MICROSCOPIC EXAMINATION THE URINE: **CRYSTALS**



Crystals Found In The Urine Sediment

Normal Acid Crystals

Amorphous urates Uric acid

Acid urates

Monosodium urate or sodium urates Calcium oxalate (also neutral and alkaline urine)

Normal Alkaline Crystals

Amorphous phosphates Triple phosphates Ammonium biurate Calcium phosphate Calcium carbonate

Abnormal Crystals of Metabolic Origin

Cystine Tyrosine Leucine Cholesterol Bilirubin Hemosiderin

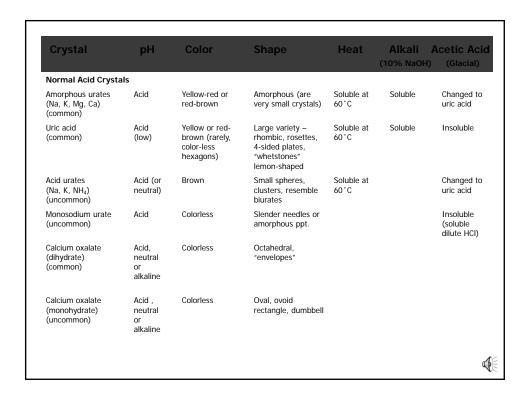
Abnormal Crystals of Latrogenic Origin (Drugs)

Sulfonamides Ampicillin

Radiographic contrast media

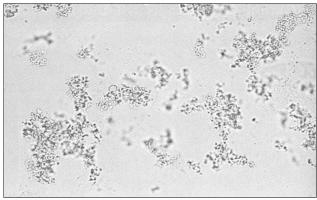
Acyclovir





Amorphous Urates

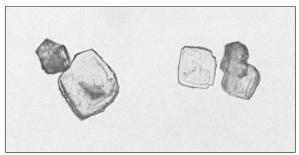
- · Yellow-brown color
- Found in acidic urine with pH > 5.7
- Forms pink precipitate upon refrigeration (uroerythrin accumulates on surface of crystal) "brick-dust"
- · Precipitate redissolves when warmed or alkali added



Amorphous urates X400

Uric Acid Crystals

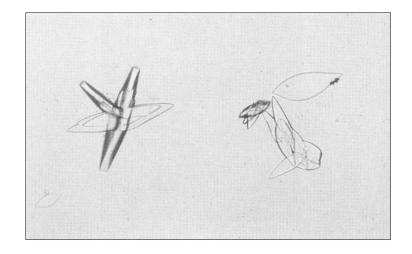
- Rhombic, 4-sided shapes, rosettes,...
- Found in acidic urine with pH < ~5.7
- Usually yellow-brown
- Birefringent
- Associated with increased purine metabolism



Uric acid, whetstone shape X160



Uric Acid Crystals

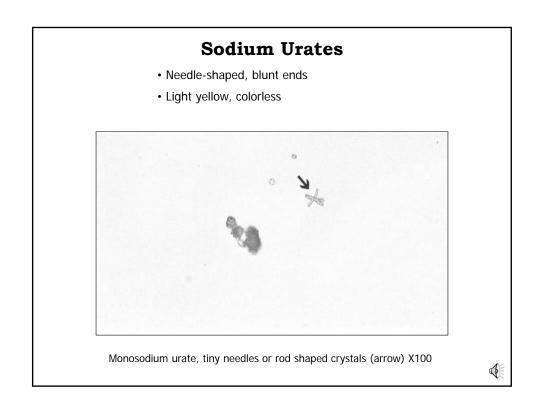


Uric acid crystals, urine sediment X100



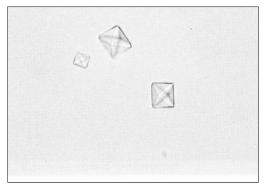
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Acid Urates • Granules with spicules • Brown Acid urates X400



Calcium Oxalate Crystals

- · Seen in urine of any pH
- Dihydrate → octahedral (2 pyramids joined at base) most common form
- Found in 67% of renal calculi in US
- · Associated with a diet rich in oxalic acid

