with cystine calculi.

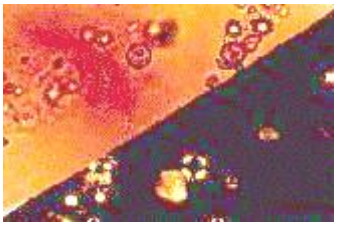
Cystine Crystals

B. .Tyrosine. Crystals



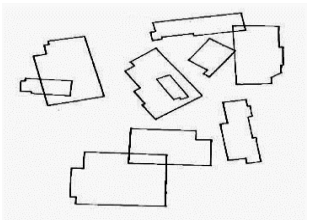
- Tyrosine crystals are fine, delicate, colorless or pale yellow elongate needles that may be single or may appear together in clusters or sheaves.
- It is one of the most difficult to see due to its relatively low refractive index.
- Tyrosine crystals in the urine are uncommon, even in sever liver disease.
- **Soluble** in NH_4OH and **insoluble** in acetic acid.

C. Leucine. Crystals



- The leucine crystals are seen as highly refractile brown-yellow spheres with concentric and radial strias.
- These crystals can sometimes be **mistaken** with cells, the central part simulating a nucleus. Under polarized light, the former presents a maltese cross interference pattern.
- They may be seen in association with tyrosine crystals.
- They are **insoluble** in ether or HCl.
- Leucine crystals commonly seen in patients with sever liver disease, such as fulminant hepatitis and advanced liver cirrhosis, as well as patients with congenital metabolic conditions.

D. .Cholesterol. Crystals



- Cholesterol crystallizes as thin rectangular plates with one of the corners (sometimes two or more) having a square notch. They often overlap or appear together.
- The presence of these crystals is normally accompanied by a **heavy proteinuria**.
- Cholesterol crystals are occasionally found in the urine sediment of patients with lipoid nephrosis, membranous glomerulonephritis, or polycystic renal disease and in patients with the nephritic syndrome (edema, lipiduria, lipidemia, hypercholesterolemia). In lymphatic obstruction due to neoplasms or parasitic disease (filariasis), chyluria may

be a consequency if the dilated lymphatics rupture into the kidney or urinary tract.

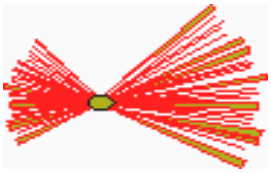
E. .Bilirubin Crystals

- Bilirubin crystals in the urine as fine short needles that regroup in a clump or as red brown granules or spheres.
- It may be difficult to distinguish from amorphous urates or phosphates. Confirmatory chemical testing (dipstick) is necessary.
- For these crystals to form, high levels of do\irect bilirubin need to be reached in the blood and urine, usually as a result of obstructive jaundice.

Bilirubin Crystals

4. OTHER CRYSTALS

Includes **Sulphonamide** crystals and **radiographic contrast media** crystals.



Acetylsulfadiazine , sulfadiazine

Yellow brown crystals
Of variable shape
Asymetric rosette

Sulfamethoxazole (seen in overdosage)

Brown spheres thin plates and rosette

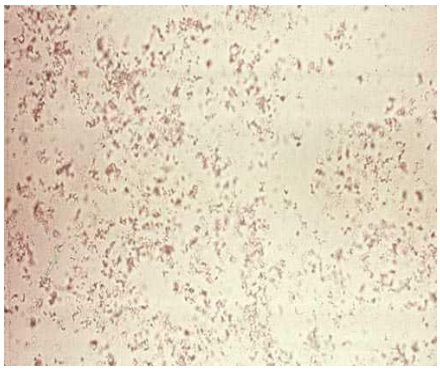
Renografin (Contrast agent)

Uncolored plates
Strongly birefringent
Mimics cholesterol

B- IN ALKALINE URINE

1- PHOSPHATE CRYSTALS

Amorphous phosphates



- Amorphous phosphates are the name given to a granular precipitate containing calcium and phosphate in **an alkaline urine**.
- Calcium phosphate crystals, regrouped under the term **apatite**, have mineralogical names that differ according to their chemical composition:
  - **$CaH_2PO_4*(2H_2O)$** → Brushite
  - **Calcium hydroxyl phosphate** → hydroxyl-apatite.
  - **Calcium bicarbonate phosphate** → Dahlite or carbonate-apatite.
- The **distinction between** amorphous urates and amorphous phosphates is often made on the **urinary pH basis**. With a simple examination of the centrifuge pellet, the precipitate of calcium phosphate is **white**, while that amorphous urate is **pink**.