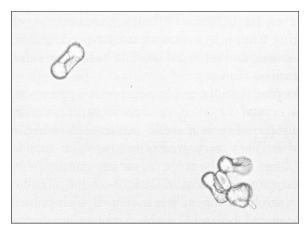


Calcium oxalate, three typical octahedrals, X160

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Calcium Oxalate Crystals

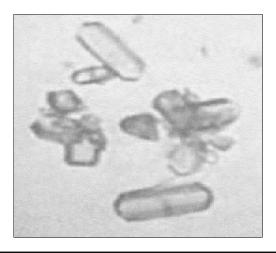
- Monohydrate form → oval or dumbbell
- Found in ethylene glycol poisoning



Calcium oxalate, rare large ovoid form, X400

Hippuric Acid Crystals

- Elongated needles, prisms
- Yellow-brown or colorless
- Found in high vegetable diets

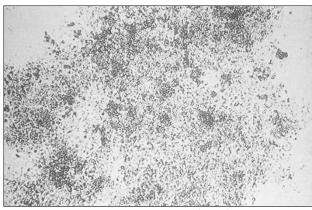




Crystal	pН	Color	Shape	Heat	Acetic Acid (Glacial)
Normal Alkaline Crystals			•		
Amorphous phosphates (Mg, Ca) (common)	Alkaline	Colorless	Amorphous granules	Insoluble	Soluble
Triple Phosphate (NH4, Mg) (common)	Alkaline or neutral	Colorless	3-6 sided prisms – "coffin lids" (common) flat, fern leaf, sheets, flakes (less common)		Soluble
Calcium phosphate (uncommon)	Alkaline	Colorless	Slender prisms with 1 wedgelike end, often in rosettes, flat plate (rare)	Insoluble	Soluble
Ammonium biurate (common in old urine)	Alkaline	Dark yellow or brown – like uric acid/urates	Spheres or "thorn apples"	Soluble at 60°C with acid	Slowly change to uric acid
Calcium carbonate (uncommon)	Alkaline	Colorless	Tiny spheres in pairs or fours (crosses)		Soluble effervesces

Amorphous Phosphates

- · Granular, colorless
- · Found in alkaline urine
- · Forms white precipitate upon refrigeration
- Does NOT redissolve upon warming but dissolves in acetic acid



Amorphous Phosphates (X 400)

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Triple Phosphate Crystals

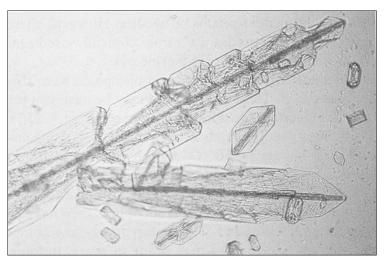
- Ammonium, Magnesium, Phosphate precipitates
- •"Coffin-lid" prism shape most common
- Can also see flat sheets or fern-leaf shapes
- Colorless
- Birefringent
- Often seen in highly alkaline urine associated with UTI



Triple Phosphate Crystal (X400)



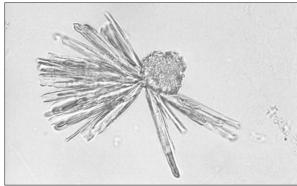
Triple Phosphate Crystals



Triple phosphate, unusual fern-leaf form of crystals going into solution, X400.

Calcium Phosphate Crystals

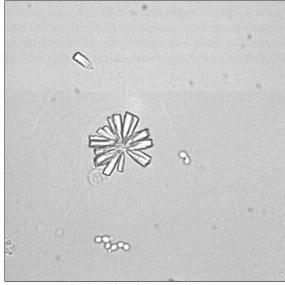
- Slender prisms with one tapered end and one blunt end
- Often arranged in rosettes
- Flat rectangular plates also seen
- Colorless
- Common constituent of renal calculi



Calcium phosphate, X400



Calcium Phosphate Crystals



Calcium Phosphate crystals, X400

Calcium Carbonate Crystals

- Small round or dumbbell shape
- Often in clumps
- Colorless
- Forms CO2 when mixed with acetic acid
- Birefringent

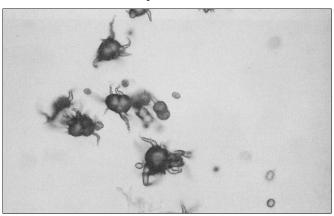


Calcium Carbonate crystals (X 400)



Ammonium Biurate Crystals

- Spicule covered spheres; "thorny apples"
- Yellow-brown
- Dissolves at 60°C
- Converted to uric acid crystals when acetic acid added



Ammonium Biurate Crystals (X 400)



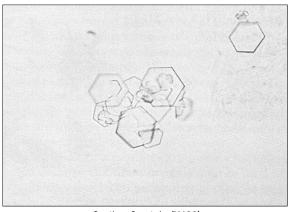
Crystal	pH	Color	Shape	Confirmatory Test
Crystals of Physio	logic (Metal	polic) Origin		
Cystine (most common physiologic/ abnormal crystals)	Acid	Colorless	Transparent, usually refractile six-sided plates. May polarize (depending on thickness)	Cyanide nitroprusside reaction—red purple color
Tyrosine (rare)	Acid	Colorless (usually appear black w/focusing)	Fine silky needles arranged in sheaves or rosettes usually occur with leucine	Nitrosonaphthol test— orange color
Leucine (extremely rare)	Acid	Yellow	Oily-appearing spheres with radical and concentric striations usually occur with tyrosine	Amino acid separation
Cholesterol (rare)	Acid or neutral	Colorless	Flat plate with corner notch (seen with large proteinuria and after refrigeration)	
Bilirubin (uncommon)	Acid	Reddish brown	Amorphous needles, rhombic plates or cubes; may color uric acid crystals	
Hemosiderin	Acid or neutral	Golden brown	Granules, in clumps, in cells, casts	Blue with Prussian blue reaction (Rous Test)

Crystal	pH	Color	Shape	Confirmatory Test	
Crystals of Iatroge	enic Origin	(Drugs)			
Sulfonamides (most common drugs seen)	Acid	Yellow to brown	Various—depends on the drug. Mimics various forms of uric acid/urates/biurates.	ics various forms of with heat and acid.	
Acetylsulfa- diazine	Acid	Yellow-brown	Sheaves of wheat with eccentric bindings		
Sulfadiazine	Acid	Brown	Dense globules		
Acetylsulfa- methoxazole	Acid	Brown	Dense spheres or irregularly divided spheres		
Ampicillin (Penicillins)	Acid	Colorless	Long slender needles, form clusters. Sheaves after refrigeration.		
Radiographic media (meglumine diatrizoate)	Acid	Colorless	Flat plates, some with corner notch like cholesterol; elongated crystals	Specific gravity >1.035 False-positive SSA protein test	
Acyclovir (rare)	Alkaline (7.5)	Colorless	Fine slender needles	Infrared analysis and/or clinical history	



Cystine Crystals

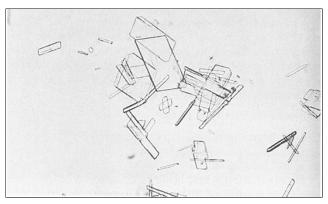
- Indicative of cystinuria or cystinosis
- Hexagonal plates but sides uneven
- Can be thick or thin; often in layers



Cystine Crystals (X400)

Cholesterol Crystals

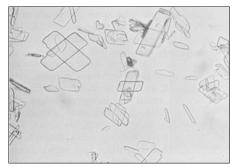
- Found in lipid disorders, nephrotic syndrome
- · Rectangular plates with notched corners
- Birefringent
- Seen in conjunction with fatty casts, oval fat bodies and protein



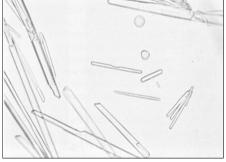
Cholesterol crystals. Notice the notched corners (X 400)

Radiographic Dye Crystals

- · Similar to cholesterol in appearance
- · Associated with markedly elevated SG



Radiographic contrast media, meglumine diatrizoate (Renografin), appearing somewhat like cholesterol, X400

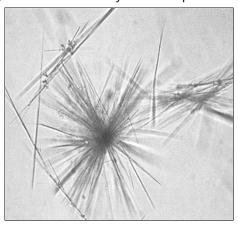


Radiographic contrast media (meglumine diatrizoate) X400



Tyrosine Crystals

- Fine needles
- Arranged in clumps or rosettes
- · Colorless to yellow
- Usually occur with leucine crystals and a positive bilirubin