Calcium phosphates

- The calcium phosphate crystals are also named di-calcium phosphate or hydroxyl-apatite. Its mineral name is brushite.
- This substance crystallizes as a long large thin irregular **prism** with one sharped end.
- Calcium phosphate crystals are **found with triple phosphates** and their clinical meaning is identical.

2- CALCIUM CARBONATES

- The calcium carbonate crystals as very small spheres. These spheres can be found alone, in pair as dumbbell shape or in four units taking a cross shape.
- Calcium carbonate crystals are rare, probably because they are difficult to distinguish from amorphous phosphates.
- They are **soluble** in acetic acid with evolution of gases.

- The clinical meaning of the calcium carbonate is the same as amorphous phosphates.

AMMONIUM BIURATE

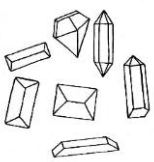
- The ammonium biurates have characteristic ox-horn projections or thorn-apple or crab-like shape. They are **yellowish-brown** and often demonstrate radial or concentric striations in a central sphere with arms or spicules radiating from it.
- These crystals are **soluble** in NaOH.
- Ammonium biurates are **rarely** seen in a <u>fresh</u> specimen. The former are found in <u>old</u> specimens that turned alkaline as they occur during ammonical fermentation.

Ammonium biurate

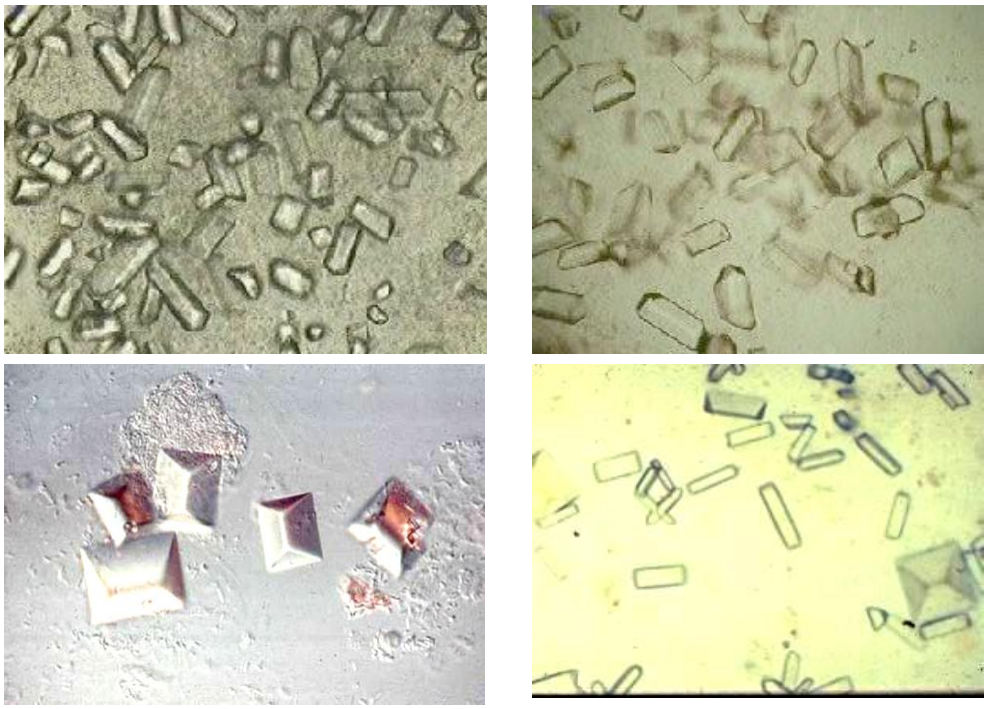
C- IN NEUTRAL URINE or slightly alkaline

1- TRIPLE PHOSPHATES (Mg^{++} NH_4 Phosphates)

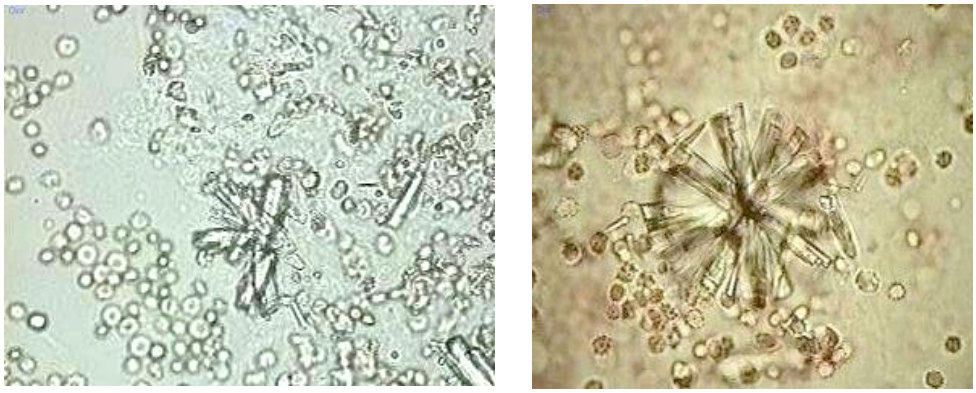
- Triple phosphates are found in **neutral** and **slightly alkaline** urines.
- The shape is usually colorless **"coffin-lid"** appearance which vary greatly in size.