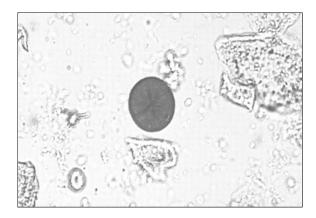


Tyrosine crystals; urine sediment; X 400



Leucine Crystals

- Yellow-brown spheres with concentric circles and radial striations
- · Usually occur with tyrosine crystals

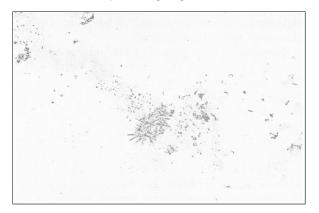


Leucine crystals; urine sediment; X 400

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Bilirubin Crystals

- Clumps of needles, granules or plates
- · Highly colored yellow to reddish brown
- Present in liver disorders producing large amounts of bilirubin in urine



Bilirubin Crystals; urine sediment; X 400

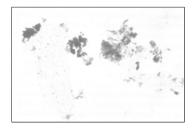


Hemosiderin

- Appears in urine 2-3 days following a severe hemolytic episode
- · Coarse, yellow-brown granules
- · Found free-floating or within cells
- · Stains with Prussian blue



Free-floating hemosiderin granules Brightfield X400

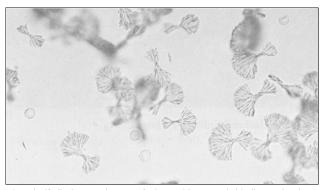


Hemosiderin granules stained with Prussian Blue



Sulfonamide Crystals

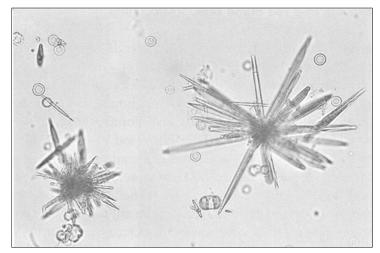
- · Sulfa drugs used in treatment of UTI
- Variety of drugs, therefore a variety of shaped crystals
- Needles, rhombus forms, sheaves of wheat, rosettes
- Colorless to yellow-brown



Acetylsulfadiazine, as sheaves of wheat with eccentric binding and red blood cells, X $400\,$

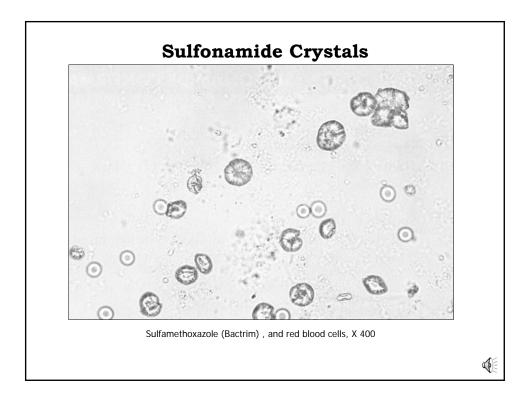
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Sulfonamide Crystals



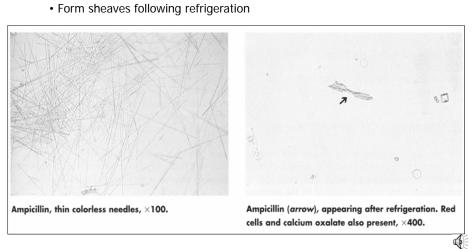
Sulfamethoxazole (Septra) rosette, and red blood cells, X 400





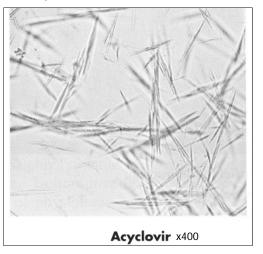
Ampicillin Crystals

- Rarely seen; found after massive doses of ampicillin and inadequate patient hydration
- Slender needles in clusters; colorless



Acyclovir Crystals

- · Rarely seen
- Acyclovir: antiviral drug for treatment for herpes simplex infections
- Found in alkaline urine
- Fine needles; colorless