- The primary factor to the triple phosphate crystals formation is the ammonia concentration. Alkalanisation of a urine specimen with ammonia generates triple phosphates while alkalanisation with NaOH does not.
- Triple phosphates are usually associated with **bacterial growth**. With a first-morning fresh specimen, triple phosphates can indicate urinary tract infection.



Triple Phosphate Crystals "Coffin-lid" shape



Triple Phosphate Crystals Fan shape

2- HIPPURIC ACID CRYSTALS

- They are usually seen as colorless, elongate **prisms** with pyramidal ends; they may also thin and needle-like.
- They are commonly present in **neutral** pH.
- Associated with diets high in fruits and vegetables containing large quantatities of benzoic acid.

MISCELLANEOUS

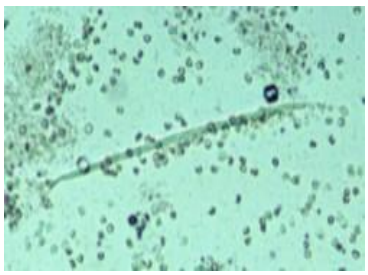
PARASITES

The Ova of Enterobius vermicularis (pinworm) are occasionally found, especially in children, and are the result of fecal contamination. The female worm lays her eggs in the perirectal region and during urine collection they may be carelessly carried into the urine collection bottle, especially if the collection is not performed under supervised and controlled conditions and the genital area has been inadequately cleaned.

The ova of Schistosoma hematobium is clear and colorless. It has a characteristic terminal spine or spike and a elliptical shape. Schistosoma eggs measure approximately 150 μ in length and 60 μ in diameter.

Trichomonas vaginalis is the most frequently encountered parasite in urine sediment is usually a contaminant from the vagina. These flagellated protozoa are **actively motile** in freshly voided urine, and have a characteristic appearbance. The body measures **10 – 30 μm** in length and typically has an **undulating membrane** and at about half its length; there are four anterior flagella.

Also, **Microfilaria** may be seen in the urinary sediment.



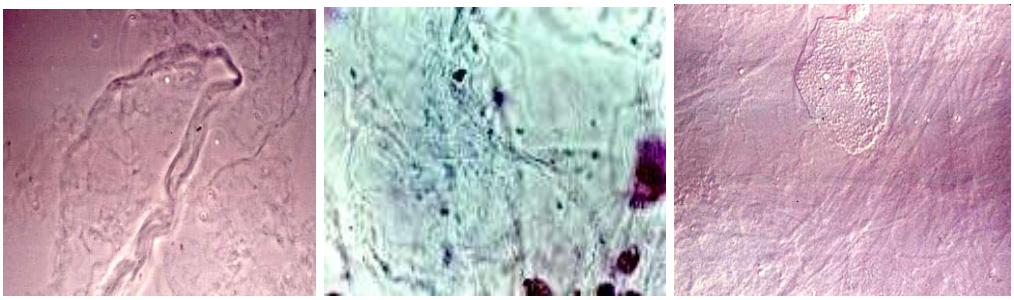
Microfilaria

SPERMATOZOA

- Urinary spermatozoa is a **contamination** after ejaculation or coitus.
- **With a male subject**, these represent a residual drainage **while with a female**, these have a vaginal contamination source.

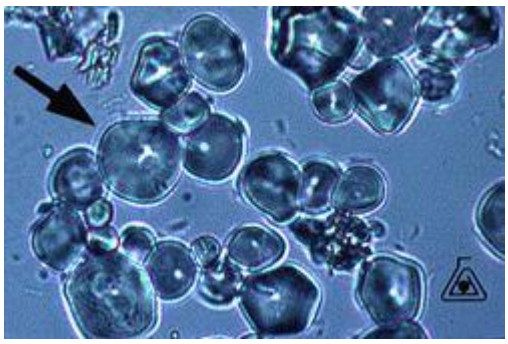
MUCUS

- Mucus is a frequent finding of the urinary sediment.
- Mucus can also **protect** the lower urinary tract against irritating chemical agents.
- Mucus forming cells are found scattered all over the urinary tract from the ascending section of the loop of Henle to the bladder. Consequently, mucus can originate from the kidney or from the lower urinary tract. Mucus originating from the kidney is made of **Tamm-Horsfall protein**. This explains the **frequent association** of mucus threads and casts. In elderly patients, mucus is a frequent finding and seems to originate from the lower urinary tract.
- In the majority of cases, presence of mucus threads is a benign situation. An irritating factor could stimulate mucus secretion.



Mucus

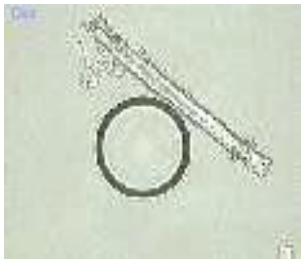
ARTIFAFCTS



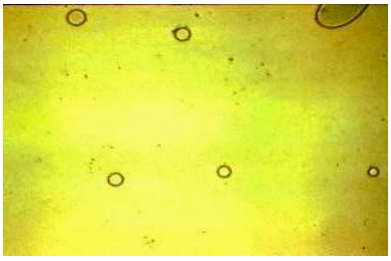
Starch

Pollens and Spores

Fiber



Air Bullae



Air Bullae

URINE ANALYSIS FOUND IN COMMON URINARY SYSTEM DISEASES

DISEASE	Diagnostic physiochemical findings (Macroscopic Urinalysis)	Diagnostic urinary sediment findings (Microscopic Urinalysis)
Acute glomemlonephritis	- Decreased urine volume - Increased turbidity (smoky) - Proteinuria (<2 g/24 hr) - Hematuria (often gross)	**Casts:** - Erythrocytic, Blood - Pus cells - RTE casts **Cells:** - Erythrocytes (often dysmorphic) - RTEs - Occasional pus cell
Nephrotic syndrome	- Lipiduria - Significant Proteinuria (>4.5 g/24 hr)	**Casts:** Fatty and waxy casts **Cells:** lipid-laden RTEs Refractile **oval-fat bodies**
Chronic glomemlonephritis	- Occasional lipiduria - Decreased & fixed sp. Gravity - Proteinuria (>2 g/24 hr) - Hematuria	Pathological casts, especially broad types
Acute tubular necrosis	- Decreased urine volume - Decreased specific gravity - Minimal Proteinuria - Hematuria	**Casts:** pathological casts **Cells:** Intact and necrotic REs cells RE fragments
Acute pyelonephritis (tubulointerstitial inflammation)	- Occasional odor - Increased turbidity - Minimal Proteinuria - Positive nitrite reaction	**Casts:** Pus cell, bacterial, granular &waxy. **Cells:** Pus cells in clumps and RTEs
Diabetes mellitus	- Proteinuria - Glycosuria - Ketonuria	**Casts:** Fatty and waxy casts **Cells:** REs and pus cells **Oval fat bodies**
SLE	- Proteinuria	**Casts:** Pathological casts **Cells**: REs, pus cell, RBCs
Cyslinosis	- Minimal proteinuria OR - Hematuria	**Cystine crystals**
Acute allograft rejection	- Decreased urine volume - Minimal Proteinuria - Hematuria	**Casts:** REs casts **Cells:** REs cells, lymphocytes
Viral nephropathy (cytomegalic inclusion disease)	- Minimal Proteinuria - Hematuria	**Mononuclear cells** (occasional giant cell forms) with prominent intranuclear or cytoplasmic **inclusions**
Bacterial lower UTI	- Occasional odor. - Increased turbidity - Positive nitrite reaction - Occasional Hematuria	**Bacteria** **Cells:** Pus cells, TEs Absence of cast formation
Fungal UTI	- Increased turbidity - Occasional Hematuria	**Fungi** **Cells:** - Pus cells (neutrophils) - Lymphocytes - Reactive TEs
Viral UTI	- Occasional hematuria	**Viral inclusion bodies** **Cells:** Pus cells, TEs
Eosinophilic cystitis	- Hematuria	**Cells:** - Eosinophils (numerous) - Reactive transitional epi. cells Absence of cast formation
Transitional cell carcinoma	- Hematuria	Increased No. of **malignant transitional epithelial cells** with high N/C ratio, **hyperchromasia**, and **chromatin clumping**; cells appear singly and as tissue fragments