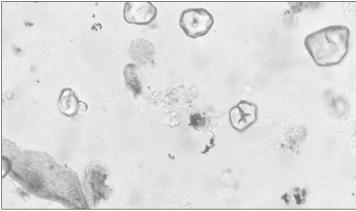


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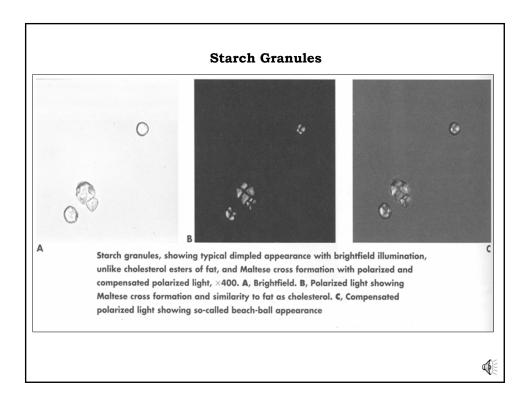
Urinary Sediment Artifacts:

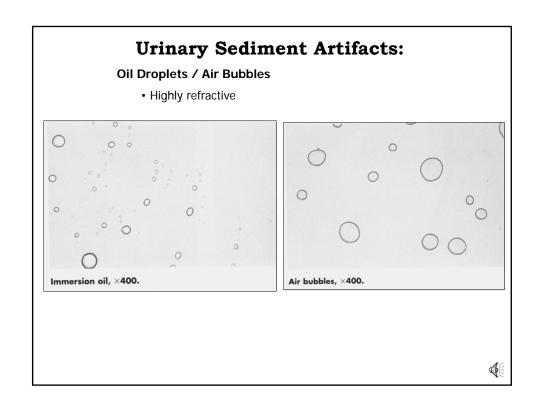
Starch Granules

- · Highly refractive
- Spherical with dimpled center
- Maltese cross formation when polarized



Starch granules, X400





Urinary Sediment Artifacts:

Glass Fragments

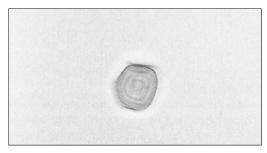


Glass fragments from coverslip, appearing like crystals, $\times 100$.

Urinary Sediment Artifacts:

Pollen

- · Seasonal contaminant
- Large spheres
- · Has cell wall and occasionally concentric circles



Pollen grain. Notice the concentric circles, X 400



Urinary Sediment Artifacts:

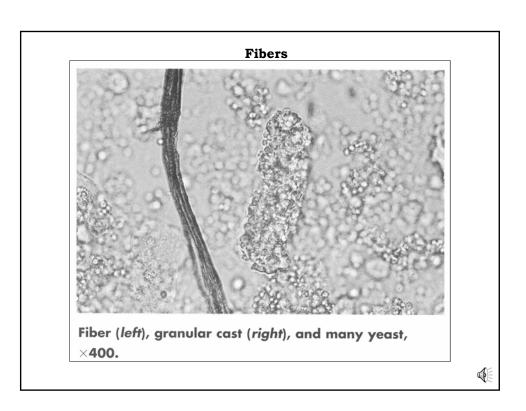
Hair and Fibers

• Similar in appearance to casts BUT longer and more refractile



Fiber, probably hair (left), waxy casts (right), Sedi-stain, X400

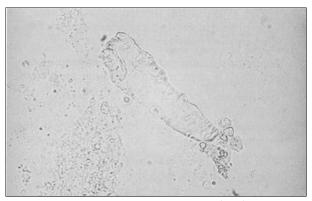




Urinary Sediment Artifacts:

Fecal Contaminants

- · Plant and meat fibers
- Brown amorphous material



Vegetable fiber resembling waxy cast (X400)



Identification Errors that Occur in the Microscopic Examination of Urine Sediment

Element Identification Error

Red blood cells Yeast, oil droplets, air bubbles
White blood cells Renal tubular epithelial cells

Oval fat bodies Air bubbles Squamous cells (folded) Casts

Transitional and RTE cells Resemble each other

Mucus threads Hyaline casts

Bacteria Amorphous urates, phosphates
Trichomonas WBCs, renal tubular epithelial cells

